CARLSBAD IRRIGATION DISTRICT
along the Pecos River
13 miles north to 15 miles southeast of
Carlsbad
Carlsbad Vicinity
Eddy County
New Mexico

HAER No. NM-4



WRITTEN HISTORICAL AND DESCRIPTIVE DATA

MEASURED DRAWINGS

HISTORIC AMERICAN ENGINEERING RECORD
National Park Service
Rocky Mountain Regional Office
Department of the Interior
Denver, Colorado 80225

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# HISTORIC AMERICAN ENGINEERING RECORD
# CARLSBAD IRRIGATION DISTRICT

## INTRODUCTION

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|---|---|
| Location: | Along the Pecos River in Eddy County, New Mexico, in the vicinity of the City of Carlsbad. |
| Quads: | Angel Draw; Bond Draw; Carlsbad East; Carlsbad West; Lake McMillan North; Lake McMillan South; Loving; Malaga; Otis |
| UTM: | listed on following page |
| Date of Construction: | Project features were constructed during the Project's period of historical significance, 1888 to 1949. Principal features were constructed in 1889, 1893, 1903, 1906-07, and 1911. |
| Present Owner: | United States Department of Interior, Bureau of Reclamation |
| Present Use: | Reclamation/Irrigation system |
| Significance: | The Carlsbad Irrigation District is nationally significant as an excellent surviving representation of a large turn-of-the-century reclamation system. The District includes significant engineering features constructed by nineteenth-century private entrepreneurs as well as early twentieth-century features constructed by the United States Reclamation Service. Many of the features were technologically innovative for their day. |
| Historians: | Mark Hufstetler and Lon Johnson, Renewable Technologies, Inc., February, 1991. |

CARLSBAD IRRIGATION DISTRICT

UTM REFERENCES

| UTM Number: | Location: | Easting: | Northing: |
|---|---|---|---|
| A | Lake McMillan area | 564630 | 3610020 |
| B | Lake McMillan area | 561720 | 3606340 |
| C | Lake McMillan area | 560140 | 3606170 |
| D | Lake McMillan area | 559190 | 3608580 |
| E | Lake McMillan area | 561430 | 3610830 |
| F | Lake Avalon area | 570580 | 3594770 |
| G | Lake Avalon area | 570250 | 3594780 |
| H | Lake Avalon area | 569160 | 3595720 |
| I | Lake Avalon area | 564800 | 3598530 |
| J | Lake Avalon area | 570450 | 3597000 |
| K | Lake Avalon area | 571900 | 3595260 |
| L | canal system | 569990 | 3590540 |
| M | canal system | 569920 | 3589860 |
| N | canal system | 572570 | 3591785 |
| O | canal system | 576710 | 3586260 |
| P | First National Bank of Eddy building | 572500 | 3586920 |
| Q | canal system | 571660 | 3584170 |
| R | canal system | 576840 | 3575180 |
| S | canal system | 580700 | 3570610 |
| T | canal system | 584730 | 3569660 |
| U | canal system | 581050 | 3566130 |
| V | canal system | 590850 | 3564880 |

The Carlsbad Irrigation District is located in UTM Zone 13.

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# CHAPTER 1: HISTORY OF PRIVATE IRRIGATION EFFORTS

## A: Introduction

In much of the American West, the histories of agricultural activity and farm settlement patterns are directly tied to the availability and sources of useable water supplies. While hopeful immigrant farmers in the developing West routinely assumed that rainfall and other passive water sources would provide the necessary moisture for their crops, this was not true for much of the obviously arid southwest. Here, from the beginning, irrigation was seen as a necessary component of any large-scale agricultural activity. This concept did not originate with the southwest's Anglo-American settlers; the region was largely unique in America's western frontier in that irrigation was not a new concept, but rather a economic tradition dating back centuries. Members of both the southwest's Native American and Hispanic societies regularly watered small fields by constructing modest canal networks, often fed by short-lived brush diversion dams across nearby streams and rivers. This technology was highly vulnerable to flooding and drought, both seemingly common in many southwestern river valleys. Consequently, these reclamation practices were necessarily

restricted in their scope and effectiveness, and apparently saw only limited use by early Anglo-American settlers.[1]

The Pecos River Valley of eastern New Mexico displays a climate and geography typical of this arid, unpredictable region. The river originates in the mountains of northern New Mexico as "a typical mountain stream through narrow valleys and deeply cut gorges." The river's character changes dramatically, however, when it enters the dry, rolling topography to the south. In this region, with its broad valleys and treeless plains, the Pecos moves slowly through desolate terrain underlain with limestone, gypsum, and sinkholes. It is here that the Pecos Valley's comparatively "fine agricultural land" exists -- land that early observers saw as an excellent candidate for reclamation.[2]

The lower Pecos Valley saw relatively little early agricultural or irrigation activity. Sources suggest that the advent of permanent white settlement was inhibited by Native American hostilities and a general sentiment that the region was simply too "wild."[3] When significant Anglo-American occupation of the Pecos began during the 1870s, most of the newcomers considered southeastern New Mexico's arid plains more suitable for cattle and sheep ranching than for agriculture. These early ranches were primitive, but often massive enterprises that frequently occupied thousands of acres of the high, treeless plains. Often, the ranchers appropriated water rights for stock watering; these

allocations were among the first Pecos River waters utilized by local landowners.[4]

Although the lower Pecos Valley was initially ranching country, the 1880s saw the region's first significant attempts at farming and the construction of a number of small irrigation ditches. When Ralph S. Tarr, an observer for the United States Geological Survey, toured the Pecos Valley in 1889, he counted a total of fourteen irrigation ditches leading from small tributary rivers near the young farm and ranch community of Roswell. The largest of these canals could potentially serve perhaps 2,000 acres of farmland. Little irrigation water was diverted directly from the Pecos River, and almost no irrigation was occurring downstream (south) from Roswell. Tarr did note the site of one small brush dam and associated canal on the Pecos itself; the dam had washed out annually until the farmers gave up battling the "changeable and violent" river. Nevertheless, Tarr admired the Valley's potential for larger-scale agriculture; he estimated that the region between Roswell and the Texas line contained some 300,000 acres of fertile, irrigable land.[5]

Tarr's report suggested that the Pecos Valley was a prime candidate for large-scale reclamation activity. As settlement in the region slowly increased, others began to recognize the potential. This awakening to the commercial possibilities of irrigation occurred throughout much of the arid west during the last three decades of the nineteenth century, and entrepreneurs in

several western states began orchestrating the construction of large, privately-funded reclamation networks. William F. "Buffalo Bill" Cody lent his name to an ambitious water project in northwestern Wyoming, the Union Colony began reclaiming land near Greeley, Colorado, and work on several other projects began in California, Colorado, and elsewhere. These irrigation developments, spurred both by increasing western settlement and improvements in the nascent technology of reclamation engineering, marked the beginning of large-scale irrigation efforts in the West. When the entrepreneurs and boosters of the Pecos Valley began planning their own large irrigation network, they formed part of a pioneering trend destined to rapidly reshape western agricultural practice.[6]

**B: Pat Garrett and C.B. Eddy -- Promoting Pecos Irrigation**

Those who envisioned a larger agricultural presence in the Pecos Valley were a group of adventurous gentlemen who were relatively early arrivals in the Roswell area. The best-remembered of these settlers was probably Pat Garrett, the Lincoln County sheriff who shot Billy the Kid in 1881. Defeated in a subsequent re-election bid, Garrett abandoned southwestern New Mexico in favor of Roswell and the Pecos, where he pursued business interests and established an 1800-acre farm and ranch operation. Reportedly, Garrett sensed that the agricultural success of his farm, as well

as the other vast reaches of undeveloped land surrounding Roswell, would be far greater if the Pecos River were dammed and a large, multi-user irrigation canal constructed. Garrett's enthusiasm was apparently based on the small-scale irrigation activity he was conducting on his own acreage. An intriguing but probably apocryphal local anecdote claims that Garrett's early forays into irrigation had initially been suggested by Billy the Kid, who reputedly once told Garrett, "Why waste your time riding these damn ranges when you could run some of this water . . . and grow crops and sell lots?"[7]

By the mid-1880s, Garrett had met Charles B. Eddy, a young New Mexico rancher. Born in New York, Eddy moved to Colorado while in his early twenties to become a cattle rancher with his brother John. After acquiring two Colorado ranches, the Eddys expanded their cattle interests into southeastern New Mexico, and by 1881 the brothers had established a cattle ranch on the Pecos. The Eddys divided their time between the two states, presumably spending summers in Colorado and winters in New Mexico. "C.B.," as Charles Eddy was known, was a classic entrepreneur and promoter. A business associate recalled that "Eddy could dream up something, begin talking about it, would soon begin to believe in it himself, was then irresistible and could convince any skeptic."[8] Another friend characterized him as "nervous, high-strung, and impetuous, with a full resonant voice and impressive manner, and great personal magnetism, a typical promoter. He was always keyed up and

on the go and drank quantities of strong black coffee at every meal."[9] This energy and ambition would soon be directed towards the Pecos Valley, eventually bringing to it unprecedented change and growth.

Eddy's empire-building activities in New Mexico began with the acquisition of vast tracts of ranching land, destined to be pivotal in the future development of local irrigation. This land acquisition took place in the name of the Eddy and Bissel Live Stock Company, incorporated in Colorado in 1884 as a vehicle for ranch development in both Colorado and New Mexico. (The Eddys' partner, G.N. Bissel, was an Eddy family associate and president of the Chemical National Bank of New York.) The Company's purpose, as specified in its incorporation papers, was limited to "the buying, selling, breeding, grazing and feeding of live stock [sic]," with incidental activities related to carrying out the purposes of the corporation, including the acquisition of water rights. The possibility of developing irrigation systems was not mentioned.[10]

Apparently, both the Eddy and Bissel Live Stock Company and the Holt Live Stock Company, the lower Pecos Valley's other major ranch, manipulated provisions of the Desert Land Act of 1877 to acquire much of their land. The Act allowed individuals to file on 640 acres of arid government land for a charge of twenty-five cents per acre. If, after three years, the entryman could prove that water had been "conducted" onto a portion of the land, he received a patent to his homestead for an additional one dollar per acre.

The Act included no residency requirements. Although the Act was ostensibly designed to encourage the settlement and cultivation of irrigable lands, Pecos Valley ranchers used it to establish or expand their grazing empires. This was accomplished by paying individuals (who may have been Company employees, family, or friends) to file homestead entries and then immediately sell their entryman's interest to the Company. In doing this, the Pecos ranchers were merely following a procedure that was common throughout the West. By the time the Act was changed to limit such abuses, the Pecos Valley ranchers had already achieved their land acquisition goals.[11]

Many of the Pecos Valley's Desert Land Act entries saw several intermediate sales before the final patent was issued and the deed filed. Typical of these transactions was a tract deeded by the United States to Besilado Gallegos on January 8, 1885. Gallegos deeded the property to Fred Fuller of Arapahoe County, Colorado on February 8; Fuller, in turn, sold the land to Harrison Libby (a director of the Holt Live Stock Company) the following month. That August, a land trade transferred the tract to the Eddy and Bissel Live Stock Company. Gallegos did not receive a patent on "his" property until 1891.[12]

The Eddy and Bissel Live Stock Company further expanded its abuse of the Desert Land Act in 1886. Some of this activity was instigated by Joseph Stevens, a young man who apparently became associated with the Eddys in Colorado. (Stevens' father was also

one of Bissel's New York business associates.) On returning to New York from a visit to the Pecos region, Stevens convinced his cousin, Francis Tracy, along with four other family members and friends, to assist him in what Tracy was later to describe as "The quickest, safest, and in every way the most satisfactory way for corporation development." Each of these individuals filed on a desert land tract chosen by Stevens. In return for agreeing to deed the tracts back to Stevens, the entrymen received an expense-paid "vacation" to New Mexico when proof had to be made. All of these tracts eventually came under ownership of the Pecos Irrigation and Improvement Company.[13]

**C: Corporate Irrigation Arrives on the Pecos**

Eddy soon began to experiment with irrigated agriculture on portions of The Eddy and Bissel Company's newly-acquired holdings, although his reasons for doing so are open to speculation. In a later reminiscence, Francis Tracy stated that Eddy developed his first wells and canals in response to the "big die" of 1886, when overgrazing and a prolonged drought caused the starvation of over thirty-five percent of the Valley's cattle. Enthusiasm for the project may have also been generated by Stevens, who supposedly had "the then fabulous tales of California irrigation in mind." Regardless of his motivation, in 1887 Eddy constructed a small irrigation canal to serve a tract of Company land near present-day

La Huerta, north of Carlsbad. Stevens, who had recently "came of age and considerable inheritance," apparently funded the project.[14]

Encouraged by the canal's initial success, Stevens and the Eddy brothers incorporated their small reclamation system in October 1887 as "The Pecos Valley Land and Ditch Company." The new company's stated goals included "constructing and maintaining reservoirs and canals or ditches and pipe lines in the valley of the Pecos River . . . and for the purpose of colonization and improvement of land in connection therewith."[15] The incorporation document specified the construction of three major canal systems: canals east and west of the Pecos River in the lower Valley, and an irrigation system in the Roswell area near Garrett's first reclamation effort. Together, the three canals would theoretically allow irrigated cultivation of much of the Pecos Valley's arable land; in spite of these ambitious goals, however, the Company was capitalized at only $40,000.[16] The Land and Ditch Company apparently began work on only one of its three proposed canals; this was the "Halagueno Ditch," an expansion of Eddy's earlier private canal. The amount of work the Company actually completed, however, was probably not substantial.

By 1888, Eddy and Garrett had merged their ideas into concrete plans for a larger-scale Pecos River reclamation project. Eddy, the more business-minded of the pair, worked to enlist other potential backers for the project. The most significant of his

recruits proved to be Robert Weems Tansill, a local farmer and businessman. Tansill had made his business mark in Chicago as "an eminently successful five cent cigar man." Tansill allegedly first developed the idea of the cigar band, and his "Tansill's Punch" cigars were well known in the 1870s. He moved to New Mexico in 1888 for his health, and was actively seeking entrepreneurial opportunities when approached by Eddy.[17] Charles W. Greene later joined the group after meeting with Garrett and Eddy. Greene was an itinerant, somewhat controversial, Southwest newspaperman and booster with experience as an active entrepreneur in several Southwest communities. He had also served as the publisher of Garrett's narrative, Billy the Kid.[18] Tracy characterized Greene as "a lifelong promoter, carried away by his vision of the unlimited possibilities of developing a new empire from the 'shapeless mass' of the slumbering desert stretching untouched farther in all directions than the eye could see."[19]

Eddy complemented his recruitment and fund raising activities by reorganizing the corporate vehicle for his reclamation dream. In July 1888, the "Pecos Irrigation and Investment Company" was incorporated to assume the development of Pecos Valley irrigation projects. The new company was chartered with stated reclamation purposes similar to that of the Land and Ditch Company, and acquired the older company's incomplete irrigation works. The Irrigation and Investment Company differed from its predecessor, however, in that its incorporation documents did not specifically

mention land development. The new corporation was capitalized at $600,000, suggesting a greater seriousness of purpose than its predecessor. Eddy and Greene were among the six initial directors, though Stevens and Garrett were no longer mentioned.[20] Although the early stages of the Company's work are conjectural, it probably consisted largely of financing and promotional efforts, while project engineering received limited attention, and "scientific" feasibility studies were largely ignored. Such priorities typified most of the privately-funded reclamation projects then underway across the West.[21]

As the Pecos Irrigation and Investment Company began its full-scale activities, each of the four primary backers filled a different role in the enterprise. Garrett quickly faded from the picture, for uncertain reasons. Although it is likely he was simply outclassed by the business skills of the others, his biographer insists that Garrett was deliberately shut out of the company he helped found.[22] The company's day-to-day operation was largely managed by Eddy, who quickly assumed a dominant role in the organization's administrative affairs. Greene and Tansill became the group's primary fund raisers. Greene's solicitation activities took him first to Chicago, and then overseas, and his tenure in the Pecos Valley was brief; his departure largely ended his direct involvement in the Pecos irrigation effort. Tansill's activities were more local in nature; they included both fund raising and organizational support. His role as an advocate for Pecos Valley

reclamation was the most enduring of the four, and proved to be among the strongest.

Fulfillment of the Irrigation Company's lofty goals hinged directly on its success in attracting substantial financial backing. Consequently, Greene and Tansill's search for corporate patrons was pivotal in the company's early history. Fortunately, each man met with fairly rapid and substantial success, although on two disparate fronts. The Irrigation Company's initial financial backing came from a group of Chicago investors whom Greene had enticed to visit New Mexico on a chartered railroad car. The Chicagoans' New Mexico visit was described as "a new experience to all, -- the hot sunshine, the alkali dust, the rough roads, no shade, no water, and only one house for a distance of more than ninety miles." Nevertheless, Eddy, Garrett, and Greene proved to be persuasive hosts.[23] In 1889, the Illinois Trust and Savings Bank of Chicago sponsored the issuance of $400,000 in Pecos Irrigation and Investment Company first mortgage bonds, payable in 20 years at eight percent interest. The bonds were secured by a Deed of Trust on all property "already constructed or to be hereafter constructed" by the Irrigation Company.[24] The Chicago bond issue provided the funds needed to start construction, and in response, the Irrigation Company established a Chicago branch office. Meanwhile, Tansill cultivated a far more significant backer in the person of James J. Hagerman, a wealthy Colorado Springs capitalist and railroad builder. Almost instantly,

Hagerman became the dominant financial force behind the project, and he remained so for most of the next decade.

James John Hagerman's life was, in many ways, a quintessential Horatio Alger story. The Ontario-born son of a middle-class family, Hagerman put himself through college working on Great Lakes steamboats, and soon began an entrepreneurial career in the Milwaukee iron foundries and Great Lakes iron ore mines. His relentless business energies made him a very wealthy man, and when he relocated to Colorado Springs for his health in 1884 he could have easily assumed the quiet, aristocratic life of a retired tycoon. His incessant ambition quickly drove him back to work, however, and he was soon deeply involved in building the Colorado Midland Railroad and investing in the state's booming silver mines. Hagerman's varied portfolio included the famous Mollie Gibson mine near Cripple Creek, Colorado.[25]

Hagerman was first introduced to Tansill through Henry C. Lowe, a mutual acquaintance. Soon after Tansill and Hagerman's first meeting in Colorado Springs, Hagerman was invited to meet Eddy, whom Hagerman later termed "as persuasive a scamp as ever lived." By this time, Hagerman was largely retired from his Colorado projects, and he was receiving a substantial income from the Mollie Gibson; typically, though, he continued searching for a new empire-building scheme to occupy his time. Eddy's glowing descriptions of the Pecos region convinced Hagerman that the Pecos Valley offered just such an opportunity, and Hagerman was soon the

owner of $40,000 in Irrigation Company bonds.[26] It was the first of a great many financial contributions to the project that Hagerman was destined to make. In finding Hagerman, Tansill had quite nearly achieved his reported goal of securing "unlimited capital" for the Irrigation Company's projects.[27]

Meanwhile, Eddy's entrepreneurial spirit drove his continued organizational work on the reclamation project as well as other schemes for development of the Valley. In 1888, Eddy established a townsite near the old Halagueno Ditch in anticipation of the planned reclamation project. The newly-platted community, which Tansill reportedly insisted be named after Eddy, was certainly intended to become an integral component of the Valley's incipient agricultural economy. The establishment of such an economy depended on the irrigation system's completion, however, and until this was assured the community's development was necessarily slow. By February 1889, though, the region boasted enough new inhabitants to merit the creation of a new county for the lower Pecos Valley; the county, too, was named for Eddy.[28]

## D: "An Amazing Piece of Work" -- Construction of the Reclamation System

Armed with the financial results of Greene's and Tansill's labor, the Irrigation Company began large-scale construction work on its physical plant in 1889, marking a dramatic turnaround from

the meager Land and Ditch Company efforts of the year before. The Company's planned Pecos Valley reclamation program included large canal systems near both Roswell and Eddy, and an additional irrigation network downstream in Texas. By the time of Ralph S. Tarr's visit that March, substantial work had been completed in the Roswell area. (This was the so-called "Northern Canal," some forty miles in length, which began at a small diversion dam located on Pat Garrett's ranch.[29]) Of the Eddy project, which was to feature both a large diversion dam and a canal network, Tarr noted:

> . . . their plans are to take out a canal 45 feet wide at the bottom, 63 feet at the top, and 6 feet deep. Seven miles below the dam the canal will cross the river to the west side and there be extended 40 miles to the Texas line. It is intended to utilize all the water in the Pecos at this point and reclaim 125,000 acres of land. The plans concerning the canal are not yet matured, and the work of construction has not been commenced. The dam site is said to be good, the river being a succession of rapids, falling 50 feet in 6 miles. At this point the river never leaves its banks.[30]

This description, one of the earliest written outlines of the future Carlsbad Project, is a reasonably accurate narrative of the Irrigation Company's system as actually built, although the estimate of the amount of land to be served by the project was dramatically and typically inflated.

Within months of Tarr's visit, construction crews were at work on the Irrigation Company's canal system near Eddy. As initially planned, this portion of the project included a diversion dam (at the site of present-day Avalon Dam), a "Southwestern Canal," and an "East-Side Canal." The Southwestern Canal's route began at the

east end of the diversion dam and parallelled the river's east bank southward for three and one-half miles, where it crossed the river via a large wooden flume. Beyond the flume, the planned canal continued southward almost to the Texas line. The proposed East-Side Canal originated on the Southwestern Canal three miles below the dam and follow a circuitous route to the southeast.[31]

The reclamation system's engineering and design work was performed by the Irrigation Company itself, using the talents of three Colorado engineers whom Hagerman had presumably drawn to New Mexico. Engineering work was supervised by H.H. Cloud, a railway engineer who had previously worked for Hagerman on the Colorado Midland Railroad. Little else about his career is known. Cloud's assistants included Louis D. Blauvelt and Edwin S. Nettleton. Blauvelt also worked on railroad construction projects in Colorado; in the early 1900s he was chief engineer for the Denver, Northwestern & Pacific Railroad (the "Moffat Road") as it constructed its torturous railway ascent of the Front Range. In the 1920s, Blauvelt worked as an engineer for the Colorado State Highway Department.[32]

In contrast to his co-workers, Nettleton possessed extensive experience in reclamation engineering, and this made him one of Hagerman's chief advisors. A graduate of Oberlin College in civil and mechanical engineering, Nettleton moved to Colorado in 1870 with the Union Colony of Greeley. Nettleton reportedly platted the townsite of Greeley and its surrounding irrigation systems, and

later performed similar work at Colorado Springs and Manitou Springs. He served as Colorado State Engineer from 1883 to 1887, and participated in John Wesley Powell's short-lived western irrigation survey of 1888-89. As early as 1878, he was termed "one of the most accomplished irrigation engineers in the west."[33] Nettleton was reportedly responsible for the Irrigation Company's initial, wildly optimistic belief that the lower Pecos River carried enough water to irrigate 200,000 acres of farmland.[34]

As the Irrigation Company began construction in the lower Pecos Valley, the town of Eddy displayed significant growth; much of that expansion occurred in direct anticipation of the prosperity and increased population which the new reclamation system seemed destined to provide. The canal system's construction was followed with considerable local interest, and monitored almost weekly in the community's newspaper, the Eddy Argus. By November 23, 1889, the Argus reported that "Work on the dam at the head gates of the great canal is being pushed at a rapid rate, and no doubt the structure will be finished by January 15, when the water is to be turned into the canal."[35] Not surprisingly, the January 15 completion date proved to be exceedingly optimistic, although the construction apparently encountered few technical difficulties.

The Irrigation Company's 1889 and 1890 work centered on the diversion dam and the upper reaches of the Southwestern Canal. Work was performed on all three of the initial project's major features simultaneously -- the diversion dam, the canal, and the

wooden flume across the Pecos River. The project's construction activity was divided among various contractors. These contractors recruited substantial numbers of out-of-area workers who were housed in temporary camps near each of the projects. These primitive camps were a source of interest to the Argus:

> The camp at the dam is a veritable city of tents. It is inhabited at present by one hundred and eighty laborers, besides a competent force of mechanics. There is a blacksmith shop, a harness shop, a commissary store, etc., and an immense dining tent for the men. Here and there and everywhere are sleeping tents. This canvas city is well worth seeing and the ARGUS suggests that Eddy people who have not seen it pay it a visit. . . . The camp at the great flume is called Flumetown.[36]

Day-to-day life at the construction camps was probably tedious, at best. Acts of violence among the workers were not unknown, and the hazardous working conditions posed additional dangers. In February 1890, for example, "an accidental explosion of giant powder at the dam" resulted in two fatalities and five injuries.[37]

Work on the canal was performed under contract by the firm of Bradbury & Company.[38] The scope of the project elicited great praise from the Argus, which reported:

> No one can realize how big the canal is until he drives through it. It is wide enough at the bottom to allow four teams to pass. When full of water the tallest man in America could not wade it. A boat twenty-five feet wide and drawing six feet of water could be propelled on its surface. The banks on either side are wide enough at the top for wagon drives. It is wonderful, an amazing piece of work, and it must be seen to appreciate it.[39]

The Pecos River Flume was probably the most complex component of the new canal network, and was constructed under a separate

contract by the Witt Brothers Company.[40] When the Argus viewed the completed flume in March 1890, the paper's scrivener proudly proclaimed that "It is truly a great flume, the greatest, perhaps, in the country."[41]

Work on the dam was frustratingly slow, preventing full use of the new canal system during the 1890 season. That March, the reporter for the Argus noted:

> There is still a great deal of work to do on the dam. There is a gap a hundred feet long and twenty-five feet deep to be filled with stone. Then the whole dam will have to receive an additional five feet of rock. After that, sand bags and dirt must be thrown in to prevent the dam leaking. In the meantime the spillways will require a great deal of work. The great rock cut for the canal has been completed, and work on the ponderous headgate was commenced Monday. . . . Over three hundred men are now at Rock Dam Camp.[42]

Both the flume and primary canal were largely finished well before the dam was completed in mid-1890, although by the end of the year both the dam and much of the canal network were ready for operation. The Company had expended $90,000 building the dam and an additional $400,000 constructing its first canals.[43] In August 1890, the new dam faced the first of many Pecos River floods that would challenge its strength and design. Although the possibility of a dam failure caused many of Eddy's residents to make "a wild scramble for . . . elevated places," by all accounts the dam and its headgates performed flawlessly. The Argus boasted that the structure was "built to stay right there."[44]

The Irrigation Company's completed physical plant was both large and technically complex for its day. The new diversion dam was easily the project's most substantial engineering and construction feature. The structure was originally conceived as a simple water diversion facility, but Cloud reportedly persuaded the Irrigation Company to enlarge the dam to provide water storage as well. Consequently, the completed dam impounded a reservoir six miles long, with an estimated capacity of one billion cubic feet of water.[45] The dam was known variously during its first years as "Eddy Dam," "Reservoir No. 2," "Six Mile Dam," and "Rock Dam," although within a few years it received its permanent appellation of "Avalon Dam."

Avalon Dam was especially significant for its rockfill design. Rockfill dams, mainly with timber facing, had first been constructed in California during the 1860s and 70s to serve hydraulic mining activities. Some of these dams were later adapted for irrigation purposes.[46] Avalon was one of the first rockfill dams with an impervious earthfill facing to be constructed in the United States for irrigation purposes.[47] In an 1892 article comparing different types of dam construction, W. W. Follett, an engineer with the U.S. Department of Agriculture, reported that it was only within the "last few years that the loose rock dam has been looked on with favor by engineers." He included an extensive discussion of the design of Avalon Dam, noting some design problems but concluding that "the general design of the structure was good.

... Right here I want to call attention to the fact that no other kind of dam could have stood what this one has and remain intact."[48]

Avalon Dam was designed as a "prism of loose rock" with an upstream face of earth (see accompanying HAER photograph #B-50). It was constructed on bedrock, the river being routed to erode the earth off the bedrock as the dam was being constructed. The rockfill was placed in lifts of four to ten feet.[49] This fill was separated from the impervious earth by a hand-laid rock wall with a width-to-height slope of 0.5:1. The maximum height of the dam was approximately 45 feet with a crest length of approximately 1070 feet. The rockfill was 100 feet wide at the base and 12 feet wide at the top with a downstream slope of 1.5:1. The earthfill, comprised of sacked earth, gravel, boughs, and loose earth, initially had a slope of 2:1; this fill washed out shortly after its construction and was replaced with fill 200 feet wide at the bottom and 10 feet wide at the top with an upstream slope of about 3:1. Ten feet of loose rock was placed at the toe of the upstream face of the dam to protect against undercutting. The original earthfill was protected against wave action with 18 inches of riprap.[50] Although not mentioned in a description of the dam while it was under construction, by the fall of 1891 the dam was described as forming an "L" shape, with the short leg pointing upstream. This short leg was constructed of earth fill and added 530 feet to the length of the dam. The reservoir's capacity was

initially estimated at approximately 23,000 acre-feet, although a more accurate estimate of 6,887 acre-feet was used by 1896.[51]

A relatively unusual and daring feature of Avalon Dam was a scourway or sluicegate passing through the dam towards the eastern abutment (HAER photographs #B-50 and B-52). The scourway's presence added to the structure's complexity, since it is technologically difficult to obtain a solid connection between the earth of the dam and any type of conduit passing through it. Many of the dams employing such features have failed over the years.[52] Avalon's scourway had an opening four feet by eight feet and was 90 feet long. The scourway discharged 2,000 second-feet with the reservoir full. It was constructed of stone laid in concrete and was eight feet thick. Drawings of the dam under construction show the scourway walls flaring outward both above and below the dam. These early drawings also show a wooden flume entering and leaving the scourway. This flume supplied water to the existing Halaquena Canal during construction of the dam. A 36-foot-long vertical screw operated a gate placed at the upper end of the scourway. In an early letter describing the system, Charles Eddy stated that the scourway was used to lower the reservoir in anticipation of floodwaters. In 1896, the Engineering News reported that the scourway "was found to be of no value and was removed."[53]

Besides the scour gate, the original Avalon Dam was provided with two spillways (originally called wasteways). A spillway at the west end of the dam was located in a 300-foot-long channel five

feet below the crest of the dam and had a width of 256 feet. Another spillway was located along the outlet channel above the headgates. It had a length of 206 feet and was located seven feet below the crest of the dam. The spillway was supplied with 31 gates, five feet wide by seven feet, two inches high. Flashboards were provided to enable the gates to be closed. With the flashboards in place, water could flow over the top of the gates at an elevation ten feet below the crest of the dam. If the reservoir level needed to be lowered further, the gates could be swung open horizontally by a "blow on the vertical releasing rod." Another set of gates was located below the headgates and are described as not being capable of being "lowered when the cut is full of water, but can be dropped in case of necessity. Adjacent to these was a set of 10 escape gates, each 7 feet wide, giving a clear escape-way back into the river."[54]

The canal headworks were located in a 500-foot-long channel, cut through solid limestone at the east side of the dam (HAER photograph #B-50). Six wooden headgates with a combined discharge capacity of 3,000 second-feet controlled the flow of water from the reservoir into the canal system. These vertical gates, each five feet wide by nine feet high, slid between pairs of wooden posts. The gates were operated by "a male screw of steel attached to each gate, on which a female screw of malleable iron is turned from above."[55]

At its head, the main canal was 45 feet wide at the bottom and 70 feet wide at the top; its capacity was reportedly 1,100 second-feet. The canal was a side-slope excavation permitting the flood waters from arroyos to enter the canal and spread out, creating small reservoirs. Three and one-half miles below the headgates, the canal split into the Eastern (now called the East Side Canal) and the Western canals (now called the Main Canal). The Eastern Canal had a capacity of 150 cubic feet per second. Regulating gates controlled the flow of water into each canal and an escape-way channeled waste water back into the Pecos River.[56]

Just below the point of bifurcation, the Western Canal crossed the Pecos River by means of a wooden flume (HAER photograph #E-14). The flume was located between two terrepleins, the approach being 1600 feet long and the exit being 300 feet long. Both reached a height of 24 feet. The wooden flume, 475 feet long by 25 feet wide and carrying eight feet of water, was supported on a series of wooden trestle bents.[57] By 1891, the Main Canal was completed to the Black River, and 100 miles of lateral canals carried water to the project lands. The Engineering News noted that the $10 per acre perpetual water right and the annual water rental of $1.25 per acre were "very low" and speculated that they would rise once settlement increased in the area.[58] This sharply contrasted with a statement in Tarr's 1889 report suggesting that the project's water fees were excessive.[59]

**E: The Maturing of Corporate Reclamation**

As the Irrigation Company's construction projects progressed during 1889 and 1890, Hagerman, obviously enchanted with the thought of personally transforming the Pecos Valley, was making plans to revamp the Company's corporate structure and expand its scope. On July 1, 1890 the Pecos Irrigation and Improvement Company, a Colorado corporation organized and led by Hagerman, absorbed the assets of the Pecos Irrigation and Investment Company. The new corporation was capitalized at $1,000,000, and designed to operate the local reclamation system as well as undertake related promotional activities. With the assistance of Greene, who was in Europe soliciting both corporate financing and immigrant farmers, a syndicate of Swiss bankers was reportedly persuaded to purchase $500,000 of Irrigation Company bonds. Hagerman simultaneously induced several of his Colorado business associates to invest in his newest dream. Hagerman also secured the monetary backing of C.A. Otis of Cleveland, a young financier who had spent his post-college years as a cowpuncher in Colorado.[60] Hagerman served as president of the new corporation, with Eddy as general manager.

The new corporation's financial resources were provided in a variety of forms. The Irrigation Company's 1889 bond issue was supplemented by a second offering sponsored by the Central Trust Company of New York in February 1892. This issue authorized $800,000 in six percent bonds, also protected by a Deed of Trust on

the Irrigation Company's physical plant.[61] In general, the two bond issues represented the investments of midwestern, eastern, and European capitalists, while Hagerman, Otis, and their associates received stock in return for their investments. The bondholders enjoyed a relatively secure position, since their funds were protected by a lien on the Company's physical plant. In contrast, the stockholders' investments were unsecured, leaving their fortunes completely dependent on the Company's eventual success or failure.

