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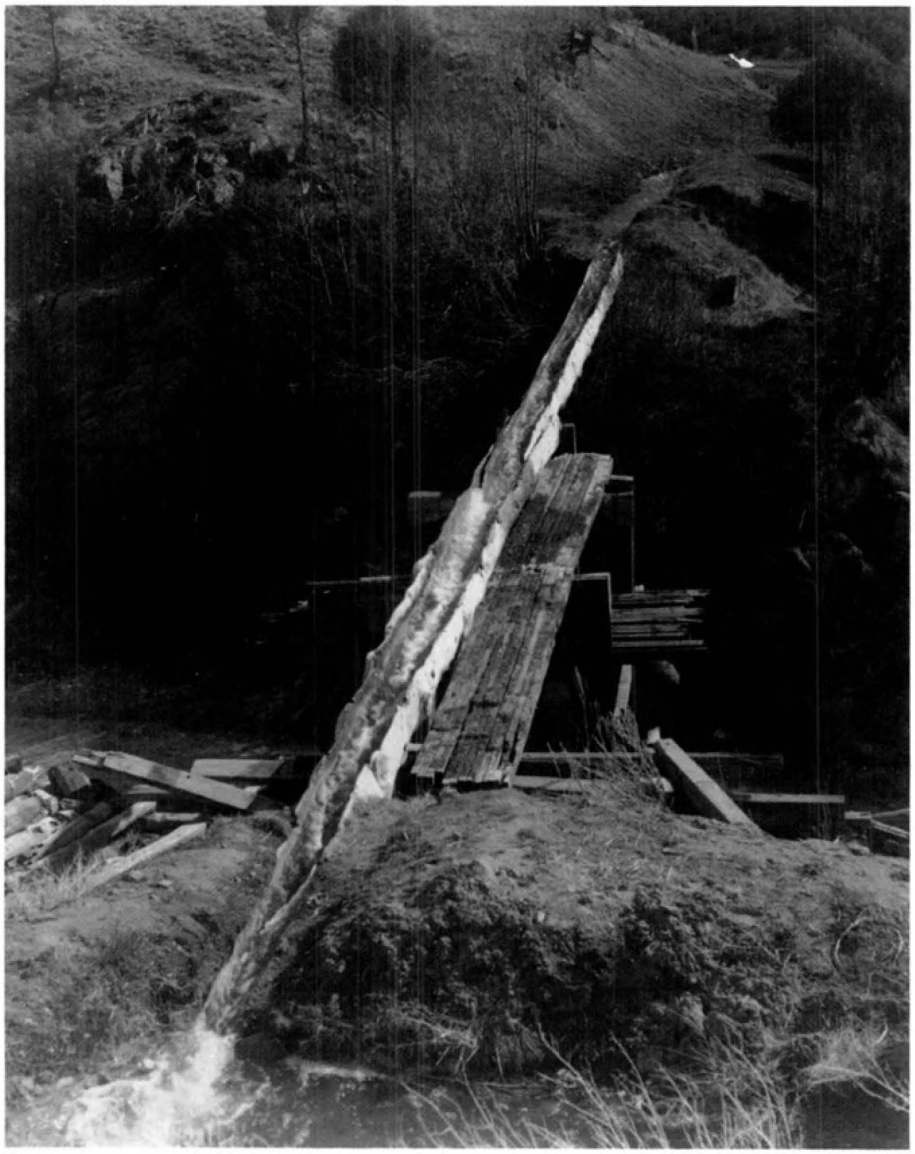
Irrigation in the Rio Grande Valley, New Mexico: A Study and Annotated Bibliography of the Development of Irrigation Systems

Frank E. Wozniak



Abstract

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This publication reviews both published and unpublished sources on Puebloan, Hispanic, and Anglo-American irrigation systems in the Rio Grande Valley. Settlement patterns and Spanish and Mexican land grants in the valley are also discussed. The volume includes an annotated bibliography.

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IRRIGATION IN THE RIO GRANDE VALLEY, NEW MEXICO

A Study and Annotated Bibliography of the Development of Irrigation Systems

by

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Prepared for

USDA Forest Service
Rocky Mountain Research Station
Ft. Collins, Colorado

September 15, 1997

The Rio Grande is the only river I ever saw that needed irrigation.

— Will Rogers

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INTRODUCTION

The purpose of this report is to describe the development of irrigation systems in the Rio Grande Valley of New Mexico from their origins until the mid 1990s (Figures 1–4). The study discusses prehistoric Puebloan irrigation, the impact of Hispanic settlement and of the rise of irrigation agriculture in the northern Rio Grande Valley during the seventeenth century, the interconnection of irrigation and land grant communities in the eighteenth and nineteenth centuries, and finally the origins and development of federal irrigation projects in the late nineteenth and twentieth centuries.

Given the vital relationship between water and settlement in all arid environments of the American West, including New Mexico, it is not surprising that the Hispanics of the seventeenth century, but particularly those of the eighteenth and nineteenth centuries, gravitated to the northern Rio Grande Valley and its tributaries. Spanish settlement depended upon irrigation agriculture for its economic base and, therefore, its survival. Extensive development and expansion of irrigation systems accompanied the introduction of community land grants into the Rio Grande Valley after the Reconquest of 1693–1696. What is surprising about irrigation agriculture in the Rio Grande Valley is its relative rarity among the Pueblo Indians before the arrival of the Spaniards. The missionaries and encomenderos imposed on the Pueblo Indians an irreversible reliance on irrigation agriculture during the seventeenth century, and this technological change irretrievably undermined and altered traditional Puebloan subsistence systems and lifeways.

When one reflects upon the universal perception that irrigation made New Mexico what it has been from the seventeenth century to the present, one is struck by the absence of any general and reliable studies of the development of those irrigation systems. Follett (1896) and Yeo (1910b, 1929) described the existing irrigation facilities in the Rio Grande Basin above El Paso and provided some information on the age of those systems, but these studies were not directed toward the question of how the irrigation systems developed. Rather, they described the systems as they then existed and detailed the growing shortage of water to supply all of them. An unpublished study of water resources in New Mexico by Linford (1956) made a beginning at a comprehensive study, but the author's interest was in developments subsequent to the American annexation of New Mexico in 1846–1848.

Consequently the present study offers a preliminary synthesis of information, the first step toward a comprehensive history of the development and growth of irrigation systems in the Rio Grande Valley of New Mexico.

RIO GRANDE VALLEY IRRIGATION BEFORE SPANISH COLONIZATION

Some common assumptions about the extent and antiquity of Puebloan irrigation can be found in all popular studies on the Pueblos as well as in most of the scholarly literature (Clark 1987:3–6; Dozier 1970:39; Hodges 1938:17; Linford 1956:1–3; Worster 1985:32–33). All Puebloan groups in the Rio Grande Valley are assumed to have been engaged in extensive irrigation agriculture before the time of the Coronado expedition (1540–1541); most studies even go so far as to assert that the Coronado expedition found the Puebloans engaged in such activity. Neither of these assertions is accurate, and neither is founded upon any scientific or documentary evidence. Nonetheless, popular and scholarly literature alike has continued for more than 50 years to assert that the Puebloans were ancient irrigators.

Recently some scholars have begun to express reservations with regard to this prevalent hypothesis (Anschuetz 1984; Cordell 1979, 1984a), but belief in Puebloan irrigation is still widespread. The principal academic proponent of the Puebloans as ancient irrigators has been Florence H. Ellis (Ellis 1970, 1979), who frequently asserted that the Rio Grande Pueblos acquired the idea and technology of irrigation agriculture from the Chacoan Anasazi (see, for example, Ellis 1979:2).

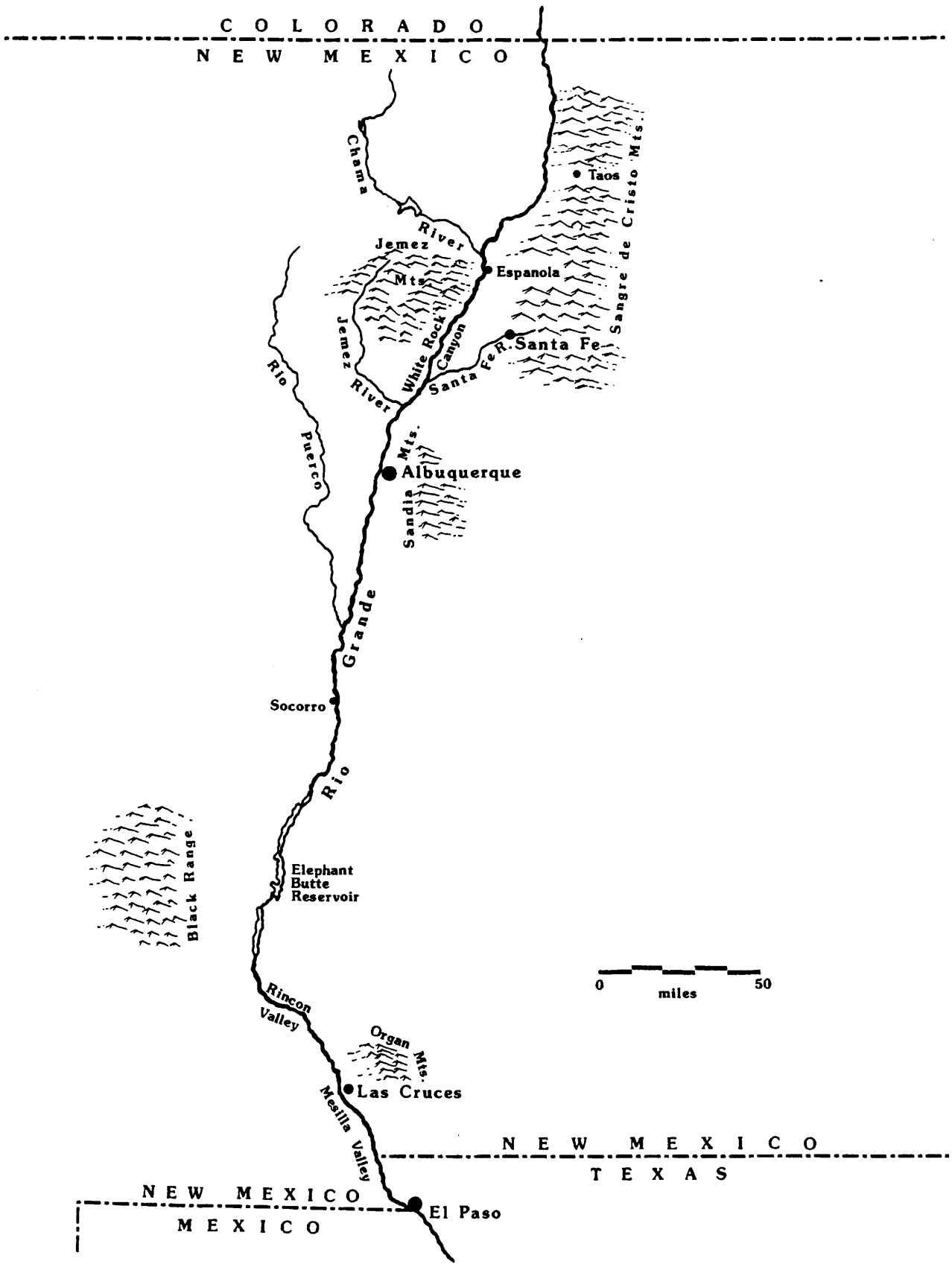

Figure 1 Rio Grande Valley, New Mexico

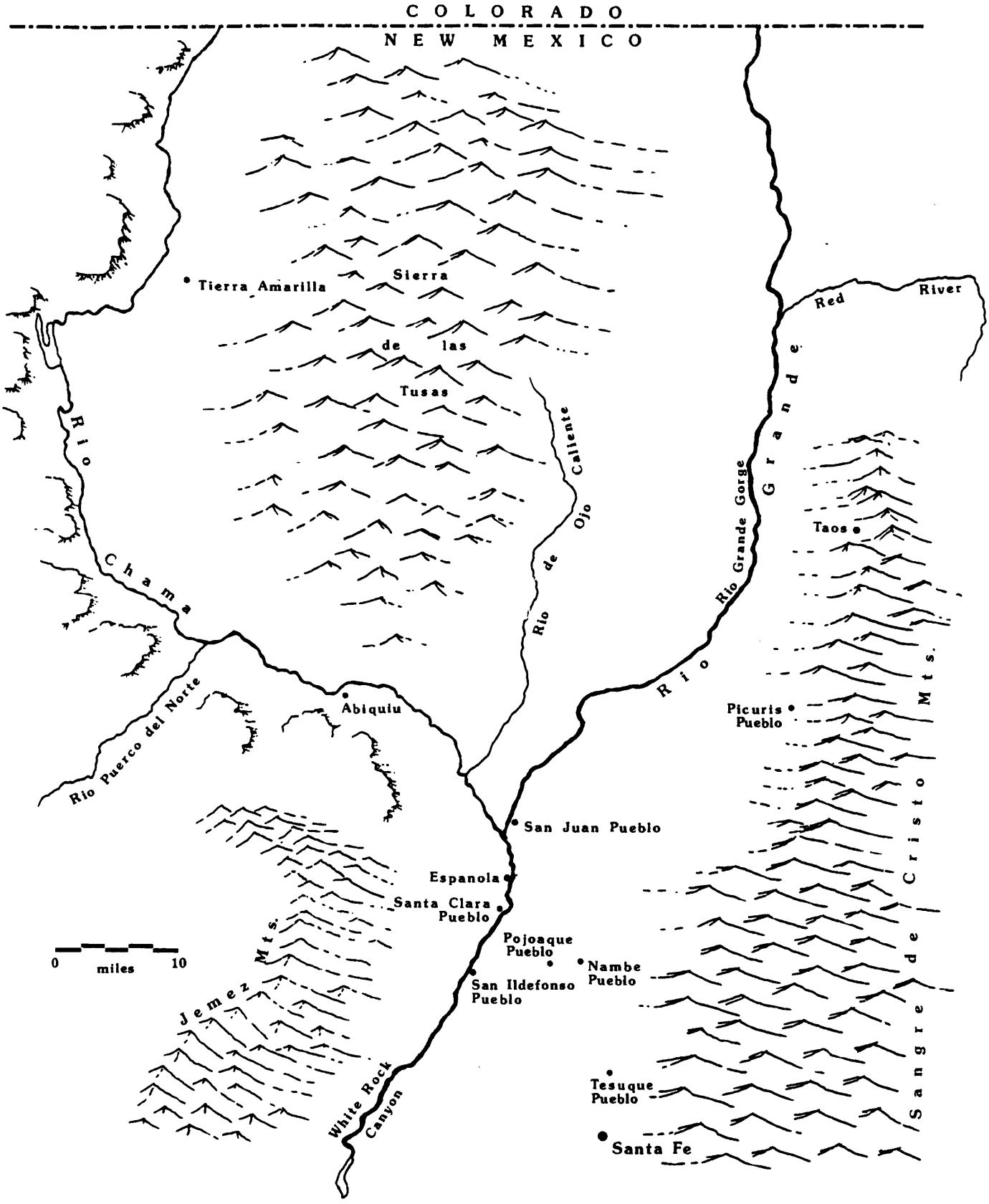

Figure 2 Upper Rio Grande Valley, New Mexico

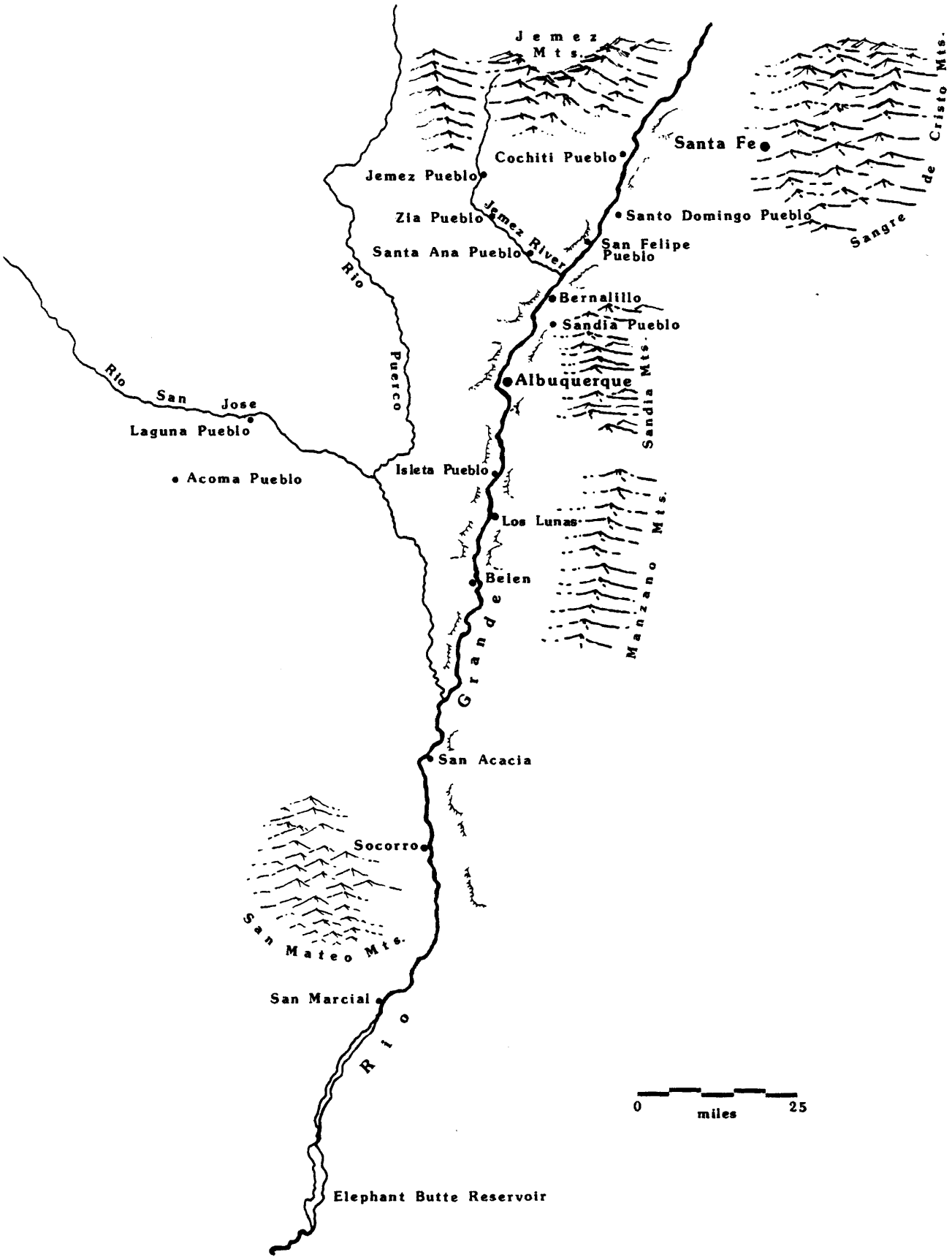

Figure 3 Middle Rio Grande Valley, New Mexico

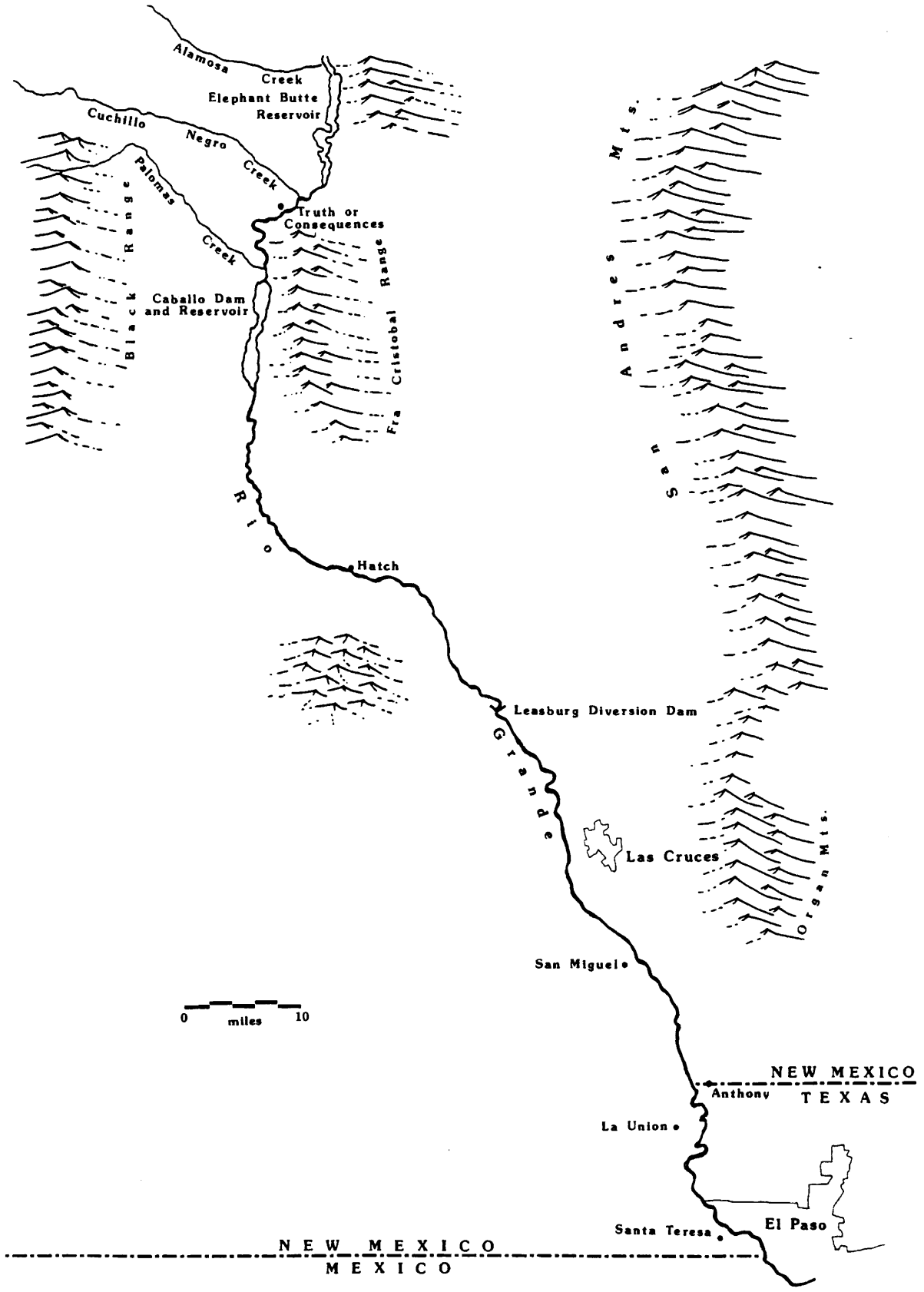

Figure 4 Lower Rio Grande Valley, New Mexico

The Chaco Phenomenon is a term that has been applied to a particularly complex and elaborate manifestation of the prehistoric Anasazi culture that flourished in the San Juan Basin of northwestern New Mexico in the tenth, eleventh, and twelfth centuries (Cordell 1984a; Vivian 1984, 1990). In response to environmental conditions that were unfavorable for agriculture, the Chacoan Anasazi invested considerable energy in soil and moisture conservation facilities such as terraces and check dams (Cordell 1984a; Vivian 1984). Actual irrigation features are much less evident. In all discussions of irrigation systems or the potential for irrigation systems one must be extremely careful to distinguish between water or moisture conservation systems, which are not irrigation systems, and water diversion systems, which are.

According to Gwinn Vivian (1974:95), the Anasazi usually opted for water control or conservation systems that did not require managerial control of water use; a possible exception could be found in Chaco Canyon. At Chaco Canyon, the Anasazi constructed facilities that were intended to control and divert rainfall runoff from the mesa tops either directly or indirectly into the northern side canyons (Vivian 1984:249–250, 1990:309–313). None of these irrigation systems are well-dated, but they do seem to have been constructed in the tenth or eleventh century (Lagasse et al. 1984:189, 207; Vivian 1984:249). Vivian notes that none of the Chacoan irrigation systems attempted to divert water from the ephemeral but flood-prone mainstream of Chaco Wash. Because of the physical characteristics of the soils and the arid environment in Chaco Canyon, serious problems developed for Chacoan agriculture as a result of the use of irrigation (Vivian 1984:252). Salinization and nutrient depletion affected the canyon soils and had a serious impact on local agriculture that depended upon irrigation. By the late eleventh century, the Chacoan Anasazi had begun to replace intensive irrigation agriculture in Chaco Canyon with more extensive agricultural systems that depended upon *akchin* or floodwater farming and to respond to degradation of canyon soils by moving to the outliers (Vivian 1984:257).

Ultimately, environmental and cultural limitations made the Chacoan system impractical and even maladaptive. Diversification of the agricultural system toward more extensive farming in the Chaco Basin during the eleventh and twelfth centuries paralleled an evolution of the Chacoan system toward decreasing complexity until the system disappeared in the thirteenth century (Vivian 1984:257).

Whatever influence the Chacoans might have exerted in the northern Rio Grande Valley of New Mexico in the twelfth and thirteenth centuries, therefore, came at a time when Chacoan farmers were abandoning irrigation agriculture because of its evident limitations. The problems of Chacoan irrigation agriculture were those that one would expect in arid to semiarid environments throughout the Southwest (including the Rio Grande Valley), where high evaporation and alkaline soils prevail.

Ellis has proposed that the Chacoans introduced and the Anasazi of the northern Rio Grande took up on an extensive scale a maladaptive agricultural system that the Chacoans were abandoning or had abandoned by the time that their alleged influences were being felt. Even if one were to accept the level of Chacoan influence for which Ellis argues—and the evidence for this influence is extremely tenuous—one would further have to accept that the Anasazi of the northern Rio Grande adopted an agricultural system that had proved to be impractical. The alleged Chacoan role in the presumed introduction of irrigation systems among the prehistoric Anasazi of the Rio Grande Valley involves many assumptions and little evidence.

What then of evidence for an independent or spontaneous development of irrigation systems among the northern Rio Grande Anasazi? Again we must return to Ellis, who is the only archaeologist to have recorded water control as opposed to water conservation features in the Rio Grande Valley dating to the prehistoric period (Ellis 1970, 1979). A careful examination of the site records at the New Mexico Historic Preservation Division reveals no other records of prehistoric irrigation systems. Steen (1977:34) reported a possible prehistoric water control system with a ditch and diversion dam on Pajarito Creek, but the irrigation facilities are not demonstrably of Anasazi construction and could as likely be Hispanic; the site records files of the State of New Mexico show that this site (LA 12701) was of unknown cultural provenience. Examination of the historical records shows that Andres Montoya received a grant of land in the Pajarito Creek area in 1739 (U.S. Court of Private Land Claims [CPLC], Case #41), and that this land was cultivated by his son-in-law, Juan Antonio Lujan. All other examinations of prehistoric Rio Grande agricultural systems (Anschuetz 1984; Biella and Chapman 1977; Buge 1984; Cordell 1979, 1984a, Earls 1986; Moore 1981; Vivian 1974) have produced considerable evidence of a variety of water and/or soil conservation features and of akchin farming but no evidence for irrigation systems. The investigators listed above describe subsistence systems that to varying degrees incorporated one

form or another of floodwater agriculture, but they do not suggest use of formal irrigation systems like those proposed by Ellis (1970, 1979).

Two ditch systems have been reported by Ellis: one in the El Rito Creek area and the other in the Pojoaque Basin (Figure 5). The ditch at Sapawe along El Rito Creek has been reported briefly in a paper given at the 1970 Pecos Conference and anecdotally in *New Mexico Magazine*. No excavation reports regarding the ditch have been produced, and the length of time since the work was done (more than a quarter of a century) and the limited information that is available make scientific assessment of the reported features impossible. Too many alternative possibilities for the origins of the ditch remain unaddressed, particularly the possibility that the ditch is simply an acequia from the late eighteenth/early nineteenth century occupation of the area. During this time period a substantial Hispanic population was settled in five plazas scattered along 7 to 8 miles of the creek (U.S. Surveyor General, El Rito Grant, Case #151). The lack of archaeological data means that the existence of an alleged prehistoric ditch at Sapawe must be considered as unproven.

For the Pojoaque Basin case, we have a more complete publication of information since Ellis's arguments were introduced in a water rights adjudication in *State of New Mexico vs. R. Lee Aamodt et al.* As primary support for her conclusions regarding alleged prehistoric ditches in the Pojoaque Basin, Ellis cited a supposed Chacoan influence on the indigenous Anasazi population in the period around AD 1200 (Ellis 1979:2). The Chacoan presence is based upon the recovery of pottery sherds with Chacoan designs during the excavation of a large thirteenth century site at Cuyamungue (Ellis 1979:1–4). No studies were made to determine whether the sherds were locally produced copies or items introduced through trade; instead the assumption of a major intrusion of foreign population was based on the presence of this Chacoan-type pottery.

Ellis's suggested prehistoric irrigation system in the Pojoaque Basin required some mechanism for the introduction of this technology. The Chacoan Anasazi would, according to Ellis, have been the only possible source of such an agricultural technology; therefore the Chacoans are suggested to have appeared *en masse* with irrigation which was adopted by the Rio Grande Anasazi. If one were to assume, as does Ellis, that every appearance of intrusive pottery types is an indication of migrations of people from the source area of the pottery to the area where the pottery is found, then one would have to suppose massive and continuous movement of peoples all over the Southwest for which there is no substantial evidence (Cordell 1984a). Migrations did occur, but Ellis has not presented convincing or testable evidence that the Chacoans moved into the Pojoaque Basin around AD 1200. Further one would have to assume that these Chacoan immigrants introduced a technology that they had already abandoned, or were in the process of abandoning, in the San Juan Basin because it was maladaptive. Ellis's hypothesis of an introduced irrigation system in the prehistoric Pojoaque Basin relies upon too many unsubstantiated assumptions for it to be seriously considered.

In addition to all the evidentiary deficiencies there are methodological considerations. Ellis assumes that the presence of potsherds in a ditch provides a reliable date for the construction of the ditch (Ellis 1979:14–18), a very questionable assumption given the well-known regime by which Indian ditches were maintained. Ditches are cleaned virtually on an annual basis by Indian populations in the northern Rio Grande Valley. The presence of sherds is thus not demonstrably associated with construction. Also the presence of sherds themselves is hardly surprising given the number of prehistoric sites in the Pojoaque Basin, which has been continuously occupied since the early thirteenth century by the ancestors of the residents of the four present-day pueblos (Ellis 1979:1–18). Ellis does not discuss the proximity of small and intermediate-sized sites to the allegedly prehistoric ditches.

Finally Ellis never undertook a systematic survey of the Pojoaque drainage in an effort to identify the locations of possibly prehistoric ditches by means of objective criteria. Rather she worked only in locations where local Indian informants asserted that ancestral Indian ditches could be found (Ellis 1979:14–18). Because these informants were parties to the adjudication, they had more than a slight material interest in its outcome. Such a circumstance does not mean that Ellis's informants did not tell the truth, but clearly there was a potential for biased information. Ellis's reliance on information provided by persons who had such a substantial interest in the discovery of prehistoric ditches is contrary to some basic premises of scientific inquiry.

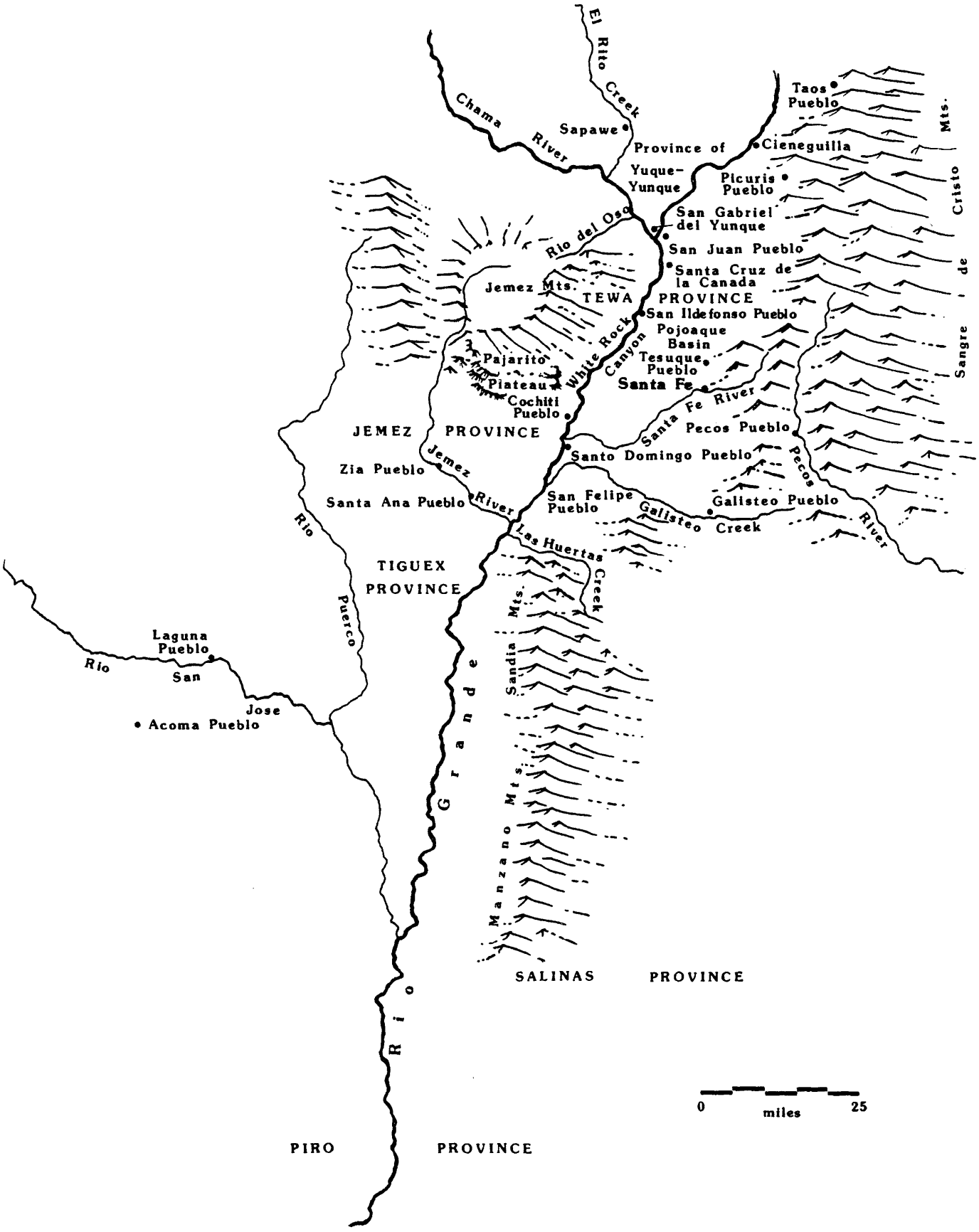

Figure 5 Rio Grande Valley in the 16th and 17th Centuries

As pointed out by Gwinn Vivian (1974:102), ditches in the northern Rio Grande Valley are difficult to date; many of those reported by informants could be post–Spanish contact acequias, either Indian or non-Indian in origin. From a late sixteenth century account, we know that the Tewas of the Pojoaque Basin had irrigation ditches in the year 1591, but there is no information as to how old those ditches were or where precisely they were located (Hammond and Rey 1966:281–283; Schroeder and Matson 1965:110–120). Nothing about Ellis's work in the Pojoaque Basin indicates with certainty that she has located any of these late sixteenth century ditches much less that she has found ditches from the thirteenth century.

If Ellis's ditches are not included, then little evidence of prehistoric diversion irrigation exists in the northern Rio Grande Valley. However, the presence of extensive soil and moisture conservation systems in this area has been documented (Anschuetz 1984; Anschuetz and Maxwell 1986; Biella and Chapman 1977; Buge 1984; Vivian 1974). At the present time it seems most prudent to assume that in the period before 1540 the northern Rio Grande Anasazi focused their energies on extensive systems of soil and moisture conservation features rather than on intensive systems such as diversion irrigation.

Several recent studies (Anschuetz 1984; Cordell 1979, 1984a; Earls 1986) have discussed some of the important problems concerning possible prehistoric ditch irrigation in the northern Rio Grande Valley. While these scholars have focused on the mainstream of the Rio Grande, their conclusions are generally applicable throughout the drainage basin. After extensive research and investigations, Anschuetz (1984:94) found no persuasive or reliable evidence that the northern Rio Grande Anasazi constructed large-scale irrigation projects before AD 1425. Anschuetz noted two references to irrigation in the Rio Grande Valley by members of Spanish expeditions: Espejo in 1582 referring to the Piros near Socorro and Sosa in 1591 concerning the Tewas of the Pojoaque Basin (see Figure 5). The paucity of such descriptions led him to believe that irrigation systems were not widespread among the Pueblos and were restricted essentially to the tributaries of the Rio Grande. Marshall (1983:137–138) suggests that prehistoric irrigation systems did exist among the Piros along the mainstream of the Rio Grande. His discussion, however, covers marginal control of floodwaters by means of brush dams, gates, and drains. These are essentially low-intensity activities that would have diverted the side flows of the Rio Grande for what is best described as subirrigation and not direct diversion irrigation agriculture on the floodplains.

Earls (1986:170–171) follows Marshall to a certain degree but provides a more precise hypothesis concerning the nature of floodplain agriculture among the prehistoric and early historic Piros. Piro agriculture was carried out in fields near the large Pueblos, she suggests, on sandy areas and marshes with numerous small diversions of water (Earls 1986:166–170). According to Earls (1986:180) the evidence points to temporary and expediently constructed ditches and diversion dams rather than to permanent irrigation systems—a response to the inherent drawbacks as well as benefits of floodplain agriculture. What Earls has described is a moderately elaborated form of floodwater farming rather than intensive irrigation agriculture. She notes that irrigation agriculture, with its emphasis on increased intensity of agricultural production, was adopted by the Piros only after they were missionized by the Spaniards in the 1620s; before that time, the Piros pursued an expansive and diverse subsistence strategy (Earls 1986:178–181).

Cordell (1984a:203) correctly points out that the Rio Grande as a source of water and the agricultural potential of the Rio Grande floodplain have often been favorably characterized. Yet prehistoric agriculturalists faced certain constraints in their utilization of the Rio Grande Valley: floods, which were frequent and devastating; salinization, which is inherent in all irrigation systems in desertic environments; dense vegetation, which would have severely restricted the amount of available arable land; and disease and insects, which are associated with stagnant water (Cordell 1984a:204). Cordell could also have mentioned the presence of heavy clay soils for which Anasazi agricultural implements were not well suited; Espejo in 1582 (Hammond and Rey 1966:172, 220–221) noted that the Piros farmed the sandy soils of the bottomlands, soils to which Anasazi tools were adapted by centuries of success in akchin farming.

In the northern Rio Grande Valley, the Anasazi developed an extremely successfully and diversified subsistence strategy that combined floodwater farming with hunting and gathering (Anschuetz 1984:96; Cordell 1984a:204). Soil and moisture conservation systems were developed as a response to moisture deficiencies and other climatic and topographic factors associated with agriculture in a semiarid environment (Bandelier 1892:37–73; Biella and Chapman 1977:301–309; Cordell 1984a:205–207). Contour terraces, grid gardens, check dams, and gravel mulch gardens were part of an extensive agricultural strategy that largely eschewed labor-intensive irrigation development. Some late

prehistoric irrigation systems were constructed but only in a very few places and only among a small number of Puebloan groups (Hammond and Rey 1966:170, 220–221, 281–283).

Records from the sixteenth century Spanish expeditions into the greater Southwest show that irrigation agriculture was found among some of the indigenous peoples of this region. The Coronado (1540–1541) and Ibarra (1563–1564) expeditions observed irrigation agriculture in several of the river valleys of present-day Sonora (Hammond and Rey 1928:159–164, 173; 1940:296–297). These protohistoric Sonoran farmers used canals to irrigate their fields in the bottomlands of the Rio Yaqui and Rio de Sonora. Riley (1982:35) concludes that the "Serrana area in the sixteenth century had an economy based firmly on irrigation agriculture."

The participants in the various Spanish entradas who produced reports or narrative accounts were cognizant of the primitive irrigation systems and appear to have reported them whenever they were observed. They also provided brief assessments of the agricultural potential and productivity of most regions that they visited. An analysis of the records of Spanish expeditions into present-day Sonora demonstrates their attention to local conditions and their abilities to discriminate among types of agricultural systems (Hammond and Rey 1928, 1940). The mere report of abundant crops in the greater Southwest by a Spanish witness does not necessarily mean that irrigation was being used; the Spaniards appear to have specifically reported irrigation systems when they were present. They were vitally interested in the economic potential and level of sociopolitical organization in every region that they visited; the presence of irrigation agriculture and/or abundant crops would have an important effect on any assessment of a region's suitability for incorporation within the territories directly governed by representatives of the king of Spain.

The Spaniards were aware that some areas could produce abundant agricultural products in an arid or semiarid environment apparently without the benefits of irrigation (Hammond and Rey 1940:182–183, 223–257, 299–300, 309–310). While it would be a mistake to assume that the surviving reports of sixteenth century Spanish expeditions enumerate every irrigation system that existed in Sonora and New Mexico, it would also be erroneous to propose that the mere reference to an abundance of crops indicates the existence of irrigation agriculture. The Spaniards did not fall into that trap and we should avoid it as well.

The records of the Coronado Expedition (1540–1541) are silent on the question of irrigation agriculture among the New Mexican Pueblos (Hammond and Rey 1940:182–183, 252–257, 299–300). The Coronado expedition visited some, though not all, Puebloan areas (Zuni, Acoma, the Tiguez province, and Pecos) for a sufficient time to have observed the local agricultural system, and brief visits were made to yet other areas (the Keresan pueblos, the Jemez province, the Tewa province of Yuque-Yunque, and the Galisteo pueblos). The Spanish respondents universally noted the abilities of the Puebloans as agriculturalists and the abundance of their crops (Hammond and Rey 1940:182–183, 252–257, 309–310), but not once did any of the Spaniards report the presence of an irrigation system of any sort among the New Mexican pueblos, even though these same persons had observed and reported irrigation in the Sonora region. Consequently one must conclude, in the absence of any evidence to the contrary, that irrigation agriculture was either not practiced or practiced only to an insignificant and inconsequential degree among the New Mexican Pueblos in the first half of the sixteenth century.

The Spaniards did not again visit the New Mexico region until the latter part of the sixteenth century, some 40 years after the initial expeditions. A series of expeditions entered the Rio Grande Valley during the decade from 1581 to 1591 and reported on conditions among the New Mexican Pueblos (see Figure 5). No one expedition visited all of the Puebloan provinces, and none actually visited Taos, Picuris, or the Jemez province. While the information from these expeditions is not wholly corroborative, a sufficient degree of overlap exists in order to draw some conclusions regarding Puebloan irrigation systems in the greater Rio Grande Valley during the late sixteenth century.

The Rodriguez-Chamuscado expedition (1581) traversed the Piro province, the Tigua province, and the Galisteo Basin and visited the Salinas pueblos, Cochiti, Zia, Santo Domingo, Acoma, and Zuni (Hammond and Rey 1966). The report of this expedition by Hernan Gallegos is less than satisfactory with regard to information on Puebloan agriculture, but it does not mention the presence of irrigation among the Pueblos. In 1600 Martin de Pedrosa made a list of the pueblos in the provinces explored by Francisco Sanchez Chamuscado (Hammond and Rey 1966:115–120). Pedrosa extracted the information from the papers of Francisco Dominguez, which evidently contained information on the Chamuscado expedition that has subsequently been lost. The Pedrosa list provides the first positive evidence of irrigation in the Rio Grande Valley during the sixteenth century. On the right bank (i.e., the eastern bank) of the Rio Grande, in the area north

of present-day Bernalillo and near the confluence of the Rio Grande and the Jemez River, Pedrosa reported the existence of a small pueblo. Near the pueblo was "a stream of water with which the natives irrigated their cornfields" (Hammond and Rey 1966:118). This stream is probably Las Huertas Creek, which enters the Rio Grande from the east between Bernalillo and San Felipe Pueblo. Las Huertas Creek drains the northern end of the Sandia Mountains and was a permanent stream until its upper reaches were dammed and diverted in the twentieth century; it is the only stream entering the Rio Grande from the east below the Santa Fe River that has been permanent in historical times.

The Espejo expedition (1582–1583) visited the Piro province, the Salinas province, the Tigua province, the Keresan pueblos, Acoma, Zuni, the Hopi province, the Tanoan pueblos of the Galisteo Basin, and Pecos. In his account of this expedition, Diego Perez de Luxan almost always noted the abundance of the crops produced by the various pueblos and the quantities of food that were stored (Hammond and Rey 1966:153–212). Luxan reported irrigated cornfields along the Rio de San Martin (possibly the Rio San Jose or Rio Cubero), with canals and dams that looked as if they had been built by Spaniards (Hammond and Rey 1966:182). The Espejo expedition passed through this valley on the way from Acoma Pueblo to Zuni. In the Zuni region, Luxan noted that a quarter of a league (some one-half to two-thirds of a mile) from the pueblo of Hawikuh there was a large marsh with many water holes from which the natives irrigated some cornfields, apparently using two canals that tapped the marsh (Hammond and Rey 1966:186).

In his report, Capt. Antonio de Espejo reported that the Puebloans of the Piro province grew an abundance of corn, beans, calabashes, and tobacco (Hammond and Rey 1966:220). He noted that the Piros depended upon rain or irrigated by means of ditches, utilizing sandy stretches of Rio Grande bottomlands that were naturally adapted for the production of abundant corn crops (Hammond and Rey 1966:220). Captain Espejo also reported that the fields of Acoma were located two leagues from the pueblo near a medium-sized river (unnamed in Espejo's account). He described the Indians as irrigating their farms with small streams of water that were diverted from a marsh near the river (Hammond and Rey 1966:224). Espejo also noted Puebloan settlements that produced abundant crops even when he did not associate that production with irrigation. It is interesting that Espejo did not characterize the irrigated fields at Acoma as being particularly productive as he had those of the Piros.

In 1590 and 1591, Gaspar Castaño de Sosa led an expedition into New Mexico visiting Pecos, the Tewa province, the Keresan pueblos along the Rio Grande, and the Tanoan pueblos of the Galisteo Basin. In a region that neither the Chamuscado nor the Espejo expedition had visited, Sosa reported the existence of irrigation canals (Hammond and Rey 1966:281–283). After leaving Pecos on January 7, 1591, Sosa visited a series of Tewa pueblos in the Santa Fe region and the Pojoaque Basin. He reported that all six of the pueblos that he visited after his departure from Pecos had canals for irrigation; these pueblos were Tesuque, Nambe, Pojoaque, Cuyamungue, Jacona, and another unidentified pueblo. The Pueblo of San Ildefonso, which was visited on January 11, 1591, also had fields under irrigation and was the only one of several Tewa pueblos along the Rio Grande itself reported as having irrigation canals. Though other pueblos were described as having produced and stored considerable quantities of food, only those visited by Sosa between January 7 and 11, 1591, were described as having irrigation canals.

Collectively the reports of the Chamuscado, Espejo, and Sosa expeditions provide some interesting details regarding the existence and extent of Puebloan irrigation systems in the late sixteenth century. They do not, however, provide any information about the antiquity of such systems. The accounts are remarkably consistent with regard to the geographical circumstances in which irrigation was practiced. With the apparent exception of the Piro province, which will be treated below, the Puebloan irrigation systems recorded in the late sixteenth century were all located along or in association with what can be identified as small permanent streams or marshes. Las Huertas Creek, the Rio San Jose or Rio Cubero, and the Rio Pojoaque and Rio Tesuque are all small permanent streams that flood in the spring but are otherwise characterized by constant but low flows; such conditions would have posed only minimal engineering difficulties for Puebloan farmers wishing to utilize these streams for irrigation. While some (e.g., Schroeder and Matson 1965:120) have proposed that the San Ildefonsos used the Rio Grande for irrigation, nothing in Sosa's account necessitates the conclusion that the irrigation water came from the Rio Grande rather than the Rio Pojoaque. At Zuni and along the Rio San Jose, marshes were tapped for irrigation, again a process posing minimal engineering problems for Puebloan irrigators.

In the case of Piro irrigation, Earls (1986:166–171) has provided the best analysis of the Piro agricultural system. First, as Espejo states, Piro agriculture depended as much on rainfall as on irrigation; various forms of dry farming, including floodwater farming, appear to have been at least as important as irrigation agriculture in which water was diverted by

means of dams and ditches. Even where ditch irrigation was practiced, Earls (1986:180) concludes, the irrigation facilities were of a temporary and expedient variety. Piro irrigation is best characterized as an elaborated version of floodwater farming that utilized the side flows and marshes along the Rio Grande and not its main channel. This characterization of Piro irrigation agriculture meshes quite well with the historical documentary descriptions of late sixteenth century Puebloan irrigation.

We can conclude that irrigation was practiced by some Puebloans in the late sixteenth century, but not all Puebloan groups can necessarily be assumed to have utilized irrigation systems. The Piros, the Acomas, the Zunis, one group of Keresans, and some Tewas can be demonstrated to have had irrigation agriculture in specific circumstances. Floodwater and other forms of dry farming, however, would appear to have been virtually the exclusive form of agriculture among most Puebloan groups and to have remained a major component of the subsistence technology even among those who utilized some form of irrigation. The case of the Piros is an excellent demonstration of this mixed agricultural strategy.

Chapter 2

SEVENTEENTH CENTURY IRRIGATION AGRICULTURE

With the colonization of New Mexico by the Spaniards, irrigation and irrigation development entered into a new era in the Rio Grande Valley. The introduction of new crops, such as wheat, that required irrigation in order to produce harvests in semiarid New Mexico encouraged the development and/or expansion of Pueblo Indian irrigation systems (see Ressler 1968:10–17 on irrigation requirements to grow wheat, barley, oats, and fruit trees in the desert Southwest). The Spaniards insisted that the Indians grow these crops, particularly wheat, so that the Spaniards could obtain their customary foodstuffs even in New Mexico. At least part of the tribute that the Spanish regime required from the Puebloans was exacted in the form of wheat, so the Indians had to irrigate in order to meet these demands. Other tribute demands for foodstuffs would also push the Puebloans toward intensive (i.e., irrigation) agriculture during the seventeenth century, with considerable disruptive consequences for both Puebloan and Spanish society in New Mexico.

In 1598, when Oñate brought the first Spanish settlers into New Mexico, the Spaniards marched through the Piro and Tiguex provinces with scarcely a pause (see Figure 5). In the Keresan region, Oñate stopped long enough at Santo Domingo to accept the formal obedience of the Rio Grande pueblos before continuing north to the Tewa province. It appears that from the very beginning Oñate had the Tewa region as his goal. Sosa had reported very favorably on the area in the Memorial of 1592 (Hammond and Rey 1966:281–283), and it is possible that the potential for irrigation agriculture in the Tewa province was what encouraged Oñate to establish his headquarters and the first Spanish settlement at the confluence of the Rio Grande and Rio Chama.

On August 11, 1598, in one of the first activities initiated by the Spaniards, 1500 Puebloan laborers began the construction of an irrigation ditch for the villa of San Francisco, the Tewa Pueblo of Yuque-Yunque (Hammond and Rey 1953:322–323). This construction marked the beginning of Spanish irrigation in New Mexico and the imposition of Spanish agricultural demands on the New Mexico Pueblos. The location of this settlement violated the Ordinance of 1573 regarding the proximity of a Spanish villa to an Indian pueblo (Simmons 1972:138), and this circumstance would later play a role in the movement of the Spanish capital from San Gabriel del Yunque (so named after 1599) to Santa Fe in 1609/1610.

As noted, the nature and quantities of the Spanish tribute demands compelled the Puebloans to intensify their agricultural production; only irrigation farming could enable them to grow wheat and other European foodstuffs and to increase their production of native food crops to support themselves and the Spanish colonists. By 1600 Oñate could report that in the area of the capital at San Gabriel, the Indians harvested 1500 fanegas of wheat for the Spaniards (Hammond and Rey 1953:619–620).

Native agricultural practices did not immediately disappear. In his report of March 1601 to the viceroy, Captain Velasco stated that the Puebloans depended upon rainfall for the production of most of their maize (Hammond and Rey 1953:610). While regaling the reader with a multiplicity of self-serving and contradictory testimony on the fertility or sterility of New Mexican fields, the report of the Valverde investigation of conditions within the new colony yields a variety of information concerning Puebloan agriculture (Hammond and Rey 1953:624–668). Joseph Brondate and Manuel de Espinosa both reported that for some fields the Puebloans used irrigation but that for others they depended upon rainfall (Hammond and Rey 1953:626, 634). Espinosa's report also makes clear the broad spectrum of economic requirements that were imposed upon the Indians; in addition to supporting themselves they planted, cultivated, and harvested the Spaniards' fields at San Gabriel and tended the Spaniards' livestock (Hammond and Rey 1953:641).

The subsequent Velasco investigation (September 1601) documented the devastating impact on the Puebloan economy of the new Spanish colony (Hammond and Rey 1953:680–688). The colonists had exhausted the food supplies of the Indian pueblos near San Gabriel so that the Spaniards had to make increasingly distant forays to secure food. The witnesses testified that the Spaniards had consumed all of the natives' supplies and that many of the Indians were then starving.

The report of Fr. Juan de Escalona (October 1601) confirmed that the Spanish colonists had consumed all of the food reserves that the neighboring pueblos had built up during the 6 years preceding the arrival of the Spaniards (Hammond and Rey 1963:693). The effects of the presence of the Spanish settlers were compounded for the Puebloans in the year 1601 by adverse climatic conditions. First a drought caused the greater part of the Indians' corn crops to fail, and then a frost devastated those fields that had survived the lack of rain (Hammond and Rey 1953:696). Many pueblos harvested no grain at all. While the failure of the normal rains would not have affected all agricultural production by the Indians, it would have been particularly devastating to the corn crops since most Puebloan maize cultivation was directly dependent on rainfall; irrigation produced an insurance in case of drought (Hammond and Rey 1953:626, 634, 696). The frosts, on the other hand, would have destroyed both dry-farmed and irrigation-dependent crops.

By 1603, the Audencia in Mexico City was aware of the reports coming from New Mexico from those who wanted the colony to continue as it was and from those who wanted it reorganized (Hammond and Rey 1953:704–782). The Audencia found the reports of both sides to be exaggerated and not wholly trustworthy with regard to the characterizations of the impact of the Spanish colonists on the New Mexican pueblos (Hammond and Rey 1953:906). They determined that New Mexico had land that was suitable for farming and cattle raising, but that the region was, on the whole, not very productive; New Mexico was a land of very limited economic potential, but one in which the Spaniards should remain in order to continue the Christianization of the sedentary Indians of the Rio Grande Valley.

Direct evidence of the construction of irrigation canals can be found in the reports of the establishment of the Spanish capital at Santa Fe in 1610 (Simmons 1972:139; see also the instructions to Governor Peralta in Chavez 1929:179, 187). Two acequia madres were built to provide irrigation water for the agricultural fields of the capital, fields that would have been cultivated by Indian labor (Figure 6). Spanish irrigation techniques in seventeenth century New Mexico have been characterized as primitive owing to the scarcity of metal tools and the alleged lack of engineering expertise (Vlasich 1980:40); the results were nonetheless, adequate.

During the seventeenth century, the Spanish settlers in New Mexico survived on tribute in food and labor collected from the Puebloans under the *encomienda* and *repartimiento* systems (Scholes 1937, 1940). The Spanish missions or *reducciones* concentrated Puebloan populations into a much smaller number of pueblos than had been occupied before the arrival of the Spaniards. The reducciones were established for religious, political, economic, and military reasons and served to enhance Spanish control of and supervision over the native Indian populations (John 1974:65–67; Scholes 1937, 1940). Concentration of the heretofore scattered Puebloan settlements also enabled both ecclesiastical and secular authorities to exploit the Indian labor force more effectively and to levy tribute. Tribute demands and the reducciones themselves often drove the Puebloans to escape Spanish control by withdrawing into the mountains or joining the nomadic Indian tribes (Hammond and Rey 1953:659, 692).

Throughout the seventeenth century the Spaniards steadily increased their demands for native labor and goods while the labor force was being progressively reduced by disease and warfare (Earls 1986:192–195). Missionization appears to have produced the first of the major population declines that then continued as a result of epidemics and drought (Earls 1986:159–160). Demands for native labor by both the encomenderos and the friars along with the increasing European population placed strong pressures on the Puebloans to improve their productivity in order to supply food for both groups. These pressures led to an increased and in some cases a virtually exclusive reliance on irrigation agriculture (Earls 1986:181). The Spaniards encouraged the development of Puebloan irrigation farming not only to ensure the increased productivity that would supply them with food and to obtain introduced European crops but also because irrigation agriculture made possible the concentration of Puebloan populations in the reducciones. The friars thus intended both to increase Puebloan productivity and to maintain a newly imposed sedentism among the New Mexican Pueblos. Dry farming was replaced by more intensive agricultural strategies involving fields irrigated by artificial diversions of water through ditches. At the same time hunting virtually disappears, to be replaced by livestock herding (Earls 1986:179), and gathering of wild plants and plant products declined as the Puebloans were tied to their irrigated fields in their efforts to meet the demands of the colonists and missionaries (Earls 1986:181).

The increased and imposed sedentism among the Puebloans during the first half of the seventeenth century is described in a 1630 report by Fray Prada (Hackett 1937:108). The friar triumphantly announced the success of major efforts to "reduce" the Puebloans, to bring an end to their traditional pattern of living in different rancherias according to the

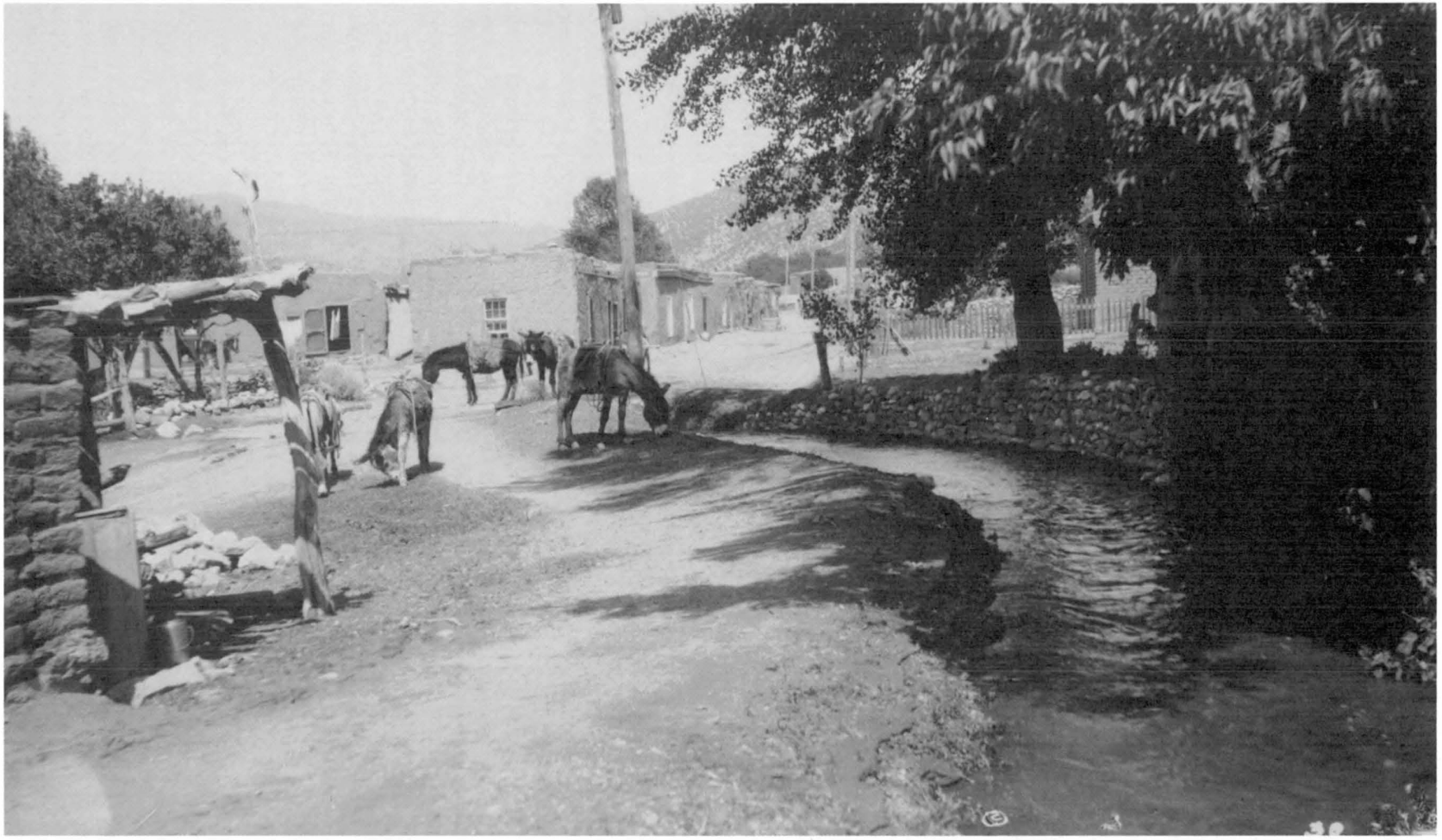

Figure 6 Burros at Acequia Madre, Santa Fe, New Mexico, ca. 1915 (Photograph by T. Harmon Parkhurst, Courtesy of the Museum of New Mexico, Santa Fe, Negative No. 11047)

seasons. In his brief characterization, Fray Prada announced the demise of the Puebloans' extensive subsistence system and the introduction of an intensive and sedentary strategy.

Agricultural intensification through irrigation was a demanding system with regard to labor, and the requirements of the system were difficult to meet owing to the decline in Indian populations. Such intensification was necessary, however, if the alimentary demands of the friars and encomenderos and the simultaneous demands for other goods and services were to be met (Earls 1986:192). Contrary to Ellis's (1970) contention that the Spaniards found irrigation widespread and flourishing in the Rio Grande Valley, it was the institution of the reducciones that produced a rapid change in the Puebloan subsistence system from expansive to intensive agriculture. This increased and heretofore unnecessary dependence on agriculture led to a decrease in hunting, gathering, and trade in subsistence goods with the nomadic tribes.

While the broad patterns of development of irrigation agriculture in the seventeenth century Rio Grande Valley are known insofar as they were related to the reducciones and encomiendas, specific information is generally scarce except for the period of the 1630s. In his Memorial of 1630, Fray Benavides discussed the fertility of the soils and the abundance of the crops among most Puebloan groups (Forrestal and Lynch 1964:39). He noted that very fine crops of wheat could be harvested merely from the stubble of the previous year without any additional labor other than a little irrigation (Forrestal and Lynch 1964:39). According to Benavides's Memorial of 1634, the Tewas suffered from famines as a result of a lack of water for irrigation until Fr. Andres Baptiste showed them how to divert water from the Rio Grande in order to irrigate their lands (Hodge et al. 1945:69). As a result of the friar's initiative the Tewas then lived in plenty. Fray Baptiste must have had considerable engineering skill; not only did he rationalize the Tewa irrigation systems by tapping the Rio Grande, he also supervised the construction of the church and *convento* at San Ildefonso.

The Petition of Fr. Juan de Prada (September 1638) summarized conditions in New Mexico during the second quarter of the seventeenth century, some two generations after the Spaniards arrived to colonize the Rio Grande Valley (Hackett 1937:108–113). According to this document, wheat was raised exclusively with irrigation; corn was cultivated with rainfall alone. The Indians were obliged to pay their tithes in grain, such as wheat, raised from seed brought from Spain (Hackett 1937:112). These crops for tithes were produced with irrigation on the farmlands of the Spaniards, i.e., on the land of the missions and the encomenderos and not on the Indians' own lands. The Pueblos were allegedly more inclined to hunt than to cultivate the land; consequently it was necessary to compel them to plant crops (Hackett 1937:113). Fray Prada's characterization of Puebloan farmers reflects the shift from traditional extensive Puebloan subsistence strategies to intensive strategies focused on sedentism and irrigation. When the Pueblos were harassed by the encomenderos, they were inclined to abandon their villages and revert to a less sedentary, more traditional way of life (Hackett 1937:111).

In his petition of February 1639, Francisco Martinez de Baeza reported that 10 to 12 Spanish farms (i.e., haciendas) were located between Senecu (south of Socorro) and Santa Fe (Hackett 1937:119–120). These haciendas produced wheat and maize crops that were irrigated with water from the Rio Grande (Hackett 1937:119). The Indians who did the work on these haciendas were apportioned among the encomenderos and paid tribute in return for Spanish military protection (Hackett 1937:120). Baeza also noted that the haciendas raised cattle and sheep (Hackett 1937:120).

Conditions began to deteriorate seriously in New Mexico in the third quarter of the seventeenth century. In 1659, the first major regionwide famine occurred (Hackett 1937:272); between 1666 and 1668 and in 1670 and 1671 famine once again struck the New Mexican Pueblos (Hackett 1937:302). In the early 1670s the suffering of the Puebloans was exacerbated by disease and the onset of devastating Apache raids (John 1975:92–95).

Economic exploitation, religious persecution, and the failure of the Spaniards to protect the Puebloans from nomadic raiders culminated in the Pueblo Revolt of 1680 (Hackett 1942:1:1–82; John 1975:96–97). After decimating the Spanish settlements and driving the remaining settlers from the northern Rio Grande Valley, the Puebloans shed Spanish religion and culture but retained Spanish crops and technology, both civilian and military (Hackett 1942:1:12–18, 1942:2:235). The continuing legacy of Spanish colonization could be seen in the residual importance of irrigation agriculture. Once the Spaniards were gone, the Pueblos quickly broke up into warring factions. In 1689, Acoma and Laguna persisted in a long-standing dispute over boundaries and water along the Rio San Jose even while the returning Spaniards sacked their fellow Keresan pueblo of Zia (U.S. Surveyor General, Pueblo of Acoma, Case B, Testimony of Bartolome de Ojeda).

Puebloan factionalism and calculated economic warfare ultimately enabled Diego de Vargas to reduce the Pueblos once again to Spanish rule between 1692 and 1694 (Espinosa 1942:85–208). Only Vargas himself was authorized to have an encomienda after the Reconquest; all other Spanish settlers were to support themselves by their own labors (Bloom 1937:371–383). Economic conditions, however, forced the newly returned Spaniards to rely upon a system of tribute in food and labor from the exhausted Pueblos that, in its operations and efforts, resembled the discredited encomienda and repartimiento system. These exactions drove most of the Puebloans into a second revolt in 1696 (Espinosa 1942:228–246; SANM II:74). The Spaniards crushed the new revolt with the assistance of those Pueblos that did not join the rebellion (Espinosa 1942:296–303). After 1697, a new economic regime was established in New Mexico, one that centered on community land grants rather than encomiendas.

Chapter 3

SPANISH COLONIAL NEW MEXICO: 1692–1821

With the reconquest of New Mexico, the Spaniards instituted a new settlement system that transformed the way they utilized the resources of New Mexico. Before the Pueblo Revolt the Spaniards had occupied New Mexico with a small number of settlers who held large tracts of land. These seventeenth century settlers grazed livestock and depended upon the Puebloans to produce surpluses of food as well as products such as woven goods, salt, and piñoñ nuts. After the Reconquest, because a secure hold on New Mexico had a higher value than extraction of economic wealth, the Spanish government made grants of land (*mercedes*) to ensure the effective occupation of New Mexico by means of self-sufficient farming and herding communities.

In place of a small number of exploitive encomiendas, which had proved to be a political, military, and economic disaster, the Spanish authorities established an ever-expanding number of land grants on which the settlers supported themselves through agriculture and stock-raising (Carlson 1971:41). In the early days after the Spanish reconquered New Mexico, a number of individual land grants were given to people who had been prominent in the Reconquest. Though given to individuals, these were not encomiendas; the recipients were expected to support themselves by their own endeavors and those of their extended families and servants (Carlson 1975:49–51; Van Ness 1979:31). Indian labor was virtually unavailable owing to the catastrophic population decline of the late seventeenth century. This decline continued at a reduced level in the eighteenth century, while the non-Indian population steadily expanded. At the same time the Spaniards were prohibited from exploiting what little Indian labor might have been available (Simmons 1969:10–12). The Indian pueblos settled into a system of local self-sufficiency under the religious but not economic supervision of the mission frairs (Adams and Chavez 1956). Most land grants in the eighteenth century were given to groups rather than individuals, in an effort to settle as many people as possible on the land and in order to provide for defensible settlements (Simmons 1969; Westphall 1983:3–23). New Mexico became a region of small, self-sufficient Puebloan and Hispanic communities, held together by fear of nomadic raids and by the necessities of mutual defense.

In order for a settlement to succeed, irrigable land was necessary (Carlson 1971:46; Ressler 1968:10–17; Van Ness 1979:31–32). The accessibility of water to cultivate bottomlands was a primary consideration in the grants of land by the Spanish government. Subsistence agriculture employing irrigation and livestock herding was the economic basis for these settlements. Consequently land grants were made primarily along the Rio Grande and the Rio Chama and their perennial tributaries. The irrigable lands on each grant were divided among the settlers, while the rest of the land was held in common for pasture and woodland (Van Ness 1979:21–44; Westphall 1983:3–23). While Spanish colonial ordinances required, and the times in which the grants were made frequently dictated, that settlements be compactly organized for defense, most New Mexican land grant settlements were straggly communities of dispersed ranchos (Simmons 1969:12–20). Formal plazas were rare, despite the threat of Indian raids. Even the villas of Santa Fe, Santa Cruz, and Albuquerque were scattered over large areas in order for farmers to live near their irrigable fields (Simmons 1969:10–12; Snow 1977:47–48).

The development of irrigation systems for agriculture was a primary consideration in the foundation or resettlement of villas after the Reconquest. Two acequia madres that had existed at Santa Fe since approximately 1610 were rehabilitated after the resettlement in 1693 (Simmons 1972:139). When the Spaniards resettled Santa Cruz de la Cañada in 1695, they dispossessed the Tanoan residents and took over their irrigation system (CPLC, Cases 110 and 194; SANM I:882). At Albuquerque in 1706, one of the first tasks of the new settlers was the construction of acequias (Hackett 1937:379; SANM II:124).

It is true that an atmosphere of expediency surrounds the development of land grants and land grant settlements in eighteenth century New Mexico. On the other hand, the prohibition of encomiendas, combined with the government's expressed desire to have the province securely occupied by Hispanic settlers who could defend it, means that some thought had been given to the requirements for settlement.

Some, such as Alvar Carlson (1971, 1975), have proposed a degree of agrarian planning as a part of Spanish settlement in the Rio Grande Valley during the eighteenth century. A study of the land grant procedures, which were highly formalized, would seem to support such a conclusion. The suggestion that authorities in Spain or Mexico actually proposed the division of land grants among large numbers of individuals settled in long lots (Carlson 1975) is speculative, however. Carlson (1975:53–54) could find no precedent for the long-lot system in Spanish law, and this system was not used with land grants in Mexico or Arizona. Neither does this form of property division resemble the Puebloan field system of the seventeenth or eighteenth centuries. Undoubtedly the long-lot system did prevail, but it seems to have been formalized as a regular part of the granting of lands only around the middle of the eighteenth century, after a period of experimentation by local New Mexican officials.

The long-lot system was developed to accommodate community land grants and as a response to local conditions in the Rio Grande Valley of northern New Mexico. Long-lot farms developed as a means of growing introduced crops that required irrigation in a semiarid environment where both land and water resources were limited (Carlson 1975:54–55; Van Ness 1979:32). The system assured settlers maximum access to limited water resources and proved to be a practical and equitable method of partitioning irrigable lands among the large numbers of settlers required by military necessities. The resulting small subsistence farms never produced significant agricultural surpluses nor were they intended to do so (Carlson 1975:55). Colonial policy was not directed toward economic prosperity but toward the successful occupation of New Mexico, which the defense of New Spain was deemed to require (Carlson 1975; John 1975).

