# Carlsbad Project

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At the turn of the century, New Mexico was still a territory. In many ways, the "Great American Desert" of the Southwest was still a frontier. A former haven for desperadoes and renegade Apaches, New Mexico was experiencing the last days of unbounded adolescence. Only a few years before, the Lincoln County War erupted in violence, threatening the countryside of eastern New Mexico. Here, on the high plains of the Trans-Pecos, a former sheriff of Lincoln County named Pat Garrett dug a small ditch to his land near Roswell.

The settlement of the American West has long been linked to the availability of water. In eastern New Mexico, early irrigation attempts focused on the Pecos River. Extensive private ventures in the area, for all their good intent, eventually met failure. Like many irrigation projects across the West, the Carlsbad Project was resurrected by the Bureau of Reclamation. Carlsbad was one of the earliest Reclamation projects, and is one of the more significant projects in terms of surviving examples of mixed 19th and 20th century technology.

## Project Location and Description

The Carlsbad Project is located along the Pecos River in southeastern New Mexico near the city of Carlsbad. Located in the Chihuahuan Desert, the project enjoys a number of sun-drenched days during the 212 day growing season. Temperatures sometimes reach 111 degrees at the project's 3100 foot elevation. Rainfall of only 12.4 inches a year forced settlers to rely on irrigation methods.

The project's water supply derives from two river basins. The Pecos River Basin above Lake McMillan drains 16,990 square miles with annual runoff of 234,700 acre-feet. Part of the project's water comes from diversion of the Black River, 15 miles southeast of Carlsbad, and three miles northwest of Malaga. The river basin above the diversion point drains 343 square miles generating 9,000 acre-feet.[1]

The project included four dam sites and reservoirs, and an extensive lateral and canal

1. United States Department of the Interior, Bureau of Reclamation, Regional Director, Region 5. *Factual Data-Carlsbad Project*, 196.

network. Avalon Dam and Reservoir are located five miles north of Carlsbad on the Pecos River. McMillan Dam was breached following construction of Brantley Dam, in 1987. It was located nine miles above Avalon, and 14 miles northwest of Carlsbad. Both Avalon and McMillan represented early private irrigation ventures rehabilitated by Reclamation.

Sumner Dam and Lake lie 250 miles north of Carlsbad, 16 miles northwest of Fort Sumner, New Mexico. Previously known as Alamogordo Dam and Reservoir, the location was redesignated in 1974, to help tourists avoid confusing the place with the city of Alamogordo, 150 miles away. Brantley Dam, between McMillan and Avalon, is located 13 miles north of Carlsbad near the old McMillan site. Both Brantley and Sumner were designed and constructed from the outset by the Bureau of Reclamation.

Forty-one miles of canals, 137.6 miles of laterals, and 32 miles of drains comprise the distribution system. At the east end of Avalon Dam, the Main Canal runs south along the Pecos River three miles below the dam, where it divides into the East Canal and the Southern Main Canal.

The East Canal continues for six miles on the east side of the Pecos River. The Southern Main Canal runs south to the river, which it crosses one mile northwest of Carlsbad via concrete aqueduct. The Southern Main Canal then moves south for 21 miles to the Black River Canal at Malaga.[2]

The Carlsbad Irrigation District includes 25,000 acres of irrigable land. These lands extend for 20 miles along the Pecos River, three to five miles in width. The project's irrigation system serves more than 700 persons on 155 farms.

Most of the irrigated lands of the project lie between Avalon Dam on the north, and the mouth of the Black River near Malaga. Stretching north along the project at its inception were the towns of Malaga, Loving, Otis, Phoenix, Carlsbad, Avalon, and Lakewood, at Lake McMillan.

## Historic Setting

2. U.S. Department of the Interior, Water and Power Resources Service. *Project Data, 1981*, U.S. Govt. Printing Office, Denver, 1981, 111-3.