In addition to the sounder financial base provided by the reorganized Irrigation Company, Hagerman apparently possessed other motives for changing the project's corporate structure. He later stated that the Pecos Irrigation and Improvement Company's charter "did not suit us, did not allow us to do what we wanted to do."[62] Hagerman was presumably referring to the right to acquire, hold, and sell land. In an 1890 description of the Irrigation and Improvement Company, Eddy emphasized that "The Company owns no land, has never sought to acquire any, and is prohibited by law from acquiring more than is necessary for canal and reservoir purposes."[63] These legal constraints vanished with the formation of the Irrigation and Investment Company, however, and during the early 1890s the Company's backers acquired thousands of acres of land near the canal network. Again, the Desert Land Act proved to be an efficient vehicle for land procurement. Many of the first 150 or so Desert Land Certificates issued in Eddy County went to

Irrigation Company directors and their families, as well as other prominent out-of-state individuals, mainly from New York, Chicago, and Colorado.[64] These lands were formally transferred to the Pecos Irrigation and Investment Company during the first few months of 1892. Unlike the earlier transactions involving Stevens, the Company ostensibly paid these individuals from nine to 35 dollars per acre for their lands.[65] The integrity of these transactions was later questioned by observers. While testifying in a 1926 District Court lawsuit, Tracy was asked whether "from your observation that those desert entries were of the most part bogus characters." Tracy brusquely replied, "I think that is immaterial," and the subject was dropped.[66]

The Irrigation Company also added to its land holdings by acquiring the tracts of legitimate Desert Land entrymen. Reportedly, the Company would either purchase the land outright at ten to thirty dollars per acre, or would trade permanent water rights for 80 acres in exchange for a deed to the remaining 560 acres. The Company seemingly had little trouble selling these lands for a minimum of forty dollars per acre.[67]

In an apparent good-faith effort to comply with the Desert Land Act, the Irrigation Company did build a water distribution system capable of serving at least 40 acres of each 640 acre Desert Land tract. In total, the Company issued water rights and built lateral canals to some 54,000 acres, although it never actually supplied water to more than 14,000 acres in a given year.[68] The

lands receiving water were scattered throughout the lower Pecos Valley, "depending very largely on where the General Manager of the Company individually owned land he wanted to sell."[69]

The federal government attempted to curb the more blatant abuses of the land laws with passage of the General Revision Act on March 3, 1891. One of the Act's provisions, however, was of potential benefit to the Irrigation Company: it granted organized irrigation companies rights-of-way across public lands and reservations. Once an application was approved by the Secretary of the Interior, all subsequent federal land disposals were made subject to the platted rights-of-way.[70] Despite the large acquisitions that had already taken place, substantial tracts of vacant land still remained in the Valley and the Irrigation Company quickly requested right-of-way approval for the three existing and proposed reservoir sites. For an unknown reason, however, the Company neglected to file similar requests for the associated canal network. The Company's site maps were returned several times for corrections, and the area was completely re-surveyed in 1895; consequently, the Secretary of the Interior's approval of the withdrawals was delayed until 1897 (see accompanying HAER drawings #A-55 and B-77).[71]

An additional legal requirement for the Company involved the formal procurement of the necessary Pecos River water rights. Nineteenth-century New Mexico water right claims are incompletely documented, due largely to the somewhat fragmentary nature of the

Territory's water law; the first comprehensive water code for New Mexico was not enacted until 1905. An 1891 law, however, formalized a procedure for filing water right claims with county probate offices, and still earlier rights could exist based simply on prior use of the water.[72] Based on these sources, twentieth-century research by the Reclamation Service determined that the Company's formal rights to Pecos River water began with an October 31, 1887 filing by the Pecos Valley Land and Ditch Company. This right was succeeded by a July 16, 1888 right filed by the Pecos Irrigation and Investment Company, which was in turn replaced by a May 15, 1890 filing by the Pecos Irrigation and Improvement Company. The latter two claims appropriated all of the Pecos River water not previously appropriated.[73]

Meanwhile, Hagerman realized that the region's ultimate success would require the ability to easily transport farm products to market. In a reprise of his 1880s role in the construction of the Colorado Midland Railroad, Hagerman decided to provide the Pecos Valley with a railroad link to the outside world. In 1890, he announced the incorporation of the Pecos Valley Railroad Company. The proposed line would connect Eddy with Pecos, Texás, and the main line of the Texas & Pacific Railroad. Bradbury & Company, builder of the Irrigation Company's canals, was contracted to build the railroad. Construction continued throughout the summer and fall of 1890 with the first train reaching Eddy in January 1891.[74]

The completion of the first canals and of the railroad made Hagerman the controlling owner of the Pecos Valley's two largest and most important business enterprises. However, a third major company, the Pecos Valley Town Company, remained controlled by the Eddy interests. Reportedly, internal conflicts among the companies increased as their level of operations grew. These conflicts may have been symptomatic of an increasing discord between Hagerman, Eddy, and the other corporate promoters. In an effort to reduce these squabbles, the three companies were united under a single holding corporation, the Pecos Valley Company, in 1893. This improved the coordination among the Valley's various development enterprises, although it did not heal the discord between Hagerman and Eddy.[75]

By the summer of 1891, the Valley's irrigation system and railroad were in place and operational, and the community of Eddy was growing rapidly. Eddy was proud to report that the Irrigation Company's efforts had brought tremendous growth to the lower Pecos Valley:

> We are daily receiving numerous inquiries from farmers and prospective settlers all over the country who are just beginning to learn the advantages of a steady supply of water by means of irrigation . . . and the valley is now very rapidly filling up with settlers. . . . The soil is so rich, its cultivation so easy and the product so large, that a small piece of land will answer well for a family, and the valley can and undoubtedly will support a population of many thousand within a comparatively short time.[76]

One of the many men and women who moved to Eddy in response to the Company's promise of agricultural plenty was a young New Yorker named Francis G. Tracy. After learning of the Pecos country from Joseph Stevens, his cousin, Tracy visited New Mexico in 1889 and settled in Eddy early the following year with "a brace of fine Collie shepherd dogs" and land interests south of town.[77] He soon developed a variety of entrepreneurial interests and became a leading figure in the Irrigation Company's operations. In recalling those early years, Tracy mused:

> The prospectuses of those days show plans for irrigating more than 1,000,000 acres of land between Roswell and Pecos. In the company's employ were the finest bunch of young enthusiasts, and inexperienced dreamers of middle age that could possibly be determined. The stage was all and properly set for limitless expansion, and surely we had a great time![78]

Such expansive corporate expectations were still far from fulfillment by the early 1890s. Most of the Irrigation Company's physical plant had been constructed relatively quickly and cheaply, accompanied by extremely unrealistic assumptions of the system's efficiency. The Irrigation Company soon discovered that it was simply unable to supply water to all (or even most) of the lands within reach of the canals. This was partially due to a tremendous water loss caused by seepage from the company's reservoir and canal network. The Irrigation Company had also accepted the then-popular notion that "rain follows the plow," suggesting that the area's irrigated farmlands would require less annual water after they had been under irrigation for a time. This fallacious belief, combined

with the equally implausible idea that the Company's canals would "become cemented and better conveyors of water" through years of use, doomed the Company to initial disappointment.[79]

**F: The System Expands -- The Construction of McMillan Dam**

The Irrigation Company also quickly realized that Avalon Dam and Reservoir were far too small to provide the needed water reserve for the canal system, and a second reservoir was needed to provide additional water storage. From the beginning, the Company's long-term plans included two storage reservoirs just upstream from Avalon, and work began at the uppermost of these sites in October 1892. The new dam was initially known as "Seven Rivers Dam" or "Reservoir No. 1," although it soon received the permanent appellation "McMillan Dam."[80] The Irrigation Company considered both earthfill and rockfill dam designs for the new structure, eventually settling on the latter in a possible tribute to the perceived success of Avalon. The rockfill configuration was chosen even though its $175,000 projected cost was more than double the $82,500 estimate for an earthen dam.[81] The Argus reported that McMillan Dam would be rock-filled and faced with earth, 1,686 feet long and up to 51 feet high. The reservoir thus created could reportedly hold eight times as much water as Avalon, enough to completely supply the canal system for 72 days of irrigation.[82]

As the main storage reservoir for the Pecos Valley irrigation project, Lake McMillan was designed to hold water for release to Lake Avalon where it could then be diverted into the canals of the irrigation system. The Engineering Record claimed that Lake McMillan, on completion, was "probably the largest artificial reservoir in America and . . . one of the greatest in the world."[83] The dam itself continued to be listed as the second oldest surviving (Avalon was the oldest) and one of the most important composite (rock-fill with earth fill on upstream face) dams in the United States into the 1940s.[84]

Displaying either the typical boosterism of the period or a simple lack of understanding of the true nature of the reservoir site, the Engineering Record's claim was based on an assumed reservoir capacity of 138,000 acre-feet. An 1895 survey of the reservoir, however, listed a maximum capacity of only 82,644 acre-feet. Notwithstanding the possibility that the capacities of the other reservoirs on the list might also have been based on inflated figures, McMillan Reservoir still ranked second in size in the United States (only the Helmet Valley, California reservoir ranked larger) and fourth in size in the world.[85]

McMillan Dam is a rockfill dam constructed under the supervision of Louis D. Blauvelt as chief engineer.[86] When completed, McMillan Dam had a maximum height of 55 feet and an average height of 37.8 feet. The structure was 1,686 feet long. The rockfill had a crest width of 14 feet with a downstream slope

of 1.5:1. The upstream face was of hand-laid stone 2 feet thick with a slope of 0.5:1. The earth facing placed against the upstream slope of the rockfill had a 6-foot crest and an upstream slope of 3.5:1. Total width at the base was 290 feet.

The 1,100-foot long outlet channel located at the east side of the dam was excavated through solid limestone to an elevation 35 feet below the dam's crest (HAER photographs #A-45 and A-48). The channel discharged water directly into the Pecos River below the dam. The outlet works consisted of six wooden gates, 4 feet by 8 feet, operated by screws. Total discharge capacity of the gates was 4,400 second-feet with water at 18 feet above the floor of the outlet works.

Early maps of McMillan Dam show a spillway located between the east end of the dam and the outlet channel, although this feature is not described in any of the contemporary technical articles on the dam. An 1895 survey, however, describes the spillway as a cut 220 feet wide at an elevation 10 feet below the crest of the dam. The spillway returned waters to the Pecos River near the toe of the dam; it was abandoned and blocked by the time the Reclamation Service acquired the property in 1905.[87] Two earth embankments were originally constructed to the west of the dam to close low spots in the limestone bluffs. These were constructed with a crest width of 10 feet and a base width of 100 feet. By 1895, these embankments had apparently been joined to form a single dike some 2,600 feet long and approximately 18 feet high. A 300-foot long

spillway was located at the east end of the embankment and provided with 64 gates, each 4 feet wide and 8 feet high.[88]

Interestingly, in 1893 the Eddy and Bissel Live Stock Company still owned much of the McMillan Reservoir site, as well as the land occupied by Avalon Dam and Reservoir. By January 1893, the Irrigation Company had begun condemnation proceedings to acquire the McMillan site. In order to "settle amicably all disputes," representatives from the two companies met in New York City with an arbitrator. In the end, the Live Stock Company received a $36,193 payment, water rights, and other considerations for the land the Irrigation Company had taken.[89] Hagerman funded the land purchase from his own pocket.[90]

**G: Flood and Depression -- 1893 and Beyond**

Most of the construction work on McMillan Dam had been completed by August 1893, when the Valley's irrigation network was visited by the first of a long string of damaging natural disasters. A series of seemingly endless, pouring rains attacked the Pecos Valley early in the month, raising the Pecos River to previously unknown levels and causing a tense, dramatic period at Avalon Dam:

> For days and nights the force at the dam . . . battled with the surging sea that swept through and over the gates and mechanical contrivances for the control of the water. Down from far away gorges came the drift of a

> decade, to bury the barricades. From the plains came unnumbered carcasses of cattle to choke the gateways.[91]

The water level at Avalon Reservoir continued to rise until the dam was finally overtopped; when this happened the dam rapidly, inevitably, gave way (HAER photograph #B-53):

> It was but a few minutes after the warning came before the crest of the dam was gone. Probably in twenty minutes the water cut down twenty feet along 900 feet of the length of the dam, and in two hours more, clear to the base of the vast pile of earth and stone. . . . The opening allowed an avalanche of water to roll down upon the already choked river and whirl across bends to the slanting plains.[92]

The canal system, flume and railroad also received substantial damage from the floodwaters.

The destruction of Avalon Dam was a tremendous blow to both the Irrigation Company and the settlers it had drawn to the Pecos. The flood rendered the irrigation system useless, and the costs of repair were recognized to be enormous. The project's initial four years had already been a substantial financial drain on the Company's investors, and many were growing weary of committing funds to an enterprise that had failed to bring them returns. Moreover, the flood occurred in the midst of the Panic of 1893; the financial uncertainty of the nation as a whole made securing corporate financing all the more difficult. It was apparent that Hagerman's personal funds were the project's only hope for salvation.

The collapse in silver prices that precipitated the Panic of 1893 was devastating to Hagerman, who had drawn much of his income

from the silver mined at the Mollie Gibson. (Hagerman later stated that the Panic had reduced his worth by $2,400,000 in the course of one month.[93]) Nevertheless, Hagerman immediately decided to commit much of his remaining capital to the restoration of the Irrigation Company's infrastructure. His son later recalled:

> My father met the situation with vigor. Assurances were given that the dam would be rebuilt immediately. Six months' water rents were canceled, the settlers were made to see that they would be protected in every way. . . . The repairs cost about $150,000 and most of it came out of my father's pocket though it required great sacrifices to get it. I think most men would have thrown up their hands and quit in despair. He felt a great sense of responsibility to investors and still more to the thousands of settlers, and it was not in him to quit.[94]

Hagerman was sincere in his promise to rebuild the system as soon as possible. By the end of August, the Irrigation Company had contracted with the firm of Ward & Courtney to perform the needed repairs. By October, some 500 men and 165 teams were hard at work on both Avalon and McMillan Dams (HAER photographs #B-54 and B-55). The reconstructed Avalon Dam displayed an identical cross-section to its predecessor; the crest, however, was raised by five feet and the length increased by 65 feet to 1,135 feet. Hoping to avert a reoccurrence of the 1893 flood damage, the capacity of the spillway at the west end of the dam was increased and a third spillway added across an arroyo even farther to the west.

Other crews began reconstructing the flume and repairing canals; a contractor's salvage party scoured the river most of the way to Pecos, Texas, and returned some 60,000 board feet of flume

timbering to its former site.[95] Repairs were largely completed by early 1894, and water turned into the canals in time for the irrigation season.

Although Hagerman persevered throughout the financial and natural disasters of 1893 and 1894, the setbacks and expenditures were the beginning of Eddy's final disillusionment with the region he had helped settle. The Irrigation Company's difficulties exacerbated the already-present tensions between Hagerman and Eddy, and the two differing philosophies were no longer able to reach a compromise. Eddy disposed of most of his Pecos Valley interests in 1894, and that April he resigned as general manager of the Pecos Irrigation and Improvement Company.[96] By 1895, he had departed. Although biographers sympathetic to Hagerman explained Eddy's departure by concluding that "Eddy had demonstrated that he was a promoter of the first magnitude, but a failure as an administrator," Eddy went on to become a multimillionaire builder of railroads and other corporate dreams in New Mexico and beyond.[97] In 1899, though, his historical stature in the Pecos Valley was symbolically reduced as the community of Eddy voted to change its name to Carlsbad.[98]

**H: The Decline to Bankruptcy**

Although the Pecos Valley's irrigation system had resumed operation in time for the 1894 growing season, the Valley remained in the economic doldrums for the remainder of the decade. The Valley's recession was due, in part, to the economic problems of the nation as a whole, but local conditions were also contributing factors. The Valley's farmers had experimented with a variety of crops, but most had not proven economically viable. Those crops that were grown proved difficult to market. The Pecos Valley Railroad was the area's only viable shipping route; unfortunately, it connected Eddy with Texas and the Southwest while the Midwest and East seemed to be more appropriate markets for the Valley's products. Sensing this situation, Hagerman decided to divert his attention and resources towards expanding the Pecos Valley Railroad to the north and east. Extending the railroad from Eddy to Amarillo, Texas would provide a connection with the Atchison, Topeka & Santa Fe Railway (the "Santa Fe") and give the Valley a direct rail route to the midwest. Hagerman reasoned that this improved railroad route would provide an economic boost sufficient to rejuvenate the Valley's flagging business atmosphere, and throughout the rest of the 1890s he devoted much of his energy to the railroad project.[99]

The first stage of this railway expansion, northward to neighboring Roswell, was well underway by the summer of 1894. The

economic benefits of the Roswell line were disappointing, however, because the railroad's outlet was still to the south rather than the northeast. By this time Hagerman's personal financial resources were all but exhausted; the Pecos Valley Railroad went into receivership in 1896. In 1898, Hagerman was able to convince the Santa Fe to financially support his proposed line to Amarillo, and construction resumed. Under the corporate name "Pecos Valley & Northeastern," the new route was opened for through traffic early in 1899. The Santa Fe's financial involvement in the new route virtually assured the line's completion and eventual success, but it also presaged the complete acquisition of Hagerman's railroad by the Santa Fe. This occurred, for all intents, in 1901.[100] Interestingly, the Pecos Valley & Northwestern's principal competition came from a new rail line concurrently being constructed across New Mexico by none other than Charles B. Eddy.[101]

Although the Irrigation Company's canals continued to operate throughout the 1890s, the Pecos Valley languished economically and the Company continued to be a monetary drain on its owners. As such, the Company joined the ranks of most other large corporate irrigation efforts in the West. By 1900, some 90 percent of these companies were in or near bankruptcy. After the Panic of 1893, the traditional sources of investment capital for such developments largely dried up; even so, it is likely that the Panic only hastened the otherwise inevitable collapse of private reclamation

efforts. Private irrigation companies faced a variety of obstacles, from landowners who were either unable or unwilling to pay their irrigation assessments to land speculators who obtained large tracts of public lands within a project area without subscribing to water rights. Bondholders became less enamored with investments in irrigation as they realized that dividends, if any, occurred only after massive amounts of capital investment and years of development.[102] Equally important factors stemmed from the companies' inexperience in adapting reclamation technology to the needs of the American West. This often resulted in underfunded projects, primitive, inappropriate designs and unrealistic overall expectations. Much later, Tracy recalled:

> This was real pioneering in both irrigation and agriculture. It began twelve years before the Reclamation Act of 1902. There were no special irrigation engineers in the United States.[103] Hagerman had to use railroad engineers.

Although the Irrigation Company did not address the technical difficulties inherent in its reclamation system during the 1890s, it sought to improve its financial posture by actively seeking new farmers for the region's irrigable lands. This solicitation occurred through a variety of means, including local realtors and land promoters, the Pecos Valley Town Company, and the Irrigation Company itself. Hagerman and his Colorado investors also participated in land speculation. In 1895, the Coloradans incorporated the "Upper Pecos Land Company," "Middle Pecos Land Company," and "Lower Pecos Land Company." Each of the companies

was intended "to purchase, take, acquire, own, hold, improve, cultivate, plat, sub-divide, lay out, mortgage, lease, sell, and convey lands and interests therein, with water appurtenant thereto and water rights therefor, and, generally, to deal in lands and water rights . . . ."[104]

The business of land promotion was actively supported by the New Mexico territorial government, which maintained an active "Bureau of Immigration" during the 1890s and early 1900s. This office published numerous brochures designed to showcase New Mexico agriculture and advertise the availability of new farmland. An 1897 booklet, for example, named the Pecos Valley "The Fruit Belt of New Mexico," and promised:

> With an abundance of good water at command, a soil that might be used elsewhere with profit as a fertilizer, and a climate of matchless geniality and salubrity, the Pecos Valley is destined to become one of the most remunerative farming and fruit-growing regions within the limits of the United States.[105]

While the success of these efforts is unknown, the Irrigation Company's continued corporate hardship indicates that mere advertising could not solve the reclamation system's inherent problems.

Farmers who did settle in the Pecos Valley quickly found that much of the region's financial stagnation was due to a continued lack of success in finding an appropriate crop for the Valley's farmlands. Hagerman, the Irrigation Company, and the project's other supporters experimented with a large variety of crops during

the project's first decade. As early as 1890, the Company established an experimental nursery in the Valley under the direction of a "skilled French horticulturist."[106] The project quickly failed after a huge dust storm, which:

> obliterated the smaller ditches and borders, . . . buried the nursery stock, destroyed leaves and even twigs and the smaller trees and plants and even erased the names on the labels. The Frenchman became nearly distracted and had to be sent back to Santa Fe.[107]

Other privately-funded experiments continued, however, often on the farms owned by Company officials. The Valley's warm, sunny climate made it seem an appropriate area for growing fruit, and numerous vineyards and orchards were planted. Most died within a few years, however, victims of wind and dust storms, an erratic water supply, or a root disease which attacked many of the Valley's trees and crops. Alfalfa became something of a staple crop, though its yields were disappointing. Farmers experimented with more exotic crops, as well: Indian corn, kaffir corn, milo maize, sorghum, canaigre. These novelty crops met with mixed initial success, but as the years passed most succumbed to soil depletion or root-rot. Today, these crops serve largely as a reminder that the Irrigation Company's boosters were sincere in their efforts to help the Valley succeed, and that they were not simply attempting to bilk the region's immigrants and investors.[108]

The region's crop difficulties must have been extremely discouraging to Hagerman, but he continued to invest heavily in the region while assisting in the search for an appropriate local crop.

Experiments in growing sugar beets during the 1890s initially seemed encouraging; by 1896 Hagerman was sufficiently enthusiastic about the crop that he persuaded a group of investors (associated with the Schlitz Brewing Company) to construct a sugar beet factory in Eddy. Again, though, crop yields were disappointing and the factory soon closed due to a lack of farmer support. In 1902, the facility mysteriously burned to the ground.[109]

Although Hagerman stoically continued to pump money into the Pecos Valley, by 1896 his personal discouragement with the area was becoming more and more visible. His biographers almost uniformly suggest that this change came about because Hagerman, for the first time, finally allowed himself to see the Valley's faults. He now noticed the region's relatively poor soils, which were growing worse due to improper farming practices and over-irrigation. He also awoke to the irrigation system's rapid, slipshod construction, with its leaky reservoirs and canals, and high maintenance requirements. Almost certainly, Hagerman began to realize that he had been talked into investing most of his personal fortune in a seemingly hopeless venture, and that he, in turn, had convinced many of his associates to do exactly the same thing.[110] The first visible result of Hagerman's change of heart came on August 1, 1896, when he allowed the Irrigation Company to default on an interest payment to its bondholders. It marked the beginning of the end for the company Hagerman, Eddy, and the others had envisioned.

As Hagerman's disillusionment with the lower Pecos grew, he devoted less and less of his money and energy to the Eddy region and concentrated more and more on the Company's Northern Canal near Roswell. Hagerman finally gave up on the lower Pecos near the end of 1897, when he and Otis gave notice to the Irrigation Company's Swiss and other bondholders that they would provide the Company with no more money unless the bondholders also agreed to increase their investment. In what was probably a surprise to no one, the bondholders steadfastly refused. This precipitated a corporate financial crisis that was destined to rapidly force the Company into receivership.

Responding to Hagerman's blunt announcement, a representative for the Swiss investors reportedly toured the Pecos Valley to evaluate the situation. This visit almost certainly brought the bondholders to the same realization that had finally struck Hagerman: that the Pecos Irrigation and Improvement Company's prospects for generating a profit for its backers were virtually nil. Hagerman feared that the Swiss investors would pursue litigation against him, since they thought him responsible for the crisis. Such litigation would be potentially disastrous to the Valley, possibly resulting in the collapse of the pivotal Pecos Valley & Northeastern Railroad project, or even in the closure of the reclamation system itself.[111]

In order to prevent the collapse of Hagerman's Pecos Valley developments, all parties involved agreed to work toward a

negotiated compromise. (Tracy later claimed much of the credit for convincing the two factions to negotiate.[112]) A preliminary agreement was hammered out at a May 1898 meeting in New York which included Hagerman, Otis, Tansill, and Tracy (who was acting as the Swiss bondholders' representative). In short, the agreement stipulated that Hagerman would pay off many of the Company's outstanding bills and make a cash payment to the bondholders; in return, he would take full possession of the Northern Canal and forfeit all rights to the southern canals and reservoirs. The bondholders, through a receiver, would then reorganize the Company's southern holdings into a new corporation in which their investments would be represented by equal amounts of bonds and stock. The new Company would be capitalized at $650,000, suggesting the realization that much of the $2,300,000 previously invested would never be recovered. (By 1898 the Company considered its Southern canals to be worth approximately $650,000, while the Northern Canal was valued at $100,000.)[113]

This proposal was agreed to by all in attendance at the May meeting, although it was a significant monetary blow for Hagerman and the Company stockholders affiliated with him. This stock represented $1,750,000 of the Irrigation Company's total capitalization. Both Hagerman and Otis had personally advanced additional funds to the Company, as well. The Company's stock, however, was an unsecured debt, subsidiary to the property mortgages held by the bondholders. Hagerman therefore had little

choice but to accept the huge financial losses as an expensive lesson in business restraint. In all likelihood, Hagerman was simply happy to finally be rid of the Irrigation Company's southern canal system once and for all. He would then be free to devote his considerable business energies to the development of the Roswell area. By this time, Hagerman had already disposed of most of his personal holdings in Eddy and moved to the South Spring Ranch near Roswell.

A reorganization agreement based on the principles outlined at the May meeting was signed by the parties involved on August 27, 1898. For unknown reasons, however, the plan was not immediately implemented, and the bankrupt Company limped into the twentieth century with Tansill operating it as receiver. Despite Hagerman's avowed disenchantment with the Carlsbad region, Tansill apparently spent substantial time in a vain effort to convince Hagerman to resume investing his dwindling assets on the project.[114] Available documents do not fully disclose the additional corporate maneuvering that took place during the receivership years, although the bondholders' continuing resentment climaxed in a lawsuit filed in Illinois in 1900. The 1898 reorganization plan was finally implemented, and on August 17, 1900, the Pecos Irrigation Company was incorporated in New Mexico to assume the Carlsbad-area operations of the old Pecos Irrigation and Improvement Company. Tracy and Tansill were among the Company's first directors, and Tracy became its general manager.[115] The Pecos Irrigation Company

began operations on February 1, 1901, as the receivership of its corporate predecessor ended.[116]

**I: The Reorganized Company -- Brief Optimism**

Even though the reorganized Pecos Irrigation Company was now bereft of its long-standing access to Hagerman's checkbook, its management displayed limited optimism during the Company's first years. Tansill had managed to show a small positive cash flow during the receivership period which, according to Tracy, a "restored confidence promised to increase."[117] The Company still owned some 30,000 acres of Valley farmland with the potential for development. Except for the deteriorating Pecos River flume, the Company's physical plant was thought to be in generally good condition. Company officers considered the substantial leakage from the canal network to be irrelevant since the river presumably provided a plentiful water supply. The system, however, was operating at far less than the original projected capacity: only 9,131 acres were irrigated in 1901, an increase from 7,910 acres in 1900.[118]

The Pecos Valley's economy also began a gradual improvement after the turn of the century, perhaps largely due to the completion of the Pecos Valley & Northeastern's line to Amarillo. The new route finally gave the Valley the direct market connections it had sought since the 1880s. The first carloads of Pecos Valley

fruit were shipped from the Tracy farm in 1900, and the Valley's other crop uncertainties began to ease. Each year, the Irrigation Company managed to slowly increase the number of acres it provided with water. Agricultural land values remained lower than Carlsbad's "boosters" had hoped, however.[119]

The Valley's agricultural situation further stabilized with the introduction of cotton as a staple crop. Egyptian cotton was first grown locally in an experimental plot near La Huerta for the Department of Agriculture, and the results were impressive enough to induce the operators of a Texas cotton gin to relocate to Carlsbad in 1903. The Valley's cotton fields displayed an immediate and relatively substantial success, and by the end of the decade cotton had become one of the Valley's primary agricultural products. It remains an important local crop today.[120]

The Irrigation Company remained marginally profitable after its release from receivership, although the optimism of 1901 began to fade as management realized that substantial improvements to the Company's physical plant would soon be necessary. By 1902, Tracy and Tansill recognized that the Pecos River flume needed immediate replacement and that any future expansion of the system hinged on a reduction of the canal network's substantial seepage problem. The magnitude of these projects suggested to Tansill that the Company's investors would be better served if a buyer for the entire system could be found. Perhaps noting the legislative progress of the Reclamation Act of 1902, Tansill suggested that the United States

government might be such a buyer. In late 1902, he managed to lure F. H. Newell, the Chief Engineer of the newly-formed United States Reclamation Service, to Carlsbad to discuss possible federal purchase and expansion of the Company's reclamation system.[121]

Meanwhile, Tracy began the task of raising the money needed to replace the wooden Pecos River flume. Hagerman's absence made this job a difficult one, but Tracy managed to gather the needed $50,000 by the early fall of 1902. The Irrigation Company's trying financial situation was reflected by the fact that the corporate directors were forced to personally guarantee repayment of a portion of the money borrowed.[122] To design the flume, the Company hired Thomas Taylor Johnston, a civil engineer from Chicago. Johnson possessed experience with the U.S. Army's Engineering Corps, specializing in the hydraulics of western rivers. After his stint in the military, Johnston worked for various public works agencies in Chicago; he also designed waterworks for Memphis and Savannah, and a water power system for Seattle.[123]

The original Pecos River Flume was constructed of wood, typifying nineteenth-century American canal design. By the turn of the century, however, reinforced concrete was also commonly used to construct flumes. The adaption of masonry for bridge superstructures was a revitalization of an age-old concept, dating back at least to Roman times. The development of reinforced concrete flume designs closely followed similar developments for

reinforced concrete bridges, and the earliest designs for both were arch structures. Reinforcement of the concrete with iron or steel bars allowed a significant reduction in the mass of the bridge structure. Ernest L. Ransome built the first reinforced concrete arch bridge in the United States in 1889, and by the end of the century engineers were building reinforced concrete-arch bridges with spans in excess of 100 feet.[124] Johnston's 1902 recommendations to the Pecos Irrigation Company displayed at least a basic awareness of the advantages of reinforced concrete design; he noted that "Portland cement concrete masonry with imbedded metal constitute meritorious and desirable materials of construction."[125] Compared to the construction of a steel viaduct flume, Johnston concluded that a reinforced concrete design "would be more desirable and less expensive."[126]

In the end, Johnston's plans for the flume specified the construction of a massive reinforced concrete aqueduct some 497 feet long and up to 47 feet high, with a capacity of 1,500 cubic feet per second (HAER photographs #E-1 through E-13, E-15). The new flume featured a water trough 18 feet high and 20 feet wide, with walls two feet thick. The trough was supported by four pairs of arches, each 25 feet high with a 100 foot span. The arch rings were five feet thick and sprung from grade. Piers, eight feet thick, stood between each pair of arch rings. The four-foot thick floor of the trough was contiguous to the arch rings. The side walls of the flume were inset from the outer edges of the floor 6

inches on each side. Some 16,000 lineal feet of rail were placed in the floor and walls of the trough and tied across the top to carry stresses in the floor and provide lateral bracing for the walls.[127] The flume was designed to carry 1,200 second-feet of water, even though the canal below the flume apparently carried only 365 second-feet.[128]

Construction work on the flume began in September 1902 and continued into 1903.[129] The completed structure, both massive and graceful, was a source of pride for the Company and the Carlsbad community; even a representative of the Reclamation Service termed the flume "a substantial piece of work . . . well worth seeing."[130] On its completion, the structure was reportedly the largest irrigation flume in the United States.[131]

**J: The Final Collapse**

The Irrigation Company's perennial misfortune returned soon after the flume's construction began. Tansill's sudden death on December 27, 1902 cost the Company one of its strongest advocates, although his wife assumed a portion of his former role with the Company. Construction work on the new flume initially proceeded rapidly, but in 1903 Johnston suffered a serious illness and his construction foreman's wife and daughter died under "exceedingly distressing circumstances."[132] These events threw the construction project into chaos. The flume was completed sixty

days behind schedule, precipitating a disastrous water shortage for the downstream farmers.[133]

Although the Irrigation Company's backers continued to hope for federal acquisition of the Pecos irrigation system, the Reclamation Service's interest in New Mexico was initially drawn elsewhere. In 1903, the Reclamation Service began a careful evaluation of the possibility of constructing a reservoir and irrigation system on the Hondo River, near Roswell. This proposed "Hondo Project" was intended to irrigate some 10,000 acres of farmland, using water that was now flowing into the Pecos River and, ultimately, McMillan Dam. It was not surprising, then, that Tracy and the Irrigation Company saw the Hondo Project as a potential threat to operations in the Carlsbad area. In June 1904, as the Project seemed more and more likely, Tracy began an active campaign to protect the Irrigation Company's water supply by attempting to halt the Hondo Project. His first protest, a long, rambling letter addressed to the Secretary of the Interior, noted that the Irrigation Company relied exclusively on Hondo River water during the spring planting season. He also claimed:

> It is a well-recognized rule of law in all of the arid West that the appropriator of the waters of a stream is considered likewise the appropriator of all the waters of all the tributaries of that stream. On this point I must contend on behalf of this Company that it is entitled to the use of all of the flood waters of the Hondo River, at least up to such time as it finds its reservoirs full of water.[134]

Tracy's claim was given credence by the fact that the Irrigation Company's corporate predecessor had made an abortive attempt to construct a storage dam on the Hondo in 1892. In view of this, the Reclamation Service began an examination of Tracy's charges; this evaluation included soliciting the opinion of James J. Hagerman. Hagerman characterized Tracy's letter as a series of "amazing statements," and he noted that the Irrigation Company had sold Hagerman its Roswell-area holdings and water rights in 1900. Hagerman, through his Felix Irrigation Company, had already agreed to sell his claims to the Hondo's floodwaters to the Reclamation Service.[135]

Meanwhile, the Irrigation Company filed a formal protest against the Reclamation Service proposal, and Newell authorized formation of a Board of Engineers to examine the Company's claims. (The Reclamation Service regularly utilized the concept of an independent "Board of Engineers" or "Board of Review" to adjudicate potentially controversial issues.) The Board conducted a series of hearings in Roswell during September 1904, and prepared a final report immediately thereafter. The Board's report maintained that the Irrigation Company's water shortages were caused solely by the Company's poorly-built, leaky physical plant, and that the Company could more than double its acreage if reservoir and canal leakage were reduced. The Company's claim of a water right on the Hondo was also refuted. The Board concluded by recommending "that the

protest be overruled and the Hondo Reservoir Project be constructed as early as practicable."[136]

The Hondo Reservoir dispute was quickly destined to become a moot issue, however. Following two years of unusual drought, in October 1904 the Pecos River's eccentricities were manifested in the largest, most devastating flood the Valley had seen in years. The flood caused significant damage throughout the Pecos basin, although the heaviest losses were felt in the Carlsbad area. These losses included railroad and highway bridges, the community light plant and cotton gin, and numerous other improvements.[137]

The amount of damage to the Pecos Irrigation Company's physical plant was enormous (HAER photograph #B-57). Perhaps the best written description of the flood's effects was provided by William Reed, a Reclamation Service engineer who visited Carlsbad several days after the height of the flood. Reed reported damage to the Irrigation Company's entire network, including both dams, much of the canal system, and the new concrete flume. Examining the dams, Reed noted:

> The dam proper at McMillan is standing and without any injury, the water having been about 8 feet below the crest. However . . . about 2000 feet of the [dam's west] embankment, ranging in height from 6 to 12 feet, has been taken away. . . . The head-gates are still standing but are weakened and with continuous high water and necessarily heavy flow through the gates may go to ruin. The elements will play a great part in the life of these works and may yet do considerable damage before the flood conditions cease.
>
> I found that about 500 feet of the main [Avalon] dam had been carried away and the river, yet in flood, was

> running through Lake Avalon without interruption. Of 32 gates in the spillway only 8, badly wrecked, were standing. The head-gates are still in, but damaged. The canal below is broken but not as badly as I anticipated.[138]

It was obvious to all that the Valley's reclamation system had suffered the worst damage in its history, and that the Pecos Irrigation Company was out of operation for the foreseeable future. The Company's fragile financial condition made the prospects for reconstruction flimsy at best. This time, there was no James Hagerman to reassure the farmers and provide a massive injection of money for repairs. The outlook for the Pecos Valley seemed bleaker than it had in years, forcing all parties involved to scramble to find a new solution.

**K: Conclusion -- The Significance of Private Irrigation on the Pecos**

In retrospect, the history of the Pecos Valley's various irrigation companies is both tenuous and disappointing, a story of huge sums of money largely wasted on false expectations and inadequate technologies. During the fifteen years that corporate reclamation was attempted on the lower Pecos, an investment of well over two million dollars failed to produce an adequate, functional irrigation network. Instead, Company engineers produced an inefficient, haphazard system, as unable to provide a consistent

water supply as it was to withstand the eccentricities of the Pecos River.

Much of the blame for the private reclamation system's failure can be traced to the lack of proven irrigation technologies available to Irrigation Company engineers. Tracy's analysis of the Irrigation Company as "real pioneering" was both accurate and perceptive -- the Pecos Valley's promoters were undertaking reclamation work at a scale and level of complexity heretofore nearly unknown in the American West. While this undeniably proved discouraging and frustrating to the system's nineteenth-century entrepreneurs, it makes the Pecos projects highly significant as a case study of early, large-scale western reclamation.