In the Rio Arriba, where the earliest and most extensive Hispanic occupation occurred, arable land was scarce and frequently located along ephemeral streams, making availability of water for irrigation and livestock a source of concern. In the Rio Abajo, where Puebloan populations south of the confluence of the Rio Grande and Rio Jemez had virtually disappeared, arable land was more plentiful, particularly along the Rio Grande. Water, also, was more securely available and more manageable for irrigation purposes in the Rio Abajo than in the Rio Arriba, especially south of San Felipe Pueblo. The continual threat and often devastating impact of raids by nomadic Indians limited expansion, however, except in the Bernalillo and Albuquerque areas.

The records of land grants in the files of the U.S. Surveyor General and the Court of Private Land Claims make it clear that the procedures for obtaining a grant of land from the governor of New Mexico were relatively formalized (generally following directives in the *Recopilacion* and other royal ordinances) and were well understood within the Hispanic and Puebloan populations. The five-part procedure consisted of a petition by the prospective settler(s); an investigation by the alcalde mayor of the jurisdiction or by some other highly placed official whom the governor might choose to designate; the formal grant of land to the petitioners by the governor; the act of possession, whereby the alcalde mayor or other appointed official placed the successful petitioners in possession of the land; and finally, after a prescribed period of time during which the grantees occupied the land according to the requirements established by royal ordinances, the acquisition of legal ownership or possession of the land by the grantees.

The investigation of local conditions at the petitioners' tract was a crucial part of the land grant procedure. The alcalde mayor had to determine whether the proposed grant would adversely affect any Indian pueblo or other third party. He also had to assess local environmental conditions to determine whether there was sufficient water for irrigation and livestock and enough cultivable, grazing, and wood-producing land to support the proposed number of settlers. Finally he had to determine whether the area could be defended by the petitioners. Implicit in the alcalde's investigation was the consideration of the military and economic needs of the province as a whole. As we shall see, land grants could be and were revoked for a variety of military and economic reasons.

Once the governor had granted the land to the petitioners, the alcalde mayor placed the new grantees in possession. At that stage the alcalde would divide the land into irrigable bottomlands, grazing lands, and woodlands, each of which had previously been determined to be sufficient to sustain the grantees. By the middle of the eighteenth century, the alcaldes also frequently allocated house lots and adjacent garden plots and corrals around a central plaza and divided the arable land among the individual settlers. Each person was allocated a tract of agricultural land and a separate garden plot, which was adjacent to his or her dwelling. Allocations of land were made in terms of a specific measured frontage on a stream or acequia madre; the width of the tract depended upon the size and configurations of the irrigable bottomlands and the number of settlers. The frontage usually measured approximately 100 to 150 varas. If, as

occasionally occurred, any unallocated bottomlands remained, they were set aside for future expansion of the population on the grant or for new settlers.

The Spanish government in New Mexico encouraged, and on occasion ordered, settlers on land grants to concentrate their residences around one or more fortified or fortifiable plazas for defense (Simmons 1969:17–20). Virtually every settlement in the Rio Grande Valley was exposed at one time or another to raids by nomadic tribes. The Hispanic settlers, however, unlike the Pueblos, generally ignored these government directives. Because they were growing introduced crops that were not completely adapted to the local environment, Spanish agricultural settlements depended upon irrigation systems (Hutchins 1928:272–273; Ressler 1968:10–17). Because the farmers built their houses near their fields, Hispanic settlements tended to be spread out along roads at the upper edge of the arable lands or along the acequia madre (Carlson 1971:81–83).

Each community had a separate irrigation or acequia system to provide water for crops (Hutchins 1928:273; Simmons 1972:140–141). Irrigation practices were derived from traditional methods in Spain and Hispanic New Spain and were regulated by royal ordinances (Simmons 1972:136; Figure 7). The laws related to irrigation permitted a certain latitude for interpretation and application. Flexibility was granted to local officials in order to meet local environmental conditions and unexpected problems (Simmons 1972:135). Irrigation systems were administered by informal local community associations (Hutchins 1928:275; Simmons 1972:140).

Beginning in the seventeenth century, Puebloan irrigation systems were organized like those of the Hispanic communities and were regulated by the same laws (Hutchins 1928:263; Simmons 1972:137). Puebloan community organization facilitated the construction and maintenance of irrigation systems and the adjudication of water allocation disputes within the individual pueblos. Coalescence of the Spanish and Puebloan systems occurred in part because of the joint use of acequias by some Hispanic and Puebloan communities in the eighteenth and nineteenth centuries.

Irrigation works were simple and only moderately efficient owing to the scarcity of metal tools (at least in the eighteenth century) and the general absence of trained engineers (Simmons 1972:143). Head works were primitive and temporary; as they were constructed of logs, brush, and stones, these facilities were regularly washed out during any moderate increase in stream flow, especially during the spring runoff and summer thunderstorm seasons.

Collective community manpower was used to construct and maintain the community acequia systems (Hutchins 1928:271; Simmons 1972:143). Community leaders managed the maintenance of the systems and appear to have allocated water within the local systems during periods of drought. Conflicts among community ditch associations, whether non-Indian or Indian, were common in times of scarcity (Simmons 1972:144).

Figure 7 Canoa (flume), Truchas, New Mexico, ca. 1955 (Photograph by Tyler Dingee, Courtesy of the Museum of New Mexico, Santa Fe, Negative No. 91937)

Chapter 4

PATTERNS OF SETTLEMENT IN THE EIGHTEENTH AND NINETEENTH CENTURIES

Because of the close relationship between community land grants and irrigation agriculture, a study of the growth and expansion of land grants will provide a broad picture of the spread and development of irrigation systems in colonial New Mexico. Specific information on the irrigation systems themselves will be presented in the following section.

The villa of Santa Fe was the first pre–Revolt Hispanic community to be resettled during the Reconquest (see Figure 5). After a brief but bloody encounter, Vargas's forces recaptured the remains of the former capital in December 1693 (Espinosa 1942:161). Because of the persistence of Puebloan resistance, the Hispanic settlers were unable to rehabilitate the old acequia madres until either 1695 or 1697.

At Santa Cruz de la Cañada the Spaniards took possession of a fully functioning irrigation system. On March 20, 1695, Governor Vargas ordered the Tanos of the pueblos of San Lazaro and San Cristobal to move to the Cañada de Chimayo, because they had settled during the Pueblo Revolt on lands that had formerly belonged to Spaniards (CPLC, Cases 111 and 194; SANM I:882). Shortly thereafter Lt. Gov. Luis Granillo examined the former settlement, farms, and ranchos at Santa Cruz de la Cañada. On April 19, 1695, Governor Vargas formally reestablished the villa and granted to the prospective settlers at Santa Cruz the agricultural lands and the acequias that the Tanoan Indians had used to irrigate their crops; ranchos and farmlands were to be given to each settler (CPLC, Case 194). On April 22, 1695, Governor Vargas, who had provided the supplies, equipment, and military escort for the enterprise, gave the settlers formal possession of the villa and lands of Santa Cruz de la Cañada. The initial settlement was troubled by the outbreak of the second Pueblo Revolt in 1696, which found the villa of Santa Cruz in the heart of the turmoil (Espinosa 1942:229–244). Unstable conditions over the following years caused the settlement to be abandoned for the most part, so that Governor Vargas found it necessary during his second term in office to revive the community through a regrant of the lands to the original settlers in February of 1704 (CPLC, Case 194). Such tentative periods in the early life of a land grant were not uncommon in colonial New Mexico, but after 1704 Santa Cruz grew rapidly and without setback throughout the first half of the eighteenth century, becoming the center from which other land grants in the Rio Arriba were founded.

In the period from 1695 to 1705, however, the villa of Santa Fe was the origination point for the movement to land grants and the focal point of that settlement (Figure 8). But even relatively close proximity to the villa of Santa Fe did not necessarily ensure that a land grant could be successfully occupied in the early years of Spanish resettlement in New Mexico. On February 10, 1695, Capt. Jacinto Pelaez received a grant of the lands at Pena Blanca that had belonged to his father, Andres Gomez, before the Revolt (U.S. Surveyor General, Case 124). Because Pelaez did not fulfill his obligations to occupy the grant legally, he had to seek and receive regrants of the land from Governor Cubero in 1698 and Governor Vargas in 1704. It appears that Pelaez never utilized these lands successfully, because tracts in and around Pena Blanca were granted to Juan Fernandez in 1728 and Juan Montes Vigil in 1754 (U.S. Surveyor General, Case 124). This early attempt of Jacinto Pelaez to recover lands that had belonged to his family before the Pueblo Revolt was similar to efforts by other pre–Revolt settlers who returned to New Mexico; the promise to restore lost landholdings had been one means by which Governor Vargas had sought to gain support for the Reconquest among the pre–Revolt Spanish settlers of New Mexico (Espinosa 1942:24–55).

The focus of early grantees on safe and relatively secure lands in the vicinity of Santa Fe and Santa Cruz can be seen in the records of the years immediately after the Reconquest. In 1695 Joachim Anaya de Almayor was granted 1 fanega of planting land and pasture for 200 sheep and 20 cattle at La Cieneguilla in the Santa Fe Valley to the west of the villa itself (CPLC, Case 84; U.S. Surveyor General, Case 115). In 1698 or 1699 Francisco Romero received land in the Santa Cruz Valley below the villa from Governor Cubero sufficient to plant 1 fanega of corn and half a fanega of wheat (CPLC, Case 262). Similarly Antonio de Sella obtained a grant of farming land at La Cañada in March 1699 (CPLC,

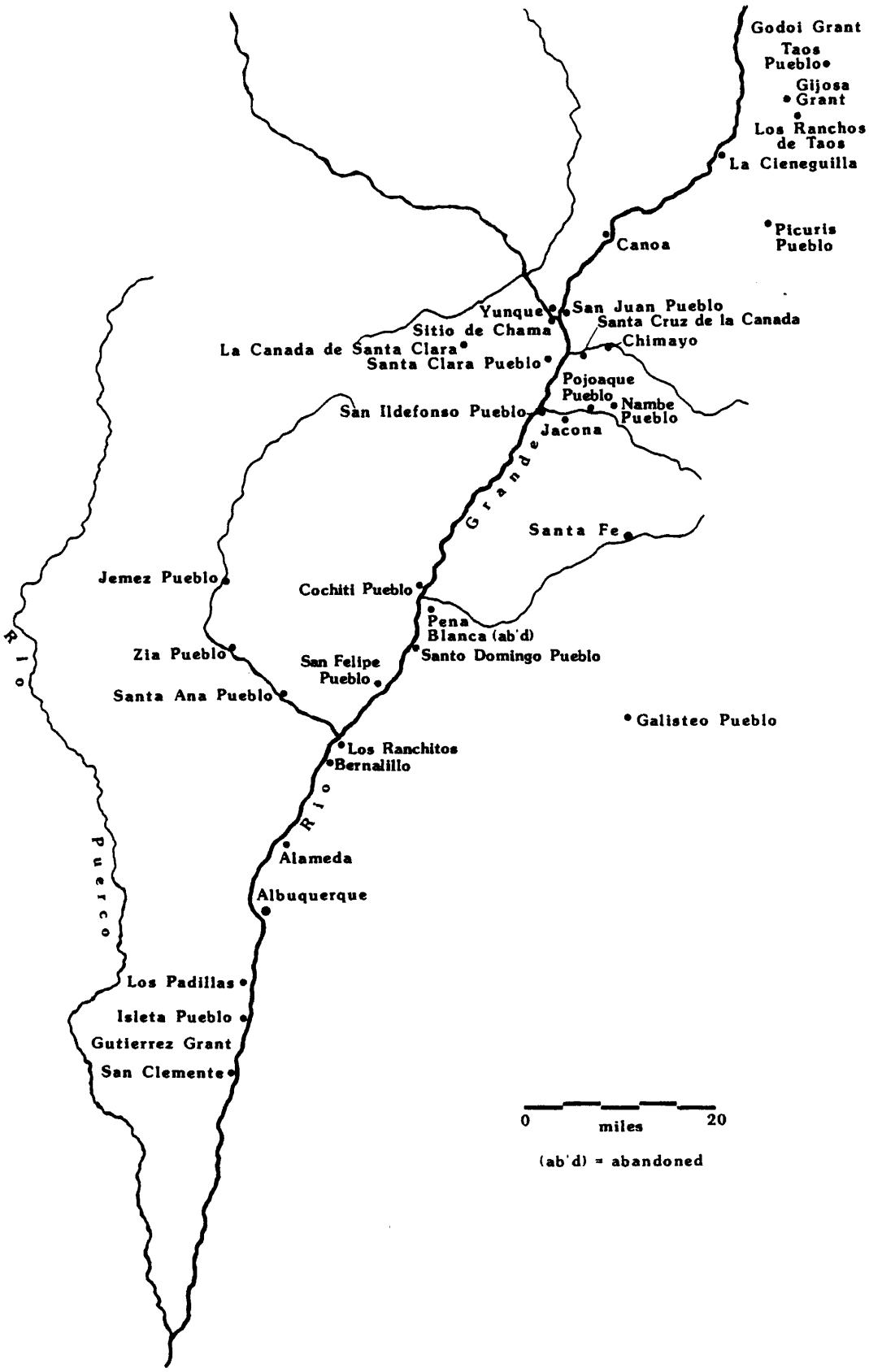

Figure 8 Rio Grande Valley in 1720

Case 262). On May 24, 1700, Jose Trujillo was placed in formal possession of the Mesilla grant, which was principally grazing land on the uplands between Santa Cruz de la Cañada and San Ildefonso; the grant included some cultivable land along the lower Arroyo Seco (U.S. Surveyor General, Case 112). Not being one to venture far afield, Trujillo would extend his grazing lands in the area through a further grant in May 1707.

During the years 1699 to 1702 many land grants were made in the area of the Pueblo of Pojoaque, which had been abandoned during the second Pueblo Revolt and which was not reoccupied by the Indians until 1707. In 1699 Governor Cubero made a grant of the abandoned pueblo of Jacona to Capt. Jacinto Pelaez (U.S. Surveyor General, Case 80). Later, in December 1699, Juan de Mestas received an adjacent tract of 3 fanegas of farmland, which lay to the east of Jacona toward Pojoaque (U.S. Surveyor General, Case 80). Between 1699 and 1701 Francisco Anaya received a tract of farmland near that of Juan de Mestas (U.S. Surveyor General, Case 80). The Anaya and Mestas tracts were south of the Rio Pojoaque and immediately to the west of the abandoned Pueblo of Pojoaque. In 1701 Carlos Lopez and Juan Lopez were given lands in the same area but north of the Rio Pojoaque (SANM I:928, 927, 735). In 1702 Governor Cubero made a grant of land to Matias Madrid in the area between the lands at Jacona, held by Jacinto Pelaez, and those of the Pueblo of San Ildefonso (SANM I:1351; U.S. Surveyor General, Case 92).

Early developments in the Pojoaque area were brought to a conclusion between 1704 and 1707. Alfonso Rael de Aguilar received formal possession of farmlands at the abandoned pueblo of Cuyamungue in October 1704 (SANM I:733). These lands originally had been granted to him by Governor Cubero in May 1699 (U.S. Surveyor General, Case 80).

Aguilar's civil and military responsibilities seem to have prevented him from pressing his claim for legal possession of the land for more than 5 years. Finally, in 1707, Governor Cuervo y Valdez reestablished the Indian Pueblo of Pojoaque with Tewan and Tanoan refugees (Baxter 1984:14). The Puebloan reoccupation of Pojoaque did not invalidate these earlier grants; most were recertified by Governor Mogollon in 1713 (Hackett 1937:380).

In the period from 1697 to 1702, Cristobal Nieto, Sebastian de Mondragon, and Baltazar Romero received small tracts of land as grants from Governor Cubero in the area of Santa Fe itself (CPLC, Cases 16 and 81). In 1706, Governor Cuervo reestablished the Pueblo of Galisteo to the south of Santa Fe and reported that the formerly scattered Tanos had planted cornfields (Hackett 1937:379). Moving much further afield, Jose Dominguez of Santa Fe sought a grant of lands in the Taos Valley that had formerly belonged to Francisco Gomez Robido (U.S. Surveyor General, Case 120). On February 9, 1702, Governor Cubero made the grant. At a later but unknown date, the alcalde mayor of Taos, Juan Paez Hurtado, placed Dominguez in possession of these lands after ascertaining that Dominguez's future Indian and non-Indian neighbors had no objection to the grant. Records of proceedings before the U.S. Surveyor General in 1878 seem to indicate that Dominguez never fulfilled the legal obligations to occupy the grant, probably because the area was too exposed to nomadic raids.

A few of the successful early Reconquest era land grants to be located outside the immediate environs of Santa Fe and Santa Cruz were in the Velarde area and thus still within reasonable proximity of Santa Cruz. In 1703 Sebastian and Antonio Martin occupied a tract of arable and grazing land in the Rio Grande Valley above the Pueblo of San Juan (U.S. Surveyor General, Case 28). They received the land as a grant from Governor Vargas, though they did not gain formal possession until the governorship of Cuervo y Valdez. Remaining on the land despite Apache raids, Sebastian Martin and his five brothers cultivated the bottomlands and irrigated their crops with water from an acequia madre that they had built to take water out of the Rio del Norte, i.e., the Rio Grande (U.S. Surveyor General, Case 28). For defense, the brothers built a four-room house with two strong towers that enabled them to survive frequent Apache raids. The Martins not only survived but prospered, being able to acquire, between 1707 and 1712, the adjacent properties of Antonio Cisneros. Finally, in May 1712, Governor Villaseñor investigated the Martin claims. On May 23, 1712, he conferred a new grant encompassing all the original and acquired properties and declared the Martins to be the legal owners (U.S. Surveyor General, Case 28).

The town of Bernalillo also appears to have been occupied in the period between 1700 and 1704. In 1701 Felipe Gutierrez and others received a grant of land along the Rio Grande at the present site of Bernalillo (U.S. Surveyor General, Case 83). Bernalillo had been an important assembly point and logistical center during the Reconquest from 1694 to 1697, at which time the placita was apparently located on the west side of the river (Espinosa 1942:200–202, 259; SANM I:78; SANM II:60). The petition of 1701 was an attempt to formalize the settlement at Bernalillo; in December 1701, Governor Cubero granted the petitioners' request (U.S. Surveyor General, Case 83). Because formal

possession requirements were not met, Governor Vargas revalidated the original grant in January 1704, and ordered the alcalde mayor to place the petitioners in legal possession of the grant. It was not until January 1708, however, that Alcalde Mayor Martin Hurtado placed Gutierrez and others in formal possession of the lands that they had probably occupied at least since 1696 (U.S. Surveyor General, Case 83).

In the meantime Spanish settlement had leapfrogged south of Bernalillo, down the Rio Grande Valley. In the early 1700s the settlement of the Rio Abajo began in earnest, marking the first wave of expansion outside the Santa Fe and Santa Cruz region. For the next several years most of the granted land was in the area between Albuquerque and Bernalillo, but early efforts at settlement in the Chama Valley also began at this time.

As early as 1702, the Pueblo of Alameda was resettled with Tiwa Indians, but in 1708 Governor Villaseñor depopulated the area when he gathered the Tiwas and moved them south to refound the Pueblo of Isleta (Armijo 1929:277). In 1711, Governor Mogollon founded a Spanish settlement at Alameda.

In 1706 Governor Cuervo y Valdes established the villa of Albuquerque, which became the focal point for settlement in the Rio Abajo (Hackett 1937:379). On February 5, 1706, Lorenzo de Carabajal was given possession of a piece of farming land in the new settlement of Albuquerque (SANM I:156; U.S. Surveyor General, Case 130). No sooner had the residents at Bernalillo received legal possession of their land than Capt. Manuel Baca sold the Santa Ana Pueblo part of the lands held by a grant from Governor Vargas. On June 27, 1709, Baca certified before the alcalde mayor, Antonio de Armenta, that he had sold a piece of farming land in a bend of the Rio del Norte at the mouth of the Santa Ana River, i.e., the Rio Jemez (CPLC, Case 157). These lands were located north of the Rio Jemez on the west side of the Rio Grande. Purchase by the Santa Ana residents of agricultural lands along the Rio Grande would continue throughout the eighteenth century (Santa Ana Pueblo Land Records, Special Collections, Zimmerman Library, UNM).

The area between Bernalillo and Albuquerque began to fill up in January 1710, the year Francisco Montes Vigil and others received a grant of lands near the abandoned Pueblo of Alameda along the Rio Grande (U.S. Surveyor General, Case 91). Because of Vigil's participation in royal service, the grant was not settled, and in July 1712 he sought to avoid forfeiture so he could convey the properties to Capt. Juan Gonzales of Bernalillo (CPLC, Case 11; SANM I:302; U.S. Surveyor General, Case 91). Gonzales obtained a revalidation of the Vigil grant from Governor Mogollon in October 1712.

Within the next year Gonzales acquired and presented for confirmation a series of grants made in the Alameda area since the Reconquest. One of these grants was made in March 1696 to Maria Barba Lujan by Governor Vargas. This grant consisted of land that had formerly belonged to Estevan Barba, who had purchased the lands from Capt. Joseph Telles Xiron before the revolt. The second grant acquired by Gonzales was originally made in June 1699 by Governor Cubero, who granted lands in the Alameda area to Capt. Diego Montoya. In December 1711 Governor Gongora granted to Captain Gonzales the abandoned Pueblo of Puara, which was contiguous to lands that Gonzales had purchased from Juan de Ulibarri (CPLC, Case 11). By September 1713, Captain Gonzales had consolidated all of these contiguous and potentially conflicting claims in his own hands (CPLC, Case 11).

In September 1712, Diego Montoya was placed in possession of lands newly granted to him by Governor Villaseñor; these lands, which lay north of the villa of Albuquerque, had allegedly been granted to Montoya by Governor Vargas in 1694 (CPLC, Case 11). By the end of 1712 Diego Montoya was in legal possession of lands which, at the end of the century, would be conveyed to Elena Gallegos by Diego's grandson Antonio Montoya (CPLC, Cases 11 and 51).

Expansion up the Chama Valley began somewhat tentatively in August 1707, when Bartolome Sanchez received possession of lands at sitio de Zama, along the lower Rio Chama not far above the confluence with the Rio Grande, under a grant from Governor Cubero (SANM I:824). Sanchez had the grant revalidated and received possession again in November of 1711 (CPLC, Case 264, SANM I:827). Other settlers attempted to move into the area at Yunque (site of the former capital of San Gabriel). In 1712, 11 settlers from Santa Cruz de la Cañada petitioned the governor for lands at Yunque but were refused because their departure would seriously weaken the defense of Santa Cruz itself (SANM I:1020).

The interest of settlers in the lower Rio Chama was not stifled by Governor Villaseñor's response to that petition; in August 1714 Salvador de Santistevan and Nicolas de Valverde were in legal possession of lands at Yunque (CPLC, Case

264). By 1712 the town of Chamita was in existence, and by 1714 a flurry of activity demonstrated settlers' interest in the area (U.S. Surveyor General, Case 36). In August 1714, Bartolome Lovato successfully petitioned for and received legal possession of the surplus agriculture lands of both Santistevan and Valverde at Yunque (CPLC, Case 264; SANM I:433, 435, 436). The alcalde mayor, Sebastian Martin, measured 4 fanegas of corn-planting land for Santistevan and Valverde and placed Lovato in possession of the remaining 2 fanegas of corn-planting lands originally granted to Santistevan and Valverde. Interest in the area continued into 1715, when the new settler, Bartolome Lovato, complained to Governor Mogollon about encroachment on his lands by Capt. Jose Trujillo (CPLC, Case 264). The governor ordered Trujillo to end his attempt to settle illegally on Lovato's property.

Attempts to acquire surplus property from the holdings of Santistevan and Valverde did not end with Lovato's successful venture. At virtually the same time, Cristobal Crespin and Nicolas Griego sought land for planting wheat and corn along the Rio Chama (CPLC, Case 232). When Governor Mogollon ordered the alcalde, Sebastian Martin, to delineate the Santistevan and Valverde holdings and to give 2 fanegas of the surplus to Bartolome Lovato, he also ordered Martin to give what was left over to Crespin and Griego (CPLC, Case 232). On August 31, 1714, Sebastian Martin placed Crespin and Griego in possession of three pieces of land at sitio de Chama: one was on the east side of the Chama above the lands of Santistevan, and the other two were on the west side of the Chama between the confluence with the Rio Grande and the first narrows of the Chama (CPLC, Case 232; SANM I:167). Martin also placed Antonio de Salazar of Santa Cruz in possession of lands on the west side of the Rio Grande between the junction with the Chama and the lands of Santa Clara Pueblo (U.S. Surveyor General, Case 132). Salazar had successfully petitioned Governor Mogollon for these lands, which had allegedly been farmed by his grandfather, Alonzo Martin Barba, before the Revolt. Mogollon ordered Salazar to settle on the land within 6 months and Crespin and Griego to do so within 1 year, as required by royal ordinances (CPLC, Case 232; U.S. Surveyor General, Case 132).

Settlement was also taking place near Taos at this time. As we have seen, Jose Dominguez appears to have received a grant near Taos Pueblo around 1702. Cristobal de Serna made a petition in early 1710 for the former lands of Capt. Fernando Chaves at Los Ranchos de Taos (SANM I:240; U.S. Surveyor General, Case 158). The dangers of occupying land at the extreme edge of the New Mexican frontier are well illustrated by the history of the Serna Grant. Governor Peñuela (Villaseñor) made the grant in April 1710, but the grantee did not successfully settle on it—largely, it would seem, because of conflicting military obligations. In May 1715, Serna obtained a revalidation of his grant from Governor Mogollon and was placed in possession by Alcalde Juan Pineda in June 1715, after the Pueblo Indians of Taos had agreed to the grant (SANM I:830; U.S. Surveyor General, Case 158).

At the same time, Francisco Antonio de Gijosa sought a grant of the lands belonging to the deceased Bartolome Romero, apparently another pre-Revolt landholder in the Taos area (CPLC, Case 16; SANM I:309; U.S. Surveyor General, Case 109). On June 16, 1715, Governor Mogllon made the grant to the widow Gijosa but directed the lieutenant alcalde mayor of Taos, Juan de la Mora Pineda, to determine if the leaders of Taos Pueblo had any objections. After finding that the cacique and other Taos officials did not object, Pineda placed the widow Gijosa in possession of the granted lands in September 1715 (U.S. Surveyor General, Case 109).

In October 1716, Antonio Martinez made a petition for the lands in the Taos area that had belonged to Diego Lucero de Godoi before the Pueblo Revolt (SANM I:503; U.S. Surveyor General, Case 116). Gov. Felix Martinez issued the requisite decree and, because the alcalde mayor, Cristobal Tafoya, was on campaign, ordered Capt. Miguel Tenorio to place Martinez in possession of the lands. Tenorio found that the Taoseños cultivated land in the valley, but that they had no objections to the grant of the Godoi lands; consequently on October 29, 1716, Tenorio placed Martinez in legal possession of the grant lands near Taos (U.S. Surveyor General, Case 116). The Martinez or Godoi grant was the last land grant in the Taos region until the middle of the eighteenth century.

In the meantime settlement had begun at the southernmost parts of colonial New Mexico. In 1716 the frontier in the Rio Abajo was pushed south of Isleta Pueblo and the villa of Albuquerque. Antonio Gutierrez obtained a grant for grazing and agricultural lands on the west side of the Rio Grande below Isleta; the lands had belonged to Cristobal de Tapia before the Pueblo Revolt (CPLC, Cases 274 and 275; SANM I:315). In November 1716, Alcalde Mayor Baltazar Romero was ordered to place Gutierrez in possession of those lands.

Earlier in the same year Ana de Sandoval y Manzanares sought a grant for grazing and agricultural lands at San Clemente that she had inherited from her father, Mateo de Sandoval y Manzanares; the lands were located near the

abandoned pueblo of San Clemente and had been owned by her father before the Revolt of 1680 (U.S. Surveyor General, Case 67). On July 13, 1716, Gov. Felix Martinez ordered Capt. Antonio Gutierrez to place the widow Manzanares in possession of the granted lands; she was given 6 months in which to settle the grant. Captain Gutierrez did place Felix de la Candelaria, the son of Ana de Sandoval y Manzanares, in possession of these lands on the east side of the Rio Grande in late July 1716, at which time Gutierrez petitioned for vacant lands that lay just to the north of the San Clemente tract (CPLC, Cases 274 and 275; U.S. Surveyor General, Case 67).

The San Clemente grant was the southernmost settlement in the Rio Abajo for nearly 20 years, but one more grant was made below Albuquerque in the interim. In May 1718, Diego de Padilla petitioned Governor Valverde for land on the east side of the Rio Grande between Isleta and Albuquerque that his family had held before the Revolt (SANM I:681). On May 14, 1718, the alcalde mayor of Isleta, Alonso Garcia, placed Padilla in possession of those lands, after making the customary investigation (CPLC, Case 63; U.S. Surveyor General, Case 146).

During the 1720s and 1730s the focus of territorial expansion in New Mexico was in the Chama Valley (Figure 9). Some 10 years after the area near the confluence of the Rio Chama and Rio Grande had been settled, settlers from the Chamita and Santa Cruz areas began an expansionist drive up the Chama that reached the middle parts of the valley by the early 1730s. Most of the interest was in grazing lands, but cultivation was a consideration too.

In 1723 Governor Bustamante appears to have given Cristobal de Torres a grant of lands at the abandoned pueblo of Chama (Tsama) (CPLC, Case 250). According to the testimony of his son, Diego de Torres, Cristobal occupied the grant from 1724 to 1727, when Indian raids forced him to abandon the area (CPLC, Case 250; SANM I:943). In August 1731, Diego de Torres made a claim before the governor of New Mexico for lands that had originally been granted to his father. Because of the danger of Ute and Comanche attacks, he had invited others to join him and share equally in the agricultural lands, which had been put under ditch irrigation (CPLC, Case 140; SANM I:943). In November 1733, Governor Cruzat y Gongora heard the case and found that the grant had been abandoned; the governor declared the lands to be part of the royal domain and opened them for settlement on November 24, 1733 (CPLC, Case 140; SANM I:943).

During the early 1730s Jose de Riaño, one of the wealthiest men in New Mexico, obtained rights to grazing lands in the Piedra Lumbre Valley above Abiquiu, at some distance from other settlements in the Chama Valley (U.S. Surveyor General, Cases 73 and 131). At the same time, the Valdez families settled along the Rio del Oso, which they occupied until 1736, when the Comanches drove them out (U.S. Surveyor General, Case 149). The forfeiture of the Cristobal de Torres grant opened the area around Abiquiu for settlement. In August 1734, Bartolome Trujillo and nine other settlers sought a grant of agricultural lands along the Rio Chama at Abiuqu (CPLC, Cases 257 and 263; SANM I:954). On May 30, 1734, Lt. Gov. Juan Paez de Hurtado placed the settlers in possession and divided up the agricultural lands among them (CPLC, Cases 257 and 263).

While the need for agricultural land was being met in the Chama Valley, the pressure for grazing lands increased. The large livestock operations in Santa Cruz and the lower Chama Valley had expanding herds with voracious appetites for new grazing lands. In a single concerted effort during 1735, the *patrones* attempted, with the aid of the acting governor, Juan Paez de Hurtado, and the alcaldes, Diego de Torres and Juan Garcia de Noriega, to acquire huge tracts of grazing land during Governor Cruzat y Gongora's absence in El Paso.

In March 1735, Geronimo Martin and others acquired title to cultivable and grazing lands on the west bank of the Chama between Abiquiu and the Piedra Lumbre, where Jose Riaño had already acquired a large tract of grazing lands (CPLC, Cases 97 and 265; SANM I:578). At the same time a group led by Josefa de Ontiveros received lands above the Bartolome Trujillo grant on the east side of the river (CPLC, Cases 257 and 263; SANM I:1077). In May Manuela Garcia de las Rivas (the widow of Capt. Salvador Montoya), Isabel Montoya, and Francisco Quintana acquired 4 fanegas of corn-planting lands on the north side of the Chama at the old Pueblo of Abiquiu (CPLC, Case 249; SANM I:322). Alcalde Mayor Juan Estevan Garcia de Noriega placed the widow Rivas in possession of the grant that lay north of lands already given to Antonio de Ulibarri. In January 1735, Ulibarri had received 3 fanegas of corn-planting lands at Pueblo Colorado; this land was north of and adjacent to that of Bartolome Trujillo (CPLC, Case 259; SANM I:1022). One month after Alcalde Mayor Juan Garcia de Noriega placed Ulibarri in possession of those lands, Noriega himself petitioned acting Governor Hurtado for, and received a grant of, one and one-half fanegas of corn-planting lands and

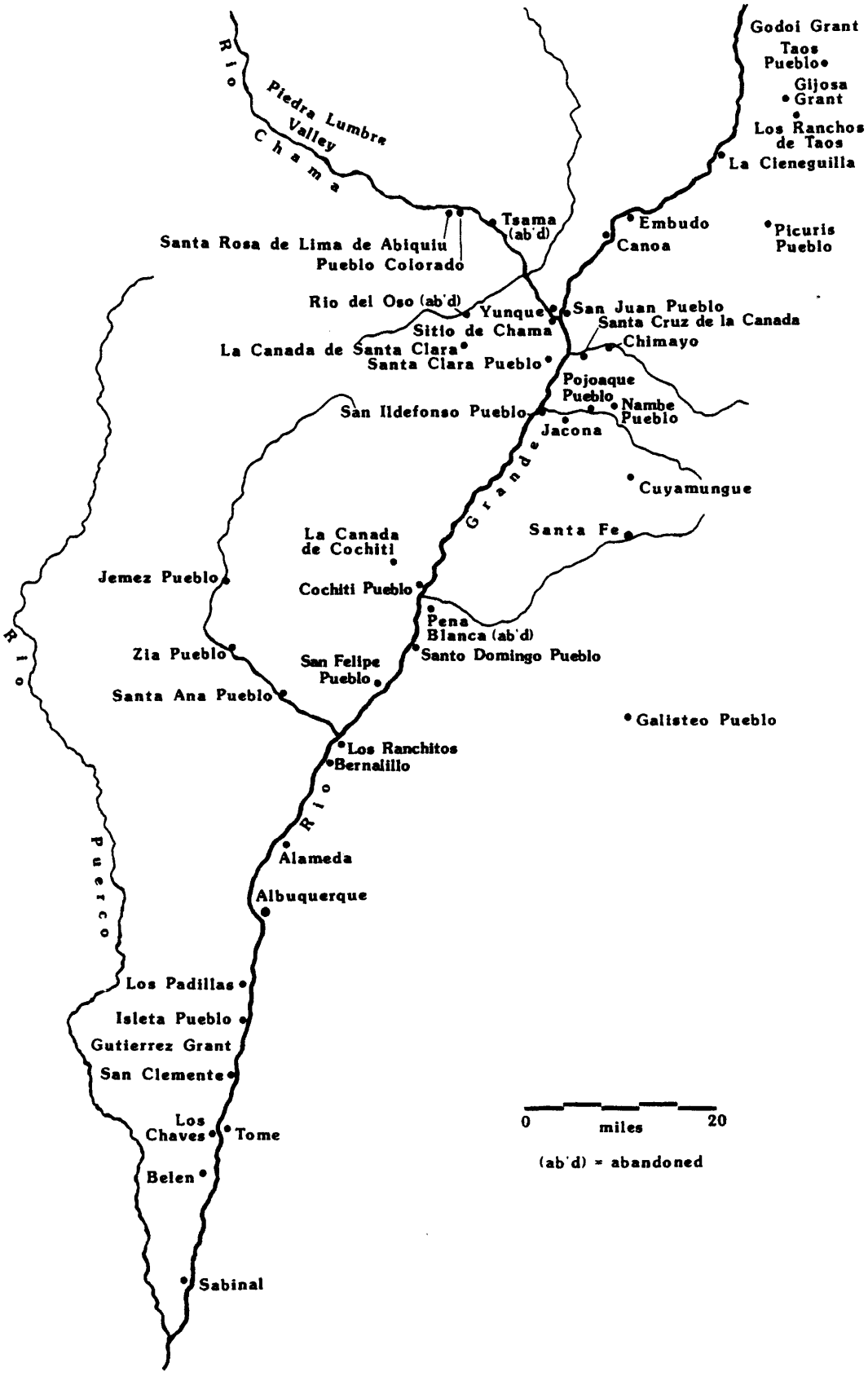

Figure 9 Rio Grande Valley in 1740

extensive grazing lands above Pueblo Colorado (CPLC, Case 254; SANM:I:320). At approximately the same time Jose Antonio Torres received a grant of lands from the acting governor; Torres's lands lay south of those given to Antonio de Ulibarri (CPLC, Case 255; SANM I:955).

When Governor Gongora returned from El Paso in late 1735, he immediately moved to nullify the actions of his acting governor. On November 11, 1735, Gongora revoked all the grants of land made by Hurtado during Gongora's absence in El Paso (SANM I:524). The governor ordered all the alcaldes to publish and enforce the revocation (SANM I:524). This is the only instance of mass nullification of land grants by a New Mexico governor. The action affected only the Chama Valley, where Hurtado and the alcaldes mayor had compounded with the local landowners to make an organized raid on the royal domain. Like most governors of New Mexico, Gongora wanted to control and regulate the advancement of settlements, especially on critical frontiers such as the Chama, where a false step or precipitous action could set off a war with the Utes. Gongora permitted the earlier settlements at Abiquiu to continue, however. After a brief hiatus, consolidation of the Spanish hold on the lower Chama continued in the late 1730s and early 1740s. While the large landowners of the jurisdiction of La Cañada sought to expand their grazing grounds up the Chama during this period, some citizens from the Santa Cruz area settled at El Embudo above the Sebastian Martin grant (CPLC, Case 173; SANM I:1038).

Throughout the expansionist era some people still preferred to acquire land in the area around Santa Fe and Santa Cruz. In 1727 the Tafoya family acquired grazing land by a grant from the governor of New Mexico; the land lay above the Pueblo of Santa Clara along the Cañada de Santa Clara (SANM I:942; U.S. Surveyor General, Case 138). Throughout most of the rest of the eighteenth century this grant would be the cause of repeated disputes between the settlers and the Indians over the utilization of the waters of the Rio Santa Clara, but the Tafoyas had secured for themselves, at least for a time, valuable grazing lands within the settled and secure core of the Rio Arriba (Taylor 1982:72–75). In May 1728, Jose de Leyba acquired a half fanega of corn-planting land near Santa Fe (CPLC, Case 278). During April 1731, the alcalde of Santa Fe placed Manuel Trujillo in possession of land to the east of the villa near the intake of the acequia madre (CPLC, Case 116; U.S. Surveyor General, Case 89). In January 1731 Bernardino de Sena and Luis Lopez acquired grazing land at the abandoned Pueblo of Cuyamungue that lay to the south of the Pueblo of Pojoaque; the lands were those, or were near those, that Alfonso Rael de Aguilar had attempted to settle earlier in the century (CPLC, Case 112; U.S. Surveyor General, Case 54). Jose Antonio Lucero and Luis de Armenta preferred to petition for small tracts of cultivated land near Santa Fe, which they acquired in 1732 and 1733 (CPLC, Case 103; U.S. Surveyor General, Cases 60 and 147).

Other settlers who preferred to remain within the bounds of the more secure core area of colonial New Mexico sought larger holdings than those available near Santa Fe. In August 1728, Antonio Lucero of Albuquerque made a petition for planting and grazing land in and around the Cañada de Cochiti (CPLC, Case 205; U.S. Surveyor General, Case 135). An investigation by Capt. Andres Montoya found the grant to be noninjurious to other parties.

Still other settlers were willing to forgo the safety of the core region and pushed the frontiers of the Rio Abajo many leagues to the south during the late 1730s and early 1740s. Around 1737, 50 families from the Albuquerque area established a settlement at Garcia Real or Nuestra Señora de la Concepcion, which lay on a fertile plain some 6 leagues (ca. 15 miles) south of the villa of Albuquerque (Hackett 1937:400). The community was able to irrigate its fields with water from the Rio del Norte (Rio Grande). In June 1739, Nicolas Duran y Chavez petitioned for grazing land between the Rio Grande and the Rio Puerco. This land lay south of the earlier Gutierrez grant (U.S. Surveyor General, Case 155). By the time Duran acquired possession of the tract in August 1739, Juan Barela and others had received a grant of land that had once belonged to Tomé Dominguez (SANM I:956; U.S. Surveyor General, Case 2). The petitioners had complained of the lack of land and water near Albuquerque. The residents of the newly established community of Tomé were allocated farmlands and given possession of their grant in July 1739. The very next year the community of Belen was founded. In November 1740, Gov. Gaspar de Mendoza made a grant of land at Belen to a group of settlers from the Albuquerque area led by Capt. Diego Torres de Salazar (U.S. Surveyor General, Case 13). On December 9, 1740, the alcalde mayor of Albuquerque, Nicolas Duran y Chavez, placed the settlers in possession of the newly granted lands. The new neighbors did not settle into a harmonious relationship, even though their properties were exposed to Apache raids, making cooperation advantageous. As early as 1744 Duran y Chavez was involved in a boundary dispute with Bernabe Baca, and in 1749 the residents of Belen petitioned the governor to establish the boundary between their lands and those of Nicolas Duran y Chavez (U.S. Surveyor General, Case 155). The Tomé and Belen grants, with their

secondary settlements that reached south as far as Sabinal, remained the southernmost extent of Spanish settlement in the upper Rio Grande Valley until the early nineteenth century (Adams and Chavez 1956:208).

While settlement was expanding to the south in the Rio Abajo, colonists tried to consolidate the Spanish hold on the Chama Valley in the north (Figure 10). In 1739 the Valdez family, who had been forced by Ute raids to abandon the upper Rio del Oso and seek shelter at Santa Cruz de la Cañada, acquired possession of lands at Plaza Colorado under a grant from Gov. Domingo de Mendoza (CPLC, Case 2). The next year Juan Jose Lovato successfully petitioned for land that he and Capt. Diego de Torres had previously been granted (CPLC, Case 140). This land appears to have been located between Plaza Colorado and the Pueblo de Chama and to have been declared royal domain in 1733 by Governor Cruzat y Gongora after it was abandoned by Diego de Torres's father (CPLC, Case 140). Lovato received possession of the grant but by 1744 was already having problems with rival claims by families who asserted that they had acquired lawful possession under Governor Gongora's order of 1733, which opened the area to settlement. In June 1744 Lovato had his title to the lands in question confirmed by Governor Rabal (CPLC, Case 140). Sometime in the early 1740s, Antonio Montoya acquired the Riaño holdings in the Piedra Lumbre Valley because of this acute need for grazing lands (U.S. Surveyor General, Cases 73 and 131). Settlement along the Chama and its tributaries continued until the outbreak of hostilities with the Utes and Comanches in the 1740s.

In January 1746, Roque Jacinto Jaramillo and Juan Manuel de Herrera sought confirmation of a grant of land along the Rio del Oso, allegedly made to them by Governor Bustamante (CPLC, Case 228; SANM I:413). Governor Rabal had the claim investigated by Juan Abeytia, who found the lands to be vacant. On February 12, Governor Rabal declared the lands to be part of the royal domain and granted them to Jaramillo and Herrera, who were placed in possession of the grant in March 1746 (CPLC, Case 228).

In 1743 Juan Garcia de Mora and Diego de Medina petitioned Governor Mendoza for grazing and arable land along the lower Rito de Ojo Caliente. This land had previously been granted to Miguel de Quintana and Pedro Sanchez in 1731, but Quintana and Sanchez had never occupied the grant (CPLC, Case 56). An investigation of the grant by the lieutenant alcalde mayor, Domingo Vigil, in October 1743 found that Quintana and Sanchez had planted corn and pumpkins on a part of the grant but had quickly abandoned the attempt at settlement owing to adverse conditions; consequently Medina and Mora were placed in possession of the lands (CPLC, Case 56). Antonio Abeyta also was recorded as occupying land in the Medina grant along the Rito de Ojo Caliente above the Mora and Medina tract (CPLC, Case 68). A settlement appears to have been established even farther up the valley, at the site of Ojo Caliente itself, but the only records are derived from a report that Ojo Caliente and Abiquiu were abandoned in 1747 following a devastating Comanche raid (SANM I:28; SANM II:485, 499).

During 1745 the Montoyas had already left the Piedra Lumbre valley because of Ute incursions; after the Comanche raid of 1747 the Chama Valley was virtually abandoned, with the settlers retiring to the relative security of Santa Cruz. With the increasing threat of Comanche and Ute raids, petitions for grants in the more stable areas of settlement around Santa Fe and Santa Cruz increased. In October 1739, Vicente Duran y Armijo sought agricultural land to the east of Nambe Pueblo, in what he asserted were the surplus lands of the pueblo (SANM I:26; U.S. Surveyor General, Cases 31 and 87). Armijo was a resident of Santa Fe who claimed that he had lost his crops on lands along the Santa Fe River because of a scarcity of water. This shortage could have been caused by the surge of new grants along the Rio Santa Fe in the years 1742 to 1743. Because the Indians of Nambe objected to a grant of land to the east of their pueblo, they agreed to exchange their rights to agricultural lands that lay between Nambe and Pojoaque and that were already under ditch, if not cultivated, for those for which Duran y Armijo had petitioned (SANM I:26; U.S. Surveyor General, Case 31).

While Duran y Armijo was trying to move away from the Rio Santa Fe valley, others were trying to obtain lands there. In August 1742, Catarina Maese was placed in possession of lands along the acequia madre to the west of Santa Fe (CPLC, Case 119; SANM I:527). In the same month Juan Jose Archuleta received a grant of lands that lay adjacent to those of Catarina Maese (CPLC, Case 124; SANM I:24). Also in August of 1742 Juan de Leon Brito and Juan Cayetana Lovato received possession of separate grants of agricultural lands adjacent to the earlier grant made to Luis de Armenta in 1733 (CPLC, Case 103). Farther to the west, above the lower reaches of the Rio Santa Fe and adjacent to the Rio Grande, in an area called the Caja del Rio, Nicolas Ortiz obtained a substantial tract of grazing land by grant from Governor Mendoza (SANM I:1078; U.S. Surveyor General, Case 63). In the same year Pedro Sanchez obtained a grant to cultivable lands lying south of those used by the Indians of San Ildefonso, north of the Caja del Rio grant, and west

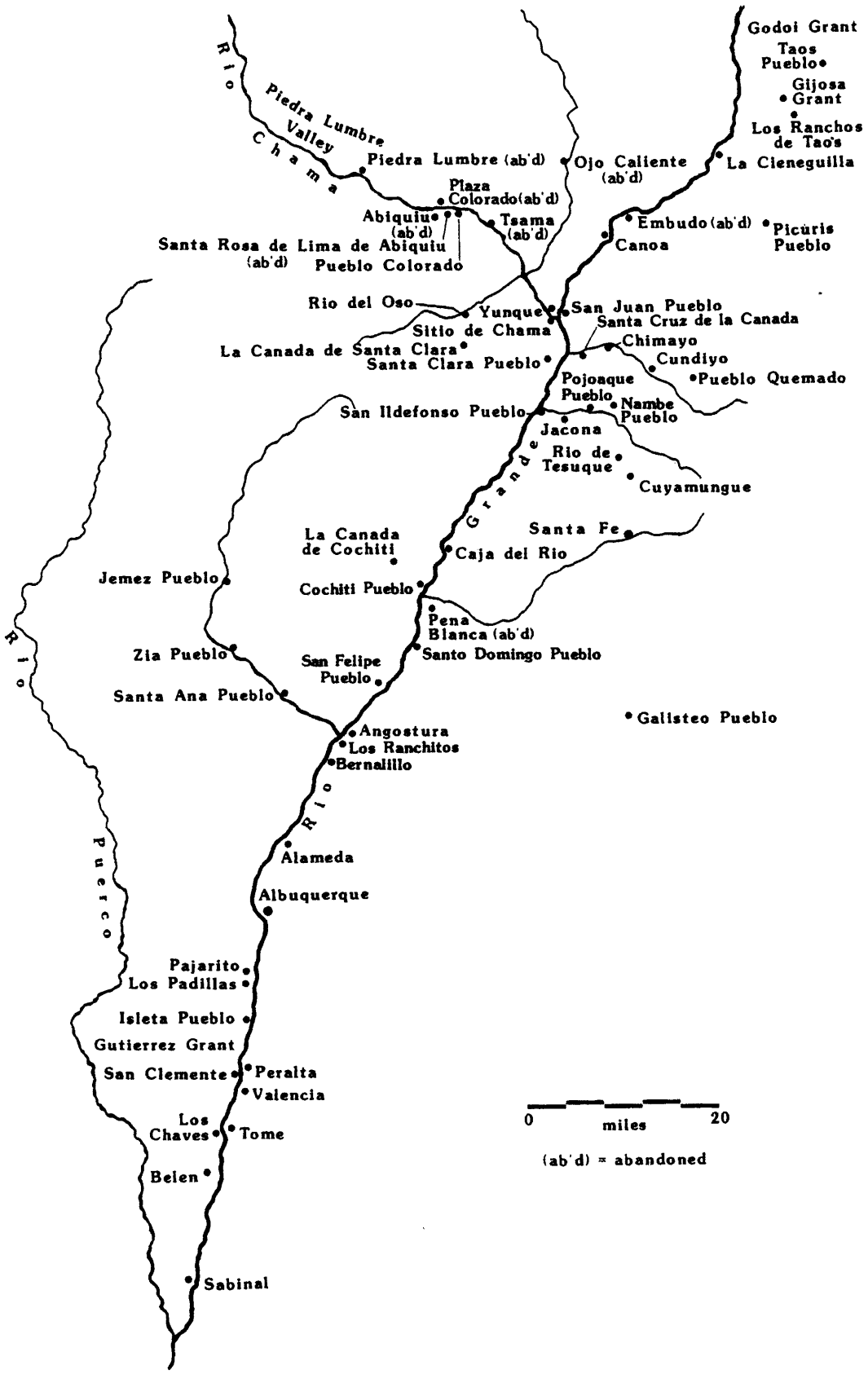

Figure 10 Rio Grande Valley in 1750

of the Rio Grande. When placing Sanchez in possession of his grant and setting forth the boundaries, the alcalde mayor, Juan Jose Lovato, extended the agricultural lands of San Ildefonso and got the parties to agree to an established boundary (U.S. Surveyor General, Case 38). In 1744 Juan Jose Moreno was placed in possession of one and one-half fanegas of corn-planting land and a tract of adjacent grazing land that lay north of Cochiti Pueblo on the west side of the Rio Grande below the grant to Pedro Sanchez (CPLC, Case 260). In the meantime Salvador Gonzales gained a considerable advantage over other farmers and water users in the Rio Santa Fe valley when he received a grant of agricultural lands along the Rio Santa Fe in the cañon to the east of the villa boundaries (SANM I:332; U.S. Surveyor General, Case 82).

Interest in the Santa Fe Valley continued during 1743, despite the shortage of water claimed in the earlier case of Vicente Duran y Armijo. In April 1743, Juan Antonio de Archuleta and Leonardo Gonzales received possession of a piece of cultivable land along the Rio Santa Fe sufficient to plant 6 fanegas of wheat and 4 fanegas of corn (CPLC, Case 104). In September of the same year Joseph Isidro de Medina and three other residents of Chimayo in the jurisdiction of Santa Cruz de la Cañada petitioned for and received possession of grazing land and 3 fanegas of corn-planting land in the area of Cundiyo (CPLC, Case 211). The grant excluded the cultivated lands of the residents of Pueblo Quemado, another satellite community of Chimayo that was occupied under the terms of an unknown grant (CPLC, Case 212; SANM I:718).

Santiago Ramirez obtained a grant of land on both sides of the Rio Santa Fe between Peñasco Largo and Cieneguilla in July 1744 (U.S. Surveyor General, Case 136). In January 1746, Jose Romo de Vera of Santa Fe was placed in possession of a tract of land on the Rio Santa Fe below the villa (CPLC, Case 122). While there is no record of the original grant for lands along the Rio Tesuque above Tesuque Pueblo, we do know that on November 25, 1744, Capt. Antonio Montoya of Santa Rosa de Lima de Abiquiu sold a tract of land along the Rio Tesuque to Lt. Juan de Benavides (CPLC, Case 123). Captain Montoya was acting as executor for the estate of his deceased brother, who had purchased the land from Pedro Vigil of Santa Cruz de la Cañada in August 1744. Further, we have the 1776 testimony of Juan Candelaria of Albuquerque to the effect that the town of Rio Tesuque was settled in 1740 (Armijo 1929:285).

In 1742 the only new grant of land in the Taos Valley dating to the mid eighteenth century was made at Los Luceros. Pedro Montes Vigil, on behalf of himself and his two nephews, petitioned for and received a tract of land between the Arroyo Hondo and the lands of the Pueblo of Taos which had previously been granted to others by Governor Felix Martines but which had not been occupied (U.S. Surveyor General, Case 47). Three years later Antonio Martin received lands east of the lands of the Pueblo of Taos that lay between the lands of his father, Sebastian Martin, and those of Pedro Montes Vigil (U.S. Surveyor General, Case 47).

While the early 1740s had seen a rapid expansion of settlements south of Isleta in the Rio Abajo, by the middle of the decade there was more interest in land closer to Bernalillo and Albuquerque. At the same time, in 1746, Governor Rabal and Fray Menchero reestablished the Pueblo of Sandia with refugees from the Hopi province (SANM I:531, 848, 1347; U.S. Surveyor General, Case P). In November 1745, Juan Jose Gallegos of Cieneguilla made a petition for vacant land on the east bank of the Rio Grande above Bernalillo (U.S. Surveyor General, Case 84). The land was a vacant tract between those held by the pueblos of San Felipe and Santa Ana. Land at the Rancho de Pajarito south of Albuquerque and west of the Rio Grande was occupied in 1746 (CPLC, Case 73; U.S. Surveyor General, Case 157). In that year Governor Rabal settled the estate of Josepha Baca, which included the Rancho de Pajarito. Before 1750 the Lo de Padilla tract had been occupied by Diego Padilla, who was also the owner of the El Tajo grant (CPLC, Case 273). On February 4, 1750, the seven heirs of Diego Padilla certified before Capt. Miguel Lucero, alcalde mayor of Albuquerque, that they had sold the rancho to Isleta Pueblo.

In the early 1750s the settlers who had abandoned the Rio Chama in the late 1740s because of Ute and Comanche raids reoccupied some of their communities (SANM I:186; Figure 11). In 1750 Governor Cachupin threatened the Chama Valley refugees at Santa Cruz de la Cañada with forfeiture if they did not resettle their grants, but he also promised a military escort to protect them (SANM I:1100). Some of the settlers were still reluctant to return. Bartolome Trujillo, for example, directly refused the governor's order and had his property restored to the royal domain (CPLC, Case 263; SANM I:247). The lands at Santa Rosa de Lima de Abiquiu were reoccupied in April 1750. Four years later Governor Cachupin sought to buttress the defenses of the area as well as the nerve of its Hispanic residents by establishing a genizaro settlement at the abandoned pueblo of Abiquiu (CPLC, Case 52; U.S. Survey General, Case 140). Ojo Caliente was resettled in 1753 under the supervision of the alcalde mayor, Bernardo de Bustamante y Tagle (SANM I:650).

Other potential settlers also appear to have been reluctant to leave the safety of the area around Santa Cruz and Santa Fe. In June 1752, Juan de Gabaldon received possession of a grant of cultivable land on the Rio Tesuque above the holdings of Lt. Juan de Benavides (SANM I:352); U.S. Surveyor General, Case 65). Gabaldon sought these lands because of the unavailability of planting land near Santa Fe caused by the scarcity of irrigation water

To the north along the Rio Truchas, Francisco Montes Vigil of Santa Cruz sought uncultivated lands near the new settlement of Nuestra Señora del Rosario, San Fernando y Santiago. On orders from Governor Cachupin, the alcalde of Santa Cruz, Juan Jose Lovato, made certain that the requested grant would not adversely affect the community of Nuestra Señora or the village of Santo Tomas del Rio de las Trampas. Vigil was given possession of the grant during May of 1754 (SANM I:1053).

In the late 1750s and through the 1760s a surge of settlement activity occurred along the major western tributaries of the Rio Grande as a result of continued peace with the Navajos (Widdison 1958). Most of the activity was focused in the Rio Abajo, particularly in the valley of the Rio Puerco and in the San Mateo Mountains (Mt. Taylor). Agricultural grants extended from the confluence of the Rio Puerco and Rio San Jose to near the headwaters of the Rio Puerco in the area around present-day Cuba. Grazing grants covered the uplands and valleys to the west of the Rio Puerco as far as San Mateo on the west side of Mt. Taylor. Most of the settlers in this western region came from the Albuquerque area, where land was scarce because of population growth.

In 1768 the first Spanish settlement in the Jemez Valley occurred when Paulin Montoya and five other residents of the Albuquerque area obtained possession of agricultural land along Vallecitos Creek to the northeast of Jemez Pueblo (CPLC, Cases 130 and 182; SANM I:584). As early as 1744, Hispanic settlers had taken an interest in the lands west of the pueblos of Jemez and Zia. In that year Jose Mariano de los Dolores and other vecinos had petitioned for land with water for farming and herding that lay west of Zia and Jemez. The request was refused by the governor because the lands were too far from other settlements and thus too exposed to attacks from nomadic Indians (SANM I:965). Some attempts were made to settle the eastern edge of the Rio Grande Valley near Albuquerque, despite the continual danger of Comanche raids. In February 1763, Cristobal Jaramillo and other residents of the Albuquerque area received a grant that included agricultural land at Carnuel near the mouth of Tijeras Canyon (SANM I:202; U.S. Surveyor General, Case 150). Two years later settlers from Bernalillo, led by Juan Gutierrez, sought to settle on previously occupied but currently abandoned lands at the north end of the Sandia Mountains (CPLC, Case 90; U.S. Surveyor General, Case 144). An investigation of the Las Huertas Valley by Alcalde Mayor Bartolome Fernandez showed that sufficient land and water existed in the small valley to sustain eight families. By 1767, 21 families had settled at San Jose de las Huertas as a result of the consent of Governor Cachupin to Gutierrez's earlier petition. In December 1767, the settlers sought and received a grant of land at Las Huertas, for which they received royal possession in January 1768 (U.S. Surveyor General, Case 144).

In the meantime, Comanche raids had caused the settlers at Tomé to abandon that community sometime in the late 1750s or early 1760s. This exposed settlement was resettled in 1765 (Thomas 1932:106) during the expansionist period of the mid eighteenth century in the Rio Abajo. At about this same time references to a community at Las Nutrias (south of Tomé near the mouth of the Abo arroyo) appear in the documentary sources (SANM I:780 and 791; U.S. Surveyor General, Case 99).

In 1765 Miguel and Domingo Romero of Cieneguilla were ordered by Governor Cachupin to vacate a tract of land on the Rito de los Frijoles that they had occupied since 1759 or 1760. They claimed that this land had been given as a grant to their grandfather, Andres Montoya, in 1739 (CPLC, Case 41), but Governor Cachupin found the grant to be defective and illegal, since they were cultivating land that was royal domain and only to be used for the grazing of livestock. In 1767 Governor Mendinueta heard a further appeal by the Romeros and declared that they had no claim to a grant but had the right to graze livestock on this royal domain, as did anyone else (CPLC, Case 41). In April 1768, the residents of the town of Atrisco, who held sufficient farming land along the Rio Grande, sought and received grazing lands to the west, toward the Rio Puerco (SANM I:694; U.S. Surveyor General, Case 145).

Throughout the Chama Valley resettlement continued in the 1760s. In 1766 Pedro Martin Serrano of Abiquiu petitioned the governor for a grant of the lands of the late Jose de Riaño in the Valle de la Piedra Lumbre (U.S. Surveyor General, Case 73). Serrano had been grazing his stock on the lands that he had acquired from Domingo de Luna of Tomé but had found that Luna and his predecessors, Antonio Montoya and Jose de Riaño, had an imperfect title to the land because

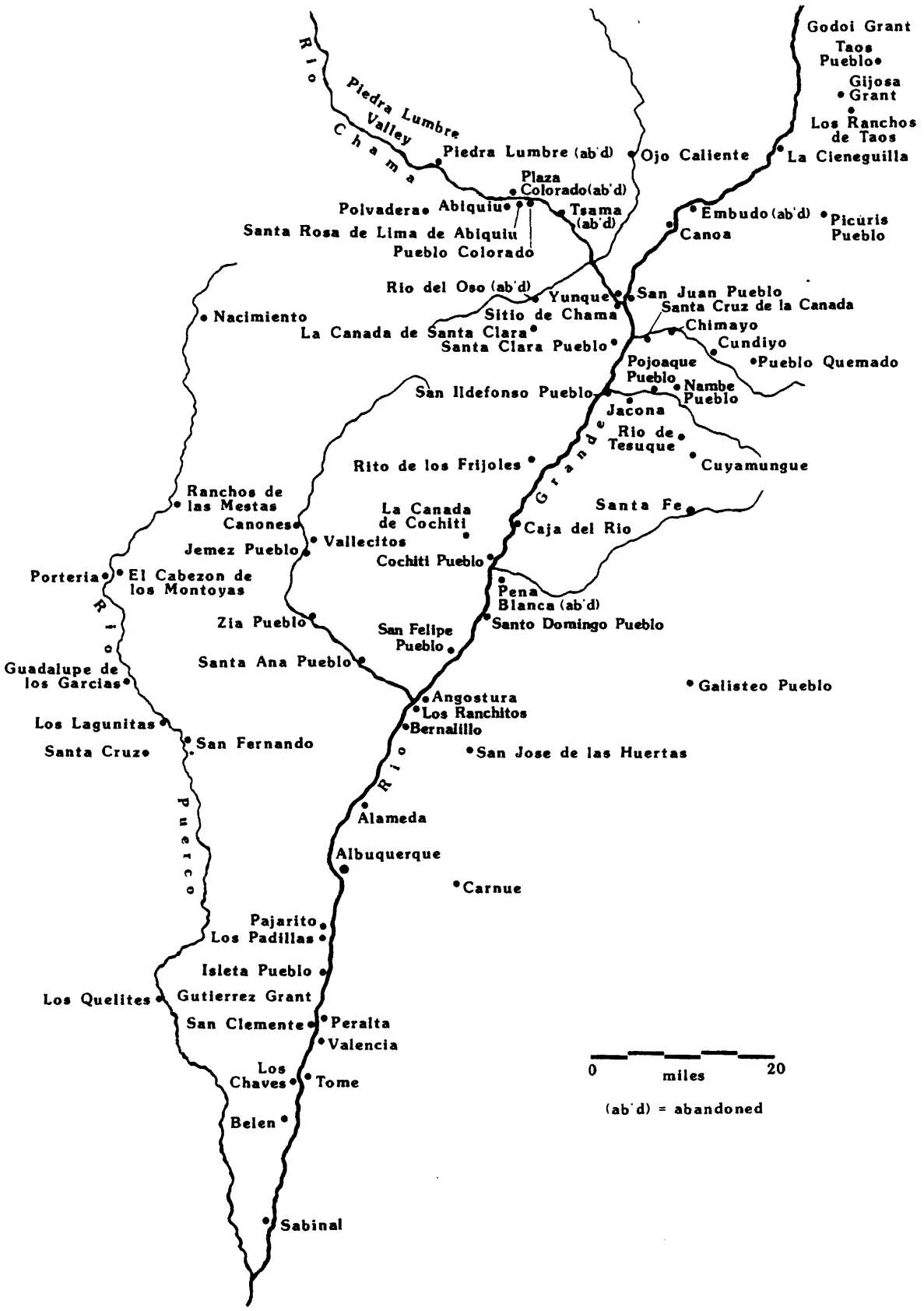

Figure 11 Rio Grande Valley in 1770

of repeated abandonments. On February 18 Pedro Martin Serrano was placed in possession of the lands in the Piedra Lumbre Valley by the alcalde mayor of Abiquiu (U.S. Surveyor General, Case 73). One day later Serrano's brother, Juan Pablo Martin, received possession of agriculture and grazing land along the Polvadera Valley, which was adjacent to the Piedra Lumbre grant (SANM I:568; U.S. Surveyor General, Case 131).

In 1753 Ojo Caliente had been resettled but was abandoned again shortly thereafter (SANM I:650). On February 15, 1766, Governor Cachupin declared all the lands at Ojo Caliente to be royal domain because they had been forfeited by the previous settlers (CPLC, Case 227). In December, 1767, Governor Mendinueta offered a resettlement right to those who had abandoned lands at Ojo Caliente, if they presented themselves to the governor within a prescribed time. When no one came forward, Governor Mendinueta declared the lands open for settlement on March 11, 1768 (CPLC, Case 227; SANM I:655 and 656). Ten days later Jose Ignacio Alarid and Gabriel Quintana petitioned for the rancho at Ojo Caliente that had been abandoned by Geronimo Pacheco (CPLC, Case 227; SANM I:43). On March 24, 1768, the alcalde mayor of San Cruz de la Cañada, Antonio Jose Ortiz, placed Alarid and Quintana in possession of the rancho with its agricultural and grazing land along the Rito de Ojo Caliente (CPLC, Case 227).

As quickly as the expansion of settlements had occurred, the frontier communities were abandoned (Figure 12; compare with Figure 11). The renewal of Navajo attacks and the intensification of Comanche and Apache raids ravaged New Mexico in the 1770s. The nomads would hold the Rio Grande settlements in a vise for two decades, as attacks came from the south, east, and west; only the precarious peace with the Utes saved New Mexico from attacks from the north (John 1975:465–486, 557–611). In 1771 settlers at Carnuel abandoned the settlement and sought permission from Governor Mendinueta to abandon the site permanently (U.S. Surveyor General, Case 150). The governor ordered the refugees from Carnuel to return to their community, but on April 24, 1771, in a meeting at Albuquerque with the alcalde mayor, the settlers declined to resettle Carnuel because of the danger of Apache attacks. Consequently on May 20, 1771, Governor Mendinueta ordered the alcalde mayor, Jose Apodaca, to demolish the settlement at Carnuel, which was accomplished on May 27, 1771 (U.S. Surveyor General, Case 150).

In 1771, the community of Las Nutrias was abandoned as a result of Apache raids (Adams and Chavez 1956:254; SANM I:645). The settlement was reported by Fray Dominguez to have had good agricultural lands, which were irrigated with water from the Rio del Norte, but the friar's 1776 description of this recently abandoned community points out the fundamental cause of its failure: Las Nutrias was a settlement of ranchos and not a village with its population concentrated around a defensive plaza.

The Rio Puerco settlements suffered a similar fate. Navajo raids during 1772 forced Governor Mendinueta to organize a military expedition to carry out the evacuation of the settlements and ranchos in the Rio Puerco region; by the end of 1774 the Spaniards had abandoned the western settlements, except for Vallecitos above the Pueblo of Jemez, and retired into the Rio Grande Valley (Adams and Chavez 1956:254). At the same time, the Ojo Caliente Valley was again abandoned as a result of Comanche attacks (Adams and Chavez 1956:78).

In the face of nomadic onslaughts, virtually the entire expansion of the 1750s and 1760s was wiped out in only 2 years. The Spaniards considered themselves lucky to be able to retain control of the Rio Grande Valley itself. No land grants were established or resettled during the 1770s. Petitions for grants were received, but they were rejected, as in the case of 36 refugee settlers from the Rio Puerco, who petitioned for lands at the recently abandoned site of Carnuel (SANM I:46). Only limited new settlement occurred during the 1780s. New land grants were confined to the Santa Fe area and along the Rio Jemez.

In September 1782, Mateo Roybal obtained a regrant of the lands at the Pueblo of Jacona, east of San Ildefonso, that were originally given to Ignacio Roybal by Governor Cubero (CPLC, Case 35; SANM I:1261). In January 1782, Domingo Romero and other residents of Santa Fe obtained a grant of grazing lands along the Galisteo River, where the last Tanoan Indians would finally abandon the Pueblo of Galisteo after 1780 because of persistent and crippling Comanche raids (SANM II:1188; U.S. Surveyor General, Case 64). By the 1780s the only unclaimed lands in the Santa Fe area seem to have been grazing lands. In 1785 Roque Lovato petitioned for and received land north of the villa from Governor Anza (U.S. Surveyor General, Case 52). In November 1785, Bartolome Fernandez sold 700 varas of arable land at La Majada to Miguel Ortiz (CPLC, Case 89). The only other grant of land made by Governor Anza was to Antonio Armenta and Salvador Antonio Sandoval in 1786 for arable lands at San Ysidro, which lay between Jemez and Zia pueblos along the Rio Jemez (U.S. Surveyor General, Case 24).

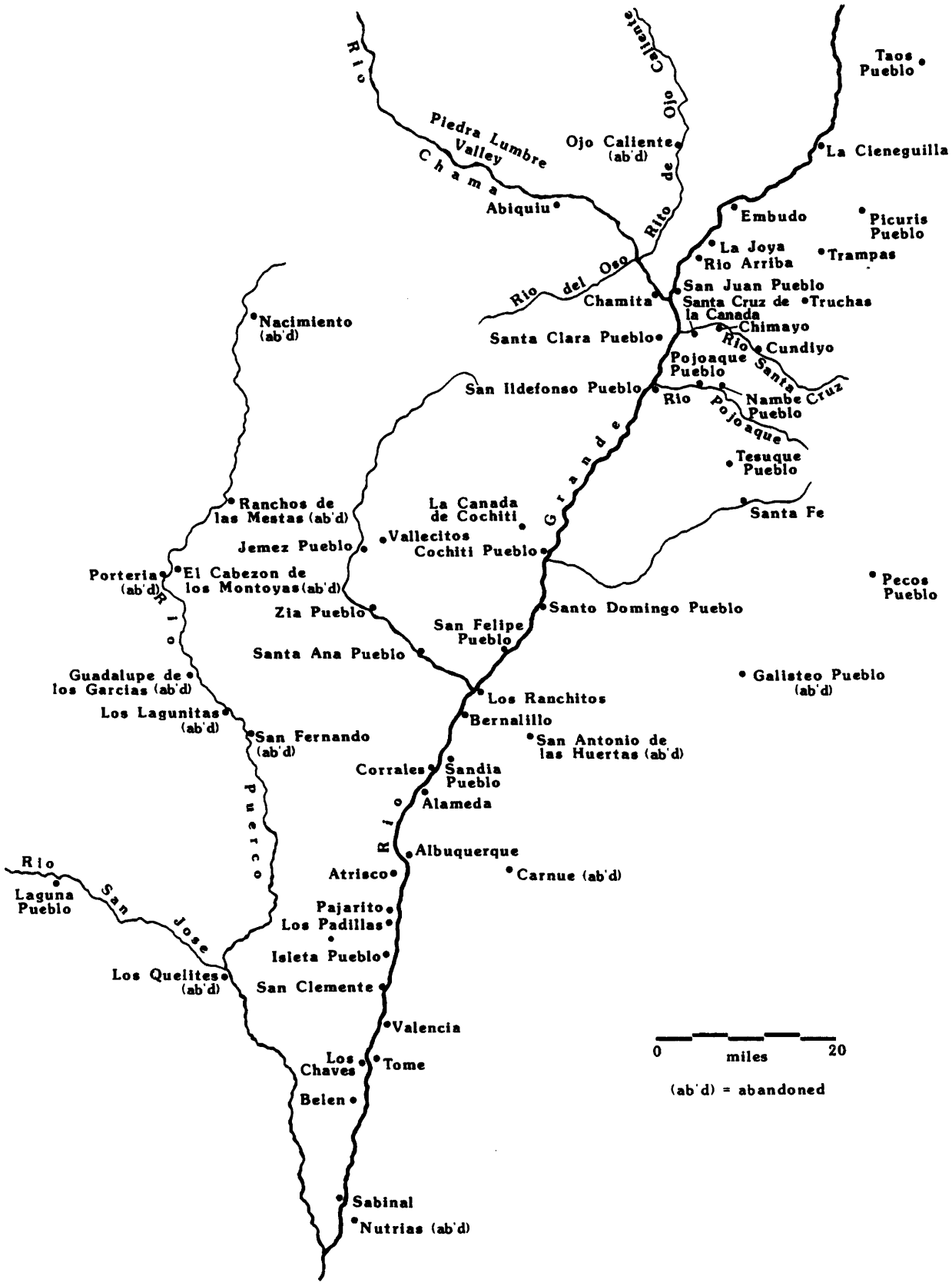

Figure 12 Rio Grande Valley in the 18th Century (to 1776)

By the time he left office in 1787, Governor Anza had established the first peace with the Comanches that would last for more than a brief period; he had also restored peace with the Navajos and considerably reduced the danger from Apache raids (John 1975:656–735). As a result a new wave of settlement and expansion began in the late 1780s and lasted throughout the mid 1790s. Even the Mesilla Valley in southern New Mexico became an object of interest for settlers; around 1790 Juan Antonio Garcia apparently received a grant to graze cattle at Santa Teresa, which was intermittently occupied for the next 30 years, depending upon the presence or absence of Apache raiders (CPLC, Case 168; U.S. Surveyor General, Case 111).