Long before expeditions crossed the staked plains of eastern New Mexico and west Texas, Native Americans made the area their home. In the arid region of the Trans-Pecos, irrigation was necessary to supplement a diet which relied upon the availability of meat on the hoof. To the northwest, in the "four corners" region, the Anasazi-Pueblo culture had employed flood-water farming, cultivating small, widely scattered plots.[3] Descendants of the Anasazi moved south and east along the Rio Grande and as far east as the Pecos River. Coronado counted three villages on the Pecos during his unsuccessful 16th century bid to find gold in the Southwest.[4]

Various bands of Apache roamed southeastern New Mexico into the late 19th century. The Apache maintained a presence in the area as long as buffalo were nearby and the Comanche were not. Sheepherders took advantage of lush grasses along the Pecos River until Charles Goodnight and Oliver Loving began trailing cattle through the region in 1865.[5]

Most 19th century history of the Trans-Pecos reflected ranching interests, not farming. Consequently, water rights were first appropriated for cattle and sheep along small tributaries of the Pecos River. But, U.S. Geological Surveys suggested that with the proper irrigation tools in place, the region would become a prime growing area.[6]

Early promoters of Pecos country irrigation included Pat Garrett, known primarily as the Lincoln County sheriff who shot William Bonney, or "Billy the Kid", in 1881. Garrett established an 1800 acre farm near Roswell in the mid 1880's. Garrett met Charles B. Eddy, a New Mexico and Colorado rancher who established himself on the Pecos River in 1881. Eddy was adept at public relations, promoting irrigation in the Pecos valley while accumulating vast tracts of land and water rights.[7] Eddy's ranching enterprise, the Eddy and Bissel Livestock

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3. Ira G. Clark. *Water in New Mexico*. Albuquerque: University of New Mexico Press, 1987, 5, 6.
4. *Ibid*., 6.
5. F. Stanley, *The Carlsbad New Mexico Story*, Pep, Texas, 1963,3.
6. U.S. Dept. of the Interior, National Park Service. Historic American Engineering Record: *Carlsbad Irrigation District, HAER No. NM-4, vol. 2*: Historical and Descriptive Data, 6, 7. (hereafter cited as HAER, Carlsbad).
7. U.S. Dept. of the Interior, Bureau of Reclamation. *Carlsbad Project: Annual Project History, Through 1913 [1&2] and 1910-1912, vol. 1*, R.G. no.115, Records of the Bureau of Reclamation, Project Histories, Carlsbad, 1913, Box 3, pp. 17, 18. Denver: National Archives. ( Hereafter cited as R.G. 115, followed by box number, volume, and page number).

Company, and the Holt Livestock Company were the two prominent ranching endeavors on the lower Pecos. As in many parts of the West, land acquisitions along the Pecos resulted from manipulation of the Desert Land Acts of 1877 and 1886.[8]

By 1886, Eddy had constructed a small irrigation ditch near La Huerta, north of Carlsbad, possibly in response to the legendary winter and drought of that year. Eddy incorporated his small system in October, 1887 with the intention of building three major canal systems east and west of the lower Pecos, and near Roswell.[9]

In 1888, Garrett and Eddy joined forces and sought financial backing. They enlisted the support of Robert Weems Tansill, who had made a fortune selling cigars in Chicago, and Charles W. Greene, sometime newspaperman and full-time Southwest promoter. In July, 1888, the Pecos Irrigation and Investment Company, backed by Chicago investors, replaced Eddy's Pecos Valley Land and Ditch Company.

Although settlers began arriving as early as 1888, the townsite of Eddy was not officially founded until 1889. Originally, the new irrigation headquarters was to be called Halagueno, but Tansill and his wife convinced Eddy that the proposed name was too hard to pronounce.

The *Eddy Argus*, the local newspaper, touted the growth of the new town. Over 12,000 shade trees had been planted by November 22, 1890. Plans called for a new courthouse, parks, schools, and railroad facilities. The new town boasted a livery stable and feed corral, blacksmith and wagon shop, two real estate and insurance firms, a brickyard and lime kiln, lumber yard, four grocery stores, two drug stores, two barber shops, a butcher shop, billiard hall, a sixty-room hotel, several residences, restaurants, a stage line, three churches - and absolutely no liquor.

Persons not so temperately inclined were directed a mile down the road to Phoenix, a community of outlaws, gamblers, and prostitutes, with a population of 900. After the departure of Charles Eddy, in 1895, the town of Eddy renamed itself Carlsbad.[10]

Besides the establishment of a thriving town, the recruitment of James J. Hagerman, a

8. HAER, 10, 11, 12.
9. HAER, Carlsbad, 13.
10. F. Stanley, 3.

Colorado Springs capitalist was crucial to future irrigation activities in the lower Pecos valley. Hagerman made a fortune in Colorado and Idaho silver mining and railroad construction.[11]

With financial backing from Hagerman and others, the new company began designing a workable irrigation system. The company first built a diversion dam at present-day Avalon, and a canal which paralleled the east bank of the Pecos. The canal crossed over the river three miles south of Avalon by wooden flume.