Among the irrigation system's physical features, Avalon and McMillan Dams were easily the largest and most significant. The rockfill design of both structures represented innovative reclamation engineering for the day, as one stage in a complex evolutionary process of dam design. Rockfill dams such as Avalon and McMillan consist of loose, dumped rocks which, by their mass, resist the horizontal force of the water the dam impounds. The dam must rely on an impermeable zone or membrane to keep water from passing through it. Rockfill dams may be divided into two categories, those with a waterproof upstream face and those with an impermeable core. In twentieth-century practice, the upstream face of the former is generally concrete and the core of the latter is impermeable earthfill. Rockfill dams with an impermeable upstream

face are the older of the two types; the widespread acceptance of this structural form dates to the years following the California gold rush when miners needed to impound water for hydraulic mining. The earliest dams in the mining regions were small, timber-crib structures with a plank upstream face, based on a technology widely used in the eastern states. As miners built larger dams, the timber cribs became rock-filled, and eventually the timber cribs were eliminated altogether. These dams were rendered relatively impervious by anchoring an upstream face of wood planks to the rockfill. Such dams were favored because they were less expensive to construct than masonry dams and they were considered less prone to failure than earthfill dams. It was not until the late nineteenth century that the upstream wood planking began to be superseded by concrete.[139]

Late in the nineteenth century, the use of an impermeable earth core or upstream apron became more common. Some dams had a central earthfill core with rockfill both upstream and downstream, while others simply had an upstream zone of impermeable earthfill with a gradual slope and an upstream face of rock riprap to resist the erosive action of the reservoir. As these dam forms developed, engineers finally accepted the safety of rockfill dams, or loose-rock dams as they were sometimes called. Some engineers actually considered rockfill to be the safest dam technology because of the inherent flexibility of the structure. The most highly recommended version of the rockfill dam -- used at both Avalon and McMillan --

employed the impermeable earthfill upstream zone and a riprapped upstream face. Such a structure was sometimes called a "composite dam." Some engineers preferred not to consider composite dams a sub-category of rockfill dams, because the earthfill zone made them more comparable to standard earthfill dams. Others argued that composite dams were truly rockfill dams because the mass of rock provided the main resistance to the horizontal force of water in the reservoir, while the choice of impermeable element -- wood, earth, concrete, or steel -- was of secondary importance.[140]

Contemporary professional observers considered both Avalon and McMillan Dams to "most boldly exemplify" the rockfill dam technology as practiced during the late nineteenth century.[141] Such dams, however, had to be constructed properly. During Avalon's initial construction in 1890, the earth zone was simply backfilled against the rockfill: it was neither wetted nor compacted. Consequently, the potential existed for a sudden, powerful flood to impregnate the loose, sandy-loam earthfill with water, causing the earthfill to settle and exposing the dam's loose rock to the force of the water. This could, in turn, lead to the dam's failure. Unfortunately for the Pecos Valley's residents, the unpredictable Pecos River demonstrated just such a scenario in both 1893 and 1904.[142]

Other aspects of the system's construction also reflected incorrect design based on uninformed judgements or inadequate technology, including the roughly-built canal network and the

vulnerable, ephemeral wooden Pecos River Flume. These facilities, in common with the dams themselves, reflected the philosophies of current reclamation design, but contained inadequacies that required correction before the system could fill even a portion of its intended potential.

Finally, the grandiose plans of Eddy, Hagerman, and the others were also unfulfilled due to a basic misunderstanding of the land itself. Large-scale irrigation was introduced to the Pecos Valley without a clear understanding of what the land was capable of growing, how local crops could best be managed, and the amount of return these crops could generate. Unrealistic expectations of the Valley's agricultural productivity not only left many farmers disappointed, but diminished the revenue of the irrigation companies. As with the reclamation system's engineering, the farmers' eventual success was dependent on refining local agricultural methods and technologies.

The myriad of difficulties encountered by the sponsors of Pecos irrigation projects frequently mirrored the obstacles encountered by other irrigation companies across the West. Late nineteenth-century enthusiasm for corporate reclamation schemes resulted in a variety of private irrigation projects scattered across the western states. Few, however, proved successful; most clearly reflected the inadequate funding, ineffective engineering, and false expectations that characterized the Pecos Irrigation Company and its predecessors.[143]

As a whole, then, corporate irrigation in the Pecos Valley and elsewhere generally proved unsuccessful. The experiences of nineteenth-century irrigation entrepreneurs, however, served as a proving ground for the embryonic field of reclamation engineering. As the twentieth century began, this field was poised to initiate a rapid period of expansion and development, and the technologies employed by the early irrigation companies would continue to evolve. Now, however, the impetus for technological advancement was to come from the federal government rather than the private developer. Nonetheless, the Pecos Valley was once again destined to be a showplace for these changes.

# CHAPTER 2: ACQUISITION AND RECONSTRUCTION BY THE BUREAU OF RECLAMATION

## A: Introduction

While the early history of irrigation promotion and development in the Pecos Valley is largely a story of private enthusiasm and entrepreneurship, federal officials concerned with reclamation also showed an early awareness of the region and its assumed agricultural potential. This governmental interest stemmed from a nationwide movement during the 1870s and 1880s to develop "scientific" methods of coping with the lack of agricultural water in the arid West.

A basic understanding of the circumstances of the "Great American Desert" was implanted in the nation's collective mind by the middle years of the nineteenth century. Most travelogues and descriptive narratives of the period advanced the concept that much of the West was simply too arid to grow viable crops without irrigation. That notion was particularly descriptive of much of the American Southwest.[144] In the case of New Mexico, the apparent lack of surface and ground water seemed to completely preclude the possibility of successful agricultural settlement in much of the Territory. Any publicity of such conditions,

naturally, was anathema to the growing numbers of residents in the Territory, and an increasing spirit of "boosterism" worked to rebuke the notion that much of New Mexico was useless land. The Southwest's boosters gladly accepted the popular notion that rainfall would increase once the land was settled, and that the technologies of wells and river reclamation projects would be able to provide any supplemental water that might be needed. These fallacious beliefs proved strong enough to encourage settlement without proof of their accuracy.[145]

By the 1860s, the federal government had begun an active involvement in the issue of how western lands should be managed. In part, this involvement attempted to respond to the region's broad, unanswered questions of water availability. The Preemption and Homestead acts of the 1860s established basic frameworks for the transfer of individual western tracts to small farmers, and the following years saw more specific legislative efforts directed specifically at management of arid lands. The Desert Land Act of 1877 was a significant development, marking the beginning of the development of federal land policy geared to the management of arid western lands. The Act provided an initial, basic framework for the transfer of arid agricultural lands to individual farmers who agreed to place the land under irrigation. In retrospect, many historians found the Act to be an inappropriate response which complicated and compounded existing management difficulties, and at least one knowledgeable contemporary observer shared that view.

That observer was John Wesley Powell, the noted western explorer. Throughout the late 1860s and 1870s, Powell was a major advocate for the reform of government policy towards western lands. His perceptive statements noted the certainty of disaster when the inevitable droughts struck new farmers in the western deserts, and he proposed a more restrained settlement policy based on small-scale collective irrigation projects. Powell's lobbying and advocacy ultimately persuaded the United States Congress to attach a reclamation provision to its appropriations bill of October 2, 1888. This legislation directed the U.S. Geological Survey to begin a field survey of "the arid region of the United States," intended to identify locations suitable for future reclamation projects and to withdraw them from private appropriation. In theory, this would allow an orderly federal development of such areas without interference from land speculators and those planning inappropriate uses.[146]

In the Pecos Valley, the field survey thus mandated was performed in early 1889 by R.S. Tarr of the Geological Survey. Tarr's brief narrative (termed a "Hydrographic Survey") marked the first published federal attempt to evaluate the agricultural and reclamation potential of the Valley. His document included brief descriptions of the region's water resources, as well as reports on present and proposed agricultural and irrigation efforts. Despite observing a variety of small active irrigation projects developed by both Hispanic and Anglo-American settlers, Tarr emphasized that

"No attempt at scientific application" of the Valley's water had yet been made.[147]

Tarr's reconnaissance report included a cursory description and evaluation of the incipient activities of the Pecos Irrigation and Investment Company. He noted that the Company had "the most extensive scheme on foot in the Pecos Valley." After reporting on the group's grandiose plans for the Hondo area (near Roswell), he complained that the planned fee schedule for water rights seemed excessive, and speculated, "that much of the land taken up under the ditch will become the property of the company through failure to pay the taxes; and it is possible that the company looks at the matter in the same light." The Company's Southern Canal (the future Avalon Dam project) was also briefly described, although he noted that "the plans concerning this canal are not yet matured, and the work of construction has not been commenced. The dam site is said to be good, the river being a succession of rapids, falling 50 feet in 6 miles."[148]

Tarr concluded with a bit of speculation on the Valley's potential for reclamation development. He pronounced the question to be "an engineering problem of such magnitude that I fear to make even a suggestion," noting that "In the middle and lower Pecos the river bed is of changing sand and seems to offer no means of permanently securing a dam."[149] The soil itself appeared well-suited for agriculture, however, and Tarr seemed confident that local farming would succeed -- provided that an appropriate

reclamation technology could be developed for the region. To Tarr, what that technology would be seemed to be very much an unresolved question.[150]

The specific governmental response to Tarr's narrative is unclear, although the 1888 legislation succeeded in thoroughly clouding the status of the West's arid lands. Vast tracts of lands were withdrawn from settlement in response to the act, and the validity of the many private land entries in the affected areas was called into question. The situation inevitably led to a long, acrimonious congressional debate over the efficacy of the 1888 law and Powell's philosophies in general. Much of the fuel for the polemic was provided by the ongoing activities of the Pecos Irrigation and Improvement Company. The Company's congressional supporters, aided in part by an unhappy letter from Hagerman, portrayed the act of 1888 as conspiring to disenfranchise thousands of newly-arrived Pecos homesteaders, as well as to render useless the Company's $700,000 investment in its physical plant. Similar situations existed in other western states, and landowners and developers from throughout the region managed to convince much of Congress that Powell's legislation was too impractical and far-reaching, destined to unfairly halt the West's rapid growth. Consequently, most key provisions of the 1888 arid lands legislation were rescinded in 1890. The 1890 legislation marked a major defeat for Powell and his progressive philosophies of planned reclamation, and saw the federal government abandon most of its

efforts to plan western reclamation and irrigation programs.[151] In New Mexico, the Pecos Irrigation and Improvement Company continued its substantial reclamation developments with only minimal government attention. The only significant local action by federal authorities was approving the withdrawal from public entry of the Irrigation Company's three Eddy County reservoir sites in 1897.

The federal government's laissez-faire attitude towards western irrigation during the 1890s allowed land promoters throughout the West to proceed apace with planning grandiose corporate reclamation projects. Enthusiasm for such programs continued to rise throughout the decade, encouraged both by the developers themselves and by the strong advocacy of some scientists and other professionals interested in the subject. Supporters of western irrigated agriculture advertised their cause through annual "Irrigation Congresses," beginning in 1891. A new journal entitled Irrigation Age also helped disseminate information on the emerging technology.[152]

Not surprisingly, the number of reclamation ventures actually constructed in the west fell significantly short of the number envisioned over the years. Of the private irrigation companies that did begin construction, most managed to achieve only a fraction of their announced goals before failing due to inadequate funding, poor engineering, or an inherent lack of water. In an effort to aid the struggling reclamation movement, Congress in 1894

passed the Carey Act, which allowed each western state to receive title to up to 1,000,000 acres of federal land -- provided that the state could arrange to have the land irrigated, settled, and farmed. Although a variety of Carey Act projects were attempted, most were wholly unsuccessful. The Carey Act was most actively employed in Wyoming, successfully in projects such as Wheatland Reservoir and unsuccessfully in efforts such as the Buffalo Bill Project near Cody. Even in Wyoming, however, the state only managed to patent 11,321 acres of Carey Act land. Other western states saw even less economic benefit from the Act. The Act saw almost no use in New Mexico, in part because it did not apply to territorial governments until 1909.[153]

As the inherent problems with the private irrigation companies and the Carey Act experiments became more and more evident, Congress continued debate on the reclamation issue. Despite the recognized inadequacies of nineteenth-century American water policy, it was not until Theodore Roosevelt's assumption of the presidency in 1901 that federal involvement in reclamation became a reality. In a significant shift from earlier federal policy, Roosevelt strongly advocated the establishment of a federal program of reservoir construction. The framework for such an endeavor was codified in the Reclamation or Newlands Act of June 17, 1902 (32 Stat. 388). This statute created a United States Reclamation Service (initially operating under the U.S. Geological Survey), charged with the construction and maintenance of reservoirs and

irrigation systems in 16 western states and territories. Funding for Reclamation Service projects was to come from a revolving "Reclamation Fund," containing the proceeds from federal western lands sales. Farmland in these project areas would be made available to individuals under the terms of the Homestead Act; this limited an individual's irrigated holdings within a project to 160 acres. Project landowners were required to reimburse the Reclamation Fund for the project's construction costs, as well as ongoing operating and maintenance expenses. Construction costs were to be repaid over a ten-year period, interest-free.[154]

The new Reclamation Service, needing to establish a perception of efficacy, quickly began work on a number of western projects. In New Mexico, the Hondo Project was approved within months of the Reclamation Service's establishment. This project included a diversion and storage dam on the Rio Hondo, a Pecos tributary west of Roswell, and an associated canal network. The location had been the site of earlier, aborted reclamation attempts by the Pecos Irrigation and Improvement Company and others. The Hondo Project was the first federal reclamation effort in New Mexico Territory, and it proved to be a rapid and unquestioned failure. An inadequate water supply and a highly porous reservoir floor made the lake virtually impossible to fill, and the $375,000 undertaking was largely abandoned after 1907. It proved to be an inauspicious beginning for the Reclamation Service in New Mexico.[155]

**B: The Reclamation Service Arrives in Carlsbad -- the 1905 Fiasco**

In the meantime, however, the Reclamation Service continued to review other possible New Mexico projects. The massive Elephant Butte Project on the Rio Grande was underway by mid-decade. In 1904, the lower Pecos Valley became a prime candidate for federal intervention. In the years since Tarr's 1889 field survey, the Pecos Irrigation and Improvement Company had developed a substantial network of reclamation facilities to the north and south of the town of Carlsbad. The Company's holdings included Avalon and McMillan Dams and Reservoirs, some 63 miles of primary canals and over 500 miles of laterals. The Irrigation Company's physical plant irrigated approximately 14,000 acres in the Carlsbad region. On October 1 and 2, 1904, however, a major flash flood along the Pecos River largely destroyed Avalon Dam and damaged much of the canal system; this made the Company's irrigation network inoperable and threatened the farmers dependent on it with rapid ruin.

Within days of the disaster, both the Irrigation Company and the farmers it served began searching for a solution that would allow the system to be rebuilt. It quickly became evident to both groups that Reclamation Service intervention was the only solution to the dilemma. The landowners immediately formed the "Pecos Water Users Association" to serve as an advocacy group. On October 8, the Association wrote the Pecos Irrigation Company, "to ascertain

from you at the earliest possible moment, what may be the disposition of your company respecting the immediate reconstruction of the damaged portion of your system."[156] The letter also requested that the Company provide a full valuation of its local holdings, "in the event of your company being unable or unwilling to make the repairs above mentioned, we may as speedily as possible arrive at a basis of value for presentation to the proper authorities at Washington in the hope of obtaining their assistance in the reconstruction of our system of water supply."[157] The Company responded three days later with a letter declaring it to be "heartily in accord with the proposition to sell the property of that company to the United States Government," and it promised to rapidly establish a sales price.[158]

The Irrigation Company was near bankruptcy by 1904, and there is little doubt that it was more than eager to sell its holdings to the federal government. Before the month was out, Francis Tracy, the Irrigation Company's general manager, had written Frederick H. Newell, the Reclamation Service's Chief Engineer, requesting that the government take over the Company's physical plant "at once." The plea for federal intervention was carried still further by Company investors, who persuaded noted Senator Henry Cabot Lodge to write the Secretary of the Interior on the Company's behalf. Tracy, in an attempt to appear conciliatory, also formally withdrew the Irrigation Company's protests against the upcoming Hondo Project.[159]

Meanwhile, the Reclamation Service dispatched William Reed, a U.S. Geological Survey Engineer at the Hondo Project, to Carlsbad to study the flood damage. Reed possessed a unique familiarity with the Carlsbad area, having worked for the Irrigation Company from 1889 to 1900; he had served as its chief engineer from 1898 to 1900.[160] Reed reached Carlsbad by foot on October 6 (floodwaters had severed the rail line), surveyed the situation, and was immediately met by a committee from the local Commercial Club. The committee members bombarded Reed with tales of the potentially disastrous consequences of the loss of the irrigation system, and informed him that local sentiment strongly favored government intervention in the matter. It was locally realized that the Company would be unable or unwilling to finance the system's needed repairs, and the committee felt that the Reclamation Service was the irrigators' only hope. Reed was generally sympathetic to the committee's plea, terming the situation "almost a public calamity," and immediately contacted Newell.[161] In response, Newell cited the large number of other Reclamation Service projects that were already underway in the West, and proclaimed:

> We should, I think, finish our operations near Roswell before getting involved in another locality. All of these matters require time and careful consideration; it is impossible for the Department to take action rapidly as in the case of a corporation, as details must be referred to many persons. I cannot, therefore, encourage the idea of taking up work at Carlsbad immediately . . .[162]

Nevertheless, the Water Users Association intensified its entreaties to the Reclamation Service. The Pecos Irrigation Company notified the Water Users that it would sell its irrigation system for $350,000, provided that "reasonable assurance will be given by the Government that the property will be taken over at an early date."[163] Armed with this information, the Water Users met on November 8 and prepared a resolution pleading for the Reclamation Service's assistance in reconstruction. The Water Users' resolution emotionally related the necessity of the irrigation system and noted the disastrous consequences to local farmers which were inevitable without the Reclamation Service's aid:

> The people who occupy these small farms . . . have built them over the past twelve years, planting orchards, alfalfa fields, building roads, school houses and churches, with the firm faith that the result of their industry would be a means of sustenance to themselves and a heritage for their children. Without the aid of your department, they are confronted with ruin -- complete, and immediate.[164]

The Water Users emphasized that their situation was an emergency demanding immediate attention, and asked Newell to appoint "a Board of Engineers to examine the conditions now existing in this portion of the Pecos Valley . . . to the end that the reservoirs, canals, flume, water rights and franchises now owned by the Pecos Irrigation Company, may be taken over by the U.S. Government under the Reclamation Act."[165] The resolution's message was reinforced by a delegation of ten Carlsbad citizens who

traveled to a November "Irrigation Congress" at El Paso to meet with Reclamation Service officials.[166]

The Reclamation Service responded to the Water Users' pleas by authorizing B.M. Hall (a U.S.G.S. engineer based in El Paso) to undertake an "investigation" of the costs of rehabilitating the Pecos facilities. By early December, Reclamation Service engineers had established a temporary encampment near Avalon Dam and had begun an evaluation of the local situation. In a preliminary, handwritten report dated December 15, Hall and Reed stated that the system could be temporarily repaired for the 1905 growing season at a cost of $20,000. It was reported that the Water Users Association had "practically begged" for the Reclamation Service to design and supervise the repairs. The actual labor would be performed under the aegis of the Irrigation Company. Hall and Reed were highly sympathetic to the Water Users' dilemma; their report concluded, "We believe the Reclamation Service can do no greater public good at the present, than to encourage and aid these struggling people in every way that may be possible."[167]

The response from Washington (dated December 21) was now somewhat more encouraging. Hall was instructed to permanently relocate to Carlsbad and begin design work for the temporary repairs. While he supervised the repair work, he was also to continue his evaluation of the local system's long-term needs. An eventual federal takeover of the Pecos physical plant was now termed "very desirable," although the Reclamation Service

privately considered the Pecos Irrigation Company's proposed sale price to be "absurdly high."[168] Federal acquisition of the Pecos properties began to seem increasingly possible, although a period of negotiation and uncertainty still appeared inevitable.

While the Reclamation Service's planning and survey activities continued at Avalon during December 1904, additional plans were being finalized to temporarily repair the irrigation system for the 1905 growing season. Financing these repairs became a primary concern and obstacle. Since the physical plant remained under the Irrigation Company's ownership any repairs would need to be performed by them. The Company, however, had neither the financial resources nor the credit standing required to finance the work. It fell, then, to the members of the Water Users Association to secure the necessary funds. The Water Users inaugurated a subscription drive, and by early January 1905 were able to loan the $20,000 needed for the repairs to the Irrigation Company. Newell was immediately notified of the fund-raising success, and on January 12, 1905 he formally approved the Reclamation Service's supervisory and design role in the upcoming project. Newell designated Hall as the Reclamation Service's local supervisory representative.[169] By this time, however, Reclamation Service engineers had already completed substantial engineering work and construction was underway.

Much of the project's design work was performed by E.W. Myers, a Reclamation Service engineer assigned to the effort. Myers

initially prepared three alternative proposals for the most complex portion of the undertaking: the repair of the washed-out Avalon Dam. His first two proposals involved closing the dam's breach with either an earthen or timber structure, while the third alternative specified the construction of a small, entirely new diversion dam just upstream from the failed dam. The latter plan, while possessing some design advantages, would have required extending the canal system upstream, as well. Myers' final design for the new dam was heavily influenced by the project's financial constraints, and his more complex and technically sophisticated proposals were rejected by the Irrigation Company as being too expensive. The design finally adopted specified an earthen dam erected atop a rock-filled timber-crib foundation. A wooden spillway was integrated into the primary dam, placed at the height needed to divert a 5 foot head of water into the existing Main Canal. The total structure was to be 714 feet long, up to 29.7 feet high, and 8 feet wide at the crest. It was to contain 27,332 cubic yards of earth.[170]

Work crews and equipment began arriving at the site on January 3, 1905 and construction commenced immediately. Most of the project's laborers were locally-hired Hispanics; additionally, local farmers hauled earth with their personal teams and wagons, earning both cash payments and credits on past and future water rents. Project foremen were Irrigation Company employees, leaving only the design supervision to Reclamation Service personnel.

Reclamation Service engineers complained at length about the quality of the labor force, noting that workers were continually "laying off from work for a day or week whenever it suited them." This caused recurring shortages of either manual laborers or teams and drivers, reducing the project's efficiency.[171]

Crews constructed an access road to the site during the first week, and later built a timber bridge across the river. This allowed earth moving to begin. Meanwhile, a series of second-hand 12-inch by 12-inch timber piles was driven in the dam abutments; crossmembers attached to these piles formed cribs which were filled with earth and stone. The spillway was also constructed of timber; it was 100 feet long, featuring a 17-bent timber trestle as framing with a stone fill and wood surfacing. Unusually high water repeatedly hampered construction of the spillway, and on April 24th a flood washed out seven of the newly-installed bents and their cribbing. Reclamation Service engineers blamed Irrigation Company officials for the recurring water damage, since the Company had refused to drain McMillan Reservoir to protect against downstream flooding. The Company had reportedly feared a shortage of irrigation water if McMillan were drained, and did not anticipate the unusually heavy spring 1905 rainfall.[172]

As work on the dam progressed, other crews began the task of rehabilitating the system's canal network. The primary element of this project was the repair and reinforcement of the Pecos River

flume. Concrete masons completed some $8,000 of work on the structure during the spring of 1905.

The repeated flooding at the Avalon site significantly delayed the dam's completion, but the structure was finally closed on the morning of June 2. Workers noticed some settling of the dam earthwork as the reservoir filled but the problem seemed minor and at 8:00 P.M. on June 4 water began flowing into the irrigation canal. Four and one-half hours later, however, a large whirlpool appeared in the reservoir, indicating the presence of a severe leak. The dam failed within minutes (HAER photograph #B-56). Some 40 feet of the structure quickly washed away, and the rushing water stripped the riverbed down to bedrock.

In retrospect, Myers suggested the probability that the failure occurred due to the unanticipated porosity of the soil beneath the dam substructure, but he also implied that the earlier flooding at the construction site contributed to the failure.[173] As might be expected, however, Tracy held an opposing view. He professed outrage at the Reclamation Service's squandering of Company funds on a structure he considered to have been poorly designed and built. He questioned the engineering competence of Hall and especially of Myers, whom he claimed "had no experience, was stubborn, obtuse, and never planned ahead." Tracy also noted that the fiasco had completely drained the Company's fiscal resources, and that a return to receivership was a definite possibility.[174] Tracy's allegations were destined to haunt the

Reclamation Service locally in future years, and his anger would soon be a recurring theme in the project's existence.

Regardless of the cause, however, the failure of the temporary dam was a significant blow to the Valley's farmers. Although local residents initially contemplated another temporary reconstruction effort, a lack of funds and enthusiasm for the scheme soon made it obvious that the irrigation system was lost for the 1905 season, at least. All reconstruction work on the canal system and the half-repaired flume was halted soon after the flood. The fruitless venture had cost the Pecos Irrigation Company nearly $35,000, and the lack of success doomed the Valley's farmers to a dry, disastrous summer.

**C: A Permanent Presence -- The Reclamation Service Takes Over**

While the Reclamation Service and Pecos Irrigation Company pursued their futile 1905 attempt to restore irrigation service, other developments began to lay a framework for future, large-scale rehabilitation and long-term federal involvement. Throughout the 1905 season, Hall, Myers, and their technical crews surveyed and mapped the region, preparing both geological reports and engineering studies of the existing reclamation system and of a possible government rehabilitation effort (to be known as the "Carlsbad Project"). To the Reclamation Service field personnel and local farmers, these efforts seemed a reassurance that federal

takeover of the irrigation system was imminent. No such transfer had yet taken place, however, and negotiations and uncertainty on that front continued throughout much of the year.

One of the first field studies was completed in March 1905 by Thomas Means, an "Engineer of Soils" for the U.S.G.S. His report identified some 52,300 acres of "first and second class land" (well-suited for irrigation) within the Carlsbad area. He chided the area farmers for their neglect of fertilization, drainage control, and other scientific agricultural practices, noting that current practices were both limiting crop yields and damaging the soil. He stated, however, that with irrigation and appropriate farming practices "any intelligent man willing to work should successfully manage any first class land under the Carlsbad Project and be able to pay for his water right and adequately support a family. Many men could put money in the bank each year in addition."[175]

Meanwhile, the Reclamation Service mapping and survey crew completed extensive triangulation work and contour mapping of the McMillan and Avalon Dam sites and other Irrigation Company facilities. These studies were apparently intended as base materials for any future federal reconstruction work. Geological and engineering reports were also prepared for the same purpose. Much of this work culminated in an August 31, 1905 report to the Reclamation Service Chief Engineer, summarizing the local situation and recommending a plan for government action. This document was

signed by an appointed 5-member "Board of Engineers" which included Reed and Hall, but not Myers.

The Board's report reaffirmed the seriousness of the local water situation and recommended a federal takeover of the project. Existing reservoir storage capacities suggested to the board that a federally-managed system would be able to irrigate approximately 20,000 acres of farmland, and an analysis of local economic and agricultural conditions indicated that a maximum construction assessment of $30 per acre could be levied on the land to be served. (Reclamation Service projects were intended to be financed through time-payment assessments on a district's farmland.) These figures produced a maximum project budget of $600,000. Repair costs to the existing system were estimated at $450,000, thus suggesting a $150,000 purchase price for the Irrigation Company's assets. This figure was substantially less than the Company's original $350,000 asking price, and only a small fraction of the total capital investment in the physical plant. Nevertheless, the board considered the $150,000 price to be fair, in light of the facility's ruined condition.

These financial constraints caused the Board of Engineers to recommend that the Carlsbad Project be undertaken, but only if the Pecos Irrigation Company agreed to the $150,000 sale price. If their agreement was not forthcoming, the Board recommended that all work on the project cease. The Company was given a September 30 deadline to accept the sale price.

Additionally, the Board noted that other nearby lands existed which could benefit from irrigation. The construction of a third storage reservoir ("Reservoir No. 3") was considered as a possible means of expanding the scope of the project. The Reservoir No. 3 site, approximately midway between McMillan and Avalon Reservoirs, had been considered as a possible storage dam site since at least the 1890s. The Board concluded that the construction of Reservoir No. 3 could effectively double the project acreage at the same per-acre cost. Some mapping and geologic activity had already been performed at the site, and the Board suggested that analysis of Reservoir No. 3 be continued. If the reservoir site proved feasible, the Board recommended that it be "taken up for construction."[176]

Federal evaluation of the Reservoir No. 3 site continued throughout the autumn of 1905. The geologists working there received a small surprise that November, when one of their drill cores suggested that the discovery of an "oil or asphalt" field might be imminent. Hall briefly suggested that the Reclamation Service could "turn this discovery to account in some way and supply the proceeds to the Carlsbad Project," but nothing apparently came of the idea.[177] The final report on the reservoir site, prepared by Willis T. Lee in December 1905, did not mention petroleum products. Instead, Lee emphasized the presence of gypsum deposits beneath the reservoir bed. Gypsum is a highly porous, soluble mineral which virtually dissolves beneath a reservoir

floor; similar deposits contributed to the failure of the Hondo Project and were responsible for substantial leakage at McMillan. Consequently, Lee doubted that the reservoir would hold water, stating that "there is little to favor the project and very much to discourage it."[178]

Meanwhile, the process of transferring the Pecos Irrigation Company's physical plant to the federal government proceeded at a faster pace. Although Tracy and the Irrigation Company's investors were unhappy with the financial ultimatum specified in the August 31 report, they had agreed to the sale by September 23.[179] The Water Users Association continued to bombard the Reclamation Service, the Secretary of the Interior, and other government officials with emotional pleas for rapid intervention. Although there was still some official doubt that the Secretary of the Interior would approve another large reclamation project, he formally did so on November 28. His decision set aside the requested $600,000 from the Reclamation Fund, and authorized work to begin subject to several conditions. The Pecos Irrigation Company was required to transfer its reclamation system with clear title, and to agree to dispose of its agricultural lands "in tracts not exceeding 160 acres, so that the same may become subject to the provisions of the Reclamation Act."[180] (The Act required landowners receiving federal irrigation water to reside near their farms and to own no more than 160 irrigable acres.) In turn, the Water Users Association members were required to contract for the

project's water at a price sufficient to pay for the project's construction, operation, and maintenance costs.[181]

All parties involved worked rapidly to comply with the Secretary of the Interior's conditions. On December 5, Reclamation Service and Irrigation Company officials completed an agreement in principle on terms of the irrigation system transfer, and a warranty deed was executed on December 18, 1905. The same day, the Water Users Association held a special meeting to approve the necessary contracts with the government. As the government's fiscal agent for the Carlsbad Project, the Water Users Association served as the contractual and financial intermediary between the Reclamation Service and the farmers. By December 28, the Water Users had subscribed 10,512 irrigable acres for the project; an additional 21,168 acres was under contract for water but needed to be subdivided and transferred to individual owners. (Nearly two-thirds of the latter acreage was owned or controlled by either Tracy or the Pecos Irrigation Company.) On that date, the Geological Survey notified the Secretary of the Interior that his conditions had been "substantially complied with," and a rapid beginning of construction was recommended.[182] The following January 23, Hall formally notified the New Mexico Territorial Engineer that the federal government would be appropriating all previously unused Pecos River water for use by the reclamation project. In doing so, the government was basically re-filing for the water rights claimed by the Pecos Irrigation Company.[183] As

late as 1923, lacking a formal adjudication of Pecos River water rights, the government claimed the Carlsbad Project to have senior rights subject only to prior beneficial use of small tracts by "Mexicans and Indians."[184]

The Reclamation Service quickly prepared to solicit contractors for the rebuilding of Avalon Dam; the remaining, smaller rehabilitation work would be constructed directly by the Reclamation Service under "force account." ("Force account" projects were those directly undertaken by Reclamation Service crews rather than by government contractors.) By the end of 1905, much of the necessary engineering work for the Avalon Dam reconstruction had been completed and construction was ready to begin. A number of design alternatives for the dam had been formulated during the year, including a reconstructed rockfill dam with a new steel or concrete core and the replacement of the dam with a "concrete overfall dam" upstream from the former site. Primarily for cost reasons, it was eventually decided to rebuild at the original site, and to reuse that portion of the original dam which remained standing. The Reclamation Service completed final drawings and specifications for the Avalon Dam project early in 1906 and issued a request for bids, but no offers were received. In April, the government decided to erect the dam itself by force account. Preliminary work at the site began on May 1, 1906, and construction was underway by June 1 (HAER photograph #B-58). Work progressed from both ends of the structure simultaneously.[185]

The Reclamation Service designs for Avalon Dam reflected many of the contemporary advances in dam engineering and technology. By the early 1900s, it had become a common practice to place a corewall of some type in earthen and rockfill dams. The corewall was intended to serve two functions: it prevented water moving in riverbed gravel beneath the earthfill from creating channels which could eventually undermine the dam's foundation and it prevented burrowing animals from making tunnels through the dam that could enlarge in response to water pressure. After taking material bids for a proposed steel sheet piling core, B.M. Hall, the project's supervising engineer, recommended the substitution of a thin concrete core wall (HAER photographs #B-60 through B-62). Though the cost of the steel sheet piling was a probable factor, Hall also feared that the river's high salt content would result in rapid deterioration of the steel. Reclamation engineers in Washington, D.C., approved Hall's request, but increased the thickness of the diaphragm.[186]

As built, the new rockfill dam featured a rubblestone concrete core wall that was 3 feet wide at the top and battered 1:24 on both sides (HAER drawing #B-78). A 200-foot section of the wall near the eastern abutment was designed with a much thicker cross-section to serve as an overflow weir during construction of the dam. The flow of the river was directed over this weir until construction reached a point where the river could be diverted into the canal. To avoid trenching in the surviving portions of the old dam, steel

sheet piling was substituted for the concrete. The entire core wall, both concrete and steel, was topped with a 24 foot high concrete diaphragm running the length of the dam.

The width of the rockfill crest of the dam was increased 33 feet on the upstream side of the dam to permit the core wall to clear the inside slope of the rockfill surviving from the former dam. The earth fill on the upstream face of the dam, while retaining the original 3.5:1 slope for approximately one-half of the height of the dam, was then increased to a 2:1 slope to the crest. The earth-fill was riprapped with limestone. The rebuilt Avalon dam was 1,025 feet long and up to 50 feet high (HAER photographs #B-64 and B-66).[187]

Other work at Avalon included the construction of a new concrete headworks structure with six sluice gates operated by ball bearing gate stands and the reconstruction of Spillway No. 1 (HAER photographs #B-26 through B-28, B-59, B-67 through B-69, and drawing B-79). The new concrete Spillway No. 1 featured 39 pairs of wooden, "quick acting emergency gates of special design," each 5 feet wide and 10 feet high. One gate of each pair opened upstream, the other downstream. The inner door in one opening was connected by cables and pulleys to the outer door in the adjacent opening. The Reclamation Service purported the doors could be "quickly opened and closed by water pressure" (HAER drawings #B-80 and B-81)[188] The novel design of the new gates would be severely tested by the Pecos River within a matter of years.

Avalon's two other spillways, both of the overflow type and surviving from the original dam, were enlarged and improved. Portions of these spillways are carved directly into the site's natural rock formations. The new spillway configurations featured a substantially larger capacity than those of the former structures.[189]

As the work on Avalon Dam began, planning was underway for smaller-scale rehabilitation efforts on virtually every other segment of the irrigation network. The largest of these additional projects involved completing the aborted rehabilitation of the Pecos River Flume (HAER photographs #E-1 through E-13, E-16 through E-18, and drawings E-19 and E-20). The Reclamation Service spent nearly $18,000 repairing cracked concrete, widening and strengthening the footings, and lengthening the structure to reduce bank erosion. A new siphon across Dark Canyon became the canal's second major concrete structure (HAER photographs #F-1 through F-6 and drawing F-7). This structure was designed to convey the main canal beneath the floor of Dark Canyon, thus eliminating the washouts caused by the canyon's perennial flooding. The siphon, some 400 feet in length, was constructed during the winter of 1906-1907.