The government did not always encourage settlement. In 1790 citizens from the Rio Arriba petitioned to be allowed to settle at Ojo Caliente, but the governor denied their request on the grounds that the area was too exposed to raids by nomadic tribes (SANM I:1062). The end of the Comanche threat in the Rio Arriba on the west side of the Rio Grande restored a sufficient sense of security so that in September 1793, 53 residents at Ojo Caliente, who had already demonstrated the feasibility of settlement by moving to the area, again petitioned Governor Concha for formal possession of their lands (CPLC, Case 88; SANM I:644). On October 5, 1793, Manuel Garcia de la Mora, alcalde mayor of the jurisdiction of La Cañada, placed these 53 vecinos in possession of the grant at the mouth of the Cañada de los Comanches and divided up the agricultural land into pieces that each measured 150 varas wide (CPLC, Case 88; SANM I:664; U.S. Surveyor General, Case 77).

In June of 1793 the alcalde mayor of San Geronimo de Taos placed Salvador Lovato and two other settlers in possession of land that lay along the road from Taos to Picuris, in what had previously been a dangerous location (CPLC, Case 93). This was the first grant of land within the jurisdiction of Taos in almost 50 years and was followed in 1795 and 1796 by further grants.

In February 1795, the alcalde mayor, Antonio Jose Ortiz, placed 20 families in possession of land at Cieneguilla on the Rio Grande above Embudo and on the road from Taos to Ojo Caliente (U.S. Surveyor General, Case 62). The alcalde divided the agricultural land among the settlers and laid out the plaza, which Governor Chacon had ordered because of the settlement's exposed position (U.S. Surveyor General, Case 62). Two months later Chacon ordered Ortiz to place Jose Mirabel and several other petitioners in possession of grazing lands above San Francisco de las Trampas, despite that community's objections, which were based on fear that the new grant would jeopardize the Las Trampas irrigation water supply (U.S. Surveyor General, Case 58).

Early in 1796 Governor Chacon entertained a petition from Valentin Martin, Usebio Martin, and Juan Olguin to resettle the abandoned sitio of Santa Barbara, which lay near present-day Peñasco (CPLC, Case 96). The governor made the grant on the condition that at least 50 families settle at Santa Barbara. At the same time he declared that the former settlers had forfeited any rights by abandoning the grant. On April 3, 1796, Manuel Garcia, the alcalde mayor of the jurisdiction of La Cañada, placed 67 vecinos in possession of the grant and divided the agricultural land into tracts 100 varas wide along the river (CPLC, Case 96). In May 1796, the alcalde mayor of Taos placed 63 families in possession of lands at Don Fernando de Taos under a grant from Governor Chacon (SANM I:883; U.S. Surveyor General, Case 125).

While the Taos area was attracting settlers for the first time in more than half a century, settlement continued in the Jemez Valley, where an agricultural community was established in 1798 at the confluence of the Rio Guadalupe and Rio Jemez (SANM I:375; U.S. Surveyor General, Case 25). The grant was adjacent to Jemez Pueblo lands. This grant to the brothers Francisco and Antonio Garcia de Noriega and several dozen other petitioners was an extension of the boundaries of an earlier grant received by the Garcias in 1788. This was the last expansion of settlement in the Jemez Valley for nearly a decade (U.S. Surveyor General, Case 122).

In the meantime the Comandante General of the Provencias Internas ordered Governor Nava to extend the southern boundary of the Rio Abajo and thereby increase security along the road from Santa Fe to El Paso (SANM I:1171). Governor Nava was to establish new settlements at the abandoned pueblos of Senecu, Socorro, Alamillo, and Sevilleta (SANM I:1199). Nava decided to begin with Alamillo, but because of the exposed and dangerous location of the proposed site, the governor had no success in attracting volunteers to settle there and instead had to dragoon settlers into taking up residence at the new settlement during the spring of 1800 (CPLC, Case 13; SANM I:1171).

The interest of the government in increasing security along the road from El Paso to Santa Fe and the need for additional grazing lands in the El Paso area caused Juan Antonio Garcia to occupy land at El Brazito, where he constructed an acequia in 1805 (SANM I:410; U.S. Surveyor General, Case 6). By gifts of corn, Garcia secured peace with the Apaches and occupied the tract of pasture land for 11 years before seeking to legalize his possession (U.S. Surveyor General, Case 6). A similar occupation occurred in northern Rio Abajo around 1803 when Bartolome Fernandez settled on vacant land between Santo Domingo and San Felipe, although he waited 12 years before seeking a formal grant (CPLC, Case 267).

During the first decade after the turn of the nineteenth century the most active area of settlement was in the Chama Valley above Abiquiu. In July 1806, Mariano Martin and the other heirs of Pedro Martin (Serrano) petitioned Governor Alencaster for a revalidation of the land grant to Pedro Martin at Las Casas de Riaño, which had been abandoned during the Navajo wars (CPLC, Case 30). A favorable investigation by Manuel Garcia de la Mora, alcalde mayor of the jurisdiction of La Cañada, caused Alencaster to order Mora to place the heirs to Pedro Martin in possession of the Piedra Lumbre grant on August 10, 1806 (CPLC, Case 30). Actual possession, however, was not given until April of 1807.

In July 1806, Francisco Salazar and two dozen other residents of Abiquiu petitioned Governor Alencaster for a tract of unsettled land at Cañon del Rio de Chama that lay above the Martin lands (CPLC, Cases 107 and 218; U.S. Surveyor General, Case 71). On July 14, 1806, the alcalde mayor of La Cañada, Manuel Garcia de la Mora, reported on a careful investigation of conditions at El Cañon del Rio de Chama, which he had made on orders from Alencaster. Mora found the area suitable for an agricultural community, with sufficient land for 31 settlers and easy access to irrigation water at five or six places. As a consequence of this report Governor Alencaster made the grant to Salazar and 25 other settlers on August 1, 1806, but they did not receive possession of their lands until March 1808, apparently because of adverse military conditions in the region (CPLC, Cases 107 and 218; U.S. Surveyor General, Case 71).

During February of 1807 Juan Bautista Valdez and seven other residents of Abiquiu declared that they had cleared 200 varas of vacant land in the Cañon de los Pedernales with the permission of the alcalde, Manuel Garcia de la Mora (CPLC, Case 179). The alcalde certified that the settlers' statements were correct and that they had cleared the land because of the lack of sufficient cultivable land at Abiquiu. On December 16, 1807, Governor Alencaster made the grant to Valdez, and he and the other settlers were placed in possession by Mora on February 4, 1808 (CPLC, Case 179). In 1824 the settlement was considerably expanded when displaced settlers from Rito Colorado (near El Rito) were moved onto vacant land at San Miguel de Los Cañones, where agricultural land had been cleared in 1814 (CPLC, Case 179). About 1807 Joaquin Garcia acquired land at El Rito (apparently by a grant from Governor Alencaster), parts of which he sold as early as June of 1808 to other interested parties from Abiquiu, Ojo Caliente, Taos, Las Casas de Riano, and Cañon del Rio de Chama (U.S. Surveyor General, Case 151).

The renewal and persistence of Navajo raids and the fear of antagonizing the Utes caused the government to refuse to entertain any more petitions for land grants in the Chama Valley for nearly 15 years (SANM II:2285, 2714, 1282). In the interim the pace of settlement accelerated in other parts of New Mexico, especially in the Rio Abajo.

At the end of 1808 Governor Alencaster made a grant to Sgt. Cristobal de Gongora of land north of the villa of Albuquerque at the site of the abandoned rancho of Luis de Carabajal (CPLC, Case 8). In April 1814, Juan Antonio Lujan received permission from Governor Manrique to reoccupy the Rito de los Frijoles, which he had occupied until 1811 under a grant from Governor Anza dated 1780 (U.S. Surveyor General, Case 133).

In the mid 1810s the settlement frontier of the Rio Abajo jumped south to Socorro. This set off a wave of movement into the area of the former Piro Province, which had been abandoned by the Indians more than a century earlier (U.S. Surveyor General, Case 107). The settlement of Socorro was part of the plan formulated in 1800 by the Comandante General of the Provencias Internas to increase the security of the road from El Paso to Santa Fe (CPLC, Case 127; SANM I:1171 and 1199). Around 1815 Governor Maynes ordered the alcalde mayor of Belen, Bartolome Baca, to permit the resettlement of Socorro. In November 1817, Xavier Garcia and Anselmo Tafoya petitioned Governor Allande on behalf of themselves and 70 other families who resided at Socorro for documents showing their legal ownership of the grant (CPLC, Case 127; SANM I:382 and 890; U.S. Surveyor General, Case 107). In August 1818, Governor Melgares ordered the alcalde mayor to provide the residents of Socorro with the necessary legal documents (U.S. Surveyor General, Case 107).

One year later Pedro Armendaris received possession of a large grazing grant with farmlands on the east side of the Rio Grande at the northern edge of the Jornada del Muerto; Governor Melgares made the grant in order to facilitate travel and stock drives across the Jornada (U.S. Surveyor General, Case 33). The grant included farming lands at Valverde along the river, where Armendaris erected a mill and constructed an acequia in 1820. In 1825 the Navajos destroyed the farm and the Mexican garrison at Valverde; as a result Armendaris abandoned the grant and returned to Chihuahua (U.S. Surveyor General, Case 33).

The year 1819 was a busy one in the Rio Abajo. First, the site of Carnuel was reoccupied in March. In November of the previous year Juan Duran and 19 other settlers from Albuquerque had petitioned for land at Carnuel; an investigation by the alcalde mayor was favorable, but no grant was made (U.S. Surveyor General, Case 150). Subsequently, in January 1819, Juan Ignacio Tafoya and 26 other residents of Albuquerque petitioned Governor Melgares for the same land. In February 1819, the alcalde mayor made an investigation of conditions at Carnuel, and on the basis of his favorable report Governor Melgares ordered the alcalde to divide the agricultural lands at Carnuel and place the settlers in possession of the grant (U.S. Surveyor General, Case 150).

In May 1819, Carlos Gabaldon and other residents of the town of Sevilleta obtained a grant of lands that lay south of Sabinal and north of the Arroyo San Lorenzo (CPLC, Case 55; U.S. Surveyor General, Case 95). Sevilleta was one of the sites that had been proposed for resettlement in 1800 (SANM I:1171). In June 1819, the alcalde mayor of Belen placed Carlos Gabaldon and 67 other settlers in possession of lands that lay on both sides of the Rio Grande, under the condition that they maintain a required level of weapons and horses (CPLC, Case 55; U.S. Surveyor General, Case 95).

Meantime, in the Taos area settlement began to move north. On February 21, 1813, Governor Maynes issued a decree inviting all inhabitants of New Mexico without sufficient cultivable land to settle on vacant royal lands (U.S. Surveyor General, Case 159; see also SANM I:1104 for 1815). In March 1815, Nerio Sisneros and more than three dozen other residents of Taos made a petition for unoccupied lands at Arroyo Hondo in which they referred to Governor Maynes's decree. In April 1815, on orders from Governor Maynes, Pedro Martin, alcalde mayor of Taos, placed 44 families, including that of Nerio Sisneros, in possession of lands at Arroyo Hondo, on the condition that they reside in a central plaza and remain well armed (CPLC, Case 5; U.S. Surveyor General, Case 159). Subsequent records show that additional settlers moved onto the grant throughout the 1820s (CPLC, Cases 175 and 176). On October 30, 1821, Jose Ignacio Martin petitioned for agricultural lands in the upper Arroyo Hondo that he had occupied in 1816; these fields were under irrigation from the acequia he had helped build from the Arroyo Hondo to the Arroyo Seco (CPLC, Case 174). In October 1815 the alcalde mayor, Pablo Lucero, gave possession of lands along the Rito San Cristobal to Severino Martinez and his son Juan Antonio Martinez (U.S. Surveyor General, Case 110). During 1835 surplus agricultural lands along the San Cristobal River were given to a group of settlers led by Antonio Jose Martinez (U.S. Surveyor General, Case 110).

While much vacant land was still available in New Mexico, the government was not always willing to make grants to royal domain. In 1815 Jose and Miguel Montoya petitioned for lands at the abandoned settlement of Nacimiento but were refused owing to the exposed and isolated location of the area (CPLC, Case 144).

As early as 1794 a grant of lands on the Pecos River had been made at San Miguel del Vado. In the 1810s and 1820s the pace of settlement to the east of the Rio Grande Valley picked up, first as further grants were made along the Pecos (Hall 1984:3–66) and then in the 1820s and 1830s on the east side of the Sangre de Cristos, the Sandias, and Manzanos. Grants were also made in the Estancia Valley and as far east as the middle Canadian River, but the focus of settlement remained in the Rio Grande Valley throughout the Mexican period.

Chapter 5

THE MEXICAN REGIME AND LAND GRANTS IN THE RIO GRANDE VALLEY

Little changed in the formalities of obtaining land grants under the Mexican regime, and the vicissitudes of settlement remained much the same as well (Figure 13). The total area given in land grants between 1821 and 1846, however, probably exceeded that granted during the preceding 125 years (Westphall 1983:25–65). Most of these grants were outside the Rio Grande Valley and placed large areas of grazing land under the control of individuals in massive and sometimes questionable transfers of public lands to prominent New Mexicans, who were aided and abetted by Mexican government officials in New Mexico. This raid on the public domain had precedents in the grazing grants west of the Rio Puerco in the 1760s and had been attempted in the Chama Valley in 1735 by the ricos from Santa Cruz de la Cañada.

In the Rio Abajo, the southernmost limit of successful settlement had been retracted to Socorro when the Armendaris rancho at Valverde was abandoned in 1825 (U.S. Surveyor General, Case 33). In September, 1823, Jose Maria Perea and 42 other residents of Manzano had their request for lands between Tomé and the abandoned settlement of Las Nutrias approved by the *ayuntamiento* of the province (U.S. Surveyor General, Case 5). This move from Manzano was probably in response to a decree from the governor on April 23, 1823, ordering all settlements scattered in the mountains and valleys to attach themselves to settlements in the Rio Grande Valley (CPLC, Case 90). In particular the governor ordered the alcalde at Alameda to have the residents of San Antonio de las Huertas move into the valley and to make cultivable lands available for them (CPLC, Case 90). On April 25, 1823, the alcalde at Algodones reported that he had distributed the residents of Las Huertas from Angostura to the boundary of San Felipe Pueblo (CPLC, Case 90). On April 25, 1825, the constitutional alcalde for Socorro, Juan Francisco Baca, placed Antonio Chaves and Pedro Jose Perea in possession of agricultural and grazing lands along the Arroyo San Lorenzo on the west side of the Rio Grande above Socorro (SANM I:218; U.S. Surveyor General, Case 79).

After a serious setback, in which a number of peripheral settlements were abandoned in the early 1820s during the Navajo wars, the Chama Valley experienced an increase in settlement during the mid 1820s (SANM I:1282). In May 1824, Juan Benito Sanchez was placed in possession of 200 varas of land at Vallecito de Lovato; he had cleared this land in 1822 but had been forced to abandon it because of Navajo raids (CPLC, Case 142). Also in early 1824 Francisco Garcia and 15 other residents of the jurisdiction of Abiquiu were placed in possession of vacant land some two leagues from Rito Colorado above El Rito by the alcalde, Manuel Garcia, only to be driven off by ricos from Abiquiu, Ojo Caliente, Taos, Las Casas del Riano, and Cañon del Rio de Chama (CPLC, Case 179). The governor rejected the petition of the refugees from Rito Colorado but directed the alcalde of the jurisdiction of Abiquiu to find some vacant land for them at Las Casas del Riano (SANM I:387). Over the protest of the residents of San Miguel de los Cañones, vacant agricultural land sufficient to give 150 varas to each refugee was found above the community of Cañones (CPLC, Case 179). In February 1824, Jose Rafael Samora and 25 other residents of the jurisdiction of Abiquiu received possession of lands at Vallecito that lay above the lands of Juan Valdez on the Rio de Ojo Caliente (U.S. Surveyor General, Case 108).

Because of the increasing density of settlement in the Rio Arriba and Taos areas, large tracts of grazing land became scarcer and more valuable. Juan de Jesus Lucero petitioned Governor Narbona for just such a tract on the west side of the Rio Grande above Ojo Caliente at the Llanos de los Aguajes (CPLC, Case 169; U.S. Surveyor General, Case 117). On September 9, 1826, Francisco Vigil, alcalde at Abiquiu, placed Lucero in possession of the grazing grant on the orders of Governor Narbona but under the condition that Lucero and his men be well armed.

Meanwhile, on the east side of the Rio Grande, Governor Vizcarra subdivided the Arroyo Hondo grant by assigning surplus agricultural lands to Manuel Fernandez in 1823 and Felipe Medina in 1824 (CPLC, Cases 175 and 176). The uplands at Cañada de las Mestanas that separated the Arroyo Hondo and Rito Cristobal were defined as vacant land

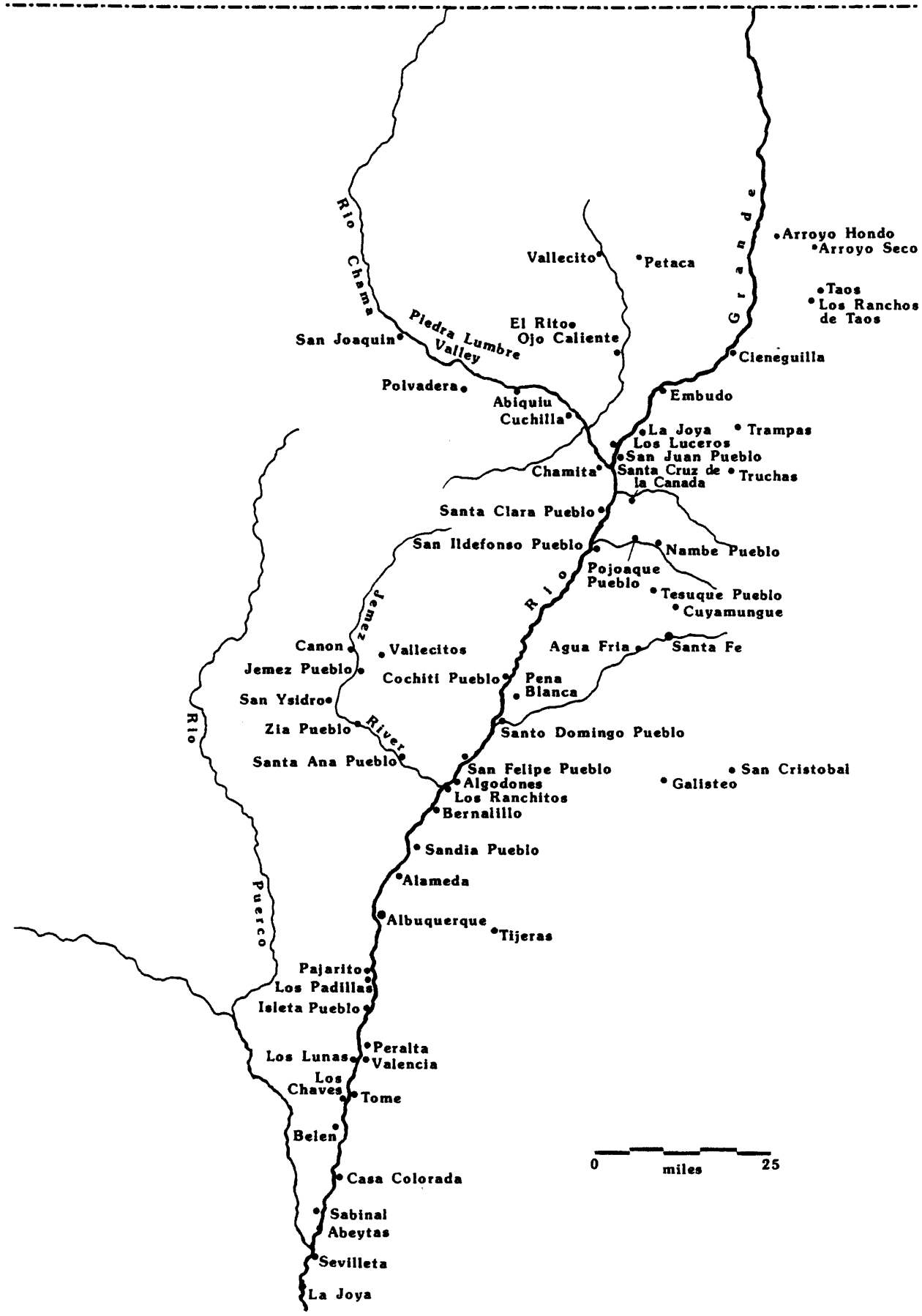

Figure 13A Rio Grande Valley in 1821/1823 (northern half)

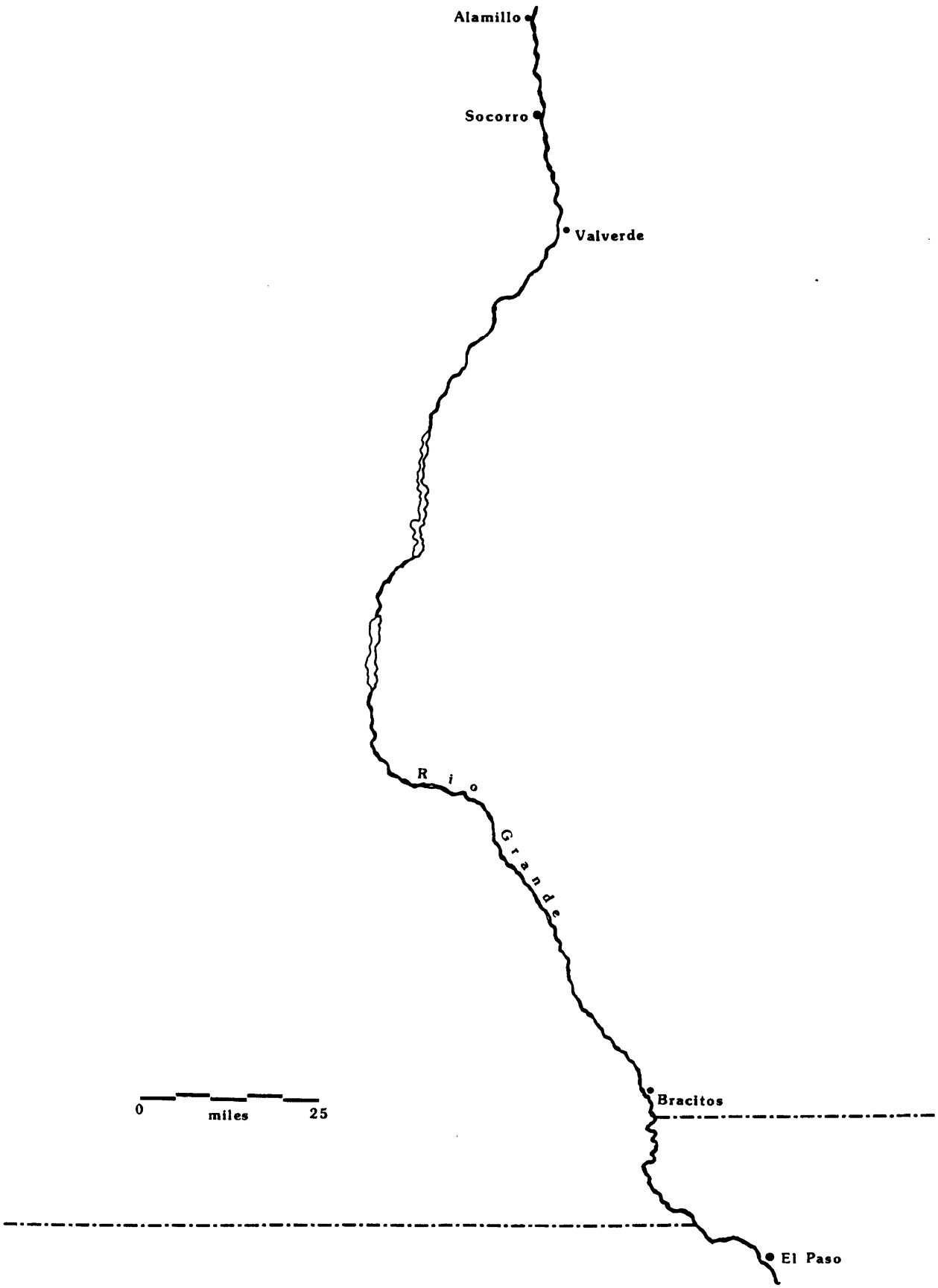

Figure 13B Rio Grande Valley in 1821/1823 (southern half)

under the decree of 1813 and given to a small group of settlers in December 1828 (CPLC, Case 163). The alcalde, Vicente Trujillo, ordered the settlers to build a well-fortified plaza and to provide themselves with firearms. He also allowed these settlers to take irrigation water from the Rito Cristobal (CPLC, Case 163).

To the south of Taos, lands were assigned by the ayuntamiento of La Cañada. In April 1829, after an investigation of a petition by 20 settlers for vacant land on the upper Rio del Pueblo and despite objections by the Pueblo of Picuris, Rafael Fernandez and the other settlers had their grant approved (CPLC, Case 65). In April 1832 Fernandez and 22 other settlers sought to have the grant approved by the ayuntamiento of Taos; on August 16, 1832, the alcalde placed the petitioners in possession of their land and divided the agricultural lands among 42 families (CPLC, Case 65). The occupation did not succeed, however. Because they had failed to settle the grant in 1832, the alcalde, Juan Antonio, had to give Fernandez and the other petitioners possession of the grant once again in April 1837, this time on the condition that they settle and cultivate the land (CPLC, Case 65).

Even before the end of the colonial regime, Manuel Martinez, Juan Pablo Romero, and other wealthy stockmen from Abiquiu had petitioned the governor for land in the area of Tierra Amarilla (SANM I:615). In 1824 Martinez and Romero repeated the petition for the Tierra Amarilla land grant (SANM I:805). The petitioners, including a number of the most substantial landowners and stockmen from the lower Chama Valley who needed the rangeland to pasture their growing flocks of sheep, sought the land under the pretense of poverty. Finally, in July 1832, the grant was made by the ayuntamiento, but the alcalde refused to place Martinez and his associates in possession because of the imminent danger of Indian attacks (U.S. Surveyor General, Case 3). Martinez and his associates never were given formal possession of the lands at Tierra Amarilla but utilized the grazing lands intermittently whenever Indian hostilities abated (CPLC, Case 3).

Sometime in the early 1830s a small tract of land near Abiquiu at Plaza Blanca, which lay east of Plaza Colorado, was occupied by farmers from the area (CPLC, Case 32). In January 1836, Jose Antonio Martinez, Francsico Antonio Atencio, and the latter's sons petitioned the ayuntamiento for a tract of land at Petaca near Ojo Caliente, which they claimed to have owned for 12 years, but which they had never cultivated and thus had forfeited (U.S. Surveyor General, Case 105). On March 25, 1836, at the orders of Gov. Alvino Paez, the alcalde, Jose Antonio Martinez, placed the petitioners in possession of the lands at Petaca, where they resided, dividing the agricultural lands among them (U.S. Surveyor General, Case 105). Finally, in 1840, the last grant in the Chama Valley was completed when Jose Antonio Valdez and several others received possession of agricultural and grazing lands along the Rio del Oso (CPLC, Case 177).

During 1836 and 1837 two more grants were made in the jurisdiction of Taos. In June 1836, Antonio Armenta, Jose Victor, and Jose Manuel Sanchez, received possession of lands in the Cañon del Rio Colorado that lay several leagues north of Rito San Cristobal (SANM I:801; U.S. Surveyor General, Case 93). On October 25, 1837, Manuel Alvarez received possession of the Ocate grant from the alcalde of Taos, Juan Antonio Aragon (U.S. Surveyor General, Case 143). During the last year of the Mexican regime Juan Carlos Santistevan and five other residents of the jurisdiction of Taos sought agricultural lands along the Rito Lama between the Rio Colorado and the Rito San Cristobal (U.S. Surveyor General, Case 61). In January 1846, Governor Armijo approved the grant at Cebolla.

In the northern Rio Abajo only one grant in the Rio Grande Valley was made during the Mexican period. On November 17, 1840, the constitutional alcalde, Antonio Montoya, gave Salvador Barreras and his associates possession of the Tejon or Arquito tract which lay in the uplands to the east of the abandoned pueblo of Tunque (CPLC, Case 145). In the Albuquerque area the only grant dating to this period was made to Antonio Sandoval for the area of Las Lagunitas (U.S. Surveyor General, Case 154). By 1827 Sandoval occupied the area and had dug an acequia along the foothills south of Las Barelas.

On the Rio San Jose, Rafael Sanchez and other vecinos petitioned for land below the Pueblo of Laguna in 1829. Before he could give possession of the land, the constitutional alcalde of Laguna was required to investigate whether cultivation of this area would depend upon water already being used for irrigation by the Indians of Laguna and Acoma (SANM I:1291).

In the southern Rio Abajo Antonio Sandoval (probably not the same one who acquired the Arquento grant near Albuquerque in 1827) petitioned Governor Armijo for land at Bosque del Apache, which he needed for grazing sheep

but which he also intended to cultivate. On March 7, 1846, Sandoval was placed in possession of the Bosque del Apache grant by the alcalde of Socorro, Vicente Piño (U.S. Surveyor General, Case 35).

In the Rio Grande Valley the most extensive efforts to establish agricultural communities during the Mexican period took place in the Mesilla Valley. The area of the Santa Teresa grant had been occupied by Francisco Garcia as early as 1790 (CPLC, Case 168), but frequent Indian raids caused these grazing lands to be used only intermittently until 1824, when Francisco Garcia died. Around 1820 Toribio Benavides and others settled at Ancon de Moleros, where apparently they farmed (CPLC, Case 168). In 1840 Jose Maria Garcia permanently reoccupied the lands of his father, repairing the buildings and putting a portion of the grant under cultivation; in 1853 Jose Maria received a confirmation of his ownership from Mexican authorities after grant documents had been destroyed during the American occupation of El Paso in 1846–1847 (CPLC, Case 168).

In 1805 Juan Antonio Garcia de Noriega received permission from Governor Alencaster to settle at El Bracito (U.S. Surveyor General, Case 6). Garcia obtained peace with the Apaches by providing them with corn, which he grew there. In November 1816, and again in February 1820, Garcia petitioned the comandante general for a grant of the lands at Bracito that he had occupied and cultivated since 1805. Garcia's next attempts to obtain a formal grant in 1821 and 1822 met opposition from citizens of El Paso, who used the area as pasture and woodland (U.S. Surveyor General, Case 6). Meanwhile Garcia was forced to abandon the tract because of Apache attacks and move back to El Paso. After receiving a formal grant from the new government of Chihuahua in 1823, Juan Antonio Garcia reoccupied the lands at El Brazito in late 1824 or early 1825 (U.S. Surveyor General, Case 6). When Garcia died in 1827, his servants continued to occupy the grant until 1828 when they abandoned it because of Apache raids. The Garcias occupied the grant intermittently until 1861, when they sold most of it to Hugh Stephenson (U.S. Surveyor General, Case 6).

Full-scale settlement of the Mesilla Valley began in 1843 with the establishment of the Doña Ana Bend Colony (U.S. Surveyor General, Case 85). Despite a shaky start, when most of the original settlers abandoned the effort, the arrival of a small garrison in April 1843, enabled the colony to survive, so that in January 1848 the prefect, Guadalupe Miranda, issued title papers to the original allottees (U.S. Surveyor General, Case 85). As the colony grew, it expanded to the south; new settlements were established within the grant at Las Cruces and Tortugas, so the farmers could live closer to their fields (U.S. Surveyor General, Case 85).

After New Mexico was annexed by the United States in 1848, the government of Chihuahua continued to make grants of land in the portion of the Mesilla Valley that remained a part of the Republic of Mexico. Around March 1850, 60 citizens of Doña Ana moved across the Rio Grande to La Mesilla out of fear of the Texans, who were claiming that the colonists at Doña Ana lacked valid title to the grant (CPLC, Case 151; U.S. Surveyor General, Case 86). By January 1852, approximately 2000 New Mexican emigrants had settled on lands subsequently covered by the Mesilla Civil Colony, Refugio Civil Colony, and Santo Tomas y Iturbide grants. In January 1852, Commissioner Ramon Ortiz formally established the Mesilla Civil Colony (CPLC, Case 151; U.S. Surveyor General, Case 86). During August 1853, Commissioner Guadalupe Miranda divided the Mesilla grant upon the petition of the citizens at Santo Tomas, thereby forming two civil colonies (U.S. Surveyor General, Case 139). The Refugio Civil Colony was founded in 1850 by 50 families who had emigrated from lands ceded to the United State under the Treaty of Guadalupe Hidalgo (U.S. Surveyor General, Case 90). In 1851 Commissioner Ramon Ortiz gave them a grant of their lands, to which he gave them formal title in June 1852 (U.S. Surveyor General, Case 90). Finally, in June 1853, Jose Manuel Sanchez Baca, who had elected to repatriate himself to Mexico after the Treaty of Guadalupe Hidalgo, received a grant of land to the south of the Santo Tomas grant under Article 3 of the Act of the State of Chihuahua, issued January 15, 1849 (CPLC, Case 138; U.S. Surveyor General, Case 129). Even before this, Baca was already cultivating 200 acres in the northeast corner of the tract, where he had constructed an acequia (CPLC, Case 138). The land grant to Jose Manuel Sanchez Baca was the last land grant issued in New Mexico and marked the end of a 150-year-old process by which the Rio Grande Valley had been settled.

Chapter 6

IRRIGATION SYSTEMS IN THE RIO GRANDE VALLEY: 1694–1846

The Spanish settlers took one and a half centuries to settle the Rio Grande Valley (see Figures 8–13, above, and Figure 16, below). The settlement process was not continuous or without retrogressions and even complete failures. In particular a large segment of the valley between Socorro and Doña Ana was never successfully occupied in the Spanish or Mexican periods; for military and physiographic reasons, no one was able to hold this area, and except for the Apaches, few even tried to take possession.

Except for those land grants of the Spanish and Mexican periods that were purely for grazing, irrigation agriculture accompanied and made possible the establishment of land grant communities in the Rio Grande Valley and along its tributaries. Under Spanish and Mexican law grantees had to occupy and cultivate the land within a specific period of time, generally ranging from 3 months to 1 year. Given the semiarid environment, construction and operation of irrigation systems was a necessary part of any successful agricultural enterprise in colonial New Mexico, although contemporary land grant documents and records frequently do not mention irrigation systems directly.

The *Recopilacion de Leyes de los Reynes de las Indias*, especially Titles 7, 12, 16, and 17 of Book 4, established the legal framework regarding settlements and irrigation in New Spain; these laws were applicable to New Mexico as part of the Audencia of Guadalajara. Generally, legal title to grant lands was dependent upon occupation and improvements: building dwellings, clearing fields, digging ditches, and cultivating crops. The connections among land grants, their settlement communities, and irrigation agriculture are best exemplified by the land grant procedure itself. Petitioners almost always emphasized their desire for cultivable land for subsistence agriculture. In New Mexico that meant land for which irrigation water was readily available. In most instances the matter was left at that point either because earlier settlements had been successfully established on the same stream system so that water availability was already known to local government officials or because, in the case of a previously unsettled area, stream flows were so obviously sufficient that the question of availability was moot. In some instances, however, the governors would specifically order the alcalde mayor to assess the suitability of the area for irrigation as part of his investigation of the lands for which a petition had been received. Whether such concerns were expressed explicitly or not, the governors and the alcaldes mayor were aware of the association between a successful land grant settlement and irrigation requirements for subsistence agriculture.

In 1695, examination of the former villa, ranchos, and farms at Santa Cruz de la Cañada by Lt. Gov. Luis Granillo showed that the Tanos of San Lazaro and San Cristobal had maintained or built dams and acequias to irrigate their crops. When Governor Vargas dispossessed the Tanos, their irrigation system was part of the property that the new settlers at Santa Cruz acquired (CPLC, Case 195).

Lands along the upper Rio Tesuque were granted to Juan de Gabaldon in 1752 after an investigation of conditions at the proposed grant. The grant was made with the provision that the grantee was not to interfere with existing irrigation facilities. Gabaldon seems to have improved his chances for obtaining the grant by proposing to construct a reservoir that would improve irrigation along the Rio Tesuque for all users (U.S. Surveyor General, Case 65).

Governor Cachupin's grant of land to a group of genizaros at the abandoned Pueblo of Abiquiu was made only after an investigation determined that the permanent stream running through the pueblo had the capacity to irrigate all arable lands along the creek (U.S. Surveyor General, Case 140).

When Juan Gutierrez of Bernalillo sold his rancho to the Pueblo of Santa Ana in 1765, he petitioned the governor for new lands at Las Huertas. Gutierrez declared that sufficient land and water could be found there to support eight families (U.S. Surveyor General, Case 144).

In May 1768, Governor Mendinueta ordered the alcalde mayor of Jemez, Zia, and Santa Ana, Bartolome Fernandez, to investigate, among other things, how many families could be settled at Ojo de San Jose. On June 13, 1768, the alcalde reported that sufficient land and water existed at Ojo de San Jose along the Rito Vallecitos for the five petitioners and a few other settlers (CPLC, Case 182).

During July 1806, Alcalde Mayor Manuel Garcia de la Mora carried out a careful examination of the lands at Cañon del Rio de Chama for which Francisco Salazar and other residents of the jurisdiction of Abiquiu had petitioned Governor Alencaster (U.S. Surveyor General, Case 71). The alcalde found that 2 leagues of planting land could be found in the cañon bottom with places for the heads of five or six acequias along the length of these croplands.

In March 1824, settlers at Rito Colorado (near El Rito) complained to the governor that, under a grant from Governor Vizcarra made in March of 1823, they had begun to construct an acequia only to be dispossessed by their more powerful neighbors (CPLC, Case 179). After an investigation of the conditions at Rito Colorado, the governor ruled that the plaintiffs had infringed on the rights of other settlers at El Rito and further that there was insufficient water for irrigation at Rito Colorado.

Near the very end of the Mexican regime in northern New Mexico, Juan Carlos Santistevan and five other persons sought land between the Rito San Cristobal and the Rio Colorado above Taos. They proposed to irrigate their croplands from the Rito Lama. In January, 1846, after investigating conditions in the area, the constitutional alcalde recommended that the grant be made, with the provision that the petitioners be required to limit their irrigation use to water drawn from the Rito Lama (U.S. Surveyor General, Case 61).

The close association of irrigation agriculture and land grant communities can also be seen in the formal ceremony by which grantees were placed in possession of the grant. By the middle of the eighteenth century on almost every grant for which agriculture was the sole or principal activity of the settlers, the alcalde mayor would divide the arable/irrigable land among the grantees, giving each one a specific number of varas of land. This allotment varied generally from 50 to 200 varas, with 100–150 varas being the most common. The size of the allotments depended upon the number of settlers and the total amount of available cultivable land, for which irrigation was universally a requisite. The measurement in varas referred to the stream or ditch frontage as measured for each individual arable tract. The total area of each allotment of cultivable land would vary from land grant to land grant depending not so much upon the frontage as measured in varas but upon the width of the bottomlands that were deemed suitable for agriculture. There is some reason to believe that allotments were roughly comparable from land grant to land grant, but there does not appear to have been a standard size of allotment other than a rough estimate of the minimal arable acreage necessary for basic subsistence.

The role and importance of irrigation can also be seen in the settlement patterns on the land grants. Central plazas were rare, even when the danger and risks of nomadic raids might have been quite high (Carlson 1975:53). Instead, colonial settlers wanted to live near their cultivated land. As a result, dwellings were most frequently widely spaced along a road above irrigable land or along the acequia madre itself.

Irrigation systems were necessary in colonial agriculture because of the introduction of European crops, such as wheat, barley, and oats, and of orchards, all of which required irrigation water in order to be productive in the arid New Mexican climate (Ressler 1968:10–17; Simmons 1983:5–6). Constant growth within the Hispanic and Hispanicized segment of the New Mexican population also encouraged irrigation agriculture, which could more easily produce increasing quantities of food (whether native or introduced) and was less risky than dry farming of indigenous crops. Colonial settlers occupied lands where water was available for irrigation to sustain subsistence agriculture; the colonial economy was not directed toward the production of commercial surpluses.

In 1803, Governor Chacon described conditions in New Mexico to the Commandante General of the Provincias Internas (SANM II:1670a). The report found farming methods to be very backward; as a result Governor Chacon requested government assistance to introduce new techniques (Figure 14). The governor also reported that because of a lack of markets, subsistence agriculture prevailed in New Mexico and no incentives existed for commercial agriculture.

Figure 14 Releasing Water from an Acequia to Irrigate a Field (N.B. Water Gate Made of Old Log) Rio Arriba County, New Mexico, October 6, 1938 (Photograph by Holzman, Courtesy of the Museum of New Mexico, Santa Fe, Negative No. 5541)

Spanish colonial laws regulated the irrigation systems with some modifications to take into account local conditions (Hutchins 1928:265; Simmons 1972:140). Each community had a separate irrigation system that generally consisted of many small, short ditches. Some systems did include canals several miles long, as in the case of the acequia from the Arroyo Hondo to the Taos Valley that was constructed in the early 1800s (CPLC, Case 174). The colonial systems were simple and only moderately efficient. The scarcity of iron tools for much of the Spanish period and the general absence of individuals with training in engineering resulted in primitive facilities. Diversion dams were simple, temporary constructions of boulders, logs, and brush that frequently and regularly washed out during the spring thaw or summer thunderstorms.

At first the individual or group that had built the acequia controlled the ditch. As population and number of users grew, however, the system became more complex, and water was sometimes in short supply. Ultimately ad hoc arrangements for maintenance and allocation were impractical. Community-level organization became necessary to handle the allocation of water and to maintain the ditches and their associated facilities, but these organizations often were quite informal.

Statutes for the province of New Mexico that were used in 1826 by Governor Narbona spelled out the fines that could be levied for taking more than one's allocation of water during a drought and for not taking part in the maintenance of a community's acequia madre (Perrigo 1952:70). One or more mayordomos or prominent local leaders were selected or elected by the community of users to allocate water in times of shortage and to supervise repair and maintenance of the system. Providing labor for repair and maintenance was the collective responsibility of all of the water users along a particular ditch. Conflicts among users along the same acequia were not uncommon, and quarrels between different community ditch associations were also known to occur, as in the case of the disputes in the Taos Valley during the early 1820s (SANM I:1292).

PUEBLOAN IRRIGATION IN THE EIGHTEENTH AND EARLY NINETEENTH CENTURIES

The arrangement of field systems and the nature of land ownership were very different among the Pueblos and in the Hispanic land grant communities. The Pueblo irrigation systems, however, were similar in engineering and organization to the Spanish ditches (Simmons 172:144), and the Pueblos and Hispanics were governed by the same laws concerning irrigation systems and water rights. Under Spanish law all flowing streams were owned by the king (*Recopilacion*, Book 3, Title 1, Law 1). In the absence of an actual grant (*merced de aguas*), all users of water for irrigation had only a usufructuary right (*Recopilacion*, Book 4, Title 12, Law 14 and Book 4, Title 10, Law 10); it should be noted that no instance of a merced de aguas has yet come to light in New Mexico. If not exercised on a regular basis, usufructuary rights to land and water were forfeit and reverted to the royal domain (*Recopilacion*, Book 4, Title 12, Law 11). All users of water in a stream system, whether Indian or non-Indian, had equal access and were subject to equitable distribution of water through the quasijudicial/administrative procedure known as *repartimiento de aguas* (Meyer 1984:135–137).

Throughout the eighteenth and first half of the nineteenth centuries the Indian pueblos suffered from declining populations and had to compete with Hispanic settlements for arable land and to a lesser extent for water. Unfortunately information regarding Puebloan irrigation systems is scarce and spotty, but enough can be derived from ecclesiastical reports to provide an adequate picture of Puebloan irrigation during the Spanish and Mexican periods. The best and most extensive report on the Pueblo Indians was that of Fray Dominguez from the latter part of the eighteenth century, but other, less comprehensive reports also exist.

In 1730, Bishop Crespo of Durango made a visitation in New Mexico, which was the most remote region of his ecclesiastical jurisdiction (Adams 1954:97–98). The only useful information for this study provided by the bishop concerns the Tewa pueblos (i.e., San Juan, Santa Clara, San Ildefonso, Pojoaque, Tesuque, and Nambe), Taos, and Picuris. Bishop Crespo noted that in 1730 these northern pueblos had abundant harvests because the weather had been favorable and because they all had access to irrigation water from perennial streams (Adams 1954:97). Interestingly, in 1583 Gaspar Casteño de Sosa had made similar remarks regarding the six Tewa pueblos of the Pojoaque Basin (Hammond and Rey 1966:281–283).

Bishop Tamaron, who visited New Mexico in 1760, provided more detailed information and information on a wider variety of pueblos than had Bishop Crespo. He described the Pueblo of Nambe as having an irrigation ditch from a river that always contained water and notes that, as a consequence, the people of Nambe planted many fields (Adams 1954:55). Fifteen years earlier Fray Trigo had reported that the abundant water at Nambe produced consistently good harvests (Hackett 1937:466). In the Taos Valley, Bishop Tamaron described three rivers north of the Rio de las Trampas as providing irrigation water; the southernmost of them is referred to as having abundant ditches for irrigation (Adams 1954:56). The scarcity of water at the Pueblo of Galisteo meant, Bishop Tamaron reported, that the residents had to rely on gathering piñon nuts rather than on irrigation agriculture (Adams 1954:53). Finally the Pueblo of Isleta was described as irrigating its lands from the Rio del Norte, i.e., the Rio Grande (Adams 1954:71).

In 1776, Fr. Francisco Atanasio Dominguez wrote a description of the missions of New Mexico, which he had visited in the course of his duties as Commissary Visitor to the Franciscan Missions (Adams and Chavez 1956). Fray Dominguez's report provides a detailed and informative picture of conditions among the Indian and non-Indian inhabitants of late eighteenth century New Mexico. Fray Dominguez visited and reported on each of the 19 Rio Grande pueblos that existed in 1776; he also discussed Pecos and Zuni, which lie outside the Rio Grande Valley.

The Pueblo of Nambe irrigated the cultivable lands above the pueblo with an acequia madre that originated some distance upriver (Adams and Chavez 1956:59). All of the arable land above and below the Pueblo of Tesuque was under irrigation with what Fray Dominguez termed to be fairly good acequias (Adams and Chavez 1956:50–51). Pojoaque was a small pueblo that was completely surrounded by the Spaniards. The Pojoaque Indians irrigated their lands with ditches that were used by both Indians and non-Indians (Adams and Chavez 1956:60–63).

The Pueblo of San Ildefonso appears to have been the best situated of the Tewa pueblos in the Pojoaque Basin with regard to irrigation. As early as 1704, the Indians of San Ildefonso had an acequia and cultivable fields on the west side of the Rio Grande that were reserved to them by the governor when resolving a boundary dispute between the Indians and Ignacio Roybal (SANM I:1339). The people of San Ildefonso irrigated their kitchen gardens from a pool of water that was fed by the acequia madre from the Rio Pojoaque on the east side of the Rio Grande. This acequia madre is described as having been built of *terrones* — blocks of sod arranged with the grassy side facing the water (Adams and Chavez 1956:69). All of the cultivated lands of San Ildefonso on the west side of the Rio del Norte were irrigated by ditches from that river; some of the lands on the east side were also irrigated from the Rio del Norte (Adams and Chavez 1956:71).

The record of a boundary dispute with Mateo Trujillo shows that the people of San Ildenfonso irrigated lands around Black Mesa in 1724 (SANM I:1344). A similar dispute with Baltasar Trujillo developed in 1736 over the latter's encroachment on the Indian's acequia and cultivated lands near Black Mesa; Governor Bustamante had the matter investigated (SANM I:1351). Most of the lands around the pueblo itself were irrigated with ditches that tapped springs in a small adjacent swamp or else took water from the depleted Rio Nambe; by the time it reached the lands of San Ildefonso the latter had been reduced to a trickle by upstream users, both Indians and non-Indians (Adams and Chavez 1956:71). Fifty years later, a report by Fr. Teodoro Alcina showed that conditions remained unaltered for the Tewa Indians of the Pojoaque Basin (Taylor 1982:25).

The people of San Juan Pueblo farmed lands above and below the pueblo and on both banks of the Rio del Norte (Adams and Chavez 1956:89–90). The most fertile lands, which apparently lay near the pueblo itself, were irrigated from a ditch that was used by both Hispanic settlers and Indians. This acequia (which may have been the El Guique ditch on the west side of the Rio Grande, since the Alcalde ditch was not extended down to San Juan lands until after 1900) diverted water from the Rio del Norte 1 league (some 2 miles) above the pueblo. The Indians of Picuris had cultivated fields in the cañada at Picuris that they irrigated from the small local stream (Adams and Chavez 1956:97–98). In 1745 Fray Trigo reported that the river at Picuris had an abundant flow of water, which accounted for the generally good harvests at the pueblo. He noted that little corn or chile had been harvested that year but attributed the crop failure to the weather (Hackett 1937:467). The residents of the Pueblo of Taos had their farmlands along the Rio de Taos and the Rio Lucero; water was diverted from both streams to irrigate the Taoseños' croplands (Adams and Chavez 1956:111–112). At Santa Clara Pueblo, farmlands were located in the Cañada de Santa Clara, on the bajada that sloped down to the Rio del Norte, and in meadows along the cañada itself (Adams and Chavez 1956:118–119). Most of the bajada land was too high to permit irrigation from the Rio del Norte, and the stream in the cañada frequently dried up

in the summer, making irrigation problematic. Only the lands at the edge of the river could be irrigated from the Rio del Norte, and these lands had the highest potential for good harvests as a result.

For nearly half a century the Indians at Santa Clara were in conflict with non-Indian settlers over the utilization of the small stream in the Cañada de Santa Clara (SANM I:942; U.S. Surveyor General, Case 138). In 1724, Juan and Antonio Tafoya received a grazing grant in the cañada on the condition that they not use the land for farming because the Santa Claras used the tiny stream for irrigation nearer their pueblo. By 1733, the Tafoyas had constructed at least one ditch from the Rio Santa Clara and sought to legitimize this appropriation of water by appealing to the governor for full rights in their use of the land (SANM I:952). After a lengthy investigation the governor reconfirmed the grant for grazing purposes in November 1733, but the decree specifically excluded any farming by the Tafoyas.

The Tafoyas ignored the governor's order and continued to irrigate farmlands along the Rio Santa Clara. In August of 1756 the Santa Claras complained to the governor that the settlers in the cañada were illegally farming and that this section by the Tafoyas had cut the Indians off from water they needed for irrigation (U.S. Surveyor General, Case 138). Governor Martin del Valle had the matter investigated and found that the Tafoyas only had the right to graze livestock on the grant. Consequently he ordered the alcalde mayor to require them to cease their agricultural activities. Instead the Tafoyas sold at least some of their land to Carlos Mirabel, who then sold his share of the grant to Joachim Mestas. In April 1758, Mestas petitioned the governor for confirmation of his rights to cultivate the land at the rancho de Santa Clara and protested against the false claims of the Indians that cultivation by settlers in the cañada had affected the Indians' water supply (U.S. Surveyor General, Case 138). Mestas claimed that he had acquired the land in the belief that he could cultivate it since the Tafoyas had done so for 17 or 18 years without complaints being made by the Indians. Governor Marin del Valle reiterated the original prohibition against non-Indian agriculture in the Cañada de Santa Clara (U.S. Surveyor General, Case 138).

Even then, the settlers refused to terminate their farming at rancho de Santa Clara, so the Indians petitioned Governor Cachupin to grant them the lands in question. In their petition of July 1763, the Santa Claras claimed that upstream irrigation by non-Indians had deprived them of irrigation water farther down the river (U.S. Surveyor General, Case 138). On July 19, 1763, Cachupin declared the grant to the Tafoyas to be contrary to the laws of the Indies and therefore forfeit. At the same time he made a grant of all the lands in the cañada to the Santa Claras and ordered all of the settlers to leave (U.S. Surveyor General, Case 138). The persistence of the settlers can be seen in the fact that on April 19, 1780, Governor Anza had to order the alcalde mayor to expel all settlers from the cañada within 8 days, finally ending almost half a century of conflict over access to irrigation water in the Cañada de Santa Clara (U.S. Surveyor General, Case 138).

The Pueblo of Santo Domingo had deep irrigation ditches that took water from the Rio del Norte to irrigate fields on both banks (Adams and Chavez 1956:137). Cochiti and San Felipe also irrigated fields on both banks of the Rio del Norte with irrigation ditches (Adams and Chavez 1956:159, 165). The residents of the Pueblo of Isleta also irrigated their fields with water from the Rio Grande (Adams and Chavez 1956:207). On the other hand, the residents of the Pueblo of Galisteo could only irrigate those fields near the convento and were otherwise dependent on rainfall for their agricultural lands (Adams and Chavez 1956:217).

Santa Ana Pueblo had acquired by purchases from Spanish landowners a league of arable land along the Rio del Norte above Bernalillo, land that they irrigated with water from the river (Adams and Chavez 1956:170). The Santa Anas also had lands along the Rio Jemez at their ancestral pueblo, but at the pueblos of Zia and Jemez the Rio Jemez was too salty and depleted by upstream users to provide irrigation water (Adams and Chavez 1956:170). The Indians of Zia dry-farmed in the uplands to the north and south of the pueblo (Adams and Chavez 1956:175). They also had farms in the bottomlands along the Rio Jemez but could obtain irrigation water only when the rains were heavy. Their dependence on dry farming put them in great difficulties if it did not rain.

The Pueblo of Jemez was the best situated of the Indian pueblos along the Rio Jemez. Fray Dominguez stated that they watered arable lands along the river by means of adequate ditches and noted that this made it possible for them to produce abundant crops (Adams and Chavez 1956:181). The Jemez Indians also had fruit orchards in a number of tributary canyons; these were watered by small streams (Adams and Chavez 1956:181).

The Pueblo of Laguna, on the bank of the Rio San Jose to the west of Albuquerque, had irrigated lands along the river, but the productivity of these lands was limited by the poor quality of the water in the Rio San Jose. The water was

generally alkaline owing to the presence of alkaline springs and soils some 2 leagues above the pueblo (Adams and Chavez 1956:186). Some arable lands around the pueblo were dry-farmed, but the best farmlands of Laguna Pueblo were at Cebolleta, where water from two streams irrigated the croplands (Adams and Chavez 1956:187).

In 1745 Fray Trigo reported that all of the crops grown by the Acoma Indians were dependent upon rainfall, the Acomas having no irrigation system (Hackett 1937:462). By 1776 Fray Dominguez was able to report that although the Acoma Indians still depended upon rainfall to water the fields that lay near their pueblo, they had begun farming at Cubero along a north-south cañada 3 leagues away (Adams and Chavez 1956:194) and along both banks of the river that flowed to Laguna (i.e., the Rio San Jose or Rio Cubero), where they irrigated their fields from the river.

In 1782, Fr. Agustin de Morfi produced a geographical description of New Mexico that provides information on irrigation at some but not all of the pueblos visited by Fray Dominguez in 1776 (Thomas 1932:87–114). The pueblos of San Felipe and Santo Domingo continued to irrigate their croplands with water diverted by ditches from the Rio del Norte (Thomas 1932:97–98). Cochiti had fertile fields on both banks of the Rio Grande that were irrigated with large ditches that took water from the river (Thomas 1932:99). As a result of the location of the ditches, Fray Morfi reported the Cochitis had to work constantly to maintain them; evidently he was referring to the ditch headings on the Rio Grande as it surged from White Rock Canyon. During the year of Fray Morfi's visit, the pueblo of Zia was apparently able to irrigate croplands from the Rio Jemez (Thomas 1932:100). At Jemez Pueblo itself, Fray Morfi found conditions that were similar to those reported in 1776 (Thomas 1932:100). At Acoma, however, conditions had deteriorated. The Acomas had extensive irrigated fields at Cubero, some 5 leagues to the west of Laguna, but they had given up cultivating them because of the threat from the Gila Apaches (Thomas 1932:105).

Little specific information with regard to Pueblo Indian irrigation is available for the period from 1782 to 1846, although some details can be found in the records of water disputes (see discussion in the next section of this report). At the same time it appears that there were no radical changes in Pueblo irrigation agriculture during the late Spanish and Mexican periods. Despite population decline, steady encroachment by non-Indians on the lands of certain pueblos, and an ambivalent social and political status in the Mexican period, the Pueblo Indians of the Rio Grande Valley continued to operate their irrigation systems throughout the period much as they had during the late eighteenth century. At the same time, Pueblo irrigation systems do not seem to have expanded much if any, a pattern that is in sharp contrast with the continuing expansion of Hispanic agriculture and irrigation systems throughout the Rio Grande Valley of New Mexico during this era.

HISPANIC IRRIGATION SYSTEMS AND THEIR OPERATION

While irrigation was pivotal to the success of agriculture and settlement in the Rio Grande Valley in the Spanish and Mexican periods, information on specific irrigation systems is not abundant. The areas for which we have the most data are those that have been the subject of historical investigations associated with water rights adjudications. The Pojoaque Basin, the Taos areas, and more recently the Jemez Valley are the three most important instances. The information for those areas is frequently quite general, however, being derived from the same documents that would be used for any study of irrigation systems.

The earliest grant of land in New Mexico after the Reconquest was for the reoccupation of the villa of Santa Cruz de la Cañada (CPLC, Case 194). As we have already seen, Governor Vargas ordered the Tanos of the pueblos of San Cristobal and San Lazaro to move from the area of Santa Cruz. In April 1695, the governor placed the new residents of the villa in possession not only of the land grant but also of the irrigation system that had been used by the Indians (CPLC, Case 194). The Tanoans had built and maintained a substantial system of acequias and dams along the Rio Santa Cruz during the 15 years of Puebloan independence. How much of this system was constructed during the period from 1680 to 1695 and how much had been constructed by or for the Spanish residents of Santa Cruz before the Revolt of 1680 cannot be ascertained. At least some of the irrigation facilities that the new settlers at Santa Cruz obtained must have been constructed before the Revolt. The irrigation system at Santa Cruz appears to have included an acequia madre on each side of the river. In 1716, Francisco Xavier Romero described the boundaries of a piece of farmland for which he sought reconfirmation from Governor Martinez (CPLC, Case 262) as having its northern boundary at the Rio Santa

Cruz and its western boundary at a ditch belonging to the Mexican families (i.e., the Mexican Indians established by Vargas in the recently vacated Tanoan pueblo at Santa Cruz).

As early as 1703 Sebastian Martin and his brothers built an acequia that took water from the Rio del Norte to irrigate their fields above San Juan Pueblo (U.S. Surveyor General, Case 28). This was probably part of either the present En Medio ditch or the La Mesa ditch. In 1776 Fray Dominguez described Sebastian Martin's house as being located at Canoa (the Spanish word for "flume"), which lay on the west bank of the Rio Grande at the upper end of what is now the Velarde Valley (Adams and Chavez 1956:91).

The acequia madres at Santa Fe had been built at the time of the founding of the villa in 1610 and remained in use throughout the seventeenth century. During his siege of Santa Fe in 1693, Vargas cut off the acequias since they provided drinking water as well as irrigation water for the residents at Santa Fe (Espinosa 1942:151–162). In April 1731, Manuel Trujillo received property at the eastern boundary of Santa Fe on the south side of the Rio Santa Fe and upstream from the headworks of an acequia (CPLC, Case 116). The western boundary to Trujillo's property was the acequia madre of Santa Fe. While one cannot be absolutely certain, it seems likely that the headworks described were those of the acequia madre.

In September 1735, the alcalde mayor of La Cañada, Juan Estevan Garcia de Noriega, measured the lands of the deceased Jose Trujillo in the area north of San Ildefonso (U.S. Surveyor General, Case 112). The cultivated lands lay near the Rio del Norte in a valley at the mouth of Arroyo Seco. Garcia de Noriega noted that these lands were easier to irrigate than any of the others in the estate of Jose Trujillo. It would appear that these lands at Mesilla de San Ildefonso were irrigated with water from the Rio Grande.

While Puebloan ditches were in use in the Pojoaque Basin throughout the eighteenth and nineteenth centuries, the locations, names, and construction dates of particular Puebloan ditches are nearly impossible to establish. In a report prepared for the Office of the State Engineer in the Aamodt Case, John Baxter suggests that the Acequia de la Communidad and the Acequia del Llano were those ditches mentioned by Fray Dominguez as being used to irrigate the lower and upper lands of the Pueblo of Nambe. As is often the case, the description is lacking in specificity and could refer to ditches that have subsequently been abandoned or replaced.

The same lack of specificity applies to the acequia madre of Tesuque, which appears to have existed at least by 1772. As early as 1752 Juan de Benavides had sought to protect his irrigation rights, and as a result Governor Bustamante included a warning in the land grant documents of Juan de Gabaldon (U.S. Surveyor General, Case 65). The governor warned Gabaldon not to interfere with his neighbors' water supply, and at the same time Gabaldon agreed to build a reservoir for the benefit of all landowners in the Tesuque Valley (U.S. Surveyor General, Case 65). When Juan de Benavides died, his mother Juana Ojula de Benavides divided the estate and sold parts of it, including one tract that had the acequia madre as its boundary (CPLC, Case 123). In the 1760s, Governor Mendinueta had allowed Benavides to use the acequia madre for 24 hours once every 8 days (Baxter 1984:39). Governor Anza restricted irrigation on the lands of the deceased Juan de Benavides to one ditch. Finally the alcalde mayor of Santa Fe, Antonio Ortiz, adjudicated a dispute over water along the Rio Tesuque, and the documents pertaining to this adjudication show the acequia madre was still in use (Baxter 1984:39–40). Deeds from the first half of the nineteenth century show that the acequia madre de Tesuque was still in use during that period (Baxter 1984:40). In April 1825, the eastern boundary of a piece of land along the Rio Tesuque was described as being the arroyo with the canoa of the acequia of Juan de Benavides (CPLC, Case 123).

After acquiring lands north of the Rio Nambe at Pojoaque in 1701, Carlos Lopez sold a piece of land that was bounded on the north by the acequia of the Indians of Pojoaque (Baxter 1984:14). In 1733 another piece of land in the same area was sold by Salvador Martinez; this land had the acequia madre as its northern boundary and the acequia of the Indians on the south (Baxter 1984:15). The latter was probably the Trujillo ditch and the former could have been the Acequia de los Joyas. Both of these ditches are mentioned in deeds from the early nineteenth century (Baxter 1984:18, 19). In 1725 Ignacio Roybal sought authorization from Governor Bustamante to construct an acequia from the Rio Tesuque to his property near the confluence of the Rio Nambe and Rio Tesuque (Baxter 1984:10). The governor issued the license, which allowed Roybal to construct what is probably the upper part of the Acequia Barranco Blanco.

When Vicente Duran y Armijo acquired lands within the boundaries of the Pueblo of Nambe in 1739 (Baxter 1984:23–24), the description of that portion of the lands that lay south of the Rio Nambe shows that an acequia ran at the foot of the hills near the eastern boundary of the pueblo. This acequia may have been the Acequia del Rincon.

In 1751, property deeds refer to the acequia madre on the south side of the Rio Nambe at Pojoaque; this could have been the Acequia Barranco Alto (Baxter 1984:15). Another ditch in the Pojoaque Basin that dates to the pre-American period is the Acequia Ancon, which is mentioned in an 1814 division of the estate of Rosa Bustamante de Ortiz. The southern boundary of these estate lands was the acequia of the Indians (Baxter 1984:18–19). A deed of sale from Joaquin Lujan to Julian Roybal mentions two ditches in the western part of the San Ildefonso grant in 1734, describing them as "the acequia del molino" and the acequia of the deceased Ignacio Roybal (Baxter 1984:12). One of these might have been the Acequia Barranco.

In the San Ildefonso area except for the acequia madre or Acequia de los Indios, which brought water to the garden plots of the Puebloans, none of the present ditches can be found in the records before the Mexican period. The Acequia de los Ortices is mentioned in deeds of sale by which Francisco Ortiz acquired property from the Indians (Baxter 1984:3–4). Other deeds describe the boundaries of tracts of land by referring to the Acequia del Rancho (in 1832), the Acequia del Medio (in 1834), and the Acequia del Alamo (in 1843; Baxter 1984:4–5).

At Nambe, the Communidad and Llano ditches could possibly be the ditches mentioned in Fray Dominguez's description of the area. The deed by which Gaspar Ortiz secured a tract of land from six Indians of Nambe Pueblo refers to a ditch that divided the property (Baxter 1984:24–25). This ditch could have been the Acequia de los Ortices or the Acequia del Cano. A deed from 1793, also to Gaspar Ortiz, mentions an acequia, "la acequia madre de dicho alfreres," which was possibly the Acequia de los Ortices (Baxter 1984:25).

Along the Rio Tesuque, we have already mentioned the Acequia Barranco Blanco, which might be the ditch for which Ignacio Roybal received a license in 1725, and the acequia madre de Tesuque that is mentioned in the division of the estate of Juan de Benavides in 1772. The Acequia del Rio, which serves the Cuyamungue area, was mentioned in the 1745 subdivision of the lands of Luis Lopez (Baxter 1984:33); deeds from 1781 and 1846 indicate the continued use of this ditch (Baxter 1984:33–34). None of the other ditches for which records exist is mentioned in the documents until after the beginning of the nineteenth century. The construction of a ditch by the Tesuque Indians caused some Hispanic farmers to complain to the acting alcalde, Manuel Delgado, that the new acequia threatened their supply of water from some springs on the Tesuque lands (Baxter 1984:33–34). The non-Indian ditch was either the Acequia de los Ortices or the Acequia de los Ojitos. Finally, the Acequia de los Romeros appears to have been built around 1837 and remained in use throughout the 1840s according to deeds from that period.

For the Santa Fe area, the acequia madres that followed both sides of the Rio Santa Fe are mentioned in land grant documents throughout the first half of the eighteenth century, including those of the Catarina Maesa grant (1742) and the Juan Cayetano Lovato grant (1742; CPLC, Cases 103 and 119). Research in the Santa Fe County Deed Records would certainly document the use and locations of the acequia madres and their laterals throughout the Spanish and Mexican periods. On the La Majada grant to the southwest of Santa Fe, Paulin and Salvador Montoya acquired lands from Bartolome Fernandez; they irrigated part of the lands by means of a ditch, which they cleaned and dug out (CPLC, Case 89). In 1799 and 1800 the Montoyas protested to the governor regarding the activities of Miguel and Manuel Ortiz. The large herds of cattle and flocks of sheep belonging to the Ortices had overused the spring with which the Montoyas irrigated their fields, causing it to dry up (CPLC, Case 89). When the Montoyas had asked the Ortices to move their livestock, the Ortices had threatened the Montoyas. In April 1800, Governor Chacon ordered the alcalde mayor of Santa Fe to see that the Ortices controlled their livestock and ceased interfering with the Montoyas' water supply (CPLC, Case 89).

In discussing the Santa Fe area, Bishop Tamaron in 1760 found that irrigation water was scarce, with the Rio Santa Fe frequently drying up in the months before the harvest (Adams 1954:47). Fray Dominguez in 1776 noted that the flow of the Rio Santa Fe was not abundant and was usually insufficient during the irrigation season (Adams and Chavez 1956:40). Too many farms tried to draw water from the river, and the upstream users took most of the water, so that the crops downstream often did not get irrigation water at all. Only in very rainy years was there sufficient water for all users on the Rio Santa Fe (Adams and Chavez 1956:40). Besides the ranchos scattered along the river near Santa Fe, other settlements were also to be found in the area. At Quemado, the farmlands were irrigated with river water (Adams

and Chavez 1956:41). The settlement at La Cienega Grande used springs to irrigate crops and water livestock (Adams and Chavez 1956:41). At the Rio Tesuque, Hispanic farmers were scattered in ranchos along a creek that had only limited amounts of water (Adams and Chavez 1956:41). Hispanic farmers also lived close to the pueblos of San Ildefonso, Pojoaque, and Nambe and used their own ditches or shared ditches with the Indians in drawing irrigation water from the Rio Nambe or Rio Pojoaque (Baxter 1984).

By 1775, Santa Cruz de la Cañada had 125 families comprising 600 persons, but the community hardly met the standards of a villa (Adams and Chavez 1956:82–83). Only eight ranchos were clustered around the church; the rest of the community was scattered along the Rio Santa Cruz, which was a dependable stream and provided sufficient water for irrigation. Settlers in the lower Santa Cruz Valley irrigated with ditches from both the Rio Santa Cruz and the Rio del Norte (Adams and Chavez 1956:83). In the upper valley at Chimayo (2 leagues above the plaza at Santa Cruz de la Cañada) a more organized plaza existed, but most families still lived in scattered ranchos (Adams and Chavez 1956:83). The Rio Santa Cruz provided Chimayo with its irrigation water. The community of Pueblo Quemado stretched along a tributary of the Rio Santa Cruz and drew water for irrigation from that stream (Adams and Chavez 1956:83). Farthest upstream was the small community of Cundiyo, which also irrigated its fields from a tributary of the Santa Cruz (Adams and Chavez 1956:59–60). The two plazas at Truchas contained the entire population of that grant—a response to the threat of Comanche raids (Adams and Chavez 1956:83). With much labor the residents of the Truchas grant had dammed a small stream and built a good ditch to irrigate their crops. Bishop Tamaron in 1760 had remarked on the sizable population and expanse of irrigated lands at Truchas (Adams 1954:55).

Along the Rio del Norte, above Santa Cruz and the Pueblo of San Juan, was a series of Hispanic communities (Adams and Chavez 1956:90–91). Rio Arriba, on the plain north of San Juan, had 51 families and 299 persons who irrigated very fertile land by drawing water from the river, as did their neighbor communities. Moya had five families and 30 persons. Bosque Grande lay opposite Rio Arriba on the west bank of the Rio Grande; here as elsewhere in the area people lived in scattered ranchos. Canoa lay above Bosque Grande and opposite Moya; the community of seven families and 30 persons included the house of Sebastian Martin, who had built the earliest Hispanic ditch in the area (U.S. Surveyor General, Case 28). Five leagues up the Rio Grande from San Juan Pueblo in a tributary valley lay the settlement of Embudo, which irrigated its lands with water from the Rio Picuris (Adams and Chavez 1956:91). In 1782, Fray Morfi noted that the community of Embudo had been abandoned as a result of incursions by nomadic raiders (Thomas 1932:88). On a branch of the Rio Picuris lay the Hispanic community of Trampas, with a population of 270 persons who lived in a plaza and not scattered along the stream from which they irrigated their fields (Adams and Chavez 1956:98–99).