Various contractors employing workers from outside the area, built tent cities near the project, one of which was christened, "Flumetown" because of its proximity to the wooden structure. Flumetown claimed 180 laborers, a number of mechanics, a blacksmith shop, commissary, and harness shop.

During the fall of 1889, construction of the flume generated considerable excitement among Eddy residents. For the time, its proportions were massive, allowing four (mule or horse) teams to walk across the floor side by side without difficulty. Eight feet deep and twenty-five feet across the top, the flume ran for 475 feet and was largely completed in the spring of 1890, by Witt Brothers Company.[12]

As work on the flume ended, work at Avalon continued. The dam was impressive for the 19th century. Although original plans called for a diversion dam, Pecos Irrigation and Investment decided to provide water storage as well. The result was a structure capable of holding back a reservoir stretching for six miles. Early estimates of reservoir capacity tended to be inflated. Estimates in 1896 were approximately 6,887 acre-feet.

Avalon's rockfill structure with impervious earthfill facing was one of the first of its type to be used for irrigation in the United States. The dam's rockfill design followed those first used in 1860's and 70's hydraulic mining in California. A hand-laid rock wall separated the rockfill from the impervious earth facing, the latter consisting of earth sacks, gravel, boughs, and loose earth. Eighteen inches of rip-rap protected the original upstream facing against undercutting. The

11. HAER, Carlsbad, 13-7.
12. HAER, Carlsbad, 19-23.

dam stood forty five feet high and stretched for 1070 feet at its crest.[13]

One of the unique characteristics of the original Avalon Dam was a sluicegate running through the dam, a technologically troublesome feature because of the possibility of earth washout around the sluice. The sluicegate, made of stone laid in concrete eight feet thick, was ninety feet long. Two thousand second-feet of water passed through the gate to feed a wooden flume and Charles Eddy's old canal near La Huerta.[14] The western spillway, five feet below crest, 300 feet long and 256 feet wide, complimented a second one located seven feet below the crest of the dam which was 206 feet long. Thirty one headgates, partially operated by a vertical releasing rod, were joined by 10 escape gates which returned water to the river.[15]

Avalon's canal headworks were built into a 500 foot channel carved out of solid limestone on the east side of the dam. Six wooden headgates controlled a capacity of 3,000 second-feet of water. The gates, five by nine feet, slid between wooden posts, and were manipulated by turning a steel screw from above.[16]

The most important player to emerge in the unfolding history of private irrigation in the lower Pecos valley, was James J. Hagerman. Hagerman fought continuously to make an oasis out of the New Mexico desert. In his mind this meant revamping the corporate structure of Pecos Irrigation and Investment Company to allow it to sell not only irrigation water, but the land to be serviced by the water.

On July 1, 1890, the Pecos Irrigation and Improvement Company absorbed all assets of the former company. The new venture was capitalized at $1,750,000[17] largely through investments by Colorado businessmen and Swiss bankers. Hagerman revised the charter of the old company which had not allowed for ownership or selling of property beyond what was necessary to provide irrigation.[18]

James Hagerman increasingly assumed major control of irrigation and transportation

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13. L. B. Howell. "The Pecos Valley Irrigation System," *Engineering News*, September 17, 1896, 181.
14. *Ibid*., 181.
15. *Ibid*.
16. Herbert M. Wilson, "Pecos Valley Canals", *Engineering News*, October 17, 1891, 351.
17. R.G. 115, Box 3, vol. 1, 20.
18. HAER, 30.

enterprises in the Pecos Valley in the 1890's. In 1890, Hagerman incorporated the Pecos Valley Railroad Company and contracted Bradbury and Company, the Denver builders of the canal system, to construct a rail line from Eddy (Carlsbad) to Pecos, Texas. Hagerman wanted his line to connect with the Texas and Pacific Railroad system to improve access to markets.