Elsewhere along the major canals, work emphasized the building of an embankment along the canal's uphill side (HAER photograph #C-28). The original Irrigation Company canals were generally banked only on their downhill slope, thus allowing the water to spread out

into arroyos and low areas on the upper side. Although the Irrigation Company claimed that this arrangement created additional "reservoir" space to hold flood waters for return to the canal, the Reclamation Service noted that this caused an "enormous" loss of water from seepage and evaporation.[190] Other sections of the canal system suffered from excessive seepage due to the presence of subterranean gypsum deposits. Portions of these areas were fully lined with concrete. A segment of entirely new canal was also constructed near the project's southern boundary, allowing excess water from the Main Canal to be used in the separate Black River canal system.

The Reclamation Service also installed new spillway structures and control gates in the major canals during the winter of 1906-1907 (HAER photographs #C-2 through C-17, C-29, C-30, D-1 through D-4, D-8, drawings C-32 through C-36, and D-11) . Substantial multi-gate spillway facilities were placed at the bifurcation point of the Main and East Side Canals, above the Dark Canyon Siphon, and at Cass Draw. The latter two placements allowed the canal's entire flow to be returned to the riverbed if necessary. Additional gates at the bifurcation point controlled the relative flow of water down the two branch canals. The Reclamation Service's new spillways and gates were of concrete, replacing the antiquated wooden structures of the Irrigation Company.

The Reclamation Service also recognized that various structural improvements would be needed at McMillan Dam. The 1904

flood had not rendered McMillan inoperable, however, so the government postponed any McMillan work until after the other projects were completed and the system was returned to service. Consequently, McMillan was largely untouched by the Reclamation Service until 1908.

Also in 1906, federal soil scientists began the task of identifying the specific sections of farmland that would be served by the completed project. Much of this work was performed by Lewis E. Foster, an assistant engineer for the Reclamation Service. (Foster later served a long tenure as the Reclamation Service's Project Manager at Carlsbad.) Foster carefully mapped the soils of the survey area and prepared brief analyses of potential agricultural practices in the region; his report was intended to ensure that the highest quality soils were the ones that received the benefits of irrigation.[191] As the final land selections were made later in the year, however, decisions based on science were occasionally tempered by legal and political realities, including the Reclamation Act's restriction of 160 acres per person. An additional complication involved those individuals who owned water rights dating from the private Irrigation Company days, but whose land was in the "gypsum districts," and not considered irrigable by federal engineers. To accommodate these rights, some tracts of less-than-prime land were admitted to the system. The final listing of lands to be irrigated was approved by Reed and submitted to the Chief Engineer on August 15, 1906.[192]

Most of the work needed to restore irrigation water to the area had been completed by early 1907. Official histories of the construction phase suggest that all work proceeded smoothly and according to schedule. Nevertheless, the construction period was marked by recurring themes of discord and strained relations, both within the Reclamation Service itself and among the Service, the Carlsbad townspeople, and the Pecos Irrigation Company. Many of these difficulties grew from allegations of Reclamation Service mismanagement of the Carlsbad Project -- allegations that would continue for years. For example, on May 29, 1906, Gerard H. Matthes, an engineer working on the Carlsbad project, prepared a scathing letter to the Reclamation Service's Chief Engineer complaining that "Indifference to existing regulations, slipshodness and unbusiness like proceedings have characterized the workings of the project office." Matthes' long list of charges was rebuffed by other project staff as a smokescreen to cover Matthes' continued "failure to perform his assigned duty," but it was nevertheless an indication of significant discord within the project staff.[193]

Similar concerns were expressed by others throughout the duration of the construction period and beyond. As early as September, 1905, Newell noted that he was "disappointed at the failure of the work [at Carlsbad] under Mr. Hall," referring both to the failed temporary dam and the other Reclamation Service efforts then underway. Newell requested that a Utah consulting

engineer provide him with a "confidential letter" evaluating the work at Carlsbad; the resulting report at least partially confirmed Newell's suspicions.[194] By 1906, these doubts began to spread throughout the Carlsbad community. The Matthes affair somehow became public knowledge, and Tracy continued to voice strong public objections to the methods and quality of the Reclamation Service's local operations. A second U.S.G.S consulting engineer, C.E. Grunsky, examined the project during June 1906 and was quickly visited by the directors of the Water Users Association, who requested information "in order that they might reply intelligently to questions and criticisms of the proposed works." Grunsky's report concluded:

> . . . it was apparent that the community was divided on the question of the professional ability of the engineers representing the Reclamation Service at Carlsbad, and that the efficiency of the proposed work on the Avalon Dam had been called into question by someone.[195]

The "someone" referred to was obviously Tracy, who paid Grunsky a call and "expressed a lack of confidence in the stability of a dam [Avalon] substantially . . . of a similar type to the structure which failed."[196]

As Tracy and the others continued to promulgate disparaging comments about the Carlsbad Project, construction crews began nearing the point where Avalon and the canals could once again begin providing irrigation water. Although the canals remained dry for a second season in 1906, enough work was completed by early 1907 to provide water to a portion of the project acreage. Water

was first turned into the canals on March 25, and some 6,000 acres of land received irrigation water that summer.[197] This was not considered a formal "opening" of the Project, but rather an "emergency" use, intended only to save the orchards and crops which had now been without water for two years. Construction activity continued on Avalon Dam and the canals during the irrigation season.[198]

The reopening of the canal headgates was a natural source of jubilation for Carlsbad residents, and the town petitioned the Territorial Legislature to proclaim a "New Mexico Irrigation Celebration" as a means of expressing thanks for the Reclamation Service's work throughout New Mexico. The festivities, financed by local subscription, were staged in Carlsbad during July 3, 4, and 5, 1907. Although the celebration was considered a success, its organizers were bitterly disappointed that high-level invited representatives from the Reclamation Service and Department of Interior failed to attend. They termed the celebration "playing Hamlet with the Prince of Denmark left out."[199]

**D: Uncertainty and Evolution -- The Reclamation Service's First Years**

The issue of supplying water during the Carlsbad Project's first year was complicated both by the partially complete distribution system and the legal stipulations of the Reclamation

Act. The Act specifically stated that recipients of irrigation water could own no more than 160 acres within the project area. Such a stipulation, however, had not applied during the Pecos Irrigation Company's operation of the system, and consequently a number of landowners possessed acreages that substantially exceeded the maximum. The terms of the project agreement mandated that these excess holdings be broken up and sold, but in the absence of irrigation water in 1905 and 1906 little of this had been accomplished. Normally, these excess lands would not have been allowed to receive water, but because of the Carlsbad Project's unique circumstances it was decided to allow temporary irrigation of the excess acreages in order to save the crops and orchards they contained. Reed had pushed for these "special contracts" out of sympathy for the landowners, but he was unhappy with the results, noting that such lands were poorly cared for because their owners were no longer assured of a long-term interest in the land. Consequently, Reed recommended that the special contracts not be renewed.[200]

In contrast, the landowners involved felt that their land was being unjustly taken from them, since they had been required to subscribe to the project contract in order to receive any water at all. Not surprisingly, these individuals displayed substantial resentment towards the Reclamation Service.[201] As late as 1910, almost 4,500 acres of these "excess lands," some now devoid of water, remained within the Project boundaries. Officials

speculated that much of the subdivision that had taken place merely involved paper transactions to ostensibly clear the title without actually transferring control. On October 7, 1910, the Secretary of the Interior attempted to end the problem by announcing that the remaining excess acreages would be removed from the project's boundaries and other land substituted.[202] Despite these federal actions, however, the excess lands controversy continued to reappear at Carlsbad for decades.

Additional controversy stemmed from the Reclamation Service's need to institute a collection schedule for the federally-mandated usage fees from the Project's landowners. These fees, established on a per-acre basis, included an annual maintenance and operation assessment as well as a charge intended to recoup the federal cost of purchasing and rehabilitating the project's physical plant. Since the project was only in partial use during 1907, it was decided not to assess the construction fee that year, but a dispute arose over the date the 1908 payment would be made due. In late 1907, the Reclamation Service announced that a $3.85 per acre water fee for the 1908 growing season would be due the following March 1. This news caused an incensed Tracy to compose an angry missive to Secretary of the Interior James Garfield. Tracy noted that it had been two to three years since the farmers had been able to grow irrigated crops, and that it was both impossible and wrong to insist on payment in advance under those circumstances. Garfield declined to intervene on Tracy's behalf, noting that water service

would not be terminated until a landowner's fees were two years in arrears. Thus, a farmer could retain service by simply making each payment one year late.[203]

The Pecos Water Users Association took up the payment issue early in 1908, and over the next few months the group issued a volley of letters to Garfield and other government officials requesting deferment of the construction assessment due March 1, 1908. The group's plaintive requests, highly reminiscent of their lobbying effort in 1905, finally met with success in November 1908 when Hill wrote the Reclamation Service director recommending that the Users' Association request be granted.[204]

While the fee schedule remained under debate, Tracy and his associates continued to complain about the Reclamation Service's management of the Carlsbad Project. In June 1908, Reed learned that Tracy had sent a letter to Reclamation Service officials "not only criticizing the management of the Carlsbad Project but also making charges of a personal nature against [Reed]."[205] Among other things, Tracy felt that construction had progressed too slowly, and that the lack of rehabilitation work on McMillan Dam was keeping the level of service too low. That same month C.H. McLenathen, Tracy's business partner, submitted a letter to the Secretary of the Interior and personally visited the Reclamation Service Director. Both communications listed a variety of allegations of mismanagement by the Reclamation Service workers at Carlsbad. These complaints generated only minor official

repercussions, but they were a substantial annoyance to Reed, who felt that the complaints did not reflect reality but rather that "Mr. Tracy and his partner, Mr. McLenathen, are making a great hullabaloo in order to further their own interests."[206]

Although McLenathen and Tracy operated a real estate business in the Carlsbad area, in all likelihood the primary "interests" to which Reed referred involved Tracy's long-standing relationship with the largely moribund Pecos Irrigation Company. At the time the Reclamation Service purchased the Irrigation Company's physical plant in 1905, the Company owned some 30,000 acres of potentially irrigable land within the boundaries of the Carlsbad Project.[207] After the sale was consummated, Tracy consistently maintained that the Pecos Irrigation Company had only accepted the government's low price because the Reclamation Service had implied that water would be provided to the Company's lands. This would have substantially increased the market value of the Company's property, and allowed it to evolve into a profitable real estate sales organization. Unfortunately for Tracy, however, the Carlsbad Project's 20,000-acre capacity meant that most of the Company's lands did not receive irrigation water, although they were within reach of the system's canals. Supplying water to the Company's lands hinged on the construction of Reservoir No. 3 and the consequent expansion of the Project's total capacity. It was not surprising, then, that Tracy was a consistent and vocal supporter of proposals to enlarge the Carlsbad Project.

As Tracy and the Irrigation Company began to realize that such expansion was not immediately forthcoming, a search began for alternative opportunities for the disposal of Company land. One such opportunity soon presented itself in the form of the Malaga Land and Improvement Company. The Malaga Company held several thousand acres of agricultural land near the southern edge of the Carlsbad Project; at least 5,000 acres of this land had been acquired from the Pecos Irrigation Company.[208] By 1908, the Malaga Company was engaged in selling real estate through the mail, offering a five acre "truck farm" and a lot in the tiny townsite of Malaga for $150.00, payable on time. Although the Malaga land was not receiving Carlsbad Project water, the Company's glowing brochures were carefully worded to imply that such water was soon forthcoming; this, however, was not the case. Tracy and McLenathen were among the local citizens listed as references in the brochures.[209]

By April 1908, the Reclamation Service was receiving letters from Malaga customers complaining of the Malaga Company's alleged fraud. The Company's promotions generated substantial concern within the Reclamation Service; McLenathen, Tracy, and others soon began receiving unhappy letters from Reclamation Service officials. Tracy responded with a rambling, typically angry, 15-page letter denying that the Malaga Company was working to "defraud certain of our weak-minded fellow citizens whom it is [the Reclamation Service's] duty to protect."[210] The Company's land sales

apparently continued unabated, despite recurring complaints. In one instance, a particularly vocal Malaga "victim" was sued by the Company for defamation.[211] The exact level of Tracy and McLenathen's involvement in the Malaga Company remains unknown, however.

The 1908 growing season saw the completion and opening of most of the remaining portions of the Carlsbad Project's irrigation network. The Reclamation Service was able to provide water to some 7,500 acres that year, an improvement over 1907 but still substantially less than the roughly 13,000 acres served by the Pecos Irrigation Company. Tracy blamed the shortfall on the Reclamation Service's failure to store winter runoff in project reservoirs and their failure to begin repair work on McMillan Dam. He bemoaned the losses caused by year after year of drought, with "orchards, vineyards, shade trees killed till the heart was sick."[212] He claimed that "the proper use of McMillan and Avalon" would have allowed the Reclamation Service to immediately irrigate 30,000 acres of Project land.[213]

Reclamation Service engineers finally turned their attention to troubled McMillan Dam in September 1908. That winter, the rotting headgates were replaced, and spillway and diking work was completed (HAER drawings #A-56, A-57, and A-26 through A-34). The McMillan complex also received a new "East Embankment;" this consisted of a 4,000-foot long dike designed to block off a large gypsum deposit along the reservoir's eastern shore (HAER

photographs #A-15 and A-16). This deposit was believed responsible for much of the seepage which had plagued McMillan throughout its history. Construction work during 1908-09 also included lining portions of the canal system which were suffering unusually high seepage rates.[214]

As the Reclamation Service completed its initial rehabilitation efforts and restored water to more and more of the Project's lands, the issue of fee payments by landowners remained unresolved. Although the Secretary of the Interior had agreed to postpone the due date of the 1908 construction assessment, this relief was partially negated by the poor crop yields experienced that year. Simultaneously, the landowners' financial obligations were increased by a small additional assessment to cover the 1908-1909 construction work at McMillan. For the year 1909, each acre of irrigable land was assessed a "construction fee" of $3.10; additional, smaller charges were levied to pay for the system's annual operating and maintenance costs. That November, the landowners petitioned the Secretary of the Interior for relief from the fee assessments, noting:

> The shareholders are anxious and willing to pay all legal charges assessed against them and they recognize this as a legal and just charge. . . . [However,] of the old timers most of them were nearly ruined by being three years without water for irrigation, and the new settlers have spent their ready money in expenditures incident to the establishment of a home in a new country.[215]

As an alternative, the Water Users proposed replacing the flat-fee annual construction assessments with a graduated system. Under

such a scheme, the annual construction levy would initially be relatively low, increasing in later years as the lands became more fully developed and, hopefully, more profitable. The group suggested a construction assessment of $1.00 per acre the first year, gradually increasing to $5.00 per acre in the tenth and final year.[216] (The Reclamation Act specified that a project's construction costs be repaid to the federal government over a ten-year period.)

In November 1909, the Department of the Interior expressed an implied recognition of the farmers' dilemma by postponing any possible forfeiture actions until March 31, 1910. As that deadline approached, the Reclamation Service noted a continued uncertainty regarding the landowners' ability to pay, "as misfortune has again overtaken the farmers and what is known as root rot has invaded this section . . . ."[217] By late March 1910, the Water Users Association had collected only $15,000 of the approximately $60,000 in annual assessments that were due that year. Nevertheless, local Reclamation Service staff counseled against the granting of further payment extensions, while still displaying leniency in individual cases showing unusual hardship. The Reclamation Service director concurred.[218]

This was not a true resolution of the issue, however, and landowners continued to ask for more substantive relief as the number and amount of delinquent assessments increased. The graduated-payments proposal remained alive; Reed approved of the

concept, calling it "conducive to the greatest prosperity."[219] By early 1911, however, the Water Users Association had supplanted its earlier proposal with a campaign to divide the nine remaining construction assessments into eighteen annual installments, while simultaneously postponing the due date of the 1911 assessment.[220] Although Reclamation Service engineers seemed to recognize the reality of the problem, the delinquency situation was generally downplayed and blamed on individual farmers rather than on the fee system itself. Federal observers seldom mentioned the fact that the Project's farmers had been without water during the system's reconstruction. After examining the circumstances of individual delinquencies, Reed noted that some farmers could afford to pay but simply had not, that others were "old-timers [who] never have and probably never will make a success at farming," and that at least one delinquent young man "cultivated his appetite for booze to a much greater extent than he has his acres."[221]

Despite Reed's analysis, it was soon apparent to the Reclamation Service that the worsening delinquency situation could not be cured by simply postponing annual assessment due dates. By March 1911, only 99 of the 461 construction assessments for the year 1909 had been collected, and only 4 of the 1910 assessments had been received. Many of the farmers who had paid their assessments had borrowed against future crops to do so. In February 1911, Congress authorized temporary relief by allowing the Reclamation Service to suspend enforcement of overdue irrigation

assessments pending restructuring of the debt, and debt enforcement at Carlsbad was suspended on March 13.[222] The assessment schedule was reevaluated over the following eleven months, and a restructured fee system was unveiled in February 1912. The new plan called for an increase in the total per-acre assessment to $45.00, with the additional funds going toward "betterments" for the system (including the repair of 1911 flood damage and the lining of some canals to reduce seepage). The concept of graduated fee payments was also adopted; the charge was set at $1.00 per acre the first year, rising to $6.00 per acre for the eighth, ninth, and tenth years.[223]

**E: The 1911 Flood -- Avalon's Cylinder Gates**

Despite the obvious financial difficulties of the Carlsbad Project and its farmers, Tracy and his supporters continued to push for the system's enlargement. They also continued to complain loudly about the Reclamation Service's supposed local mismanagement. Tracy's unhappiness was dramatically displayed following a July 1911 flash flood which washed out small portions of the east and west McMillan embankments and significantly damaged two of the Avalon spillways. After hearing of the damage and failing to obtain satisfaction through his normal channels, Tracy fired off a telegram to the White House, rhetorically asking President Taft:

> . . . if there is no redress or relief or adequate appeal for settlers from idiotic incompetence of reclamation service [sic]. Carlsbad project is now suffering from stupid obstinacy of Arthur P. Davis and W.M. Reed . . . [who are employing] underground methods to provide for our people raising the fund to repair and conceal results of [their] incompetence . . .[224]

Implying that a local reenactment of the disastrous Hondo Project was in the works, Tracy asked Taft to send an outside observer "with brains" to evaluate the situation. His request was apparently never taken up, however, and the Reclamation Service assured the Executive branch that the flood was not a major setback.[225]

The effects of the flood did, however, substantially reduce the Project's capability to store the upcoming winter's runoff for future irrigation use, and Reed immediately authorized a "force account" repair effort which continued throughout the winter of 1911-1912. The reconstruction, funded with a $50,000 supplemental Reclamation Service allocation, repaired the most significant damage at McMillan and elsewhere.[226] The first repairs, however, failed to address one of the system's largest problems: the troubled Avalon Dam and its damaged spillways. That fall, the Reclamation Service dispatched a Board of Engineers to survey Avalon and provide recommendations for needed improvements. The Board's report, issued December 7, 1911, recommended major reconstruction of both damaged Avalon spillways, smaller-scale remodeling at the third Avalon spillway, and improvements to the embankments at both Avalon and McMillan dams.[227]

The 1908 primary spillways at Avalon had been a significant source of unhappiness to Tracy (HAER photograph #B-70). When his letter to the President generated an inquiry from the Secretary of the Interior, Tracy responded claiming that the Water Users Association had recognized the "insufficiency" of design of the then-new "automatic" gates in Avalon's Spillway No. 1 as early as 1908. Tracy claimed that the spillway's design was unworkable, noting that the gates had failed to operate properly during the flood and that mules were finally needed to open them. Few primary sources describing the design or operation of these spillway gates survive today, although a letter from Tracy to the Secretary of the Interior supplies one contemporary description, supported by a period construction drawing:

> . . . the gates are double, two gates to each of 39 openings ten feet high. They were tied together in pairs, one opening up stream being fastened by cable in such fashion to the one in the next space, opening down stream, that the pressure of the water was expected, by what kind of witchery I know not, both to open the gates when the latches were loosened and to close them again when the operator so willed. It was soon found that they would close fast enough to seriously damage them whenever it was tried; but no power on earth could keep them open in a real flood.[228]

In his letter, Tracy seemed satisfied that the 1908 spillway would operate satisfactorily with the removal of the upstream set of gates, thereby obviating the need for a more expensive design solution that was already in the planning phase.[229]

Portions of the Reclamation Service's 1911 Avalon projects were designed by Frank Teichman, a Reclamation Service engineer

based in El Paso who had designed gates and valves for various Reclamation Service projects. Born in Germany in 1853 and educated in engineering in Dresden and Vienna, Teichman emigrated to the United States in 1882. After three years as a draftsman in New York, he moved to California where he worked as an engineer for both railroad and reclamation projects. He began working for the Reclamation Service in 1904 and was one of the designing engineers for Roosevelt Dam in Arizona.[230]

Teichman's plans for Avalon included a dramatic circular concrete overfall dam to be located at Spillway No. 2. D.C. Henry, consulting Engineer with the Reclamation Service in Portland, Oregon, provided design guidance. Spillway No. 2 was a remnant of the old Pecos Irrigation Company infrastructure; the spillway had been largely washed out by the 1911 flood. Teichman's replacement overfall structure had a crest some 393 feet long displaying, in plan, a full quarter-circle of curvature (HAER photographs #B-17, B-18, B-73, and drawings B-82 and B-83). The overfall's eastern half was a concrete curtain wall displaying an ogee section, while the dam's western half featured a stepped concrete wall almost resembling a giant amphitheater. The steps protected a formation of caliche, a carbonate-enriched soil found in arid and semiarid climates.

More technically impressive, however, were the "cylinder gate" outlet works Teichman designed for Avalon (HAER photographs #B31 through B-47, B-71 through B-73, and drawings B-84 through B-97).

The cylinder gate design originated in navigation canals, where they were called cylindrical valves and were used to fill or empty locks of water. Such valves were an important part of the design for the Panama Canal, and had seen wide use in the United States prior to that. Cylindrical valves displayed a technical advantage over traditional sliding gate valves in that water pressure was exerted against the cylindrical valves equally from all directions; this meant that resistance to opening and closing the valves did not increase with head. The Panama Canal's cylindrical valves were seven feet, one inch in diameter and operated by means of a single, central valve stem.[231]

The first use of a cylinder gate by the Reclamation Service was on the Yuma Project on the Colorado River in Arizona and California. As originally planned, the Yuma Project was to have a main canal entirely on the Arizona side of the river, supplying water to lands south of Yuma. However, the technical difficulties inherent in a canal crossing of Arizona's erratic, unpredictable Gila River prompted Reclamation engineers to move the canal's upper reaches to the California side of the Colorado River. The canal would then utilize a siphon to cross the Colorado near Yuma. Construction of a siphon suggested additional technical problems: the excavation and tunnelling involved would require working in shifting sand using compressed air. During planning, the Reclamation Service corresponded with engineers and contractors in Chicago, Boston, and New York, seeking both design assistance and

construction equipment suited to the task. In the midst of these technical discussions and with little fanfare, Teichman designed a cylinder gate 21 feet in diameter for the intake to the siphon. Such a gate was ideally suited to the project because the seat for the cylinder could be the same circular shape as the intake shaft. Unlike the cylinder valves used on the Panama Canal, Teichman's design for the Colorado River siphon used three threaded stems attached to the perimeter of the cylinder and driven by an electric motor to raise and lower the gate.[232]

Drawing on his experiences with the Yuma project, Teichman designed a new spillway for Avalon which incorporated the cylinder gate concept. The plan specified two vertical cylinder gates which, when closed, maintained a spillway crest similar to the reservoir's other overflow spillways. When raised, however, they permitted the rapid lowering of the reservoir in advance of anticipated flood waters; this reduced the danger of Pecos floodwaters overtaxing Avalon's overflow spillways.

Teichman's plan located the two cylinder spill gates over downward-discharging tunnels in the headworks channel. (The openings for the former gates along the crest of the spillway were filled with concrete.) The new gates were 21 feet in diameter, consisting of braced steel shells 8 feet high. The upper rims of the shells were just above the spillway crest, while the lower rims rested on sills embedded in the mouths of L-shaped concrete tunnels 20 feet in diameter. Each tunnel tapered to an elbow transition to

a horizontal tunnel which carried the water away from the base of the dam. Because Avalon was without electricity, counterbalances were added to the hoist mechanisms so that each 15,400-pound gate could be hoisted by the operator with a hand-crank. To make the operator's job easier, Teichman equipped each gate with a small water-driven turbine to power the hoist under normal conditions.[233]

By the end of September 1911, Teichman had completed his design for the cylinder gates and recommended their immediate purchase. A series of telegrams between Louis C. Hill, the Reclamation Service's supervising engineer at Carlsbad, and W.M. Reed, district engineer for the Reclamation Service in El Paso, finally resulted in a roundabout approval to purchase the gates with neither man apparently wanting to take ultimate responsibility. This foreshadowed several months of bureaucratic correspondence among Reclamation Service officials, including a statement by the Chief Engineer that challenged Reed's authority to purchase the gates and questioned the efficacy of the design and the proposed location. The December Board of Engineers report, however, finally indicated the Reclamation Service's official approval of Teichman's design.[234]

Work on the cylinder gates proceeded throughout early 1912. They operated successfully under limited testing that June, but it was not until late November that the Reclamation Service operated the gates to full capacity. The Reclamation Service invited some

of the gate's more vocal local critics to observe the tests. Much to the delight of Hill, and presumably Teichman who was also present, the gates performed "satisfactorily" with only minor problems.[235]

Following the successful implementation of the cylinder gate design at Avalon, Teichman continued to design cylinder gates for other Reclamation Service projects. Elephant Butte Dam (1912-16) on the Rio Grande Project in southwestern New Mexico was a notable example. The dam's spillway features four cylinder gates, each ten feet in diameter. As at Avalon, these gates were designed to allow operators to begin spilling in advance of water overtopping the crest of the spillway. The Franklin Canal on the Rio Grande Project utilized additional cylinder gates for "drops" (structures for facilitating sudden elevation change in a canal). These gates were only about 5 feet in diameter and could be lifted with a hand-operated winch.

By the time Elephant Butte Dam was completed, Teichman had moved to Washington, D.C. to head the Technical Section of the Reclamation Service. During the 1910s and 1920s, the Reclamation Service showed a decided preference for cylinder gates, as well as radial gates, for relatively small applications where ease of operation was important. At Sherburne Dam in Montana (1921), cylinder gates were used for the outlet works. These gates were atop shafts, similar to the Colorado River Siphon application, but

in this case the shafts were concrete outlet towers which conveyed water to conduits under the dam.[236]

The Sherburne project was a precursor to the Bureau of Reclamation's most spectacular use of cylinder gates: the intake towers at Hoover (Boulder) Dam. Hoover Dam's cylinder gates are housed in four 390-foot-high intake towers with two 32-foot diameter gates per tower, one at the base and one near the midpoint. Electric motors in the tops of the towers lift the gates by means of screw stems. At their completion, the towers were visually stunning features in the empty reservoir area; much of the towers were soon obscured by water, however, leaving little hint of the structures' relationship to the cylinder gates at Avalon. Hoover's cylinder gates reflect the Bureau of Reclamation's preference during the 1930s to use cylinder gates in intake towers and outlet works, rather than spillways.[237]

Despite the fact that cylinder gate designs saw significant Reclamation Service use both before and after Avalon Dam, Avalon's cylinder gates are unique among these projects for their particular adaptation to the circumstances, with counter-balanced hoisting works driven by water-powered turbines. Teichman's Avalon designs reflected innovative design solutions to local engineering problems. They remain among the most visually striking features of Avalon Dam today.

**F: "Homes for All Who Come" -- Promoting the Carlsbad Project**

As the first decade of the twentieth century progressed, Reclamation Service operation of the Carlsbad Project became more and more routine, and gradually the system became able to reliably irrigate additional acreage. During the Carlsbad Project's first twenty years, however, the amount of land served by irrigation was consistently less than the project's stated capacity. A number of reasons contributed to this land surplus, including the perennial "excess holdings" issue and an exodus of homesteaders during the dry years of 1905-07.

The underutilization of Carlsbad Project water was not viewed favorably by either the federal government or local settlers. The Reclamation Service almost certainly realized that a fuller utilization of its water projects would increase the agency's perceived efficacy and value, while Pecos Valley businessmen longed for the increased economic activity that additional settlers would bring. Consequently, a number of organized efforts to attract settlers to the Pecos Valley materialized during the 1900s, 1910s, and 1920s. These programs were variously supported by the Carlsbad Commercial Club, the Water Users Association, the Santa Fe Railway, and the New Mexico territorial and state government. This "official" advertising supplemented the active, ongoing promotions of local realtors and land speculators. Most such efforts, both private and public, seemed to receive at least the tacit approval of the Reclamation Service. In 1914, the Reclamation Service even

offered to maintain "an open list of lands for sale" at its Carlsbad Office.[238]

Many of the earliest promotional efforts were sponsored by the New Mexico Bureau of Immigration, a Territorial agency which had actively promoted Pecos Valley settlement during the old Irrigation Company days. A 1908 publication titled "Eddy County, New Mexico" is typical; the booklet's subtitle describes the county as

> A Land Where the Soil is Rich and Deep, the Water Abundant and Prosperity for the Industrious Farmer Assured.[239]

The brochure provided prospective farmers with detailed descriptions of the Carlsbad Project, as well as "the world-famous Pecos Valley artesian belt" near Roswell. Hopeful immigrants were enticed with glowing portraits of the county's varied crops, including the "famous . . . Carlsbad Peach." The booklet's message was obvious: the verdant Pecos Valley was ready to provide bountiful "[h]omes for all who come."[240]

Over the years, numerous other publications echoed the message and tone of the 1908 brochure. Often, such promotional brochures and posters would be accompanied by more active recruiting and salesmanship. One such program was instigated in 1916 by the owners of some of the Project's surplus lands. Ostensibly working

to reduce their unauthorized holdings within the Project, the landowners reportedly:

> decided that it was time for them to offer their lands to the farmers of other sections . . . . They, therefore, agreed to list their lands with their association, and contracted with C.F.C. Ladd, of Kansas City, Mo. to act as their colonization agent. The association will maintain an office in the Union Station, Kansas City. Mr. Ladd will have a corps of good agents in the field to acquaint prospective buyers with the rich lands and attractive farm conditions at Carlsbad, and induce them to inspect them.[241]

Although the Carlsbad Project's irrigable lands slowly began to fill, organized land promotion activities continued until the mid-1920s. In 1924, landowners in Carlsbad, Artesia, and Roswell banded together as the "Pecos Valley Association" and began a $7,500 newspaper advertising program in conjunction with the Santa Fe Railway. (The railway maintained an active "colonization office" in Chicago which worked to recruit settlers to all the railway's on-line communities.) The first day of advertisements reportedly generated "one hundred inquiries from twenty one states and one from Canada," and the effort's apparent success elicited positive interest from the Reclamation Service hierarchy. It was among the Project's last promotional undertakings, however; by late in the decade little project land was available for new settlers.[242]

**G: Dissension and Politicking: The Carlsbad Project in the 1910s**

Tracy continued to annoy Department of the Interior officials throughout the 1910s, his unhappiness presumably increasing due to the 1911 controversy involving the Avalon cylinder gates. His anger grew more vocal that year, as he began pushing his cause locally through a series of opinionated letters in the Carlsbad Argus. Late that year Tracy adopted a new tactic, attempting to use the Pecos Water Users Association as a mouthpiece for his views. At a meeting of the Association's board of directors that October 28, a sharply divided board voted to send the corporate secretary, Scott Etter, to Washington, where he would rendezvous with Tracy and the pair would submit a joint protest against Reclamation Service policies at Carlsbad. Such a protest was seen by at least one Carlsbad observer as an attempt "to legally test [the Reclamation Service's] present claim on this project, in short their ultimate object is to wrest the project's control from its present management."[243] Before Etter's departure, he reportedly received an afternoon of coaching at McLenathen's house.[244] Soon after Etter headed east, however, a mass meeting of the project's farmers convened and telegraphed Washington, stating:

> He [Etter] has gone in entire ignorance and absolute defiance of the desires of the actual farmers and we request that he be given no hearing as our representative . . . .[245]

It was apparent that Tracy's efforts enjoyed, at best, support from only one faction of the Water Users membership. He was forcefully opposed by P.J. McShane, the Association's president and an Irishman "with plenty of fighting blood in his veins."[246] Nevertheless, the Washington trip went ahead. At their meetings, the Reclamation Service patiently listened to Tracy and Etter and returned the same carefully measured, unflinching responses that had been irritating Tracy for years. The Service's director, however, suffered a brief embarrassment during the visit when he was unable to locate drawings of the Avalon cylinder gates. (Etter's Irrigation Company career displayed controversy in later years, as well; in 1915, a Reclamation Service auditor suspected that Etter was "a crook," who delayed in transferring landowners' fee payments from the Water Users to the federal government in order to make personal use of the money.[247])

Tracy's visit to Washington and his subsequent letters now took the position that the Pecos Irrigation Company's 1905 contract with the federal government gave the Company's lands a <u>right</u> to receive water from the Carlsbad Project, and that by not honoring that right the Reclamation Service was depriving the Company of its major financial consideration in the sale. The sale documents had granted such a water right provided that the holders of existing rights were first served, and if it was deemed "economically practicable" to do so.[248] While Tracy maintained that it would be quite feasible for the government to construct Reservoir No. 3 and

service the Irrigation Company's lands, the Department of the Interior countered that the reservoir site's porous soils would give it only enough capacity to compensate for the rapidly-decreasing capacity of McMillan due to the constant siltation. As Tracy continued to loudly denounce the government's bad faith, the Department of the Interior attempted to simply ignore Tracy's barbed missives as long as possible. Although it did nothing to quiet Tracy, there was considerable pleasure in the Department of the Interior when Reed unearthed a copy of Tracy's 1904 annual report to the Irrigation Company's shareholders, in which Tracy complained of a dismal financial outlook and recommended selling the irrigation system to the United States for the benefit "at least to the people under it."[249]

Although officials in Washington consistently did their best to ignore Tracy's requests for satisfaction, at least one local Reclamation Service officer did wonder about the Service's "moral and legal obligations to the P.I.Co."[250] In April 1913, Louis Hill noted that the recent improvements at McMillan would allow an increase in the Project's acreage, and questioned whether the Service should supply water to Company land near Malaga (several miles south of the Project's current limits). Davis emphatically replied that "in the opinion of this office all our moral obligations to the Company have been discharged," and he recommended that other lands nearer the existing canal network be serviced instead.[251]

Tracy's efforts continued unabated for the remainder of the decade, without visible results. In 1913, he went so far as to publish a pamphlet, "Reasons for Immediate Completion of the Carlsbad Project," in which he continued to advocate the construction of Reservoir No. 3. Although once again his motives were probably personal rather than beneficent, the potential economic growth he described was appealing to the Carlsbad Commercial Club, which issued a letter in 1914 supporting the proposal. The brochure, and the Commercial Club's response, were probably prompted by the announcement of an upcoming federal study of the Pecos drainage and its available water resources. The study had been requested by Congressman W.H. Smith of Texas, who presumably hoped for the establishment of a Pecos River reclamation project that would provide water to his state. Not surprisingly, the Carlsbad Commercial Club preferred that any surplus water remain in New Mexico.[252]

The 1914 federal study of the Pecos was completed by early September. It addressed three primary concerns in the Carlsbad Irrigation District: the loss of project water due to canal seepage, problems of over-irrigation and poor drainage of farmland, and the possibilities for expanding the acreage served. The study recommended substantial drainage work and the lining of much of the canal system to reduce seepage. These actions had the potential to improve local agricultural productivity as well as increase available water. The improved water supply, it was thought, would

allow the admission of an additional 4,500 acres of irrigable land to the project. The fees for both the new lands and existing project farmlands would be increased to cover the proposed improvements, as well as to provide a small reserve fund for future projects.[253]