Settlement of the Chama Valley began in the early eighteenth century. By 1714, acequia madres served both the east and west banks of the Chama in the area above the confluence with the Rio Grande. The western boundary of one of the tracts given to Cristobal Crespin is described as reaching as far north as the intake of the acequia madre on the east side of the Rio Chama (CPLC, Case 232). On the west bank another of Crespin's tracts had as its northern boundary the place where the valley narrowed and the west-side acequia madre began (CPLC, Case 232). Sometime in the mid 1710s, Antonio Trujillo received land near the sitio of Chamita, where he reported in 1724 that he had dug an acequia and plowed his fields (U.S. Surveyor General, Case 36). By 1734, an acequia had been dug to serve lands along the east bank of the Chama at Abiquiu; Bartolome Trujillo testified that he had irrigated land along the bank of the river opposite Abiquiu with an acequia (CPLC, Cases 257 and 263). In 1735, Manuela Garcia de las Rivas received agricultural lands in front of the old Pueblo of Abiquiu. This land is described as having as its western boundary the intake of an acequia (CPLC, Case 249). This acequia was not, however, the one that Rivas was to use to irrigate the croplands; instead the grantees were given a year to build an acequia for that purpose (CPLC, Cases 257 and 263).

Fray Dominguez found only limited settlement in the Chama Valley in 1776. Sixty-nine Spanish families and nine genizaro families were scattered in ranchos along the lower part of the river (Adams and Chavez 1956:119). These people irrigated their fields from the Rio Chama (Adams and Chavez 1956:119). The 46 families of genizaros at Abiquiu farmed fields adjacent to the pueblo, using water from a small stream, and fields along the Chama, which were irrigated from the river (Adams and Chavez 1956:125–126). A small Spanish plaza and scattered ranchos were located at Santa Rosa de Lima; the fields were irrigated from the Rio Chama (Adams and Chavez 1956:126). When Lt. Juan Ignacio Mestas sold land above Abiquiu on the Rio Chama to Bartolo Vigil, he claimed that the 446 varas came with the right to use the acequias (CPLC, Case 140). Before 1816, Manuel Martinez constructed a ditch across the lands of Ramon Martinez at Abiquiu. In July 1832, a flood on the Rio Chama washed away the diversion dam and ditch (Ebright

1979:21); when Manuel Martinez attempted to rebuild these facilities, Ramon Martinez, the land owner, prevented him. When the two went to court, the ayuntamiento found in favor of Manuel Martinez, based on customary law permitting easements for acequias if they did not harm the land to be crossed (Ebright 1979:28–30). According to testimony in the Petaca grant, acequias were first dug in the area around 1836 (CPLC, Case 99). On the Barranco tract above Abiquiu the land had been irrigated from the river since 1839 (CPLC, Case 97).

Land near Taos granted to Francesca Antonia Gijosa in 1715 is described as having its eastern boundary at the mouth (*desagua*) of an irrigation ditch on the Rio del Pueblo. Land sold by Francesca de Gijosa to Baltasar Trujillo in 1725, on the other hand, is described as having the head of an acequia on the Rio del Pueblo as its eastern boundary (CPLC, Case 16). Bishop Tamaron in 1760 had found that beyond the Rio de las Trampas three rivers crossed the Taos Valley (Adams 1954:56). The first of these rivers (i.e., the one closest to the Rio de las Trampas) is described as supplying water to a number of acequias; this was probably the Rio de San Fernando.

Fray Dominguez in 1776 reviewed current conditions in the Taos Valley, which he described as being watered by four rivers (Adams and Chavez 1956:111). The Pueblo of Taos irrigated its fields from the Rio de Taos and the Rio Lucero (Adams and Chavez 1956:112). The few Hispanic settlers lived adjacent to the pueblo, since the Spanish plaza near Taos had been abandoned owing to Comanche attacks (Adams and Chavez 1956:112). The 67 Spanish families awaited the completion of a new plaza at Las Trampas de Taos, which lay 3 leagues to the south along the river of the same name. Fray Dominguez noted that the Spaniards irrigated the farmlands on their scattered ranchos along the Rio de las Trampas from the river but lived at Taos itself.

Fray Morfi reported the availability of abundant lands at Los Ranchos de Taos, where fields were irrigated from the largest of the four rivers that watered the Taos Valley (Thomas 1932:97). The lands belonged to the Puebloans, but they allowed the Spanish settlers to use them, as indicated a few years earlier by Fray Dominguez.

In 1795 the citizens of the plaza at Las Trampas opposed the establishment of an agricultural community in the upper reaches of the river as it would cause them serious injury (Figure 15). The river, they claimed, was already limited in its flow, going dry usually around the end of August (U.S. Surveyor General, Case 58). In 1797 Governor Chacon gave the surplus water from the Rio de Taos and the Rio Lucero to the grantees at San Fernando de Taos (U.S. Surveyor General, Case 125).

In 1815, the citizens of Arroyo Hondo built an acequia that took water from the local stream (U.S. Surveyor General, Case 159). Sometime before 1821, another acequia was built from the upper arroyo so they could cultivate more land (CPLC, Case 174). The ditch was cut along a rocky slope for more than 6000 varas (3 miles). In 1822 the citizens of Arroyo Hondo protested the construction of an acequia by the residents of Arroyo Seco, claiming that this ditch took vital irrigation waters away from the fields at Arroyo Hondo (U.S. Surveyor General, Case 159). An order from Governor Vizcarra required the new users to deliver sufficient water to irrigate the downstream fields in times of scarcity. A year later the most famous water dispute in colonial and Mexican New Mexico occurred between the Indians of Taos Pueblo and the settlers at Arroyo Seco (Jenkins 1966:104–105; Meyer 1984:54–55; Taylor 1982:26–28, 34–35). Earlier arrangements and even the new ditch from the Arroyo Hondo did not satisfy the need for irrigation water at Arroyo Seco. The dispute was heard before a judge of the ayuntamiento, who suggested a repartimiento de aguas along the Rio Lucero whereby the Pueblo of Taos was to be provided for first, with the community of San Fernando de Taos receiving the remaining share. The people at Arroyo Seco, which had only recently been established, were to get a certain part of the surplus in years of abundance (SANM I:1292). Apparently Arroyo Seco also lost its use of water from the Rio Hondo in 1823 (U.S. Surveyor General, Case 159). Unfortunately we do not have the final decrees of the full ayuntamiento, so we do not know if all of the judge's suggestions were accepted.

In 1823, Felipe Medina obtained lands along the Arroyo Hondo between the acequia and the stream (CPLC, Case 175). Five years later in 1828, the settlers at Cañada de las Mestanes (which lay north of Arroyo Hondo) were allowed to use water from the Rito San Cristobal as well as their own small stream to irrigate their farmlands (CPLC, Case 163). In 1827, Nicolas Sandoval worked on an acequia at Los de Montes (apparently on the Rio de las Trampas) but could not use the water to irrigate croplands he had acquired as a result of this work because of the scarcity of water (U.S. Surveyor General, Case 58). Sandoval registered another piece of land in the same area and irrigated it from a spring. Finally in 1837 an investigation by the constitutional alcalde at Taos found that the spring had insufficient water to

Figure 15 Flume (canoa) at Trampas, New Mexico, 1969 (Photograph by J.W. Allen, Courtesy of the Museum of New Mexico, Santa Fe, Negative No. 47158)

irrigate the amount of land that Sandoval wished to claim. Further the alcalde noted that the land was part of a land grant made to other parties in 1795 and that Sandoval's proposal also would cause damage to the irrigators at Rio de las Trampas (U.S. Surveyor General, Case 58).

When Governor Cuervo y Valdez reported to the viceroy on the newly founded villa of Albuquerque, he noted that the water was running in the irrigation ditches (Hackett 1937:379). Within a quarter of a century of the founding of Albuquerque, problems were already developing over ditch construction. In the summer of 1732, Cristobal Garcia petitioned Governor Cruzat y Gongora for permission to build an acequia through the lands of Jose Montaño in order to water Garcia's lands at Albuquerque (SANM II:372). Several petitions from eight landowners opposed the proposed construction. The governor ruled that if Garcia agreed to respect the rights of the landowners he would be permitted to build the acequia (SANM II:372; see also Section 3, Title 31, Law 4 of the Siete Partidas for Spanish law on easements with which Governor Cruzat's decision was in conformity). Only a few months after the governor's decision, three landowners entered a complaint against Garcia for opening an acequia built across their lands (SANM II:379).

In 1739, petitioners for lands at Tomé supported their request with complaints that land and water were in short supply at Albuquerque (U.S. Surveyor General, Case 2). A document concerning the partition of property on the San Clemente grant (CPLC, Case 64) noted the presence of an irrigation ditch serving agricultural lands at San Andres. In 1784, Maria Catarina Piño reported the ownership of 13 cornfields south of Los Lentes, which were all under irrigation from a ditch constructed by her husband, Antonio de Luna (CPLC, Case 64).

When Fray Dominguez visited Albuquerque in 1776, he found that 24 houses were clustered near the mission church but that most of the population resided in ranchos scattered along the Rio del Norte for a league upstream of the plaza (Adams and Chavez 1956:151). The farmers were evidently quite successful in the Albuquerque area; wide, deep acequias delivered irrigation water from the Rio del Norte. By 1782, Fray Morfi noted that the residents of Albuquerque had croplands extending a league and a half up the river, irrigated by means of ditches that diverted water from the Rio del Norte. He noted, however, the crop yields were low owing to a lack of oxen for plowing and to raids by nomadic tribes (Thomas 1932:101).

The residents of Alameda lived in ranchos scattered in the meadows along the river (Adams and Chavez 1956:152–153). The settlers at Atrisco and Lower Corrales, both of which lay on the west bank of the Rio del Norte, had low crop yields because the cultivated land was too sandy (Adams and Chavez 1956:154). Residents of Upper Corrales and Bernalillo also had to cope with poor soil (Adams and Chavez 1956:144). All four of these communities irrigated their agricultural lands with water from the Rio Grande. In 1786 the residents of Atrisco protested to the governor against the actions of Diego Antonio Chaves (CPLC, Case 45). The latter had cut off the farmers from access to a spring on the grazing lands to the west of the valley; as a result they had to drive their livestock to the Rio del Norte for water. But because Chaves also controlled access to the road to the river, the people of Atrisco had to drive their livestock across their own acequia madre to get to the river, which caused considerable damage to the acequia.

On lands to the south of the Atrisco grant at Pajarito, Fray Dominguez in 1776 found scattered ranchos utilizing sandy soils irrigated with water drawn from the Rio Grande using deep acequias (Adams and Chavez 1956:207). In 1792 the heirs of Isabel Baca protested to the governor against the breaking of new ground by Lorenzo Gutierrez in an area at Pajarito where the Bacas had already built an acequia (CPLC, Case 73). In testimony given before the Surveyor General in 1887, Juan Bazan reported that the acequia madre was in operation at Pajarito from 1827 to after 1841 (U.S. Surveyor General, Case 157). Similarly about 1830 Juan Jose Gutierrez constructed an acequia to water some prospective vineyards and orchards on the Pajarito grant (U.S. Surveyor General, Case 157). The acequia began near Los Ranchos de Atrisco and ended near the house of Nestor Castillo at Pajarito.

The ranchos at Belen were reported by Fray Dominguez as being scattered in meadows along the river and dependent on deep acequias drawing water from the Rio del Norte to irrigate their croplands (Adams and Chavez 1956:208). Residents of the genizaro plaza at Belen also farmed some small plots of arable land. The ranchos at Sabinal, some 4 leagues to the south of Belen, had better land than those at Belen(Adams and Chavez 1956:208); Sabinal, the southernmost community in New Mexico until 1800, also irrigated its lands with ditches from the Rio Grande.

More recent information on irrigation facilities in the Albuquerque area comes from documents pertaining to land sales and court cases. When Francisco Gurule of Los Gallegos sold a piece of property to Juan Domingo Griego of Los

Griegos in November 1822, the eastern boundary of the land was described as being the acequia madre for Los Candelarios and Los Griegos; this was probably the Candelaria ditch (U.S. Surveyor General, Case 156). Two years later Marianne Montaño sold to Jose Maria Griego some land that was bounded on the west by the acequia madre (U.S. Surveyor General, Case 156). By the 1820s the area of Los Ranchos de Albuquerque was served by two acequias. The first, called the Chamisal, began on the lands of the Sandia Indians and terminated at Albuquerque. The second began at the Plaza of Los Garcias (sometimes known as Los Lunas) and ended at Barelas (U.S. Surveyor General, Case 156).

Around 1825, the owners of the Elena Gallegos tract had inadvertently created swamps on their land with the surplus water from the acequia (CPLC, Case 51). Before the twentieth century, acequias were generally not supplied with an outflow ditch back into the river or into a lower ditch system. Once the water passed the irrigated fields it was simply allowed to discharge into an uncultivated field or meadow (CPLC, Case 51).

Around 1829, Antonio Sandoval had an acequia madre constructed at the foot of the hills in order to irrigate his lands, which lay below Las Barelas (U.S. Surveyor General, Case 154). The acequia began just to the south of Los Candelarios and ran across the meadows to the hills and then followed the foothills (U.S. Surveyor General, Case 154). Sandoval also constructed other acequias on his land in the Mexican period. A year earlier the residents of Los Candelarios complained to the alcalde about the drain (desagua) from the acequia madre (CPLC, Case 8). The existing drain required constant repair and attention to prevent it from flooding the adjacent farmlands. The people at Los Candelarios wanted to move the desagua of the acequia madre so that it would empty into the Estero de Mejia (CPLC, Case 8). In August 1830, Jose Antonio Garcia was placed in possession of land that lay in front of his house; he was warned, however, that if the acequia madre were to break at Vadito, as frequently occurred, he would have to repair damages to his own property at his own expense (CPLC, Case 8).

In the Bernalillo area, Capt. Manuel Baca owned the land along the lower Rio Jemez at its confluence with the Rio Grande in the early 1700s. Half of this land was irrigated from the Rio Jemez and the rest from the Rio del Norte (CPLC, Case 157). In 1776 the community of Upper Bernalillo was founded on the west side of the river where the sandy soil did not permit the construction of good irrigation ditches (Adams and Chavez 1956:165). The lands at Bernalillo itself were poor but irrigated with water from the Rio Grande according to Fray Dominguez (Adams and Chavez 1956:144).

Fray Dominguez noted in 1776 that most of the farming done by the Santa Anas was on purchased lands along the Rio Grande, farming near their pueblo being dependent upon rainfall because of the unsuitability of the Rio Jemez for irrigation (Adams and Chavez 1956:170). Fray Morfi in 1782 was more specific. He described the Rio Jemez at Santa Ana as a sterile and salty stream; as a result, the lands originally assigned to the Santa Anas were almost useless, and the Indians had bought farmland north of Bernalillo on both banks of the Rio del Norte (Thomas 1932:98). The Indians of Santa Ana built an acequia from the Rio del Norte in 1763 to irrigate their newly acquired lands (CPLC, Case 157). Between 1824 and 1838 and the Santa Anas at Los Ranchitos were engaged in a dispute with the vecinos of Angostura over rights to a ditch that they used jointly (Taylor 1982:38–40). The controversy was apparently over the ditch that the Santa Anas had built in 1763 across lands of the people of Angostura; this dispute shows that the ditch remained in use at least until the late 1850s.

In 1830, the Montoyas occupied the lands on the west bank of the Rio Grande between Santo Domingo and San Felipe, an area known as the Santa Rosa de Cubero grant. They planted wheat and corn along the river using the Santo Domingo ditch for irrigation as well as a smaller ditch of their own (CPLC, Case 267).

Upriver at Peña Blanca, Fray Morfi noted in 1782 that only the family of the owner of the rancho, Jose Miguel de la Pena of Santa Fe, lived there (Thomas 1932:99). In 1788 Antonio Armenta recorded that the eastern boundary of a small tract at Peña Blanca lay along the acequia madre (U.S. Surveyor General, Case 124). Around 1805, Luis Maria Cabeza de Baca purchased land near Peña Blanca from the Cochitis and built an acequia to irrigate this land (U.S. Surveyor General, Case 124).

A settlement of 50 families was established around 1737 at Nuestra Señora de la Concepcion, 6 leagues south of Albuquerque (Hackett 1937:400). The residents irrigated their fields with water from the Rio del Norte. In 1760, Bishop Tamaron noted that the settlement at Tomé, which had been established in 1740, was the first community encountered in the Rio Abajo as one came north from El Paso (Adams 1954:43, 71). The extensive farmlands at this settlement were described as being easy to irrigate from the Rio del Norte. By 1776, Tomé had a population of 737 persons living in

in scattered ranchos and irrigating their fields with water diverted in ditches from the Rio del Norte (Adams and Chavez 1956:153). The smaller community of Valencia to the north had similarly irrigated croplands (Adams and Chavez 1956:153).

By 1784, the family of Antonio de Luna had croplands in the area south of Los Lentes under irrigation using acequias constructed around the middle of the eighteenth century by Antonio de Luna and his brother (CPLC, Case 64). In 1828 and again in 1836 the Rio Grande shifted its course between Los Lunas and Los Lentes, disrupting the irrigation system (CPLC, Case 64).

When Commandante General Pedro de Nava ordered the resettlement of Senecu, Socorro, Alamillo, and Sevilleta in 1800, he originally planned to begin at Sevilleta but found that the river had destroyed the pre-Revolt irrigation system (CPLC, Case 13). Because new ditches would have been too costly and time-consuming to build, Nava ordered the governor of New Mexico to settle Alamillo first so that delay in planting the land could be avoided. For the resettlement at Socorro, the sargento mayor of the proposed garrison was to encourage the construction of new acequias if the old ones could not be cleaned or repaired (CPLC, Case 127). When the resettlement actually occurred around 1815, it was done without government supervision or a garrison (CPLC, Cases 13 and 127). In 1820, Pedro Armendaris constructed an acequia to water his farm at Valverde (U.S. Surveyor General, Case 33).

Along the Rio Jemez and its tributaries, irrigation agriculture took place above the Pueblo of Santa Ana. Fray Dominguez in 1776 noted that Vallecito was a small settlement of ranchos with fairly good farmlands that were irrigated from a small stream (Adams and Chavez 1956:181–182). In 1782, Fray Morfi found seven Spanish families farming in the narrow valley of the stream that supplied water for the fields at Vallecito (Thomas 1932:100). In 1808, residents of Puesto del Vallecito de Xemes, which had been founded in 1768, complained to the governor regarding a proposed settlement at Rillito Abajo (SANM I:380). Toribio Gonzales and others pointed out that irrigation water was scarce during the crucial months of June, July, and August. At San Ysidro, Antonio de Armenta filed a suit in the summer of 1813 against the mayordomo of the acequia madre, Antonio Jose Mestas, over alleged injustices in the distribution of maintenance work on the acequia madre (SANM II:2503). Thirteen years later at Las Huertas in the cañon of Nuestra Señora de Guadalupe, Jose Montoya sold Santiago Montoya land and the right to use the acequia in that area (Santa Ana County Deed Records, Miscellaneous Book C:130).

In the Mesilla Valley, Juan Antonio Garcia appears to have constructed an acequia on the Brazitos tract as early as 1805 in order to irrigate his cornfields (U.S. Surveyor General, Case 6). This acequia was used until around 1828, when Apachean attacks forced the Garcias to abandon the tract. The ditch remained a prominent landmark into the 1860s and was occasionally used in boundary descriptions (U.S. Surveyor General, Case 6). When settlers moved into the Doña Ana Bend Colony Grant in April 1843, they immediately began the construction of an acequia to deliver water from the Rio Grande to their croplands (U.S. Surveyor General, Case 85). By January 1844, the acequia was completed, but it was reported to require the construction of a palisade to protect the headworks from stream erosion. Ultimately it had to be enlarged to 3 varas wide to provide sufficient water for the farmlands under cultivation and for domestic needs. As early as 1849 an acequia was constructed on the Mesilla Colony Grant; this facility remained in use until 1898 (see testimony of Thomas J. Bell before the Court of Private Land Claims, Case 151). In 1852 Jose Manuel Sanchez Baca constructed an irrigation ditch that took water from the Arroyo del Agua at the north edge of this grant (CPLC, Case 138).

Development of irrigation in the Mesilla Valley after the American acquisition of first the east and then the west bank of the Rio Grande will be treated in the following chapters.

Chapter 7

EXISTING IRRIGATION SYSTEMS IN THE LATE NINETEENTH CENTURY

TERRITORIAL PERIOD IRRIGATION: 1846–1910

When the Americans occupied New Mexico in 1846, they found a largely agrarian society that was concentrated in the Rio Grande Valley and depended for its survival upon irrigation agriculture (Figure 16). Both Hispanic and Puebloan communities controlled and managed the irrigation systems that covered most of the irrigable lands along the Rio Grande and its tributaries.

Prior to the annexation of New Mexico by the United States, Josiah Gregg visited the territory on several occasions during the 1830s. He noted the fertility of the bottomlands and the barrenness of the unirrigated uplands (1954:104). New Mexican agriculture was primitive by American standards. The crude plows were used only on loose soils; most land was cultivated with the hoe alone (Gregg 1954:107).

Most farms and settlements in New Mexico were located in valleys with perennial streams. In some valleys, crops were regularly stunted by the seasonal depletion of stream flows. One acequia madre was generally sufficient to convey water for the irrigation of an entire valley or the fields of one town or settlement (Gregg 1954:107–108). Repair and maintenance of ditches were the responsibility of the community that used the acequia and were carried out under the supervision of the mayordomo (Gregg 1954:108). Individual landowners took the water from the acequia madre by means of minor ditches (laterals) running to their own lands. In times of scarcity the use of water was carefully regulated by the community ditch association (Gregg 1954:108).

Most of the acequias in the Rio Grande Valley took water from the mainstream of the river except where a tributary was a more convenient source. Wing diversion dams of stone channeled water into the ditches, whether from the Rio Grande itself or from its tributaries. New Mexicans in the late Mexican period grew mostly corn and wheat under a system of subsistence agriculture (Gregg 1954:108). While the scope and extent of irrigation activities in the Rio Grande Valley had steadily expanded in the Spanish and Mexican periods, the nature of irrigation agriculture had remained very much the same (Figure 17). Expansion of the irrigation system in the Rio Grande Valley was strictly a response to population growth. The primary focus on subsistence agriculture persisted in the Rio Grande Valley for some time after the American annexation of New Mexico under the Treaty of Guadalupe Hidalgo.

The survival and even continued expansion of traditional New Mexico irrigation systems was possible in part because of the Kearny Code (1846) and subsequent legislation derived from it. These statutes recognized the importance of community ditch systems and gave them legal standing in the territory of New Mexico (30th Congress, 1st Session [1848], House Executive Document No. 60:219). Regulations and procedures defined in the Kearny Code and other territorial legislation on acequias were derived from Spanish and Mexican laws and practices of the period before 1846. As a consequence the Spanish/Mexican irrigation systems continued to function in traditional ways under the newly established American regime. The Americans attempted to introduce some incipient forms of commercial agricultural, but the local population generally resisted attempts to induce them to adopt Anglo-American agricultural methods, including more modern irrigation technology (Sunseri 1973:329–337).

Early descriptions of irrigation systems are usually general and specific details on specific local irrigation systems are rare. Lieutenant Abert (1848:463–499) provided some information for a few areas of the Rio Grande Valley (see Figure 16). En route from Santa Fe to El Paso, for example, Abert's detachment found their route obstructed by the acequias used by the Indians of Santa Ana for irrigating their fields at Los Ranchitos (Abert 1848:463). A little farther south, in the area between Bernalillo and Alameda, Abert had to follow a large acequia for 5 or 6 miles before he could find a practicable crossing for his men (Abert 1848:464). In the area of Atrisco, Abert's wagon bogged down in an acequia

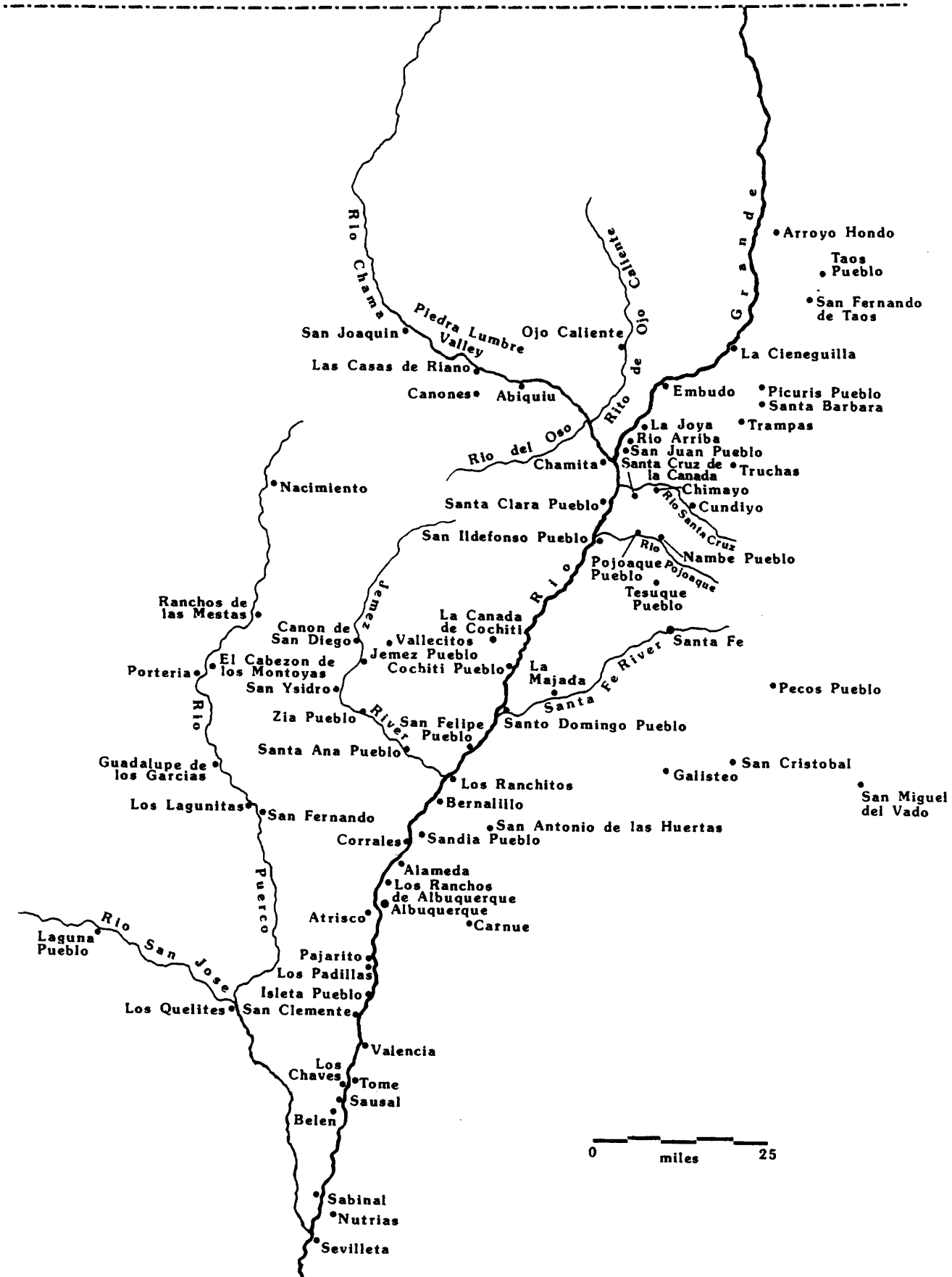

Figure 16A Rio Grande Valley in 1846 (northern half)

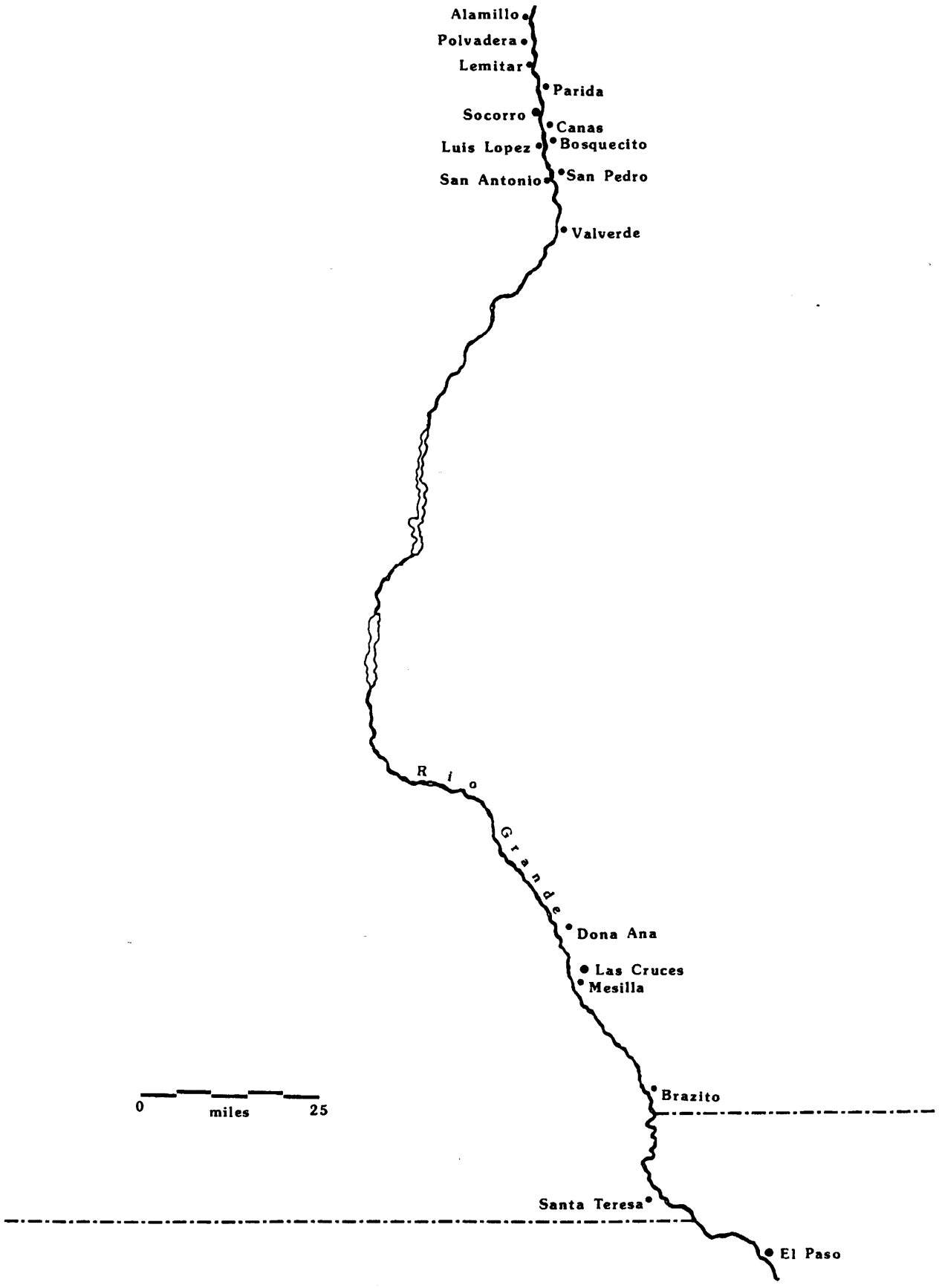

Figure 16B Rio Grande Valley in 1846 (southern half)

Figure 17 Regulating Water Flow in Acequia, Taos Valley, New Mexico, ca. 1946 (Courtesy of the Museum of New Mexico, Santa Fe, Negative No. 59302)

on the west side of the Rio Grande as his detachment marched west toward the Rio Puerco (Abert 1848:465). Finally he noted that the ruins of the acequia on the Pedro Armendaris grant at Valverde, south of Socorro, were still visible (Abert 1848:499).

In the same year, Lieutenant Emory described the remains of the rancho of Pedro Armendaris at Valverde and the remains of his acequias (Emory 1848:53). Emory (1848:48) also recorded the presence of two large acequias on the fertile plain at Tomé, describing the ditches as being 9 feet deep and 12 feet wide.

In 1850, Col. George A. McCall enumerated the irrigated and irrigable acreage in various parts of the Rio Grande Valley of New Mexico as part of his report to the Secretary of War. These estimates were based upon recent observations in New Mexico (31st Congress, Second Session, Senate Executive Document No. 26). McCall estimated that on the east bank of the Rio Grande between El Paso and Doña Ana 3200 acres were irrigated, with an additional 3200 acres being cultivable but vacant. Also on the east bank from Fray Cristobal (Valverde) to Peña Blanca 38,600 acres were under cultivation (i.e., under irrigation) and 32,000 more acres could be cultivated. On the west bank of the Rio Grande between El Paso and Peña Blanca, 30,280 ares were being cultivated while an additional 115,200 acres were cultivable. For the Taos Valley, McCall reported that 15,000 acres were under cultivation with 10,000 more acres being cultivable. For the Española Valley, 2000 out of a total of 20,000 potentially cultivable acres were actually in use in 1850. In the Chama Valley 2880 acres were being cultivated as far north as Abiquiu, with an additional 8840 acres being cultivable. In the Santa Fe area all 5000 available acres of cultivable land were being utilized for agriculture. As a result of 150 years of active irrigation development, approximately 97,000 acres were under cultivation (i.e., under irrigation) in the Rio Grande Valley of New Mexico at the beginning of the American period.

Beginning in 1849, agents of the Office of Indian Affairs assumed broad and ill-defined responsibility for the Pueblo Indians in New Mexico. The superintendents and the Indian agents gathered and reported general information on the conditions of the Puebloans but only infrequently provided any specific data about irrigation systems on Pueblo lands before the 1890 census. The information gathered during this census will be discussed later in this section. In general, however, Puebloan irrigation systems appear to have remained largely the same in both organization and extent throughout the period from 1846 to 1910 (Figure 18). Irrigation technology did not begin to change until the U.S. Indian Irrigation Service began its activities in New Mexico around 1905 (USDI, Bureau of Indian Affairs, Records of the Irrigation Division 1905–1907). With a few exceptions, Pueblo Indian irrigation systems do not appear to have expanded to any significant degree owing mainly to the continued gradual decline in populations until around 1890 or 1900. Puebloan populations stabilized at the end of the nineteenth century and then began an expansion during the twentieth century.

Because of the nature of record keeping and for various economic reasons, we have much more information on non-Indian irrigation systems and their development in the late nineteenth century than is available for Indian systems, although the first general study of irrigation systems was not made until 1896. In that year W. W. Follett was commissioned by the International Boundary (Water) Commission to gather data on irrigation systems and their probable consumption of water for agricultural purposes in the whole of the Rio Grande Valley above El Paso. Because of the short time that was allotted for the study (less than 2 months) Follett's report is necessarily cursory in many aspects (Follett 1896:10). Most of his data were reduced to tabular form. These tables give the number of ditches along a particular stream or part of a stream, the name of the ditch (if known), its probable age (this was often expressed in general terms, such as "very old"), the estimated acreage irrigated by the ditch, and ditch capacity (Follett 1896:96–134). In the short narrative report, a brief description was also provided for each of the districts into which Follett had divided the Rio Grande Valley and its tributaries (Follett 1896:86–95). While useful, Follett's report must be viewed with caution owing to its inherent limitations.

In 1910, Herbert W. Yeo prepared a study for the Reclamation Service. The report was based on records in the Office of the Territorial Engineer (Santa Fe) and on field investigations. Yeo's work was the first full study of irrigation systems in the Rio Grande Valley of New Mexico and marked the beginning of scientific investigations of irrigation in the valley. Thus Yeo's report for 1910 serves as a baseline for subsequent investigations. His report gives us a good picture of irrigation systems some 60 years after the beginning of the American occupation and provides information about development of irrigation systems in the period after the annexation but before the beginning of federal irrigation projects. The irrigation systems sponsored by federal agencies radically altered irrigation in the Rio Grande Valley in the 1920s and 1930s (see Chapter 9).

Figure 18 Irrigation Ditch near Isleta Pueblo, New Mexico, ca. 1890–1895 (Photograph by William H. Cobb, Courtesy of the Museum of New Mexico, Santa Fe, Negative No. 15141)

What is remarkable about irrigation systems in the Rio Grande Valley before 1910 is the small amount of change since 1846. After the arrival of the railroads, irrigated acreage had expanded substantially until the 1890s when drought, upstream development, salinization, defective drainage, and a development embargo by the federal government brought expansion virtually to a halt.

In 1896, Follett showed 82,710 acres irrigated along the mainstream of the Rio Grande and 61,000 acres on the tributaries of the river above San Marcial, for a total of approximately 144,000 acres; that represented an expansion of 47,000 acres in the 40 years since the annexation of the territory by the United States. Some 15,000 acres of the difference is apparently a result of McCall's not having included the Jemez and Picuris valleys in his enumeration. Another 18,000 acres of the expansion in irrigated land took place in the Española and Santa Cruz valleys, while the remaining 14,000 acres of increase was distributed throughout the rest of the Rio Grande Valley. By 1907, acreage would, overall, expand slightly to some 157,000 acres. While acreage on the tributaries remained relatively stable at around 60,000 acres during this period, irrigated acreage collapsed in the Española Valley, declining from over 14,000 acres in 1896 to less than 6000 acres in 1907. Most of the expansion took place in the Albuquerque and Socorro valleys.

Although irrigated acreage had expanded, the actual irrigation systems and their organizations had changed very little between 1846 and 1910. In the upper Rio Grande Valley, virtually all of the irrigable acreage was under ditch before 1846; in the middle valley (i.e., White Rock Canyon or Cochiti to San Marcial) most expansion after 1846 took place in areas where raids by nomadic Indians had caused earlier attempts at settlement to fail. Only in the Mesilla Valley was wholly new land brought under irrigation in the Territorial period, but even there the overall increase in acreage was not surprising or unusual, given the removal of the threat of Apachean raids by the late 1870s.

The vast majority of farmers in 1910 were still Puebloans or Hispanic New Mexicans. Increasing numbers of Anglo-Americans had begun to engage in irrigation agriculture, but most were too poor or inexperienced to introduce modern irrigation technology. The real impact of Anglo-Americans on the New Mexican economy during the Territorial period (1846–1912) was in the development of a livestock industry with its accompanying infrastructure of railroads and market towns. Since most of the essential developments in the livestock industry took place away from the Rio Grande on the uplands and plains that surrounded the valley (Westphall 1965), any impact on irrigation systems was indirect during the Territorial period.

DITCHES ON LAND GRANTS: 1854–1904

For the period before 1901, information on specific irrigation systems can be found in the records of the proceedings of the U.S. Surveyor General for New Mexico (1854–1891) and the U.S. Court of Private Land Claims (1891–1904). Information that applies to specific ditches within a number of New Mexican land grants was recorded in testimony and on maps.

For the upper Rio Grande Valley in New Mexico, specifically the Santa Fe and Santa Cruz areas and the rest of the Rio Arriba, the references to irrigation systems are not extensive. Evidence presented in testimony by claimants and witnesses shows that from 1846 to the early 1900s most agricultural land on land grants in northern New Mexico was irrigated, but the amount of specific information on the ditches or ditch systems is quite limited.

Testimony taken in 1885 before the U.S. Surveyor General shows that non-Indians had returned to the Cañada de Santa Clara despite repeated expulsions of settlers from this area by the Spanish government in the eighteenth century. These settlers were again irrigating their fields with water from the small creek, much to the consternation of the people of Santa Clara Pueblo (U.S. Surveyor General, Case 138).

The testimony of Juan Antonio Pena in 1895 indicates that he and his father built an acequia on the Petaca grant near Vallecitos in 1848 (CPLC, Case 99). Serafin Baca and Jesus Maria Olguin testified that settlers had constructed acequias on the Petaca grant after they occupied the land around 1836 (CPLC, Case 99). A map of the Petaca grant from June 1901 shows cultivated fields served by short ditches (CPLC, Case Grant 99).

A map of the boundaries of the Juan Bautista Valdez claim to the northwest of Abiquiu shows that in 1900 cultivated fields on the west side of Polvadera Creek at the boundary with the Piedra Lumbre grant were served by an irrigation ditch that took water from the creek (CPLC, Case 179).

In 1872, Geronimo Gallegos testified that all of the agricultural land within the San Joaquin del Rio de Chama grant was on the narrow bottom of the cañon (U.S. Surveyor General, Case 71). The lands were irrigated by acequias that diverted water from the Rio de Chama. Despite periodic abandonments of the area, these acequias were still arranged much as they had been when originally laid out by the alcalde mayor in 1806 (U.S. Surveyor General, Case 71).

In testimony taken in 1895, Antonio Joseph asserted that in 1855 the ruins of old ditches could be found on both banks of the Rio del Norte at the largely abandoned community of Cieneguilla in Taos County (CPLC, Case 84). In 1876, Lorain Read testified before the Surveyor General that small patches of land at the community of Cieneguilla totaling approximately 40 acres were irrigated using water from the Rio Grande (CPLC, Case 84).

A survey of the Gijosa grant near Taos Pueblo in 1901 indicated that the Los Alamitos ditch served lands on the south side of the Rio del Pueblo below the community of Los Cordovas. The same survey recorded seven unnamed acequias above Los Cordovas along the Rio del Pueblo (CPLC, Case 16).

The records of the Surveyor General and the Court of Private Land Claims are much more extensive for the Rio Abajo than for the Rio Arriba. In part this is a result of the number of overlapping claims in the Rio Abajo. Litigation concerning these overlapping claims produced considerable testimony before the reviewing authorities.

Regarding the Cañada de Cochiti grant, William Harris testified in 1894 that the existing acequia began just below the constriction of the cañon and ran on the north side of the creek (CPLC, Case 205). In the late 1890s, testimony regarding the El Ranchito area indicated that two acequias ran north-to-south on lands that lay between the river and the railroad (CPLC, Case 157). Referring to Santa Rosa de Cubero, between the pueblos of San Felipe and Santo Domingo, Antonio Garcia testified in 1898 that the small local ditch had disappeared because the Rio Grande had changed its course since the Mexican period (CPLC, Case 267). Testimony concerning the area around Bernalillo taken in 1897 indicates that in the second half of the nineteenth century, settlers cultivated land irrigated from the acequia madre (information included in the records of the U.S. Surveyor General, Case 83).

Referring to irrigation at Los Ranchos de Albuquerque, Guadalupe Gutierrez (age 59) testified in 1887 that during his lifetime the acequia de Chamisal, as well as the Griego and Candelaria acequias, provided water for agriculture (U.S. Surveyor General, Case 156). The acequia de Chamisal, which began on the Sandia Pueblo grant, was 6 miles long and measured 4 yards wide. The Griego ditch, which began at Los Garcias and ended at Barelas, and the Candelaria acequia were of the same length and width as the acequia de Chamisal (U.S. Surveyor General, Case 156). Further, Gutierrez testified that the people of Alameda used the ditches of Los Ranchos because they had lost the use of their own acequia as a result of the rise in the river (U.S. Surveyor General, Case 156). He also provided evidence on one source of drainage problems and high water tables in the area north of Albuquerque when he stated that the *esteros* (swamps, marshes) were caused by surplus water from the acequias, not by the river itself. Finally Pedro Antonio Perea testified that one-quarter to one-third of the arable land in the area of Los Ranchos de Albuquerque was under ditch and cultivated (U.S. Surveyor General, Case 156).

Regarding the Las Lagunitas area, south of Barelas, Teodoro Lopez testified that the local ditch was the acequia of Antonio Sandoval, which ran at the foot of the hills to the east of the Rio Grande. He further indicated that approximately one-half of the land between the river and the ditch was cultivated (U.S. Surveyor General, Case 154). Earlier testimony, taken in 1874 in conjunction with a lawsuit brought by the residents of Barelas against Jose Armijo y Garcia and Desiderio Griego over damages allegedly caused by the Griegos, Candelarios, and the Sandoval acequias, stated that the Sandoval ditch began at the southern end of the acequia de los Candelarios and ran across a meadow to the hills, then along the foot of the hills (U.S. Surveyor General, Case 154).

According to testimony taken in December 1885 concerning the Atrisco grant (U.S. Surveyor General, Case 145), the land under ditch on the west side of the Rio Grande was 500 varas wide and 1 league long from north to south between the river and the mesa. In 1894 when further testimony was taken before the Court of Private Land Claims the amount

of irrigated land appears to have been largely the same as it was earlier. In 1894 there were five communities on the grant: Atrisco, Placitas, Los Sanchez, Los Chavez, and Los Garcias (CPLC, Case 45).

The lands that lay directly south of Atrisco on the Pajarito tract were irrigated as early as 1857 by an acequia madre that began near Los Ranchos de Atrisco (U.S. Surveyor General, Case 154). In the area south of Albuquerque, the problems of flood control and drainage were met in the early 1850s by the construction of ditches on both sides of the Rio Grande. William H. Metzger testified in 1894 that the El Tajo ditch, which was built around 1852, was dug to relieve water overflows at Albuquerque (CPLC, Case 63). At the same time the acequia de los Padillas was utilized mainly for flood control on the west side of the river (CPLC, Case 63).

Where the Rio Grande shifted its course to the west in the area between Los Lentes and Los Lunas in 1884, the river cut through the acequia closest to the river (CPLC, Case 64). An 1898 plat of the San Clemente grant shows that two acequias lay west of the old channel of the Rio Grande; the easternmost ditch, and the one that was probably cut through in 1884, was the acequia madre. In 1898 this ditch lay east of the river (CPLC, Case 64). A map from 1901 of the overlap between the Los de Padilla and the Gutierrez and Sedillo claims shows that four acequias traversed the area that had previously lain west of the old river channel but in 1901 was east of the new channel (CPLC, Case 64).

As for the Sevilleta grant, we can conclude from testimony given in 1893 that the earliest settlers west of the Rio Grande moved there around 1858 and built a ditch that took water from the Rio Puerco (CPLC, Case 55). Around 1862, a ditch seems to have been built to divert water to these western lands from the Rio Grande, and in 1873 or 1874 Anatasio Garcia built a ditch to irrigate land west of the river and north of the Arroyo San Lorenzo (CPLC, Case 55). Finally in 1892, Ramon Luna built the Alamillo ditch on the east bank of the Rio Grande to irrigate lands within the Sevilleta grant (CPLC, Case 55).

An 1878 survey of lands north of the Socorro grant showed that two acequias crossed the northern boundary of the Soccoro grant (CPLC, Case 127). By 1877, settlers had begun to irrigate lands along the Rio Grande within the Pedro Armendaris grant, including the Valverde area where Armendaris had built a ditch in 1820 (U.S. Surveyor General, Case 33).

Chapter 8

IRRIGATION DEVELOPMENT: 1846–1910

With the American acquisition of New Mexico came the beginning of the end of the economic stability that New Mexican subsistence farmers had experienced for over a century. While the stability of the adaptation gradually disappeared, the technology of irrigation and the methods of irrigation agriculture changed very little for most farmers in the Rio Grande Valley until after the turn of the century.

In order to hold down the expenses of the American military forces in the territory, U.S. Army garrisons were required to maintain post gardens and farms. In 1851, an acequia was dug to serve the garden and farm at Fort Conrad, which lay on the Rio Grande some 25 miles south of Socorro (Frazer 1963:92). This irrigation system and those associated with Fort Craig near Valverde and Fort Fillmore in the Mesilla Valley were part of New Mexican agriculture in the Rio Grande Valley during the 1850s. Their impact on local agricultural technology appears to have been minimal, however.

The Treaty of Guadalupe Hidalgo guaranteed certain land and water rights of the original inhabitants of the new territory to the extent that land and water had been used in 1846 (9 Stat. 922 at article IX). The Kearny Code was issued in 1846 and remained the fundamental basis for the government of New Mexico even after the organization of the Territory of New Mexico by Congress in 1850 (30th Congress, 1st Session [1848], H.E.D. 60:177–229). The section of the Kearny Code regarding water declared that all laws in force at the time of the American occupation were to remain in force, except that the duties of the various local ayuntamientos were to be transferred to the local alcaldes and county prefects.

In its first session (1851), the New Mexico legislature provided for a continuation of Spanish and Mexican regulations regarding the rights and responsibilities of those who used acequias (Legislative Assembly of the Territory of New Mexico 1851:188–190). The assembly declared that the alignments of acequias already in use were not to be disturbed and that use of acequias for irrigation should take precedence over all other uses, such as powering mills. One modification of previous laws regarded easements for ditch constructions. Under territorial laws, the owners of property crossed by newly built acequias were to be paid the assessed value of the land so used; under Spanish and Mexican law the only restriction on easements for new acequias had been that the owner(s) of the lands should receive a right to use water from the newly constructed acequia. The Second Territorial Assembly (1852) set forth the requirements that all public ditches were to remain pubic and that the mayordomos of those ditches were to be elected officials (Legislative Assembly of the Territory of New Mexico 1852:276–278).

In 1854, the land laws of the United States were extended to New Mexico (10 Stat. 309). At the same time, Congress established the office of Surveyor General for New Mexico. In addition to his responsibility for surveying public lands so they could be acquired by private parties, the Surveyor General in New Mexico was required to investigate the validity of claims for Spanish and Mexican land grants and the land claims of the Pueblo Indians (10 Stat. 309). He was to report to Congress on the results of those investigations so that Congress could confirm or deny the claims. Nearly all Pueblo Indian claims and some of the non-Indian land claims were investigated by the office of the Surveyor General between 1854 and 1891. In 1891 Congress created the Court of Private Land Claims to finish the work begun by the Surveyors General (26 Stat. 864); by 1904, the Court of Private Land Claims had heard and ruled on nearly all of the remaining claims to Spanish and Mexican land grants in New Mexico.

While some have claimed that the slow pace with which land claims for Spanish and Mexican grants were resolved retarded the economic growth of the new territory, irrigation agriculture continued to expand, especially in the Rio Grande Valley. In the 1860s, it is estimated that 18,000 acres of new irrigated land was bought under cultivation; in the 1870s, 34,000 more acres were added (Linford 1956:17). A comparison of the McCall and Follett surveys shows that in the nearly 40 years from 1849/1850 to 1896, irrigated lands in the Rio Grande Valley of New Mexico expanded by some 47,000 acres (Follett 1896; McCall 1850). After 1880 irrigation agriculture developed rapidly all along the Rio Grande Valley, but nowhere was the pace and extent of growth greater than in the San Luis Valley of south-central Colorado. Before 1870 only negligible acreage was under irrigation in the San Luis Valley; by the mid 1890s more than

300,000 acres were being irrigated annually in that portion of the Rio Grande drainage (Natural Resources Committee 1938:300). As we will see, this development in Colorado was to have a dramatic impact on irrigation throughout the remainder of the Rio Grande Valley.

In the late 1880s, the government of New Mexico became increasingly interested in promoting irrigation agriculture. Legislation passed in 1886 encouraging the formation of land and irrigation companies (Linford 1956:17). Private irrigation companies, which were largely financed by capital from outside the territory, purchased land grants with existing water rights. The irrigation companies planned to turn these land and water rights into extensive modern irrigation projects; their successes, however, were not immediate and were extremely limited even in the long run.

In an 1888 report, Edmund E. Ross recorded the growing crisis in New Mexican irrigation (Linford 1956:17). The expanding demand for irrigation water could not be met with the old irrigation systems, which were already inadequate. The increasing demand for irrigation water had led to a multiplication of ditches and headings, which were almost universally poorly planned and built. In addition, much of the water needed for irrigation came during the spring runoff and was lost to floods, since no storage facilities existed along the Rio Grande or its tributaries.

By the early 1890s, serious problems had emerged in the irrigation agriculture of the Rio Grande Valley. Drought, which had struck sporadically in the 1880s, became acute in the early 1890s (Baker 1898:17–18; Wortman 1971:17); by 1889 the Rio Grande below Albuquerque literally dried up for 4 months of the year. Stream flow had been seriously depleted by rapid development of irrigation agriculture in the San Luis Valley of Colorado; the effects on downstream users were dramatic and ultimately led to federal intervention (Follett 1896; Harper et al. 1943; Harroun 1898; Yeo 1910, 1928).

Ironically, at the same time that the Rio Grande was being seasonally depleted, lands in the middle Rio Grande Valley from Cochiti to San Marcial, especially between Bernalillo and La Joya, were becoming waterlogged and thus not amendable to cultivation (Conkling and Debler 1919:77; Harper et al. 1943; Harroun 1898:2; Natural Resources Committee 1938:70). Sedimentation in the Rio Grande resulting from decreased flows had caused the bed of the main channel to aggrade; as a result the water table in many parts of the valley had begun to rise. Waterlogged lands had always been a problem near the Rio Grande owing to poor drainage and wasteful irrigation practices; under traditional agricultural methods, excess water in the acequias was simply dumped onto low-lying lands at the end of the acequia. Only a small percentage of ditches had facilities for returning the excess flow to the Rio Grande or delivering the water to downstream ditches. Each ditch system, of which there were dozens, was independent; no plan or organization to integrate the multitude of irrigation systems in the middle Rio Grande Valley existed or was deemed necessary.

As early as the 1820s, local farmers had noted the formation of marshes in the Rio Grande Valley that were the result of the dumping of excess flows from ditches (CPLC, Case 8; CPLC, Case 51). In the 1880s and 1890s, the aggrading of the Rio Grande and the rising water table had exacerbated the situation. In addition, few of the community or private ditch systems had the means or the inclination to construct drainage systems to relieve the waterlogging of agricultural lands, and few systems attempted to curtail the dumping of excess flows onto low-lying lands at the ends of their ditches (CPLC, Case 8).

In a speech to the 1889 territorial legislature, Gov. Bradford Prince recognized that the problems faced by Rio Grande irrigation agriculture were too complex and costly to be resolved by the local populations and private capital (Linford 1956:19). Governor Prince suggested that government intervention had become necessary. While he was perhaps a little early in his call for government involvement in western irrigation, Governor Prince was expressing a broad and growing public interest in the problems of irrigation agriculture in the arid regions of the United States (Reisner 1986:108–124; Worster 1985:129–143). As will be discussed in the following section, John Wesley Powell's report on arid lands in 1876 and the complaints of the Mexican government over interrupted flows on the Rio Grande in the 1880s served to focus attention on the arid West, including the Rio Grande Valley of New Mexico.

THE FEDERAL GOVERNMENT AND IRRIGATION DEVELOPMENT

John Wesley Powell was the first person to bring public attention to the possibilities of irrigating lands in what had been known since the 1830s as the Great American Desert (Gates 1968:645; Petulla 1977:225–227; Reisner 1986:16–53).

While the Rio Grande Valley was an exception to that description as a result of several hundred years of experience with irrigation agriculture, New Mexicans were not immune to the lure of the wildly optimistic prospects that Powell (1878) initially suggested for the arid regions of the United States. Within a few years after his *Report on Arid Lands of the United States* (47th Congress, 2nd Session, House Miscellaneous Document No. 45, part 4), Powell (1890) had substantially modified his initial predictions concerning amounts of potentially irrigable lands; he had come to realize that the amount of irrigable land greatly exceeded the supplies of water for irrigation (Gates 1968:646; Petulla 1977:227).

Nevertheless, Powell (1890) continued to propose irrigated acreage numbers that were quite exaggerated, and others were even more willing to ignore the vast discrepancy between potentially irrigable lands and the limited water resources (Reisner 1986:16–53; U.S. Senate 1890). In his statement to the Senate Committee on the Irrigation and Reclamation of Arid Lands, Powell (1890) reported that approximately 287,000 acres were irrigated in the counties covered by the Rio Grande Valley; what he appears to have meant was that 287,000 acres of land *could* be irrigated by existing ditches, not that 287,000 acres were actually being cultivated. This misconception has continued to the present day in the popular but distorted view of the relationship between western irrigation agriculture and the finite and easily depleted water resources that are available. Just because a piece of land is irrigable does not mean that it can be irrigated.

Despite a certain understandable element of boosterism, Powell was, from the beginning, aware of the problems attendant upon irrigation of arid lands. In particular he wanted extensive and intensive topographic and hydrographic surveys to be carried out before any program of irrigation development was proposed or sponsored by the government (U.S. Senate 1890:136–138).

The response of Congress to Powell's report was the ill-conceived and much abused Desert Lands Act of 1877 (Ganoa 1937:142–143; Gates 1968:638). This legislation opened public lands in arid regions for entry under stipulations different from those outlined in the Homestead Act of 1862. Allegedly the expansion of the allowed holding from 160 to 640 acres, of which one-eighth was to be irrigated within 3 years, was more appropriate to the regions of the Great American Desert than the provisions of the Homestead Act, which was designed for less arid environments (Dunbar 1983:46). Without digressing into unnecessary details on the implementation of the Desert Lands Act, it is possible to say that this legislation encouraged fraud, that only disappointingly small amounts of land were ever irrigated as a direct result of the act, and that the primary beneficiaries were not farmers but the barons of the cattle industry (Gates 1968:640–642).

The Desert Land Act was little utilized in the Rio Grande Valley of New Mexico, since most of the land was already owned under land grants and much of the rest was or would be settled under the Homestead Act of 1862, which did not require any acreage payments to establish a legal entry. At the same time, by the late 1870s, most of the easily irrigable land in the Rio Grande Valley was already under irrigation.

In order to carry out some of the proposals in Powell's report, Congress created the U.S. Geological Survey in 1879 (Petulla 1977:228). Heretofore, topographic surveys had been carried out by the U.S. Army Corps of Topographic Engineers; now those responsibilities were transferred to the Geological Survey, which was a civilian agency under the Secretary of the Interior. When John Wesley Powell was appointed head of the U.S. Geological Survey in 1881, he organized the topographic surveys around drainage systems (Petulla 1977:228; Powell 1890:19). Consequently, Powell and the U.S. Geological Survey were prepared to respond in the late 1880s to Congressional authorizations of studies of the feasibility of irrigation in the arid West.

Congress became immensely interested in the arid lands as a consequence of a series of events that focused local and national interest on the region west of the 100th meridian. Droughts and blizzards in the mid and late 1880s devastated the livestock industry on the Plains and pushed back the agricultural frontier in the Midwest. In 1886, the Senate ordered the Department of Agriculture to prepare a report on existing conditions of irrigation in the United States (Lampen 1930). A wave of panic over water on the Plains caused Congress in 1888 to authorize surveys of irrigable lands and reservoir sites (U.S. Senate 1890:9). The Irrigation Survey was established under the auspices of the U.S. Geological Survey to carry out these studies (Dunbar 1983:47). In anticipation of positive recommendations, Congress withdrew from entry all public lands that were under study for reservoir sites (U.S. Senate 1890:12). The actions of Congress in 1888 mark the beginning of an indirect federal involvement in irrigation projects; active participation in such projects

was less than 15 years in the future. In 1889 and 1890 the Irrigation Survey examined the upper Rio Grande Valley for potential reservoir sites and also gathered information regarding water storage and irrigable lands (Powell 1891:145).

In the winter of 1888–1889 F. H. Newell, who ran the Irrigation Survey, trained his field personnel in the Rio Grande Valley of New Mexico (Dunbar 1983:48). In 1889, the New Mexico Division of the U.S. Geological Survey extended its topographic surveys from the mountainous regions of the Rio Grande Valley into districts of irrigable land (Powell 1890:19). In the beginning, the division's work covered the areas drained by the Rio Chama, Rio Jemez, and upper parts of the Rio Puerco. Members of the Senate committee on irrigation visited New Mexico and other arid states and territories in 1889 on a fact-finding tour (Linford 1956:20). Under commission from the Senate, Richard J. Hinton prepared an extensive written report that was available in 1889 and was published in 1892. The Special Committee on Irrigation and Reclamation of Arid Lands held hearings in Washington in the summer of 1890 at which Powell and others testified. Powell and the Irrigation Survey received a less than warm reception from the committee (Majority Report, U.S. Senate 1890:1–69). Congress was beset by such a howl of complaints from speculators, land barons, and land companies over the withdrawals of reservoir sites that the Congress rescinded the 1888 enactment (in August of 1890) and slashed the budget of the Irrigation Survey (Dunbar 1983:48). The actions of Congress in the summer of 1890 virtually put an end to irrigation surveys by the U.S. Geological Survey except where they could be tied to topographic or hydrographic studies; the U.S. Geological Survey continued, however, to publish studies based upon its previous work and research by independent parties (see, for example, F. C. Baker 1898).

While Congress had truckled to a small but powerful spectrum of private interests, the year 1890 also saw the first census of farm and irrigated acreages as a part of the Eleventh Census of the United States (U.S. Department of Commerce, Eleventh Census of the United States 1890). The narrative summary was prepared by F. H. Newell of the U.S. Geological Survey Irrigation Survey. Newell described the haphazard development that had become characteristic of most irrigation activity carried out by individuals and small groups on their own land. Lack of funds and expertise contributed to the problems. Newell also reported that state-sanctioned irrigation companies and irrigation districts were poorly managed and over-bonded. While his report did not specifically deal with New Mexico, conditions in the territory were not unlike those described.

A contemporaneous report by Capt. C. E. Dutton of the Rio Grande Division of the U.S. Geological Survey found that upstream diversions of water dried up the Rio Grande below Albuquerque for 2 months during the summer of 1888 (Powell 1890:98). Dutton also noted that the indigenous irrigation agriculture was the only practicable kind without extensive and costly facilities to control water; in particular, he noted, a storage reservoir was necessary in the lower part of the Rio Grande in New Mexico above El Paso (Powell 1890:99).

A number of irrigation companies were organized in New Mexico during the late 1880s under territorial legislation passed in 1886. Most of their activities were focused on the eastern plains and Pecos Valley, but some companies also operated in the Rio Grande Valley (Linford 1956:20a). The Taos Irrigation Company built 11 miles of main canal and 14 miles of laterals on Taos Mesa; the Rio Grande Valley Irrigation Company began construction of ditches in Doña Ana County during 1889 (Linford 1956:20a).

By the late 1880s, with the decline of the cattle industry, investors in New Mexico turned from ranching to irrigation companies. In 1888, 19 irrigation companies were incorporated in New Mexico; in 1889, 32 companies; in 1890, 23 companies; and in 1891, 14 companies (Westphall 1965:82–84). In the early 1890s an estimated 40% of the land brought under irrigation was supplied by private irrigation companies (Westphall 1965:80). Efforts by individuals to bring new lands under irrigation generally failed owing to a lack of sufficient capital and to unrealistic expectations.

The report of F. H. Newell on irrigated acreages in the western United States for the 1890 Census (U.S. Department of Commerce, Bureau of the Census 1894) showed the irrigated acreage in New Mexico to be only a little more than 42,000 acres for those counties within the Rio Grande Basin:

	Acres
Bernalillo	4,643
Dona Ana	11,051
Rio Arriba	6,368
Santa Fe	1,358

Sierra	1,417
Socorro (including lands in the upper Gila)	4,798
Taos	6,420
Valencia	6,113
Total	42,168

This total is only approximately 30% of that indicated in a comprehensive survey carried out by Herbert W. Yeo in 1910. Yeo's survey showed a total of 156,785 acres irrigated in the Rio Grande Valley as of 1907 (Yeo 1928:100).

For a variety of reasons, promoters of irrigation gradually came to accept the idea of government support in the construction of irrigation projects, turning first to local and state government and ultimately to the federal government for assistance. Along the Rio Grande, as elsewhere in the West, financial and management difficulties along with drought and regular shortages of irrigation water forced irrigators to seek outside assistance.

The Cary Act of 1894 authorized the Secretary of the Interior to grant up to 1 million acres of public lands to each state or territory that would undertake to settle and irrigate those lands; each settler would receive 160 acres of which he had to irrigate 20 acres (Dunbar 1983:39; Petulla 1977:268). These sales of public land were supposed to be used to subsidize construction of irrigation projects. It quickly became evident, however, that neither the states and territories nor the private irrigation companies could raise the capital necessary for the types of irrigation systems needed to bring the lands covered by the Cary Act under irrigation. Likewise, few local governments or private enterprises could marshall the expertise needed to build the requisite irrigation facilities. In 1896, the attendees of the National Irrigation Conference in Phoenix went on record in favor of a national irrigation act to promote the reclamation of arid lands (Petulla 1977:268). Subsequently the public cry for federal intervention in the development of irrigation would grow and ultimately produce the Newlands or Reclamation Act of 1902.

Even before 1896, federal involvement in irrigation projects in the Rio Grande Valley had already been made inevitable by the difficulties with Mexico over the distribution of the waters of the Rio Grande; these difficulties threatened to escalate into an international incident (Brook 1922; Hamele n.d.:3; Lester 1977:40). By the early 1880s, climatic conditions and depletions by upstream users forced the Republic of Mexico to complain to the United States on behalf of irrigators in the Juarez area with regard to diminished flows in the Rio Grande (Brook 1922; Hamele n.d.:3–4). The Mexican government attributed the depletion of the water supply for irrigation at and below Juarez to upstream irrigation development. By the late 1880s, residents of the El Paso area entered similar complaints with local, state, and federal governments (Lester 1977:39). While the Mexicans and Texans attributed part of the depletion to recent developments in the Mesilla Valley of New Mexico, everyone, Mexicans, Texans, and New Mexicans, agreed that the principal cause was massive and continuing development of irrigation resources in the San Luis Valley of Colorado (Follett 1896). Between 1870 and the early 1890s, irrigators in the San Luis Valley had brought more than 300,000 acres under cultivation (Natural Resources Committee 1938:300). By comparison, in the Rio Grande Valley within New Mexico it had taken nearly 200 years to bring approximately 200,000 acres under irrigation (Natural Resources Committee 1938:70). Because of complaints from the Mexican government on behalf of Mexican irrigators and complaints from Texan and New Mexican irrigators on their own behalf, Congress passed a concurrent resolution in April 1890 regarding the irrigation of arid lands in the Rio Grande Valley (Hamele n.d.:5). In the resolution, Congress urged the president to negotiate with the government of Mexico over the depleted water supply in the Rio Grande Valley and proposed a storage reservoir on the Rio Grande at or above El Paso as a possible solution to Mexican complaints.

In a related matter, the Rio Grande Dam and Irrigation Company secured the rights-of-way on public land necessary to construct a dam and storage reservoir near Elephant Butte during February of 1895 (Lester 1977:50). The grant of rights-of-way by the Secretary of the Interior sparked renewed protests by Mexico with regard to continued unrestricted irrigation development on the Rio Grande, which Mexico felt infringed upon the rights of Mexican irrigators at and below Juarez.

Responding to these and other Mexican concerns, the United States entered into a convention with Mexico to have the International Boundary Commission investigate conditions along the Rio Grande above El Paso and suggest solutions to the problems (Brook 1922). Investigations for the International Boundary (Water) Commission were carried out by

W. W. Follett between August and October, 1896. Based upon Follett's findings (1896:10–134), the commission filed a report on November 25, 1896, finding that the scarcity of water at Juarez was a result of upstream diversions in Colorado since 1880 (55th Congress, 2nd Session [1896], Senate Executive Document 299; Mills and Follett 1986). The report also stated that New Mexico and Texas had suffered adverse effects to their irrigation supplies as a result of development in the San Luis Valley. A drastic decline in irrigated acreages had allegedly occurred in the middle Rio Grande Valley around Albuquerque. While the alleged decline was not nearly as clear-cut as some have claimed, Colorado irrigators had literally drained the Rio Grande dry for 4 months of the year. In 1894, the Rio Grande went dry near Corrales in the vicinity of Albuquerque (Harroun 1898). Because of the demonstrable impact of upstream development, the International Boundary (Water) Commission recommended an embargo on any further upstream development, especially reservoirs, and the construction of a storage dam on the Rio Grande at or above El Paso in order to secure water supplies for Mexican irrigators below Juarez (55th Congress, 2nd Session [1896], Senate Executive Document 229).

At the formal request of the Mexican Foreign Minister, the Secretary of the Interior imposed an embargo on irrigation development in the Rio Grande Valley above El Paso on December 5, 1896 (Hamele n.d.:14). The General Land Office was ordered to suspend all applications for rights-of-way on public lands for the purpose of using the waters of the Rio Grande or its tributaries for irrigation. Because of the necessity of such rights-of-way for any storage reservoir or distribution facilities, the order of the Secretary of the Interior effectively brought irrigation development to a halt.

This solution to the complaints of Mexico was endangered by the existing rights-of-way held by the Rio Grande Dam and Irrigation Company. If the Rio Grande Company built its dam, then the commitment to a dam at El Paso would be nullified as engineers stated that there was insufficient water for two dams between El Paso and San Marcial (Brook 1922; Harroun 1896). At the same time, New Mexicans expressed strong opposition to the location of an international dam above El Paso, since the resultant reservoir would inundate substantial parts of the Mesilla Valley and waterlog other parts (Brook 1922; Hamele n.d.:20; Lester 1977:65). The Secretary of State and the Secretary of the Interior struggled to find a way to cancel the rights of the Rio Grande Dam and Irrigation Company; finally on May 7, 1897, they filed suit against the company (Lester 1977:62). The long, drawn out legal battle ended in May 1903, when a final court decree cancelled the rights-of-way of the Rio Grande Dam and Irrigation Company (Lester 1977:63–64).

Some have concluded that the United States government destroyed the Rio Grande Dam and Irrigation Company in order to save the international dam at El Paso and the agreements with Mexico (Brook 1922). The ultimate irony is that 18 months after the court decree, the newly created U.S. Reclamation Service recommended the construction of a dam at Elephant Butte as a better means of meeting the claims of Mexico than construction at the El Paso site (Rio Grande Project History 1912:7). Finally in May 1906, after further negotiations, the United States and Mexico entered into a treaty concerning the equitable distribution of the waters of the Rio Grande (34 Stat. 2953). The treaty permitted the construction of a dam and storage reservoir at Elephant Butte from which irrigation water would be delivered to the Mexican irrigators at and below Juarez (34 Stat. 2953 at Article 1).

During the 1890s, public opinion increasingly favored federal development of irrigation projects (Dunbar 1983:49–50; Gates 1968:649; Petulla 1977:268). Despite the incentives of the Cary Act, western states and territories found themselves strapped for funds to support irrigation development. The financial weakness of western states and territories and the problems attendant upon the regulation of interstate streams encouraged the shift in opinion among the promoters of irrigation to support of federal involvement (Gates 1968:649), as did the high rate of failure of private irrigation enterprises.

Dreams of extensive irrigation agriculture propelled the irrigation movement in the Rio Grande Valley and throughout the West. The grandiose plans of the Rio Grande Dam and Irrigation Company for the Mesilla Valley are a good example of late nineteenth century private irrigation enterprises. Private irrigation efforts almost universally fell into early difficulties, beset by problems of poor planning, construction, and management. Those projects that were completed were vastly inefficient. By 1902 an estimated 90% of private irrigation companies were in bankruptcy (Dunbar 1983:50; Gates 1968:651).

For New Mexico and the Rio Grande Valley, local developments paralleled those at the regional level. In 1891, the territorial legislature required a sworn statement describing any new water control works to be filed with the probate clerk of the county (Linford 1956:28). Seeking to document conditions throughout the territory, the legislature created

the Commission on Irrigation and Water Rights in March 1897 (Harroun 1898). The commission was ordered not only to investigate but also to make recommendations to the legislature and governor by 1899. The result was a rather cursory report by P. G. Harroun that provided inflated estimates of irrigated acreages. Harroun stated that some 290,000 acres were under irrigation in the Rio Grande Valley in 1898, when in fact the amount of irrigated acreage was probably closer to 200,000 acres (Natural Resources Committee 1938; Yeo 1910, 1928).

In the same year that the Harroun report appeared, Congress passed the Ferguson Act, which gave New Mexico some 600,000 acres of public land (Linford 1956:36). Income from the sale of this land was to be used to develop the water resources of the territory. In 1901, the Commission on Irrigation and Water Rights was given responsibility for selling the public lands received under the Ferguson Act and using the money to develop irrigation and storage reservoirs (Linford 1956:36–37). This latest congressional initiative was no more successful than earlier ones in promoting state or local sponsorship of irrigation projects, particularly in the Rio Grande Valley of New Mexico.

The failures of private enterprise and local government did not dampen the enthusiasm of irrigation promoters; they merely shifted their target for funds to the federal government. In 1896, the U.S. Army Corps of Engineers produced an unpublished study of reservoir sites in Colorado and Wyoming in which they recommended the construction of reservoirs by the federal government (Dunbar 1983:50). The limitations of the Cary Act and the Ferguson Act were evident by 1900 (Dunbar 1983:50; Gates 1968:651; Petulla 1977:268). Out of self-interest, westerners swallowed their prejudices against federal involvement in the development of arid lands. Where private enterprise and rugged individualism had failed, the westerners now wanted the federal government to step in and bail them out.

In 1902 Congress did exactly that in the Reclamation Act, sponsored by Rep. Francis G. Newlands of Nevada (Dunbar 1983:51; Gates 1968:652; Petulla 1977:268). Enough has been written about the passage and effects of the Reclamation Act so that it is not necessary to repeat the details here. The essentials of the Act, however, as they affected the Rio Grande Valley, are briefly described. The Secretary of the Interior was authorized to construct irrigation projects in 16 western states and territories. The projects would be paid for by the sale of public lands within the project areas. Water users were to repay the costs of construction over a 10–year period; money from repayment was to be placed in a revolving reclamation fund to sponsor future projects. To encourage small farmers, a maximum of 160 acres per holding could be irrigated with water from federal reclamation projects. In a concession to western sensibilities, the distribution and allocation of water from these federal projects were to be covered by local water laws. Finally, the Reclamation Act created the U.S. Reclamation Service, under the aegis of the U.S. Geological Survey, to carry out the federal projects; F. H. Newell was appointed the first director (Petulla 1977:270).

During 1903 the Secretary of the Interior authorized the first five reclamation projects, and by 1907 he had approved 24 projects including the Rio Grande Project in southern New Mexico and western Texas (Dunbar 1983:51). Because the Secretary of the Interior insisted that construction agreements be signed between the Reclamation Service and Water Users' Associations as agents of the individual water users, the Territorial Legislature authorized the organization of water users' associations in New Mexico under the territorial laws of incorporation in 1905 (Linford 1956:30). Four years later, the legislature authorized the organization of public irrigation districts as quasi-municipal corporations (Linford 1956:31).

UPPER RIO GRANDE VALLEY OF NEW MEXICO

Given the limitations of locally available technology, the irrigation resources of the upper Rio Grande had already been developed to virtually their fullest extent by 1846. Because most of the irrigated acreage in the northern Rio Grande Valley was along the tributaries and not along the mainstream of the river, the Rio Arriba was not as severely affected by development in the San Luis Valley as were the middle and lower portions of the valley (Follett 1896; Harroun 1898; Yeo 1910).

The records of proceedings before the Surveyor General and Court of Private Land Claims provide some information on irrigation systems in the Rio Arriba area (Figure 19). These records show that some expansion and intensification of irrigation occurred during the period in question, but the increases in irrigated acreage are difficult to quantify. District Court records and those of the Superintendent of Indian Affairs for New Mexico indicate that population growth

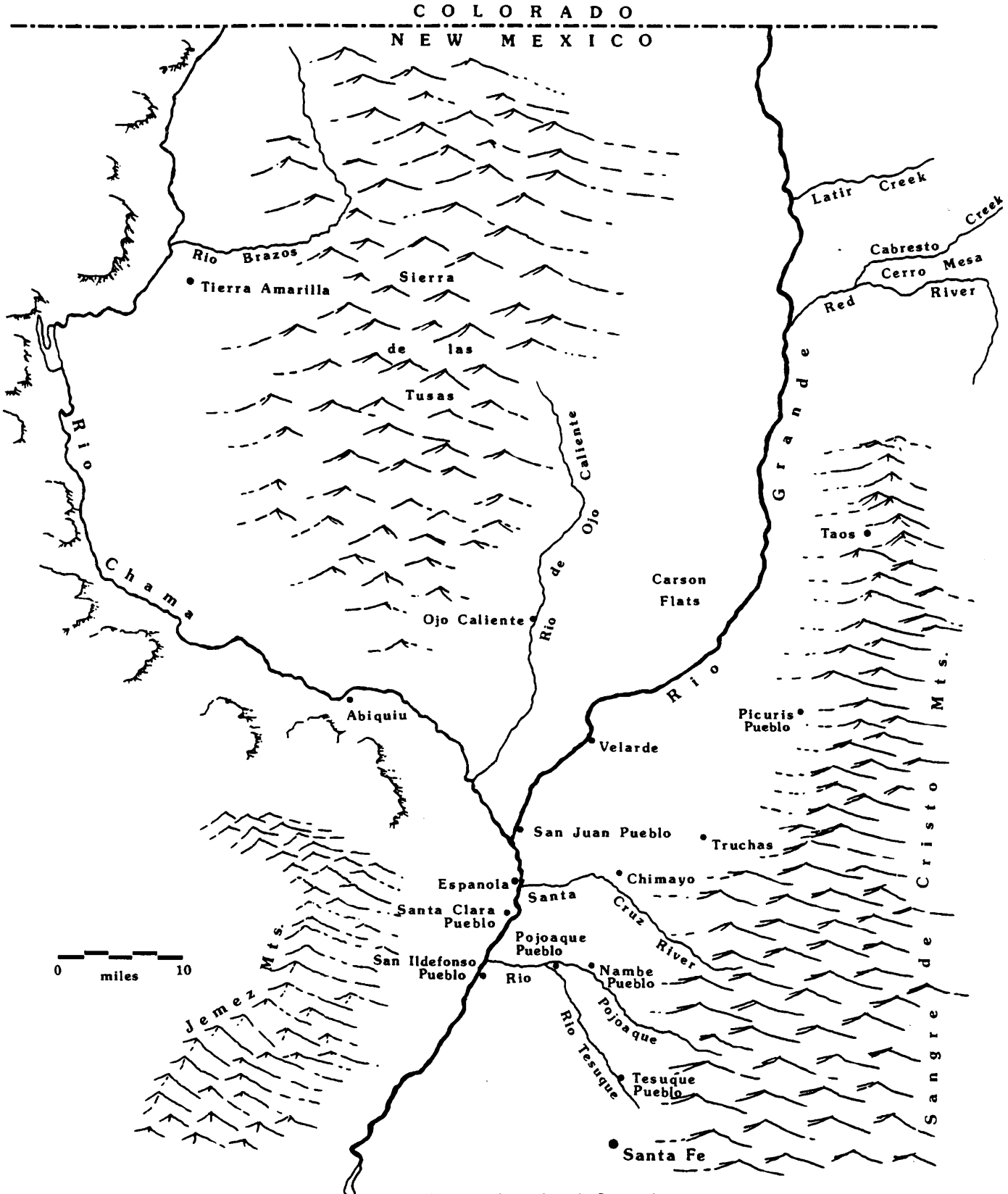

Figure 19 Upper Rio Grande Valley, Late 19th and 20th Centuries

and extension of irrigated acreage created conflicts over access to the generally limited water resources on the tributaries. Competition for irrigation water appears to have been particularly acute in the Pojoaque Basin north of Santa Fe and on Taos Mesa along the Rio Pueblo and Rio Lucero. The records of the Superintendent for Indian Affairs and the records of the Pueblo Indian Agency for the 1870s and 1880s demonstrate the existence of a constant series of disputes between Indians and non-Indians over acequias and access to irrigation water at virtually every pueblo in the Rio Grande Valley. Expansion of irrigation in the Rio Arriba appears to have been directly linked to water availability in local streams; trans-basin diversions were very few and occurred only on Taos Mesa and in the upper Santa Cruz and associated valleys.

Most irrigation development in the upper Rio Grande Valley in the period before 1910 was concentrated in the tributary valleys that had been the focus of settlement and irrigation agriculture in the Rio Arriba since the early eighteenth century. The small valleys north of Arroyo Hondo, however, had been settled only late in the Mexican period, and these areas experienced population growth and new settlement in the late nineteenth century. Red River, Cabresto Creek, and Latir Creek all were tapped by a number of small irrigation ditches constructed in the period between 1880 and 1907 (Yeo 1928:157–160). The newly irrigated lands amounted to 3000 to 4000 additional acres by 1907 and 1910 (New Mexico State Engineer's Office [NMSEO] 1974).

Along the mainstream of the Rio Grande, irrigated acreage appears to have declined rapidly in the Española Valley from a peak of 14,060 acres in 1896 (Follett 1896) to 5335 acres by 1907 (Yeo 1928:163). In the valley of the Rio Brazos and around Tierra Amarilla limited irrigation development occurred beginning in the 1870s. The Rio Brazos had 2300 irrigated acres in 1910 out of a total of ca. 25,000 acres in the entire Rio Chama drainage; most of this total acreage had already been irrigated before 1846 (Yeo 1928:156). Some private companies proposed to construct irrigation systems in various parts of the northern Rio Grande Valley, but with few exceptions these schemes never went beyond incorporation of the company; even small reservoir projects were beyond the financial abilities of most private irrigation companies.

Expansion of irrigated acreage occurred in the upper Chama and north of Taos Mesa once the U.S. Army had removed the threat of Ute, Apache, and Comanche raids during the 1870s. Prior to the mid 1870s settlement in these areas had been nearly impossible. Hispanic settlers occupied existing Spanish or Mexican land grants that had heretofore been only sparsely settled, if at all. Communities of settlers constructed acequias like those of earlier Hispanic settlements from the eighteenth or early nineteenth century.

Toward the end of the nineteenth century, Santa Fe County was divided into 12 irrigation precincts, each of which elected its own mayordomo (Figure 20). The irrigated acreage was not large owing to a scarcity of water in the small stream systems, though the local population did produce good crops of wheat, alfalfa, and fruit in the bottomlands (Hinton 1892:205–207). Only about 50% of the irrigable acreage was actually cultivated in any one year. Hinton (1892:207) suggested that the construction of one or more storage facilities would be necessary to increase the proportion of irrigated land.

While the number of ditches in some parts of the Rio Arriba multiplied and the amount of irrigated land expanded, the total irrigated acreage did not increase as dramatically as one might have expected, in part because the acreage in the Española Valley declined rather substantially (Follett 1896; Linford 1956:299–312; Yeo 1910, 1928). The development of irrigation in the Rio Arriba from 1846 to 1910 was, for the most part, an extension of earlier, traditional patterns with few if any dramatic departures (Figure 21). After the arrival of the railroads in the 1880s, opportunities for wage labor were opened up for the local population, both Indian and non-Indian (Calkins 1937e:2). The scarcity of agricultural and grazing resources produced the need for supplemental income throughout the upper Rio Grande Valley as populations expanded in the late nineteenth and early twentieth centuries (Calkins 1937e:11).

MIDDLE RIO GRANDE VALLEY

Though more urbanized and subject to outside influences than their neighbors to the north, residents of the middle Rio Grande Valley maintained patterns of irrigation agriculture that were remarkably traditional in the period before 1910 (Harper et al. 1943). After the early 1880s and the arrival of the railroad, some commercial agriculture was introduced

Figure 20 Acequia Madre, Santa Fe, New Mexico, ca. 1890 (Courtesy of the Museum of New Mexico, Santa Fe, Negative No. 55021)

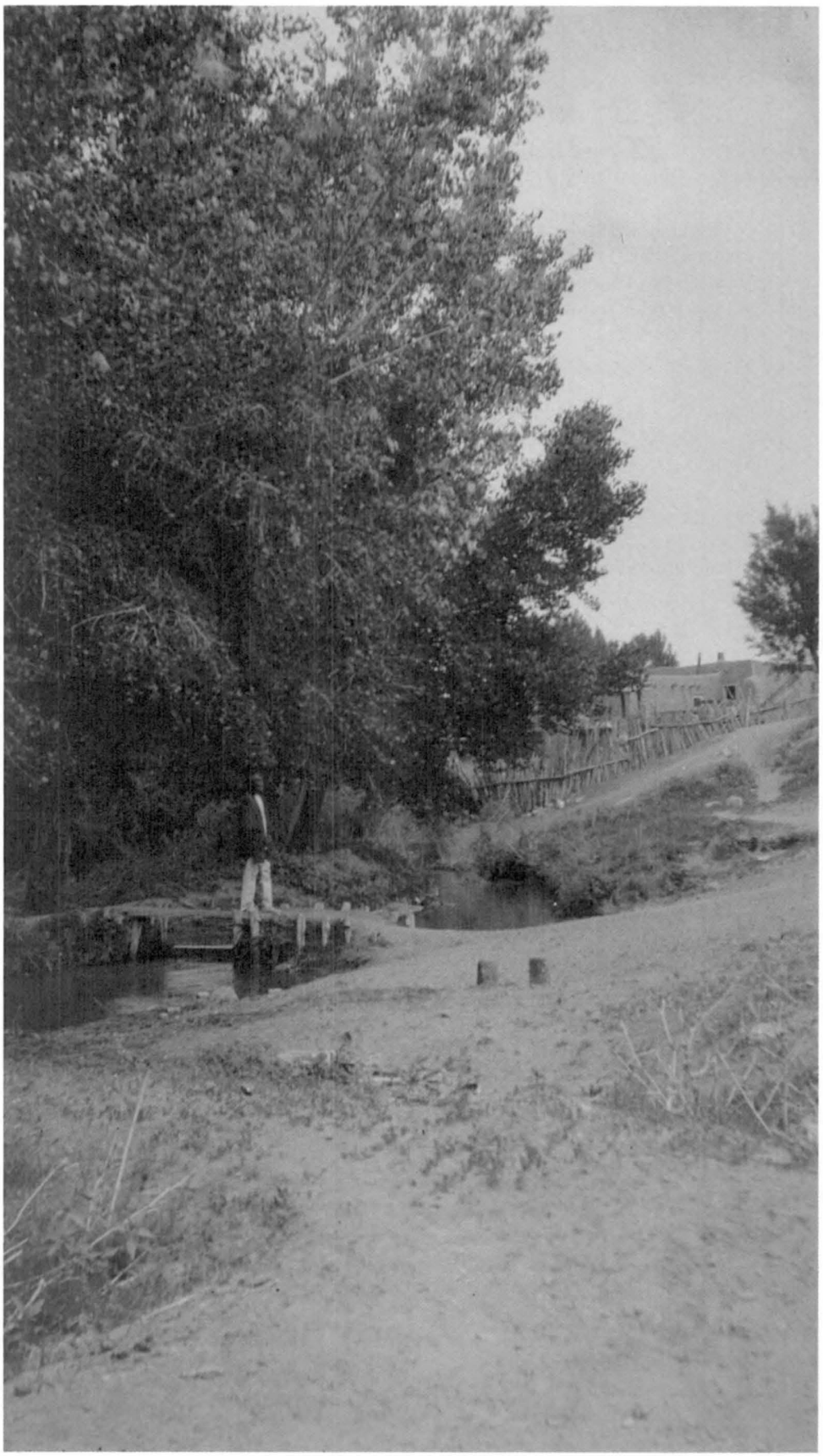

Figure 21 Irrigation Headgate, Taos, New Mexico, ca. 1911 (Photograph by H. F. Robinson, Courtesy of the Museum of New Mexico, Santa Fe, Negative No. 37408)

in the area around Albuquerque, Belen, and Socorro, but for the most part irrigation agriculture preserved its traditional orientation toward subsistence farming. At least 90% of the farmers were Hispanic or Puebloan, and approximately 90% of the irrigated acreage was farmed by them (Natural Resources Committee 1938). Nonetheless, irrigated acreage did expand in the middle Rio Grande Valley in the 1860s to early 1890s.

At San Pedro, which lies on the east side of the Rio Grande about midway between Socorro and San Marcial, can be found an excellent example of the persistence of traditional irrigation agriculture in the middle Rio Grande Valley into the early twentieth century (see Figure 3). In the late nineteenth or early twentieth century, the mayordomo, Vivian Tafoya, designed and supervised the construction of an elevated siphon north of San Pedro. This facility was built to alleviate siltation of the acequia madre from a major arroyo (Marshall and Walt 1984:284). Approximately 500 m of the elevated canal siphon, which was built of terrones, has survived partially intact (Marshall and Walt 1984:289).

Beginning in the mid 1890s, droughts, sedimentation, aggradation of the main channel, salinization, seepage, and waterlogging caused an overall decline in irrigable acreage in the middle Rio Grande region (Figure 22). The total amount of actual irrigated acreage remained relatively stable or even expanded, however, as previously uncultivated lands were brought into production to replace adversely affected acreage. From a total of approximately 31,700 acres in 1896 (Follett 1896), the irrigated acreage increased to around 45,000 acres in 1907 as a result of development of irrigation between Albuquerque and La Joya and between Socorro and San Marcial (Yeo 1928). The Socorro Irrigation Company brought at least 2000 acres under cultivation around Elmendorf before 1910, while large tracts of irrigated land near Soccoro only supported native hay (Sullivan 1908:45; Yeo 1910:11). The acreage served by the Socorro ditch, which was the largest in the area in 1910 with 3100 acres under cultivation, was decreasing due to seepage problems (Yeo 1910:24–26).

Much of the potentially irrigable acreage in the middle Rio Grande Valley had been damaged by poor drainage and the rising water table and had been retired from production by the early twentieth century (Dortignac 1956:29–30; Wortman 1971:17–18). Thousands of acres were rendered unusable by the related problems of waterlogging and alkalinization; at the same time, floods were frequent and often devastating (Figure 23). The flood of 1874 destroyed almost every building between Alameda and Barelas (Carter 1953). In 1884, Tomé, Valencia, and Belen were under water during the spring floods (Yeo 1943:20). The flood of 1886 wiped out part of the Pueblo of Santo Domingo, and a new church had to be built. In 1904 most of the bridges on the Rio Grande were destroyed by a late summer flood. The spring flood of 1905 washed away the community of Tomé (Yeo 1943:39).

As early as the 1890s, the desirability of reorganizing the middle Rio Grande Valley irrigation systems was recognized by a few individuals. In 1891, Gov. Bradford Prince referred to the surveys carried out by the Rio Grande Irrigation and Colonizing Company in preparation for the development of an irrigation system for the middle valley (Linford 1956:274).

In late 1889 and early 1890, the Rio Grande Irrigation Company was induced by the United States to seek right-of-way across the lands of the Pueblo of Cochiti for the construction of an irrigation canal, but only after the Pueblo Indian agent had informed the chief engineer for the company that they would have to negotiate for the right-of-way with the officials of Cochiti Pueblo (Special Agent Frank D. Lewis to Commissioner of Indian Affairs, January 27, 1890, National Archives, Record Group [RG] 75). The Indian Agency was in favor of the project as a means of securing a better supply of irrigation water for the Indians in the Rio Grande Valley. A multitude of related and unrelated problems caused the failure of the Rio Grande Irrigation Company's project.

Dozens of ditches with dozens of diversions crisscrossed the Rio Grande bottomlands from Cochiti to San Marcial, creating a welter of confused claims and rights (Figure 24). As a result, private irrigation companies found it impossible to undertake projects in many parts of the valley. The companies that did succeed were those that could acquire easily irrigable bottomlands that did not require elaborate facilities to secure irrigation water. The need for a unified and rational system of irrigation and drainage was great, but such a development was hampered by misunderstanding and mistrust (Linford 1956:277). Local residents were naturally reluctant to surrender or assign water rights to private irrigation companies in return for the promise of a more secure water supply in the future. Such a hesitancy was well founded; as noted in an earlier section of this report, by 1902, 90% of the private irrigation companies in the western United States were bankrupt—hardly a record to engender confidence in a privately sponsored reorganization of the middle Rio Grande Valley's irrigation systems.

Figure 22 Dry River Bed of the Rio Grande near the Head of the Isleta Ditch (Looking Southwest), July 7, 1931 (Courtesy of Middle Rio Grande Conservancy District, Albuquerque)

Figure 23 Waterlogged Lands in Corrales Area (North of Albuquerque), 1931 (Courtesy of Middle Rio Grande Conservancy District, Albuquerque)

Figure 24 Head Gate of Old Ditch at Point Where New Ditch Begins (near Albuquerque), July 22, 1930 (Courtesy of Middle Rio Grande Conservancy District, Albuquerque)

MESILLA VALLEY

While it is possible to trace the general character of irrigation development in the upper and middle parts of the Rio Grande Valley, specific data are much more difficult and frequently impossible to obtain. Traditional Hispanic and Puebloan irrigation agriculture, which was typical of the area north of San Marcial in the late nineteenth century, generally did not produce documentary records that would permit a more detailed study without an inordinate investment of time. Even in cases where the State Engineer's Office has requested information from ditch owners as to the construction dates or the earliest date of beneficial use of water from a particular acequia, the owners often cannot provide specific information or supporting evidence.

For the Mesilla Valley, the story of irrigation development is much clearer and better documented than anywhere else in the Rio Grande Valley of New Mexico (Figure 25). Consequently the depth of discussion in this section will be greater than was possible for the other parts of the valley. Because the western part of the Mesilla Valley was not annexed by the United States until 1853, the history of the Mexican period in the Mesilla Valley extends to the time of the Gadsden Purchase.

In April 1851, John Bartlett (1854) reported that a Mr. Magoflin was the only cultivator of land on the east side of the Rio Grande between El Paso and Las Cruces. Near Antony, New Mexico, Mr. Magoflin had constructed a large ditch to irrigate his lands, but a shortage of water caused his crops to fail and the land was abandoned after only a short occupation (Bartlett 1854:199).

Population increases in the Mesilla and Santo Tomas land grants between 1850 and 1857 greatly exceeded the amount of vacant irrigable land. As a result, landless colonists moved to La Mesa in 1857 onto vacant land between the Baca and Refugio grants (Bowden 1971:35). The new settlers immediately began the construction of an acequia from the Rio Grande. When Jose Manuel Sanchez Baca refused to give the colonists at La Mesa permission to construct the ditch across his land, they blackmailed him into selling them the grant (Bowden 1971:35–36). Shortly thereafter the La Mesa acequia was completed and opened. At the same time, other landless persons from the Mesilla Valley and the El Paso area established the community of San Miguel; they were able to construct their acequia without the difficulties experienced by their neighbors at La Mesa (Bowden 1971:36). The year 1857 saw the construction of one more new ditch—the Acequia Brava or Old Santo Tomas ditch was built to supply the fields of the Santo Tomas grant (Perkins 1914:11).

While new ditches were being constructed in the Mesilla Valley, older ditches sometimes went out of service. The shallow gradient of the Rio Grande made it very prone to channel relocations. In 1862, a shift in the main channel of the Rio Grande stranded the head of the Brazitos ditch (U.S. Surveyor General, Case 6); between 1862 and 1865 the head of the Mesilla ditch had to be changed 13 times (Yeo 1943:14). In 1865 a major spring flood caused damage throughout the Rio Grande Valley but particularly in the Mesilla Valley (Yeo 1943:11–12). The community of Santo Tomas and its acequias were destroyed. The river breached the levee between the communities of Mesilla and Picacho, moving Mesilla to the east bank and leaving Picacho on the west bank when the river shifted its channel (Lester 1977:22). Cut off from Mesilla and isolated on the west bank of the river, the community of Picacho would gradually die out.

Farther south during this same flood, the river's main flow diverted into the La Mesa ditch, following that acequia until it reached the Arroyo del Agua where the floodwaters turned back to rejoin the main channel (U.S. Surveyor General, Case 6). The upper portion of the La Mesa ditch was not rebuilt; instead the ditch users connected the lower part of the San Miguel ditch at the new community of Santo Tomas (LaMar 1984:29). In 1869 a separate diversion was built on the river for the La Mesa ditch (Perkins 1914:14).

After the 1865 flood, 200 refugee families from La Mesa settled at Old Chamberino (Bowden 1971:28). Other refugees from the flood founded the community of La Union on lands between the Refugio and Santa Teresa grants (Bowden 1971:28). The Chamberino and La Union ditches were constructed immediately following the establishment of these settlements.

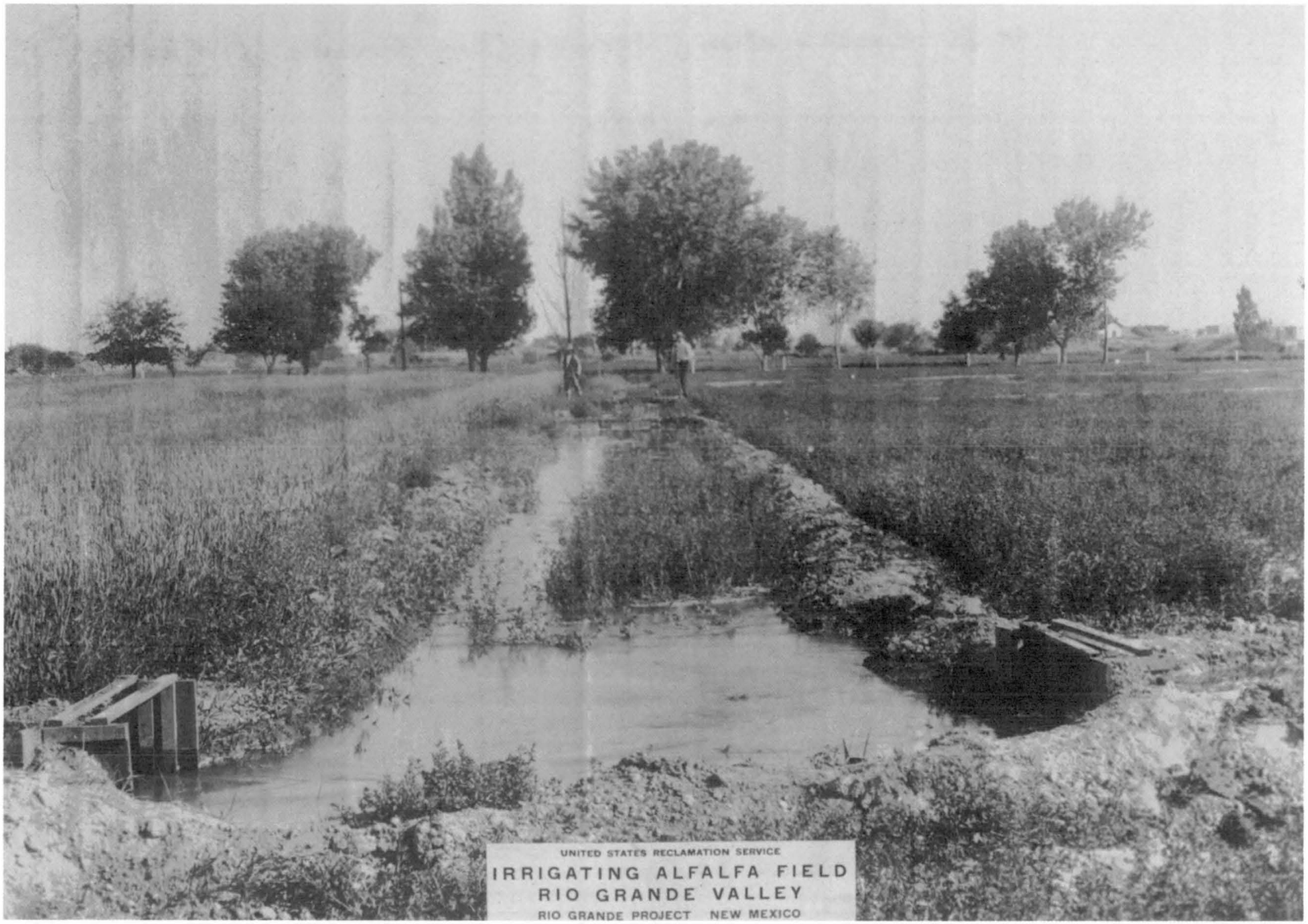

Figure 25 Irrigating Alfalfa Field, Rio Grande Valley, U.S. Reclamation Service, Rio Grande Project (Courtesy of Museum of New Mexico, Santa Fe, Negative No. 73554)

Spring floods in 1872 caused the river to break into the Las Cruces acequia; it took the entire available labor force from Doña Ana and Las Cruces 10 days to save the heading of the acequia on the swollen Rio Grande (Yeo 1943:14). During the 1870s the Three Saints or Berino ditch was constructed on the east side of the Rio Grande. In the early 1870s settlement began to extend upstream into the Rincon and Palomas valleys. The Hatch ditch appears to have been constructed around 1870 (Perkins 1914:5). Settlers at Las Palomitas maintained a heading for a ditch on the Rio Grande from the early 1870s to 1887, when a flood destroyed the ditch and the village of Las Palomitas was abandoned (Yeo 1928:109). Settlement continued in the Palomas Valley at the community of Las Palomas, but the residents took their irrigation water from Palomas Creek, not from the Rio Grande (Yeo 1928:109).

Yeo (1928:105–106) provides some estimates of irrigated acreages in the Mesilla Valley for the period from 1880 to 1903:

	1880 Acres	1890 Acres	1903 Acres
Doña Ana ditch	7000	4600	3260
Las Cruces ditch	6000	6000	5000
La Mesilla ditch	4000	4300	5500
Picacho ditch	2500	—	—
San Miguel ditch	1500	1500	1800
Santo Tomas ditch	1200	5000	150
Mesquite ditch	500	500	—
La Mesa ditch	1500	1500	1130
Chamberino ditch	3000	2250	5000
Anthony ditch	—*	1000	2320
Old La Union ditch	4000	500	100

* 500 acres in 1887

The drastic decline in acreage for the Old La Union ditch was a result of shifts in the channel of the Rio Grande that stranded portions of the land served by the ditch so that most of it could not be served through the old ditch heading.

About the time that the railroad arrived in the Mesilla Valley (1881), the effects of local climatic conditions and upstream development on irrigation began to be felt (LaMar 1984:70). The flow of the Rio Grande became so reduced during the growing season that irrigators abandoned the Picacho ditch after 1880, taking 2500 acres out of cultivation (Lester 1977:27). By the mid 1880s adverse conditions caused farmers to abandon approximately 9500 acres under the Las Cruces ditch owing to a lack of water (LaMar 1984:26).

The spring of 1884 brought another destructive flood to the Mesilla Valley (Yeo 1943:18). The river destroyed the Santo Tomas ditch and flooded out the communities of Old Chamberino, La Union, and Refugio de los Amoles (Bloom 1903:67). The latter village was resettled, but the residents of Old Chamberino and La Union moved their communities to higher ground at the western edge of the valley. In the same year Salem was settled in the Rincon Valley by a religious group. These settlers remained until 1901 when internal dissension caused the community to be disbanded (Bloom 1903:62). The Santo Tomas ditch was not reopened until 1890 when a new heading was built on the San Miguel ditch (Perkins 1914:11).

The mid 1880s witnessed the beginning of activities by private irrigation companies in the development and management of irrigation systems in the Mesilla Valley. In 1885, the Mesilla Valley Irrigation Company was chartered under the laws of New Mexico (Elephant Butte Irrigation District Papers, Box 16, folder 10). Beginning with the Anthony ditch, which irrigated lands between Mesquite and Anthony, the company went on to acquire the San Pedro and San Jose community ditches by 1906.

Even more ambitious schemes were to emerge in the Mesilla Valley. During 1888, citizens from El Paso and southern New Mexico organized the Jornada and El Paso Canal and Reservoir Company, which proposed to build a dam and reservoir on the Rio Grande above the Palomas Valley and bring water south across the Jornada into the Mesilla and El Paso valleys in order to relieve the recurring shortages of irrigation water (U.S. Senate 1890:3:90). The participants

in the company subscribed funds for a preliminary survey and to seek the aid of Congress for engineering and construction of the project. Perceived need for such a project remained high; by 1888 irrigated acreage along the Doña Ana ditch had decreased from an original 7000 acres to around 4600 acres (Perkins 1914:6).

The organizers of the Jornada and El Paso Company were not the only persons interested in federal assistance for irrigation in the Mesilla Valley; several witnesses from the valley appeared before the Special Senate Committee on Irrigation to seek government assistance in the construction of a storage reservoir on the Rio Grande (U.S. Senate 1890:3:5–90). In the same hearings, John Wesley Powell concluded that sufficient irrigable lands existed in the Mesilla Valley to take the entire flow of the Rio Grande at the head of the valley (U.S. Senate 1890:4:31).

In his report on irrigation, Hinton (1892:217–218) found well-established fruit and grape production in the Mesilla Valley and noted that corn, grain, and vegetables grew well in both the Rincon and Mesilla valleys. Hinton also reported (1892:218) that the predominantly Hispanic farming population was ready to accept the replacement of the old community ditches with large canals if their water rights were recognized and protected (Figure 26). Many of the small-scale irrigators were opposed to this change, however, because they lacked cash to pay water fees; they were accustomed to pay for water with labor.

As discussed in the previous chapter, the U.S. government was being confronted by increasingly vocal complaints from the Republic of Mexico over shortages of irrigation water for the Juarez Valley. Because they depended on the same stream of water, Mexican and U.S. citizens found that their interests coincided. The Mexicans, Texans, and New Mexicans agreed that a storage facility was needed; the only difference of opinion was over where to locate the dam and reservoir (Lester 1977:39). The citizens of El Paso and Juarez wanted the dam to be located at the narrows above El Paso, which came to be known as the international dam site (Brook 1922; Hamele n.d.:3). New Mexicans opposed this site since it would flood or waterlog thousands of acres of irrigated or irrigable land in the southern Mesilla Valley; instead they wanted a dam above the head of the Rincon Valley (Hamele n.d.:20; Lester 1977:65–68; Linford 1956:278). During the 1880s and 1890s, the U.S. Geological Survey included the Elephant Butte and international dam sites in their reservoir investigations (LaMar 1984:3).

The Rio Grande Irrigation and Colonizing Company conducted surveys in anticipation of the construction of a large-scale irrigation system from Peña Blanca, on the north, southward through the center of New Mexico Territory (Linford 1956:274). Their grandiose plans were stymied by lack of capital.

In the early 1890s a drought, which lasted until 1904, struck the Rio Grande Basin, especially the Mesilla, El Paso, and Juarez valleys. Nonetheless ditch construction continued in various parts of the Mesilla and Rincon valleys. When the heading of the La Union ditch was stranded by a shift in the main channel of the Rio Grande that placed most of the lands served by the ditch on the east side of the river, the ditch association constructed an entirely new ditch. The acreage irrigated by the old ditch had decreased by 90% since the ditch was originally built in 1865–1866 (Perkins 1914:16). In 1909 the river would shift again so that most of the lands under the La Union Ditch were again on the west side of the river; at that time a new heading was constructed for the La Union ditch (Perkins 1914:16). Completing development in the Rincon Valley was the construction of the Garfield ditch in 1895 and of the Arroyo ditch in 1909 (Perkins 1914:3–4).

After the failure of the Jornada and El Paso Company and because of the continuing reluctance of Congress to involve the federal government directly in reclamation projects, local irrigation promoters continued to propose grandiose private schemes for the irrigation of the Mesilla and El Paso valleys. In 1893, Nathan E. Boyd of Las Cruces formed the Rio Grande Dam and Irrigation Company (LaMar 1984:30). Because of the usual financial difficulties, the company was sold to a group of British investors in 1894. With this new financial backing, the company proposed to build a dam at Elephant Butte to provide irrigation water for the Mesilla Valley. In February 1895, they filed and received the approval of the Secretary of the Interior for the necessary rights-of-way on public land to undertake the scheme (Lester 1977:50–51). Given 5 years to complete the project, the Rio Grande Company began site work in 1897, just in time to be brought to court by the United States.

Because of preliminary agreements with the Republic of Mexico, the Secretary of the Interior placed an embargo on dam construction within the upper Rio Grande Basin and sought to nullify the rights-of-way held by the Rio Grande Dam and Irrigation Company. In order to mollify the Mexican government over the potential conflict between the

Figure 26 Acequia in Doña Ana County, New Mexico, 1904 (Courtesy of the Museum of New Mexico, Santa Fe, Negative No. 55132)

agreed-upon international dam and the Elephant Butte dam, the United States went to court in May 1897 to seek an injunction (Brook 1922; Lester 1977:62–63). As we have already seen, the United States won its case in 1903 but ironically later decided to build the storage reservoir at the Elephant Butte site to meet its agreements with Mexico (Lester 1977:74).

From the beginning, the New Mexicans had opposed construction of an international dam at El Paso because it would ruin agriculture in the southern Mesilla Valley and because they could receive no benefits from a storage facility that lay downstream of them. By 1900, the residents of the Mesilla Valley were promoting the Elephant Butte site as beneficial to all parties and causing harm to none (Lester 1977:68). A report by F. C. Baker (1898) in the Water Supply Papers of the U.S. Geological Survey described conditions in the Mesilla Valley in 1898. This report illustrated the need for a storage reservoir to serve the Mesilla Valley as well as for the rehabilitation of the irrigation facilities in the valley (Baker 1898:15–19).

At the same time, Baker (1898:13) noted that although Anglo-American farmers who had begun to settle in the Mesilla Valley in significant numbers during the early 1890s had adopted the traditional irrigation system, they had also modernized agriculture through the consolidation of lands into large tracts for the production of alfalfa, through the utilization of farm machinery, and through the introduction of new varieties of fruits. Nonetheless, despite the fertility of the soil and the favorable climate, agricultural development was limited by the uncertainties of the water supply (Baker 1898:17). Baker (1898:37) also drew attention to the alkali problem that was inherent in most of the soils in the Mesilla Valley.

A severe drought in 1903 was accompanied by a spring flood that destroyed the Acequia de los Amoles and the village of Amoles (Lester 1977:71–72; Yelo 1928:104). These two events illustrated the urgent need for a storage and flood control dam on the Rio Grande above the Mesilla Valley.

The passage of the Reclamation Act in 1902 opened up an avenue of relief for the residents of the Mesilla Valley. In March 1903, the Reclamation Service began its investigations to identify a site for a storage reservoir on the Rio Grande above El Paso (Rio Grande Project History 1912:6). After preliminary work, the engineers focused on the Elephant Butte site; they found it to be the best choice for storage, for flood control, and for meeting the claims of Mexico (Lester 1977:74–75). By late 1904, the Reclamation Service had concluded that the Elephant Butte site was definitely superior to the international dam site (Linford 1956:279; U.S. Reclamation Service 1903–1904:398). They urged construction of a storage facility at Elephant Butte and also proposed the construction of a diversion dam at Leasburg to provide immediate relief to the irrigators of the Mesilla Valley (U.S. Reclamation Service 1903–1904:418–419, 424). The Leasburg diversion would be connected to existing ditches and replace the primitive structures that were then in use.

During 1905, Congress amended the Reclamation Act to include Texas, so areas around El Paso could participate in the proposed Rio Grande Project (Hamele n.d.:23), and authorized the construction of a dam on the Rio Grande in New Mexico (33 Stat. 814). The New Mexico Territorial Legislature authorized the organization of a water users' association so that irrigators could meet the Reclamation Service's requirements for contracts to construct reclamation projects (Linford 1956:30). Almost immediately, the Elephant Butte Water Users' Association was formed to cover the Rincon and Mesilla valleys (Lester 1977:81–82; U.S. Reclamation Service 1904–1905:279).

In the summer of 1905, the Reclamation Service began surveys for the proposed diversion structure at Leasburg, which marked the inception of the Leasburg Project (Rio Grande Project History 1912:8; U.S. Reclamation Service 1904–1905:280). One year later the Reclamation Service entered into a contract with the Elephant Butte and El Paso Water Users' Associations for the construction of the dam at Elephant Butte and for delivery of water from the resulting reservoir (Lester 1977:83). During the spring of 1907, Congress appropriated 1 million dollars as the United States' share of the costs of the construction of Elephant Butte dam (Rio Grande Project History 1912:10). A year later the United States filed with the newly created Office of the Territorial Engineer (New Mexico) a statement of intent to use approximately 2 million acre-feet of unappropriated water for irrigation on the Rio Grande Project (Linford 1956:280).

Upon completion of the Leasburg diversion in 1908 (Figure 27), the Reclamation Service delivered irrigation water to the Doña Ana, Las Cruces, and Mesilla community ditches (Rio Grande Project History 1912:19–20). While the new structure did not cause an increase in irrigated acreage, it did mean a more assured supply and encouraged increased productivity (U.S. Reclamation Service 1908–1909:141). The storage reservoir at Elephant Butte would have to be

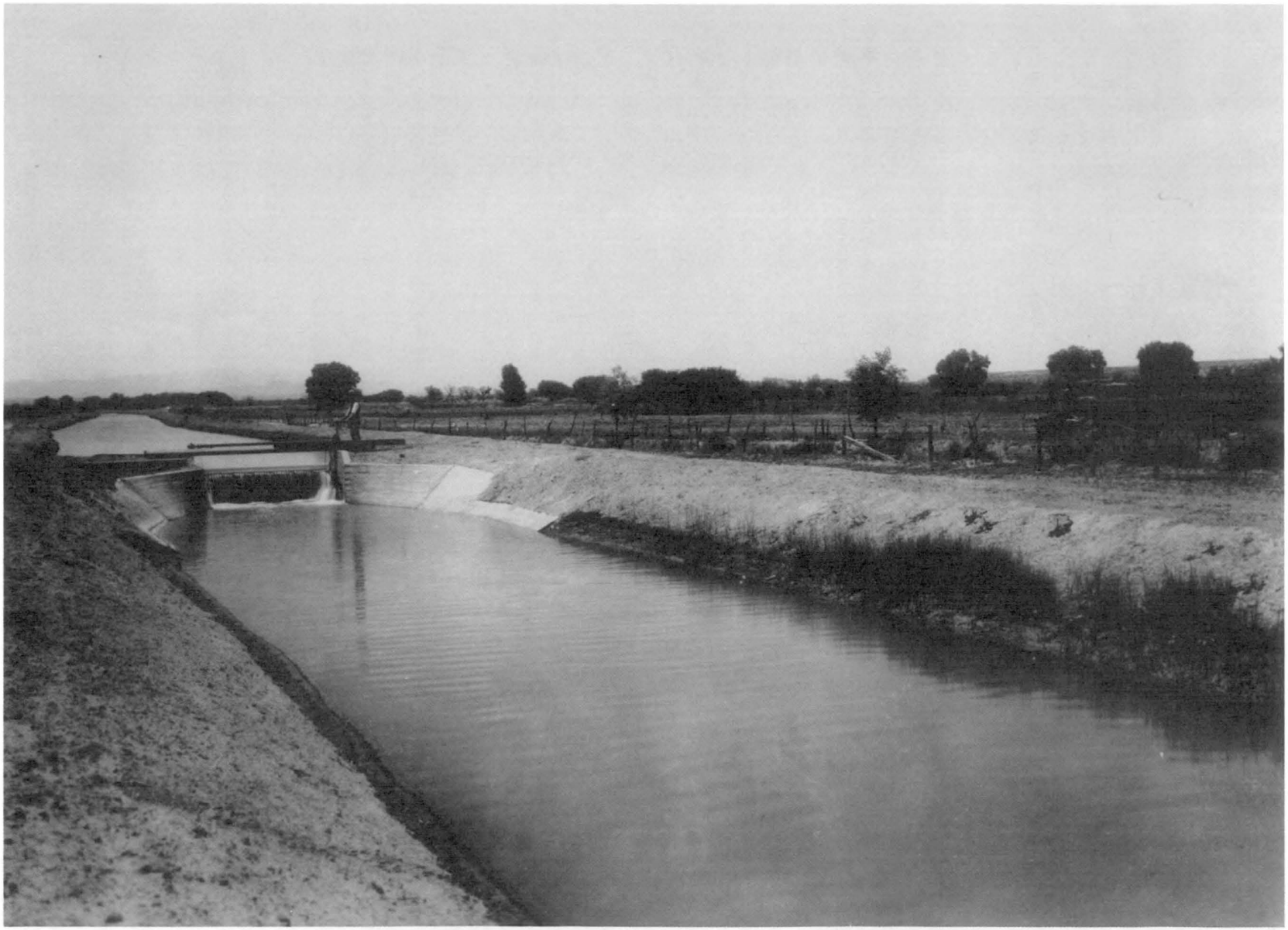

Figure 27 Rio Grande Canal below Leasburg, New Mexico (Courtesy of the Museum of New Mexico, Santa Fe, Negative No. 5537)

completed before an expansion of irrigated acreage would be possible. Between 1896 and 1910, irrigated acreage remained relatively stable at approximately 27,000 acres in the Mesilla Valley; irrigated acreage declined in the Rincon Valley, however, from nearly 10,000 irrigated acres in 1896 to less than 4500 acres in 1910 (Follett 1896; Yeo 1910, 1928). With the start of actual construction on Elephant Butte Dam in 1911 (Figure 28), irrigators in both the Mesilla and Rincon valleys anticipated substantial increases of irrigated acreage in the foreseeable future (Lester 1977:84; U.S. Reclamation Service 1911–1912:144–145).

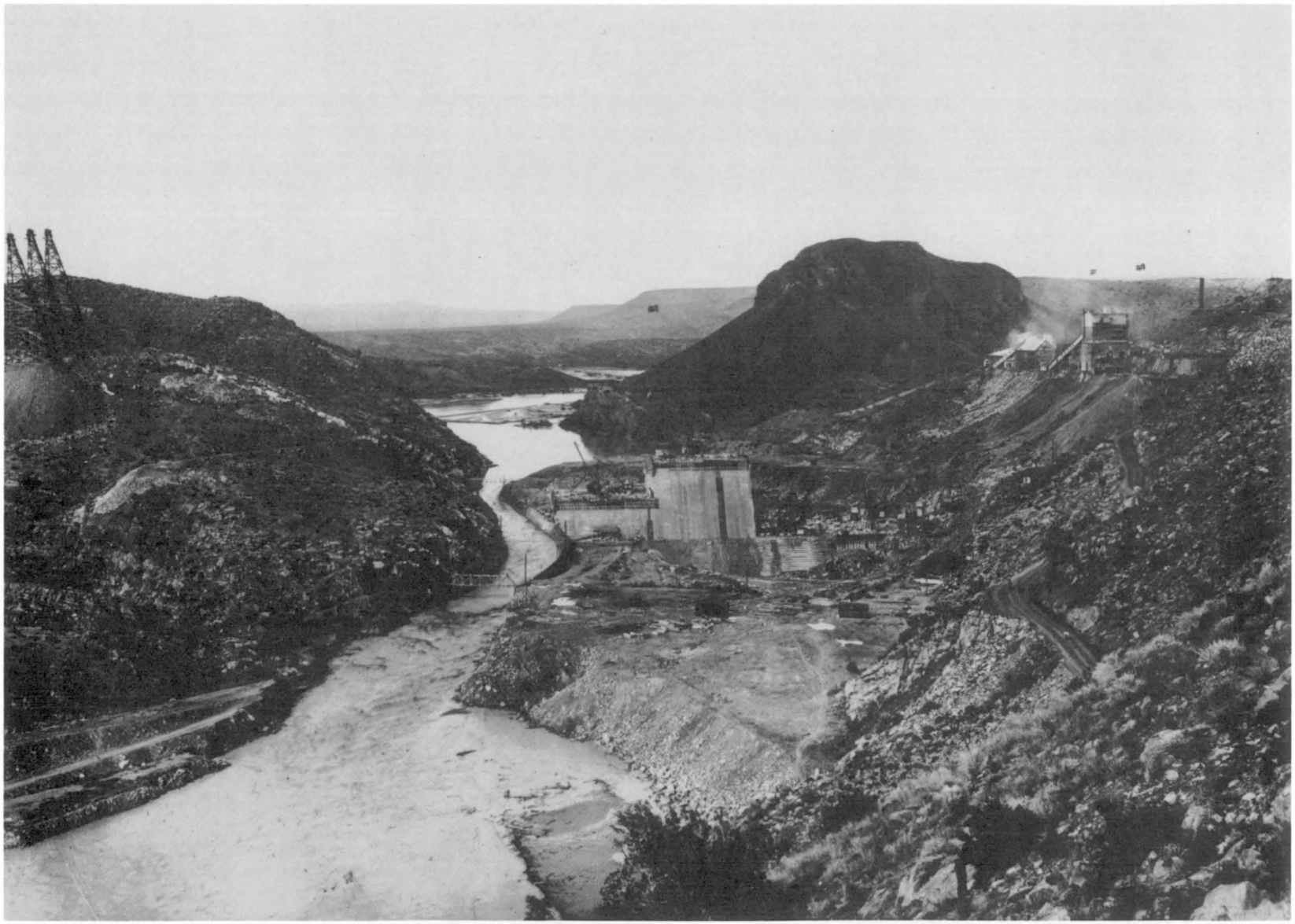

Figure 28 View of Early Stages of Construction at Elephant Butte Dam, New Mexico (Courtesy of Rio Grande Project, U.S. Bureau of Reclamation, El Paso, Texas)

Chapter 9

IRRIGATION DEVELOPMENT: 1910–1945

UPPER RIO GRANDE VALLEY OF NEW MEXICO

The upper Rio Grande Valley contains few areas where extensive irrigation agriculture is feasible. Instead the region consists of a multitude of pockets of irrigable land stretching along the numerous tributaries of the Rio Grande and Rio Chama (see Figure 19). In 1910, the Española Valley contained the largest single area of irrigated land with approximately 5500 acres (Yeo 1928:163). By 1910 only a few parts of the upper Rio Grande Valley had the potential for additional agricultural expansion, since most of the irrigable land was already under cultivation (Figure 29).

In a 1919 study for the Reclamation Service, Conkling and Debler (1919:10–11) noted that the Española Valley did not need additional irrigation or drainage. The irrigated acreage had not changed significantly since 1910 and was served by 16 canals (Yeo 1928:163). The Alcalde ditch had recently been extended from Alcalde plaza to cover lands belonging to the Pueblo of San Juan on the east side of the Rio Grande (Yeo 1928). As a result of erosion and intrusions by small ephemeral streams and arroyos that crossed the Española Valley ditches, the alignments of ditches changed frequently and maintenance costs were high (Yeo 1928:164). Yeo (1928:164) was of the opinion that it would be difficult to expand the irrigated acreage in the Española Valley; poor soils, extensive previous development, and other factors limited the potential for increasing irrigated acreage.

Throughout the upper Rio Grande Basin, only a few areas experienced any significant expansion of acreage under irrigation between 1910 and 1928 (Yeo 1928:150–156). In the upper Chama Valley around Tierra Amarilla, 2555 acres irrigated from nine new ditches were added after 1910 (Yeo 1928:156). The apparent increase in the lower Chama Valley, especially on lands belonging to the Pueblo of San Juan, has subsequently been found to be the result of inflated estimates made in the 1920s (NMSEO 1961). Actual increase in irrigated acreage did occur along the creeks north of Taos in the 1910s and 1920s, mostly as a result of the activities of small private irrigation projects. The Llano Irrigation Company built a few ditches and brought several hundred acres under irrigation along the lower part of Cabresto Creek (Linford 1956:305). In the upper portion of the same drainage, the Cabresto Lake Irrigation Company had plans for development that never came to fruition (NMSEO 1974:I:176–277). On northern Cerro Mesa, the Sunshine Valley Conservancy District undertook the development of irrigation, but the results were meager (Linford 1956:306). In 1924, the Sunshine Valley Conservancy District constructed a canal along the lower Red River, but the enterprise failed by 1934 owing to the lack of a storage reservoir (Linford 1956:306). Around 1912, the residents of Arroyo Hondo completed an irrigation project that was intended to stabilize the water supply and distribution system for the valley (History of Engineering Program 1979:35022).

The epitome of the problems of private irrigation development can be seen in the events that occurred in the uplands to the west of the Rio Grande at Carson Flats. In 1907, Mormon farmers settled along the Arroyo Aguaje de la Petaca, an ephemeral tributary of the Rio Grande (Linford 1956:307). They formed the Settlers Ditch and Reservoir Company, which was later organized into the Carson Irrigation District. In order to assure the water users of a late summer water supply, the company constructed a concrete and stone dam (Linford 1956:307). When the dam was completed in 1936, they found that it would not hold water. It was constructed of porous basalt that absorbed the water as quickly as it was collected (Linford 1956:307).

On Taos Mesa itself, the extent of irrigation agriculture had remained for some time at approximately 14,200 acres served by 30 ditches (Yeo 1928:162). Well before 1910 the water resources had been fully developed. Future development depended upon the construction of a storage reservoir to hold the spring runoff for delivery later in the season.

Figure 29 "Canoa" Irrigation Flume, New Mexico, June 1949 (Photograph by Anacleto G. Apodaca, Courtesy of Museum of New Mexico, Santa Fe, Negative No. 142319)

In the mid 1930s the Soil Conservation Service carried out Human Dependency Surveys throughout New Mexico in order to assess the economic condition of subsistence farmers and to propose solutions to their problems (Calkins 1935b, 1937a, 1937b, 1937e; Forrest 1989; USDA Soil Conservation Service 1935–1939, 1936a, 1936b, 1938; Weigle 1973). The most intensive surveys were in Rio Arriba County (Forrest 1989; USDA Soil Conservation Service 1935–1939; Weigle 1973). These were the only surveys in which the raw data were synthesized and reduced to a printed report; in this case a three-volume study entitled Tewa Basin Studies was produced between 1935 and 1939. The studies focused on economic conditions in the farming communities (Indian and non-Indian) of Rio Arriba County. Most of these communities were villages of subsistence farmers who practiced agriculture in areas that were generally short of irrigation water.

In the Pojoaque Basin, researchers noted that disputes over irrigation water were frequent, especially between downstream and upstream users, with the former accusing the latter of stealing all of the water (Weigle 1973:42–60). The disputes cut across racial lines since both Indian and non-Indian users were affected. The construction of a new ditch at Nambe in 1931, for example, had serious adverse effects on Indian and non-Indian users at Pojoaque, Jacona, and San Ildefonso.

While nearly all of the irrigators in the lower Santa Cruz Valley were members of the Santa Cruz Irrigation District, most irrigators in the upper basin around Chimayo had chosen not be become members of the irrigation district (Weigle 1973:72–93). Farmers throughout the Santa Cruz Basin depended upon irrigation agriculture for their food and livelihood; a large number of individuals grew chiles as a commercial crop.

At Cordova (Figure 30), residents irrigated 180 acres of fruit orchards from four small ditches (Weigle 1973:106–107). In Truchas, the supply of water for irrigation was inadequate; scarcity of water also affected Las Trampas and the Rio Pueblo district (Weigle 1973:114). At Española, the land was inferior, leading to an emphasis on orchards (Weigle 1973:119–128). The Velarde area was also well known for its orchards (Weigle 1973:178). Along the lower Rio Chama, the SCS researchers found that all of the villages had good supplies of irrigation water, but their agricultural methods and irrigation technology were primitive (Weigle 1973:131–143). The area around Abiquiu exhibited wide variability from place to place in the amount of irrigated acreage owing to erosion and floods along the Rio Chama; in any case, most of the available farmland was owned by a single man, Mr. Gonzales (Weigle 1973:155–162). Along El Rito Creek 2000 acres were under cultivation, but farmers were dependent upon the summer rains for irrigation water (Weigle 1973:147–149) in an elaborated form of floodwater farming.

The Soil Conservation Service (1938:16), in a study of the Rio Chama valley above Española, found that all of the arable land was already developed and intensively utilized for irrigation agriculture. In this area 10,400 acres were irrigated while 27,400 acres were dry-farmed (USDA, Soil Conservation Service 1938:22).

The condition of irrigation among the Pueblos of New Mexico in the Rio Grande Valley was reported by Hodges in 1938. At Taos Pueblo, the competition between Indians and non-Indians for irrigation water on Taos Mesa continued (Hodges 1938:52–67). The Indians of Taos irrigated between 1650 and 1900 acres in the early 1910s, using 13 irrigation ditches from the Rio Lucero and Rio Pueblo. The Rio Pueblo was tapped by a number of small ditches with brush diversions, but along the Rio Lucero, the Indian Irrigation Service built ditches beginning in 1908 and constructed a diversion dam in 1932 (Hodges 1938:60–61). The small canals used by the Indians had also been improved by the Indian Irrigation Service (Harris and Williams 1936:3), but the lack of fertilizers combined with certain agricultural practices reduced yields and the amount of cultivable land (Harris and Williams (1936:3–5).

The Pueblo of Picuris irrigated less than 200 acres throughout the 1910s, 1920s, and 1930s (Hodges 1938:93–102). Even the construction of a new diversion structure by the Indian Irrigation Service in 1934 did not cause an expansion of irrigated acreage (Hodges 1938:101). The acequia madre, which was extended a half a mile in the early twentieth century, was 3 feet deep and 3 feet across (Ford 1977:143).

Hodges (1938:107) noted that the estimates for irrigated acreage at San Juan Pueblo were exaggerated in the 1911 declaration to the State Engineer's Office (then the Territorial Engineer's Office). By 1937, the Indians of San Juan irrigated approximately 1100 acres from the Rio Grande and Rio Chama. This increase was in part a result of work by the Indian Irrigation Service (Hodges 1938:110–111).

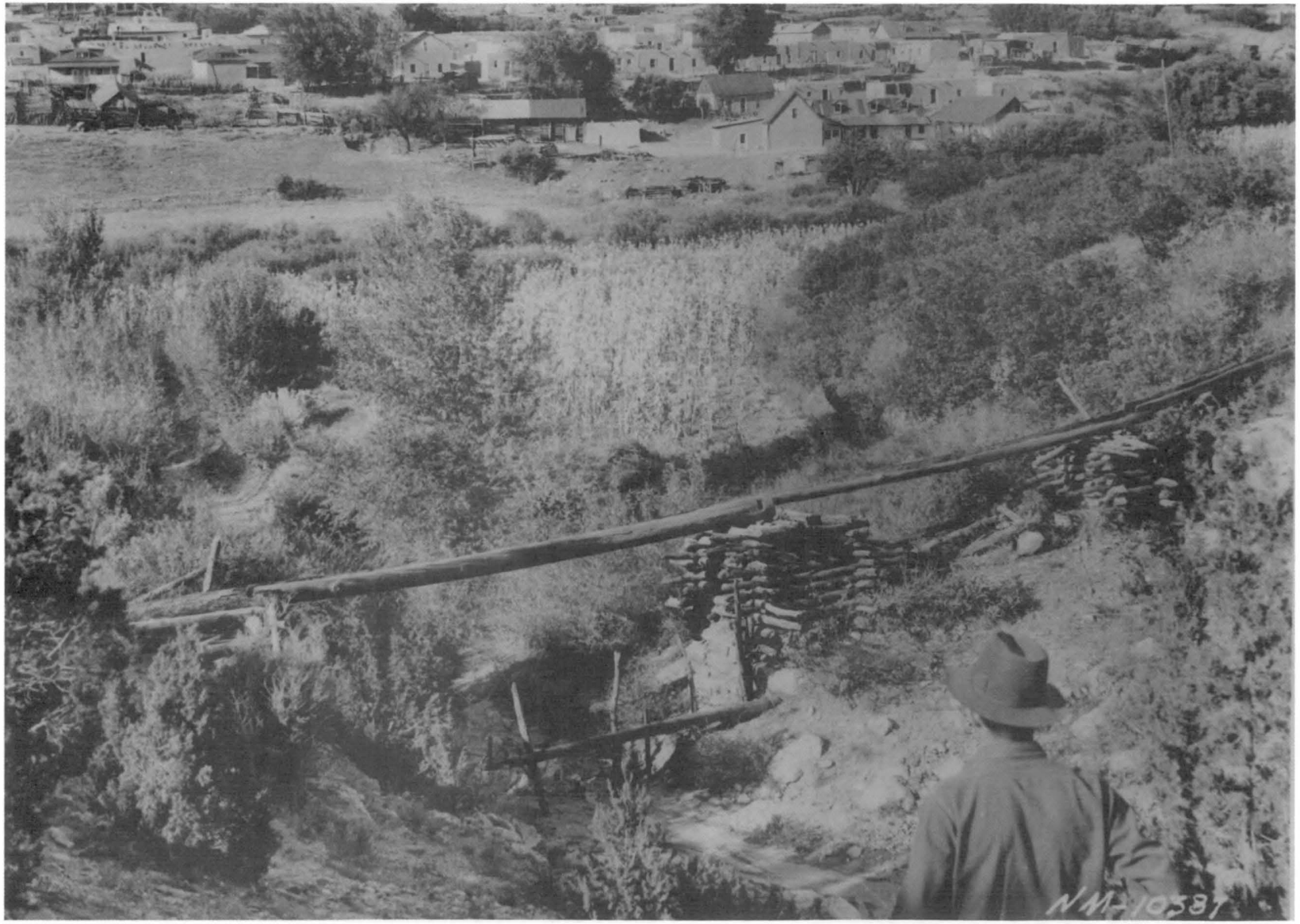

Figure 30 Acequia de los Espinosos Crossing an Arroyo near Cordova, New Mexico (Courtesy of the Museum of New Mexico, Santa Fe, Negative No. 9051)

The five Tewa pueblos below San Juan all had persistent water shortages throughout the period from 1910 to 1938 (Hodges 1938:126–254). The Pueblo of Santa Clara had only two ditches: one from the Rio Grande and the second from the Rito Santa Clara (Hodges 1938:126). The Indian Irrigation Service invested considerable maintenance effort on the ditch in the Cañon de Santa Clara but without substantial increases in irrigated acreage (Hodges 1938:137). The ditch was damaged by floods in 1911, and the temporary diversion structure was frequently destroyed (Hill 1982:26; Hodges 1938:129, 137). Tesuque experienced a gradual decline in irrigated acreage, despite the construction of infiltration galleries along the Rio Tesuque by the Indian Irrigation Service (Hodges 1938:146–164). As already noted, a new main ditch was constructed at Nambe in 1931, and a new diversion structure for that ditch was built in 1934 (Hodges 1938:192–203). The Pueblo of Pojoaque only irrigated 40 acres from ditches that were shared with non-Indians (Hodges 1938:226–227). Because of extremely limited water supplies from the Rio Pojoaque, the Indian Service had built a ditch from the Rio Grande, but this ditch was washed out repeatedly (Hodges 1938:250–254). After the ditch was destroyed once more in 1911, the Indian Irrigation Service decided that it was impracticable to maintain a ditch heading on the Rio Grande and abandoned the effort.

Of all the facilities in the upper Rio Grande Valley, the Soil Conservation Service invested the greatest amount of effort in investigations and plans for rehabilitation in the Santa Cruz Irrigation District (Calkins 1935, 1937c; Elmendorf 1940). In the mid 1930s, Calkins (1935:12) found that approximately 5200 acres were under irrigation from 13 large and three small ditches; maintenance was expensive, however, and storm damage was frequent.

As early as the 1890s some commercial agriculture had been practiced in the lower Santa Cruz Valley (Calkins 1937c:1). These commercial farms were the primary promoters of development within the valley during the early twentieth century. In 1923, landowners in the lower valley organized a conservancy district (Calkins 1937c:2). They proposed to build a ditch from the Rio Grande to provide an assured supply of irrigation water but were stymied by legislation designed to protect irrigators in the Mesilla Valley against new withdrawals of water from the Rio Grande (Calkins 1937c:2).

In 1925, John Block organized the landowners in the lower valley to construct a storage reservoir on the Santa Cruz River (Calkins 1937c:3). The landowners in the upper valley around Chimayo refused to join and so were excluded when shortly thereafter the Santa Cruz Irrigation District was formed. The irrigation district issued $250,000 worth of bonds to pay for the construction of the dam and initiated a water rights adjudication that in 1931 assigned all of the floodwaters of the Rio Santa Cruz to the Santa Cruz Irrigation District (Calkins 1937c:4–5; Elmendorf 1940:34). By 1928, three construction companies had gone bankrupt, and the dam was only partially completed (Calkins 1937c:6–7). A new bond issue of $250,000 was floated, and the dam was completed in 1929 (Figure 31); the reservoir, however, could only hold sufficient water to supply 60% of the acreage for which it had originally been planned (Calkins 1937c:7). As a result, no new lands were brought under cultivation. The lack of new irrigated acreage to help bear the costs of repaying the construction bonds placed the irrigation district in a difficult financial position; these difficulties were compounded by a substantial and continually increasing level of delinquent assessment payments (Calkins 1937c:8). By 1933 the Santa Cruz Irrigation District was in receivership, but in 1935 it was refinanced by the Reconstruction Finance Corporation with federal funds (Calkins 1937c:8–12). The experiences of the Santa Cruz Irrigation District were to be replayed during the 1930s on a much larger scale by the Middle Rio Grande Conservancy District.

MIDDLE RIO GRANDE VALLEY

In the Middle Rio Grande Valley (Figure 32), 125,000 acres were reportedly under irrigation between Cochiti and San Marcial in the 1880s (Hedke 1925; Thompson 1956), and the acreage fell to approximately 40,000 acres by 1925 (Hedke 1925). Hedke's numbers were frequently cited in the 1930s and 1940s to show the extent of the alleged tragedy in middle valley irrigation (see especially Hodges 1938; Harper et al. 1943). A careful examination of the data upon which Hedke relied shows that the figure of 125,000 irrigated acres was largely conjectural, a projection of the acreage that could have been served by the ditches that probably existed in 1880. It was not an estimate of actual cultivated lands.

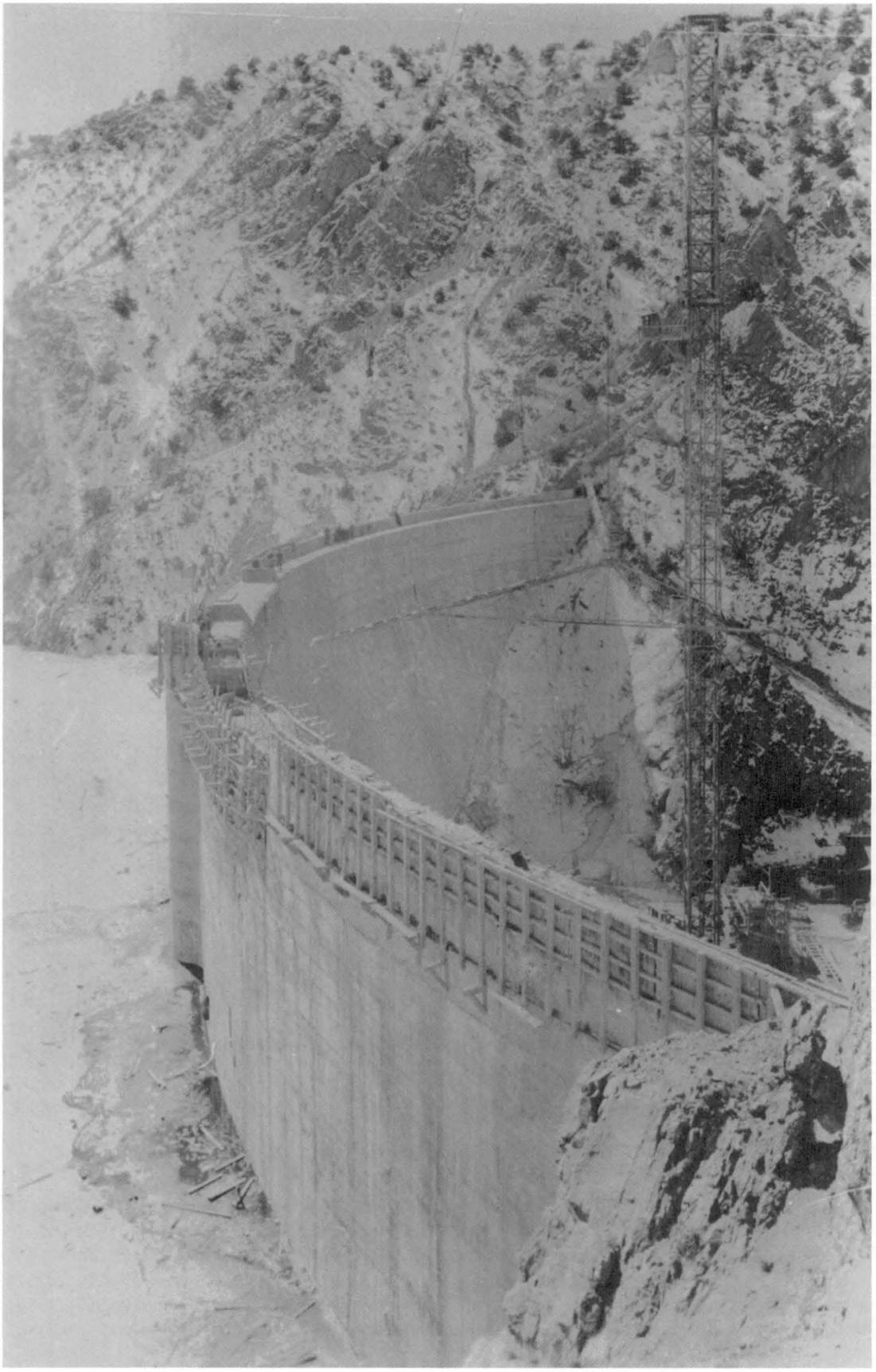

Figure 31 Santa Cruz Dam (under construction) (Photograph by T. Harmon Parkhurst, Courtesy of the Museum of New Mexico, Santa Fe, Negative No. 144614)

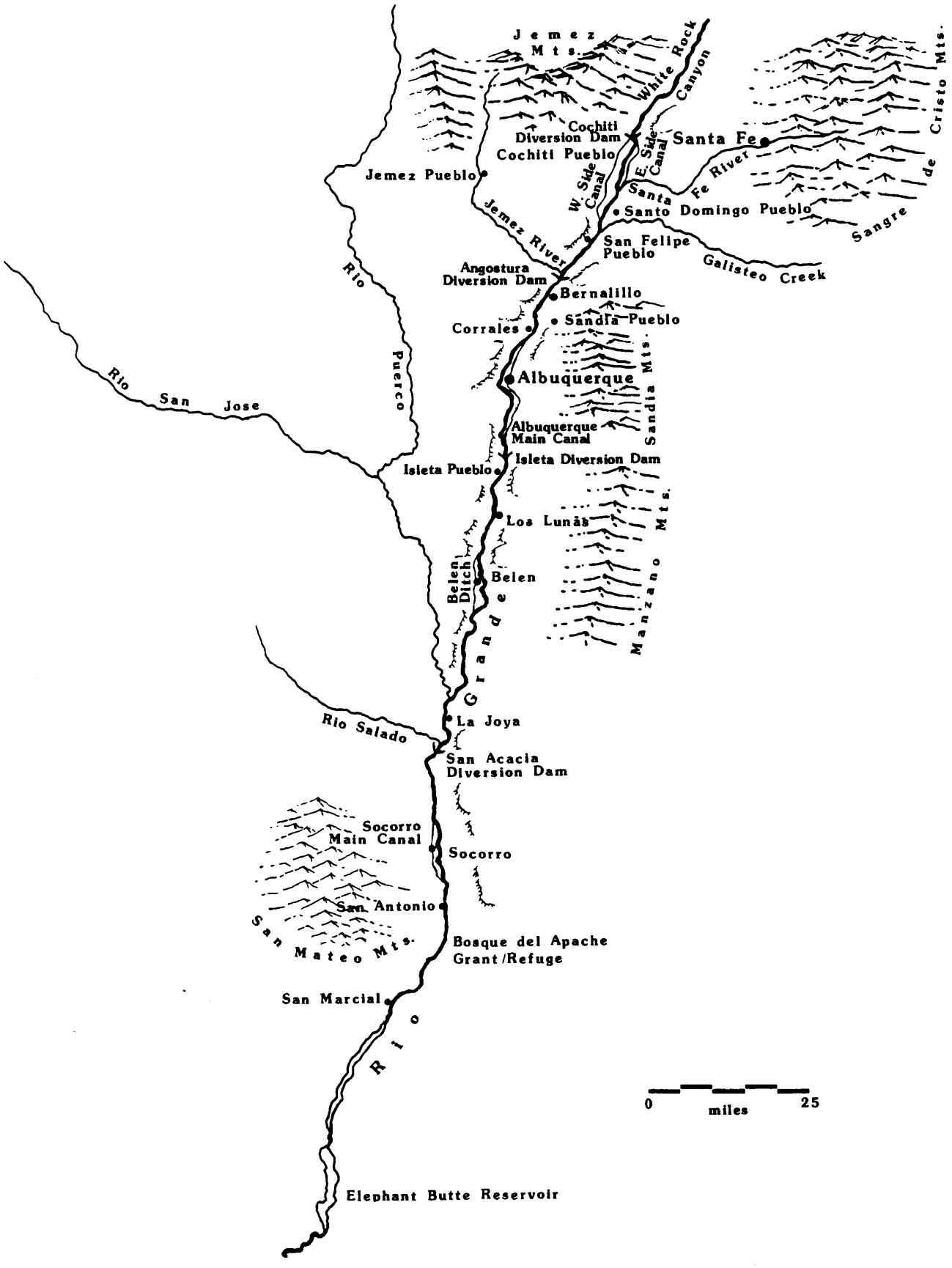

Figure 32 Middle Rio Grande Conservancy District

Even Hedke (1925) indicated that only about 44,000 acres were actually irrigated in 1880. By 1896, as a result of development in the San Luis Valley and a decade-long drought, irrigated acreage had fallen to approximately 32,000 acres in the middle Rio Grande Valley (Follett 1896). Irrigated acreage rebounded to approximately 45,000 acres by 1910 (Yeo 1910), to 48,000 acres in 1918, and to almost 49,000 acres in 1923 (Gault 1923), then fell to around 40,000 acres in 1925 (Hedke 1925). This last decline had at least as much to do with the collapse of agricultural prices after World War I as it did with the deterioration of the physical resources in the middle Rio Grande Valley, although the latter certainly occurred as well.