A second study, with more significant implications, examined the Carlsbad Project the following year. This "Local Cost Review Board" was authorized by the Secretary of the Interior in January 1915, in response to local farmers' increasingly vocal claims of Reclamation Service inefficiencies and overcharges. The Board was instructed to impartially review the Reclamation Service's expenditures on the Carlsbad Project, and determine whether the federal charges that had been assessed to the project landowners were justified. The Board consisted of three members: Scott Etter, representing the Water Users; D.W. Murphy, representing the Reclamation Service; and T.U. Taylor, a presumably neutral professional from the University of Texas faculty. The trio's fact-finding activities consisted largely of reviewing official documents and conducting public hearings at Carlsbad in April 1915. The Reclamation Service's annual Carlsbad Project report quietly noted that the hearings "produced some friction between Service officials and Association officials."[254]

As might be expected, the Board failed to reach a consensus in its conclusions. Etter and Taylor prepared a "majority" report, forcing Murphy to submit a supplemental "minority" report. The

majority report was an emotional, scathing indictment of the U.S. Reclamation Service, reciting a litany of botched government decisions and foolish expenditures. The alleged poor management greatly escalated the project costs -- costs which, under the terms of the Reclamation Act, the project farmers were required to repay through their annual assessments. Among the report's many complaints were allegations that the 1911 flood damage at Avalon was caused by a sleeping Reclamation Service watchman, and that the cylinder gates constructed in response to the flood were "elaborate," "costly," and "unnecessary."[255] The report recommended that the project landowners be relieved of repayment responsibility for many of these costs. The document further suggested that it was a violation of "law and equity or square dealing" to force the project farmers to pay for improvements that were owned not by them, but by the federal government.[256] Taylor and Etter concluded by suggesting that the alleged cost excesses and the payments towards federally-owned assets not be charged to the landowners. Doing so would reduce the total per-acre assessment by over one-half. The document dramatically concluded with the phrase, "GOD PITY THE WATER USER ON THE CARLSBAD PROJECT."[257]

Murphy's minority report was a careful attempt to discredit the majority report, point by point. He concluded that all of the Reclamation Service's charges to the project were fair and justified, and that Taylor and Etter were guilty of sloppy research

and a predisposition towards the Water Users' claims. Etter and Taylor responded with a "Supplemental Majority Report," which refuted the minority report; soon after, Murphy countered with a "Supplemental Minority Report." It became obvious that the Review Board's intended goal of adjudicating the finances of the Carlsbad Project had collapsed into yet another barrage of accusations and conflict.[258]

Unfortunately for the Reclamation Service, the majority report's authors rapidly released their exposé to the press, and their comments received wide circulation, both in New Mexico and in other western states. The report was also reprinted as a pamphlet, which was distributed among water users in a number of Reclamation Service projects. This resulted in substantially increased resentment towards a Reclamation Service that was already less than popular. (Although Taylor later removed some of the report's more emotional statements, he continued to steadfastly stand by its conclusions.) The following spring, after emotions had subsided somewhat, a Reclamation Service "Central Board of Review" examined the majority report and explicitly rejected most of its contentions, while praising the Reclamation Service and subtly criticizing its detractors. The Central Board concluded that the project's construction assessments should remain largely unchanged.[259]

The Central Board dealt with the issue of title to the system's improvements by simply recommending that the entire

project be turned over to local ownership and control as soon as possible.[260] The concept of a return to local ownership had been discussed before, and it was destined to surface again. The idea received support as early as 1914, when the Water Users Association submitted a resolution to the Department of the Interior asking that they be given control of the Project. The resolution seemed to draw little attention, presumably because many of the Project's farmers were satisfied with the project's federal management. Reportedly, the desire for local control was promulgated, at least in part, by owners of large tracts who were unhappy with the 160-acre restrictions embodied in the Reclamation Act.[261]

Although the graduated fee payment system adopted at the Carlsbad Project in 1912 had quieted some of the financial discord among project farmers, it was not seen as a perfect solution. The local farmers' recurring difficulty in meeting their construction assessments also mirrored serious problems inherent in most of the Reclamation Service's projects, and by 1914 Congress realized that a nationwide restructuring of the system was in order. The result was the Reclamation Extension Act, approved by Congress on August 13, 1914. The Act, recognizing that the huge expenses of Reclamation Service construction simply could not be repaid in ten years, doubled the allowable repayment period to twenty years. Locally, the Reclamation Service and Pecos Water Users Association wasted no time in urging local farmers to accept the terms of the Act, noting that their annual assessments would be greatly reduced

by doing so.[262] Nearly all the Carlsbad Project irrigators apparently took advantage of the Act. The lengthened repayment period eased the farmers' financial pressures, although their continuing difficulty is reflected in the passage of 1926 legislation (44 Stat. 649) which increased the allowable repayment period to 40 years.[263]

The passage of the Reclamation Extension Act was one reflection of an increasing congressional awareness of major problems inherent in nearly all Reclamation Service projects. These problems included the financial hardships experienced by project farmers, the underutilization of project waters, the inadequacy of some local soils, and occasional difficulties in contracting local landowners to use project water. In most Reclamation Service projects, the severity of these problems eventually resulted in huge financial write-offs by the government; difficulties at some Reclamation projects were so severe that their complete abandonment was seriously considered. In contrast, the Carlsbad Project exhibited most of these problems in only limited measure. Consequently, by the 1920s comparative studies of western irrigation projects often pointed to Carlsbad as a relative example of Reclamation Service success. The 1927 volume Economics of Land Reclamation, for example, termed Carlsbad the second most successful of all Reclamation Service projects, based on land utilization. According to the book, this was because "the high

prices of cotton have brought about a full utilization of the lands in spite of a somewhat uncertain water supply."[264]

**H: Project Expansion and Refinement During the 1910s**

The less restrictive repayment terms embodied in the Reclamation Extension Act presented the Carlsbad Project's managers with an opportunity to increase the total project budget and undertake additional rehabilitation work. The need for this work had been codified in the Reclamation Service's 1914 study of the project, and project administrators now saw the opportunity to accomplish some of the report's goals. Accordingly, by late 1914 the Service had prepared an ambitious plan to line much of the Project's main canal system with concrete to reduce seepage and increase the acreage served. The project would be partially financed by an additional $10.00 per acre assessment on existing Project lands. Under the new federal regulations, this fee would be paid in installments after the current $45.00 per acre fee had been completely repaid. The new acreage to be added to the district was to be assessed a single construction fee of $60.00 per acre. This scheme was approved by the majority of the Project's landowners, allowing the concrete lining work to begin during the winter of 1914-1915.

The canal lining project allowed the Reclamation Service to expand the area served by the 4,500 acres specified in the 1914

report. The expansion was announced by a public notice dated April 10, 1915, enumerating Reclamation Service plans prepared the preceding year and approved by the Water Users Association. The lands eligible to be added were already within reach of the Project's canal network, and substantial additional construction was not required. The lands admitted were placed under a variety of fee payment schedules, depending on the status of the land's water rights and the wishes of its owners. Landowners who chose to take advantage of the Reclamation Extension Act were offered the most lenient terms: a graduated repayment plan stretching over twenty years.[265] The new fee schedules implemented in 1915 further complicated the repayment system; there were now perhaps half a dozen repayment schedules in place on Project lands, varying substantially in duration, scope, and amount.

As the 1915 project expansion got underway, the Reclamation Service once again evaluated the possibilities of larger-scale project growth, and once again the concept centered around the oft-discussed Reservoir No. 3. Although Willis Lee's 1905 geologic examination of the reservoir site had resulted in an unfavorable recommendation, a similar study in 1911 by geologist G.B. Richardson presented diametrically opposed conclusions. Richardson's study assumed that Reservoir No. 3 would serve as a replacement for McMillan; he stated that the new site was "unusually good for the Pecos Valley . . . much better than that of Lake McMillan."[266] Although Richardson's report received little

response in 1911, it somehow surfaced in 1915 as support for a much larger expansion of the Carlsbad Project. The 1915 federal proposal involved the construction of Reservoir No. 3 as a supplement (rather than replacement) for McMillan, and using the impounded water to irrigate vast tracts of land west of the existing project. This would be accomplished by constructing a new concrete-lined "West Side Canal," providing access to some 19,000 acres of irrigable land. The report also suggested the construction of a "High Line Canal," which would utilize water pumped from the West Side Canal and serve an additional 7,500 acres. Electric generating facilities would also be provided at the new dam.[267] The proposal failed to result in federal action, however, and a follow-up query by the Carlsbad Commercial Club produced the response that "conditions have been found to be such as not to warrant an effort to get through general legislation upon this subject."[268]

Meanwhile, though, the Project was visited by another of the Pecos River's recurring flash floods, and the very safety of the Project's physical plant was called into question. The floodwaters pounded McMillan Dam for three days in mid-April 1915, completely submerging the facility's east embankment. A small leak appeared in the main dam at the height of the flood, and for a time the dam's collapse seemed imminent. Many Carlsbad residents quickly scurried for higher ground on hearing the news. A heroic sandbagging effort by Geological Survey personnel at the scene

stemmed the leak after several hours of uncertainty, and "the old pile of earth and rock" was saved, only slightly damaged.[269] Simultaneously, the high water caused varying levels of damage to portions of the project canals and to the concrete siphon beneath Dark Canyon.

In reviewing McMillan's flood damage E.H. Baldwin, the local supervising engineer, bluntly reported that "The dam is not safe," and remarked that "There is no good reason for the dam being almost intact to-day, for it is only in defiance of all laws of force that it is still standing."[270] He recommended that a Board of Engineers convene immediately to consider reinforcing the structure. The requested Board convened that June, and strongly recommended that McMillan be provided with a concrete "siphon or gate controlled spillway" large enough to accommodate the most severe expected floods.[271]

Throughout most of 1915 and into 1916, Reclamation Service engineers undertook extensive design studies aimed at providing the additional spillway capacity called for in the Board of Engineers report. Test pits sunk into the McMillan Dam indicated the presence of cracks and holes serious enough to require immediate attention. In response, a trench averaging 12 feet deep was dug across the top of the dam and filled with puddled clay and gravel. As the design studies for the spillways dragged on, Hill urged the Reclamation Service office in Denver to begin work as rapidly as possible "in order to save the McMillan reservoir and hence the

Carlsbad Project."[272] Plans and cost estimates were completed at each of four potential spillway locations for low head radial gates, high head radial gates, roller gates, and a spillway siphon. Of the alternatives, the least expensive solution was for placing a controlled spillway in or near the dam. A Board of Engineers finally met at McMillan in May 1916 to consider all of the proposed alternatives. After test borings in the foundation of the dam, the Board was adverse to any alternative that would dump water near the toe of the dam. The fact that McMillan's capacity was rapidly diminishing due to silting was also a factor. The reservoir's apparently short lifespan caused the board to question the prudence of spending large sums of money on an elaborate solution "if any other scheme can be devised, which during the next ten years may give at least reasonable protection."[273] They proposed simply widening two of the existing spillways and providing low earthen dikes across their openings that would wash out during floods.[274]

The spillways finally constructed were more permanent than those proposed by the Board. Spillway No. 1 was located in a saddle approximately 2,500 feet northwest of McMillan Dam (HAER drawings #A-58 and A-59). The spillway consists of a 1400-foot long concrete weir placed between concrete abutments. The weir rises only a few inches above the surrounding ground level, which in places was raised to the appropriate elevation with rock riprap (HAER photographs #A-18 and A-19). Water passing over the spillway enters a channel and discharges into the Pecos River about one-half

mile below McMillan Dam. To protect the Atchison, Topeka, and Santa Fe's adjacent railroad bed, a 3000-foot long rock-filled dike with an earth-fill face was constructed (HAER photographs #A-20 through A-22, drawings A-62 and A-63).[275] Engineers had to give special consideration to a portion of the lower end of the dike that was subject to high water velocities; here, the Reclamation Service developed an innovative wire-bag riprap. Use of the large wire bags had two advantages: the 6-inch mesh of the bags allowed the use of rock that was otherwise too small to be used in traditional riprapping and labor was reduced by the ability to fill the bags directly from wagons.[276]

The most impressive new structure, however, was Spillway No. 2 (HAER photographs #A-23 through A-25, A-49, drawings A-60 and A-61). In plan, the mouth or crest of the spillway opens from the north. The spillway then swings around to discharge water in a west-southwesterly direction. The mouth of the spillway is 350 feet wide. The spillway was originally 740 feet long, although a relocation of the Santa Fe Railway through the site in the 1980s reduced the spillway's length to 487 feet. The spillway has a concrete floor with concrete sidewalls rising 8 feet and sloping outward. A 5- to 6-foot high training wall through a portion of the center of the structure directs the flow of the water around the curve to the throat where the spillway straightens out.[277]

Work on the new McMillan spillways began in the fall of 1916. With the approval of the Water Users Association, the new spillways

were funded with a portion of the increased construction assessment approved in 1914. Work was performed under Reclamation Service supervision, and was officially completed on May 26, 1917.[278] The remaining flood damage had been repaired during 1916. This work included extending the Dark Canyon siphon by some 200 feet to prevent further erosion damage to the structure. Meanwhile, the Pecos River's erratic nature continued to manifest itself, with additional flooding in August 1916, followed by a substantial water shortage in 1917.[279]

The 1917 water shortage caused the Reclamation Service to cast a critical eye towards upstream users of Pecos River water. This scrutiny led to a federal lawsuit against upstream operators of irrigation pumping plants.[280]

The impact of the 1917 drought was further exacerbated by the rapidly decreasing storage capacity of McMillan Reservoir. This was a long-standing project concern, stemming largely from the substantial amount of silt the Pecos River annually deposited in the reservoir. The problem had been recognized early in McMillan's history, and seemed destined to rapidly destroy the dam's effectiveness unless corrective measures were taken. By 1916, the Reclamation Service estimated that some 3,900,000 cubic yards of silt already reposed in McMillan Reservoir, and that within twenty years the reservoir would be virtually filled with silt. Several possible solutions to the problem were suggested and rejected: dredging the reservoir floor was dismissed as technologically

impractical, and periodically raising the dam height would become progressively more expensive over the years. It was concluded, then, that the project's health required that "storage must be found for about 50,000 acre-feet free from the evil of silting."[281] For some observers, at least, finding a new reservoir site somewhere upstream from the community of Fort Sumner seemed to be the way to achieve that goal.

**I: Continued Controversy -- The Post-World War I Years**

The long-discussed concept of additional upstream storage for the Carlsbad Project was destined to come to fruition, but not immediately. During the 1910s and 1920s, the Reclamation Service continued to study possible Project expansion; these studies looked both at increasing the farmland served by the Project and providing a more stable water supply for the existing Project acreage. Both of these goals depended on the development of increased reservoir storage capacity, and various Reclamation Service reports examined three possible methods for achieving this end: building the long-discussed Reservoir No. 3, raising Avalon Dam, and constructing a reservoir upstream near Fort Sumner. The Fort Sumner area already hosted a small, private diversion dam and irrigation canal; Reclamation Service proposals contemplated the federal takeover and enlargement of the private canal as part of a new storage dam project.

The Reclamation Service's continued expansion studies were partially the result of enthusiastic lobbying by the Pecos Water Users Association and its new president, none other than Francis G. Tracy. Under Tracy's leadership, the Water Users went beyond their earlier efforts by agreeing to financially support local Reclamation Service study projects. This support, raised by subscription among the Water Users membership, was contractually specified at $10,000, although the local fund raising reportedly fell substantially short.[282] Tracy was presumably influential in instituting this fund-raising effort, seeing it as yet another chance to provide irrigation to additional Valley lands. Two areas were being considered for possible addition to the project: large tracts in the Malaga region south of the existing canals (where Tracy may still have held a financial interest), and a district to the west of the project, which had been a part of the earlier "High Line" canal proposal. Federal studies seemed to prefer the latter area, which would have been serviced by a new canal network originating at Reservoir No. 3.[283]

Tracy and the Water Users Association generally favored the Reservoir No. 3 proposal, and their financial contributions were originally intended for studies of that site and associated canal expansion. The Reclamation Service, however, remained skeptical of Reservoir No. 3, repeatedly noting the "cavernous limestone underlying the dam site and gypsum outcrops near the center of the reservoir."[284] The Service seemed to look more favorably on

constructing a dam at the Fort Sumner site, which seemed to display none of the geological obstacles of Reservoir No. 3. In 1922, the Water Users agreed to allow a portion of their contributions to fund surveys of the Fort Sumner site.[285]

The Reclamation Service completed a substantial series of geological and reclamation studies at both Pecos River sites between 1920 and 1923. This work culminated in a voluminous May 1923 summary report by Ferd Bonstedt and E.B. Debler, two Reclamation Service engineers. Bonstedt and Debler's document evaluated reservoir and irrigation problems and opportunities throughout the Pecos River basin. While the Bonstedt and Debler report did not provide explicit recommendations for future development, the pair looked favorably on constructing the Fort Sumner reservoir to provide water for both Carlsbad and Fort Sumner farmers. Their conclusions generated substantial correspondence within the Department of the Interior, but failed to create an immediate federal resolve to proceed with new construction.[286]

Despite the unresolved issues relating to the Carlsbad Project's water supply, a small amount of additional acreage was added to the Project in 1919. This "Third Unit," comprising 1,131 acres, brought the total farmland served to 25,000 acres. Reportedly, the added lands were expected to be populated in part by returning soldiers from World War I.

Although Tracy and the Water Users Association displayed a surprisingly cooperative attitude by agreeing to help fund the

Reservoir No. 3 studies, their combative spirit remained active on other fronts. This was demonstrated in 1919 when the Water Users took up the cause of ending Reclamation Service liens on Project farmlands. The government imposed mandatory liens on the Project's farmland as a condition of receiving water; the liens were intended to ensure repayment of the Project construction assessments. The government held two liens on each of the Project's farms: the first lien represented the amount of land an owner had subscribed to the project, while the second was placed when the owner filed for a record of water rights. According to the Water Users, the government liens "made it impossible for us to borrow any money elsewhere upon our equity (if indeed . . . we have any equity) in the lands we occupy and presume to own."[287] In particular, the settlers were unable to obtain loans from Federal Farm Loan Banks, which required a first mortgage as security. Although some insurance companies recognized an equity above these liens and did provide loans to farmers, they did so at a less favorable interest rate.

This situation, which the Water Users characterized as "serfdom under a department of the United States," allegedly caused the farmers substantial hardship, and in April 1919 the Water Users began a campaign to have the property liens removed.[288] The centerpiece of their effort was a preprinted letter sent to various senators and representatives claiming that the liens made their water rights "a perpetual liability instead of an ever growing

asset," and that the problem was exacerbated by the government's exorbitant late payment fees.[289] An identical letter was sent to New Mexico's governor, who also began writing sympathetic letters to Washington. Secretary of the Interior Franklin Lane was unmoved, however, pointing out that the liens were mandated by the Reclamation Act and suggesting that the Water Users could operate the system themselves if they were unhappy with federal control.[290] Lane's suggestion presumably involved the organization of a local Irrigation District, which would allow the government to remove the first liens and ease the borrowing process for the farmers. Water users at other Reclamation Service projects had already taken this step, and it is unknown why the farmers at Carlsbad failed to do so.

Although the Water Users recurring complaints to the government generally seemed to fall on deaf ears, actions such as the 1915 Board of Cost Review served to indicate that the Reclamation Service was at least somewhat concerned about the efficiency of the Carlsbad Project. This concern was further demonstrated in 1923 when the Department of the Interior dispatched a special investigator to Carlsbad to examine the project's operating and maintenance costs. This man, C.R. Trowbridge, independently expanded his inquiry to encompass virtually every aspect of the Project's operation. His final, 66-page report provided some 44 recommendations for improving the Project's management and eliminating allegedly inappropriate or illegal

practices by Project staff. Trowbridge's exposé uncovered supposed problems in virtually every sector of the Project's operation, and included a recommendation that L.E. Foster, the Project Manager, be fired. The most serious charges revealed possible conflicts of interest involving Foster and other Project employees, some of whom were operating farms on land served by federal water. Other problems were more minor, such as Trowbridge's observation that a lack of spittoons at the Project headquarters forced employees to expectorate out an office window.[291] It is unknown how aggressively the Reclamation Service responded to Trowbridge's report, but Foster successfully weathered Trowbridge's attack and remained at his position at Carlsbad until 1945.[292]

The continuing issue of excess individual land holdings within the project was one of the problems addressed by Trowbridge. In spite of the long-standing legal prohibition against ownership of more that 160 acres of land in a reclamation district, Trowbridge identified a total of seventeen landowners who each owned or controlled over 200 acres within the Carlsbad Project. Among them, this group held a total of 9,413 acres of irrigable land, more than one-third of the project's total area.[293] In a probable reaction to Trowbridge's report, Foster received instructions from Washington to begin a crackdown on excess landowners, most of whom had been easily circumventing the federal acreage restrictions for years. In response, Foster complained that the rule was difficult to enforce, stating:

> In a number of cases where the title is shown on the County records in one name, we have evidence that the title really rests in another person who is holding land in excess of that permitted by law. Where an excess land owner disposes of land held in excess of the law, it has been the custom heretofore on this project for such owner to use the names of "dummy" owners. This means that a certain amount of land is deeded to someone else by Warranty or Quit-Claim Deed, such deed being recorded on the county records. In such cases the land is deeded back by the "dummy" owner to the real owner and the returned deed is not recorded.[294]

The continuing 1920s studies aimed at increasing water storage for the Carlsbad Project were perhaps a cause for optimism among the Project's landowners, but they were simultaneously an equally powerful source of concern for other groups who also relied on Pecos River water for their livelihood. The potential for disputes over water rights on the Pecos came to the surface in 1923, as the Reclamation Service began active study of a reservoir site at Red Bluff, on the Texas end of the Pecos basin. This, and other proposed Pecos River reclamation projects in both Texas and New Mexico, demonstrated the need for a formal agreement allocating the basin's water supply. Representatives of the two states began work on such an agreement in 1923, and by February 1925 a negotiated "Pecos River Compact" was submitted to the two states' legislatures for approval. New Mexico's legislature ratified the Compact, but it was vetoed by the governor following protests by the Pecos Water Users Association. Although the Compact continued to be discussed until at least 1933, it was never fully accepted by both states,

and it remained for a future generation to negotiate a final allocation of Pecos River water.[295]

By the late 1920s, the proposed Fort Sumner project began to receive less and less federal attention. In its place appeared various schemes to raise Avalon Dam to increase the reservoir's storage capacity. This proposal attracted considerable federal attention between 1927 and 1930, generating numerous Bureau of Reclamation reports. The reasons for this shift in attention are speculative, although it is likely that pressure from the Water Users Association was largely responsible. In May 1926, the Water Users formalized a contract with the Bureau of Reclamation authorizing the first of the Avalon studies, and the group displayed vocal support for the proposal over the next several years. They were perhaps distrustful of moving the Carlsbad Project's water storage to far-away Fort Sumner; at any rate, they consistently maintained that "the annual run-off of the Pecos River at Avalon is much more than ample for all needs for [the] Carlsbad Project."[296] The Bureau of Reclamation also professed interest in the idea, but in part for a different reason. Government reports indicated that Avalon Dam, while a basically safe structure, would possibly collapse if McMillan failed and sent its waters towards Avalon. If both the project's dams were to fail, the ensuing flooding would be both devastating and deadly to the townsite of Carlsbad. Raising Avalon Dam would reduce the likelihood of such a disaster.[297]

Much of the official study centered on the unknown efficacy of an enlarged Avalon Reservoir. Although the existing Avalon Dam and Reservoir were relatively leak-free, there was concern that a higher water level would penetrate some of the same gypsum formations that made Reservoir No. 3 such an uncertain proposition. The first of these reports was completed in February 1927 by Kirk Bryan of the Geological Survey. Bryan's report appeared to indicate that the expansion proposal showed at least some merit. At the time, Avalon's high-water line was established at elevation 3,177 feet; the proposed expansion would raise the water level to 3,200 feet and provide at least a sixfold increase in Avalon's storage capacity. Bryan believed that Avalon could easily and safely be raised to 3,192 feet, but that some potential for leakage existed at the 3,200 foot level.[298]

At least five additional federal reports on the subject were filed in the ensuing two years, each coming to a slightly different conclusion. The majority of the Bureau's engineers seemed to feel that, while the risk of reservoir leakage was present, the potential benefits of a larger reservoir outweighed the risks. (Most, however, suggested that a water level higher than 3,192 feet would have a relatively high potential for seepage.) In contrast, Bryan became less and less comfortable with the proposal as his local studies continued.[299]

The Water Users Association quickly began utilizing these generally favorable reports in an aggressive campaign to win

federal funding for enlarging Avalon. These efforts were well underway by November 1927, when the Water Users issued a resolution requesting that Congress approve emergency funding for the project, which they estimated would cost $900,000. Such action, according to the Water Users, was the only way to counteract "the crop losses we have already suffered, and are facing every year until this storage is provided."[300]

The Water Users continued to lobby for the reservoir's expansion through 1929, although Bureau of Reclamation support for the proposal was lukewarm at best. A.F. Walter, the Bureau of Reclamation's Chief Engineer, feared that the Bureau would be left holding the financial bag if the enlarged reservoir failed to hold water, and suggested "that if the water users are desirous of going ahead with this work, they finance the undertaking themselves."[301] Nevertheless, the Water Users began enjoying some success in Congress by 1928. The following year they managed to win a federal appropriation for the dam, dependent only on receiving a final, favorable report from yet another engineering Board of Review. The report, presumably intended to be the final word on the Avalon proposal, admitted that the Carlsbad Project's need for additional water was "obvious and impressive."[302] The Board claimed to have made "an earnest effort to find a sound [geological] basis" for increasing Avalon's storage capacity, but concluded that the physical conditions at the site rendered the proposal completely unpractical.[303]

Despite the Water Users pleas, the Board's report effectively killed the Avalon proposal, at least for the time being. In November 1929, the Bureau informed the Water Users that "It is believed under the circumstances [that the Water Users] must proceed along such lines as their interests require and with their own initiative."[304] Tracy expressed the Water Users' substantial frustration with the situation, complaining that the negative reports contained "fundamental errors" which remained even though they had been "exploded by data and measurements of the Bureau of Reclamation." Tracy also stated that the entire deadlock had come about simply because of a faulty federal decision not to construct Reservoir No. 3.[305] Nevertheless, he stated that "I feel that the dam will be raised some day. We could finance it ourselves if it were not for the $800,000 federal farm loans upon the project lands which effectively block us from any bond issue."[306] Meanwhile, though, the Carlsbad Project remained without an adequate reserve water supply.

**J: The 1930s -- Modernization and Expansion**

The Carlsbad Project entered the 1930s weary from a quarter century of infighting and political bickering. The resentments various individuals and groups held against one another had become more and more pronounced over the years, and showed little sign of abating. The project suffered from an obvious and long-standing

need for expansion and improvement, but a decade of planning and lobbying had failed to produce locally-desired results. By 1932, Carlsbad's difficulties were being compounded by the worsening nationwide agricultural market. That year, the project's average crop value dropped below $20 per acre -- the lowest point since the project's earliest days. In 1933 the district reported a sixty percent delinquency rate on farm mortgages.[307]

By the early 1930s, it was obvious that Water Users and the Bureau of Reclamation were tired of one another, and that it was only a matter of time before the Carlsbad Project was turned over to local control. This concept had been outlined by federal administrators for years with varying degrees of seriousness and specificity, and by the 1920s the transfer of most government irrigation projects to local control was an accepted part of federal reclamation policy. A 1923 government study of its western reclamation systems had noted:

> The Reclamation Service has retained the full management of all but two of the projects. This has not been satisfactory. The project management and the Washington office have become targets for criticism. The water users have come to look upon themselves as wards of the Government, a specially favored class with special claims upon Governmental bounty. The Extension Act provides that the operation and maintenance of the project may be turned over to the water user. This should be done at the earliest possible date.[308]

The report went on to specifically list a number of Reclamation Service projects that should be turned over to the local users. The Carlsbad Project was not among those so listed, even though its

history displayed a quintessential portrayal of the problems outlined in the report.[309]

The joint failure of the Reclamation Service and the Water Users to agree upon and fund a project to increase the Project's water supply was probably the single largest factor encouraging a shift from federal to private control. By early 1932 the decision to proceed with the transfer had, in essence, been finalized by both Bureau of Reclamation and Water Users leaders. All that remained was to perform the mechanics of the transaction. This required that the old Water Users Association be replaced with a new "Carlsbad Irrigation District," which would have the legal authority to acquire the government physical plant, issue bonds for further improvements, and assess landowners for the costs of the system's operation.

The Water Users Association scheduled an election for June 20, 1932, at which the project landowners would vote on the Irrigation District's formation. The issue generated significant local interest, since it was assumed that approval of the Irrigation District implied an impending local takeover of the reclamation system. When the votes were tallied, the Irrigation District had been approved by a large majority, but the slate of Irrigation District directors proposed by the Water Users Association was soundly defeated by an opposition ticket organized by the project's farmers. Observing the election for the Bureau of Reclamation, Foster reported that "As near as I can judge at this time the

campaign of the winning side was based on opposition to the water users taking over the operation of the project."[310] Of the ten candidates Foster reported as being on the ballot, the man who received the fewest number of votes was Francis G. Tracy.[311]

In spite of Foster's evaluation of the prevailing local sentiment, the new Irrigation District and Bureau of Reclamation ostensibly planned to proceed with the transfer to local control. The District's first operating contract with the Bureau provided for a five-year transition period, with the District assuming full control of the project on January 1, 1938. (For unknown reasons, however, this scheduled transfer failed to take place.) The contract also provided for a downward readjustment of the landowners' fee payment schedules in accordance with 1926 federal reclamation legislation. This legislation relieved farmers in Bureau of Reclamation projects from repayment of certain related federal expenditures -- signifying at least a partial confirmation of the Board of Cost Review's statements of the previous decade.[312]

Local circumstances began to improve significantly soon after the Irrigation District's formation, although the District could claim little credit for most of the changes. Instead, the nationwide economic policies of Franklin Roosevelt's New Deal directly or indirectly brought about the most dramatic local events, including both a general improvement in the local agricultural economy and the construction of many of the

reclamation improvements local residents had pleaded for and dreamed about for decades.

Most of these physical improvements can be directly traced to the establishment of the Civilian Conservation Corps (CCC). The CCC program placed camps of young men at locations across the country to undertake various public works projects; each camp was under the jurisdiction of a specific state or federal agency. The Bureau of Reclamation was among the agencies allowed the benefit of CCC crews, and the Bureau's Carlsbad Project was destined to be among the first and most substantial beneficiaries of this nearly-free labor source. CCC camp #BR-3 was established north of Carlsbad in August 1934, and the camp's workers immediately began the first of a long series of varied improvements on the Project's physical plant.[313]

Many of the CCC crews' assignments consisted of general maintenance and repair work, but more significant projects were also undertaken throughout the camp's tenure. The program's first major local project, during 1934 and 1935, involved the construction of a 2,000-foot extension to the east embankment at Lake McMillan. As with the reservoir's original east embankment, the extension was designed to remove small areas from the reservoir which were causing substantial water loss due to seepage. The project involved the placement of some 43,000 cubic yards of earth and 9,400 cubic yards of rock at the site by hand (HAER photograph #A-17).[314]

When the McMillan embankment was completed in late 1935, the CCC crews moved to Avalon Dam, beginning one of the program's largest projects at Carlsbad (HAER photograph #B-74). Earlier, a federal Board of Engineers had recommended that the Bureau of Reclamation "increase the safety factor of all the constructed works against momentary flood flows."[315] Much of this concern was directed at Avalon, which needed the strength to withstand the effects of a possible failure at McMillan. Consequently, it was decided to use CCC labor to raise the dam's height by 6 feet. This was accomplished by adding a rubble masonry wall resting on the concrete corewall, and simultaneously raising the dam's earthen and rockfill portions. The channel at Spillway No. 2 was also widened and strengthened. Although the rebuilt Avalon was substantially stronger and more massive, it did not have a significantly increased storage capacity. As such, it was only a partial fulfillment of the project's engineering dreams of the decade before.[316]

Following the completion of the Avalon project, the CCC crews turned their attention to the further rebuilding of McMillan Dam. McMillan had been seriously threatened by Pecos River flooding during May and June, 1937, when its water level reportedly reached "an unprecedented level."[317] The high water caused leakage cracks to develop, and federal observers feared that the entire dam might be endangered. A party of engineers from the Bureau of Reclamation's Denver office inspected McMillan soon after the flood

and recommended immediate reconstruction of the dam. The planned improvements included the addition of compacted earth fill to the dam's upstream slope, widening its crest from 16 feet to 25 feet. The fill was topped with 3 feet of rock riprap. Additional work at McMillan included pouring a concrete apron below the dam's headgates and clearing the channel below the headgates. The McMillan reconstruction project began in November 1937, and the CCC crews completed most of the improvements by the following spring (HAER photographs #A-38 through A-41, A-51 through A-54, and drawing A-63).[318]

The Roosevelt administration's strong commitment to public works projects allowed the achievement of a major Carlsbad Project goal: the long-proposed Fort Sumner storage dam. Plans for the new structure, to be named "Alamogordo" after a nearby Pecos tributary, were finalized by 1935. The dam's incipient construction was seen as a tremendous boost to the Carlsbad Project, but the proposal was viewed with substantial trepidation by residents of west Texas, who envisioned Alamogordo usurping that state's share of the Pecos water supply. In turn, eastern New Mexico water users once again expressed concern over the planned Red Bluff project on the Pecos River in Texas. These two upcoming projects served as a reminder of the need for a formal interstate water compact for the Pecos basin. (Despite years of discussion, the Pecos River Compact of 1925 had still not been accepted by all concerned, and was not viewed with complete favor by either Texas

or New Mexico.) A solution to the states' concerns was outlined in the so-called "Alamogordo Agreement," which was signed on August 2, 1935. The Alamogordo Agreement specified that New Mexico would irrigate no more than 76,000 acres of the Pecos basin, and that Texas would continue to receive the surplus floodwaters it had gotten in the past. Approval of the Agreement by interested parties in both Texas and New Mexico allowed construction to proceed on both the Alamogordo and Red Bluff projects, even though the document was never formally ratified by state legislative bodies.[319]

The final approval for Alamogordo's construction came soon after the signing of the Alamogordo Agreement. The dam was formally authorized in late 1935 as a work relief project, aided by a $1,000,000 appropriation under the Emergency Relief Appropriation Act. The dam's primary funding, however, came from a $2,500,000 authorization approved by the Carlsbad Irrigation District shareholders in 1934. Bids for Alamogordo's construction were opened on December 21, 1935, and the contract was awarded to Hallett Construction Company of Crosby, Minnesota. Work on the dam began on March 5, 1936. Construction proceeded at a rapid pace, with as many as 900 men employed at the height of the project. Although the dam was not formally completed until 1938, enough work had been finished by mid-1937 to allow Alamogordo to begin storing reserve water for the Carlsbad Project. This allowed McMillan to be largely drained, facilitating the CCC's repair work there.[320]

The completed dam was an impressive structure, significantly larger than either Avalon or McMillan. It was built with a combination of earth and rockfill, and reached a maximum height of 149 feet. The dam was 1,600 feet long, 1,150 feet wide at its base and 35 feet wide at the crest. The dam featured an open concrete spillway and a primary outlet works with a 69-foot high intake tower and a 581-foot long diversion tunnel. The completed dam formed a reservoir some fifteen miles long with a capacity of 157,000 acre-feet of water.[321]

The added storage provided by Alamogordo was a substantial blessing to the Carlsbad Project, which had suffered from an inadequate -- and worsening -- storage capacity for decades. The tremendous rate at which McMillan had filled with silt during its early years had slowed with the natural formation of a brush-filled delta near the dam's inlet, but McMillan's combination of decreasing capacity and increasing leakage had rendered the facility far less useful than was needed. In contrast, Alamogordo's upstream location and larger capacity made it far less susceptible to silting. The dam's location would also help stabilize the river's wildly erratic flows, and lessen the damage caused by its frequent floods. This was first demonstrated in June 1937, when the still unfinished Alamogordo was visited by its first Pecos River flood. The new dam successfully managed the floodwaters and, according to the Bureau of Reclamation:

> was credited with averting serious flood losses in the Pecos Valley and Fort Sumner, Roswell and Carlsbad. The flood peak would have practically washed away the entire Fort Sumner Valley and would undoubtedly have caused serious damage to Roswell . . . . It was known the McMillan dam at Carlsbad was in a weakened condition from lower floods and probably would not have withstood the added strain of another flood.[322]

With Alamogordo's completion, it became the primary storage reservoir for the Carlsbad Project. Quantities of water would be released from Alamogordo as needed (from one to five times per year, depending on precipitation). This water would then be held temporarily at McMillan or Avalon for gradual release into the canal system.[323]

Meanwhile, Carlsbad's CCC workers continued working on a variety of reclamation projects. The long-standing effort to fully line the Project's main and lateral canals with concrete or rock masonry received much of the CCC's attention from 1938 onward (HAER photographs #C-31, D-6, D-7, D-9, and D-10). Numerous other CCC projects were also completed, however, including a suspension footbridge at Avalon, reinforcement of the Pecos River Flume, and a new access road and landscaping at Avalon (HAER photographs #B-5, B-6, B-13 through B-16, B-75, B-76, drawings B-98 and B-99). The CCC also operated a gravel pit and "concrete block plant" at the Carlsbad Project, and maintained an aggressive "rodent control" program. The local CCC program received a significant boost in 1938, when a second Bureau of Reclamation CCC camp was authorized for the Carlsbad Project. This second camp, designated BR-82, was

originally planned for the Alamogordo site, where a federally-sponsored recreation project was to be built. However, as a cost-saving measure the new camp was finally erected as an extension of Camp BR-3; a small "side camp" was established at Alamogordo to allow CCC work to begin there.[324] Camp BR-82 operated until November 1, 1941, and Camp BR-3 closed in May 1942 when it fell victim to the nationwide shutdown of the CCC program brought about by onset of the Second World War. Unquestionably, the CCC's eight years of activity at Carlsbad produced the most significant renovation of the reclamation system since the Reclamation Service's initial efforts in 1906-07.

Wartime restrictions and a local labor shortage reduced the Carlsbad Project's improvement program to a pre-New Deal level. (The labor shortage was also keenly felt by local cotton farmers, who succeeded in having the Project's old CCC facilities turned into a prisoner-of-war camp to provide an agricultural labor supply.[325]) Local economic activity rebounded after the war's end, although during 1945 and 1946 the Pecos Valley experienced the most severe period of drought in memory. Even though the project's expanded physical plant was presumably better able to handle such situations, the Bureau's 1946 "Annual Report" noted that the project's farmers were unconvinced:

> A general dissatisfaction among project farmers with the Bureau of Reclamation was evident during 1946, their complaint being a water shortage within their storage system which they contend was caused by inadequacy of Alamogordo Dam to serve the Carlsbad Project. Holdings

> of mass meetings among the project farmers resulted in the adoption of a program by which construction charges would be withheld by them. This resulted in slow collections, and by December 31, 1946, approximately $22,000 remained unpaid on 1945 Construction Charges.[326]

The Bureau of Reclamation eventually responded to such concerns by undertaking yet another improvement project at McMillan Reservoir. Unlike earlier projects, which had generally concentrated on the rehabilitation of the dam itself, the 1940s efforts attempted to address the water loss from McMillan's reservoir pool. Although much of the loss resulted from hard-to-control seepage through the reservoir floor, significant water loss was also attributed to the huge delta of silt that had accumulated at the reservoir's inlet. This area was overgrown with "salt cedar" (actually Tamarisk), which was absorbing great quantities of the reservoir's inflow through transpiration. In an attempt to reduce this problem, the Bureau of Reclamation authorized construction of a new river channel to bypass the salt cedar area. Construction of the 4.24-mile channel began in October 1948, and Reclamation crews completed the project the following April. The salt cedar area was sprayed with herbicide in 1949 in a further attempt to reduce the problem.[327]

**K: Post World War II -- A Return to Local Control**

In 1948, the Carlsbad Project was still being maintained and operated by the Bureau of Reclamation, as it had been for the past

forty years. Although the Carlsbad Irrigation District had been organized in 1932 for the express purpose of assuming control of the local reclamation system, little movement in that direction had actually taken place. The Irrigation District continued to operate in much the manner of its predecessor, the old Water Users Association. The retention of federal ownership probably indicated a continued Irrigation District hesitancy to assume the added responsibilities that a transfer would imply. In October 1948, however, federal officials abruptly ordered that the Carlsbad Project be transferred to local control effective January 1, 1949. A delegation from the Irrigation District immediately visited Washington in an effort to have the decision rescinded. Meanwhile, the District's attempts to prepare a plan for local operation of the system met with "little or no visible progress."[328] Several months of uncertainty followed during which it was frequently uncertain when, or if, the control of the Project would be transferred. A period of negotiations between the Bureau of Reclamation and the Irrigation District finally settled on a transfer date of October 1, 1949. (The October 1 date was chosen in order to give the Irrigation District operational experience prior to the 1950 irrigation season.) On October 1, operating control of the Carlsbad Project's physical plant, with the exception of Alamogordo Dam, was conveyed to the Carlsbad Irrigation District.[329]

The Irrigation District inherited a reclamation system that the Bureau of Reclamation recognized as being "generally in poor operating condition."[330] In an immediate attempt to begin restoration of the system's physical plant, the Irrigation District increased the operation and maintenance assessment for 1950 and began a program of repairs. The Bureau of Reclamation happily observed that "it is evident that the District is taking an aggressive attitude toward the improvement of the Project's distribution system."[331]

The Carlsbad Project's transfer to local control did not, however, end the Bureau of Reclamation's local involvement. The Bureau retained ownership of the physical plant and continued to maintain an office in Carlsbad. The Bureau also persisted in its habit of sponsoring field studies of possible solutions to the Project's water storage problems. One such report appeared in December, 1950; another study, released in 1957, advanced the idea of storing project water in the underground caverns and cavities that laced the reservoir area.[332] A comprehensive 1960 Bureau study, entitled "Reconnaissance Report on the Pecos River Basin, New Mexico-Texas," again recapped the Project's "manifold problems" and evaluated possible solutions.[333] Four years later, yet another Bureau report considered providing additional irrigation water by tapping the underground reservoir beneath Major Johnson Springs, just below McMillan Dam.[334] As with most of the government's previous studies, however, these research efforts did

not immediately spur substantial new construction programs. Instead, McMillan's difficulties were temporarily mitigated by additional rechanneling and salt cedar control projects upstream.[335]

**L: Brantley Dam -- A New Look for the Project**

The Carlsbad District's water storage problems remained a significant issue into the 1960s. Silting at McMillan Reservoir continued to inhibit the facility's storage capacity, and concerns over McMillan's structural safety persisted. The safety issue generated increasing federal attention as the years went by. In 1964, the Bureau of Reclamation prepared a "Safety Evaluation Study" of McMillan and Avalon, which concluded that "a potential flood would exceed existing spillway capacity at McMillan Dam and cause the dam to be overtopped, which would cause the failure of both dams."[336] This dire forecast finally roused the federal government to action -- action which would dramatically alter the infrastructure of the Carlsbad Project.

Extensive Bureau of Reclamation research on possible solutions to the Carlsbad Project's shortcomings culminated in a massive 1967 report proposing the replacement of McMillan Dam and Reservoir with a new structure. The new dam would be located between Avalon and McMillan, creating a large new reservoir that would completely inundate the McMillan site. The proposed facility was designated

"Brantley," after an early officer of the Carlsbad Irrigation District. Although Brantley's site was upstream from the long-proposed Reservoir No. 3, the proposal was, in many ways, a final implementation of the nearly century-old idea.

The 1967 report was intended, in part, to serve as a basis for securing Congressional authorization of the Brantley project. This approval came on October 20, 1972 in the form of Public Law 92-514, which authorized the Department of the Interior's construction and future operation of Brantley Dam and Reservoir. The project's stated goals included "the purposes of irrigation, flood control, fish and wildlife and recreation, and for the elimination of the hazards of failure of McMillan and Avalon Dams . . . ."[337] The authorization was contingent on the Bureau of Reclamation's retention of Alamogordo Dam and Reservoir, and on the Bureau's establishment of procedures that would "preclude any detrimental effect on water rights in the Pecos River."[338] A total of $45,605,000 in federal funding was initially authorized for the project.[339]

Planning work for Brantley Dam continued throughout the 1970s. Changes made during this period included relocating the dam's axis to help satisfy geological concerns and increasing the size of the reservoir's minimum pool to improve wildlife habitat. A further change was the decision to breach McMillan Dam after Brantley's completion. (Original plans had called for the relocated Atchison,

Topeka & Santa Fe Railway to cross Brantley Reservoir atop the abandoned McMillan Dam.)[340]

The financial responsibility for Brantley's construction was divided between the federal government and the Carlsbad Irrigation District. The Irrigation District would shoulder only those project costs associated with providing additional irrigation water (estimated at $1,066,000 in 1975), while the bulk of Brantley's costs, associated with flood control and dam safety, were assumed by the federal government. Total estimated project costs climbed steadily as the plans for Brantley were refined. By 1982 the estimated costs of the project had risen to $218,300,000, and they rose still higher as the decade progressed. Interestingly, the 1982 project budget reduced the amount chargeable to the irrigation district to only $157,000.[341]

The final plans for Brantley Dam specified a structure combining a concrete gravity center section flanked by rolled earth-fill wings. The concrete section is approximately 143.5 feet high and 760 feet long. The dam's earth-fill wings reach a maximum height of 118.5 feet and have a crest width of 30 feet. The wings extend both east and west of the concrete core, bringing the total dam length to some four miles. The concrete section features a central overflow spillway controlled by six radial gates, providing a maximum discharge capacity of 352,000 cubic feet per second. The spillway supplements the dam's regular outlet works, which consists

of two 4-foot by 4-foot conduits with a capacity of 1,230 cubic feet per second.[342]

Preparatory land acquisition, site clearing, and archeological mitigation work was underway at the Brantley site by the early 1980s. This phase of work also included relocating highways and utility lines, and constructing a $15,000,000 realignment of the Santa Fe Railway. Monterrey Construction Company, the Bureau of Reclamation's prime contractor for the project, began actual construction of the dam in 1984. Concrete work was completed by autumn 1987, and soon after the Pecos River was diverted through the new Brantley floodgates for the first time. That winter, still another channel was dredged through the McMillan silt to ease the water flow into Brantley.[343]

The completion of Brantley Dam heralded a significant new era in the history of the Carlsbad Project (HAER photographs #I-1 and I-2). Brantley's construction finally allowed long-standing local concerns about dam safety to be laid to rest, and the Project's inadequate water storage capacity was simultaneously resolved. Unlike McMillan, Brantley was designed in anticipation of future siltation, and the dam is high enough to allow for gradual raising of the reservoir pool's elevation to compensate for silting as it occurs. In a demonstration of the concept of multiple-use, plans for Brantley Reservoir also included active consideration of the recreational opportunities and waterfowl habitat the new lake would provide.[344]

The use of Brantley for Project water storage allowed the final abandonment of McMillan Dam and Reservoir, and in 1990 plans were underway to breach the historic structure (HAER photographs #A-1 through A-3). McMillan's abandonment leaves the Carlsbad Project with an eclectic mixture of physical facilities: nineteenth-century canals mixed with twentieth-century lining and headgates, the striking 1903 Pecos River Flume, the 1906 Avalon Dam with its later improvements, the 1937 dam at Alamogordo, and modern-day Brantley. In design and function, each of these structures represents the era in which it was built, and the form of the Carlsbad Project at a unique point in its past. Together they display a significant technological cross-section of the history of western American reclamation.

## M: Conclusion -- The Significance of the Carlsbad Project

The slow, painful evolution of the Carlsbad Project under Bureau of Reclamation tutelage mirrors, in many ways, the advancing maturation of American reclamation technology and philosophy. Reclamation Service efforts to reconstruct Avalon in 1906 and 1907, combined with its later improvements to the dam, are today highly representative of the increasing sophistication of early twentieth-century reclamation engineering. Avalon and McMillan Dams remain especially significant for their rockfill, "composite" design, and Avalon's use of an impervious corewall is also noteworthy.

By the beginning of the Reclamation Service era, dam engineers recognized the advantages of placing a corewall in earthfill and rockfill dams. The impervious corewall, usually of steel sheet piling or concrete, was carried from bedrock into the fill, thus restricting the flow of water at the interface between the earthfill and its foundation. Although at least one Reclamation Service engineer recommended that all corewalls be carried to the crest of the dam to protect against burrowing animals, in some early Reclamation Service projects the corewall was carried only a few feet upward into the fill.

Of the 37 major Reclamation Service dams and diversion dams described in the volume Irrigation Works Constructed by the United States Government, Avalon Dam is one of only three rockfill dams with an impervious earthfill upstream facing, and the only rockfill dam with a corewall extending from bedrock to the dam's crest. The other two dams of similar construction were the Minidoka Dam on the Minidoka Project in Idaho and the Clear Lake Dam on the Klamath Project in California and Oregon. Both of these dams had concrete corewalls only at the base of the upstream toe of the rockfill. Avalon Dam was comparable in size to Minidoka and Clear Lake, although its reservoir was far smaller than that of the others. Similarly, Minidoka and Clear Lake were components of far larger Reclamation Service projects, each helping supply water to hundreds of thousands of acres.[345]

As the twentieth century progressed, rockfill dams continued to be popular in certain applications and, while some composite dams were built, most had concrete membranes on the upstream face. Among rockfill dams with an earthfill facing, Avalon and McMillan were among the largest nineteenth century dams in terms of length and height, but there were other nineteenth century dams with impermeable cores or with concrete or timber upstream faces which greatly exceeded the Pecos River dams in height. Later in the twentieth century, rockfill dams with an earthfill facing would reach heights of almost 200 feet. Nevertheless, Avalon and McMillan are significant because they were among the first important rockfill dams with an earthfill facing in the United States.[346]

Less-prominent features of the Carlsbad Project's physical plant also represent the early technological evolution of the Bureau of Reclamation. The most noteworthy of these are Avalon Dam's 1911 cylinder gates, an early implementation of a design form which saw later use in the intake towers of Hoover Dam. The Avalon project apparently marked the earliest use of the cylinder gate design in a major dam spillway.

In addition to the Carlsbad Project's physical landmarks, its operational history also typifies the evolution of public-sponsored reclamation in the American West. The Project's long-standing attempt to maintain fiscal responsibility without unduly burdening Project farmers replicates the primary concern of most Reclamation

Service projects, and Carlsbad's relative success in achieving such a financial balance made the Project a source of federal pride. Carlsbad is also nationally representative in its long-discussed, but slowly implemented, transition from federal to local control.

Still, a number of factors make the Carlsbad Project historically unique. While the Reclamation Service imposed many of its contemporary designs on the project, these features were added to an irrigation system of private origin and largely nineteenth-century construction. This resulted in a physical plant displaying true dichotomies of design and philosophy, exhibiting both private and public design philosophies, as well as both nineteenth- and twentieth-century engineering techniques. While the Pecos Valley was not alone in possessing a privately-constructed irrigation system that was later acquired by the federal government, the relatively massive size of the private system was unusual among such projects. Although the federal government's construction and rehabilitation investments at Carlsbad were substantial, during the Reclamation Service's first years the Project largely remained a private, nineteenth-century system imbued with the trappings of federal funding and control. Although this characterization gradually faded with each government improvement project, the dichotomy remains sharply visible today.

## EPILOGUE

The construction of Brantley Dam and Reservoir represents a substantial betterment of the Carlsbad Project's physical plant, increasing both water storage and dam safety. The price paid for these improvements, however, was the loss of part of the historic fabric which had resulted in the Carlsbad Irrigation Project being designated a National Historic Landmark in 1963.[347] These losses include the draining of McMillan Reservoir and the proposed future use of the reservoir basin by Brantley Reservoir, as well as the breaching and partial inundation of McMillan Dam itself.

In accordance with Section 106 of the National Historic Preservation Act of 1966, as amended, the Bureau of Reclamation and the Advisory Council on Historic Preservation determined in 1977 that Brantley's construction would have an "adverse effect" on the National Historic Landmark as defined in 36 CFR 800. To mitigate, in part, this adverse effect, the Bureau of Reclamation agreed to sponsor a historic survey and recordation of the Carlsbad Project according to the standards of the Historic American Engineering Record (HAER). This historical narrative is one principal product of the HAER survey; other products include measured drawings, photographs, and a revised National Historic Landmark Nomination. This material is being deposited as part of the permanent HAER collection at the Library of Congress.[348]

ENDNOTES

1. A discussion of Native American and Hispanic practices relating to water is found in Chapters 1 and 2 of Ira G. Clark, Water in New Mexico (Albuquerque: University of New Mexico Press, 1987).

2. A number of Reclamation Service, Bureau of Reclamation, and United States Geological Survey reports contain detailed descriptions of the geography of the Pecos River Valley; these quotes are from the Geological Survey's "Report Upon a Reconnaissance of the Pecos Valley, by Ralph S. Tarr: March 11, 1889." RG 115, Entry 3, Box 443, File 651, National Archives, Washington, D.C.

3. Ibid. Tarr's narrative provides the best contemporary description of early agricultural development in the Pecos Valley.

4. For a general discussion of this period see Clark, Water in New Mexico, Chapter 4. A good local example of this process is provided by the Eddy brothers' Pecos ranching activities; for background material on the Eddys see "The Eddy Brothers," typescript in History File (County) #14, New Mexico State Records Center & Archives, Santa Fe.

5. Tarr, "Report Upon a Reconnaissance of the Pecos Valley."

6. Brief contemporary descriptions and analyses of the West's pioneering reclamation efforts may be found in William E. Smythe, The Conquest of Arid America (New York: Harper & Brothers, 1900).

7. "Robert Weems Tansill," in Eddy County New Mexico to 1891 (Carlsbad, New Mexico: Southeastern New Mexico Historical Society, 1982), 172.

8. This quote is attributed to William A. Hawkins, who served as Eddy's general counsel; see Chapter 11 of William A. Keleher, The Fabulous Frontier (Albuquerque: University of New Mexico Press, c1945, 1962). Also see "The Eddy Brothers" typescript.

9. Francis G. Tracy, "Pecos Valley Pioneers," New Mexico Historical Review 33 (July 1958): 187-204.

80. McMillan Dam "was named for W. H. McMillan, a wealthy man who was associated with C.B. Eddy and was a brother of United States Senator McMillan." See L.E. Foster to Charles Ethrige Minton, 1 October 1940, WPA File #201, "Eddy County Points of Interest," New Mexico State Records Center & Archives, Santa Fe.

81. Louis D. Blauvelt to C.B. Eddy, files of the Pecos River Projects Office, Bureau of Reclamation, Carlsbad, New Mexico.

82. Eddy [New Mexico] Argus, October 28, 1892, as quoted in Myers, The Pearl of the Pecos.

83. "Lake McMillan Dam, Pecos River," Engineering Record (June 9, 1894), 24.

84. Creager et.al., Engineering for Dams, vol. 3, 810.

85. "Lake McMillan Dam, Pecos River," 24. Although Lake McMillan had a reservoir capacity of about 89,000 acre-feet, actual capacity was limited by the lack of adequate embankments to the west of the dam. At a reservoir height 17 feet below the crest of the dam, McMillan held about 50,000 acre-feet.

86. James Dix Schuyler, Reservoirs for Irrigation, Water-Power, and Domestic Water-Supply (New York: John Wiley & Sons, 1902), 55.

87. Department of the Interior, U.S. Reclamation Service, "[Carlsbad] Project History from Inception of Project to December 31, 1913," 13, Carlsbad Irrigation District Office, Carlsbad, New Mexico.

88. The earliest description of McMillan Dam appears in "Lake McMillan Dam, Pecos River." Descriptions can also be found in Schuyler, Reservoirs for Irrigation, 55-56. A site plan of the dam appears in "Field Notes of the Survey of the Pecos Irrigation & Improvement Co's Reservoir No. 1, Eddy Co., New Mexico" (the notes were sent to Washington, October 7, 1895), located at the Pecos Valley Projects Office, Bureau of Reclamation, Carlsbad, New Mexico. A similar plan with a cross section of the dam appears on the "Plat of the Pecos Irrigation and Improvement Co's Storage Reservoir No. 1," 1895, RG 49, Division F, "Canals and Reservoirs," National Archives, Washington, D.C.

89. See pages 88-99 of "Deed Record Book 6," located at the Eddy County Courthouse, Carlsbad, New Mexico.

90. Hagerman, "In the Matter of the Hondo Reservoir."

23. Tracy, "Eddy County, New Mexico."

24. "Abstract of Title to T21S, R26E, NMPM, Section 12" (page 57), located in the Pecos Valley Projects Office, Bureau of Reclamation, Carlsbad, New Mexico.

25. "James John Hagerman: Memoirs of His Life, Written by Himself at Roswell, New Mexico in 1908." Typescript in the Rio Grande Historical Collections, New Mexico State University Library, Las Cruces.

26. Ibid.

27. Tracy, "Eddy County, New Mexico."

28. "On R.W. Tansill: the Entrepreneur," Carlsbad Current-Argus, March 20, 1988.

29. Clark, Water in New Mexico, 88.

30. Tarr, "Report Upon a Reconnaissance."

31. "Pecos Irrigation and Improvement Company, Report to the Stockholders, December 15, 1891." RG 115, Entry 4, Box 1, File 25, National Archives, Washington, D.C.

32. "H.H. Cloud" and "L.D. Blauveldt" biographical files, Colorado Historical Society, Denver, Colorado.

33. "Edwin S. Nettleton" biographical file, Colorado Historical Society, Denver, Colorado; "The Founding and Early Years of Eaton, Colorado," Colorado Magazine 18 (March 1941), 54-55.

34. Tracy, "Pecos Valley Pioneers," 203.

35. Eddy [New Mexico] Argus, 23 November 1889, as quoted in Lee C. Myers, The Pearl of the Pecos, 1974 typescript, located in the Pecos Valley Projects Office, Bureau of Reclamation, Carlsbad, New Mexico.

36. Eddy [New Mexico] Argus, December 28, 1889, as quoted in Myers, The Pearl of the Pecos.

37. Eddy [New Mexico] Argus, March 1, 1890, as quoted in Myers, The Pearl of the Pecos.

38. Ibid. The location of Bradbury & Company's home office is unknown.

39. Eddy [New Mexico] Argus, 28 December 1889, as quoted in Myers, The Pearl of the Pecos.

40. Eddy [New Mexico] Argus, November 23, 1889, as quoted in Myers, The Pearl of the Pecos. Again, the hometown of the Witt Brothers Company is unknown.

41. Eddy [New Mexico] Argus, March 29, 1890, as quoted in Myers, The Pearl of the Pecos.

42. Ibid.

43. Herbert M. Wilson, "Pecos Valley Canals," Engineering News 26 (17 October 1891), 351.

44. Eddy [New Mexico] Argus, August 16, 1890, as quoted in Myers, The Pearl of the Pecos.

45. C. B. Eddy to L. Bradford Prince, 3 September 1890, Reel 107, Frames 37-43, Records of the Territorial Governors, New Mexico State Records Center & Archives, Santa Fe.

46. Eric B. Kollgaard and Wallace L. Chadwick, eds., Development of Dam Engineering in the United States (New York: Perigamon Press, 1988), 889.

47. Although no conclusive data has been found dating the construction of rockfill dams for irrigation purposes, Avalon Dam is listed as the earliest surviving among "important composite rock-fill and earth dams" in: William P. Creager, Joel D. Justin, and Julian Hinds, Engineering for Dams, vol. 3, Earth, Rock-fill, Steel and Timber Dams (New York: John Wiley & Sons, Inc., 1945), 810; Avalon Dam is described as "a great dam" heading one of the "three most important canal systems in New Mexico" (the other two are the dam across the Hondo and a dam being constructed just across the Texas state line, both also owned by the Pecos Irrigation and Improvement Company). Avalon Dam and its canal system are described as the project of principle interest to the engineer "from its construction and magnitude" in: Herbert M. Wilson, "Pecos Valley Canals," Engineering News 26 (17 October 1891), 350.

48. W. W. Follett, "Earthen vs. Masonry Dams," Engineering News 27 (9 January 1892), 29.

49. L. D. Blauvelt to C. B. Eddy, 12 March 1893, files of the Pecos River Projects Office, Bureau of Reclamation, Carlsbad, New Mexico.

50. Wilson, "Pecos Valley Canals," 351.

51. L. B. Howell, "The Pecos Valley Irrigation System," Engineering News 36 (17 September 1896), 181.

52. Calvin Victor Davis, ed., Handbook of Applied Hydraulics (New York: McGraw-Hill Book Company, Inc., 1952), 150.

53. Howell, "The Pecos Valley Irrigation System," 181.

54. For early descriptions of Avalon Dam see: "Rock Fill Dam Across the Pecos River," Engineering News 23 (17 May 1890), 459-460; Follett, "Earthen vs. Masonry Dams," 28-29; and Wilson, "Pecos Valley Canals," 350-351.

55. Wilson, "Pecos Valley Canals," 351.

56. Ibid.

57. "Minutes of First Annual Meeting of the Stockholders of Pecos Irrigation Company," 10 February 1902, RG 115, Entry 3, Box 449, File 875, National Archives, Washington, D.C.

58. Wilson, "Pecos Valley Canals," 351.

59. Tarr, "Report Upon a Reconnaissance of the Pecos Valley." See Chapter 2 for a more detailed discussion of Tarr's criticisms.

60. Tracy, "Eddy County, New Mexico." For a capsule biography of Otis, see Elroy McKendree Avery, A History of Cleveland and Its Environs, vol. 2 (Chicago and New York: The Lewis Publishing Company, 1918), 31-32.

61. "Abstract of Title to T21S, R26E, NMPM, Section 12" (pp. 70-89), located at the Pecos Valley Projects Office, Bureau of Reclamation, Santa Fe, New Mexico.

62. J.J. Hagerman, "In the Matter of the Hondo Reservoir," transcript of testimony given against building the Hondo Reservoir, September 6, 1904, p. 1, RG 115, Entry 4, Box 1, File 25, National Archives, Washington, D.C.

63. Charles B. Eddy to L. Bradford Prince, 3 September 1890, Reel 107, Frames 37-43, Records of the Territorial Governors, New Mexico State Records Center & Archives, Santa Fe.

64. See "Patent Record" book (for example, pp. 33, 34, 70, 73, 95, 98, 103, 104, 105, 107, 112, 138, 150, 165), located at the Eddy County Courthouse, Carlsbad, New Mexico.

65. See "Deed Record Book 1" (for example, pp. 24, 25, 55, 99, 102, 121, 123, 129, 141, 241, 243), located at the Eddy County Courthouse, Carlsbad, New Mexico.

66. "United States of America Vs. Hope Community Ditch, et.al.," testimony taken at Carlsbad, New Mexico, January 4, 1926, typescript located at the Office of the State Engineer, Santa Fe, New Mexico.

67. Tracy, "Pecos Valley Pioneers," 203.

68. "United States of America vs. Hope Community Ditch, et.al."

69. Hagerman, "In the Matter of the Hondo Reservoir."

70. Clark, Water in New Mexico, 62.

71. "Plats of the Pecos Irrigation and Improvement Co's Storage Reservoir No. 1, No. 2, and No. 3," RG 49, Division F, Canals and Reservoirs File, National Archives, Washington, D.C.

72. For a discussion of the evolution of New Mexico water law, see Clark, Water in New Mexico, 115-132.

73. A compilation of these rights is found in an undated typescript forming a part of the Reclamation Service's "Project Reports" collection, RG 115, Box 134, National Archives--Denver Branch, Denver, Colorado.

74. Eddy [New Mexico] Argus, May 31, 1890, as quoted in Myers, The Pearl of the Pecos; Tracy, "Eddy County, New Mexico."

75. John J. Lipsey, The Lives of James John Hagerman, Builder of the Colorado Midland Railway (Denver: Golden Bell Press, 1968), 225.

76. Eddy to Prince, 3 September 1890.

77. Eddy [New Mexico] Argus, February 1, 1890, as quoted in Myers, The Pearl of the Pecos.

78. Tracy, "Eddy County, New Mexico."

79. Francis G. Tracy to the Secretary of the Interior, 23 June 1904, RG 115, Entry 4, Box 1, File 25, National Archives, Washington, D.C.

80. McMillan Dam "was named for W. H. McMillan, a wealthy man who was associated with C.B. Eddy and was a brother of United States Senator McMillan." See L.E. Foster to Charles Ethrige Minton, 1 October 1940, WPA File #201, "Eddy County Points of Interest," New Mexico State Records Center & Archives, Santa Fe.

81. Louis D. Blauvelt to C.B. Eddy, files of the Pecos River Projects Office, Bureau of Reclamation, Carlsbad, New Mexico.

82. Eddy [New Mexico] Argus, October 28, 1892, as quoted in Myers, The Pearl of the Pecos.

83. "Lake McMillan Dam, Pecos River," Engineering Record (June 9, 1894), 24.

84. Creager et.al., Engineering for Dams, vol. 3, 810.

85. "Lake McMillan Dam, Pecos River," 24. Although Lake McMillan had a reservoir capacity of about 89,000 acre-feet, actual capacity was limited by the lack of adequate embankments to the west of the dam. At a reservoir height 17 feet below the crest of the dam, McMillan held about 50,000 acre-feet.

86. James Dix Schuyler, Reservoirs for Irrigation, Water-Power, and Domestic Water-Supply (New York: John Wiley & Sons, 1902), 55.

87. Department of the Interior, U.S. Reclamation Service, "[Carlsbad] Project History from Inception of Project to December 31, 1913," 13, Carlsbad Irrigation District Office, Carlsbad, New Mexico.

88. The earliest description of McMillan Dam appears in "Lake McMillan Dam, Pecos River." Descriptions can also be found in Schuyler, Reservoirs for Irrigation, 55-56. A site plan of the dam appears in "Field Notes of the Survey of the Pecos Irrigation & Improvement Co's Reservoir No. 1, Eddy Co., New Mexico" (the notes were sent to Washington, October 7, 1895), located at the Pecos Valley Projects Office, Bureau of Reclamation, Carlsbad, New Mexico. A similar plan with a cross section of the dam appears on the "Plat of the Pecos Irrigation and Improvement Co's Storage Reservoir No. 1," 1895, RG 49, Division F, "Canals and Reservoirs," National Archives, Washington, D.C.

89. See pages 88-99 of "Deed Record Book 6," located at the Eddy County Courthouse, Carlsbad, New Mexico.

90. Hagerman, "In the Matter of the Hondo Reservoir."

91. Eddy [New Mexico] Argus, August 11, 1893, as quoted in Myers, The Pearl of the Pecos.

92. Ibid.

93. "James John Hagerman: Memoirs of His Life."

94. Lipsey, The Lives of James John Hagerman, 225-226.

95. Eddy [New Mexico] Argus, September 1, 1893; October 20, 1893; December 8, 1893, as quoted in Myers, The Pearl of the Pecos.

96. Eddy [New Mexico] Argus, April 27, 1894, as quoted in Myers, The Pearl of the Pecos.

97. For more on Eddy's later life, see Chapter 11 of Keleher, The Fabulous Frontier.

98. The name "Carlsbad" is an Americanization of "Karlsbad," the site of a noted European mineral water spa. The Pecos Valley contains a mineral spring reportedly similar to the one at Karlsbad, and the town's name change was part of a futile attempt to promote the New Mexico springs. See Myers, The Pearl of the Pecos, 145.

99. Lipsey, The Lives of James John Hagerman, 225-237.

100. L. L. Walters, Steel Trails to Santa Fe (Lawrence: University of Kansas Press, 1950), 347-348; Lipsey, The Lives of James John Hagerman, 225-237.

101. Keleher, The Fabulous Frontier. The route Eddy constructed ran from northeast from El Paso, traveling through Alamogordo and connecting with the Chicago, Rock Island & Pacific in northeastern New Mexico. It is now operated as the "Golden State Route" of the Southern Pacific Railroad.

102. Michael C. Robinson, Water for the West: The Bureau of Reclamation, 1902-1977. (Chicago: Public Works Historical Society, 1979), 9-10.

103. Tracy, "Eddy County, New Mexico." This is an apparent reference to Nettleton, whose reclamation background was either overlooked by Tracy or unknown to him.

104. "Articles of Incorporation of the Lower Pecos Land Company," New Mexico State Records Center & Archives, Santa Fe. The State Records Center also holds the incorporation documents for the "Upper" and "Middle" land companies.

105. "Farming by Irrigation in New Mexico." ([Santa Fe:] New Mexico Bureau of Immigration, 1897), 1,9.

106. Tracy, "Pecos Valley Pioneers," 200.

107. Ibid.

108. Tracy, "Eddy County, New Mexico;" Tracy, "Pecos Valley Pioneers," 200.

109. Tracy, "Eddy County, New Mexico."

110. See, for example, C.A. Hundertmark, "Reclamation in Chaves and Eddy Counties, 1887-1912," New Mexico Historical Review, 47 (1972):301-316.

111. Tracy, "Eddy County, New Mexico."

112. Ibid.

113. "Plan for the Settlement of the Affairs of The Pecos Irrigation and Improvement Company of New Mexico and for the Reorganization of a New Company by the Bondholders," RG 115, Entry 4, Box 1, File 25, National Archives, Washington, D.C.

114. Tracy, "Eddy County, New Mexico."

115. The Pecos Irrigation Company's complete list of incorporators included Tansill, Tracy, Rufus S. Benson, Abram N. Pratt, and James O. Cameron. See "Articles of Incorporation of the Pecos Irrigation Company," New Mexico State Records Center & Archives, Santa Fe.

116. Tracy, "Eddy County, New Mexico."

117. Ibid.

118. Ibid.

119. Ibid.

120. Ibid.

121. Ibid.

122. Ibid.

123. History of Chicago: Its Men and Institutions (Chicago: InterOcean, 1900), 83-84.

124. For background material on the evolution of reinforced concrete bridge design, see B.A. Etcheverry, Irrigation Practice and Engineering: Vol. II, Conveyance of Water (New York: McGraw-Hill Book Company, Inc., 1915), 198, 223-224; Carl W. Condit, American Building Art: The Nineteenth Century (New York: Oxford University Press, 1960), 248-254; Condit, American Building: Materials and Techniques from the Beginning of the Colonial Settlement to the Present (Chicago: University of Chicago Press, 1968), 172-176.

125. "Minutes of the First Annual Meeting of Stockholders of Pecos Irrigation Company," February 10, 1902, RG 115, Entry 3, Box 449, File 651, National Archives, Washington, D.C.

126. Ibid.

127. "Minutes of Second Annual Meeting of the Stockholders of the Pecos Irrigation Company," 10 February 1903, RG 115, Entry 3, Box 449, File 875, National Archives, Washington, D.C.

128. Hagerman, "In the Matter of the Hondo Reservoir." Hagerman stated that, with work, the lower canal's capacity could be increased to a maximum of 600 second-feet.

129. "History of Carlsbad Project -- 1912," files of the Pecos River Projects Office, Bureau of Reclamation, Carlsbad, New Mexico.

130. C. H. Finch to F. H. Newell, 24 February 1903, RG 115, Entry 3, Box 443, File 651, National Archives, Washington, D.C.

131. C. J. Blanchard, "Millions for Moisture: An Account of the Work of the U.S. Reclamation Service," National Geographic Magazine 18 (April 1907): 223.

132. Tracy, "Eddy County, New Mexico."

133. Ibid.

134. Francis G. Tracy to the Secretary of the Interior, 23 June 1904, RG 115, Entry 4, Box 1, File 25, National Archives, Washington, D.C.

135. James J. Hagerman to W. M. Reed, 1 July 1904, RG 115, Entry 4, Box 1, File 25, National Archives, Washington, D.C.

136. A. P. Davis, et.al. to F. H. Newell, 10 September 1904, RG 115, Entry 4, Box 1, File 25, National Archives, Washington, D.C.