Gault (1923) probably has the best estimate of the amount of irrigated acreage in the middle Rio Grande Valley during the mid 1920s; he estimated that approximately 48,750 acres were cultivated and 58,000 acres were waterlogged or otherwise unusable. At that time, just before the formation of the Middle Rio Grande Conservancy District, some 70 ditches were in operation in the middle valley (Burkholder 1928:25).

Physical resources did deteriorate in the middle Rio Grande Valley from the 1890s to the mid 1920s (Harper et al. 1943:28), but the extent of the decline of irrigated acreage has been greatly exaggerated. Water shortages resulting from drought and especially from over-exploitation of surface water for irrigation in the San Luis Valley were frequent throughout the period after the early 1880s (Conkling and Debler 1919; Follett 1896; Gault 1923; Hodges 1938; Yeo 1910). These shortages were often tragically combined with devastating floods (Figure 33; Carter 1952; Yeo 1943). Water shortages particularly affected the annual flows on the middle and lower Rio Grande, producing increased sedimentation and dramatic channel aggradation in the early twentieth century that choked the ditches (Harper et al. 1943:36–40). The aggradation of the main stream channel increased the frequency and destructiveness of floods and also contributed to the waterlogging of arable lands in the middle and lower valley through lateral seepage and raised water tables (Figure 34; Burkholder 1928:34; National Resources Committee 1938:70). Waterlogging was frequently accompanied by salinization and alkali poisoning of soils (Conkling and Debler 1919:77; Harper et al. 1943:36–40). The changes in the hydrology of the valley were not the only causes of waterlogging and its accompanying effects on arable lands (Figure 35). Traditional irrigation practices in the middle valley encouraged and frequently were a primary cause of the decrease in arable acreage (Stewart 1936). The combined effect of all of these factors was a decline in irrigation agriculture in the middle Rio Grande Valley (Harper et al. 1943:51).

In 1919 Conkling and Debler did a study entitled *Water Supply for Possible Development of Irrigation and Drainage Projects on the Rio Grande* in the area above El Paso, Texas, for the U.S. Reclamation Service. The report (Conkling and Debler 1919:77) stated that only 50,000 acres of 180,000 irrigable acres were actually cultivated in 1919 because the great majority of lands were so badly waterlogged. They also noted that in 9 of the 22 years from 1895 to 1919 the Rio Grande had gone completely dry as far north as San Marcial during the irrigation season (Conkling and Debler 1919:84). They suggested that major flow losses occurred in the middle valley owing to evaporation from undrained areas and main channel percolation (Conkling and Debler 1919:91). To even out the flows and to ensure the availability of irrigation water for the middle and lower Rio Grande Valley above El Paso, Conkling and Debler (1919:94) proposed the construction of a storage reservoir on the Chama River at El Vado.

Concern over the deterioration of conditions in the middle Rio Grande Valley gradually grew in the 1920s (Burkholder 1928; Linford 1956:287–289). In 1921, the State Legislature created the Rio Grande Survey Commission to study conditions in the middle valley in cooperation with the U.S. Reclamation Service (Hedke 1925). The result of those studies and of increased public pressure was the enactment of the New Mexico Conservancy Act of 1923 (Linford 1956:289). In the same year, a citizens group formed the Middle Rio Grande Reclamation Association (Wortman 1971:25). Finally during August 1925 the Middle Rio Grande Conservancy District was organized under the 1923 Act (Linford 1956:289; Wortman 1971:25). Because it was believed to be impractical to include the numerous scattered acequia systems in the upper Rio Grande tributaries, and because of the severity of the flood problems at San Marcial, the boundaries of the district were established at the Sandoval County line (approximately the mouth of White Rock Canyon) in the north and just above San Marcial in the south (Calkins 1937d:18). When the district was organized, two-thirds of the arable bottomlands within its boundaries were subject to seepage or were waterlogged (Burkholder 1928:45–55; Conkling and Debler 1919:77).

Over the next three years an official plan for reclamation, flood control, and irrigation was developed; the plan was presented in its final form by the chief engineer of the district, Joseph L. Burkholder, in 1928. The plan covered flood

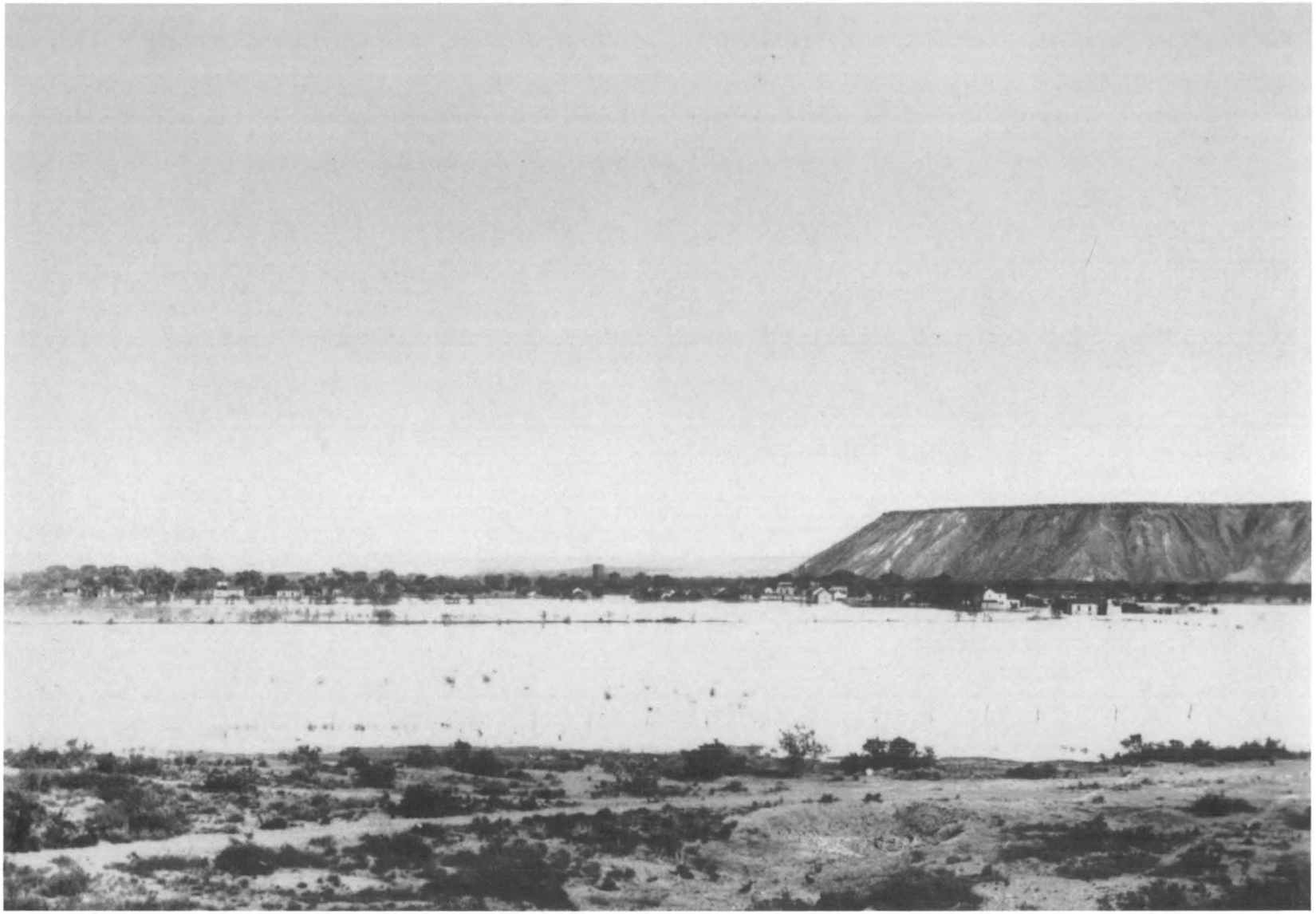

Figure 33 San Marcial under water, May 1920 (Courtesy of Rio Grande Historical Collection, New Mexico State University Library, Las Cruces, Negative No. RG90-26-341)

Figure 34 Waterlogged Lands in the North Valley of Albuquerque, ca. 1930 (Courtesy of Middle Rio Grande Conservancy District, Albuquerque)

Figure 35 Aerial View of Rio Grande Valley North of Albuquerque, May 26, 1930. Note Alkali Land (Courtesy of Middle Rio Grande Conservancy District, Albuquerque)

and river control, irrigation (especially diversion dams and main canals), drainage, water supply (a reservoir at El Vado), management of Indian Lands belonging to five pueblos (Congressional legislation was needed in order to include Pueblo lands within the Middle Rio Grande Conservancy District), and sedimentation control (dealing with aggradation of the Rio Grande, channel shifts, lateral seepage, and waterlogged lands). The cost for the entire project was estimated at $10 million. In March 1928, Congress authorized the Secretary of the Interior to enter into an agreement with the Middle Rio Grande Conservancy District for irrigation, drainage, and flood control on the lands of the pueblos of Cochiti, Santo Domingo, San Felipe, Santa Ana, Sandia, and Isleta (45 Stat. 321; Middle Rio Grande Conservancy District 1928, 1929).

The Pueblo of Cochiti had two ditches that served Indian lands during the first part of the twentieth century (Hodges 1938:264). By 1930 when the Middle Rio Grande Conservancy District began work at the pueblo, most of the land cultivated by the Cochitis was on the west side of the Rio Grande (Hodges 1938:268). Because of their locations, neither Cochiti nor the other Rio Grande pueblos suffered any serious shortages of water.

The Pueblo of Santo Domingo had some of the best agricultural land in the middle Rio Grande Valley and irrigated from two ditches, one on either side of the river (Hodges 1938:272, 278). As in the case of Cochiti, however, the irrigable land at Santo Domingo was threatened by erosion from the Rio Grande (Hodges 1938:266, 278).

The Pueblo of San Felipe (Figure 36) needed irrigation system improvements because its agricultural lands were crossed by irrigation ditches to Santa Ana Pueblo and non-Indian lands north of Bernalillo (Hodges 1938:311). In the late 1920s other improvements in addition to flood control works were recommended for the lands of the Pueblo of San Felipe (Hodges 1938:314, 317).

Though the Pueblo of Santa Ana is located in the lower Jemez Valley, the Santa Ana Indians carried out irrigation agriculture exclusively on the Los Ranchitos Tract, which lay along the Rio Grande (Hodges 1938:304). The Indians had begun to move down to the Rio Grande in the early eighteenth century; as reported above, Fray Dominguez and Fray Morfi recorded the final shift to farming in the Rio Grande Valley above Bernalillo in the 1760s.

The Pueblo of Sandia continued to use a single ditch that had been in use since the resettlement of the pueblo in the mid-eighteenth century (Hodges 1938:320). Government investigations found that much of Sandia's irrigable lands were badly waterlogged in the late 1920s (Hodges 1938:323). The Middle Rio Grande Conservancy District planned to drain these lands.

At the Pueblo of Isleta, the federal government had already constructed a drainage ditch, which had demonstrably improved agricultural conditions on the lands covered by the drain (Hodges 1938:330). Much of the Isletan lands remained waterlogged and affected by alkali deposits, however, and required attention from the Conservancy District (Hodges 1938:331).

Vlasich (1980:34–35) found that the Pueblos accepted the various New Deal agricultural programs as well as the projects of the Middle Rio Grande Conservancy District. The construction of new ditches and diversion headings, the rehabilitation of canals, and measures toward flood control all increased the arable acreages for the individual pueblos, and were accepted. At the same time, the Puebloans as a group tended to resist participation in agricultural education programs that were intended to modernize their agricultural techniques and technology (Vlasich 1980:35).

During 1929, the Middle Rio Grande Conservancy District issued bonds to finance the construction of the proposed projects (Middle Rio Grande Conservancy District 1929; Wortman 1971:25). Floods during the summer of 1929 emphasized the need for immediate remedies to some of the pressing problems of the middle valley. The 1929 floods devastated the lower Middle Rio Grande Conservancy District from San Acacia to San Marcial (Yeo 1943:74). The September flood destroyed 90% of the crops in that region; obliterated the villages of San Acacia, San Antonito, and San Marcial; and inflicted almost irreparable damage on dikes and ditches between San Antonio and San Marcial (Black 1930:4). The irrigation systems of the villages of San Acacia, Polvadera, Lemitar, Socorro, San Antonio, Valverde, and La Mesa were mostly destroyed and their croplands were flooded (Calkins 1937d:9). With funds made available by the Bureau of Reclamation and the State of New Mexico, dikes were rebuilt between San Acacia and San Marcial and the main canals for San Acacia, Polvadera, Lemitar, Luis Lopez, Laboricito, San Antonio, San Antonito, Guadalajara, and Valverde were reconstructed by local residents (Black 1930:2–4).

Figure 36 Aerial View of Rio Grande Valley near San Felipe Pueblo, May 26, 1930 (Courtesy of Middle Rio Grande Conservancy District, Albuquerque)

In the area just south of the limits of the Middle Rio Grande Conservancy District the effects of the 1929 floods were most devastating. New San Marcial had emerged as a community in the mid 1880s when the Santa Fe Railroad established a division point near the community of Old San Marcial (Calkins 1937d:6). In 1910, all of the agricultural lands at New San Marcial were irrigated from four old acequias, one or more of which had been built in the mid nineteenth century (Yeo 1910:14–17). Prior to 1908 some land near Old San Marcial also remained in production, but most of the land had been ruined by seepage and silt from arroyos (Calkins 1937d:3). In 1925, the owners of the Pedro Armendaris Grant fenced the uplands, which brought an end to the livestock raising that had been a mainstay of the economy in the San Marcial area (Calkins 1937d:2). The 1929 flood then destroyed or set in motion the destruction of what remained of the economy.

After the flood of 1911, the State Engineer's Office had constructed a levee to protect New San Marcial; further efforts were necessary following the flood of 1920 (Calkins 1937d:7–8). Then on August 12 and 13 and again on September 23 and 24, 1929, two floods irrevocably altered life in the area. New and Old San Marcial as well as their irrigation system were wiped out in the September flood (Calkins 1937d:10–11). After a nearly half-century battle with the river, the Santa Fe Railroad removed the division point from New San Marcial in October 1929, thus eliminating local wage labor opportunities (Calkins 1937d:12).

After 1929, a progressive decline in agriculture occurred in the San Marcial area; much of the land was already waterlogged or encroached upon by bosque, reducing the cultivated acreage by 60% even before the 1929 flood (Calkins 1937d:13–16). Most of the population left New San Marcial in response to the destruction of their farmlands through progressive waterlogging. Backwater from Elephant Butte Reservoir had already drowned or waterlogged lands at Contadora below San Marcial (Calkins 1937d:20). By 1937 most of the lands at La Mesa, Valverde, San Geronimo, Old San Marcial, and New San Marcial were under water. Aggrading of the Rio Grande channel continued, and in 1937 another major flood put an end to the remnants of irrigation agriculture in the San Marcial area (Calkins 1937d:18).

While part of the Rio Grande Valley was still recovering from the effects of the 1929 floods, the Middle Rio Grande Conservancy District filed an application with the State Engineer's Office to consolidate 71 old diversions into six new permanent diversions (Figure 37; Linford 1956:292). In 1930 the State Engineer's Office approved that consolidation and authorized the construction of the dam and storage reservoir at El Vado, which involved the acquisition of unappropriated waters from the upper Chama drainage (NMSEO, Annual Report 1930). By this time the U.S. Reclamation Service had also completed its investigations to determine the effects of the operation of the proposed works of the Middle Rio Grande Conservancy District on waters entering Elephant Butte Reservoir and on lands that depended upon that reservoir for irrigation (Debler 1932). Based upon field work carried out between April 1926 and October 1928, Debler (1932) concluded that the district's works would lower the losses of water that flowed through the middle valley, would lower the silt load and thus increase the longevity of the reservoir at Elephant Butte, would not diminish the water supply for lands that depended upon Elephant Butte Reservoir, and would not increase the concentration of alkali in the river water.

Construction of the El Vado dam and renovation of the irrigation facilities in the middle valley began in 1930 (Harper et al. 1943:53; Middle Rio Grande Conservancy District 1930). The dam was completed in 1935 and the irrigation facilities in 1936 (Middle Rio Grande Conservancy District 1936). Renovation of the irrigation system included consolidation of the diversions and construction of four new diversion structures (Cochiti, Angostura, Isleta, and San Acacia), a siphon at Corrales, and two diversion headings (Atrisco and San Juan). Some 767 miles of canals were constructed or rehabilitated (Figure 38); 342 miles of interior and riverside drains were built; and 180 miles of riverside levees were completed (Figures 39 and 40). By 1936, 61,294 acres of irrigated land were under cultivation as compared with approximately 45,000 acres in 1928 (Middle Rio Grande Conservancy District, Annual Report of Chief Engineer 1936; National Resources Committee 1938:309; Yeo 1928:100). While problems with siltation and flooding continued to affect lands within the Conservancy District, the new facilities initially functioned well; large areas had been drained and were being reclaimed (Figure 41), and the irrigation system was substantially improved (USDA Soil Conservation Service 1936a; Wortman 1971:40). The drains were insufficiently maintained, however, and their effectiveness rapidly deteriorated; the channel of the Rio Grande continued to aggrade (Thompson 1956:27; Wortman 1971:43).

Many of the problems faced by the Middle Rio Grande Conservancy District in the late 1930s were a result of inadequate funding (Middle Rio Grande Conservancy District Annual Report 1937, 1938, 1939). One of the major purposes of the district's facilities had been to revitalize agriculture in the middle valley, but the whole project was

Figure 37 River Channel between San Acacia and La Joya, April 2, 1931 (Courtesy of Middle Rio Grande Conservancy District, Albuquerque)

Figure 38 Construction of Ditch Heading for Lemitar Ditch, near Socorro, New Mexico, March 3, 1931 (Courtesy of Middle Rio Grande Conservancy District, Albuquerque)

Figure 39 Albuquerque Riverside Drain, July 30, 1931 (Courtesy of Middle Rio Grande Conservancy District, Albuquerque)

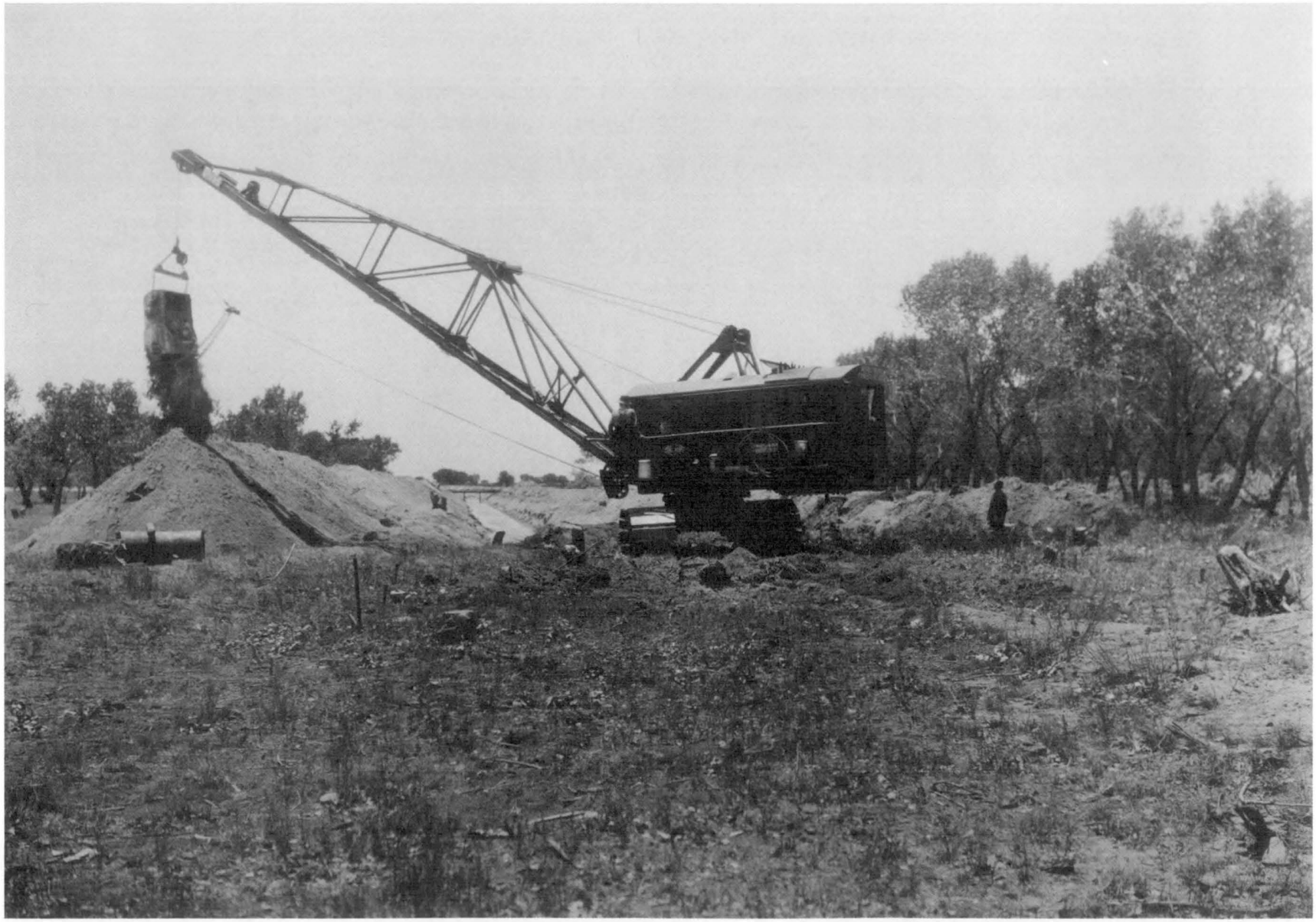

Figure 40 Bosque Interior Drain, near Belen, New Mexico, June 12, 1930 (Courtesy of Middle Rio Grande Conservancy District, Albuquerque)

Figure 41 Aerial View of Belen Riverside Drain and Levee (Note Areas of Alkali Land in Center and Lower Left), May 26, 1930 (Courtesy of Middle Rio Grande Conservancy District, Albuquerque)

completed in the shadow of the Great Depression, which devastated the profitability of agriculture. Just when the district needed to have a stable revenue base, the farming economy was depressed, leading to an inadequate rate of collection of assessments. It is generally agreed that the assessment system itself was deficient and even retrograde, which only exacerbated the collection problems (Linford 1956:295; Wortman 1971:43–45). In order to carry out the extensive but necessary construction program, the district had saddled itself with a huge indebtedness that required a stable revenue. Questions have also been raised regarding the quality of financial management that was exercised by the district (Wortman 1971:43–45). By the late 1930s, the delinquency rate on payment of assessments was 60% throughout the district (Harper et al. 1943:53; Middle Rio Grande Conservancy District 1938, 1939).

At first, the district attempted to relieve its difficulties by negotiating with the bond holders to get the interest rates reduced. Ultimately the Reconstruction Finance Corporation intervened and helped to refinance the bonds (Middle Rio Grande Conservancy District Annual Report 1938). The resultant lowering of the costs of servicing the district's debt and the financial stability that was provided by government payments for the costs of construction and operations on Indian lands provided temporary relief for the Conservancy District. Nonetheless, the district was barely able to fund routine operation and maintenance costs when the newly constructed systems began to show signs of rapid deterioration: the cleaning of drains and repairs to the diversion dams were largely beyond their means (Middle Rio Grande Conservancy District Annual Report 1938, 1939, 1940).

In 1942 the U.S. Army Corps of Engineers and the U.S. Bureau of Reclamation began investigations into the problems of the district and suggested solutions (USDI Bureau of Reclamation 1946:99–109; Wortman 1971:28). While many of the problems were technical, the real source of difficulties continued to be money; despite a revived economy as a result of World War II, the financial problems of the district persisted. Finally in 1947, the federal government took direct responsibility when President Truman proclaimed a unified plan for the Middle Rio Grande Valley (Wortman 1971:28).

MESILLA AND RINCON VALLEYS: THE RIO GRANDE PROJECT

On the eve of the construction at Elephant Butte Reservoir in 1910, surveys of irrigated and irrigable acreage showed that approximately 26,230 acres were being irrigated in the Mesilla Valley and 4370 acres in the Rincon Valley (Yeo 1928:100). The very next year, the U.S. Reclamation Service began actual construction on Elephant Butte Dam and also initiated work on related distribution facilities (Figure 42) in order to make effective use of the water from Elephant Butte Reservoir when it became available (Figure 43; Lester 1977:84; U.S. Reclamation Service 1911–1912:144–145).

In the Mesilla Valley a system of mixed farming prevailed until 1910, despite the arrival of the railroad and the opening of markets for agricultural products (USDA, Soil Conservation Service 1936b:4). After 1910 a more highly commercialized system of farming that focused on the production of cash crops, such as cotton and alfalfa, gradually changed the character of irrigation agriculture in the Mesilla Valley (USDA, Soil Conservation Service 1936b:6). The Rio Grande Project, which imposed a considerable financial burden on local farmers, helped to force commercialization on the valley, a trend exemplified by the rapid growth of cotton farming (USDA, Soil Conservation Service 1936b:8–10).

During the period of the construction of Elephant Butte Dam, which lasted until 1916, a controversy developed between the water users' association, which had agreed to foot the bills, and the Reclamation Service over escalating costs of the project (Elephant Butte Water Users' Association, 11th Annual Report 1915:8; Lester 1977:88–92). Ultimately the Elephant Butte and El Paso Water Users' Associations found it necessary to accept the increased costs.

Once construction had begun (Figure 44) and especially when completion of the dam at Elephant Butte was in sight, local efforts developed to encourage immigration into the Mesilla and Rincon valleys (Elephant Butte Water Users' Association, 12th Annual Report 1916:3–5; Lester 1977:95). The hope was that the new settlers would share the escalating costs of the project; most new settlers lacked capital, however, which limited their abilities to bring land under irrigation given the development costs and water user charges (Lester 1977:95–96). Even before the dam had released a gallon of irrigation water, the Elephant Butte Water Users' Association faced the financial burden of reimbursing the

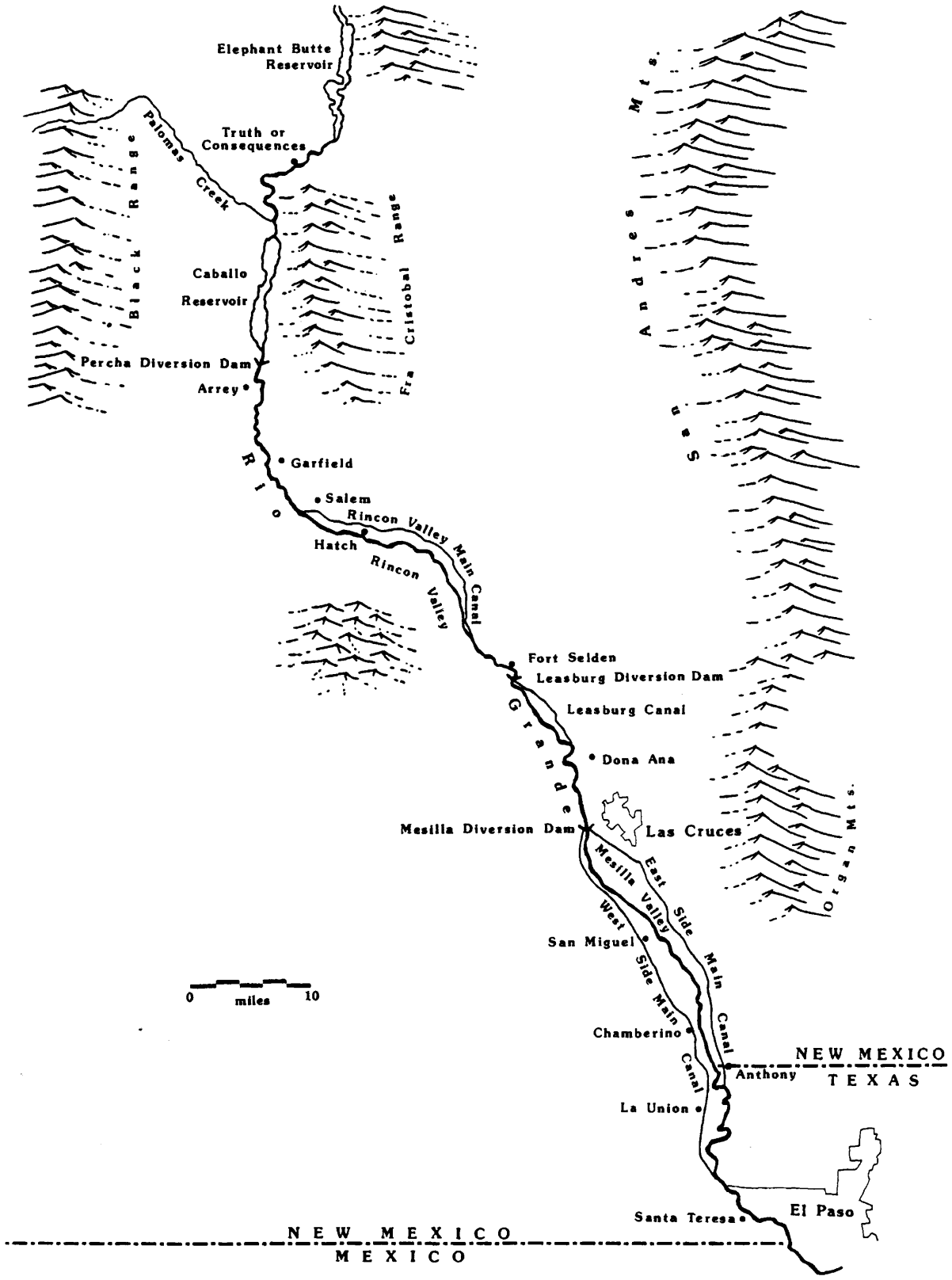

Figure 42 Rio Grande Project, New Mexico

Figure 43 Las Cruces Canal and Diversion Dam, Rio Grande Project, New Mexico (Courtesy of Rio Grande Historical Collection, New Mexico State University Library, Las Cruces, Negative No. RG 90-26-186)

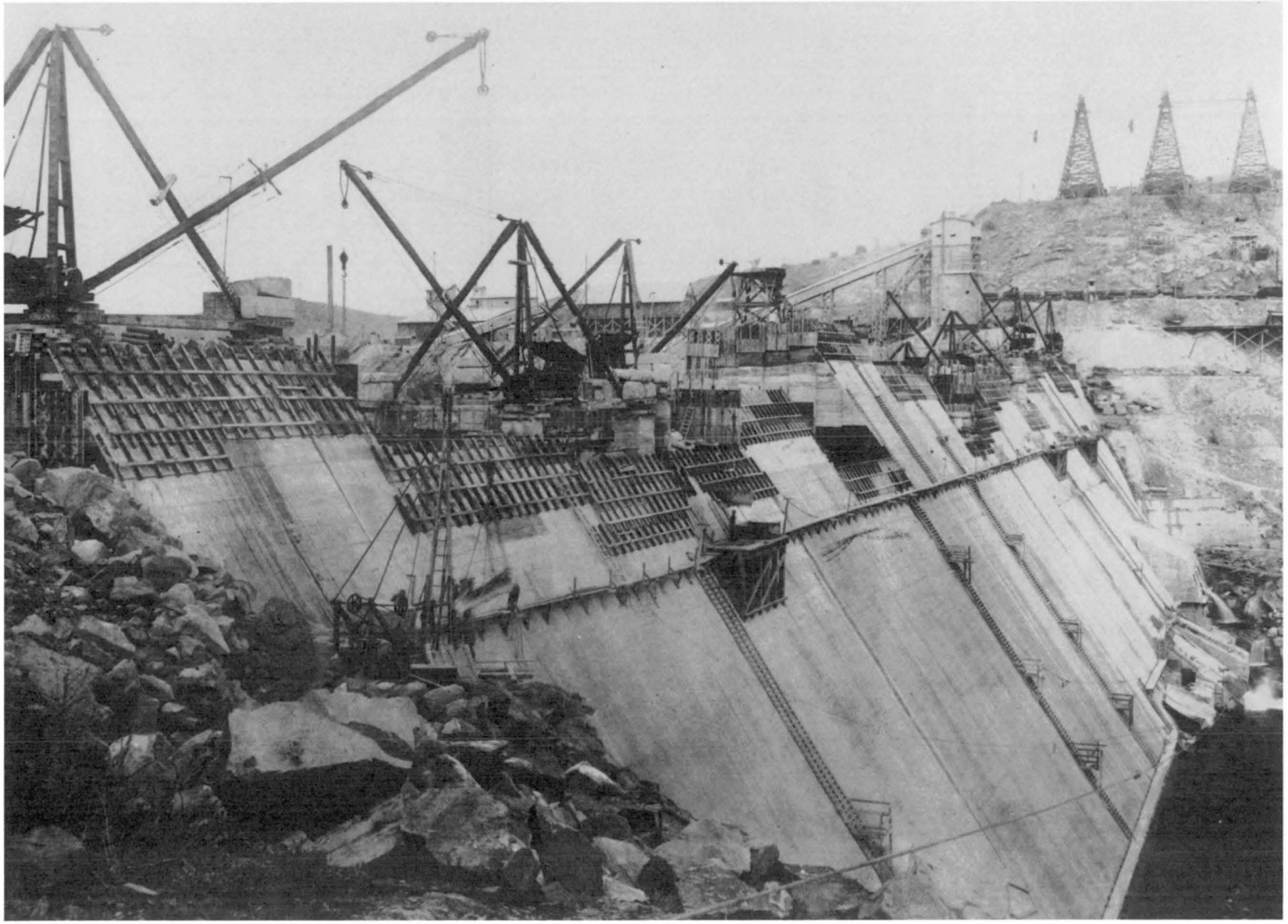

Figure 44 Construction of Elephant Butte Dam (Courtesy of Rio Grande Project, U.S. Bureau of Reclamation, El Paso)

United States government for construction costs and the routine costs of operation and maintenance for a large growing irrigation system (Elephant Butte Water Users' Association, 12th Annual Report 1916:1).

In 1914, Congress responded to problems of escalating costs of reclamation projects throughout the West, and to the resulting financial strain on individual irrigators and their water users' associations, by passing the Reclamation Extension Act (Gates 1968:671). The Act extended the repayment period for reclamation project construction costs from 10 years to 20 years.

The first deliveries of water from Elephant Butte Reservoir occurred during the 1915 irrigation season (Figure 45), even before the dam was completed (Rio Grande Project History 1915–1916:330). In the same year the Mesilla Diversion Dam was completed, as were the East Side and West Side canals (Rio Grande Project History 1915–1916:326). With the completion of the dam in 1916 (Figure 46), deliveries of irrigation water were made to irrigators in the central and southern parts of the Mesilla Valley (Rio Grande Project History 1916:10). At the same time the Holly Sugar Company announced plans to build a refinery at Las Cruces; the prospects for successful cultivation of sugar beets as a cash crop encouraged immigration into the region (Rio Grande Project History 1916:117–118). New canals would need to be constructed, however, before more land could be brought under irrigation (Rio Grande Project History 1916:118).

The records of the Elephant Butte Water Users' Association show the irrigation acreage cultivated in 1917 during the year immediately after deliveries of water from Elephant Butte reservoir began in the Mesilla Valley:

	Acres
Chamberino ditch	4,880
La Mesa ditch	2,608
San Miguel ditch	1,780
Three Saints lateral	5,581
La Union ditch	11,587
Las Cruces ditch	5,000
Mesilla lateral	6,880
Doña Ana ditch	7,394
Castillo ditch	285
Total	45,986

The Garfield Community Ditch irrigated 3165 cultivated acres in the Rincon Valley during 1918, but there is no information on other ditches in that valley for the same year. In the Mesilla Valley alone, however, almost as much land was being irrigated as in the entire middle Rio Grande Valley.

To handle the complex task of operating an expanding irrigation system, the Reclamation Service encouraged the residents of the Rincon, Mesilla, and El Paso valleys to form irrigation districts (Lester 1977:96–99; Rio Grande Project History 1918:12). In response, the Elephant Butte Water Users' Association, which covered the Rincon and Mesilla valleys in New Mexico, approached the State Legislature during 1918 and 1919 and requested authorization of irrigation districts within New Mexico (Lester 1977:99–100). The legislature responded, and in March 1919 the Elephant Butte Irrigation District was organized (Lester 1977:100–102). The new district was primarily a financial institution whose purpose was to collect water fees and charges in order to reimburse the federal government for the construction costs of the Rio Grande Project and to pay for operation and maintenance costs (Lester 1977:102; U.S. Reclamation Service 1917–1918:255).

While farmers in the Rincon and Mesilla valleys could anticipate substantial benefits from the operation of Elephant Butte Dam (Figure 47), residents of the Palomas Valley, which lay immediately below the reservoir, found themselves in a much less enviable situation. A study by H. M. Gault in 1918 of a proposed irrigation system for the Palomas Valley found that the costs of a gravity canal system made the proposal impracticable (Palomas Valley District 1918). The residents of Palomas Valley had only one small community ditch with which they diverted water from the Rio Grande with considerable difficulty. Because of certain financial and organizational impediments, the Palomas Valley Irrigation District never joined the Elephant Butte Irrigation District and thus never became a part of the Rio Grande Project

Figure 45 Irrigation Ditch at Las Cruces, New Mexico, 1915 (Photograph by R. Banner, Courtesy of the Museum of New Mexico, Santa Fe, Negative No. 78388)

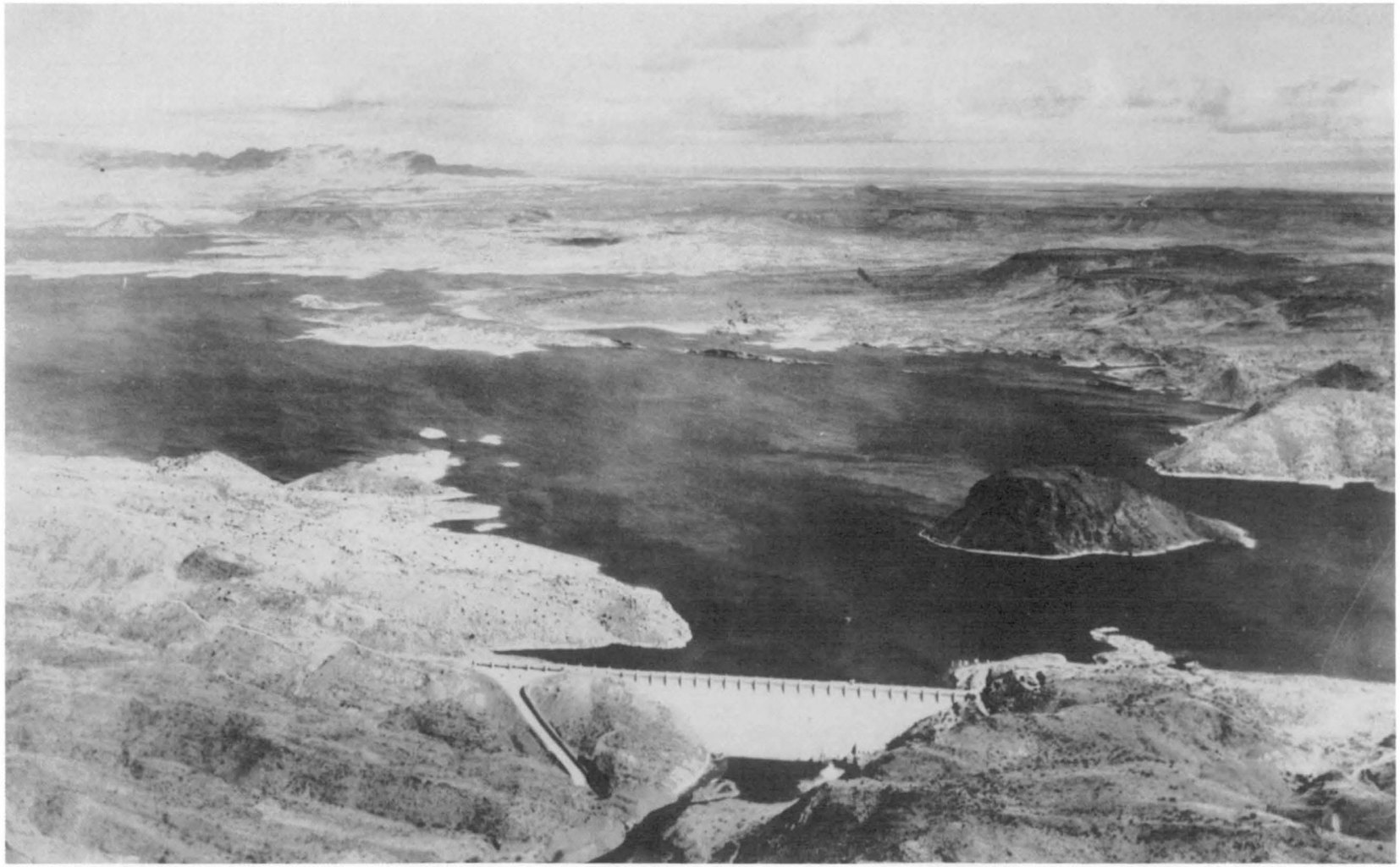

Figure 46 Aerial View of Elephant Butte Dam after Completion (Photograph by 3 Hawks, Courtesy of Museum of New Mexico, Santa Fe, Negative No. 58276)

Figure 47 Irrigation Ditch under Elephant Butte Project, Sierra County, New Mexico (Photograph by Aultman and Dorman, Courtesy of the Museum of New Mexico, Santa Fe, Negative No. 59302)

(Palomas Valley District 1922–1929). In the end, the difficulties attendant upon irrigation in the Palomas Valley were solved after a fashion when most of the area was drowned under the waters backed up behind Caballo Dam.

Beginning shortly after the commencement of regular deliveries of water from Elephant Butte Reservoir, the Reclamation Service became concerned about drainage of waterlogged lands within the Rio Grande Project, especially in the Mesilla Valley (LaMar 1984:38; Lester 1977:102; U.S. Reclamation Service 1917–1918:257). As early as 1917, the seepage problem began to affect the valley's arable land, particularly since 70% of the irrigable land suffered naturally from poor drainage (LaMar 1984:100–101). Finding themselves with a relative abundance of water, irrigators overwatered their crops; this meant not only a waste of water but also a dramatic increase in the seepage problem (LaMar 1984:99; U.S. Reclamation Service 1917–1918:257, 1918–1919:267). Thousands of acres of poorly drained land became waterlogged in a short period of time. The condition could only be relieved by the construction of a drainage system for the Mesilla Valley coupled with a program for the reclamation of areas poisoned by alkali as a result of overwatering (LaMar 1984:99; Rio Grande Project History 1919:14). The problem from a financial point of view was that the water users' associations would have to bear considerable additional costs beyond the original plans for the project. These costs could not be avoided, however, except at the price of abandoning most of the arable lands that the Rio Grande Project was intended to irrigate. Between 1917 and 1925, the Reclamation Service devoted considerable effort to construction and maintenance of drainage ditches that would ultimately have a significant positive effect on irrigation within the Rio Grande Project (Lester 1977:102).

In 1918, the Percha Diversion Dam, the last of the facilities scheduled for construction under the original project, was completed (Figure 48). By 1918, however, the Reclamation Service had come to accept the necessity of a greater and longer-term involvement in the actual distribution of water (Figure 49; Rio Grande Project History 1918:3, 10). In 1918 and 1919, the Reclamation Service took control of all large community ditches in the Mesilla Valley with the exception of the La Union ditch, which it acquired in 1920 (Figure 50; Rio Grande Project History 1919:170, 1920:8; U.S. Reclamation Service 1918–1919:264). At the same time, the service also acquired control of the ditches in the Rincon Valley as well as responsibility for all construction (Rio Grande Project History 1919:170). In 1920 all of the proposed irrigation facilities were completed in the Rincon Valley, and the Reclamation Service began reconstruction of the ditches that it had recently acquired in the Mesilla Valley (Figure 51; Rio Grande Project History 1920:113–114). The renovation of the larger ditches lasted until 1922 (Rio Grande Project History 1922:6).

The embargo on irrigation development along the Rio Grande that had been imposed in 1896 was finally reviewed in 1923 by the Secretary of the Interior. The review led to the establishment of the Rio Grande Commission, which was charged with developing an agreement among the states of Texas, New Mexico, and Colorado for the equitable distribution of the waters of the Rio Grande not covered by the Treaty of 1906 with the Republic of Mexico (Hamele n.d.:30).

Because of the economic depression of the early 1920s, which particularly affected agricultural prices, Congress extended the repayment period on reclamation projects to 40 years in 1924 (Gates 1968:674). Despite the depression, agriculture was reported to be doing well in the Mesilla Valley (Rio Grande Project History 1922:11, 1923:8, 1924:15, 1925:10). Also in 1924, the Reclamation Service was reorganized as the Bureau of Reclamation (43 Stat. 701). In the Rio Grande Project area, the bureau assumed responsibility for all construction as well as for operation and maintenance under contracts with the Elephant Butte Irrigation District (Gates 1968:677; Rio Grande Project History 1925).

By the end of the 1920s the settlement of the Mesilla and Rincon valleys was virtually complete (Rio Grande Project History 1929:71). Ninety percent of the currently irrigable land was under cultivation, and more land was being reclaimed through the progressive expansion of the drainage system into the early 1930s. These reclaimed lands would gradually be added to the arable acreage (LaMar 1984:139; Rio Grande Project History 1929:53). In 1929, approximately 56,000 acres were under cultivation in the Mesilla Valley, with an additional 12,480 acres being farmed in the Rincon Valley; in 1930 the Rincon Valley had 12,702 acres under cultivation and the Mesilla Valley had 65,747 acres (Rio Grande Project History 1929:53, 1930:56). By 1938, the citizens of Arrey in the northern Rincon Valley were irrigating 952 acres of land, divided into 29 farms, and raising mainly cotton and alfalfa (Calkins 1938b:18–19). Only 100 acres of potentially irrigable land remained in the area of Arrey at that time.

The effects of the Great Depression were not immediately felt in the Mesilla and Rincon valleys, but by 1931 crop prices collapsed (Rio Grande Project History 1931:9). This situation caused the Elephant Butte Irrigation District to take a step

Figure 48 Mesilla Dam from Upstream, December 1917 (Courtesy of the Rio Grande Historical Collection, New Mexico State University Library, Las Cruces, Negative No. RG90-26-210

Figure 49 Construction of Hatch Siphon, July 1918 (Courtesy of the Rio Grande Historical Collection, New Mexico State University Library, Las Cruces, Negative No. RG90-26-245)

Figure 50 Removing Silt, Westside Canals, Mesilla Valley, December 1917 (Courtesy of the Rio Grande Historical Collection, New Mexico State University Library, Las Cruces, Negative No. RG90-26-248)

Figure 51 Heading of New Doña Ana Canal, Rio Grande Project, New Mexico (Courtesy of the Rio Grande Historical Collection, New Mexico State University, Las Cruces, Negative No. RG90-26-183)

already proposed on other reclamation projects; they requested relief from the repayment of the costs of construction of the Rio Grande Project (Rio Grande Project History 1931:12). The developing financial crisis for the Elephant Butte Irrigation District would last throughout the 1930s, but like all of the reclamation projects, they would receive relief from Congress. In 1932, Congress deferred all payments for 1931 and for one-third of 1932 (Gates 1968:687). In 1933, 1934, 1935, and 1936, payments were annually deferred. Finally in 1936, Congress appointed a committee to investigate the condition of settlers on all reclamation projects and to determine their abilities to repay the costs of construction under the current 40–year formula; in the interim, payments were again deferred (Gates 1968:687). After three years of study, the committee made recommendations that were enacted by Congress: first, part of the debt was written off; second, settlers were exempted from payments for the period from 1939 to 1943; and third, the period for repayment of the costs for the construction of reclamation project was extended to 50 years (Gates 1968:687).

In the interim, the Rio Grande states had finally come to an agreement on the apportionment of Rio Grande water, but only after lengthy conflict and negotiations. In 1929 the Rio Grande Compact was signed by Texas, New Mexico, and Colorado (Dunbar 1983:144). The compact of 1929 provided for the equitable distribution of the waters of the Rio Grande and was to last for 5 years until a new, permanent compact could be negotiated. When the parties were unable to reach a new agreement, Texas brought suit in October 1935 against New Mexico for allowing new diversions and impoundments of water (Dunbar 1983:144). The construction of the dam at El Vado was the proximate cause of the Texas suit. President Roosevelt ordered an immediate embargo on new irrigation development along the Rio Grande (September 1935) unless it was approved by the National Resource Committee (Dunbar 1983:144). The committee not only oversaw the embargo but also, and more productively, carried out a new investigation of conditions in the Rio Grande Valley (National Resources Committee 1938). These investigations led to the signing of a new Rio Grande Compact in 1938, at which point Texas dropped its suit against New Mexico (Dunbar 1983:144–145).

Development had not ceased in the Mesilla and Rincon valleys during the 1930s, but cultivated acreage fluctuated considerably. In 1935 irrigated acreage reached a low of 53,591 acres in the Mesilla Valley and 11,834 acres in the Rincon Valley before recovering to 64,085 acres and 14,152 acres, respectively, in 1938 (Rio Grande Project History 1935:38, 1938:52–53). Irrigated acreage remained stable until 1943, when the war effort spurred considerable expansion. The last major irrigation facility to be constructed within the New Mexico portion of the Rio Grande project was brought into operation in 1938 when Caballo Dam was completed (Rio Grande Project History 1938:42). The dam was built to alleviate flooding caused by runoff from ephemeral tributaries of the Rio Grande that originated in the Black Range on the west side of the river.

Because of the reclamation of waterlogged lands and the maintenance of the renovated irrigation system within the Elephant Butte Irrigation District by the U.S. Bureau of Reclamation, farmers in the Rincon and Mesilla valleys were able to increase their cultivated acreage dramatically during the Second World War. In 1943, the Rincon Valley had 16,225 acres under cultivation (compared with 12,702 in 1930), while the Mesilla Valley had 71,770 acres (compared with 65,747 in 1930; Rio Grande Project History 1943:26); in 1945 the acreage in the Rincon Valley expanded only slightly to 16,272 acres but in the Mesilla Valley the acreage jumped to 88,714 (Rio Grande Project History 1945:38). The Rio Grande Project in the Rincon and Mesilla valleys had proved to be, without question, a success as an irrigation and reclamation project in terms of increased irrigated acreage and commercial agriculture.

Chapter 10

IRRIGATION AFTER WORLD WAR II

In the time since the end of the Second World War, the Bureau of Reclamation and the Corps of Engineers have played a large role in many irrigation activities throughout the Rio Grande Valley in New Mexico (Clark 1987; Welsh 1985). This circumstance is a continuation of the roles that these two agencies had begun to play in irrigation throughout the West during the Depression. The role of the Bureau of Reclamation (BOR) was particularly evident in the postwar period because it remained in control of the Elephant Butte Irrigation District and came into control of the Middle Rio Grande Conservancy District (Clark 1987:381). The role of the Corps of Engineers expanded significantly in the Rio Grande Valley because of its construction of important flood control and water storage structures.

During World War II, Congress had directed the Bureau of Reclamation and the Corps of Engineers to cooperate in the development of a joint use plan for portions of the Rio Grande Valley in New Mexico (Welsh 1985:109–110). These endeavors were directed particularly toward the Middle Valley. The planning efforts toward irrigation improvements and flood control which began in the early 1940s culminated in the initiation of major engineering projects in the late 1940s and early 1950s which tied together the entire Rio Grande Valley in New Mexico even more closely than it had been before. The problems that these projects were intended to address linked the various reaches of the river together because of the downstream effects and overlapping impacts of irrigation and flood control activities by the Bureau of Reclamation and the Corps of Engineers in the upper Rio Grande Valley.

The Bureau of Reclamation had primary responsibilities in the areas of irrigation systems and water conservation resources. The Corps of Engineers had primary responsibilities for flood control measures. Nonetheless, overlaps in the purposes of water projects and budget cuts in the early 1950s heightened the endemic conflicts of interest between the Corps of Engineers and the Bureau of Reclamation as restrictions were imposed on water projects throughout the West.

In the meantime, the role and administration of community ditch systems, which were the heart of irrigation in the upper Rio Grande Valley, were clarified in 1945 when the state legislature tightened the administration requirements of the acequias (Clark 1987:350). Mayordomos and treasurers were required to make full written annual reports to their ditch commissioners. At the same time, the commissioners were required to maintain written public records of their proceedings. In 1965, the role of the community ditches was further clarified when acequias and community ditches were declared to be political subdivisions of the state of New Mexico (Clark 1987:389). The ditches then became eligible for state funds for ditch improvements and the associations were authorized to borrow money and to accept grants from the federal government. The latter authority was particularly important since arrears in assessments affected day-to-day operations; the need for maintenance and renovations exceeded the financial resources of the vast majority of the community ditch systems.

After World War II, New Mexico attempted to restructure older institutions and created new institutions as a part of efforts to protect the state's natural resources and to bring into effect a more orderly development and use of water (Clark 1987:374). New Mexico's efforts were in part due to inducements from the federal government. Federal agencies were prepared to share the costs of water development projects in order to obtain intergovernmental cooperation as a part of the federal government's attempt to slow and even to reverse the deterioration of the nation's water resources.

In the 1940s, federal funding of river basin studies in the West was expanded to provide a basis for regional planning (Clark 1987:375); however, the suspicion by local residents of extensive planning remained prevalent in the West, including in New Mexico. As planning efforts continued into the 1950s and 1960s and beyond, the criteria for water use shifted. The original predominance of agricultural interests was increasingly challenged by other competing municipal and industrial interests and also by recreational, aesthetic, and environmental interests. The conflicts of competing interests have continued to play themselves out to the present day.

In the midst of these developments on the national, regional, and local level, the Bureau of Reclamation evolved from an agency with primary responsibilities in the storage of irrigation water to broader responsibilities as the waters in its reservoirs were increasingly sought for purposes other than agriculture, such as municipal and industrial water supply, generation of hydroelectric power, outdoor recreation, flood control, fish and wildlife protection, and water quality (Clark 1987:381). In the Rio Grande Valley, the BOR retained control over the Elephant Butte Irrigation District and was given major responsibilities for the Middle Rio Grande Conservancy District and for the construction and operation of the San Juan–Chama Project.

The Corps of Engineers, which had previously only been marginally involved in activities in the Rio Grande Valley, became a major player in the 1950s and 1960s and beyond because of major flood control projects in the upper and Middle Rio Grande Valley (Welsh 1985). The Corps became directly involved in irrigation activities once its reservoirs, which were originally designed or built solely for flood control, were utilized as water storage facilities. In the 1980s, the corps was also given responsibility for the rehabilitation of community ditches in New Mexico, including those in the Rio Grande Valley.

LOWER RIO GRANDE VALLEY

After World War II, the Bureau of Reclamation remained in control of the Elephant Butte Irrigation District. The Elephant Butte Irrigation District had oversight with regard to the distribution of irrigation waters below Elephant Butte Reservoir, which was itself operated by the Bureau of Reclamation (Rio Grande Project 1945–1979). During the drought of the 1950s, water users in the Mesilla Valley turned to underground water sources to supplement the surface waters from Elephant Butte Reservoir (Clark 1987:351). Because of the drought, surface water supplies from Elephant Butte were uncertain and more than 1300 wells were developed in the Elephant Butte Irrigation District over the next 25 years. There were no controls or regulations over these withdrawals of subsurface waters in the lower Rio Grande Valley in New Mexico because the state had not declared the area to be an underground basin (Clark 1987:351).

Problems with rampant drilling of wells for irrigation emerged in the late 1970s when the Elephant Butte Irrigation District itself entered the process by developing deep wells from which it intended to sell water in times of short supply of surface water (Clark 1987:351). In 1980, the city of El Paso entered the scene when it declared its intent to appropriate subsurface water from the Mesilla Valley and export the water into Texas. The New Mexico State Engineer, Steve Reynolds, responded by declaring the lower Rio Grande a river basin, which thereby placed the subsurface waters in the Mesilla Valley under his jurisdiction and regulation. From this declaration, a legal dispute between the state of New Mexico and the city of El Paso developed in the 1980s.

After 1940, the financial position of Mesilla Valley farms improved dramatically (LaMar 1984:145). The prices for agricultural products, especially cotton, rose sharply. Land values simultaneously increased as there was no longer any undeveloped land in the valley. This combination of economic factors led to the consolidation of landholdings in the Mesilla Valley during the late 1940s and 1950s. Yet at the same time, the urban areas of Las Cruces and El Paso expanded, which led to the increasing subdivision of agricultural lands for suburban homes (LaMar 1984:266). The process began in the 1940s and continues to the present time.

For the Elephant Butte Irrigation District, the period since World War II has been dominated by the persistence of concerns over real and imagined threats of restrictions of water supply from two sources: upstream developments and displacement of storage capacity at Elephant Butte Reservoir by silt, impoundments of surface water in the upper and Middle Rio Grande Valley, and recreational developments at the reservoir itself. All of these factors could interfere with releases of water from Elephant Butte Dam for agricultural uses (Clark 1987:382). Nonetheless, the Elephant Butte Irrigation District was able to meet its financial obligations to the United States and made the final payment on its repayment contract to the federal government in September 1971 (Rio Grande Project 1971). However, it was not until 1979 that the district assumed responsibility for and control over the operations and maintenance of the district irrigation ditch and drainage systems and for the distribution of water which was delivered to the district by the Bureau of Reclamation (Rio Grande Project 1979; Clark 1987:382). The Bureau remained in charge of Elephant Butte Dam and Reservoir, the district's diversion dams, and the apportionment of water between Texas, New Mexico, and the Republic of Mexico (Clark 1987:382).

The operation of Elephant Butte Reservoir has remained the source of considerable controversy and contention throughout the entire postwar period. The reservoir had been a favorite location for recreation from the early days of the dam despite the lack of any recreation facilities except those built during the Depression by the Civilian Conservation Corps (Clark 1987:407). No problems developed as long as recreation did not interfere with the irrigators in the Elephant Butte Irrigation District below the dam. During the severe drought of the 1950s, conflicts did develop (Rio Grande Project 1951–1956). The state of New Mexico and the town of Truth or Consequences brought legal action against the BOR to prevent releases of water for irrigation because of the alleged impacts of these releases on the reservoir's fishery. The state and town obtained a temporary injunction in state court but the Bureau of Reclamation responded by taking the matter to federal court. In federal court, the BOR secured a reversal of the state court decision on the grounds that the state court's injunction interfered with the obligation of the United States to meet treaty requirements for prescribed deliveries of water to the Republic of Mexico. With the end of the drought, the controversy over releases of water from Elephant Butte Reservoir for downstream agricultural uses subsided temporarily (Clark 1987:407). In 1962, Congress directed the Secretary of the Interior to construct recreational facilities at Elephant Butte and Caballo reservoirs. Shortly thereafter, the Bureau of Reclamation relinquished control of recreational facilities at both reservoirs to the State of New Mexico.

The potential for disputes between agricultural and recreational users of waters from Elephant Butte and Caballo reservoirs was not resolved. Consequently, a search was made for additional sources of water above Elephant Butte Reservoir. Heron Lake in northern New Mexico was seen as a possible source since the lake stored water diverted from the San Juan drainage into the Rio Grande drainage (for the San Juan–Chama Project, see below) for use by specific recipients, including the city of Albuquerque and the Middle Rio Grande Conservancy District. Neither Albuquerque or the Middle Rio Grande Conservancy District could make immediate use of their allocations of San Juan–Chama water. Both agreed to relinquish a portion of their allocations for the creation of a permanent pool at Elephant Butte Reservoir for recreational purposes until the time that the city and district would need the water. This solution (however temporary) to the recreational uses of Elephant Butte Reservoir was acceptable to the Elephant Butte Irrigation District and the El Paso County Water Improvement District (Texas). The terms of this agreement were incorporated into an ommibus recreation bill that was passed by Congress in 1974 (Rio Grande Project 1974; Clark 1987:408).

In the meantime, the Corps of Engineers made its first and thus far only venture into the construction of facilities in the lower Rio Grande Valley of New Mexico. In 1962, Congress provided for the construction of a flood protection project for the city of Las Cruces by the Corps of Engineers (Clark 1987:407). The project was delayed for years by the community's repeated failures to provide the local cooperation that the law required. Finally, in the early 1970s, Las Cruces voters approved a bond issue to cover the local share of construction costs and the city entered into a contract with the Corps of Engineers. Construction of the flood protection project began quickly and was completed in 1975 (Clark 1987:416).

UPPER AND MIDDLE RIO GRANDE VALLEY

These two portions of the valley in New Mexico were tied together in the post–World War II era by water and flood control projects. In the spring of 1941, a severe flood which hit the Middle Rio Grande Valley focused attention on its continuing vulnerability (Welsh 1985:110). The danger of flooding was accompanied by the related problems of the aggrading of the Rio Grande stream bed, salinization, and seepage. All of these problems were to have been solved by the construction of facilities by the Middle Rio Grande Conservancy District in the 1930s and had major impacts on irrigation agriculture. The danger of floods complicated the problems of the conservancy district because they maintained the levees in the Middle Valley (Berry and Lewis 1996:3). However all of the activities of the Middle Rio Grande Conservancy District were threatened by its precarious financial condition (Clark 1987:354). To meet the growing array of needs, the district's assessments increased steadily in the 1940s. Most of the funds that were levied went to flood control, with only very modest amounts going to irrigation facilities (DuMars and Nunn 1993:20–21). To address the critical problems faced by the district, an increasingly heavy tax burden on the lands of the district was required. At the same time, administrative problems over the extent of the district's authority to make levies and assessments emerged as the tax levies and assessments rose (Clark 1987:354).

By the late 1940s, the need for flood control and rehabilitation of irrigation facilities was overwhelming the Middle Rio Grande Conservancy District (DuMars and Nunn 1993:22). The physical and financial difficulties of the district were largely beyond the abilities of the district or the state to solve. The conservancy district could provide some short-term relief of some of the adverse conditions, but the underlying impediment was the financial weakness of the district. The weakness was exacerbated by the unequitable and economically unsound methods of assessments by the district. By 1944, nearly one-third of the irrigable, non-Indian lands had been confiscated by the state of New Mexico for failure to pay taxes and district assessments (DuMars and Nunn 1993:21). Meanwhile, traditional agricultural patterns persisted in the district, consisting of small farms that made a minimal, if any, profit. Traditional farmers supplemented their income with wage labor. The farm owners, who were predominantly Hispanic, were unable to pay their district assessments so that by the mid 1940s, 60% of the farms in the district were delinquent on their assessments (DuMars and Nunn 1993:21; Clark 1987:387). These farms encompassed 90% of the total irrigated acreage in the Middle Rio Grande Valley. While the district struggled with its finances, the river channel continued to aggrade, vegetation clogged the drainage system, and sand filled the outlets of the ditches. The problems of sedimentation, salinization, and seepage threatened the agricultural foundations of the conservancy district (Clark 1987:387).

By the late 1940s, many parts of the Middle Rio Grande Valley had reverted to preconservancy conditions. Therefore the state and the district turned to the federal government for assistance and relief. Senator Dennis Chavez was prevailed upon to promote the Middle Rio Grande Project (Welsh 1985:114). As a first step, in 1947, the Secretary of the Interior and the U.S. Army Corps of Engineers entered into a memorandum of agreement defining their respective areas of responsibilities in the Rio Grande Basin (Welsh 1985:115). In 1948, Congress passed a Flood Control Act which authorized the construction of a flood control dam on the Chama River above Española and on the Jemez River above Bernalillo (Clark 1987:388). The act also provided for flood protection work for the Middle Rio Grande Valley as well as the rehabilitation of irrigation systems. A study by the Bureau of Reclamation found that the economic well-being of the Middle Valley was threatened by conditions with which the district was unable to cope: continued aggrading of the Rio Grande's main channel, a continual rise in the water table, reduced crop yields, delinquencies in payments, incipient flood damage, water supply problems, and finally, New Mexico's inability to fulfill deliveries under the Rio Grande Compact (Clark 1987:387). The BOR urged an early resolution to these conditions and formulated a plan of action. The Corps of Engineers would build three flood control dams in the upper and middle valley and would construct levees for local flood protection in the Middle Valley (Welsh 1985:115). The Bureau of Reclamation would rehabilitate the irrigation and drainage systems in the Middle Valley, rectify the channel in the Española Valley, and dredge a low-flow channel into Elephant Butte Reservoir (Clark 1987:388). This plan was encompassed in the Flood Control Acts of 1948 and 1950.

Senators Chavez and Hatch pushed this federal program through Congress despite concerns from the other signatories of the Rio Grande Compact (Clark 1987:388). Under the Flood Control Act of 1948 the United States would acquire all of the Middle Rio Grande Conservancy District's outstanding debt and receive all of the district's property rights in irrigation works and land, including lands that had passed to the state of New Mexico from delinquencies in taxes and assessments, as security for the debt. Under the 1948 Act, the BOR was also mandated to study ways to reduce nonbeneficial consumption of water by native vegetation on the Rio Grande and its tributaries above Caballo Dam. The Flood Control Act of 1950 provided federal financial assistance to improve the economy of the Middle Rio Grande Valley by the rehabilitation of the Middle Rio Grande Conservancy District's facilities and by controlling sedimentation and flooding on the Rio Grande. In September 1951, the Bureau of Reclamation and the conservancy district signed a contract for the rehabilitation program (Middle Rio Grande Project 1951; DuMars and Nunn 1993:22). The Middle Rio Grande Conservancy District agreed to repay the United States for the costs of rehabilitation of the irrigation and drainage systems, for channel improvements, and for operation and maintenance costs as long as they were the responsibility of the Bureau.

The Bureau's rehabilitation program provided for repairs to El Vado Dam and to the Isleta, Angostura, San Acacia, and Cochiti diversion dams; extensive work on laterals and drains; and channelization of 127 miles of the river to Elephant Butte Reservoir. From 1955 to 1965, the Bureau took over operations and maintenance for the whole of the district. In order to meet the fiscal requirements of the Flood Control Acts, the Bureau introduced a new assessment system which remains in effect in the Middle Rio Grande Conservancy District today (DuMars and Nunn 1993:22). In the end, the Bureau of Reclamation's rehabilitation program cost more than $35 million, of which it was determined that the Middle Rio Grande Conservancy District was responsible for reimbursing $15 million to the United States (Clark 1987:388). The taxpayers of the United States paid the other $20 million of the costs. In 1956, 53,000 acres were irrigated in the

Middle Rio Grande Valley; by 1969, this total had increased to 59,000 acres of irrigated land (Clark 1987:388). During this time, Bernalillo County experienced progressive losses of cultivated acreage but these losses were made up by the expansion of irrigated lands in Valencia and Socorro counties, especially in the Belen area (DuMars and Nunn 1993:13, 24). The losses of irrigated acreage in Bernalillo County were largely due to the expanding subdivisions in the Albuquerque area. By the mid 1980s, more than 25% of the lands within the boundaries of the Middle Rio Grande Conservancy District were urban (DuMars and Nunn 1993:13). The most significant changes in land use were in the north and south valleys of Albuquerque where the conversion from irrigation agriculture to urban subdivisions has been the most extensive and evident.

The Middle Rio Grande Project under the Flood Control Acts of 1948 and 1950 called not only for the rehabilitation of Middle Rio Grande Conservancy District facilities by the Bureau of Reclamation but also for flood and sedimentation control by the Corps of Engineers (Middle Rio Grande Project 1951; Welsh 1985:116–117). In 1950, Congress authorized the construction of Jemez Canyon Dam on the Jemez River above Bernalillo; this flood control dam was completed in late 1952 (Welsh 1985:118). Jemez Canyon Dam was the first phase in the plan for flood protection in the Middle Rio Grande Valley. The next phase was to be Abiquiu Dam in the middle Chama Valley. The original plans in the 1948 and 1950 Flood Control Acts provided for a dam at Chamita on the lower Chama; however, engineering problems at the site and budget constraints caused the Corps of Engineers to shift the location of the dam on the Chama River to Abiquiu (Welsh 1985:130–131). The new location had twice the storage capacity of Chamita but also was opposed by Texas, which was concerned about water deliveries under the Rio Grande Compact. The fears of the Texans about an even larger dam on the upper Rio Grande were intensified by the drought of the early 1950s and New Mexico's repeated and persistent failures to provide water deliveries to Texas at the levels prescribed in the Rio Grande Compact (Welsh 1985:131–132). The Flood Control Act of 1948 had provided that the Middle Rio Grande Project works, including the eventual Abiquiu Dam, would be operated in conformity with the Rio Grande Compact (Clark 1987:388). This provision was pointed out to the state of Texas, and the Corps of Engineers proceeded to award the first construction contract for Abiquiu Dam in 1956 (Welsh 1985:133). By February 1963, construction was completed and water began to fill the reservoir (Welsh 1985:134). Even though the dam was for flood control purposes, local efforts began shortly to establish a permanent pool for recreation. Opposition for this endeavor came not only from the state of Texas but also from downstream Hispanic and Indian irrigators on the Chama. The efforts to establish a permanent pool behind Abiquiu Dam for recreation eventually overlapped other needs for storage capacity at Abiquiu Reservoir (Welsh 1985:134). In the late 1970s, the San Juan–Chama Project (which will be discussed below), which was storing its water at El Vado and Heron lakes, needed additional storage. In 1982, Congress authorized the storage of San Juan–Chama water at Abiquiu Reservoir and in the mid 1980s, the Corps of Engineers expanded the reservoir pool to accommodate the San Juan–Chama water (Welsh 1985:136).