137. W. M. Reed to the Chief Engineer, U.S. Reclamation Service, 10 October 1904, RG 115, Entry 3, Box 443, File 651, National Archives, Washington, D.C.

138. Ibid.

139. J. Barry Cooke and Arthur G. Strassburger, "Rockfill Dams," in Kollgaard and Chadwick, Development of Dam Engineering in the United States, 887; Follett, "Earthen vs. Masonry Dams," 20-21, 28-29; J.D. Galloway, "The Design of Rock-Fill Dams," Transactions of the American Society of Civil Engineers 104 (1939): 3-5.

140. Follett, "Earthen vs. Masonry Dams," 28-29; Galloway, "The Design of Rock-Fill Dams," responses to Galloway's paper by Howard F. Peckworth, 30-31, by C.S. Jarvis, 68-69, and by Galloway, 83; Creager et.al., Engineering for Dams, vol. 3, 806.

141. For contemporary analyses of rockfill dam design, see James D. Schuyler, "Reservoirs for Irrigation," Eighteenth Annual Report of the United States Geological Survey, 1896-97: Part IV -- Hydrography (Washington: 1897), 645; Follett, "Earthen vs. Masonry Dams," 28-29; Schuyler, Reservoirs for Irrigation, 51-52.

142. Ibid.

143. Most of these projects are briefly described in Part 3 of Smythe, The Conquest of Arid America.

144. Brief excerpts from these narratives may be found in Clark, Water In New Mexico, 45-46. Chapters 4 and 5 of this volume provide a good overview of early Federal concepts of the arid Southwest.

145. Ibid.

146. Ibid., 56-63. For additional discussion on the legislation and its effects as perceived by Congress, see the Congressional Record -- Senate: 51 Congress, 1st Session, 7269-7346.

147. Tarr, "Report Upon a Reconnaissance of the Pecos Valley."

148. Ibid.

149. Ibid.

150. Ibid.

151. Clark, Water in New Mexico, 58-62.

152. Smythe, The Conquest of Arid America, 261-274. Smythe was the founder of Irrigation Age and a leader behind the annual Irrigation Congresses.

153. For background information on the Carey Act and on early Wyoming reclamation, see T.A. Larson, History of Wyoming (Lincoln: University of Nebraska Press, 1965), 346-365. For information on the Act in the context of New Mexico water history, see Clark, Water in New Mexico, 75-76, 86-87.

154. A brief outline history of the Reclamation Service and the legislation affecting it may be found in the Introduction to "Preliminary Inventory of the Records of the Bureau of Reclamation" (Washington: The National Archives, 1958).

155. Clark, Water in New Mexico, 87.

156. R. S. Benson, et.al. to Francis G. Tracy, 8 October 1904, files of the Pecos River Projects Office, Bureau of Reclamation, Carlsbad, New Mexico.

157. Ibid.

158. F. G. Tracy to R. S. Benson, 11 October 1904, RG 115, Entry 3, Box 443, File 652, National Archives, Washington, D.C.

159. Gardner P. Stanford and Charles S. Kelley to William S. Greene, 25 October 1904; Henry Cabot Lodge to E.A. Hitchcock, 29 October 1904; Francis G. Tracy to E. A. Hitchcock, 10 November 1904, RG 115, Entry 4, Box 1, File 25, National Archives, Washington, D.C.

160. Hagerman, "In the Matter of the Hondo Reservoir."

161. W. S. Reed to Chief Engineer, U.S. Reclamation Service, 10 October 1904, RG 115, Entry 3, Box 443, File 651, National Archives, Washington, D.C.

162. Chief Engineer, U.S. Geological Survey to W. M. Reed, 10 October 1904, RG 115, Entry 3, Box 443, File 651, National Archives, Washington, D.C.

163. Francis G. Tracy to R. S. Benson, 8 November 1904, RG 115, Entry 3, Box 443, File 652, National Archives, Washington, D.C.

164. Pecos Water Users Association to Frederick H. Newell, 8 November 1904, RG 115, Entry 3, Box 443, File 652, National Archives, Washington, D.C.

165. Ibid.

166. "The Carlsbad Project History," The Carlsbad Current, June 19, 1914, p. 1.

167. B.M. Hall and W.M. Reed to the Chief Engineer, U.S. Geological Survey, 15 December 1904, RG 115, Entry 3, Box 443, File 651, National Archives, Washington, D.C.

168. A. P. Davis to B. M. Hall, 21 December 1904, RG 115, Entry 3, Box 443, File 651, National Archives, Washington, D.C.

169. Pecos Water Users Association and Pecos Irrigation Company to F.H. Newell, 5 January 1905; F.H. Newell to Francis G. Tracy, 12 January 1905, RG 115, Entry 3, Box 443, File 652, National Archives, Washington, D.C.

170. E. W. Myers, "Report to B. M. Hall, Supervising Engineer, on the Design and Construction of the Replacement and Repair Work for the Pecos Irrigation Co. Near Carlsbad, New Mexico." RG 115, Entry 3, Box 443, File 651, National Archives, Washington, D.C.

171. Ibid.

172. Ibid.

173. Ibid.

174. F.G. Tracy to G.B. Shaw, 3 July 1905, RG 115, Entry 3, Box 443, File 651, National Archives, Washington, D.C.

175. Thomas H. Means, "Report on Agricultural Possibilities of the Carlsbad Project, New Mexico." RG 113, Entry 3, Box 438, File 338, National Archives, Washington, D.C.

176. W.M. Reed, et.al. to the Chief Engineer, U.S. Reclamation Service, 31 August 1905, RG 115, Entry 3, Box 443, File 651, National Archives, Washington, D.C.

177. B.M. Hall to the Chief Engineer, Reclamation Service, 22 November 1905, RG 115, Entry 3, Box 443, File 651, National Archives, Washington, D.C.

178. Willis T. Lee, "Report on the Geology Near Carlsbad, New Mexico [December, 1905]." RG 115, Entry 3, Box 443, File 651, National Archives, Washington, D.C.

179. F.G. Tracy to F.H. Newell, 23 September 1905, RG 113, Entry 3, Box 443, File 651, National Archives, Washington, D.C.

180. Chief Engineer, Reclamation Service to Pecos Water Users' Association, 1 December 1905, RG 115, Entry 3, Box 443, File 652, National Archives, Washington, D.C.

181. Ibid.

182. Director, U.S. Geological Survey to the Secretary of the Interior (with attachments), 28 December 1905, RG 115, Entry 3, Box 443, File 652, National Archives, Washington, D.C.

183. Herbert W. Yeo, "Report on the Present and Future Duty of Water on The Carlsbad Project, New Mexico." Pecos Valley Projects Office, Bureau of Reclamation, Carlsbad, New Mexico.

184. "Report on Investigations Pecos River and Carlsbad Project Extensions in New Mexico, May 1923," RG 115, Entry 7, Box 451, File 301, National Archives, Washington, D.C.

185. Department of the Interior, U.S. Reclamation Service. "History of Carlsbad Project -- 1912." RG 115, Box 3, National Archives--Denver Branch, Denver, Colorado.

186. B.M. Hall, "Reinforced Concrete Diaphragms for Earth Dams," Engineering News 59 (6 February 1908): 145. For discussions regarding the design of the core wall, see correspondence in: RG 115, Entry 3 (File 449, File 895) National Archives, Washington, D.C. Interestingly, Hall designed a 92-foot high dam in Puerto Rico two years later with a 6-inch core wall through its entire height.

187. "Plan and Typical Cross Section, Avalon Dam," Record Drawing, Accession No. 17353, 1916, Box 16, Federal Records Center, Denver, Colorado. Also see Department of the Interior, "Project History from Inception of Project to December 31, 1913," by the Reclamation Service, located at the Carlsbad Irrigation District Office, Carlsbad, New Mexico.

188. Department of the Interior, Sixth Annual Report of Reclamation Service, 1906-1907 (Washington: GPO, 1907), 150. Untitled construction drawing of the gates, Number 5-500-231, Box 16, National Archives--Denver Branch, Denver, Colorado. Department of the Interior, U.S. Reclamation Service, "Carlsbad Project, New Mexico: Project History," 1912, Carlsbad Irrigation District Office, Carlsbad, New Mexico. Project histories were prepared annually by the U.S. Reclamation Service from 1912-1923, and by the Bureau of Reclamation from 1924-1951; slight title variations occur amongst the years but herein are all cited as in this note.

189. Department of the Interior, U.S. Reclamation Service, " [Carlsbad] Project History from Inception of Project to December 31, 1913," 5-9, Carlsbad Irrigation District Offices, Carlsbad, New Mexico.

190. U.S. Department of the Interior, "Fifth Annual Report of the Reclamation Service, 1907," (Washington: GPO, 1908), 147-150.

191. Lewis E. Foster, "Soils and Agriculture of the Carlsbad Project," 1907, RG 115, Entry 2, Box 438, File 338, National Archives, Washington, D.C.

192. W.M. Reed to the Chief Engineer, U.S. Reclamation Service, 15 August 1906, RG 115, Entry 3, Box 441, File 338-B, National Archives, Washington, D.C.

193. W.M. Reed, et.al. to B.M. Hall, 23 June 1906, RG 115, Entry 3, Box 441, File 466, National Archives, Washington, D.C.

194. F.H. Newell to W.H. Sanders, 27 September 1905; W.H. Sanders to F.H. Newell, 13 October 1905, RG 115, Entry 3, Box 443, File 651, National Archives, Washington, D.C.

195. C.E. Grunsky to the Director, U.S. Geological Survey, 27 June 1906, RG 115, Entry 3, Box 443, File 651, National Archives, Washington, D.C.

196. Ibid.

197. W.M. Reed to the Director, U.S. Reclamation Service, 22 November 1907, RG 115, Entry 3, Box 438, File 338-A1, National Archives, Washington, D.C.

198. H.C. Rizer to the Secretary of the Interior, 22 November 1906, RG 115, Entry 3, Box 438, File 338-A1, National Archives, Washington, D.C.

199. C.H. McLenathen to Frederick H. Newell, 8 July 1907, RG 115, Entry 3, Box 441, File 466-B, National Archives, Washington, D.C.

200. W.M. Reed to the Director, U.S. Reclamation Service, 18 October 1907, RG 115, Entry 3, Box 438, File 338-A, National Archives, Washington, D.C.

201. See, for example, F.E. Bryant's editorial, "Uncle Sam Is A Water Hog," Field and Farm [Denver, Colorado], February 29, 1908.

202. A.P. Davis to the Secretary of the Interior, 6 October 1910, RG 115, Entry 3, Box 438, File 338-A, National Archives,, Washington, D.C.

203. Francis G. Tracy to James R. Garfield, 30 December 1907; James R. Garfield to Francis G. Tracy, 9 January 1908, RG 115, Entry 3, Box 438, File 338-A1, National Archives, Washington, D.C.

204. Louis C. Hill to the Director, U.S. Reclamation Service, 21 November 1908, RG 115, Entry 3, Box 438, File 338-A1, National Archives, Washington, D.C.

205. W.M. Reed to the Director, U.S. Reclamation Service, 24 June 1908; Louis C. Hill to the Director, U.S. Reclamation Service, 30 June 1908; Director, U.S. Reclamation Service to L.C. Hill, 10 June 1908, RG 115, Entry 3, Box 441, File 466, National Archives, Washington, D.C.

206. Ibid.

207. J.J. Hagerman, "In the Matter of the Hondo Reservoir," transcript of testimony given against building the Hondo Reservoir, September 6, 1904, p. 27, RG 115, Entry 4, Box 1, File 25, National Archives, Washington, D.C.

208. Information concerning the relationship between the Pecos Irrigation Company and the Malaga Land Company is contained in a deposition by Tracy attached to a letter from W.M. Reed to the Chief Engineer, U.S. Reclamation Service, 17 November 1908, RG 115, Entry 3, Box 442, File 466-4, National Archives, Washington, D.C.

209. Descriptions and a sample of the Malaga Land Company brochures are found in RG 115, Entry 3, Box 442, File 466-4, National Archives, Washington, D.C.

210. Francis G. Tracy to Morris Bien, 9 June 1908, RG 115, Entry 3, Box 442, File 466-4, National Archives, Washington, D.C.

211. W.M. Reed to the Chief Engineer, U.S. Reclamation Service, 17 November 1908, RG 115, Entry 3, Box 442, File 466-4, National Archives, Washington, D.C.

212. Francis G. Tracy to Morris Bien, 9 June 1908, RG 115, Entry 3, Box 442, File 466-4, National Archives, Washington, D.C.

213. Ibid.

214. Department of the Interior, U.S. Reclamation Service, "Carlsbad Project, New Mexico: Project History," 1912, Carlsbad Irrigation District Office, Carlsbad, New Mexico.

215. Pecos Water Users' Association to R.A. Ballinger, 29 November 1909, RG 115, Entry 3, Box 438, File 338-A1, National Archives, Washington, D.C.

216. Ibid.

217. Director, U.S. Reclamation Service to the Secretary of the Interior, 22 March 1910, RG 115, Entry 3, Box 438, File 338-A1, National Archives, Washington, D.C.

218. Ibid.

219. W.M. Reed to the Director, U.S. Reclamation Service, 5 March 1910, RG 115, Entry 3, Box 439, File 338-A4, National Archives, Washington, D.C.

220. Pecos Water Users' Association to the Secretary of the Interior, 1 March 1911, Rg 115, Entry 3, Box 438, File 338-A1, National Archives, Washington, D.C.

221. W.M. Reed to L.C. Hill, 15 April 1910, RG 115, Entry 3, Box 438, File 338-A1, National Archives, Washington, D.C.

222. Director, U.S. Reclamation Service to the Secretary of the Interior, 13 March 1911, RG 115, Entry 3, Box 438, File 338-A, National Archives, Washington, D.C.

223. F.H. Newell to the Secretary of the Interior, 13 February 1912, RG 115, Entry 3, Box 438, File 338-A, National Archives, Washington, D.C.

224. Francis G. Tracy to the President (telegram), 9 September 1911, RG 115, Entry 3, Box 441, File 466, National Archives, Washington, D.C.

225. Ibid.

226. W.M. Reed to the Director, U.S. Reclamation Service, 27 October 1911, RG 115, Entry 3, Box 437, File 331; F.H. Newell to Louis C. Hill, 16 December 1911, RG 115, Entry 3, Box 443, File 651, National Archives, Washington, D.C.

227. D.C. Henny and Louis C. Hill to the Director, U.S. Reclamation Service, 7 December 1911, RG 115, Entry 3, Box 443, File 651, National Archives, Washington, D.C.

228. Francis G. Tracy to the Secretary of the Interior, 23 September 1911, Pecos Valley Projects Office, Bureau of Reclamation, Carlsbad, New Mexico.

229. Ibid.

230. John William Leonard, Who's Who In Engineering (New York: Who's Who Publications, Inc., 1925), 2061.

231. H.F. Hodges, "General Design of the Locks, Dams, and Regulating Works of the Panama Canal," 10, and L.D. Cornish, "Design of the Lock Walls and Valves of the Panama Canal," 83-84, both in George W. Goethals, ed., The Panama Canal: An Engineering Treatise (New York: McGraw-Hill Book Company, Inc., 1916).

232. Board of Engineers to Director, 11 April 1911, RG 115, Entry 3, Box 1094, File 241, National Archives, Washington, D.C.; Francis L. Sellew, "The Colorado Siphon at Yuma, Arizona," Engineering News 68 (29 August 1912): 377-385.

233. F. Teichman to the Director, U.S. Reclamation Service, 3 November 1911; W.M. Reed to the Director, 16 November 1911; F. Teichman to W.M. Reed 16 November 1911; W.M. Reed to the Director 27 December 1911, RG 115, Entry 3, Box 443, File 651, National Archives, Washington, D.C.

234. For the telegrams between Reed and Hill, see Bureau of Reclamation, General Correspondence Files of the Office of the Chief Engineer, RG 115, Box 269, File 77G, National Archives, Denver, Colorado. For the extensive correspondence between the local and district engineers and the USRS, Washington, D.C., see RG 115, Entry 3, Box 443, File 651, National Archives, Washington, D.C.

235. Assistant Engineer McIntyre to District Engineer, 29 June 1912, General Correspondence Files, Office of the Chief Engineer, Records of the Bureau of Reclamation, RG 115, Box 269, File 77G, National Archives, Denver, Colorado; Louis C. Hill to Chief Engineer, 14 January 1913, RG 115, Entry 3, Box 442, File 351, National Archives, Washington, D.C.

236. Department of the Interior, Bureau of Reclamation, "Valves, Gates, and Steel Conduits," Design Standards Handbook No. 7, 1956, p. 1.26 and fig. 42, file in the basement of the Central Snake Projects Office, Boise; Wesley R. Nelson, "Construction of the Boulder Dam," The Story of Boulder Dam (reprints of articles from Compressed Air Magazine, 1931-1935), (Las Vegas: Nevada Publications, n.d.), 138.

237. Davis, Irrigation Works Constructed by the United States Government, 240-241, 252-253; Bureau of Reclamation, Reclamation Project Data (Washington: Government Printing Office, 1941), 189, 193, 369, 371; Director and Chief Engineer to District Engineer Office, 11 March 1915, RG 115, Entry 3, Box 291, Files 910-12, National Archives, Washington, D.C.

238. L.E. Foster to the Water Users, Carlsbad Project, 29 August 1914, RG 115, General Correspondence Files, Box 282, File 85, National Archives--Denver Branch, Denver, Colorado.

239. "Eddy County, New Mexico," ([Santa Fe:] Bureau of Immigration of New Mexico, 1908).

240. Ibid.

241. Etter, "Carlsbad Project Makes Bid for Farmers," 121.

242. L.E. Foster to the Commissioner (with attachments), 11 November 1924, RG 115, General Correspondence Files, Box 282, File 85, National Archives--Denver Branch, Denver, Colorado.

243. P.J. McShane to W.M. Reed, 30 October 1911, RG 115, Entry 3, Box 441, File 466, National Archives, Washington, D.C.

244. Ibid.

245. The telegram is quoted in A.P. Davis to F.H. Newell, 4 November 1911, RG 115, Entry 3, Box 441, File 466, National Archives, Washington, D.C.

246. W.M. Reed to A.P. Davis, 18 November 1911, RG 115, Entry 3, Box 441, File 466, National Archives, Washington, D.C.

247. C.G. Smith to the Comptroller, U.S. Reclamation Service, 8 August 1915, RG 115, Entry 3, Box 438, File 338-A1, National Archives, Washington, D.C.

248. Francis G. Tracy to Samuel Adams, 1 February 1912, RG 115, Entry 3, Box 441, File 466, National Archives, Washington, D.C.

249. W.M. Reed to the Director, U.S. Reclamation Service, 12 February 1912, RG 115, Entry 3, Box 441, File 466, National Archives, Washington, D.C.

250. Louis Hill to the Director, U.S. Reclamation Service, 17 April 1913, RG 115, Entry 3, Box 449, File 875, National Archives, Washington, D.C.

251. Ibid.; A.P. Davis to Louis Hill, 19 May 1913, RG 115, Entry 3, Box 449, File 875, National Archives, Washington, D.C.

252. Carlsbad Commercial Club to Robert Ervien, State Land Commissioner, 17 February 1914, RG 115, Entry 3, Box 441, File 466, National Archives, Washington, D.C.

253. Department of the Interior, U.S. Reclamation Service, "Carlsbad Project, New Mexico: Project History," 1914, Carlsbad Irrigation District Office, Carlsbad, New Mexico.

254. Department of the Interior, U.S. Reclamation Service, "Carlsbad Project, New Mexico: Project History," 1915, Carlsbad Irrigation District Office, Carlsbad, New Mexico.

255. T.Y. Taylor and Scott Etter to Franklin K. Lane, 17 June 1915, RG 115, Entry 4, Box 10, File 262-D3, National Archives, Washington, D.C.

256. Department of the Interior, U.S. Reclamation Service, "Carlsbad Project, New Mexico: Project History," 1915, Carlsbad Irrigation District Office, Carlsbad, New Mexico. Portions of the Local Board's report, and the rebuttal by the Reclamation Service, are printed as "Report of the Central Board of Review on the Carlsbad Project, New Mexico," Reclamation Record, (July 1916): 298-308.

257. "Report of the Central Board of Review."

258. All of these documents may be found in RG 115, Entry 4, Box 10, File 262-D3, National Archives, Washington, D.C.

259. "Report of the Central Board of Review on the Carlsbad Project, New Mexico," reprinted in Reclamation Record, July, 1916, 298-308.

260. "Report of the Central Board of Review on the Carlsbad Project, New Mexico," reprinted in Reclamation Record, July, 1916, 298-308.

261. M.L. Muggeridge to F.K. Lane, 13 April 1914, RG 115, Entry 3, Box 449, File 1158, National Archives, Washington, D.C.

262. W.A. Ryan, Comptroller, U.S.G.S. to W.B. Wilson, Pecos Water Users' Association, 17 October 1914 (with attachments), RG 115, Entry 3, Box 440, File 338-A5, National Archives, Washington, D.C.

263. Robinson, Water for the West, 42-44, 58; "Preliminary Inventory of the Records of the Bureau of Reclamation," 1.

264. Ray P. Teele, The Economics of Land Reclamation in the United States (Chicago and New York: A.W. Shaw Company, 1927), 187. Teele's book ranks only the Salt River Project in Arizona as being more successful than Carlsbad.

265. A.P. Davis to the Secretary of the Interior (with attachment), 10 April 1915, RG 115, Entry 3, Box 438, File 338-A, National Archives, Washington, D.C.

266. G.B. Richardson, "Notes on Proposed Reservoir Site No. 3, Carlsbad Project, New Mexico." RG 115, Entry 3, Box 443, File 651, National Archives, Washington, D.C.

267. Department of the Interior, United States Reclamation Service, "Report on the Proposed West Side Addition to the Carlsbad Project, New Mexico: March 2, 1915." RG 115, Entry 3, Box 442, File 351, National Archives, Washington, D.C.

268. A.A. Jones, Department of the Interior, to Frank H. Richards, Carlsbad Commercial Club, 13 April 1916, RG 115, Entry 3, Box 441, File 466, National Archives, Washington, D.C.

269. "McMillan Stands the Test," The Carlsbad Argus, 23 April 1915.

270. E.H. Baldwin to the Director and Chief Engineer, U.S. Reclamation Service, 23 April 1915, RG 115, Entry 3, Box 442, File 351, National Archives, Washington, D.C.

271. D.C. Henny, et.al. to the Reclamation Commission, U.S. Reclamation Service, 11 June 1915, RG 115, Entry 3, Box 442, File 351, National Archives, Washington, D.C.

272. For correspondence regarding the design of the spillways at McMillan, see: RG 115, Entry 3 (File 442, File 351), National Archives, Washington, D.C.

273. Ibid.

274. Ibid.

275. Department of the Interior, Bureau of Reclamation, "McMillan Dam: General Plan and Sections with Proposed Improvements," 1937, Engineering drawing number 5-D-489 from aperture card, Bureau of Reclamation, Salt Lake City, Utah.

276. L.E. Foster, "Wire-bag Method of Riprapping Embankment, Lake McMillan, Carlsbad Project," Reclamation Record 10 (January 1919): 33-34.

277. Department of the Interior, Reclamation Service, "Detail Construction Spillway No. 2," 1917, Engineering drawing from aperture card, Bureau of Reclamation, Salt Lake City, Utah.

278. Department of the Interior, U.S. Reclamation Service, "Carlsbad Project, New Mexico: Project History," 1917, Carlsbad Irrigation District Office, Carlsbad, New Mexico.

279. D.C. Henny to the Chief of Construction, U.S. Reclamation Service, 23 August 1916; L.E. Foster to the Directory, U.S. Reclamation Service, 5 October 1917, RG 115, Entry 3, Box 442, File 651, National Archives, Washington, D.C.

280. Department of the Interior, U.S. Reclamation Service, "Carlsbad Project, New Mexico: Project History," 1917, Carlsbad Irrigation District Office, Carlsbad, New Mexico.

281. Department of the Interior, United States Reclamation Service. "Report of Board of Engineers, May 3, 1916: Water Supply and Storage -- Carlsbad Project." RG 115, Entry 3, Box 442, File 351, National Archives, Washington, D.C.

282. Director, United States Reclamation Service to the Chief Engineer, United States Reclamation Service, 25 March 1921, RG 115, Entry 7, Box 451, File 301, National Archives, Washington, D.C.

283. Chief Engineer, U.S. Reclamation Service, to the Commissioner, U.S. Reclamation Service, 8 August 1923, RG 115, Entry 7, Box 451, File 351, National Archives, Washington, D.C.

284. Taylor to the Director, U.S. Reclamation Service, 4 June 1923, RG 115, Entry 7, Box 451, File 301, National Archives, Washington, D.C.

285. Ibid.

286. Ferd Bonstedt and E.B. Debler, "Report on Investigations: Pecos River and Carlsbad Project Extensions in New Mexico, May, 1923." RG 115, Entry 7, Box 451, File 301, National Archives, Washington, D.C.

287. Pecos Water Users' Association to "Mr. Congressman or Senator," 5 April 1919, RG 115, Entry 3, Box 438, File 338-A1, National Archives, Washington, D.C.

288. Pecos Water Users' Association to "Mr. Congressman or Senator," 5 April 1919, RG 115, Entry 3, Box 438, File 338-A1, National Archives, Washington, D.C.

289. Ibid.

290. Franklin K. Lane, Secretary of the Interior to O.A. Larrazolo, Governor of New Mexico, 29 May 1919, RG 115, Entry 3, Box 438, File 338-A1, National Archives, Washington, D.C.

291. C.R. Trowbridge, "Report on Inspection of Carlsbad Project -- Reclamation Service," RG 115, Entry 7, Box 445, File 105.21, National Archives, Washington, D.C.

292. Department of the Interior, Bureau of Reclamation, "Carlsbad Project, New Mexico: Project History," 1945, Carlsbad Irrigation District Office, Carlsbad, New Mexico.

293. C.R. Trowbridge, "Report on Inspection of Carlsbad Project -- Reclamation Service," RG 115, Entry 7, Box 445, File 105.21, National Archives, Washington, D.C.

294. L.E. Foster to the Commissioner, Bureau of Reclamation, 20 October 1923, RG 115, Box 282, File 85, National Archives, Denver, Colorado.

295. Clark, Water in New Mexico, 229.

296. L.E. Foster to the Commissioner, Bureau of Reclamation, 3 November 1927 (with attachments), RG 115, Entry 7, Box 451, File 301, National Archives, Washington, D.C.

297. C.P. Gross, Army Corps of Engineers, to the Secretary of the Interior, 30 October 1928, RG 115, Entry 7, Box 452, File 301.1, National Archives, Washington, D.C.

298. Kirk Bryan, "Geology of Avalon Reservoir, Carlsbad Irrigation Project, New Mexico, With Respect to Proposed Increase in Height of the Dam" (typescript), United States Geological Survey, February, 1927. RG 115, Entry 7, Box 453, File 301.12, National Archives, Washington, D.C.

299. Commissioner, Bureau of Reclamation to Sam G. Bratton, United States Senate, 23 February 1929, RG 115, Entry 7, Box 452, File 301.1, National Archives, Washington, D.C.

300. L.E. Foster to the Commissioner, Bureau of Reclamation (with attachment), 3 November 1927, RG 115, Entry 7, Box 451, File 301, National Archives, Washington, D.C.

301. A.F. Walter, Chief Engineer, to the Commissioner, Bureau of Reclamation, 1 March 1928, RG 115, Entry 7, Box 451, File 301, National Archives, Washington, D.C.

302. O.E. Meinser, et.al. to the Director, U.S. Geological Survey, 10 September 1929, RG 115, Entry 7, Box 451, File 301, National Archives, Washington, D.C.

303. Ibid.

304. Francis G. Tracy to George B. Harrison, 24 December 1929, New Mexico State Records Center & Archives, Santa Fe.

305. Ibid.

306. Francis G. Tracy to Herbert W. Yeo, New Mexico State Engineer, 9 January 1930, files of the Office of the State Engineer, Santa Fe, New Mexico.

307. Clark, Water in New Mexico, 251.

308. "Reclamation Advisors Report on Needs of Projects and Policy for Future Irrigation," Engineering News-Record 92 (1923), 726-729.

309. Ibid.

310. L.E. Foster to the Commissioner, Bureau of Reclamation, 21 June 1932, RG 115, Box 277, Files 1 and 2, National Archives--Denver Branch, Denver, Colorado.

311. Ibid.

312. Department of the Interior, Bureau of Reclamation, "Twenty-Sixth Annual Report of Operation and Maintenance, Combined with the Annual Project History for the Calendar Year 1932, Carlsbad Project, Carlsbad, New Mexico."

313. Department of the Interior, Bureau of Reclamation, "Carlsbad Project, New Mexico: Project History," 1932, Carlsbad Irrigation District Office, Carlsbad, New Mexico.

314. Department of the Interior, Bureau of Reclamation, "Carlsbad Project, New Mexico: Project History," 1934, Carlsbad Irrigation District Office, Carlsbad, New Mexico.

315. Department of the Interior, Bureau of Reclamation, "Carlsbad Project, New Mexico: Project History," 1934, Carlsbad Irrigation District Office, Carlsbad, New Mexico, 4.

316. Department of the Interior, Bureau of Reclamation, "Carlsbad Project, New Mexico: Project History," 1935, Carlsbad Irrigation District Office, Carlsbad, New Mexico, 4-6; Department of the Interior, Bureau of Reclamation, "Carlsbad Project, New Mexico: Project History," 1936, Carlsbad Irrigation District Office, Carlsbad, New Mexico, 11-71.

317. Department of the Interior, Bureau of Reclamation, "Carlsbad Project, New Mexico: Project History," 1937, Carlsbad Irrigation District Office, Carlsbad, New Mexico, 32. Detailed descriptions of the flood and its effects are found in pages 24-31.

318. Ibid.; Department of the Interior, Bureau of Reclamation, "Carlsbad Project, New Mexico: Project History," 1938, Carlsbad Irrigation District Office, Carlsbad, New Mexico, 20-37.

319. Clark, Water in New Mexico, 229-231.

320. Department of the Interior, Bureau of Reclamation, "Carlsbad Project, New Mexico: Project History," 1934, Carlsbad Irrigation District Office, Carlsbad, New Mexico; Department of the Interior, Bureau of Reclamation, "Carlsbad Project, New Mexico: Project History," 1936, Carlsbad Irrigation District Office, Carlsbad, New Mexico; Department of the Interior, Bureau of Reclamation, "Carlsbad Project, New Mexico: Project History," 1937, Carlsbad Irrigation District Office, Carlsbad, New Mexico.

321. Department of the Interior, Bureau of Reclamation, "Carlsbad Project, New Mexico: Project History," 1936, Carlsbad Irrigation District Office, Carlsbad, New Mexico.

322. Department of the Interior, Bureau of Reclamation, "Carlsbad Project, New Mexico: Project History," 1937, 26-27, Carlsbad Irrigation District Office, Carlsbad, New Mexico.

323. The schedule of water releases from Alamogordo and the amount of each release is faithfully recorded in each of the Carlsbad project's "Annual Reports."

324. Department of the Interior, Bureau of Reclamation, "Carlsbad Project, New Mexico: Project History," 1938, Carlsbad Irrigation District Office, Carlsbad, New Mexico.

325. Department of the Interior, Bureau of Reclamation, "Carlsbad Project, New Mexico: Project History," 1944, Carlsbad Irrigation District Office, Carlsbad, New Mexico.

326. Department of the Interior, Bureau of Reclamation, "Carlsbad Project, New Mexico: Project History," 1946, Carlsbad Irrigation District Office, Carlsbad, New Mexico.

327. Department of the Interior, Bureau of Reclamation, "Carlsbad Project, New Mexico: Project History," 1949, Carlsbad Irrigation District Office, Carlsbad, New Mexico.

328. Department of the Interior, Bureau of Reclamation, "Carlsbad Project, New Mexico: Project History," 1949, Carlsbad Irrigation District Office, Carlsbad, New Mexico, 5.

329. Ibid.

330. Department of the Interior, Bureau of Reclamation, "Carlsbad Project, New Mexico: Project History, 1950-1951."

331. Ibid.

332. Department of the Interior, Bureau of Reclamation, "Plans for Rehabilitation of the Carlsbad Project and for Water Salvage Measures in the Pecos River Basin, New Mexico," August, 1950; F.C. Walker, et.al. to the Assistant Commissioner and Chief Engineer, Bureau of Reclamation, 19 September 1957, files of the Office of the State Engineer, Santa Fe, New Mexico.

333. A synopsis of the early 1960s federal studies relating to the Carlsbad Project is in Department of the Interior, Bureau of Reclamation, "Plan of Development for Brantley Project, New Mexico," Bureau of Reclamation, Region 5, 1967, 12-14.

334. Ibid.

335. Ibid., 11-12.

336. Department of the Interior, Bureau of Reclamation, "Brantley Project, New Mexico: Definite Plan Report." Amarillo, Texas: Bureau of Reclamation, Southwest Region, 1982, I-5.

337. The complete text of Public Law 92-514 is found in Appendix A of Department of the Interior, Bureau of Reclamation, "Brantley Project, New Mexico: Definite Plan Report." Amarillo, Texas: Bureau of Reclamation, Southwest Region, 1982.

338. Ibid.

339. Ibid.

340. Department of the Interior, Bureau of Reclamation, "Brantley Project, New Mexico: Definite Plan Report." Amarillo, Texas: Bureau of Reclamation, Southwest Region, 1982, I-5 to I-9.

341. Department of the Interior, Bureau of Reclamation, "Brantley Project, New Mexico: Definite Plan Report." Amarillo, Texas: Bureau of Reclamation, Southwest Region, 1982. See especially Chapter 3, "Economic and Financial Analysis."

342. Department of the Interior, Bureau of Reclamation, "Brantley Project, New Mexico: Definite Plan Report." Amarillo, Texas: Bureau of Reclamation, Southwest Region, 1982, II-4.

343. "Brantley Dam Nears the End of An Era," Carlsbad Current-Argus, 20 March 1988.

344. Department of the Interior, Bureau of Reclamation, "Brantley Project, New Mexico: Definite Plan Report." Amarillo, Texas: Bureau of Reclamation, Southwest Region, 1982.

345. Davis, Irrigation Works Constructed by the United States Government; Department of the Interior, Bureau of Reclamation, Reclamation Project Data (Washington: Government Printing Office, [1948]); Hall, "Reinforced Concrete Diaphragms for Earth Dams," 145-146.

346. Creager, et.al., Engineering for Dams, vol. 3, 808-810, 825.

347. Early determinations of the District's historic significance may be found in Department of the Interior, National Park Service, National Survey of Historic Sites and Buildings inventory form for the Carlsbad Reclamation Project, September, 1963; Department of the Interior, National Park Service, National Register of Historic Places Inventory -- Nomination Form for the Carlsbad Reclamation Project, December 8, 1975.

348. See Robert H. Weimer to Louis Wall, 15 August 1977 (with attachments), files of the Pecos Valley Projects Office, Carlsbad, New Mexico.

## SOURCES OF INFORMATION

### 1: Bibliographic Essay of Archival Sources:

Records located in the National Archives, Washington, D.C.:

The National Archives is the principal repository for documents and records generated by the Bureau of Reclamation and its predecessor, the Reclamation Service. Documents found here are generally from files in the Washington offices of these agencies; relatively few materials from local or regional offices exist in this collection.

All documents at the National Archives are classified into one of over four hundred "Record Groups" (abbreviated as "RG" in endnote citations). Each Record Group contains documents from the files of a single governmental department or agency. By far the largest grouping of material relating to the Carlsbad Project is found in Record Group 115, "Records of the Bureau of Reclamation," which also includes earlier Reclamation Service material.

Record Groups are subdivided into subgroupings called "entries," which generally contain files originally maintained in a single, unified collection at the source agency. Easily the largest amount of Carlsbad material is found in Entry 3 of RG 115, "General Administrative and Project Records, 1902-19." Later general material is in Entry 7, "General Administrative and Project Records, 1919-45." An additional source is Entry 4, "Oversize

Records, 1902-19." Entries 1, 2, 5, and 6 contain various indexes of the material contained in Entries 3, 4, and 7.

Records located in the Denver Branch, National Archives, Denver, Colorado: The Denver Branch of the National Archives contains a smaller collection of Carlsbad Project material, generally dating from the pre-World War II era. Of special interest are the General Correspondence files of the Chief Engineer and the engineering drawings of the Reclamation Service's reconstruction of Avalon and McMillan Dams. The Denver Branch also holds an almost complete set of Project Histories. This material is also categorized as being a part of Record Group 115 (see above), but it is arranged differently from the Washington, D.C. material, and generally originates from local or regional Bureau of Reclamation offices. Most of the material retains the classification system originally imposed on it by the Bureau of Reclamation.

Records Located in the New Mexico State Records Center and Archives, Santa Fe: The New Mexico State Records Center and Archives holds a variety of material relating to the Carlsbad Project. Of specific interest are the correspondence files of the Territorial Governor, Engineer, and Office of Immigration (which promoted settlement). The Records Center also holds the articles of incorporation for all of the incorporated companies which did

business in the Pecos Valley and a WPA history of the project written by Francis G. Tracy.

Records located in the History Museum, Museum of New Mexico, Santa Fe: The History Museum holds an extensive collection of regional and local histories. The "Irrigation" vertical file contains several promotional pamphlets published by the private irrigation companies and the Territorial Office of Immigration.

Records located in the Office of the New Mexico State Engineer, Santa Fe: The relevant holdings here are fairly limited, and are generally duplicated by holdings in the New Mexico State Records Center. There are, however, some miscellaneous pieces of correspondence that are not available elsewhere, including the transcript of the United States vs. the Hope Community Ditch trial.

Records Located in the New Mexico State University Library, Las Cruces: New Mexico State University's library is home for a variety of relevant source materials, both primary and secondary. Of special note in the former category is a collection of manuscript material relating to James John Hagerman.

Records located in the Special Collections of the University of New Mexico Library, Albuquerque: The collections held by the

University of New Mexico Library of interest to this project are limited mainly to regional and local histories.

Records located in the Pecos Valley Projects Office, Bureau of Reclamation, Carlsbad, New Mexico: The records held by the Pecos Valley Projects Office are in uncatalogued boxes as they arrived when the Amarillo Office of the Bureau of Reclamation was closed. There are several boxes of original survey note books and the general background research undertaken by a previous cultural resource consultant. Of particular interest to this project are the abstracts of title to some of the properties within the Carlsbad Irrigation District boundaries.

Records located in the Carlsbad Irrigation District Office, Carlsbad, New Mexico: The Carlsbad Irrigation District Office holds a complete set of annual Project Histories. The Office also has a limited number of engineering drawings which are duplicated at the Denver Branch of the National Archives and/or the regional office of the Bureau of Reclamation in Salt Lake City. Of special interest, however, is the extensive historic photograph collection.

Records held by the Bureau of Reclamation Office, Denver, Colorado: All of the historic records held by the Bureau of Reclamation have been transferred to the Denver Branch of the National Archives. The Library does hold copies of Reclamation

Era, a popular magazine, which includes some articles on the Carlsbad Irrigation District.

Records held by the Regional Office, Bureau of Reclamation, Salt Lake City: The Regional Office of the Bureau of Reclamation in Salt Lake City holds an extensive collection of engineering drawings on aperture cards. The only other items of particular interest are reports and studies dating from the post-World War II era.

**B: Selected Bibliographic Citations:**

Books

Avery, Elroy McKendree. A History of Cleveland and Its Environs. Vol. 2. Chicago and New York: The Lewis Publishing Company, 1918.

Clark, Ira G. Water in New Mexico: A History of Its Management and Use. Albuquerque: University of New Mexico Press, 1987.

Condit, Carl W. American Building Art: The Nineteenth Century. New York: Oxford University Press, 1960.

_____. American Building: Materials and Techniques from the Beginning of the Colonial Settlement to the Present. Chicago: University of Chicago Press, 1968.

Cornish, L.D. "Design of the Lock Walls and Valves of the Panama Canal." The Panama Canal: An Engineering Treatise. Edited by George W. Goethals. New York: McGraw-Hill Book Company, Inc., 1916.

Creager, William P., Joel D. Justin, and Julian Hinds. Engineering for Dams. (New York: John Wiley & Sons, Inc., 1945), Vol. 3, Earth, Rock-fill, Steel and Timber Dams.

Davis, Arthur Powell. Irrigation Works Constructed by the United States Government. New York: John Wiley & Sons, Inc., 1917.

Davis, Calvin Victor, ed. Handbook of Applied Hydraulics. New York: McGraw-Hill Book Company, Inc., 1952.

Etcheverry, B.A. Irrigation Practice and Engineering. (New York: McGraw-Hill Book Company, Inc., 1915), Vol. II, Conveyance of Water.

Green, Donald E. Land of the Underground Rain: Irrigation on the Texas High Plains, 1910-1970. Austin: University of Texas Press, 1973.

History of Chicago: Its Men and Institutions. Chicago: InterOcean, 1900.

Hodges, H.F. "General Design of the Locks, Dams, and Regulating Works of the Panama Canal." The Panama Canal: An Engineering Treatise. Edited by George W. Goethals. New York: McGraw-Hill Book Company, Inc., 1916.

James, George Wharton. Reclaiming the Arid West: The Story of the United States Reclamation Service. New York: Dodd, Mead and Company, 1917.

Keleher, William A. The Fabulous Frontier: Twelve New Mexico Items. Albuquerque: University of New Mexico Press, c1945, 1962.

Kollgaard, Eric B., and Wallace L. Chadwick, eds. Development of Dam Engineering in the United States. New York: Perigamon Press, 1988.

Larson, T.A. History of Wyoming. Lincoln: University of Nebraska Press, 1965.

Lee, Lawrence B. Reclaiming the American West: An Historiography and Guide. Santa Barbara, California: American Bibliographical Center -- Clio Press, 1980.

Leonard, John William. Who's Who in Engineering. New York: Who's Who Publications, Inc., 1925.

Lipsey, John J. The Lives of James John Hagerman, Builder of the Colorado Midland Railway Denver: Golden Bell Press, 1968.

Metz, Leon C. Pat Garrett: The Story of a Western Lawman. Norman: University of Oklahoma Press, 1973.

Nelson, Wesley R. "Construction of the Boulder Dam." The Story of Boulder Dam (reprints of articles from Compressed Air Magazine, 1931-1935) Las Vegas: Nevada Publications, n.d.

Newell, Frederick Haynes, and Daniel William Murphy. Principles of Irrigation Engineering. New York: McGraw-Hill Book Company, 1913.

Robinson, Michael C. Water for the West: The Bureau of Reclamation, 1902-1977. Chicago: Public Works Historical Society, 1979.

Schuyler, James Dix. Reservoirs for Irrigation, Water-Power, and Domestic Water Supply. New York: John Wiley and Sons, 1902.

Smythe, William E. The Conquest of Arid America. New York: Harper & Brothers, 1900.

Southeastern New Mexico Historical Society. Eddy County New Mexico to 1981. Lubbock, Texas: Craftsman Printers, Inc., 1982.

Stegner, Wallace. Beyond the Hundredth Meridian: John Wesley Powell and the Second Opening of the West. Boston: Houghton Mifflin Company, 1954.

Teele, Ray P. The Economics of Land Reclamation in the United States. Chicago and New York: A.W. Shaw Company, 1927.

Thomas, George. The Development of Institutions Under Irrigation. New York: The Macmillan Company, 1920.

Walters, L.L. Steel Trails to Santa Fe. Lawrence: University of Kansas Press, 1950.

Magazine and Journal Articles

Blanchard, C.J. "Home-Making by the Government: An Account of the Eleven Immense Irrigating Projects to be Opened in 1908." The National Geographic Magazine 19 (March 1908): 250-287.

_____. "Millions for Moisture: An Account of the Work of the U.S. Reclamation Service." The National Geographic Magazine 18 (April 1907): 217-243.

Bryant, F.E. "Uncle Sam is a Water Hog." Field and Farm [Denver, Colorado] (29 February 1908).

Etter, Scott. "Carlsbad Project Makes Bid for Farmers." Reclamation Record 7 (March 1916): 121.

Follett, W.W. "Earthen vs. Masonry Dams." Engineering News 27 (9 January 1892): 28-29.

Foster, L.E. "Wire-bag Method of Riprapping Embankment, Lake McMillan, Carlsbad Project." Reclamation Record 10 (January 1919): 33-34.

"The Founding and Early Years of Eaton, Colorado." Colorado Magazine, 18 (March 1941): 54-55.

Galloway, J.D. "The Design of Rock-Fill Dams." Transactions of the American Society of Civil Engineers 104 (1939): 3-5. Also responses to Galloway's paper by Howard F. Peckworth, 68-69, and Galloway, 83.

Hall, B.M. "Reinforced Concrete Diaphragms for Earth Dams." Engineering News 59 (6 February 1908): 145-146.

Howell, L.B. "The Pecos Valley Irrigation System. Engineering News 36 (17 September 1896): 181.

Hundertmark, C.A. "Reclamation in Chaves and Eddy Counties, 1887-1912." New Mexico Historical Review 47 (1972): 301-316.

"Lake McMillan Dam, Pecos River." Engineering Record (9 June 1894): 24.

McCormick, Wilfred. "The Magic of Water." New Mexico Magazine 17 (October, 1939): 22-23.

"Report of the Central Board of Review on the Carlsbad Project, New Mexico." Reclamation Record (July 1916): 298-308.

"Reclamation Advisors Report on Needs of Projects and Policy for Future Irrigation." Engineering News-Record 92:17 (1923): 726-729.

"Rock Fill Dam Across the Pecos River." Engineering News 23 (17 May 1890): 459-460.

Sellew, Francis L. "The Colorado Siphon at Yuma, Arizona." Engineering News 68 (29 August 1912: 377-385.

Tracy, Francis G. "Pecos Valley Pioneers." New Mexico Historical Review 33 (July 1958): 187-204.

Wilson, Herbert M. "Pecos Valley Canals." Engineering News 26 (17 October 1891): 350-351.

_____. "The Irrigation Problem in the West." Engineering News 28 (December 1892): 386-410.

Worster, Donald. Rivers of Empire: Water, Aridity, and the Growth of the American West. New York: Pantheon Books, 1986.

Newspapers

Note: Numerous relevant articles transcribed from the Eddy (New Mexico) Argus, 1889-1897, were found in Lee C. Myers, The Pearl of the Pecos, 1974 typescript located in the Pecos Valley Projects Office, Bureau of Reclamation, Carlsbad, New Mexico.

"Brantley Dam Nears the End of An Era." Carlsbad Current-Argus (20 March 1988).

"Carlsbad Project History." Carlsbad Current (19 June 1914).

"McMillan Stands the Test." Carlsbad Argus (23 April 1915).

Federal Documents

U.S. Department of the Interior. "Valves, Gates, and Steel Conduits." Design Standards Handbook No. 7, 1956. Located in the Central Snake Projects Office, Boise, Idaho.

U.S. Department of the Interior, Bureau of Reclamation. "Brantley Project, New Mexico: Definite Plan Report." Amarillo, Texas: Bureau of Reclamation, Southwest Region, 1982.

U.S. Department of the Interior, Bureau of Reclamation. "Geology of Avalon Reservoir, Carlsbad Irrigation Project, New Mexico, With Respect to Proposed Increase in Height of the Dam," (typescript) by Kirk Bryan, U.S. Geological Survey, February 1927. RG 115, Entry 7, Box 453, File 301.12, National Archives, Washington, D.C.

U.S. Department of the Interior, Bureau of Reclamation. "Plan of Development for Brantley Project, New Mexico." Amarillo: Bureau of Reclamation, Region 5, 1967. Located in the Library, Bureau of Reclamation, Salt Lake City, Utah.

U.S. Department of the Interior, Bureau of Reclamation. "Plans for Rehabilitation of the Carlsbad Project and for Water Salvage Measures in the Pecos River Basin, New Mexico," by F.C. Waler, et.al, Bureau of Reclamation, 19 September 1957. Located in the files of the Office of the State Engineer, Santa Fe.

U.S. Department of the Interior, Bureau of Reclamation. "Reclamation Project Data." Washington: Government Printing Office, 1941, [1948].

U.S. Department of the Interior, U.S. Geological Survey. "Hydrographic Survey 243, Report Upon a Reconnaissance of the Pecos Valley (March 11, 1889)," by Ralph S. Tarr, U.S. Geological Survey. RG 115, Entry 3, Box 443, File 651, National Archives, Washington, D.C.

U.S. Department of the Interior, U.S. Geological Survey. "Reservoirs for Irrigation." Eighteenth Annual Report of the United States Geological Survey, 1896-97: Part IV -- Hydrography. Washington: [Government Printing Office, 1897].

U.S. Department of the Interior, U.S. Reclamation Service. "[Carlsbad] Project History from Inception of Project to December 31, 1913." Carlsbad, New Mexico: U.S. Reclamation Service. Located at the Carlsbad Irrigation District Office, Carlsbad, New Mexico.

U.S. Department of the Interior, U.S. Reclamation Service. "Carlsbad Project, New Mexico: Project History." Prepared annually 1912-1951 with slight variations in title; prepared by the Bureau of Reclamation after 1923. Located in the Carlsbad Irrigation District Office, Carlsbad, New Mexico.

U.S. Department of the Interior, U.S. Reclamation Service. Fifth Annual Report of the Reclamation Service, 1907. Washington: Government Printing Office, 1908.

U.S. Department of the Interior, U.S. Reclamation Service. "Report of Board of Engineers, May 3, 1916: Water Supply and Storage -- Carlsbad Project." RG 115, Entry 3, Box 442, File 351, National Archives, Washington, D.C.

U.S. Department of the Interior, U.S. Reclamation Service. "Report on the Proposed West Side Addition to the Carlsbad Project, New Mexico: March 2, 1915." RG 115, Entry 3, Box 442, File 351, National Archives, Washington, D.C.

U.S. Department of the Interior, U.S. Reclamation Service. Sixth Annual Report of Reclamation Service, 1906-1907 Washington: Government Printing Office, 1907.

New Mexico State and County Documents

"Articles of Incorporation of the Eddy and Bissel Live Stock Company." New Mexico State Records Center and Archives, Santa Fe.

"Articles of Incorporation of the Pecos Irrigation and Investment Company." New Mexico State Records Center and Archives, Santa Fe.

"Articles of Incorporation of the Pecos Irrigation Company." New Mexico State Records Center and Archives, Santa Fe.

"Articles of Incorporation of the Pecos Valley Land and Ditch Company." New Mexico State Records Center and Archives, Santa Fe.

"Deed Record Book 1." Eddy County Courthouse, Carlsbad, New Mexico.

"Deed Record Book 6." Eddy County Courthouse, Carlsbad, New Mexico.

"Patent Record" Book. Eddy County Courthouse, Carlsbad, New Mexico.

Unpublished Sources

"Abstract of Title to T21S, R26E, NMPM, Section 12." Located in the Pecos Valley Projects Office, Bureau of Reclamation, Carlsbad, New Mexico.

Baldwin, E.H. to the Director and Chief Engineer, U.S. Reclamation Service, 23 April 1915. RG 115, Entry 3, Box 442, File 351, National Archives, Washington, D.C.

Benson, R.S., et.al. to Francis G. Tracy, 8 October 1904. Located in the Pecos Valley Projects Office, Bureau of Reclamation, Carlsbad, New Mexico.

Blauvelt, L.D., to C.B. Eddy, 12 March 1893. Located in the Pecos Valley Projects Office, Bureau of Reclamation, Carlsbad, New Mexico.

Board of Engineers to Director, 11 April 1911. RG 115, Entry 3, Box 1094, File 241, National Archives, Washington, D.C.

Bonstedt, Fred and E.B. Debler, "Report on Investigations: Pecos River and Carlsbad Project Extensions in New Mexico, May, 1923." RG 115, Entry 7, Box 451, File 301, National Archives, Washington, D.C.

Carlsbad Commercial Club to Robert Ervien, Stante Land Commissioner, 17 February 1914. RG 115, Entry 3, Box 441, File 466, National Archives, Washington, D.C.

Chief Engineer, U.S. Geological Survey to W.M. Reed, 10 October 1904. RG 115, Entry 3, Box 443, File 651, National Archives, Washington, D.C.

Chief Engineer, U.S. Reclamation Service to Pecos Water Users Association, 1 December 1905. RG 115, Entry 3, Box 443, File 652, National Archives, Washington, D.C.

Chief Engineer, U.S. Reclamation Service to the Commissioner, U.S. Reclamation Service, 8 August 1923. RG 115, Entry 7, Box 451, File 351, National Archives, Washington, D.C.

Commissioner, Bureau of Reclamation to Sam G. Bratton, U.S. Senate, 23 February 1929. RG 115, Entry 7, Box 452, File 301.1, National Archives, Washington, D.C.

Davis, A.P. to B.M. Hall, 21 December 1904. RG 115, Entry 3, Box 443, File 651, National Archives, Washington, D.C.

Davis, A.P. to F.H. Newell, 4 November 1911. RG 115, Entry 3, Box 441, File 466, National Archives, Washington, D.C.

Davis, A.P., et.al. to F.H. Newell, 10 September 1904. RG 115, Entry 4, Box 1, File 25, National Archives, Washington, D.C.

Davis, A.P. to Louis Hill, 19 May 1913. RG 115, Entry 3, Box 449, File 875, National Archives, Washington, D.C.

Davis, A.P. to the Secretary of the Interior, 6 October 1910. RG 115, Entry 3, Box 438, File 338-A, National Archives, Washington, D.C.

Davis, A.P. to the Secretary of the Interior (with attachment), 10 April 1915. RG 115, Entry 3, Box 438, File 651, National Archives, Washington, D.C.

Director and Chief Engineer to District Engineer Office, 11 March 1915. RG 115, Entry 3, Box 291, Files 910-912, National Archives, Washington, D.C.

Director, U.S. Geological Survey to the Secretary of the Interior (with attachments), 28 December 1905. RG 115, Entry 3, Box 443, File 652, National Archives, Washington, D.C.

Director, U.S. Reclamation Service to L.C. Hill, 10 June 1908. RG 115, Entry 3, Box 441, File 466, National Archives, Washington, D.C.

Director, U.S. Reclamation Service to the Chief Engineer, U.S. Reclamation Service, 25 March 1921. RG 115, Entry 7, Box 451, File 301, National Archives, Washington, D.C.

Director, U.S. Reclamation Service to the Secretary of the Interior, 13 March 1911. RG 115, Entry 3, Box 438, File 338-A, National Archives, Washington, D.C.

Director, U.S. Reclamation Service to the Secretary of the Interior, 22 March 1910. RG 115, Entry 3, Box 438, File 338-A1, National Archives, Washington, D.C.

Eddy, C.E. to L. Bradford Prince, 3 September 1890. Reel 107, Frames 37-43, Records of the Territorial Governors. New Mexico State Records Center and Archives, Santa Fe.

Finch, C.H. to F.H. Newell, 24 February 1903. RG 115, Entry 3, Box 443, File 651, National Archives, Washington, D.C.

Foster, Lewis E. "Soils and Agriculture of the Carlsbad Project." 1907. RG 115, Entry 2, Box 438, File 338-B, National Archives, Washington, D.C.

Foster, L.E. to Charles Ethrige Minton, 1 October 1940. WPA File #201. New Mexico State Records Center and Archives, Santa Fe.

Foster, L.E. to the Commissioner, Bureau of Reclamation, 3 November 1927 (with attachments). RG 115, Entry 7, Box 451, File 301, National Archives, Washington, D.C.

Foster, L.E. to the Commissioner, Bureau of Reclamation, 20 October 1923. RG 115, Entry 7, Box 282, File 85, National Archives, Washington, D.C.

Foster, L.E. to the Commissioner, Bureau of Reclamation, 21 June 1932. RG 115, Entry 7, Box 277, Files 1 and 2. National Archives, Washington, D.C.

Foster, L.E. to the Director, U.S. Reclamation Service, 5 October 1917. RG 115, Entry 3, Box 442, File 651, National Archives, Washington, D.C.

Garfield, James R. to Francis G. Tracy, 9 January 1908. RG 115, Entry 3, Box 438, File 338-A1, National Archives, Washington, D.C.

Gross, C.P., Army Corps of Engineers to the Secretary of the Interior, 30 October 1928. RG 115, Entry 7, Box 452, File 301.1, National Archives, Washington, D.C.

Grunsky, C.E. to the Director, U.S. Geological Survey, 27, June 1906. RG 115, Entry 3, Box 443, File 651, National Archives, Washington, D.C.

Hagerman, J.J. "In the Matter of the Hondo Reservoir." Transcript of testimony given against building the Hondo Reservoir, September 6, 1904. RG 115, Entry 4, Box 1, File 25, National Archives, Washington, D.C.

[Hagerman, James John]. "James John Hagerman: Memoirs of His Life, Written by Himself at Roswell, New Mexico in 1908." Typescript in Rio Grande Historical Collections, New Mexico State University Library, Las Cruces.

Hagerman, James J. to W.M. Reed, 1 July 1904. RG 115, Entry 4, Box 1, File 25, National Archives, Washington, D.C.

Hall, B.M. and W.M. Reed to the Chief Engineer, U.S. Geological Survey, 15 December 1904. RG 115, Entry 3, Box 443, File 651, National Archives, Washington, D.C.

Hall, B.M. to the Chief Engineer, U.S. Reclamation Service, 22 November 1905. RG 115, Entry 3, Box 443, File 651, National Archives, Washington, D.C.

Henny, D.C. and Louis C. Hill to the Director, U.S. Reclamation Service 7 December 1911. RG 115, Entry 3, Box 443, File 651, National Archives, Washington, D.C.

Henny, D.C. to the Chief of Construction, U.S. Reclamation Service, 23 August 1916. RG 115, Entry 3, Box 442, File 651, National Archives, Washington, D.C.

Henny, D.C., et.al. to the Reclamation Commission, U.S. Reclamation Service, 11 June 1915. RG 115, Entry 3, Box 442, File 351, National Archives, Washington, D.C.

Hill, Louis C. to the Chief Engineer, 14 January 1913. RG 115, Entry 3, Box 442, File 351, National Archives, Washington, D.C.

Hill, Louis C. to the Director, U.S. Reclamation Service, 17 April 1913. RG 115, Entry 3, Box 449, File 875, National Archives, Washington, D.C.

Hill, Louis C. to the Director, U.S. Reclamation Service, 21 November 1908. RG 115, Entry 3, Box 438, File 338-A1, National Archives, Washington, D.C.

Hill, Louis C. to the Director, U.S. Reclamation Service, 30 June 1908. RG 115, Entry 3, Box 441, File 466, National Archives, Washington, D.C.

Jones, A.A., Department of the Interior, to Frank H. Richards, Carlsbad Commercial Club, 13 April 1916. RG 115, Entry 3, Box 441, File 466, National Archives, Washington, D.C.

Lane, Franklin K., Secretary of the Interior to O.A. Larrazola, Governor of New Mexico, 29 May 1919. RG 115, Entry 3, Box 438, File 338-A1, National Archives, Washington, D.C.

Lee, Willis T. "Report on the Geology Near Carlsbad, New Mexico, [December 1905]." RG 115, Entry 3, Box 443, File 652, National Archives, Washington, D.C.

Lodge, Henry Cabot to E.A. Hitchcock, 29 October 1904. RG 115, Entry 4, Box 1, File 25, National Archives, Washington, D.C.

McIntyre, Assistant Engineer to District Engineer, 29 June 1912. General Correspondence Files, Office of the Chief Engineer, Records of the Bureau of Reclamation, RG 115, Box 269, File 77G, Denver Branch, National Archives, Denver.

McLenathen, C.H. to Frederick H. Newell, 8 July 1907. RG 115, Entry 3, Box 441, File 446-B, National Archives, Washington, D.C.

McShane, P.J. to W.M. Reed, 30 October 1911. RG 115, Entry 3, Box 441, File 466, National Archives, Washington, D.C.

Means, Thomas H. "Report on Agricultural Possibilities of the Carlsbad Project, New Mexico." RG 113, Entry 3, Box 438, File 338, National Archives, Washington, D.C.

Meinser, O.E., et.al., to the Director, U.S. Geological Survey, 10 September 1929. RG 115, Entry 7, Box 451, File 301, National Archives, Washington, D.C.

"Minutes of First Annual Meeting of the Stockholders of Pecos Irrigation Company, February 10, 1902." RG 115, Entry 3, Box 449, File 875, National Archives, Washington, D.C.

"Minutes of Second Annual Meeting of the Stockholders of the Pecos Irrigation Company, February 10, 1903." RG 115, Entry 3, Box 449, File 875, National Archives, Washington, D.C.

Muggeridge, M.L. to F.K. Lane, 13 April 1914. RG 115, Entry 3, Box 449, File 1158, National Archives, Washington, D.C.

Myers, E.W. "Report to B.M. hall, Supervising Engineer, on the Design and Construction of the Replacement and Repair Work for the Pecos Irrigation Co. Near Carlsbad, New Mexico." RG 115, Entry 3, Box 443, Tile 651, National Archives, Washington, D.C.

Newell, F.H. to Francis G. Tracy, 12 January 1905. RG 115, Entry 3, Box 443, File 652, National Archives, Washington, D.C.

Newell, F.H. to Louis C. Hill, 16 December 1911. RG 115, Entry 3, Box 443, File 651, National Archives, Washington, D.C.

Newell, F.H. to the President (telegram), 13 February 1912. RG 115, Entry 3, Box 441, File 466, National Archives, Washington, D.C.

Newell, F.H. to W.H. Sanders, 27 September 1905. RG 115, Entry 3, Box 443, File 651, National Archives, Washington, D.C.

"The Eddy Brothers." Typescript in History File (County) #14. New Mexico State Records Center and Archives, Santa Fe.

Pecos Irrigation and Improvement Company, Report to the Stockholders, December 15, 1891. RG 115, Entry 4, Box 1, File 25, National Archives, Washington, D.C.

Pecos Water Users Association and Pecos Irrigation Company to F.H. Newell, 5 January 1905. RG 115, Entry 3, Box 443, File 652, National Archives, Washington, D.C.

Pecos Water Users Association to Frederick H. Newell, 8 November 1904. RG 115, Entry 3, Box 443, File 652, National Archives, Washington, D.C.

Pecos Water Users Association to "Mr. Congressman or Senator," 5 April 1919. RG 115, Entry 3, Box 438, File 338-A1, National Archives, Washington, D.C.

Pecos Water Users Association to R.A. Ballinger, 29 November 1909. RG 115, Entry 3, Box 438, File 338-A1, National Archives, Washington, D.C.

Pecos Water Users Association to the Secretary of the Interior, 1 March 1911. RG 115, Entry 3, Box 438 File 338-A1, National Archives, Washington, D.C.

"Plan for the Settlement of the Affairs of the Pecos Irrigation and Improvement Company of New Mexico and for the Reorganization of a New Company by the Bondholders." RG 115, Entry 4, Box 1, File 25, National Archives, Washington, D.C.

Reed, W.M. to A.P. Davis, 18 November 1911. RG 115, Entry 3, Box 441, File 466, National Archives, Washington, D.C.

Reed, W.M., et.al., to B.M. Hall, 23 June 1906. RG 115, Entry 3, Box 441, File 466, National Archives, Washington, D.C.

Reed, W.M. to L.C. Hill, 15 April 1910. RG 115, Entry 3, Box 438, File 338-A1, National Archives, Washington, D.C.

Reed, W.M. to the Chief Engineer, U.S. Reclamation Service, 17 November 1908 (includes deposition by F.G. Tracy regarding the Malaga Land Company). RG 115, Entry 3, Box 442, File 466-4, National Archives, Washington, D.C.

Reed, W.M., et.al., to the Chief Engineer, U.S. Reclamation Service, 31 August 1905. RG 115 Entry 3, Box 443, File 651, National Archives, Washington, D.C.

Reed, W.M. to the Chief Engineer, U.S. Reclamation Service, 15 August 1906. RG 115 Entry 3, Box 441, File 338, National Archives, Washington, D.C.

Reed, W.M. to the Chief Engineer, U.S. Reclamation Service, 10 October 1904. RG 115 Entry 3, Box 443, File 651, National Archives, Washington, D.C.

Reed, W.M. to the Chief Engineer, U.S. Reclamation Service, 17 November 1908. RG 115, Entry 3, Box 442, File 466-4, National Archives, Washington, D.C.

Reed, W.M. to the Director, U.S. Reclamation Service, 16 November 1911. RG 115, Entry 3, Box 443, File 651, National Archives, Washington, D.C.

Reed, W.M. to the Director, U.S. Reclamation Service, 5 March 1910. RG 115, Entry 3, Box 439, File 338-A1, National Archives, Washington, D.C.

Reed, W.M. to the Director, U.S. Reclamation Service, 12 February 1912. RG 115, Entry 3, Box 441, File 466, National Archives, Washington, D.C.

Reed, W.M. to the Director, U.S. Reclamation Service, 18 October 1907. RG 115, Entry 3, Box 438, File 338-A, National Archives, Washington, D.C.

Reed, W.M. to the Director, U.S. Reclamation Service, 22 November 1907. RG 115, Entry 3, Box 438, File 338-A1, National Archives, Washington, D.C.

Reed, W.M. to the Director, U.S. Reclamation Service, 25 June 1908. RG 115, Entry 3, Box 441, Box 466, National Archives, Washington, D.C.

Reed, W.M. to the Director, U.S. Reclamation Service, 27 December 1911. RG 115, Entry 3, Box 443, File 651, National Archives, Washington, D.C.

Reed, W.M. to the Director, U.S. Reclamation Service, 27 October 1911. RG 115 Entry 3, Box 437, File 331, National Archives, Washington, D.C.

Richardson, G.B. "Notes on Proposed Reservoir Site No. 3, Carlsbad Project, New Mexico." RG 115, Entry 3, Box 443, File 651, National Archives, Washington, D.C.

Rizer, H.C. to the Secretary of the Interior, 22 November 1906. RG 115, Entry 3, Box 438, File 338-A1, National Archives, Washington, D.C.

Ryan, W.A., Comptroller, U.S.G.S. to W.B. Wilson, Pecos Water Users Association, 17 October 1914 (with attachment). RG 115, Entry 3, Box 440, File 338-A5, National Archives, Washington, D.C.

Smith, C.G. to the Comptroller, U.S. Reclamation Service, 8 August 1915. RG 115, Entry 3, Box 438, File 338-A1, National Archives, Washington, D.C.

Stanford, Gardner P. and Charles S. Kelley to William S. Greene, 25 October 1904. RG 115, Entry 4, Box 1, File 25, National Archives, Washington, D.C.

Taylor (no first name) to the Director, U.S. Reclamation Service, 4 June 1923. RG 115, Entry 7, Box 451, File 301, National Archives, Washington, D.C.

Taylor, T.Y. and Scott Etter to Franklin K. Lane, 17 June 1915. RG 115, Entry 4, Box 10, File 262-D3, National Archives, Washington, D.C.

Teichman, F. to W.M. Reed, 16 November 1911. RG 115, Entry 3, Box 443, File 651, National Archives, Washington, D.C.

Teichman, F. to the Director, U.S. Reclamation Service, 3 November 1911. RG 115, Entry 3, Box 443, File 651, National Archives, Washington, D.C.

Tracy, F.G. to F.H. Newell, 23 September 1905. RG 113, Entry 3, Box 443, File 651, National Archives, Washington, D.C.

Tracy, F.G. to G.B. Shaw, 3 July 1905. RG 115, Entry 3, Box 443, File 651, National Archives, Washington, D.C.

Tracy, Francis G. to George B. Harrison, 24, December 1929. New Mexico State Records Center and Archives, Santa Fe.

Tracy, Francis G. to Herbert W. Yeo, New Mexico State Engineer, 9 January 1930. Located at the Office of the State Engineer, Santa Fe.

Tracy, Francis G. "Eddy County, New Mexico." Typescript in WPA File #199. New Mexico State Records Center and Archives, Santa Fe.

Tracy, Francis G. to James R. Garfield, 30 December 1907. RG 115, Entry 3, Box 438, File 338-A1, National Archives, Washington, D.C.

Tracy, Francis G. to Morris Bien, 9 June 1908. RG 115, Entry 3, Box 442, File 466-4, National Archives, Washington, D.C.

Tracy, F.G. to R.S. Benson, 11 October 1904. RG 115, Entry 3, Box 443, File 652, National Archives, Washington, D.C.

Tracy Francis G. To R.S. Benson, 8 November 1904, RG 115, Entry 3, Box 443, File 652, National Archives, Washington, D.C.

Tracy, Francis G. to E.A. Hitchcock, 10 February 1904, RG 115, Entry 4, Box 1, File 25, National Archives, Washington, D.C.

Tracy, Francis G. to the President (telegram) 9 September 1911. RG 115, Entry 3, Box 441, File 466, National Archives, Washington, D.C.

Tracy, Francis G. to Samuel Adams, 1 February 1912. RG 115, Entry 3, Box 441, File 466, National Archives, Washington, D.C.

Tracy, Francis G. to the Secretary of the Interior, 23 June 1904. RG 115, Entry 4, Box 1, File 25, National Archives, Washington, D.C.

Tracy, Francis G. to the Secretary of the Interior, 23 September 1911. Located in the Pecos Valley Projects Office, Bureau of Reclamation, Carlsbad, New Mexico.

Trowbridge, C.R. "Report on Inspection of Carlsbad Project -- Reclamation Service." RG 115, Entry 7, Box 445, File 105.21, National Archives, Washington, D.C.

"United States of America vs. Hope Community Ditch, et.al." Testimony taken at Carlsbad, New Mexico, January 4, 1926. Transcript located at the Office of the State Engineer, Santa Fe.

Walter, A.F., Chief Engineer, to the Commissioner, Bureau of Reclamation, 1 March 1928. RG 115, Entry 7, Box 451, File 301, National Archives, Washington, D.C.

Miscellaneous Sources

[Automatic Spillway Gates at Spillway No. 1, Avalon Dam]. Construction drawing number 5-500-231, Box 16. Denver Branch, National Archives, Denver.

"Detail Construction, Spillway No. 2," 1917. Engineering drawing from aperture card. Bureau of Reclamation, Salt Lake City, Utah.

"L.D. Blauveldt." Biographical file, located at the Colorado Historical Society, Denver.

"H.H. Cloud." Biographical file, located at the Colorado Historical Society, Denver.

"Edwin S. Nettleton." Biographical file, located at the Colorado Historical Society, Denver.

"Field Notes of the Survey of the Pecos Irrigation & Improvement Co's Reservoir No. 1, Eddy Co., New Mexico." Located at the Pecos River Projects Office, Bureau of Reclamation, Carlsbad, New Mexico.

Malaga Land Company. Descriptions of Company and a sample brochure are located in RG 115, Entry 3, Box 442, File 466-A, National Archives, Washington, D.C.

"McMillan Dam: General Plan and Sections with Proposed Improvements," 1937. Engineering drawing number 5-D-489 from aperture card. Bureau of Reclamation, Salt Lake City, Utah.

"Plan and Typical Cross Section, Avalon Dam." Record Drawing, Accession No. 17353, 1916. Box 16. Denver Branch, National Archives, Denver.

"Plats of the Pecos Irrigation and Improvement Co's Storage Reservoir No. 1, No. 2, and No. 3." RG 49, Division F, Canals and Reservoirs File, National Archives, Washington, D.C.

ADDENDUM TO:
CARLSBAD IRRIGATION DISTRICT
Along Pecos River Valley, 13 miles North to 15 miles Southeast of Carlbad
Carlsbad vicinity
Eddy County
New Mexico

HAER NM-4
*HAER NM,8-CARL.V,1-*

FIELD RECORDS

HISTORIC AMERICAN ENGINEERING RECORD
National Park Service
U.S. Department of the Interior
1849 C Street NW
Washington, DC 20240-0001