The San Juan–Chama project was an ambitious program to alleviate the persistent water shortages in the Rio Grande Valley by means of a transbasin diversion from the San Juan drainage in the upper Colorado River valley to Heron Lake in the Chama drainage of the upper Rio Grande valley (San Juan–Chama Project 1963). The San Juan–Chama Project was connected to the Navajo Indian Irrigation Project on the San Juan River near Farmington, which was intended to irrigate thousands of acres of land on the Navajo Indian Reservation (Clark 1987:509). The San Juan–Chama Project would provide 110,000 acre-feet of water per year to the Rio Grande Valley: 57,000 acre-feet to Albuquerque; 23,000 acre-feet to supplement the water supply for the Middle Rio Grande Conservancy District; and the remaining 30,000 acre-feet to four districts on tributaries of the Upper Rio Grande (San Juan–Chama Project 1963; Clark 1987:509).

The four districts on the upper Rio Grande were designated the Cerro, Llano, Taos, and Pojoaque units. In these economically depressed areas of northern New Mexico, irrigation agriculture was the principal source of income; consequently a supplemental supply of water to cover the water deficits of the late summer growing season was extremely important to the economic health of the four areas (Clark 1987:509–510). The water from the San Juan–Chama Project was intended to provide this supplemental source of water. The defense facilities at Albuquerque and Los Alamos would also benefit from the increased water supplies that the project would make available either directly or indirectly (Clark 1987:510). When Senators Anderson and Chavez introduced the bill in Congress in 1958 to fund the San Juan–Chama Project, the Elephant Butte Irrigation District and the state of Texas opposed the project (Clark 1987:510). They were fearful of upstream diversions of water in times of drought; traditionally upstream users had satisfied their own needs rather than release water downstream to users below Elephant Butte Reservoir. Both the district and the Texans believed that they had suffered during the drought of the early 1950s because of excessive and illegal diversions by the Middle Rio Grande Conservancy District. Neither party saw the added waters from the

proposed San Juan–Chama Project as solving this fundamental problem. Rather they saw the additional waters as merely providing greater opportunities for upstream users to abuse their geographical advantage (Clark 1987:510). They were particularly concerned since the directors of the Middle Rio Grande Conservancy District had declared that they would take care of local users in times of drought, a statement which was not designed to reassure either the Texans or the Elephant Butte Irrigation District (Clark 1987:510). The support of both Texas and the district was needed for passage of the proposed legislation. Both wanted guarantees that the San Juan–Chama Project would be operated in strict conformity with the terms of the Rio Grande Compact and that the state of New Mexico would assume responsibility for limiting use of water by the four project units in the upper Rio Grande to the amounts imported through the project. The Senate complied with these wishes so that Texas accepted the project but the Elephant Butte Irrigation District resisted the authorization of the project until the very end (Clark 1987:511). The Congressional authorization of the project was passed in 1962, some four years after it was initially introduced.

At the same time that the Elephant Butte Irrigation District and the state of Texas were opposing the San Juan–Chama Project, there was some resistance as well from all four of the project units on tributaries of the Rio Grande, particularly from the Cerro unit located on the uplands north of Questa (Clark 1987:510). Hispanic landowners of the Cerro unit were suspicious of the plans to retire submarginal agricultural lands within the unit and to replace them with the development of better agricultural lands. The landowners feared that they would be forced to move or that they would lose their water rights. These fears were justified by previous experience of small farmers in New Mexico. Senator Montoya sought to address these concerns and to reassure the small farmers.

Construction on the San Juan–Chama Project began in 1964 and was completed in 1971 (San Juan–Chama Project 1964–1971). In November 1971 water flowed for the first time from the San Juan drainage into the Rio Grande Basin at Heron Lake. Of the four project units that were to receive supplemental water supplies, two of the units, Cerro and Valdez (Taos), were not built because further review of these portions of the project found them to be unfeasible. Local opposition to the Llano unit at Española and to Indian Camp Dam on the Taos unit meant that the Llano and Taos units were not built. Of the four irrigation units on tributaries of the Upper Rio Grande, only the Pojoaque unit was built (Clark 1987:514). In 1970, the local farmers in the Pojoaque Basin formed the Pojoaque Valley Irrigation District. Construction of the water storage dam at Nambe Falls was begun in 1974 and completed in 1976 when the project unit was placed in operation (Clark 1987:514).

As for the Middle Rio Grande Conservancy District, which was one of the major beneficiaries of the San Juan–Chama Project, its need for and use of San Juan–Chama water has varied from year to year (DuMars and Nunn 1993:29). In years of high runoff in the Rio Grande Basin, the entire annual allocation of nearly 21,000 acre-feet of water is stored at El Vado Reservoir for use during times of shortage (Clark 1987:515). In years of low runoff, the district has used its entire San Juan–Chama allocation and has, in addition, contracted with the city of Albuquerque for the purchase of additional water from the city's allocation.

The statutory protections in the enabling legislation for the San Juan–Chama Project have not ended the controversies over the enforcement of the Rio Grande Compact. Beginning in the 1950s, the Bureau of Reclamation and the Corps of Engineers took a variety of measures to address deteriorating conditions in the Middle Rio Grande Valley by the rehabilitation of Middle Rio Grande Conservancy District facilities, flood control, control of phreatophytes, and dredging of a low-flow channel into Elephant Butte Reservoir (DuMars and Nunn 1993:22–26; Berry and Lewis 1996:33). Colorado, Texas, and southern New Mexico were sympathetic to these problems but they all objected to the size of the three reservoirs planned for the Middle Rio Grande Project, especially since these reservoirs were allegedly for flood control and silt retention (Clark 1987:531–532).

After the completion of Abiquiu Dam in 1963, the second stage of the Middle Rio Grande Project was concluded (the first stage had been the construction of Jemez Canyon Dam). The two remaining projects of the Middle Rio Grande Project were Cochiti Dam and Galisteo Dam, which were intended for the flood protection of Albuquerque and the Middle Valley (Middle Rio Grande Project 1963; Welsh 1985:137). The Pueblos of Cochiti and Santo Domingo were opposed to the projects because the two dams would be built on, and have adverse impacts on, their lands. Santo Domingo Pueblo was opposed to Galisteo Dam, and Cochiti Pueblo was opposed to Cochiti Dam because the project would take a total of 3500 acres of the pueblo's land for the dam site and would result in the innundation of a significant amount of its farmlands along the Rio Grande (Welsh 1985:142, 159). This latter impact would directly affect Cochiti Pueblo's agricultural activities. The Corps of Engineers declared that the dams were needed for flood control and silt

retention because the levees in the Albuquerque area were not adequate to prevent floods (Clark 1987:415). Further, the Bureau of Reclamation needed the reservoir capacity behind Cochiti Dam for the storage of water from the San Juan–Chama Project for the city of Albuquerque; therefore, the BOR pushed for a permanent pool at Cochiti to hold this water for Albuquerque (Welsh 1985:146). In 1960, Congress authorized the construction of Galisteo Dam; however, the dam was not completed until 1970 (Clark 1987:415–416). When Congress authorized the San Juan–Chama Project in 1964, they included permission for the Bureau of Reclamation to store Albuquerque's 57,000 acre-feet of water behind Cochiti Dam (Welsh 1985:151–152). In 1967, construction began on Cochiti Dam and the project was completed in 1974 (Welsh 1985:153, 159).

With the completion of the Bureau of Reclamation and Corps of Engineers projects in the middle and upper Rio Grande Valley, the Middle Rio Grande Project was completed. Meanwhile the BOR's rehabilitation of the Middle Rio Grande Conservancy District's irrigation and drainage facilities and the improvements to the river channel into Elephant Butte Reservoir led to the salvaging of large amounts of water and facilitated the delivery of water downstream to the reservoir for users in southern New Mexico, Texas, and the Republic of Mexico (Clark 1987:536). By 1972, New Mexico had retired the water delivery debt which it had incurred in the 1940s, 1950s, and early 1960s and even had a small water credit under the terms of the Rio Grande Compact (Clark 1987:536).

The activities of the Corps of Engineers in the Rio Grande Valley expanded in the 1960s when the Flood Control Act of 1958 authorized the construction of a levee project to protect Socorro; this was completed in 1964 (Clark 1987:416). In 1975, the Corps completed the construction of levees at Las Cruces and in the mid 1990s plans were underway for the construction by the Corps of Engineers of a new levee system in the Middle Valley to improve flood protection for the Albuquerque area (Clark 1987:416; Berry and Lewis 1996:33–34). In the meantime, the availability of an inexpensive and reliable water supply from the Rio Grande and other sources sustained farming in the middle Rio Grande (DuMars and Nunn 1993:29). Much of the farming involved the production of forage crops (hay), which consume large amounts of water in a semi-arid environment (DuMars and Nunn 1993:29). Most farmers were not involved in production for profit but basically as a semi-recreational activity that met the minimum requirements of state water law to retain water rights whose monetary value was increasing yearly. The escalation in the value of water rights was due to the competition of municipalities for water. Urban and industrial users put pressure on farmers and the Middle Rio Grande Conservancy District to release water for "higher valued" economic uses (DuMars and Nunn 1993:30). The economic value of crops in the Middle Rio Grande Valley was relatively small, especially when compared with the rest of the regional economy (DuMars and Nunn 1993:31). Most agriculture in the Middle Valley can be described as recreational farming on small and uneconomic farming units, particularly in the greater Albuquerque area. Traditional farming continues in large part because of the availability of cheap irrigation water and because of the services that the Middle Rio Grande Conservancy District provides to farmers at nominal cost.

Because the problems associated with the operations of irrigation systems in the Rio Grande Valley were not confined to the large conservancy and irrigation districts but also affected the smaller ditch associations, the Water Resources Development Act of 1986 authorized the Corps of Engineers to restore and rehabilitate acequia systems in New Mexico (U.S. Army Corps of Engineers 1987:3). The community ditches and acequia systems throughout New Mexico suffered from deterioration of facilities and lack of adequate financial resources to rehabilitate the systems. The 1986 Act covered the rehabilitation of these irrigation systems without regard to the economic analysis that is customarily associated with water development projects. The community ditches and acequias were to be restored for their cultural and historical value to the region. Congress had found these irrigation systems to have been significant in the settlement and development of the West. The Corps of Engineers has developed a priority list based on a determination of the acequia systems with the greatest needs for rehabilitation (U.S. Army Corps of Engineers 1987:5). Of the estimated 1000 acequia systems and community ditches in New Mexico, the majority are located in north-central New Mexico.

Historically the most important problem has been the inability of these particular ditches to provide an adequate supply of water. This situation has been due to structural deficiencies of the diversion dams, inadequate main delivery systems, inefficient water application facilities, and the size of landholdings, which are small, inefficient units that are difficult to irrigate (U.S. Army Corps of Engineers 1987:16). The latter problem is the result of historical inheritance patterns in northern New Mexico which has produced the repeated division of agricultural properties among the heirs of each generation into smaller and smaller pieces of property. The most serious problem of most of these acequia systems is the inadequate stream flow in the peak summer irrigation season; however, this problem was not addressed by the Water

Resources Development Act. The only means to alleviate this situation would be the costly construction of water storage facilities on dozens of small streams.

The rehabilitation of the community ditch systems was to be undertaken as a cost-sharing endeavor. The federal government was to cover 65% of the cost and the communities 35%; the latter funds came not from the communities themselves but from funds provided by the state of New Mexico. This project began in 1987. By the mid 1990s the Corps of Engineers had rehabilitated the facilities on 35 community ditches and acequia systems on the Rio Grande and Pecos in northern New Mexico and also the La Joya Community Ditch in the Middle Rio Grande Valley between Belen and Socorro (Ron Kneebone, U.S. Army Corps of Engineers, Albuquerque District, personal communication 1997).

Chapter 11

CONCLUSIONS

Since 1598, irrigation has been central to the character of New Mexico. Because of economic and political necessities, the life of New Mexicans was tied to irrigation agriculture and the maintenance of irrigation systems throughout the Spanish and Mexican periods. The vital interconnection of irrigation agriculture with the economy of the Rio Grande Valley persisted until the middle of the twentieth century. Subsistence agriculture based on irrigation farming and stock-raising was at the heart of New Mexican society and economy throughout nearly the whole of the period from 1598 to 1945.

Before the arrival of the Spaniards, the Pueblo Indians had a mixed economy that was based upon floodwater farming, hunting, and gathering. In that subsistence system, irrigation agriculture played a minor role: some Puebloan groups had irrigation and others did not need it. The arrival of the Spaniards changed the lives of the Puebloans, inexorably and irretrievably altering Puebloan society. With the missions and the encomiendas came the unavoidable necessity of adopting irrigation agriculture as the principal component of Puebloan subsistence. This resulted in the abandonment during the seventeenth century of what had been the traditional Puebloan economy. The pressure created by these and other changes caused the Pueblo Indians to rebel against Spanish rule in 1680. Although they maintained an independent existence for more than a dozen years, the Puebloans did not revert to their pre-Hispanic economic systems but rather continued the system that had been imposed upon them.

When Governor Vargas ultimately forced the Puebloans to accept Spanish rule, he did not reintroduce the encomiendas; individuals and communities were given grants of land with the understanding that they would sustain themselves rather than being permitted to exploit Indian labor. Under this new regime, the survival of New Mexico was tied to the establishment of self-sufficient agrarian communities whose livelihood depended upon irrigation agriculture and stock-raising. Consequently one can trace the development of irrigation systems in the Rio Grande Valley by studying the progressive expansion of land grants in the eighteenth and first half of the nineteenth centuries. Because agriculture required irrigation and land grant communities depended upon subsistence agriculture, irrigation systems shaped the development and character of New Mexican society in the Rio Grande Valley during the eighteenth, nineteenth, and early twentieth centuries.

The arrival of the Anglo-Americans did not noticeably alter the relationship between New Mexicans and irrigation. At first the Americans found their greatest economic opportunities in the livestock industry, which touched the Rio Grande Valley economy but was not part of it. Irrigation systems expanded in response to continued population growth but were not directly affected by the Anglo-American presence until the early twentieth century.

Beginning in the 1910s and 1920s, federally controlled or influenced reclamation projects were undertaken, first in the Mesilla and Rincon valleys with the Rio Grande Project and the construction of Elephant Butte Dam, and second in the middle Rio Grande Valley with the establishment of the Middle Rio Grande Conservancy District. In the first instance the project was initiated by the newly founded U.S. Reclamation Service. In the second case, the endeavors were the result of local, in-state initiatives; studies and surveys by the U.S. Bureau of Reclamation played a primary role in the delineation of the problems and the proposed solutions.

The arrival of modern irrigation technology not only meant a reorganization of the irrigation systems, a renovation of the facilities, and a rationalization of the structure of irrigation but also an infusion of outside influences and a tremendous escalation in the costs of irrigation. Much of the latter impact was absorbed by the largesse of the federal government, which wrote off or massively subsidized the costs of irrigation agriculture in the Rio Grande Valley as it did in the rest of the arid American West. The changes in the character of irrigation agriculture in the middle and lower Rio Grande Valley of New Mexico included (a) the appearance of modern surveyed ditch alignments to replace the old meandering systems; (b) the construction of a small number of concrete diversion structures to replace the multitudes of primitive head works; (c) construction of large water storage structures to provide a virtually guaranteed source of

water during the irrigation season; and (d) the institution of operation and maintenance methods using heavy machinery to replace hand-held shovels. Many of the old problems of flooding, sedimentation, waterlogging, alkali poisoning, and unreliable water supply were resolved or at least held in check, but they were replaced by new problems related particularly to finances, especially maintenance costs and reimbursement of construction costs. The new problems have proved to be much more intractable than the old ones.

Reclamation projects in the arid American West have come under considerable criticism in recent years. Worster (1985) and Reisner (1986), for example, have raised important questions regarding the rationale for and operation of federal and local reclamation projects. While many federal reclamation projects have received well-earned opprobrium, the projects carried out in the Rio Grande Valley of New Mexico have been the objects of minimal criticism. The reasons seem to be that these projects were well conceived and relatively inexpensive, did not drown any significant acreages of irrigable land, reclaimed tens of thousands of acres of arable land ruined by traditional irrigation practices, and brought into cultivation tens of thousands of additional acres of irrigable land; in addition, the most significant portions of the costs of water and flood control projects have been absorbed by the federal government. In other words, the Rio Grande Valley reclamation projects fulfilled the promise that John Wesley Powell and Representative Newlands had held before the nation: they reclaimed many thousands of acres of arid western land.

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A useful study of rural economic development in the Upper Rio Grande from the 16th to the 20th century. The chapter is, however, general in its treatment of subsistence and economic patterns due to a paucity of specific data for the Cochiti Reservoir area itself. Additional information could have been obtained from the records of the proceedings of the U.S. Surveyor General and the Pueblo Lands Board.

Abert, J.W.

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A contemporary report of conditions in mid–19th century New Mexico which provides some good, general information. Because Lt. Abert visited the Rio Grande Valley in late October and early to mid–November, the data which he includes on irrigation and agriculture is limited in extent.

Ackerman, Edward A. and George O. G. Löf

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Adams, Eleanor B. (ed.)

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Limited but important information on 18th century irrigation agriculture, especially on water supplies at Tomé, Santa Fe, Galisteo, Nambe, and Taos.

Adams, Eleanor B. and Fray Angelico Chavez (eds. and transls.)

1956 *The Missions of New Mexico, 1776: A Description by Fray Francisco Atanasio Dominguez.* The University of New Mexico Press, Albuquerque.

The best discussion of irrigation agriculture and irrigation systems during the Spanish colonial regime in New Mexico. The report includes other valuable information on economic conditions in late 18th century New Mexico. The discussion is broken down into the administrative divisions of the civil and ecclesiastical governments. The irrigation system of each settlement is succinctly presented in the excellent elucidation of the agricultural system of colonial New Mexico. The depth of detail in this report is not duplicated until over 100 years later in the Follett report of 1896.

Anderson, Terry L. (ed.)

1983 *Water Rights: Scarce Resource Allocation, Bureaucracy and the Environment.* Pacific Institute for Public Policy Research. San Francisco.

A collection of studies on one of the fundamental questions associated with irrigation agriculture in the desert Southwest.

Anschuetz, Kurt F.
1984 *Prehistoric Change in Tijeras Canyon, New Mexico.* Unpublished M.A. Thesis, Department of Anthropology, University of New Mexico, Albuquerque.

A much broader regional study of the Northern Rio Grande Valley than the title implies. This thesis summarizes the archaeological and interpretive data on prehistoric ditch irrigation systems in the upper Rio Grande Valley of New Mexico. The paucity of historical and archaeological information serves to indicate that such systems were probably not widespread before the Hispanic colonization of New Mexico.

Antonio Balbas (publisher)
1756 *Recopilacion de Leyes de los Reynos de las Indias*, 4 vols (2nd ed.). Antonio Balbas, Madrid.

The essential compilation of Spanish law related to the New World. Books 4 and 6 are particularly important for any understanding of water allocation and irrigation systems in New Spain of which New Mexico was a northern appendage.

Athearn, Frederic James
1974 *Life and Society in Eighteenth Century New Mexico, 1692–1776.* Unpublished Ph.D. Dissertation, University of Texas, Austin.

A relatively long but somewhat disappointing study of 18th century New Mexico. The most useful sections are those that discuss the demographic data for New Mexico, including the censuses of 1745, 1749, and 1752. The author also provides some information on irrigation in his discussion of lawsuits and judicial procedures, especially the 1732 disputes on ditches and ditch easements in the Albuquerque area.

Baker, F.C.
1898 *Irrigation in the Mesilla Valley, New Mexico.* U.S. Geological Service, Water Supply Paper No. 10. Government Printing Office, Washington, D.C.

A contemporary description of conditions in the Mesilla Valley by a local resident. The discussion is based upon conversation with irrigation farmers and personal observations. The paper provides a good discussion of local community ditch organization and distribution of water. The author also presents a critique of native New Mexican irrigation and agricultural techniques.

Baker, T. Lindsey, Steven R. Roe, Joseph E. Minor, and Seymour V. Connor
1978 *Water for the Southwest: Historical Survey and Guide to Historic Sites.* American Society of Civil Engineers Historical Publication No. 3. New York.

A discussion of historic water control and water distribution facilities in the desert Southwest. The section on New Mexico is based upon the inventory of historic water control and distribution facilities which was made by the History of Engineering Program at Texas Tech University in the late 1970s. Of relevance to the present study, the work provides brief discussions of the Taos Pueblo Ditches, the Canoas of Las Trampas, the Acequia Madre de Santa Fe, Santa Fe Water Works Reservoir, Elephant Butte Dam and the Embudo Stream Gaging Station.

Balch, W.J. and J.W. Clark
1978 *Pueblo Water Rights on the Upper Rio Grande.* New Mexico Water Resources Research Institute, Technical Report No. 98. New Mexico State University, Las Cruces.

Essentially a hydrological study that focuses on Tesuque Pueblo in the Pojoaque Basin. The authors provide a brief history of Puebloan water use in the Spanish, Mexican and American periods.

Bandelier, Adolph F.

1892 *Final Report of Investigations among the Indians of the Southwestern United States Carried Out Mainly in the Years from 1880 to 1885*, Parts I and II. Paper of the Archaeological Institute of America, Cambridge, Massachusetts.

The first scientific study of the archaeology of the desert Southwest. The first volume contains a discussion of ethnographic conditions in New Mexico, Arizona, Sonora, and Chihuahua in the 16th century as well as the contemporary condition of Indian groups such as the Pueblos of New Mexico. The focus of the second volume is on the antiquities of each Puebloan group in the Rio Grande Valley. The author noted the rarity of irrigation facilities in the archaeological record.

Baxter, John O.

1984 *Spanish Irrigation in the Pojoaque and Tesuque Valleys during the Eighteenth and Early Nineteenth Centuries*. Office of the State Engineer, Santa Fe.

A study of Hispanic irrigation in a small tributary drainage basin to the north of Santa Fe. The work was prepared in support of the continuing litigation of the case of the *State of New Mexico vs. R. Lee Aamodt et al.* and attempts to establish the earliest date for non-Indian irrigation agriculture along the numerous ditches within the boundaries of the Pueblos of San Ildefonso, Pojoaque, Nambe, and Tesuque. The study is based upon primary sources in the State Archives and the Santa Fe County Records.

Beers, Henry P.

1979 *Spanish and Mexican Records of the American Southwest*. University of Arizona Press, Tucson.

An essential reference work for the study of New Mexico in the Spanish and Mexican periods. The work provides a useful introduction to the various documentary sources and their locations. The volume is thus a good bibliographic guide to archive and manuscript sources which is conveniently organized in terms of the principal groups of records.

Belen Ditch

1912–1963 Records of La Acequia de Nuestra Señora de Belen. Rio Grande Historical Collection No. 57. Branson Library, New Mexico State University, Las Cruces.

A collection of the miscellaneous records of one of the community ditches at Belen in the Middle Rio Grande Valley. Though hardly a complete records, the files are nonetheless of great importance due to the infrequency with which such records have been preserved and become available for historic research. The collection consists of the records of meetings of the ditch commissioners, the ledgers of maintenance work on the ditch and the days of irrigation, and other miscellaneous records and correspondence.

Berman, Mary Jane

1979 *Cultural Resources Overview: Socorro Area, New Mexico*. Bureau of Land Management and USDA Forest Service, Albuquerque. Government Printing Office, Washington, D.C.

Though intended as a study of the entire Socorro Resource Area, the work actually focuses on the region to the west of the Rio Grande Valley with only cursory attention to the archaeological record of the valley itself.

Biella, Jan V. and Richard C. Chapman

1977 Survey of Cochiti Reservoir: Presentation of Data. In *A Survey of Regional Variability*, edited by Richard C. Chapman and Jan V. Biella, pp. 201–294. Archeological Investigations in Cochiti Reservoir, Vol. 1. Office of Contract Archeology, University of New Mexico, Albuquerque.

The results of a major archaeological excavation program in the northern portion of the Middle Rio Grande Valley. The data adds considerably to our understanding of prehistoric and historic subsistence systems in the Middle Rio Grande Valley that is particularly important for settlement patterns and agricultural development.

Black, R.F.

1930 Improvement of the Rio Grande in Socorro County, New Mexico during 1929–1930. Office of the State Engineer, Santa Fe. Ms. on file, Bureau of Reclamation, Regional Office, Amarillo.

A report on flood control activities along the Rio Grande from San Acacia to Elephant Butte Reservoir in response to the floods of August–September 1929. The author also reviews flood and drainage problems, their effects on irrigation ditches, and discusses necessary repairs and changes of alignments caused by the floods.

Blaney, Harry F. and Eldon G. Hanson

1956 Consumptive Use and Water Requirements in New Mexico. New Mexico State Engineer's Office, Technical Report 32, Santa Fe.

A statistical study of the consumptive use and water requirements of irrigated crops and native vegetation which focuses on the eastern plains and the Rio Grande Valley. This is a revision and update of an earlier study (1950) by the same authors.

Bloom, Maude M.

1903 *A History of the Mesilla Valley*. Unpublished M.A. Thesis, New Mexico State University, Las Cruces.

A narrative account of development in the Mesilla Valley from Spanish colonization in the late Mexican period to the end of the American Civil War. Though the work is indifferently documented, it appears to be based on original sources, some of which are quoted in the text.

Bowden, J.J.

1969 *Private Land Claims in the Southwest*, 6 Vols. Ll.M. Thesis, Southern Methodist University, Dallas.

A major study of the establishment of land claims under Spain and Mexico and their disposition under the American regime by the U.S. Surveyor General and the Court of Private Land Claims. The study, which is thorough and exhaustive, is based on original sources. The work is fundamental for an understanding of the interrelationship between land ownership and legal structures. The work also provides useful and extensive information on irrigation agriculture as associated with private and community land grants.

1971 *Spanish and Mexican Grants in the Chihuahuan Acquisition*. Texas Western Press, University of Texas at El Paso.

A thorough monograph on the land grants of the Mesilla and El Paso Valleys which was drawn from the research of the author's earlier multi-volume study (1969). The author traces the history of each grant from its inception to its final disposition by the Surveyor General or the Court of Private Land Claims. Much useful information on irrigation systems is included because of the close ties between irrigation agriculture and the success or failure of land grants in the Spanish and Mexican periods.

Brook, H.H.

1922 International Aspects of the Rio Grande Project. Ms. on file in the records of the Elephant Butte Irrigation District at the Rio Grande Historical Collection, New Mexico State University, Las Cruces.

A good chronological account of irrigation developments in the Rio Grande Valley and the impact of international relations between the United States and the Republic of Mexico over the equitable distribution of the waters of the Rio Grande. The report covers the period from the 1880s to 1906.

Brown, John P.

1974 Stream Channelization: The Economics of the Controversy. *Natural Resources Journal* 14:556–576.

A study of the benefits, losses, and problems associated with channel modification as a means of stream and flood control. The author focuses on the economics of the activities of the Soil Conservation Service and the Corps of Engineers. The effects on agriculture and irrigation systems of increased stream velocities, which are a primary consequence of stream channelization, are a useful part of this article.

Buge, David E.

1984 Prehistoric Subsistence Strategies in the Ojo Caliente Valley, New Mexico. In *Prehistoric Agricultural Strategies in the Southwest*, edited by Suzanne K. Fish and Paul R. Fish, pp. 27–34. Anthropological Research Papers No. 33. Arizona State University, Tucson.

A brief discussion of several large, late prehistoric Puebloan sites in northern New Mexico and their associated farm fields. The author provides a good analysis for the presence and absence of certain agricultural strategies including irrigation farming.

Burkholder, Joseph L.

1928 *Report of the Chief Engineer: A Plan of Flood Control, Drainage and Irrigation of the Middle Rio Grande Conservancy District.* Middle Rio Grande Conservancy District, Albuquerque.

A discussion of problems, needs and remedies which relies on Follett (1896) for historical data with narrative summaries of the technical data on flooding and siltation. While this report is useful, other contemporary documents provide fuller discussions.

Calkins, Hugh G.

1935a *Proposal for the Santa Cruz Area.* USDA Soil Conservation Service Region 8, Regional Bulletin No. 28. Conservation Economics Series No. 1. Albuquerque.

A detailed study of the subsistence economy of the Santa Cruz area. The report itself was the result of a more general assessment in the larger Tewa Basin study. The failures of previous rural rehabilitation programs in the Santa Cruz area are analyzed and proposals are made to improve the irrigation system upon which the economy of the area depended.

1935b *Rural Rehabilitation in New Mexico.* USDA Soil Conservation Service Region 8, Regional Bulletin No. 50. Conservation Economics Series No. 23. Albuquerque.

A study of several areas in New Mexico including the Santa Cruz valley near Española. The author analyzes the long term and immediate economic difficulties of the local inhabitants and suggests improvements in the agricultural system.

1937a *Inventory of Materials on the Rio Grande Watershed (An Evaluation of Surveys and Reports).* USDA Soil Conservation Service Region 8, Regional Bulletin No. 34. Conservation Economics Series No. 2. Albuquerque.

An evaluation of the surveys and reports for the Human Dependency Surveys in the northern Rio Grande Valley of New Mexico. The limitations of those studies in terms of the quantity and quality of the data that was collected are discussed; at the same time, the ancillary studies of the Section of Conservation Economics are also evaluated.

1937b *Notes on Community-Owned Land Grants in New Mexico.* USDA Soil Conservation Service Region 8, Regional Bulletin No. 48. Conservation Economics Series No. 22. Ms. on file, Soil Conservation Service, Albuquerque.

A report on the community holdings of four land grants in northern New Mexico including the Jacona grant in the Pojoaque Basin. The analysis focuses on the utilization and significance of community-held resources, which included the irrigation ditches.

1937c *The Santa Cruz Irrigation District, New Mexico.* USDA Soil Conservation Service Region 8, Regional Bulletin No. 45. Conservation Economics Series No. 18. Albuquerque.

An in-depth analysis of the Santa Cruz Irrigation District which is located on a permanent tributary of the Rio Grande in the area to the east of Española. The study includes a comprehensive discussion of the development of the district and its inherent difficulties. This is one of several SCS studies of the Santa Cruz area.

1937d *Destruction of the Villages at San Marcial.* USDA Soil Conservation Service Region 8, Regional Bulletin No. 38. Conservation Economics Series No. 11. Albuquerque.

An excellent and extremely useful discussion of the settlement, development, and decline of villages of the San Marcial district, which lies at the northern end of Elephant Butte Reservoir. The numerous radical changes in the economies of the villages illustrate the impact of the outside world on what were originally subsistence agricultural and livestock raising communities. The decline of irrigation agriculture preceded the floods of 1929 and 1937 which effectively put an end to these villages. The report also has a very good discussion of the four major ditches and their facilities.

1937e *Village Livelihood in the Upper Rio Grande Area.* USDA Soil Conservation Service Region 8, Regional Bulletin No. 44. Conservation Economics Series No. 17. Albuquerque.

A discussion of the transformation of self-sufficient village communities in the period after 1880 with the arrival of the railroads and the rise of market-oriented farming and livestock raising. Owing to limited resources, the economic situation was already critical in these villages before the Great Depression.

1938a *The Southwest Region: Annual Report, Fiscal Year 1937–1938.* USDA Soil Conservation Service Region 8. Albuquerque.

A report on the progress of the Rio Grande Watershed Survey and the Human Dependency Surveys. Most of the focus of the report is on dryland farming and rangelands.

1938b *Survey Report: Trujillo Arroyo Watershed.* USDA Soil Conservation Service Region 8. Albuquerque.

A study of the effects of flooding and siltation from an ephemeral tributary of the Rio Grande below the Percha Diversion Dam upon irrigation systems and irrigation agriculture along the main stem of the Rio Grande.

1939 *The Southwest Region: Annual Report, Fiscal Year 1938–1939.* USDA Soil Conservation Service Region 8. Albuquerque.

A discussion of the grazing land studies and erosion control activities of the Soil Conservation Service in 1938–1939.

1940 *The Southwest Region: Annual Report, Fiscal Year 1939–1940.* USDA Soil Conservation Service Region 8. Albuquerque.

Though the emphasis is upon range land studies and erosion control, new legislation (the Water Facilities Act) meant greater SCS involvement with irrigation farming communities.

1941 *The Southwest Region: Annual Report, Fiscal Year 1940–1941.* USDA Soil Conservation Service Region 8. Albuquerque.

A discussion of the Soil Conservation Service's work on irrigated lands in addition to range lands. The report also discusses the rising controversy between soil conservation and irrigation districts over the presumed conflict of water supply facilities with erosion control measures.

1942 *The Southwest Region: Annual Report, Fiscal Year 1941–1942.* USDA Soil Conservation Service Region 8. Albuquerque.

With the outbreak of World War II, the annual reports became more propagandistic with an emphasis on public relations to support the war effort rather than on specific accomplishments of the Soil Conservation Service.

Campa, Arthur L.

1979 *Hispanic Culture in the Southwest.* University of Oklahoma Press, Norman.

A study which focuses on cultural traditions and developments in Hispanic New Mexico from the 17th century to the 20th century. The discussion of the economy of 17th century New Mexico is particularly useful.

Carlson, Alvar R.

1971 *The Rio Arriba: A Geographical Appraisal of the Spanish-American Homeland (Upper Rio Grande Valley, New Mexico).* Unpublished Ph.D. dissertation, University of Minnesota, Minneapolis.

A valuable discussion of the relationship of agricultural technology and methods with land ownership patterns in northern New Mexico from the 17th to the 20th century. The focus of the description and analysis is on the subsistence agrarian system which was based upon irrigation agriculture in small, land grant communities. The pivotal place of irrigated farm lands in the traditional economy of the region is discussed as are the transformations which occurred in the 20th century. The descriptive portions of the book examine four communities: Corrales, Vadito, El Rancho, and Abiquiu, all of which are relevant to the present study of irrigation systems.

1975 Long-Lots in the Rio Arriba. *Annals of the Association of American Geographers* 65:48–57.

A good study of important aspects of Spanish agrarian planning and its role in the establishment of colonial New Mexican settlement patterns in the Rio Grande Valley. Long-lot farms were developed to cope with the semi-arid environment so that settlers were assured of maximum access to limited water resources for irrigation agriculture which was the economic mainstay of the province. The author defines not only the economic benefits but also the less positive economic consequences of this rural settlement system.

1979 El Rancho and Vadito: Spanish Settlements on Indian Lands. *El Palacio* 85:29–39.

Basically an extraction of materials from the descriptive portions of the author's large study *The Rio Arriba: A Geographical Appraisal of the Spanish-American Homeland* (1971). Some additional data make this a useful addition to the previous work.

Carter, R.H.

1953 *An Historical Study of Floods Prior to 1892 in the Rio Grande Watershed, New Mexico.* Unpublished M.A. Thesis, University of New Mexico, Albuquerque.

A study of floods in the Rio Grande Valley consisting primarily of extensive abstracts and quotes from contemporary sources. Because of the settlement and agricultural development of the floodplains of the Rio Grande and its tributaries, the significance of floods to the economy of the region increased with time.

Catron, Thomas B.

1868–1904 Papers related to Private Land Claims in New Mexico. Special Collections, Zimmerman Library, University of New Mexico, Albuquerque.

The papers of one of the most important as well as one of the most controversial lawyer/politicians of late 19th century New Mexico. Catron represented parties-at-interest in most of the land claims cases before the Court of Private Land Claims. The documents filed by petitioners before the Court of Private Land Claims and its predecessor the Office of the U.S. Surveyor General constitute the most important bodies of evidence on 18th and 19th century irrigation agriculture in New Mexico. A number of documents are found in the Catron Papers which are not in the public files of the lands claims cases.

Chapman, Richard C. Chapman and Jan V. Biella

1977–1979 *Archaeological Investigations in Cochiti Reservoir, New Mexico*, 4 Vols. Office of Contract Archeology, University of New Mexico, Albuquerque.

The results of a major excavation program in the northern portion of the Middle Rio Grande Valley. The project took a multi-disciplinary approach which produced a wealth of data, most of which is presented and synthesized in these volumes. The reports are individually and collectively very valuable for their contributions to our understanding of the prehistory and history of the region.

Chevalier, Francois

1970 *Land and Society in Colonial Mexico: The Great Hacienda.* University of California Press, Berkeley.

An analysis of the development of large landed estates in Colonial Mexico. The work is of particular value in that it sets developments in 17th century New Mexico within the context of the whole of northern New Spain.

Clark, J.W.

1978 The Upper Rio Grande. *Natural Resources Journal* 18:69–76.

A brief but useful overview of settlement and irrigation history in the Rio Grande Valley above El Paso.

Clark, Robert E.

1971 Water Rights Problems in the Upper Rio Grande Watershed and Adjoining Areas. *Natural Resources Journal* 11:48–68.

A study of the general land and resource problems of the Hispanic population in the Upper Rio Grande Valley of New Mexico essentially from a legal perspective. The focus of the research is on

water law and land grants in that economically depressed region. The author has broken the problems down into manageable segments for analysis.

Clark, Stanley C.

1939 *Annual Progress Report (1938): Cooperative Evaluation Surveys and Field Tests.* USDA Soil Conservation Service Region 8. Albuquerque.

A summary of the surveys and field tests of the Soil Conservation Service for 1938.

Conkling, Harold and Erdman Debler

1919 Water Supply for the Possible Development of Irrigated and Drainage Projects on the Rio Grande River above El Paso, Texas. Ms. on file, Bureau of Reclamation, District Office, Albuquerque.

A review of the background to and problems of irrigation agriculture and its future development in the Rio Grande Valley. The purpose of the report was to make suggestions to the U.S. Reclamation Service for facilities development to control siltation and to ensure a late season water supply for irrigation in the middle and lower valleys. The report also analyzes the specific problems of the middle and lower valleys with regard to water distribution and drainage.

Cooke, Ronald V. and Richard W. Reeves

1976 *Arroyos and Environmental Change in the American Southwest.* Clarendon Press, Oxford, England.

An important study of the causes and consequences of soil erosion and stream channel entrenchment along ephemeral streams in the desert Southwest. Both of these phenomena have had a major impact upon irrigation agriculture not only along the tributaries of the Rio Grande due to the direct loss of irrigable acreage but also along the main stem of the river due to siltation.

Cordell, Linda S.

1979 *Cultural Resources Overview: Middle Rio Grande Valley, New Mexico.* Bureau of Land Management and USDA Forest Service, Albuquerque. Government Printing Office, Washington D.C.

A useful summary of the sequence of cultures in the Rio Grande Valley of northern New Mexico with a discussion of the archaeological manifestations associated with them. The volume is best on the prehistorical period and rather superficial for historical developments. The discussion of subsistence systems is a strong point of the volume, however, the author allots too much space to the Chacoan system which is only peripherally related to developments in the prehistoric Rio Grande Valley.

1984a *Prehistory of the Southwest.* Academic Press, New York.

The latest synthesis on the subject. The book does a good job of summarizing the cultural sequences and their affiliated settlement and subsistence systems. The author provides a good summary of the evidence for water diversion and control systems in the Rio Grande Valley. The discussion of irrigation along the main stem of the river is much less naive than the earlier overview of the middle Rio Grande Valley above. A good bibliography further enhances the value of this volume.

1984b Subsistence Systems in the Mountainous Settings of the Rio Grande Valley. In *Prehistoric Agricultural Strategies in the Southwest*, edited by Suzanne K. Fish and Paul R. Fish, p. 233–241. Anthropological Research Papers No. 33. Arizona State University, Tempe.

An interesting discussion of the importance of dry farming to prehistoric Rio Grande cultures. The author notes that water conservation features are common throughout the Rio Grande Valley but irrigation systems, per se, are rare for the period before Hispanic colonization.

Court of Private Land Claims (New Mexico)
1891–1904 Records of Proceedings. New Mexico State Records and Archives Center, Santa Fe.

The records of the second effort by the federal government to resolve the complex and perplexing problem of private land claims in New Mexico. The case files contain the records of the proceedings in 282 private land claims; those files include a considerable body of documents and testimony that are relevant not only to the cases themselves but also to an understanding of land holding and subsistence systems in the 18th and 19th century Rio Grande Valley. Oral testimony is particularly useful for the light it sheds on irrigation systems associated with the land grants at issue in the claims cases.

Crouch, Dora P., Daniel J. Garr, and Axel I. Mundigo
1982 *Spanish City Planning in North America.* MIT Press, Cambridge, Massachusetts.

The volume includes an excellent description and analysis of the founding and development of Santa Fe. The author emphasizes the importance of irrigation and acequias in urban planning in colonial New Spain. The significance of agriculture in the colonial economic system caused a significant modification of the plaza plan at Santa Fe.

Debler, Erdman B.
1932 *Final Report on Middle Rio Grande Investigations.* USDI, Bureau of Reclamation. Ms. on file, Bureau of Reclamation, District Office, Albuquerque.

The culmination of a number of years' efforts to study the water problems of the Middle Rio Grande Valley in New Mexico. As a consequence of an inadequate water supply during the irrigation season, agriculture had been seriously truncated. The author emphasized the need for drainage, irrigation and river control facilities. The value of the work is enhanced by an abundance of tables and charts.

Debler, E.B. and C.C. Elder
1928 Preliminary Report on Investigations in the Middle Rio Grande Valley, New Mexico. Ms. on file, Middle Rio Grande Conservancy District Office, Albuquerque.

The initial report of the authors on the conditions of water control and distribution in the Middle Rio Grande Valley at the very beginnings of the initiation of the Middle Rio Grande Project.

de Buys, William
1985 *Enchantment and Exploitation: The Life and Hard Times of a New Mexico Mountain Range.* University of New Mexico Press, Albuquerque.

A well-written account of traditional life in the Hispanic villages of the Sangre de Cristo Mountains. The author discusses the mixed economy of these villages which consisted of stockraising and irrigation agriculture; all of the villages were communities that had their origins in the 18th or early 19th century land grants. The book also discusses transitions in village life due to economic changes caused by the villages' own overexploitation of natural resources and by outside influences.

Dortignac, E.J.
1956 *Watershed Resources and Problems of the Upper Rio Grande Basin.* USDA Forest Service, Rocky Mountains Forest and Range Experiment Station, Fort Collins, Colorado.

A reiteration of the obvious problems of the basin and the fact that the economy of the Upper Rio Grande had always been dependent on the availability, amount and quality of water supplies. The author noted the progressive development and complexity of irrigation systems throughout time from the Pueblo Indians to the Spaniards to federal projects.

Downing, Thomas E. and McGuire Gibson
1974 *Irrigation's Impact on Society.* University of Arizona, Anthropological Papers No. 25. Tucson.

A compilation of papers presented at the University of Arizona on the subject of irrigation and its impact on society. The focus of the volume is obviously on the desert Southwest with the greatest attention being given to irrigation systems in southern Arizona. The general lack of data on Rio Grande irrigation limited the discussion of that area.

Dozier, Edward P.
1970 *The Pueblo Indians of North America.* Holt, Rinehart and Winston, New York.

A standard discussion of the Pueblo Indians, most of whom reside in the Rio Grande Valley of New Mexico. The author is quite uncritical in his use of documentary sources for the early colonial period; as a consequence, he greatly exaggerates both the role and significance of irrigation agriculture to the pre-Hispanic Puebloan economy. His discussions of the Puebloan subsistence systems are much better of the later periods.

DuMars, Charles T., Marilyn O'Leary, and Albert E. Utton
1984 *Pueblo Indian Water Rights.* University of Arizona Press, Tucson.

An attempt by three New Mexican attorneys to interpret the historical and legal information on Pueblo Indian water rights and to propose a resolution of the complex confrontation of Indian and non-Indian water rights in the northern Rio Grande Valley. Most of the factual and analytical basis of their conclusions came from expert witness reports filed in the case of the *State of New Mexico vs. R. Lee Aamodt et al.* In the Pojoaque Basin of north-central New Mexico.

Dunbar, Robert G.
1983 *Forging New Rights in Western Water.* University of Nebraska Press, Lincoln.

A good discussion of federal and state government actions that led to the development of national reclamation projects and the delineation of water rights that became necessary with major irrigation development throughout the arid West. The author provides a particularly useful summary of conflicts among the states over the equitable distribution of the waters of the Rio Grande that led ultimately to the Rio Grande Compact of 1938.

Dunham, Harold H.
1974 Spanish and Mexican Land Policies in the Taos Pueblo Region. In *Pueblo Indians*, Vol. I, edited by David A. Horr, pp. 151–331. Garland, New York.

A good summary of historical developments in the Taos valley which focuses on land title questions and non-Indian encroachments within Indian lands. The report does provide some useful information on irrigation systems due to the linkage of land holdings with irrigation agriculture not only in the Taos region but throughout 18th and 19th century New Mexico.

Earls, Amy Clair
1985 *The Organization of Piro Pueblo Subsistence: AD 1300 to 1680.* Unpublished Ph.D. Dissertation, University of New Mexico, Albuquerque.

An excellent and well-reasoned study of a Puebloan province in the late prehistoric and early historic period. The author does a superb job of integrating historical and archaeological evidence and as a result she has produced probably the best and certainly the most exhaustive study of a Puebloan province during the period of transition caused by the arrival of the Spaniards in New Mexico. Dr. Earls has carefully delineated the mixed character of the Piro economy before the Spanish settlement of New Mexico in 1598. Subsequently through a careful use of historical documents and

archaeological records she has described the transformation of that economy under the impact of missionization in the first half of the 17th century. The study describes the causes and effects of the dramatic increase in Piro dependency on irrigation agriculture from the 1630s to the late 1670s. One would hope that the other Puebloan provinces will be studied as thoroughly and concisely.

Ebright, Malcolm

1979 Manual Martinez Ditch Dispute: A Study in Mexican Period Custom and Justice. *New Mexico Historical Review* 54:21–34.

A study of a ditch dispute near Abiquiu in 1832 which is based entirely upon original documents. The study provides some useful insights into the complexities of the operation of the small irrigation systems that were the mainstay of irrigation agriculture in 18th and 19th century northern New Mexico.

1980 *The Tierra Amarilla Grant: A History of Chicanery.* Center for Land Grant Studies Santa Fe.

A discussion of the community land grant in northern New Mexico under the laws of Mexico and the problems of landholdings and land grant validation under the United States. Some discussion of the attendant irrigation system is also included.

Elephant Butte Irrigation District

1913–1942 Correspondence. On file, Bureau of Reclamation, Regional Office, Amarillo.

Correspondence files between the Bureau of Reclamation, Rio Grande Project, and the Elephant Butte Irrigation District, mostly regarding construction and maintenance.

1918 Districts and Organizations. Ms. on file, Bureau of Reclamation, Regional Office, Amarillo.

Petitions by and correspondence of the Elephant Butte Irrigation District during a particularly active year.

1919–1945 Records of the Elephant Butte Irrigation District. Ms. on file, Rio Grande Historical Collection, New Mexico State University, Las Cruces.

The collection includes not only the records of the Elephant Butte Irrigation District but also those of its predecessor the Elephant Butte Water Users' Association (1904–1919). The records consist of correspondence, annual reports, constructive data, financial, and operational records. This collection of materials is invaluable for the study of irrigation in the Mesilla and Rincon valleys during the 20th century.

Elephant Butte Water Users' Association

1904–1913 Correspondence. On file, Bureau of Reclamation, Regional Office, Amarillo.

An extremely useful collection of data with regard to irrigation, canals, and water development in the Rincon and Mesilla valleys of New Mexico along the Rio Grande.

1908 Agricultural Opportunities in Connection with the Rio Grande Project. Las Cruces, New Mexico. Ms. on file, Rare Book Room, Branson Library, New Mexico State University, Las Cruces.

An interesting promotional pamphlet by the Elephant Butte Water Users' Association to encourage settlement of the Rincon and Mesilla valleys of southern New Mexico along the Rio Grande Valley.

Ellis, Florence Hawley

1970 *Irrigation and Water Works in the Rio Grande Valley.* Paper presented at the Water Control Systems Symposium, organized by J.C. Kelley. 58th Annual Pecos Conference, Santa Fe, New Mexico. Ms. on file, Laboratory of Anthropology, Museum of New Mexico, Santa Fe.

A very flawed discussion of prehistoric irrigation in the Rio Grande Valley. With little scientific data, the author alleges that prehistoric irrigation ditches were common along the Middle Rio Grande Valley in New Mexico, and that the Spaniards found irrigation to be widespread and flourishing in the valley.

1979 Summaries of the History of Water Use and the Tewa Culture of the Pojoaque Valley Pueblos. Ms. on file, Laboratory of Anthropology, Museum of New Mexico, Santa Fe.

Studies of irrigation, irrigation systems and irrigation facilities which were prepared in support of the Pueblo Indian claims in the case of the *State of New Mexico vs. R. Lee Aamodt et al.* The conclusions are much too sweeping and based upon limited and questionable data. Much of the data is extremely tenuous archaeological evidence and largely unsubstantiated hearsay and second-hand information from local informants.

Elmendorf, Harold B.

1940 *Water Facilities Area Plan for the Rio Santa Cruz Watershed, New Mexico.* USDA Bureau of Agricultural Economics, Water Utilization Section, Division of Land Economics. Washington, D.C.

A proposal to alleviate the economic plight of small subsistence farmers which is based upon an assessment of the problems of water control, storage, distribution, and management. This is another study of the New Deal era of this well-examined region in northern New Mexico along a tributary of the upper Rio Grande. On the basis of a thorough analytical discussion of the individual ditches in the Santa Cruz Valley, the author urges the rehabilitation of existing irrigation facilities as a step toward a solution of the area's depressed economic conditions.

Emory, W.H.

1848 *Notes of a Military Reconnaissance.* 30th Congress, 1st Session, House Executive Document 41, pp. 1–134. Government Printing Office, Washington, D.C.

A companion report to that of Lt. Abert. The observations of local conditions in the Rio Grande Valley are valuable for the areas around Tomé and Valverde with regard to irrigation systems.

Fish, Suzanne K. and Paul R. Fish (eds.)

1984 *Prehistoric Agricultural Strategies in the Southwest.* Anthropological Research Papers No. 33. Arizona State University, Tempe.

A compilation of papers which includes several discussions of irrigation agriculture which are useful for comparative purposes with those in the Rio Grande Valley.

Follansbee, Robert and H.J. Dean

1915 *Water Resources of the Rio Grande Basin, 1888–1913.* U.S. Geological Service, Water Supply Paper No. 358. Government Printing Office, Washington, D.C.

A tabular presentation of the records of the stream-flow gaging stations along the Rio Grande.

Follett, W.W.
1896 *A Study of the Use of Water for Irrigation on the Rio Grande del Norte above Fort Quitman, Texas.* Proceedings of the International Boundary Commission. Government Printing Office, Washington, D.C.

One of the most valuable reports on irrigation systems in the Rio Grande Valley of New Mexico. The report is based upon field observation and interviews made in the summer and fall of 1896 as well as extensive previous work in the same area by the author in 1888–1889 for the U.S. Geological Survey. After a review of the historical record on irrigation and irrigation practices in New Mexico, the author provides a narrative and tabular summary of significant data for every ditch along both the main stem of the Rio Grande and its tributaries.

Ford, Richard I.
1968 *An Ecological Analysis Involving the Population of San Juan Pueblo, New Mexico.* Unpublished Ph.D. Dissertation, University of Michigan, Ann Arbor.

An analysis of the interaction of culture, including agricultural practices, with the social and natural environment. The author notes the central role of irrigation agriculture in the Puebloan subsistence system of the 20th century.

1977 The Technology of Irrigation in a New Mexico Pueblo. In *Material Culture*, edited by Heather Lechtman and Robert Merrill, pp. 139–154. University of Washington Press, Seattle.

A useful discussion of the irrigation system and its organization at Picuris Pueblo. The focus is upon the technology of water diversion and distribution along a small tributary of the Upper Rio Grande.

Forrestal, Peter P. and Cyprian J. Lynch (transl.)
1964 *Memorial of 1630 by Fray Alonso de Benavides.* Academy of American Franciscan History, Washington, D.C.

A good, contemporary discussion of the Pueblos of the Rio Grande Valley which includes some useful information on Puebloan agriculture. The memorial clearly indicates the absence of extensive Puebloan irrigation systems in the Rio Grande Valley even thirty years after the Hispanic settlement of New Mexico.

French, James A.
1918 *Surface Water Supply of New Mexico, 1888–1917.* New Mexico Engineer Department. Albright and Anderson, Albuquerque.

A statistical study of surface water supplies in New Mexico during the late 19th and early 20th century.

Ganoe, John T.
1937 The Desert Land Act in Operation, 1877–1891. *Agricultural History*, Vol. 11:142–157.

A good narrative account of the implementation of the Desert Land Act. The author carefully delineates the role of the Act upon reclamation, correctly pointing out that the law made no provision for reclamation except by individual effort. The study provides then a very careful assessment of the impact of the Desert Land Act on early efforts at reclamation showing how the law actually thwarted efficient utilization of water in an area where farming depended upon irrigation. Finally the author discusses efforts to repeal the Desert Land Act. New Mexicans in the Rio Grande Valley did not participate to a considerable degree in taking of lands under the Act.

1937 The Desert Land Act Since 1891. *Agricultural History*, Vol. 11:266–277.

A continuation of the author's previous study of the early years in the implementation of the Desert Land Act of 1877. The focus of this article is upon efforts to repeal or revise the Act so as to eliminate or at least reduce the abusive practices which the law of 1877 permitted in land entries and the general administration of the Desert Land Act.

Gates, Paul W.

1968 Reclamation of Arid Lands. In *History of Public Land Law Development*, pp. 635–698, Government Printing Office, Washington, D.C.

Probably the best summary of Congressional legislation and government actions related to the reclamation of arid lands in the American West. Gates traces the development of the Reclamation movement from the 1876 study by John W. Powell to the Reclamation Act of 1902. He then discusses the implementation of the Reclamation Act and subsequent Congressional actions to save the reclamation projects from financial failure.

Gault, Homer J.

1923 Report on the Middle Rio Grande Reclamation Project, New Mexico. U.S. Reclamation Service, Denver, Colorado. Ms. on file in the Records of the Elephant Butte Irrigation District, Rio Grande Historical Collection, New Mexico State University, Las Cruces.

An investigation of conditions in the Middle Rio Grande Valley with recommendations for solutions to the problems of the area which draws extensively from previous government reports but also includes some field investigations.

Grassham, John W., Darlis A. Miller, and Ira G. Clark

1985 *Elephant Butte Irrigation District Records: Water Resources Archives Project.* New Mexico Water Resources Research Institute, New Mexico State University, Las Cruces.

A well-organized inventory of the non-current records of the Elephant Butte Irrigation District from 1906–1969. The files include the papers of the Elephant Butte Water Users' Association. The records of the EBID are useful for the study of the operations of the district, for the effects of irrigation on the Rincon and Mesilla Valleys and the effects of the district's operations on communities in the same valleys.

Greenleaf, Richard

1972 Land and Water in New Mexico, 1700–1821. *New Mexico Historical Review* 47:85–112.

An historical study of the development of land and water policy by the Spanish colonial government for New Spain as it was applied to and in colonial New Mexico. The focus of the study is, however, on land policy and the evolution of landholding. The operation of local customs and their supersession of government policy are also discussed. The author aptly points out that such circumstances prevailed throughout the northern, frontier provinces of New Spain and not just in New Mexico.

Gregg, Josiah

1954 *Commerce of the Plains* (originally published in 1849 by H.G. Langley, New York). Bobbs-Merrill, New York.

A very valuable eye-witness account of conditions in New Mexico during the Mexican regime (1821–1846). The author emphasizes the necessity of irrigation to New Mexican agriculture such that cultivation was confined almost exclusively to the bottomlands of valleys with permanent streams, i.e., the Rio Grande Valley and its tributaries. Gregg also gives a detailed description of the community ditch organization and its operation.

HKM Associates

1984 *Comprehensive Analysis of Irrigation and Drainage Facilities: Six Southern Pueblos*, 2 Vols. Report prepared for Bureau of Reclamation, Regional Office, Amarillo.

A report on current irrigation and drainage problems of six of the southern Pueblos especially in relationship with the Middle Rio Grande Conservancy District. Proposals for the solution of these problems are made for each individual pueblo.

Hackett, Charles W. (ed.)

1937 *Historical Documents Relating to New Mexico, Nueva Viscaya and the Approaches Thereto, to 1773*. Vol. 3. Carnegie Institution, Washington, D.C.

A collection of original translations of Spanish documents not generally available in New Mexico. The records were drawn from sources in Mexico and included reports by various Franciscan missionaries which shed valuable light on economic conditions in New Mexico during the 17th century. The reports of Fray Juan de Prada (1638) and Fray Francisco Martinez de Baeza (1639) are particularly important as are the reports of Fray Miguel de Menchero (1744), Fray Trigo (1754), and Fray Juan Lujuan (1760) for conditions in 18th century New Mexico.

1942 *Revolt of the Pueblo Indians of New Mexico and Otermin's Attempted Reconquest, 1680–1682*. 2 Vols. University of New Mexico Press, Albuquerque.

A mammoth collection of translated documents that cover the three-year period rather exhaustively. Of particular value are the records of Otermin's abortive primitive expedition which contains some of the only available indications of the locations of Spanish haciendas/encomiendas from the 17th century. These haciendas were the centers of economic production second only to the missions and thus closely associated with irrigation agriculture carried out by the Puebloans as part of their obligations to the Spaniards.

Hall, Thomas D.

1982 *Varieties of Ethnic Persistence in the American Southwest*. Ph.D. Dissertation, University of Washington, Seattle.

A study which focuses on warfare and Hispanic relations with native tribes, particularly the pacification of nomadic groups in the 17th to 19th centuries that included efforts to turn the nomads into sedentary farmers.

Hamele, Ottamar

n.d. The Embargo of the Upper Rio Grande. Ms. on file, Soil Conservation Service Papers, Special Collections, Zimmerman Library, University of New Mexico, Albuquerque.

A valuable narrative account of the causes and enforcement of an embargo on new reservoir construction and new irrigation facilities in the Upper Rio Grande Valley. The embargo was imposed in 1896 by the Secretary of the Interior following the investigation of complaints made by the Foreign Minister of the Republic of Mexico regarding damages to Mexican agricultural interests at and below Juarez.

Hammond, George P. and Agapito Rey

1928 *Obregon's History of 16th Century Explorations in Western America*. Wetzel Publishing Company, Inc., Los Angeles, California.

The most important sections of the book provide additional information regarding the Coronado and Espejo expeditions and also the best extant discussion of the expedition of Francisco de Ibarra into

Sonora (1563–1564) which provides good comparative information on other Southwestern irrigation systems.

1940 *Narratives of the Coronado Expedition, 1540–1542.* University of New Mexico Press, Albuquerque.

Contemporary accounts of the Coronado expedition which noted the obvious importance of agriculture to the Rio Grande pueblos but which found or reported no evidence of irrigation.

1953 *Don Juan de Oñate, Colonizer of New Mexico, 1598–1628.* 2 Vols. University of New Mexico Press, Albuquerque.

A translation of virtually all of the documents related to the Spanish settlement of New Mexico and the early years of Spanish colonial rule. The records demonstrate the interest of the Spaniards in encouraging and even insisting upon the practice of irrigation agriculture in the Rio Grande Valley. The introduction of new crops and the demands for surplus of agricultural products forced the Puebloans to focus on irrigation to a degree that had heretofore not been necessary.

Hammond, George P. and Agapito Rey (eds.)

1966 *The Rediscovery of New Mexico, 1580–1594.* University of New Mexico Press, Albuquerque.

Contains the report of Antonio de Espejo which provides the earliest documentation of historic irrigation in the Rio Grande Valley, in this instance in and around Socorro as well as on the tributary, Rio San Jose, at Acoma. The account of the subsequent de Sosa expedition reported irrigation canals at all six of the Tewa pueblos to the north of Santa Fe.

Harper, Allan G., Andrew R. Cordova, and Kalarvo Oberg

1943 *Man and Resources in the Middle Rio Grande Valley.* University of New Mexico Press, Albuquerque.

A valuable report on conditions in the Middle Rio Grande Valley and their causes. The authors examined the role of irrigation in the development of the valley and the attendant problems including the deterioration of the physical resources due to abusive land use practices in the late 19th and 20th century. Federal intervention and projects are proposed as the most viable solutions.

Harrington, John P.

1916 The Ethnogeography of the Tewas. *29th Annual Report of the Bureau of American Ethnology*, pp. 30–636. Government Printing Office, Washington, D.C.

The result of extensive ethnographic work among the Tewa Indians of northern New Mexico done by one of the leading ethnographers of the Pueblo Indians. This report is vital for an understanding of the Tewa Indians in the prehistoric and historic periods. The body of the volume consists of an exhaustive listing of Tewa place names for locations in north-central New Mexico with the corresponding Spanish and/or English topographic equivalents. Each item also includes a translation of definition of each Tewan place name and brief but very useful explanatory notes. The place name list is tied to extensive maps within the volume. A good bibliography is also included.

Harris, D.V.

1936 *Technical Report: Soil and Erosion Survey, San Juan Pueblo Grant.* USDA Soil Conservation, Southwest Region, Albuquerque.

A report from the Soil Conservation Service which discusses the soil conditions at San Juan Pueblo as they pertained to irrigation agriculture.

Harris, D.V. and R.D. Headley

1936a *Work Report: Detailed Soil and Erosion Survey, Isleta Pueblo Grant, Rio Grande District.* USDA Soil Conservation Service, Southwest Region, Albuquerque.

A report on soil conditions at Isleta Pueblo as they related to the cultivation of agricultural lands.

1936b *Work Report: Detailed Soil and Erosion Survey, Tenorio Tract, Taos Pueblo Grant.* USDA Soil Conservation Service, Southwest Region, Albuquerque.

A report on soil conditions within the Tenorio Tract of Taos Pueblo as they affected irrigation agriculture.

Harris, D.V. and J.A. Williams

1936 *Work Report: Soil and Erosion Survey, Taos Pueblo Grant.* USDA Soil Conservation Service, Southwest Region, Albuquerque.

A soil report which gives good information on agricultural conditions within the Taos Pueblo grant especially the problems of irrigated lands.

Harroun, P.G.

1898 Present Condition of Irrigation and Water Supply in New Mexico. Commission on Irrigation and Water Rights of New Mexico, Santa Fe. Ms. on file, State Engineer's Office, Santa Fe.

A detailed study of irrigated lands and water supply which gives a summary of irrigated acreage by stream system. This study complements that of two years earlier by Follett.

Headly, R.D.

1936 *Technical Report: Detailed Soil and Erosion Survey, Santa Ana Pueblo, El Ranchito Grant.* USDA Soil Conservation Service, Rio Grande District, Albuquerque.

A report on soil conditions within the El Ranchito tract of Santa Ana Pueblo on the Rio Grande above Bernalillo, which summaries the existing state of agriculture in the area.

Hedke, C.R.

1925 Report on the Irrigation Development and Water Supply in the Middle Rio Grande Valley, New Mexico. Rio Grande Valley Survey Commission, Albuquerque. Ms. on file, Middle Rio Grande Conservancy District Office, Albuquerque.

A good summary of the causes of the failure of water supplies and the consequent effects on irrigation agriculture in the Rio Grande Valley above El Paso. The author draws principally upon the earlier studies of Follett (1896), Yeo (1910) and Neal (1918). The study includes a brief history of irrigation development in the Rio Grande Valley to 1880 and a more detailed discussion of the progressive decline of irrigation systems in the middle valley after 1880.

Hibben, Frank C.

1937 *Excavation of the Riana Ruin and the Chama Valley Survey.* University of New Mexico Bulletin 300, Anthropological Series 2(1). Albuquerque.

A study of late prehistoric Puebloan sites in the lower Chama River Valley in north-central New Mexico. Extensive soil control and water conservation features were noted but nothing in the way of water distribution or irrigation systems.

Hill, Raymond A.

1966 Development of the Rio Grande Compact of 1938. Ms. on file, Bureau of Reclamation, El Paso.

A basic historical-documentary account of the development of the Rio Grande Compact of 1938 by one of the principal participants. It remains the fundamental study on the subject. The report was originally filed in the case of *The State of Texas and The State of New Mexico vs. The State of Colorado* before the U.S. Supreme Court. The unedited manuscript was published posthumously in 1974 in the *Natural Resources Journal.*

Hill, W.W.

1982 *The Ethnography of Santa Clara Pueblo, New Mexico.* University of New Mexico Press, Albuquerque.

This extensive ethnographic study of the Santa Clara Indians includes an excellent analysis of the nature and role of irrigation agriculture in the Puebloan economy. The author also includes a discussion of the irrigation system at Santa Clara Pueblo.

Hinton, Richard J.

1892 *Report on Irrigation and the Cultivation of the Soil Thereby.* 52nd Congress, 1st Session, Senate Executive Document 41(1–4). U.S. Government Printing Office, Washington, D.C.

A part of the Congressional study of arid lands which was a result of the growing interest in the development of desert lands in the Southwest. The section on New Mexico focuses on the condition of irrigation systems and irrigation agriculture in Santa Fe County and in the Mesilla Valley. The traditional character of irrigation still prevailed at that time. The author sought to encourage the development of modern irrigation facilities to enhance the development of agriculture.

History of Engineering Program, Texas Tech University

1979 New Mexico Historic Engineering Site Inventory. Texas Tech University, Lubbock. Ms. on file, New Mexico Historic Preservation Division, Santa Fe.

This study of engineering features contains a discussion of approximately a dozen historic water control and water distribution facilities in the Rio Grande Valley of New Mexico that includes four canals in Doña Ana County, irrigation systems in Rio Arriba County, the Acequia Madre de Santa Fe and Arroyo Hondo Irrigation Project in Santa Fe County, the Garfield Flume in Sierra County and the Los Trampas Canoas and Taos Pueblo Ditches in Taos County.

Hodge, Federick W., George P. Hammond, and Agapito Rey (transl.)

1945 *Revised Memorial of 1634 by Fray Alonso de Benavides.* University of New Mexico Press, Albuquerque.

A revised version of Benavides' 1630 memorial. The revised version gives somewhat more detail on irrigation, especially for the Tewa Indian groups of the Upper Rio Grande Valley.

Hodges, Paul V.

1938 Report on Irrigation and Water Supply of the Pueblos of New Mexico in the Rio Grande Basin. United Pueblos Agency, Albuquerque. Ms. on file, Bureau of Reclamation, District Office, Albuquerque.

A report on irrigation and water supply for each pueblo in New Mexico within the Rio Grande Basin. Background data was taken from the Follett report of 1896 and the Robinson report of 1913. A summary of irrigated land between 1917 and 1937 is included along with maps of the ditch systems. The author also presents some important historical material on the ditches and irrigation agriculture for each pueblo.

Horgan, Paul
1954 *Great River: The Rio Grande in North American History* (2 Vols.). Holt, Rinehart, and Winston, New York.

A good general narrative of events along the Rio Grande Valley especially in New Mexico. The focus of the work is on the Spanish, Mexican, and early American periods.

Hosea, R.G.
1928 Report of Irrigation in Rio Grande Valley. Rio Grande Valley Survey Commission, Albuquerque. Ms. on file, Middle Rio Grande Valley Conservancy District Office, Albuquerque.

A history of settlements and irrigation in the Rio Grande Valley from their beginnings to 1928. The report includes a good summary of developments in 19th century irrigation and a summary of irrigated acreage by stream system in the basin as of 1928. The author also provides a very useful discussion of irrigation on the western tributaries of the Rio Grande, south of San Marcial. Finally, he documents the dramatic effects of the development of large scale irrigation systems in the San Luis Valley of Colorado after 1880.

Hudson, H.H.
1953 Floods in North Central New Mexico, Frequency and Magnitude. U.S. Geological Survey, Water Resources Division, Santa Fe District. Ms. on file, Soil Conservation Service, Albuquerque.

A useful body of information on floods, which was gathered by basin and gaging station.

Huffman, R.G.
1953 Public Water Policy for the West. *Journal of Farm Economics* 35:719–727.

A brief but good outline of the proposals of the President's Water Resources Policy Commission in 1950.

Hughes, Anne E.
1914 *The Beginning of Spanish Settlement in the El Paso District.* University of California Press, Berkeley.

An historical account of Spanish settlement in the El Paso area which helps to delineate the reasons for the absence of early settlement in the Mesilla and Rincon valleys of New Mexico.

Hudley, Norris
1966 *Dividing the Water: A Century of Controversy Between the United States and Mexico.* University of California Press, Berkeley and Los Angeles.

An analysis of the international implications of water developments in the Rio Grande and Colorado River valleys. This study clearly indicates that irrigation development in the Rio Grande Valley did not occur in a vacuum.

Hutchins, Wells A.
1928 Community Acequia: Its Origins and Development. *Southwestern Historical Quarterly* 31:261–284.

The only specific study of the community acequia which was and still is the backbone of traditional Hispanic irrigation agriculture in the Rio Grande Valley of New Mexico. The author discusses the legal and customary foundations for the community acequia and its adoption into Anglo-American political and legal systems after the Treaty of Guadalupe Hidalgo.

International Boundary Commission

1903 Proceedings of the International Boundary (Water) Commission United States and Mexico, Treaties of 1884 and 1889. *Equitable Distribution of the Waters of the Rio Grande*, 2 Vols. U.S. Government Printing Office, Washington, D.C.

A report of the joint investigations by the United States and Mexico into the conditions of irrigation development and water supplies with their accompanying problems. The report includes the work of W.W. Follett as well as the recommendations of the Commission for the relief of the complaints of the Republic of Mexico.

Ireton, Hap W.

1942 Report of Flood Conditions below Elephant Butte Reservoir. USDI Bureau of Reclamation, Southwest Region, Amarillo.

A report on conditions conducive of flooding in the Rio Grande Valley below Elephant Butte Dam and suggestions for the control of floodwaters in that area. The findings are based on the Rio Grande Flood Survey of April–June 1942, the maps of which are included in the volume.

Isaacson, M.R., D.V. Harris, and R.D. Headley

1936 Work Report: Detailed Soil and Erosion Survey, San Felipe Pueblo, Rio Grande Project. USDA soil Conservation Service, Rio Grande District, Albuquerque.

A study of soils and their suitability to irrigation agriculture at San Felipe Pueblo. The investigators found that most of the irrigable acreage was poorly suited to irrigation farming due to problems with drainage, alkali and weeds.

Jenkins, Myra E.

1966 Taos Pueblo and Its Neighbors, 1540–1846. *New Mexico Historical Review* 41:85–114.

A history of the relationships and conflicts of Taos Pueblo with its Hispanic neighbors. The limited availability of irrigated farm and pasture lands created conditions that led to physical and legal confrontations over water.

1972 Spanish Land Grants in the Tewa Area. *New Mexico Historical Review* 47:113–134.

A discussion of the nature and development of Spanish land grants in the region north of Santa Fe, particularly in the Pojoaque Basin. The present work is a summary of research prepared for the case of the *State of New Mexico vs. R. Lee Aamodt et al.* The critical role of limited irrigable acreage is delineated but not fully developed in the narrative account. The focus of the work is on the conflict of Indian and non-Indian interests over land and water.

1982 . The Rio Grande Compact of 1938. Ms. on file, Bureau of Reclamation, El Paso.

A narrative of events leading to the need for the 1938 compact, including the failure of the previous (1929) compact; largely based upon Raymond A. Hill's report of these developments.

Johansen, Sigurd

1971 *New Mexico's Urban and Rural Population.* Agricultural Experiment Station Research Report No. 207. New Mexico State University, Las Cruces.

A useful profile of population trends in New Mexico from 1850 to 1970. The gradual urbanization of the state's population in the 20th century lagged behind that of the rest of the United States; in the United States as a whole, one-half of the population was urban in 1920 while that level was not reached in New Mexico until 1960 as a result of massive urbanization in the 1950s.

1972 *Changes in the Distribution of New Mexico's Population between 1930 and 1970.* Agricultural Experiment Station Research Report No. 222. New Mexico State University, Las Cruces.

A discussion of population trends in shifts in population in New Mexico. The data is broken down by county, which shows that the population of the Rio Grande Valley increased, except in Socorro County.

Jones, O.L.

1979 *Los Paisanos.* University of Oklahoma Press, Norman.

A general study of the Spanish settlers on the northern frontier of New Spain. The author provides some useful summaries of statistical data on New Mexico in the late 18th century and discusses the idiosyncrasies of the inhabitants of New Mexico, which are in part related to conditions on the frontier.

Journal of the Irrigation and Drainage Division

1956–Present *Journal of the Irrigation and Drainage Division.* American Society of Civil Engineers, New York.

Mostly technical papers in engineering, design, and hydrology as related to irrigation and drainage, but also some more general articles on the economics of water development, economic benefits of certain irrigation projects, and climatology are included on a regular basis.

Journal of Water Resources Planning and Management

1976–Present *Journal of Water Resources Planning and Management.* American Society of Civil Engineers, New York.

Technical papers on water resources planning and management, which focus on water disposal and control, groundwater pollution, as well as water allocation and distribution.

Keleher, Robert F. (ed.)

1935 *Resources and Opportunities of the Middle Rio Grande Valley.* University of New Mexico Bulletin No. 264, Economics Series Vol. 2 No. 3, Albuquerque.

A series of papers presented before the Albuquerque Rotary Club by officials of the Middle Rio Grande Conservancy District and professors at the University of New Mexico. The presentations are essentially popularized versions of developments which are available in greater detail in the annual reports of the Middle Rio Grande Conservancy District.

Kelley, J.C. (organizer)

1970 Papers presented at the Water Control Systems Symposium, 58th Annual Pecos Conference, Santa Fe, New Mexico. Ms. on file, Laboratory of Anthropology, Museum of New Mexico, Santa Fe.

A compendium of a dozen unpublished papers which were presented at the Pecos Conference in 1970. The most important for the present project was that of F.H. Ellis on irrigation works in the Rio Grande Valley.

Kelley, Wilfred D.

1955 *Settlement of the Middle Rio Grande Valley, New Mexico.* Journal of Geography 54:387–399.

A general discussion of the settlement of the Middle Rio Grande Valley which contains little information which is not available elsewhere.

Kelsay, Laura E.

1964 List of the Cartographic Records of the General Land Office. Special List No. 19. National Archives, General Services Administration, Washington, D.C.

An important body of information since the surveyors for the General Land Office frequently documented pre-existing irrigation systems and irrigation agriculture within the areas of their surveys.

1977 Cartographic Records of the Bureau of Indian Affairs. Special List No. 13. National Archives, General Services Administration, Washington, D.C.

A body of data which is particularly useful for its records of the Indian Irrigation Service which was responsible for irrigation projects and maintenance on the Pueblo lands of the Rio Grande Valley.

Korn, Lewis J.

1939 *Annual Report, Upper Rio Grande Area, 1938–1939.* USDA Soil Conservation Service, Rio Grande District, Albuquerque.

Includes a report on the Upper Rio Grande Grant Lands Project whose purpose was to enhance the low annual incomes of local non-Indian populations, who were largely engaged in subsistence agriculture, based on small-scale irrigation, and stockraising.

Kutsche, Paul (ed.)

1979 *The Survival of Spanish American Villages.* Colorado College, Colorado Springs.

A collection of papers from a 1977 symposium. Of particular value were papers by John R. Van Ness, David H. Snow and Kenneth R. Weber which are discussed below. The volume itself contains a good general bibliography on Spanish-American settlements in the northern Rio Grande Valley.

Kutsche, Paul and John Van Ness

1981 *Cañones: Values, Crises, and Survival in a Northern New Mexico Village.* University of New Mexico Press, Albuquerque.

An ethnohistorical and ethnographical study of the village of Cañones, which lies along a small tributary of the Rio Chama in the Upper Rio Grande Basin of New Mexico. The volume contains a good discussion of the local irrigation system that includes maps of the various acequias.

LaMar, Barbel Hannelore Schonfeld

1984 *Water and Land in the Mesilla Valley, New Mexico.* Unpublished Ph.D. Dissertation, University of Oregon, Eugene.

A detailed discussion of the Rio Grande Project and its effects on rural landownership and land use in the Mesilla Valley of New Mexico. The study is based primarily of an intensive archival study of a representative sample of the lands in the Mesilla Valley. The author noted major shifts in land-use patterns after the completion of Elephant Butte Reservoir. The increases in water supplies for irrigation which resulted from this major federal project appear to have profoundly altered agricultural patterns in the Mesilla Valley.

Lampen, Dorothy

1930 *Economic and Social Aspects of Federal Reclamation.* The Johns Hopkins Press, Baltimore, Maryland.

A study of the evolution of irrigation laws and policies from the inception of the Reclamation Act of 1902. The author produced an exhaustive analysis of changing economic and social conditions in the American West affected by reclamation projects. The study confronts the growing financial problems

of reclamation projects and traces the attempts from 1902 to 1929 to suggest remedies for social and economic conditions that underlay those circumstances.

Lange, Charles H.
1951 *An Evaluation of Economic Factors in Cochiti Pueblo Culture Change.* Unpublished Ph.D. Dissertation, University of New Mexico, Albuquerque.

An ethnographic and ethnohistorical study of the Cochiti Indians and their culture. The central role of irrigation agriculture to their subsistence system is discussed as is the irrigation system itself.

1959 *Cochiti: A New Mexico Pueblo, Past and Present.* University of Texas Press, Austin.

The published version of Lange's 1959 dissertation.

Lange, Charles H. and Carroll L. Riley (eds.)
1966–1984 *The Southwestern Journals of Adolph F. Bandelier, 1880–1892*, 4 Vols. University of New Mexico Press, Albuquerque.

The daily record of the first and most famous 19th century anthropologist in New Mexico and the Southwest. The first volume which encompasses the years 1880–1882 is the most important inasmuch as it details the archaeological and ethnographical investigations of Bandelier among the Pueblo Indians of the Rio Grande Valley. The contemporary data on irrigation is quite important.

Lee, W.T.
1907 Water Resources of the Rio Grande Valley, New Mexico, and Their Development. U.S. Geological Service, Water Supply Paper No. 188. Government Printing Office, Washington, D.C.

A report on the surface and sub-surface water supply in the Rio Grande Valley whose purpose is to propose potential reservoir sites in order to encourage irrigation development in the valley.

Leonard, Olen E.
1943 *The Role of the Land Grant in the Social Organization and Social Processes of a Spanish-American Village in New Mexico.* Ph.D. Dissertation, Louisiana State University, Baton Rouge.

A report which, among other things, documents the dependency of Hispanic farmers upon irrigation in order to engage in agriculture. Subsistence agriculture based upon irrigation was the norm in contemporary Hispanic villages. The author also discusses the organization of the traditional acequia system.

Lester, Paul A.
1977 *History of the Elephant Butte Irrigation District.* Unpublished M.A. thesis, New Mexico State University, Las Cruces.

A good general narrative of events leading to the formation of the Elephant Butte Irrigation District in 1919. The volume is based essentially on primary sources. This study traces the settlement of the Mesilla Valley, the development of irrigation agriculture, the international water controversy, the activities of the Rio Grande Dam and Irrigation Company, and the formation of the Elephant Butte Irrigation District. Unfortunately, little space is given to the history of the district itself or its impact on settlers in the Rincon and Mesilla valleys.

Linford, Dee
1956 Water Resources of New Mexico. New Mexico State Engineer's Office and Interstate Stream Commission. Ms. on file, New Mexico State Engineer's Office, Santa Fe.

A major study of water resources and their utilization in the Rio Grande and other valleys of New Mexico. The report was, however, never published, but includes a list of other unpublished reports on surface water which were on file in the State Engineer's Office and a massive 200 page bibliography. In addition to a discussion of hydrology, the author provides a history of water use and water rights in New Mexico. A discussion of previous federal and/or state water projects is also provided.

1967 Floral and Faunal Conditions in the Middle Rio Grande Valley, New Mexico at the Time of the U.S. Occupation. Ms. on file, New Mexico State Engineer's Office, Santa Fe.

A discussion of floral and faunal conditions in the Middle Rio Grande Valley of New Mexico, ca. 1846 which consists of extracts from contemporary reports and journals.

1968 Life Conditions in the Rio Grande Valley in New Mexico below Cochiti as Reflected in Contemporary Journals and Chronicles from 1880 to the present. Ms. on file, New Mexico State Engineer's Office, Santa Fe.

A compilation of excerpts and extracts from contemporary accounts, which includes descriptions of agriculture in the Rio Grande Valley.

Lovato, Philip

1975 *Las Acequias del Norte.* Kit Carson Memorial Foundation, Taos, New Mexico.

A discussion of the laws of acequias in New Mexico, which extracts and summarizes state law, administrative procedures and the organization of acequias.

Marker, Harrison J. and W.G. Perrin

1936 *Soil and Erosion Survey, San Juan Pueblo Grant.* USDA Soil Conservation Service, Southwest Region, Albuquerque.

A report on the soils and their potential for irrigation at San Juan Pueblo.

Marshall, Michael P.

1979 *Excavations at Nuestra Señora de Dolores Pueblo (LA 677), A Prehistoric Settlement in the Tiguex Province.* Office of Contract Archeology, University of New Mexico, Albuquerque.

A report on the excavations at a 15th century Puebloan site in Bernalillo, New Mexico which found no evidence of prehistoric irrigation but did report a superimposed 19th century irrigation ditch.

Marshall, Michael P. and Henry J. Walt

1984 *Rio Abajo: Prehistory and History of a Rio Grande Province.* New Mexico Historic Preservation Division, Santa Fe.

An excellent study of the archaeological remains in the Spanish province of the Rio Abajo from Sevilleta Wildlife Refuge to San Marcial. The report includes a good presentation of the positive and negative evidence regarding prehistoric irrigation systems in the Rio Grande Valley as well as the historical and archaeological data on historic irrigation systems in the Rio Abajo from the 16th to the 19th century. The volume contains an excellent bibliography.

McCall, George A.

1850 *Report of the Secretary of War Communicating Colonel McCall's Report in Relation to New Mexico.* 31st Congress, 2nd Session, Senate Executive Document No. 26, Government Printing Office, Washington, D.C.

A useful contemporary report on conditions in early territorial New Mexico that contains the earliest enumeration of cultivated acreages in the Rio Grande Valley of New Mexico. Colonel McCall was also careful to differentiate between actual cultivated acreages and cultivable but not utilized acreages.

Mera, H.P.

1940 *Population Changes in the Rio Grande Glaze Paint Area.* Laboratory of Anthropology Technical Series, Bulletin 9. Museum of New Mexico, Santa Fe.

A study of population shifts in the Rio Grande Valley using ceramic changes as indices.

n.d. Survey Records and Maps. On file, New Mexico Historic Preservation Division, Santa Fe.

The records of a number of years of archaeological fieldwork that documented hundreds of sites in the Rio Grande Valley and its tributaries. The site records are in many cases very cursorial.

Meyer, Michael C.

1984 *Water in the Hispanic Southwest: A Social and Legal History, 1550–1850.* University of Arizona Press, Tucson.

A very good analysis of the influence of the scarcity of water and of aridity upon the location of settlements, the conflict of ethnic and social groups, the growth and development of agriculture, and the form of governmental institutions in the Hispanic Southwest, particularly New Mexico. The centrality of water to the history of the early Southwest is fully explored in the author's discussion of the social and legal parameters of Hispanic settlement. The book considers the social implications of water scarcity and describes the role of law in adjudicating water disputes. This study was the result of the author's work as an expert witness in the case of *The State of New Mexico vs. R.Lee Aamodt et al.*

Meyer, Michael C. and Susan M. Deeds

1979 Land, Water, and Equity in Spanish Colonial and Mexican Law: Historical Evidence for the Court in the Case of *The State of New Mexico vs. R. Lee Aamodt et al.* Ms. on file, U.S. Attorney's Office, Albuquerque.

An early version of Meyer's more recent book. The original unpublished manuscript covers much the same materials and supports the same propositions. The essential differences have to do with documentation which is less succinct for this manuscript.

Michael, Robert E.

1976 *The Economic Problems of the Rio Grande Pueblos.* Unpublished Ph.D. Dissertation, University of New Mexico, Albuquerque.

A simplistic analysis of the economic problems of the Pueblo Indians of the Rio Grande Valley. This very shallow study takes a Manichean view of New Mexico and its peoples. The author is mostly interested in contemporary policies and complaints which are based on a series of self-serving interviews with Indian and government officials. This a a work of advocacy and not of scholarship.

Middle Rio Grande Conservancy District

1926–1945 Annual Reports of the Board of Commissioners. Ms. on file at Middle Rio Grande Conservancy District Office, Albuquerque, New Mexico.

These reports provide annual summaries of the activities of the MRGCD which included construction, operations, maintenance and finances. The records trace the early success of the district in its renovation of the irrigation system of the Middle Rio Grande Valley and in the reclamation of

waterlogged lands. However the reports also delineate the progressively debilitating financial problems of the district.

1928 Report of the Chief Engineer: Plan for Flood Control, Drainage, and Irrigation in the Middle Rio Grande Conservancy District. Ms. on file, New Mexico State Engineer's Office, Santa Fe.

A valuable document which sets forth the original plan for the Middle Rio Grande Conservancy District during its formative phase.

1971 Drains, Ditches Built, Maintained by the Middle Rio Grande Conservancy District. Ms. on file, Middle Rio Grande Conservancy District Office, Albuquerque.

A comprehensive list of the canals, laterals, feeders and drains of the Middle Rio Grande Conservancy District.

Miller, Charles D.

1911 *The Irrigation Resources of New Mexico.* Department of the Territorial Engineer, Santa Fe, New Mexico.

A promotional pamphlet touting the virtues of New Mexican irrigation resources in order to encourage settlement and development of the territory.

Mills, Anson and W.W. Follett

1896 *Reports on the Investigations and Survey for an International Dam and Reservoir on the Rio Grande del Norte.* U.S. Geological Survey. U.S. Government Printing Office, Washington, D.C.

A result of the investigations of the problems associated with irrigation development in the Rio Grande Valley which emerged from complaints of the Republic of Mexico. The report makes proposals to attempt to alleviate the constraints on water delivery and late-season irrigation for Mexican farmers in and near Juarez. These proposals had a significant impact on irrigation systems in New Mexico.

Moore, James L.

1981 *Prehistoric Water and Soil Conservation in the Middle Puerco River Valley.* Unpublished M.A. Thesis, University of New Mexico, Albuquerque.

An important study which provides an overview of water and soil conservation systems throughout the prehistoric Southwest, including the Rio Grande Valley of New Mexico. The volume also provides a good bibliography on prehistoric irrigation systems and prehistoric agriculture.

Morfi, Agustin de

1932 .Geographical Description of New Mexico, 1782. In A.B. Thomas (ed. and transl.) *Forgotten Frontiers, A Study of the Spanish Indian Policy of Don Juan Bautista de Anza, Governor of New Mexico 1777–1787*, pp. 87–114. University of Oklahoma Press, Norman.

A brief but excellent companion to Fray Dominguez's monumental study (1776). Morfi provides considerable data on irrigation and irrigation agriculture in late 18th century New Mexico and documents some significant changes that occurred in the brief period since Dominguez's visit.

National Resources Committee

1938 *Regional Planning, Part IV: The Rio Grande Joint Investigation in the upper Rio Grande Basin in Colorado, New Mexico and Texas, 1936–1937.* Government Printing Office, Washington, D.C.

A massive study of conditions in the Upper Rio Grande Basin. The first part is a general report on the water supply and the historic development of irrigation. Because of increasing problems of water supply which were noted as early as the Follett study (1896), the report recommended transbasin diversions to supplement diminished water supplies for irrigation agriculture in the Middle Rio Grande Valley. The report also provides a brief but useful discussion of irrigation canals and diversions in the Rio Grande Valley.

Natural Resources Journal

1961–Present *Natural Resources Journal.* School of Law, University of New Mexico, Albuquerque.

An important source of scholarly studies on water resources, water developments, water utilization, and water rights in New Mexico, generally from a legal perspective.

Nelson, Nels C.

1914 *Pueblo Ruins of the Galisteo Basin, New Mexico.* Anthropological Papers of the American Museum of Natural History 15(1). New York.

The only archaeological study ever done on the large prehistoric Puebloan sites in the Galisteo Basin. The author noted the presence of some water control features associated with several of the late prehistoric sites but found no large-scale irrigation facilities.

New Mexico State Archives and Records Center

n.d. Spanish Census of New Mexico, 1750 and 1790. New Mexico State Archives and Records Center, Santa Fe.

These censuses provide valuable information on economic activities which complement other contemporary narrative sources such as Dominguez (1776).

New Mexico State Engineer's Office

1908–Present Hydrographic Surveys Related to Stream System and/or Underground Water Basin Adjudications. Ms. on file, New Mexico State Engineer's Office, Hydrographic Survey Division, Santa Fe.

The results of the hydrographic surveys of each stream system which has been or is currently under adjudication by the State Engineer's Office. The older surveys are quite sketchy and not nearly as complete as those since World War II. The surveys include maps of the ditches along with oral and documentary data related to the ditches themselves and the water rights of the individual users along each ditch.

1969 A Roster, by County, of Organizations Concerned with Surface Water Irrigation of New Mexico (revised in 1978). Ms. on file, New Mexico State Engineer's Office, Santa Fe.

A tabulation of all community ditch associations along the Rio Grande and its tributaries as well as other stream systems.

New Mexico State University, Agricultural Experiment Station

1976 *Sources of Irrigation and Dry Cropland Acreages in New Mexico.* Research Report 324. Las Cruces.

An inventory and tabulation of current use and crops.

Northern Rio Grande RC&D Project

1973 Rio Chama Acequia Consolidation, Flood Prevention, and Irrigation. RC&D Measure Plan. Ms. on file, New Mexico State Engineer's Office, Santa Fe.

A proposal for consolidation and rehabilitation of the irrigation ditches in the Chama Valley which provides some useful information on the acequias and their condition at the time of the report.

Olmsted, Virginia L.

1973 *Spanish Census of 1790 for the Province of New Mexico.* New Mexico Genealogical Society, Albuquerque.

Contains social and economic information useful for the study of late 18th century New Mexico in the Rio Grande Valley where settlement was almost exclusively focused.

1981 *The Spanish and Mexican Censuses of New Mexico, 1750–1830.* New Mexico Genealogical Society, Albuquerque.

Though gathered in this volume for genealogical purposes, the censuses contain a variety of economic data useful to the present study.

Ortiz, Alfonso (ed.)

1979 *Southwest.* Handbook of North American Indians, Vol. 9. Smithsonian Institution, Washington, D.C.

A comprehensive compilation of articles especially commissioned for this publication. Though no article is specifically directed toward a study of irrigation systems or irrigation agriculture among prehistoric and historic Indian groups, most of the articles do touch either directly or indirectly on the subject.

Palomas Valley Irrigation District (Sierra County)

1918–1929 Correspondence. Ms. on file, Bureau of Reclamation, Regional Office, Amarillo.

An interesting collection of data on the activities of the Palomas Valley Irrigation District, which also includes the 1920 report by H.W. Yeo and W.T. Collins on the proposed Highline Canal in Palomas Valley that was prepared for the U.S. reclamation Service.

Parsons, Elsie C.

1929 *The Social Organization of the Tewa of New Mexico.* Memoirs of the American Anthropological Association No. 36. Memoirs of the American Anthropological Association No. 36. Menasha, Wisconsin.

While focusing primarily on social organization, this classical study of the Tewas in northern New Mexico contains some useful ancillary information on irrigation agriculture.

1936 *Taos Pueblo.* General Series in Anthropology No. 2. American Anthropological Association, Menasha, Wisconsin.

A frequently cited anthropological study of the Indians of Taos Pueblo in northern New Mexico; a good ethnographic study with some data on agriculture.

Pease, C.T.

1925 Report on Floods and Drainage at San Marcial, New Mexico. Ms. on file, Bureau of Reclamation, District Office, El Paso.

A comprehensive study of the problems at San Marcial, with photographs and maps. The author assesses the causes of flooding and recommends monitoring of the Rio Grande Channel. The report contains good contemporary maps showing cultivated land, ditches, and abandoned ditches near San Marcial.

Perkins, Ward A.
1914 Community Ditches in the Rio Grande Valley. Rio Grande Project; New Mexico and Texas, U.S. Reclamation Service, El Paso. Ms. on file at State Engineers Office, Santa Fe, New Mexico.

A valuable summary of data regarding the ditches in the Rincon and Mesilla Valleys. The report is limited to ditches within the confines of the Rio Grande Project; but within that scope provides historical data on irrigation ditches and irrigated acreages under each of the ditches for 1914 and occasionally for previous years. The volume also has a series of very good fold-out maps of ditches and irrigated areas as well as some good photographs of the ditches in 1914.

Petulla, Joseph M.
1977 *American Environmental History.* Boyd and Fraser Publishing Company, San Francisco, California.

A well-written study of the relationship between human activities and the environment. The parts on the reclamation movement to 1902 and on the reclamation projects provide good general background information.

Powell, J.W.
1891 *Irrigation.* Twelfth Annual Report of the U.S. Geological Survey to the Secretary of the Interior, 1890–1891, Part II. Government Printing Office, Washington, D.C.

A part of the general study of arid lands undertaken in the late 1880s by the U.S. Geological Survey during a time of increasing interest in the desert Southwest. This study provides good general information on irrigation systems in the Rio Grande Basin of New Mexico about the year 1890. Some data is also included on ditch organization and construction.

Pueblo Lands Board
1926–1932 Records, Proceedings and Findings. Ms. on file at the Southern Pueblos Agency, Albuquerque.

A result of congressional efforts to resolve the problem of non-Indian settlers within the boundaries of the Pueblo Indian land grants. The files of the Board contain unique records on non-Indian irrigation systems and irrigation agriculture for the second half of the 19th century and the first quarter of the 20th century in the Rio Grande Valley. The records are organized by pueblo and subdivided into numbered private claims files.

Reisner, Marc
1986 *Cadillac Desert: The American West and its Disappearing Water.* Viking, New York.

Certainly one of the most interesting as well as potentially controversial books to have appeared on the subject of the efforts to reclaim the arid lands of the American West. Government agencies are not going to be enamored with this volume, but the information is so crisply presented that one would feel compelled to read the book even if one took considerable exception to the author's discussion of the activities of the Metropolitan Water District of Southern California, the U.S. Army Corps of Engineers and the U.S. Bureau of Reclamation. While one might disagree with the author, Reisner has raised so many important questions regarding the costs and effectiveness of federal irrigation projects that the implications must be addressed. Though many if not most reclamation projects come under considerable criticism, it was interesting to find that federal projects in the Rio Grande Valley of New Mexico are noticeable exceptions to the author's approbations.

Ressler, John Q.
1968 Indian and Spanish Water Control on New Spain's Northwest Frontier. *Journal of the West* 7:10–17.

Though the focus of this article is upon Baja and Alta California, the author does present some good introductory remarks on irrigation in the desert Southwest as a whole. Irrigation was necessary for

successful agriculture due to erratic rainfall and the introduction of European crops such as wheat, barley, oats, and fruit trees.

Rio Grande Compact Commission

1939–1984 Annual Reports. On file, Bureau of Reclamation, El Paso.

The reports consist of the rules and regulations of the Commission as well as the records of deliveries, releases, and streamflow which are presented statistically.

Robbins, Howard E.

1947 Plan for Development, Middle Rio Grande Project, Rio Grande Basin, New Mexico. Bureau of Reclamation, Region 5. Ms. on file, Soil Conservation Service, Albuquerque.

Another plan for rehabilitation and development along the Middle Rio Grande in order to relieve a multitude of problems that had persisted despite the activities of the Middle Rio Grande Conservancy District. The focus of the recommendations is on irrigation and flood control and includes an estimate of costs.

Robinson, H.F.

1911–1913 *Statements of Indian Water Rights in the Rio Grande Valley, New Mexico.* U.S. Indian Irrigation Service, Albuquerque.

An important collection of conclusions on Pueblo Indian water rights in the Rio Grande Valley which were filed with the State Engineer's Office to support Indian claims to priorities and quantities of irrigation water. The information was gathered by Robinson in a series of inquiries made at the various pueblos.

Robinson, Michael C.

1979 *Water for the West — The Bureau of Reclamation, 1902–1977.* Public Works Historical Society, Chicago.

A good general history of the origin and activities of the Bureau of Reclamation (originally U.S. Reclamation Service) which are rooted in the problems attendant upon irrigation agriculture in the arid and/or semi-arid regions of the American West. The work contains a useful bibliography.

Rubright, Lynnell

1967 *A Sequent Occupance of the Española Valley, New Mexico.* Unpublished M.A. Thesis, University of Colorado, Boulder.

A minor study based essentially on secondary works. The author does, however, recognize the importance of irrigation agriculture to the various cultural groups (Puebloan, Hispanic, and Anglo-American) who have settled in the Española Valley of northern New Mexico.

Sargent, Kathryn

1985 An Archaeological and Historical Survey of the Village of Los Ranchos. Ms. on file, New Mexico Historic Preservation Division, Santa Fe.

An excellent combination of archaeological and historical evidence to reconstruct the history of settlement and irrigation in the Rio Grande Valley just to the north of Albuquerque. The archeological investigations noted the presence of a small irrigation canal at the Chamisal site that dated to ca. AD 1300. The study also summaries the development and decline of Hispanic irrigation agriculture along the main stem of the Rio Grande in the Albuquerque area. The volume has good maps and a good bibliography.

Scholes, France V.
1937 *Church and State of New Mexico, 1610–1650.* University of New Mexico Press, Albuquerque.

A good discussion of certain elements of New Mexico history in the first half of the 17th century. The focus of the book is on the conflicts of secular and ecclesiastical authorities; the discussion are somewhat skewed by a reliance upon inquisitorial records.

1942 *Troublous Times in New Mexico, 1659–1670.* The University of New Mexico Press, Albuquerque.

A continuation of Scholes' earlier work but this volume contains more information on economic activities.

Schroeder, Albert H.
1972 Rio Grande Ethnohistory. In *New Perspectives on the Pueblos*, edited by Alfonso Ortiz, pp. 41–70. University of New Mexico Press, Albuquerque.

A good study of the consequences of the Spanish colonization of New Mexico upon Puebloan society, economy, politics, and culture.

Schroeder, Albert H. and Dan S. Matson
1965 *A Colony on the Move: Gaspar Casteño de Sosa's Journal 1590–1591.* School of American Research, Santa Fe, New Mexico.

A good translation with commentary on the Sosa expedition which recorded important information on Puebloan irrigation in the upper Rio Grande Valley of New Mexico.

Shepard, Ward
1945 Rebuilding the Rio Grande. Bureau of Indian Affairs, Washington, D.C. Ms. on file, Bureau of Reclamation, Regional Office, Amarillo.

A study of the condition of the land and economy of the Rio Grande Valley in New Mexico and the causes of their decline in the 20th century. The author discusses the existing economic crisis among the Indian and Hispanic population of the valley and makes suggestions for the rehabilitation of the land. The study relies primarily on the Human Dependency Surveys of the Soil Conservation Service from the late 1930s.

Simmons, Marc
1968 *Spanish Government in New Mexico.* University of New Mexico Press, Albuquerque.

A study of the civil government of New Mexico in the 18th century. The volume consists primarily of a detailed analysis of Spanish governmental organization, responsibilities, and activities. One important chapter assesses the nature of local government with particular attention to the role of the alcalde major, who had an important role in the settlement of land and water disputes.

1969 Settlement Patterns and Village Plans in Colonial New Mexico. *Journal of the West* 8:7–19.

A study arising from the author's earlier examination of civil governments; here, however, the author focuses on the settlement of land grants as well as the peculiarities and idiosyncrasies of New Mexico settlers and their settlement patterns. Of particular note was the determined individualism of the New Mexican frontiersmen and their resistance to government regulations on settlements.

1972 Spanish Irrigation Practices in New Mexico. *New Mexico Historical Review* 47:135–150.

A good study of irrigation in colonial New Mexico. The author discusses the contributions of the Puebloans to the irrigation system which the Spanish settlers began as soon as they arrived in the late 16th century. He also describes the construction and organization of community ditches by village communities as well as the facilities which were used to distribute irrigation water. Spanish colonial laws on irrigation systems provided the foundation for the regulations but distinctive developments occurred in New Mexico due to local circumstances.

1982 *Albuquerque: A Narrative History.* University of New Mexico Press, Albuquerque.

A good history of the largest community on the Rio Grande from its origin to the present day. The author includes some discussion of the early acequia system which sustained the agriculture economy of the area until the advent of the railroad in the late 19th century.

1983 New Mexico's Colonial Agriculture. *El Palacio* 89:310.

A short but useful summary of Hispanic and Puebloan agricultural practices that is based upon the author's extensive research over the years on Spanish colonial settlement in New Mexico. The author discusses the effects upon the Puebloans of the introduction of new crops by Hispanic settlers, the impact of the Little Ice Age (1450–1850) on colonial agriculture, and the level of agricultural technology.

Smith, E.R.

1936 *A Report on the Rio Grande Watershed with Special Reference to Soil Conservation Problems.* USDA Soil Conservation Service, Region 8, Albuquerque.

A good summary of the interrelated problems in the Rio Grande watershed of soil and water conservation. The prevention of erosion and the maintenance of vegetative cover on the upper watersheds of the Rio Grande and its tributaries was deemed essential for the protection of irrigated lands in the valleys. The report suggested means to deal with these problems after careful analysis of the causes.

1938 *Annual Report for Fiscal Year Ending June 30, 1938, Rio Grande District.* USDA Soil Conservation Service, Region 8, Albuquerque.

In addition to a discussion of SCS activities in the areas of erosion control, range management and stock reduction, the progress of the Rio Grande Survey and the Human Dependency Surveys is also presented.

Snow, David H.

1979 Rural Hispanic Community Organization in Northern New Mexico: An Historical Perspective. In Paul Kutsche, *The Survival of Spanish American Villages.* Colorado College, Colorado Springs, pp. 45–52.

A brief discussion of the settlement systems in the Spanish, Mexican, and early American periods. The small number of formal towns and the predominance of small villages are seen as characteristic of the region. Most settlements were found on community land grants and were composed of straggling collections of ranchos with no formal plaza.

Stewart, H.C.

1936 *Measures of Erosion Control and Soil Conservation Practices by Type-of-Farming Subregion: Agronomy, Animal Husbandry, Agricultural Economics, Horticulture, and Irrigation.* USDA Soil Conservation Service, Region 8, Albuquerque.

A brief presentation of erosion control and soil conservation practices of importance to irrigation agriculture among other elements. Basically this is a summary of information gathered and presented in the Human Dependency reports for the Northern Rio Grande Valley of New Mexico. For irrigated lands, the author found improper land-use and inappropriate farming methods to be the greatest problems.

Strahorn, A.T.
1914 Soil Reconnaissance of the Palomas, Rincon, and El Paso Valleys, New Mexico — Texas. Ms. on file, Bureau of Reclamation, District Office, El Paso.

A summary of agricultural development and irrigation, which includes maps of irrigation ditches and irrigable soils.

Stucky, H.R. (ed.)
1956 *Water Resources and their Economic Importance in New Mexico.* New Mexico College of Agriculture and Mechanical Arts, Agricultural Economics Department, Special Report No. 1, State College, New Mexico.

A collection of papers presented to a seminar at what is now New Mexico State University (Las Cruces). All of the papers are brief but the three most important are those of Morris Evans on surface water studies, Leon Hill on irrigation development by the Bureau of Reclamation and John L. Gregg on the problems of the Elephant Butte Irrigation District.

Sullivan, Vernon L.
1908 First Biennial Report of the Territorial Engineer, 1907–1908. Ms. on file, State Engineer's Office, Santa Fe.

A good summary of irrigation development in New Mexico since the establishment of the Office of the Territorial Engineer. The report also contains a list of irrigation projects in New Mexico and a table of applications for future development.

1909 *Irrigation in New Mexico.* USDA Office of Experimental Stations, Bulletin 215. U.S. Government Printing Office, Washington, D.C.

A summary of the water resources of New Mexico, a brief history of irrigation development and a prospectus on future development of irrigation agriculture. The report also includes a discussion of the projects in New Mexico of the recently established U.S. Reclamation Service.

Sunseri, Alvin
1973 Agricultural Techniques in New Mexico at the Time of the Anglo-American Conquest. *Agricultural History* 49:329–337.

A study of the riverine culture of the Puebloan and Hispanic inhabitants of New Mexico which was tied to permanent water courses in the Rio Grande Valley and its tributaries. Access to perennial streams was necessary to sustain irrigation agriculture that was vital to the survival of the province. The article also discusses the early Anglo-American impressions of New Mexico agriculture.

Swadesh, Frances L.
1974 *Los Primeros Pobladores: Hispanic Americans of the Ute Frontier.* University of Norte Dame Press, South Bend.

An important description and analysis of Hispanic settlement and activities in the Chama and San Juan River Valleys during the 18th, 19th, and early 20th centuries. The vital role of irrigation agriculture to the success of Hispanic expansionism is clearly delineated. Because of the legal

requirements attendant upon a legal land grant, irrigation systems were an early and permanent part of Hispanic villages and their economies in northern New Mexico. The study includes a good bibliography.

Taylor, Marlowe M.
1960 *Rural People and Their Resources, North-Central New Mexico.* Agricultural Experiment Station Bulletin 448. New Mexico State University, Las Cruces.

A useful discussion of the condition of agrarian society in north-central New Mexico which serves in a sense as an interesting continuation of the earlier Human Dependency Survey of the U.S. Soil Conservation Service.

Taylor, William B.
1975 Land and Water Rights in the Viceroyalty of New Spain. *New Mexico Historical Review* 50:189–201.

A preliminary study of issues which were more comprehensively treated in the author's larger analysis of colonial land and water rights in the Viceroyalty of New Spain as they applied to New Mexico which was prepared for the case of *The State of New Mexico vs. R. Lee Aamodt et al.*

1982 Colonial Land and Water Rights in New Mexico Indian Pueblos. Prepared for the Case of *The State of New Mexico vs. R. Lee Aamodt.* Ms. on file, U.S. Attorney's Office, Albuquerque.

A thorough study of land and water rights which covers much of the same ground as Meyer's study *Water in the Hispanic Southwest.* Though the two authors appeared on opposite sides of the *Aamodt* case, they arrived at essentially the same conclusions regarding land and water rights. Taylor's study does, however, serve to clarify and correct some of Meyer's interpretations.

Thompson, John C.
1957 Conditions of Irrigated Sections of Middle Rio Grande in New Mexico. In *Problems of the Upper Rio Grande, An Arid Zone River*, pp. 27–29. U.S. Commission for Arid Resource Improvement and Development Publication No. 1. Washington, D.C.

A very brief summary of the problems attendant upon irrigation in the Middle Rio Grande Valley of New Mexico. The study does not cover any new ground but is useful as a concise summation of previous analyses.

Tittman, Edward D.
1927 The First Irrigation Lawsuit. *New Mexico Historical Review* 2:363–368.

A narrative discussion of the 1855 case of the *Pueblo of Acoma vs. The Pueblo of Laguna* over the rights of the respective pueblos to the waters of the Rio San Jose which were vital to their pursuit of irrigation agriculture. This lawsuit was the first case filed in the District Court for the 3rd Judicial District of the Territory of New Mexico.

Toulouse, Joseph R., Jr.
1945 Early Water Systems at Gran Quivira National Monument. *American Antiquity* 10(4):362–372.

A controversial study of the alleged irrigation system at Gran Quivira National Monument.

Twitchell, Ralph E.
1914 *The Spanish Archives of New Mexico*, 2 Vols. Torch Press, Cedar Rapids, Iowa.

A descriptive inventory and summary of selected documents of the Spanish colonial archives then housed in the Office of the U.S. Surveyor General and subsequently in the custody of the Secretary

of the Territory and ultimately in the State Records Center and Archives, Santa Fe. The collection contains numerous documents of importance to the study of irrigation agriculture in the Rio Grande Valley of colonial New Mexico (1598–1821).

U.S. Army Corps of Engineers

1882 Land Classification Map of Part of Central New Mexico. Atlas, Expeditions of 1873–1878. U.S. Army Corps of Engineers, Washington, D.C.

The earliest land classification map of lands in New Mexico. This particular map was a result of surveys undertaken by the U.S. Corps of Topographical Engineers and contained information valuable to the study of irrigated and irrigable lands along the Rio Grande.

U.S. Department of Commerce, Bureau of the Census

1790–1970 Records of the Decennial Census. National Archives Record Group No. 29. Washington, D.C.

The schedules of agriculture for 1850, 1860, 1870, 1880, and 1900 are important sources of data on irrigation agriculture as practiced in New Mexico.

1940a Irrigation of Agricultural Land — New Mexico. 16th Census of the United States. U.S. Government Printing Office, Washington, D.C.

A brief but useful summary of the condition of irrigation agriculture in New Mexico at the end of the Depression.

1940b 16th Census of the United States — Irrigation: Rio Grande Reclamation Project in New Mexico and Texas. Ms. on file, Bureau of Reclamation, Regional Office, Amarillo.

A presentation of very useful information on location, water rights, lands, drainage, description of works (i.e., facilities), capital investments and financing, maintenance and operation, and quantity of water used in 1939 for each of the irrigation districts within the Rio Grande Project.

USDA Agricultural Stabilization and Conservation Service

1967 New Mexico Special ACP Project, Rehabilitation of Community Irrigation Ditches. Ms. on file, New Mexico State Engineer's Office, Santa Fe.

Essentially a summary of costs and expenditures which gives some idea of the condition of community irrigation ditches.

USDA Soil Conservation Service

1919–1953 Soil Conservation Reports: Rio Grande. Special Collections, Zimmerman Library, University of New Mexico, Albuquerque.

An important archival collection which contains a number of Soil Conservation Service reports which are not available elsewhere in the region. These as well as the rest of the relevant reports are discussed below and in other parts of this bibliography.

1935–1939 Tewa Basin Study, 3 Vols. Soil Conservation Service, Albuquerque. Special Collections, Zimmerman Library, University of New Mexico, Albuquerque.

Probably the most important document produced by the Soil Conservation Service as part of its Human Dependency Surveys in northern New Mexico during the late 1930s. The separate volumes discuss the Indian Pueblos, Spanish-American villages, and the reports of physical surveys including irrigated lands. The first two volumes both give considerable attention to irrigation agriculture and its role in the subsistence economies of the Indian and Hispanic populations of northern New Mexico.

1936a The Significance of Human Use of Resources within the Rio Grande Watershed. Ms. on file, Soil Conservation Service, Southwest Regional Office, Albuquerque.

A summary of the Soil Conservation Service's Human Dependency Surveys in the year 1936. These activities were focused in the Rio Arriba area of the Rio Grande Valley where the Indian and Hispanic populations were concentrated in small villages. Both ethnic groups were subsistence farmers who were primarily dependent on limited irrigation systems along permanent tributaries of the Rio Grande. A secondary focus of the report was on the Middle Rio Grande Valley where the activities of the Middle Rio Grande Conservancy District were having some impact on local irrigation systems.

1936b The Sociological Survey of the Rio Grande Watershed. Ms. on file, Soil Conservation Service, Southwest Regional Office, Albuquerque.

An explication of the background for Human Dependency Surveys in the Española and Mesilla Valleys. The different character of irrigation agriculture in the two valleys appears to be primarily the result of the presence of large-scale federal reclamation projects in the Mesilla Valley and their absence in the Española Valley.

1936–1940 Records of the U.S. Soil Conservation Service. Rio Grande Historical Collection No. 190. Branson Library, New Mexico State University, Las Cruces.

The collection includes the General Survey Files of the Soil Conservation Service on communities in the northern Rio Grande Valley of New Mexico. The 1940 Survey of Economic Conditions in the Elephant Butte Irrigation District is also contained in this collection; this report contains valuable information on the Mesilla Valley.

1938 *Sub-Watershed Plan for the Rio Chama above Española, New Mexico.* Soil Conservation Service, Southwest Regional Office, Albuquerque.

A regional study which recommends the need for farm and range management programs in the Chama Valley in order to increase agricultural production and reduce abusive grazing and agricultural practices. The study found the local population to have already developed and to be intensively utilizing virtually all of the arable land in irrigation agriculture; this circumstance limited the possibilities for agrarian reform.

1940 The Rio Grande above El Paso. Ms. on file, Soil Conservation Service, Southwest Regional Office, Albuquerque.

A study of the development of surface water supplies in the Rio Grande Valley. This report is taken primarily from previous Soil Conservation Service and U.S. Reclamation Service reports.

USDI Bureau of Indian Affairs

1849–1880 Records of the New Mexico Superintendency of Indian Affairs. National Archives Record Group No. 75. Washington, D.C.

The correspondence and administrative records of the New Mexico Superintendency. The reports of the Pueblo Indian Agents are particularly useful for their information on agricultural practices and production as well as the conditions of Indian irrigation and irrigation systems.

1905–1935 Records of the Irrigation Division. National Archives Record Group No. 75. Washington, D.C.

The records, reports, and correspondence of the Irrigation Division which was formally established in 1924 but includes the records of earlier administrative units such as the Indian Irrigation Service which in New Mexico was responsible for the development, construction, and maintenance of various

irrigation projects for the Pueblo Indians (primarily in the Rio Grande Valley). The files include maps of irrigation projects, cultivated areas, canals, and ditches.

USDI Bureau of Reclamation

1902–Present *Annual Reports*. Government Printing Office, Washington, D.C.

The annual report of the director of the Bureau of Reclamation and of its predecessor the U.S. Reclamation Service. These reports summarize the local project reports.

1902–Present Records of the Bureau of Reclamation. National Archives Record Group No. 115. Washington, D.C. and Federal Records Center, Denver, Colorado.

The records of the development of surface water supplies for the reclamation of arid and semi-arid lands by the U.S. Reclamation Service and the Bureau of Reclamation. The files include extensive cartographic records of the Bureau and its predecessor the U.S. Reclamation Service as well as the general administrative records of both agencies.

1910–1942 Crop Census Reports. Ms. on file, Bureau of Reclamation, Regional Office, Amarillo.

Annual reports of crops and their values. The reports are presented by district and include a detailed breakdown by agricultural corp showing production, yields, and values within the Rio Grande Project area.

1912–1984 Rio Grande Project: New Mexico — Texas, Project Histories. On file, Bureau of Reclamation, District Office, El Paso.

Comprehensive year-by-year presentations of construction and maintenance within the Rio Grande Project area from Elephant Butte Reservoir to El Paso; the reports include reclamation activities along the tributaries of the river but focus on the main stem region. These annual reports also include investigations toward future work as well as copies of important miscellaneous correspondence relevant to the Rio Grande Project. The volumes generally include drafted maps and engineering plans and are particularly voluminous during periods of major construction.

1914–1919 Rio Grande Project, New Mexico — Texas, Surveys of Community Ditches, Mesilla Valley. Maps on file, Bureau of Reclamation, District Office, El Paso.

Cartographic records of U.S. Reclamation Service surveys of approximately 18 community ditch systems in the Mesilla Valley.

1930–1970 Rio Grande Project: Irrigable Area and Property Maps, Elephant Butte Irrigation District — Rincon and Mesilla Valleys. On file, Bureau of Reclamation, District Office, El Paso.

These maps show all dams, diversions, canals, laterals, drains, and levees as well as irrigable areas in the Rincon and Mesilla Valleys. The maps also list all U.S. Bureau of Reclamation property by grantor, type of transfer and date of transfer.

1933–1953 El Vado Dam Files. On file, Bureau of Reclamation, Regional Office, Amarillo, Texas.

Files on construction and maintenance for El Vado Dam in north-central New Mexico.

1945 *The Rio Grande Basin: Colorado — Texas*. Bureau of Reclamation, Regional Office, Amarillo.

A good general study of irrigation development in the Rio Grande Basin, which is divided into sub-basin areas for more comprehensive discussions of the conditions of irrigation agriculture, irrigation

development, and recommendations for future development. Land use and water use studies are a valuable part of this volume.

1946 *Comprehensive Plan for Water Resources Development: Middle Rio Grande Project, Rio Grande Basin, New Mexico.* Bureau of Reclamation, Regional Office, Amarillo.

A report on current conditions of irrigation in the Middle Rio Grande Valley with plans for future development. The report also analyses economic costs and benefits of water resources development in the Middle Rio Grande Valley.

1947 Rio Grande Project: Land Pattern Studies. Ms. on file, Bureau of Reclamation, Regional Office, Amarillo.

A study of the ownership of irrigated and irrigable acreages in excess of 160 acres, which provides useful description of ownership and owners. The volume also includes a comparison of land ownership patterns from 1939 to 1947.

1950 Special Report on the San Juan — Chama Project, New Mexico. Ms. on file, Bureau of Reclamation, District Office, El Paso.

An evaluation of proposed alternative uses of water allocated to New Mexico under the Upper Colorado River Compact. The study includes plans for the development of irrigation.

1951–1983 Middle Rio Grande Project, Annual Project History, vols. 1–33. On file, Bureau of Reclamation, District Office, Albuquerque.

Comprehensive annual reports on construction and operations of the Middle Rio Grande Project. The annual volumes are comparable in scope to those for the Rio Grande Project, discussed above.

1955 Plan of Development of the San Juan — Chama Project, Colorado — New Mexico and Appendices 1–8. Bureau of Reclamation, Region 5, Amarillo. On file, Bureau of Reclamation, District Office, Albuquerque.

A massive report which focuses on the plan for development of the San Juan — Chama Project and its impact on the agricultural economy and other effects. The appendices include reports from the Bureau of Mines, the National Park Service, and the U.S. Fish and Wildlife Service as well as descriptions of area projects related to the main project. The main body of the report contains a good synopsis of previous irrigation development within the project area and a discussion of previous investigations related to the San Juan — Chama trans-basin diversion proposal.

1960a Reconnaissance Report on the Rio Grande Water Salvage Project: Colorado — New Mexico. Bureau of Reclamation, Region 5, Amarillo. On file, Bureau of Reclamation, District Office, Albuquerque.

Essentially a hydrological study but includes a number of maps which show irrigated lands, bosque, canals, ditches, etc.

1960b *A Coordinated Report on the San Juan — Chama Project, Colorado — New Mexico, and the Navajo Indian Irrigation Project, New Mexico.* 86th Congress, 2nd Session, House Document No. 424. U.S. Government Printing Office, Washington, D.C.

A comprehensive study of the proposed projects, including background analysis and an evaluation of costs. The plan for development gives particular attention to irrigation and the agricultural economy of the areas within the projects as well as the benefits to both from the projects. The report includes photographs, maps, and tables summarizing the primary data.

1961 Design, Construction, Operation, and Maintenance: Canal and Lateral Systems. Ms. on file, Bureau of Reclamation, Regional Office, Amarillo.

Correspondence files regarding design, construction, operation, and maintenance, which are mostly reported in a more concise fashion in the project histories for the Rio Grande Project.

1962 Reconnaissance Report on Embudo Creek Basin, New Mexico. Bureau of Reclamation, Region 5, Amarillo. On file, Bureau of Reclamation, District Office, Albuquerque.

A study of settlement and water development as well as associated problems in the vicinity of Picuris Pueblo. The report found water and land resources to be limited and existing irrigation facilities to be crude and inefficient. Proposals are made for the construction of a storage facility and the rehabilitation of the ditch systems in the Embudo Valley. The maps of the existing irrigation facilities are particularly useful.

1963–1984 San Juan — Chama Project: Annual Project History, Vols. 1–23. On file, Bureau of Reclamation, District Office, Albuquerque.

Comprehensive annual presentation of construction progress, administration and operations of the San Juan — Chama Project in north-central New Mexico. The reports also include construction and operations data for tributary irrigation units in the Nambe, Española, and Taos areas. Most volumes have summaries of previous activities as they relate to present operations or construction. All volumes have a good photo-documentation.

1965a Reconnaissance Report on Barranca Project, New Mexico. Bureau of Reclamation, Region 5, Amarillo. On file, Bureau of Reclamation, District Office, Albuquerque.

A study of settlement and development, existing irrigation systems, the plan for development, agricultural economy, and an economic and financial analysis of the proposed project.

1965b Reconnaissance Report on El Rito Project, New Mexico. Bureau of Reclamation, Region 5, Amarillo. On file, Bureau of Reclamation, District Office, Albuquerque.

A good summary of previous agricultural activities and irrigation systems along this tributary of the Rio Chama. The report also discusses the existing condition of the irrigation facilities and proposes the development of an adequate regulated water supply and the rehabilitation of the existing ditches. Good maps of the irrigation systems are included in the report.

1965c Interim Report on Pojoaque Unit: San Juan — Chama Project. On file, Bureau of Reclamation, District Office, El Paso.

A useful analysis of conditions in the Pojoaque Valley, including hydrology and agricultural economy. The body of the report focuses on the construction of the Nambe Falls Dam, which was intended to regulate the streamflow of the Rio Nambe.

1965d Llano Unit of the San Juan — Chama Project and Santa Cruz Irrigation District. On file, Bureau of Reclamation, Regional Office, Amarillo.

Excellent maps of the irrigable land and existing ditch systems along the Rio Grande from Velarde to San Ildefonso and within the Santa Cruz Irrigation District.

1967 Reconnaissance Report on the Costella Project, Colorado — New Mexico. Bureau of Reclamation, Region 5, Amarillo. On file, Bureau of Reclamation, District Office, Albuquerque.

Similar to other reports of the same type. The report includes a summary of the settlement and development of the Rio Costella area, a history of previous investigations, farm irrigation systems, the agricultural economy of the area, engineering designs, cost estimates, and economic and financial analysis including the benefits to irrigation agriculture.

1972 Final Report on Llano Unit, San Juan — Chama Project. Bureau of Reclamation, Region 5, Amarillo. On file, Bureau of Reclamation, District Office, Albuquerque.

A report which delineates the plan for development within the Llano Unit, the hydrology of the area, the costs of the project, the economic benefits and a discussion of the existing irrigation systems.

1975a Draft Environmental Impact Statement for the Llano Unit of the San Juan — Chama Project. Bureau of Reclamation, Region 5, Amarillo. On file, Bureau of Reclamation, District Office, Albuquerque.

The impact of the proposed Llano Unit on the cultural and natural resources of the proposed project. A discussion of the socio-economic impact includes a good analysis of the effects on irrigation agriculture in the Santa Cruz Irrigation District, El Llano Conservancy District and San Juan Pueblo through a consolidation of the Rio Grande irrigators.

1975b *Final Environmental Impact Statement: Operation and Maintenance Program for the Rio Grande — Velarde to Caballo Dam, Rio Grande and Middle Rio Grande Projects*, 2 Vols. Bureau of Reclamation, Southwest Regional Office, Amarillo.

An environmental impact statement related to present and proposed operations and maintenance activities by the Bureau of Reclamation along the Rio Grande floodway from Velarde, New Mexico to Caballo Dam (New Mexico). The study contains a useful discussion of irrigation agriculture and excellent photographs and maps.

1976 New Mexico Water Resources: Assessment for Planning Purposes, 4 Vols. On file, Bureau of Reclamation, District Office, Albuquerque.

A massive study and compilation of data on the surface and ground water resources of New Mexico including the Rio Grande Valley.

1982 *Velarde Community Ditch Study, Rio Arriba County, New Mexico.* Bureau of Reclamation, Southwest Region, Amarillo.

A report on a reconnaissance survey of ditches with proposed improvements. Good maps of the existing diversions and dams are included, as well as photographs of current conditions of the facilities that are proposed for consolidation and rehabilitation.

USDI Census Office

1890 Report on Indians Taxed and Indians Not Taxed in the United States (except Alaska) at the Eleventh Census: 1890. Pg. 424–445. Government Printing Office, Washington, D.C.

A comprehensive discussion of conditions among the Pueblo Indians of New Mexico compiled by Special Indian Agent Henry R. Poore. The report contains valuable information on irrigation systems and irrigation agriculture as well as descriptive and statistical data on Puebloan farming.

USDI Water and Power Resources Service

1980 Elephant Butte Reservoir — Fort Quitman Project (New Mexico — Texas). Rio Grande Regional Environmental Project: Special Report. Bureau of Reclamation, Southwest Regional Office, Amarillo. On file, Bureau of Reclamation, District Office, El Paso.

An examination of existing and future water resources in the study area. The report seeks to provide a reliable basis for the orderly planning of future land and water use. The study also presents alternatives for better utilizing and managing existing water supplies, including those for irrigation agriculture.

1981 Project Data. Government Printing Office, Denver.

A compilation of summaries of all projects of the Bureau of Reclamation, with brief histories of their development, construction, and benefits.

U.S. Geological Survey

1888–1952 Records of Other Divisions and Branches: Irrigation Branch Report File. National Archives, Record Group 57. Washington, D.C.

The records of the Irrigation Branch whose findings have been reported in the Water Supply Irrigation Papers of the U.S. Geological Survey. These files include the background data for the reports.

U.S. Reclamation Service

1901–1902, 1931–1932 Annual Reports, Vols. 1–31. Government Printing Office, Washington, D.C.

Good yearly narrative summaries of the activities of the Reclamation service, which focus primarily on construction, maintenance, and finances.

1904 Irrigable Lands in the Mesilla Valley. 14 map sheets. Copies of the originals on file at the U.S. Bureau of Reclamation Office, El Paso, Texas.

A valuable collection of maps for the delineation of the history and development of irrigation agriculture in the Mesilla Valley of southern New Mexico.

1910–1924 Reclamation Record, Vols. 1–15(1). Government Printing Office, Washington, D.C.

A monthly publication of short articles, photographs, and maps on the activities of the U.S. Reclamation Service and their impact on agriculture, business, and daily life. The items are written by professionals within the U.S. Reclamation Service as well as local residents in the areas of reclamation projects. Summaries of legislative, judicial, and executive actions affecting water and its use are also provided in this popularizing publication.

1924–1931 *New Reclamation Era*, Vols. 15(2)–22. Government Printing Office, Washington, D.C.

A continuation of the Reclamation Record with the same focus and substance.

1928 Report on Irrigable Areas, Rio Grande Project, Together with Construction Work Required for Completion of the Project and Allocation of Project Costs to the Two Irrigation Districts. Ms. on file, Bureau of Reclamation, Regional Office, Amarillo, Texas.

The title of the report is voluminously self-descriptive. The body of the report consists of tables of data regarding costs, but it also has a group of excellent maps of the status of lands in the Rincon and Mesilla Valleys for 1928.

1932–Present *The Reclamation Era*, Vols. 23. Government Printing Office, Washington, D.C.

A continuation of New Reclamation Era, which by the 1960s had evolved into a glossy publication with less substance than the earlier publications of the U.S. Reclamation Service.

U.S. Senate, Committee on Indian Affairs

1931–1932 *Survey of Conditions of the Indians in the United States: Hearings before a Subcommittee of Indian Affairs*, Parts 19 and 20. Government Printing Office, Washington, D.C.

A valuable survey and assessment of the conditions of Indians including the Pueblos of New Mexico. Economic conditions were a major concern of the subcommittee in these hearings; consequently, the reports contain important information on Puebloan agriculture.

U.S. Senate, Special Committee on Irrigation and Reclamation of Arid Lands

1890 *Report of the Special Committee of the U.S. Senate on Irrigation and Reclamation of Arid Lands.* 51st Congress, 1st Session, Senate Report No. 928, Parts 1–6. U.S. Government Printing Office, Washington, D.C.

A massive congressional report on irrigation and reclamation of arid lands in the western United States. The separate parts consist of regional analyses in parts 1–3 which includes information on the Rio Grande Valley of New Mexico. The fourth part includes statements of the officials of the U.S. Geological Survey and a revised version of Hinton's report on irrigation in the United States to the 49th Congress.

U.S. Surveyor General of New Mexico

1854–1891 Letters sent by the Surveyor General of New Mexico to the General Land Office. National Archives Record Group No. 49. Washington, D.C.

Because of the role of the Surveyor General in the settlement of large areas of New Mexico and the settlement of boundary disputes in private lands claims, these correspondence files include useful information on irrigation systems in certain parts of the Rio Grande Valley, especially the Mesilla Valley.

1855–1887 Records of Private Land Claims Adjudicated by the U.S. Surveyor General. New Mexico State Records Center and Archives, Santa Fe.

The records of 22 Pueblo and 162 private lands claims heard by the U.S. Surveyor General. The files include original documents from the Spanish and Mexican periods as well as oral testimony of the claimants. Discussions of irrigation agriculture and irrigation systems have an important role in the records due to the nature of Spanish and Mexican land grant procedures.

Vandertulip, J.J. and John R. Erikson

1954 Irrigated lands in New Mexico. Ms. on file, State Engineer's Office, Santa Fe.

A tabular summary of irrigated acreages in New Mexico, including the Rio Grande Valley.

Van Ness, John R.

1979 Hispanic Village Organization in Northern New Mexico. In *The Survival of Spanish American Villages*, edited by Paul Kutsche, pp. 21–44. Colorado College, Colorado Springs.

A discussion of the social and corporate organization of Hispanic communities in northern New Mexico. Environmental and economic factors made corporate landholdings and management of resources necessary for the survival of these village communities. This corporate management included the community ditch association for the distribution of water for agriculture.

Van Ness, John R. and Christine M. Van Ness

1980 *Spanish and Mexican Land Grants in New Mexico and Colorado.* Sunflower University Press, Manhattan, Kansas.

Mostly directed toward land claims but does include some information on irrigation within the land grants.

Vivian, Gordon

1932 *Restudy of the Province of Tiguex.* Unpublished M.A. Thesis, University of New Mexico, Albuquerque.

An attempt to identify the early historic pueblos in the middle Rio Grande Valley which includes some information on agricultural systems.

Vivian, R. Gwinn

1974 Conservation and Diversion: Water-Control Systems in the Anasazi Southwest. In *Irrigation's Impact on Society*, edited by T.E. Downing and M. Gibson, pp. 95–112. University of Arizona Anthropological Papers No. 25. Tucson.

A good study in that it differentiates between prehistoric water conservation and water diversion systems. The author also distinguishes between the sources of water, namely rainfall, permanent water, and run-off. The analysis of archaeological data found few water control systems before AD 1400 and, except for the poorly documented ditches along El Rito Creek and in the Pojoaque Basin, few water diversion systems at any time before the late 16th century.

Vlasich, James A.

1980a *Pueblo Indian Agriculture, Irrigation and Water Rights.* Unpublished Ph.D. Dissertation, University of Utah, Logan.

An extensive study of Puebloan agriculture and irrigation which is directed toward an establishment of historical water rights. Though simplistic and superficial with regard to Anasazi and early historic Puebloan agriculture, the study does provide a comprehensive overview of major issues and developments in Puebloan irrigation and irrigation systems during the 18th, 19th, and first half of the 20th century. Most of the research for the American period is taken from original sources. This dissertation could have benefited from more maps.

1980b Transitions in Pueblo Agriculture, 1938–1948. *New Mexico Historical Review* 55:25–46.

An examination of government programs that affected Puebloan agriculture. Particular attention is given to those technical assistance programs that attempted to develop the full potential of Puebloan farmlands and to resolve water supply problems. The study is based primarily upon government documents.

Wagner, G.M.

1954 History of the San Acacia Diversion Dam and Weir. Ms. on file, Middle Rio Grande Conservancy District Office, Albuquerque.

A narrative account of the actual construction of the San Acacia Diversion Dam, with photographs.

War Production Board, Food Production Administration

1943 Irrigated Areas of New Mexico — Arranged by Natural Surface and Water Supply Areas. Ms. on file, Middle Rio Grande Conservancy District Office, Albuquerque.

A tabular summary of irrigated areas of New Mexico by basin and stream system.

Water Resources Research

1965–Present *Water Resources Research.* American Geophysical Union, Washington, D.C.

Mostly technical papers from the social and natural sciences water resources. The studies focus on the physical, chemical, and biological sciences; economics; systems analysis; sociology; and law as related to the use and development of water resources.

Weber, David J.

1982 *The Mexican Frontier, 1821–1846: The American Southwest under Mexico.* University of New Mexico Press, Albuquerque.

An excellent study of the northern territories of the Mexican Republic including New Mexico. A discussion of economic developments is a substantial contribution by this volume.

Weigle, Marta (ed.)

1973 *Hispanic Villages of Northern New Mexico* (reprint: originally published as the 1935 Tewa Basin Study, Vol 2. Soil Conservation, Albuquerque). The Lightning Tree, Santa Fe.

A reprint of volume 2 of the Tewa Basin Study of the U.S. Soil Conservation Service. The editor has added an explanatory introduction, notes and an extensive bibliography.

Welsh, Michael E.

1985 *A Mission in the Desert: Albuquerque District, 1935–1985.* U.S. Army Corps of Engineers, Albuquerque District. Albuquerque.

A good study of the role of the U.S. Army Corps of Engineers in New Mexico, West Texas, and Southwestern Colorado. The focus of the study is upon the impact of the Corps and its projects on the growth and economic development of the desert Southwest. Water policy and interagency relations were a major factor in the activities of the Corps.

Wendorf, Fred

1953 *Salvage Archaeology in the Chama Valley, New Mexico.* School of American Research Monographs No. 17. Santa Fe.

A report of excavations at two late prehistoric Puebloan sites in the Chama Valley. Irrigation agriculture is alleged to have been associated with the sites but insufficient details are provided in order to assess that hypothesis.

Westphall, Victor

1965 *The Public Domain in New Mexico, 1854–1891.* University of New Mexico Press, Albuquerque.

An important study of the surveys of public land and its disposition under the Homestead Act of 1862 and the Desert Lands Act of 1877. Due to environmental necessities, settlement was focused on sources of water, mainly for livestock but also for agriculture. Homesteading in the Rio Grande Valley was limited essentially to the Mesilla and Rincon Valleys due to the longstanding and intensive settlement of the middle and upper Rio Grande Valley by Hispanic and Puebloan residents of the Territory of New Mexico before the second half of the 19th century.

1983 *Mercedes Reales: Hispanic Land Grants of the Upper Rio Grande Region.* University of New Mexico Press, Albuquerque.

An excellent appraisal of the establishment of land grants in the upper Rio Grande area under the Spanish and Mexican regimes and the ultimate disposition of these claims under the Treaty of Guadalupe Hidalgo by the U.S. Surveyor General and the Court of Private Land Claims. This thorough, though not exhaustive, study is an essential work for an understanding of the complexities of the land grant problem and its effects upon the settlement and economy of the Territory of New Mexico.

White, Leslie A.
1935 *The Pueblo of Santo Domingo, New Mexico.* Memoirs of the American Anthropological Association 43. Menasha, Wisconsin.

A good ethnographic/anthropological study of the Indians of the Pueblo of Santo Domingo which does provide some information on agricultural practices.

Whiteman, William
1947 *The Pueblo Indians of San Ildefonso: A Changing Culture.* Columbia University Press, New York.

A useful ethnographic study of the Indians of the Pueblo of San Ildefonso in north-central New Mexico which provides some information on Puebloan agricultural practices.

Widdison, Jerold G.
1958 *Historical Geography of the Middle Rio Puerco Valley, New Mexico.* Unpublished M.A. Thesis, University of Colorado, Boulder.

An excellent overview of the vicissitudes attendant upon settlement in and agricultural exploitation of the Rio Puerco Valley by prehistoric and historic Indian populations and by historic Hispanic populations in the mid-18th century and late 19th/early 20th century. The difficulties of irrigation agriculture, which was essential for the survival of the Hispanic communities, ultimately overwhelmed the Hispanic settlers. This study clearly delineates the impediments to irrigation agriculture along not only the Rio Puerco but also many other systems in the Rio Grande Basin in New Mexico.

Wilson, J.P.
1985 *Between the River and the Mountains: A History of Early Settlement in Sierra County, New Mexico.* Report No. 40. Las Cruces, New Mexico.

An excellent study of settlement in Sierra County during the late 19th and first part of the 20th century. A major contribution of this work is a thorough examination of irrigation agriculture and irrigation systems on Alamosa, Cuchillo Negro, Palomas, Seco, Las Animas and Percha Creeks from the late 19th century to the late 1930s. The study is complemented by an extensive bibliography.

Woodbury, Richard B.
1963 Evidence of Prehistoric Farming in the Vicinity of Picuris, New Mexico. Ms. on file, Laboratory of Anthropology, Museum of New Mexico, Santa Fe.

While some evidence of prehistoric agriculture appears to have survived on the valley slopes, the author proposes that possible evidence of irrigation agriculture, if any, would have been destroyed by historic agriculture. A good demonstration of the difficulties of identifying prehistoric irrigation facilities even in likely locations.

Worster, Donald
1985 *Rivers of Empire: Water, Aridity and the Growth of the American West.* Pantheon Books, New York.

An interesting study of the interconnections of water, aridity, and growth in the lands west of the 100th meridian in the period since the American Civil War. Some introductory material on Indian and Hispanic irrigation is included; there is also a good discussion of Mormon irrigation practices. The main focus of the work however is on the institutional organization of reclamation and irrigation projects in the American West and their impact upon American society in the Arid West. The study is somewhat weakened by an attempt to interpret developments through a revisionist Marxist and neo-Wittfogelian framework. The author is particularly interested in the growth of bureaucratic involvement in irrigation development and the controls which bureaucracy has come to have over the

economic life of the West. While one might disagree with some of his more ideological analyses, the author does raise serious questions regarding the facade of rugged individualism which Westerners like to believe about themselves.

Wortman, Richard A.

1971 *Environmental Implications of Surface Water Resource Development in the Middle Rio Grande Drainage, New Mexico.* Unpublished M.A. Thesis, University of New Mexico, Albuquerque.

A study of the effects of surface water development in the 20th century along the Middle Rio Grande. The focus of the study is on the large, federally funded projects and includes an assessment of the impacts of the Middle Rio Grande Conservancy District, the Middle Rio Grande Project and the San Juan — Chama Diversion.

Yeo, Herbert W.

1910a General Description of the Rio Grande Valley from White Rock Canyon of the Rio Grande to Old Fort Craig, New Mexico. U.S. Reclamation Service, El Paso. Ms. on file, Bureau of Reclamation, Regional Office, Amarillo.

A good general description of conditions in the Middle Rio Grande Valley of New Mexico, which includes valuable information on irrigation.

1910b Report on Hydrographic and Irrigation Conditions in the Rio Grande Valley, New Mexico. U.S. Reclamation Service, El Paso. Ms. on file, Rio Grande Historical Collection 94, Branson Library, New Mexico State University, Las Cruces.

A very valuable compilation of information on hydrology and irrigation in the Rio Grande Valley of New Mexico. The report is based upon records from the Office of the Territorial Engineer (New Mexico) and upon field investigations. Most of the volume consists of a detailed discussion of each ditch, beginning at San Marcial on the main stem of the Rio Grande and working upstream systematically. Each irrigation system in all of the tributaries are discussed in a similar fashion. A number of excellent photographs are also included in the report.

1910–1941 *Elephant Butte Irrigation District Reports.* Rio Grande Historical Collection 94. Branson Library, New Mexico State University, Las Cruces.

A collection of technical reports prepared for the Elephant Butte Irrigation District and other governmental entities by one of the most important irrigation engineers of this century. The files also include numerous photographs of Elephant Butte Reservoir and the Rio Grande Valley.

1920–1951 Records of Surveys of Archaeological Sites in Southern New Mexico. On file, New Mexico Historic Preservation Division, Santa Fe.

This important collection of archaeology data includes separate reports on the archaeological work of Yeo in Sierra, Socorro, Doña Ana, Sandoval, Valencia, and Bernalillo counties in 10 individual manuscript volumes. The most intensive attention was given to Doña Ana, Sierra, and Socorro Counties.

1929 Report on Investigations in the Rio Grande Basin in Texas above Fort Quitman and in New Mexico during 1907, 1920, and 1928. Office of the State Engineer, Santa Fe.

An extremely important and massive study of irrigation and irrigation systems in the Rio Grande Valley with particular attention to those parts in New Mexico. In addition to an overview of development, the report summarizes previous investigations by Yeo and others including Follett, Perkins, and Hamele. The report includes extensive and often detailed discussions of irrigation

systems throughout the Rio Grande Valley. He also extracts from reports by H.F. Robinson and Philip Harroun as well as his own study of 1910 for the U.S. Reclamation Service.

1930 Reconnaissance of Irrigation and Water Resources in New Mexico, Utah, and Colorado. Ms. on file, State Engineer's Office, New Mexico.

A diary of a reconnaissance of irrigation and water resources with numerous photographs attached. Unfortunately very little information is included for New Mexico.

1935 Report on the Rains of August 20, 1935 in the Northern Part of the Rio Grande Basin in New Mexico and the Floods Resulting Therefrom. Soil Conservation Service, Rio Grande Project. Ms. on file, Soil Conservation Service, Albuquerque.

A good first-hand account of the floods of August 1935 with extensive photo-documentation. This report provides a good discussion of the effects of floods in the Rio Grande Valley upon irrigation agriculture and irrigation systems.

1938 Report on Chama River Watershed. USDA Soil Conservation Service, Rio Grande District. Ms. on file, Rio Grande Historical Collections 94, Branson Library, New Mexico State University, Las Cruces.

A report consisting mostly of statistical tables on streamflows and siltloads, with photographs but very little narrative.

1939 Report on Surveys, Examinations and Investigations Made near San Marcial, New Mexico during 1936, 1937, and 1938. 2 Vols. Soil Conservation Service, Rio Grande District. Ms. on file, Rio Grande Historical Collection No. 94, Branson Library, New Mexico State University, Las Cruces.

A collection of government reports, memoranda, photographs, and newspaper accounts of floods and their impact on the area around San Marcial, New Mexico. The consequences for irrigation agriculture were particularly significant.

1940 Preliminary Examination Report: Run-Off and Water Flow Retardation and Soil Erosion Prevention for Flood Control Purposes — The Rio Grande Watershed (above El Paso, Texas). Ms. on file, Rio Grande Historical Collection No. 94, Branson Library, New Mexico State University, Las Cruces.

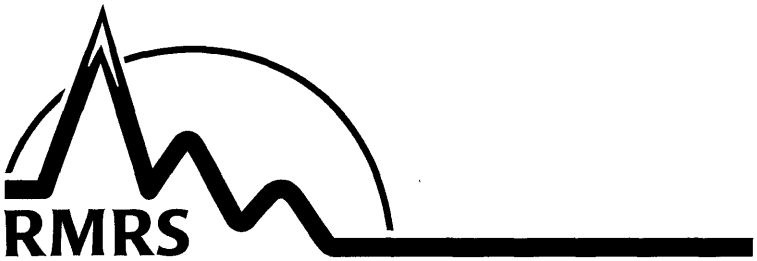
While the focus of the report is on floods and flood control, the effects of floods on irrigation systems and irrigation agriculture are also addressed.

1943a Data on Rio Grande Floods Prior to 1943. U.S. Army Corps of Engineers, Albuquerque District. Ms. on file, Bureau of Reclamation, District Office, El Paso.

A general study which is essentially a collection of narrative and contemporary accounts of floods along the Rio Grande before 1943.

1943b Data on Rio Grande Tributaries Prior to 1943. U.S. Army Corps of Engineers, Albuquerque District. Ms. on file, Bureau of Reclamation, District Office, El Paso.

A valuable compilation of data which includes a summary on irrigation with an estimate of total irrigated acreage along both permanent and intermittent streams. The main focus of this report is, however, on floods and siltation.



The Rocky Mountain Research Station develops scientific information and technology to improve management, protection, and use of forests and rangelands. Research is designed to meet the needs of National Forest managers, federal and state agencies, public and private organizations, academic institutions, industry, and individuals.

Studies accelerate solutions to problems involving ecosystems, range, forests, water, recreation, fire, resource inventory, land reclamation, community sustainability, forest engineering technology, multiple use economics, wildlife and fish habitat, and forest insects and diseases. Studies are conducted cooperatively, and applications can be found worldwide.

Research Locations

Flagstaff, Arizona
Fort Collins, Colorado*
Boise, Idaho
Moscow, Idaho
Bozeman, Montana
Missoula, Montana
Lincoln, Nebraska
Reno, Nevada
Albuquerque, New Mexico
Rapid City, South Dakota
Logan, Utah
Ogden, Utah
Provo, Utah
Laramie, Wyoming

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