In January, 1891, the line was completed, and by 1893 the irrigation system was operational. Friction between Charles Eddy's company, Pecos Valley Town Company, and Hagerman's increasing control of Pecos Irrigation and Investment led to formation of the Pecos Valley Company, in 1893. The holding company attempted to remedy the conflict between Hagerman and Eddy interests and provide greater coordination of development in the valley.[19]

According to the Reclamation Service's account, the construction of Hagerman's ambitious irrigation plant and railroad were not in keeping with the realities of the time. Construction was " several years ahead of any demand for irrigated lands in this region. There were no settlers to occupy them and no market for its products when settlers came".[20] Hagerman envisioned building his railroad to Amarillo, which had links to the midwest, but lack of funding led to the Pecos option.[21]

In August of 1893, seasonal flooding washed out the Avalon Dam, including two bridges and the wooden flume across the Pecos River. Hagerman's personal investment during 1894 resulted in further construction of rail lines to Roswell. Hagerman's irrigation company had realized before the Avalon disaster that a second reservoir was necessary to meet the needs of a burgeoning canal system. Consequently, in 1892, work had commenced on the McMillan Dam, nine miles upstream from the Avalon site. By 1894, McMillan Dam and Reservoir were in place.[22]

According to *Engineering News*, September 17, 1896, the dam was similar to the original Avalon structure, only larger. McMillan was a rockfill dam, 1,835 feet long, fifty-six feet high, with upstream earth facing. The facing was paved with eighteen inches of hand laid broken

19. HAER, 33, 34.
20. R.G. 115, Box 3, vol. 1, 21.
21. *Ibid*., 21.
22. *Ibid*., 21.

stone. Water entered into an 1100 foot rock channel 35 feet below the dam's crest via six wooden headgates. Like the Avalon works, manually operated iron screws controlled the gates. On the east side of the Pecos, a rock outlet canal diverted water out of the river bed, then back to the river some 300 feet downstream. A long earth embankment ran along Lake McMillan's west bank, creating an L where it intersected the dam. A spillway at the west end of the dam diverted water into an arroyo and back into the river bed two miles below.[23] Maximum storage capacity for the newly created reservoir was 80,000 acre-feet.[24] McMillan served as a storage facility, releasing water to downstream Avalon, which served as the distribution center for the canal system.

Right in the midst of the greatest irrigation efforts by Hagerman and company, disaster struck. The destruction of Avalon Dam in 1893 occurred at a most inopportune time. Hagerman's main source of capital came from the silver mines of Colorado. With the collapse of silver prices precipitating the Panic of 1893, Hagerman boldly decided to invest what he could into rebuilding the Avalon Dam and infrastructure.

Interestingly, irrigation promoters were using the panic as an argument for development of arid lands. Irrigated lands would provide the "safety valve" alluded to by historian Frederick Jackson Turner, and give the downtrodden a new chance in the West. Settlers, however, balked at paying higher prices for watered lands in the West than they would pay for prime lands back east. The Third National Irrigation Congress was preparing to address the issue. Settlers across the West clamored for state or federal bonds to pay for irrigation projects, and the extension of automatic water rights.[25]

By October, 1893, work crews totaling 500 men and 165 teams started rebuilding the hapless Avalon Dam. Similar to the original structure, the new dam was raised five feet and extended sixty five feet. The capacity of the west end spillway was increased to deal with flood

23. R.G. 115, Box 3, vol. 1, pp. 12, 13.
24. L. B. Howell. " The Pecos Valley Irrigation System", *Engineering News*, September 17, 1896, 181,182. Reclamation figures differ slightly as to the features and dimensions of the dam. For example, the crest length in Reclamation's Project Histories is given as 1685 feet, with a height of 52 feet. Storage capacity was estimated at 80,000 second-feet, with the reservoir submerging 8,331 acres. see various figures in Carlsbad Project History, R.G. 115, Box 3, vol. 1.
25. *Engineering News*, July 26, 1894, 72.

waters, and a third spillway was added further west.[26] Salvage crews returned 60,000 board feet of flume timbers from as far away as Pecos, Texas, and rebuilt the wooden structure.[27]

In 1894, as Hagerman's railroad reached Roswell, Charles Eddy resigned as general manager of Pecos Irrigation and Improvement Company, and sold most of his holdings in the valley. The departure of Eddy represented only one in a series of downturns for Pecos Irrigation. Contemporary articles attested to the presence of fertile soils bearing fruits, grains, and vegetables, capable administration, and maintenance by local "ditch-riders".[28] Such journal articles and accolades by the New Mexico "Bureau of Immigration" proclaiming the Pecos as a veritable "fruit belt" had little to do with actual experience.

Experimentation with a variety of crops in the region had met with limited success. Vineyards and orchards succumbed to dust storms, root disease, and an erratic water supply. Further experimentation entailed the use of Indian corn, kaffir corn, milo maize, sorghum, alfalfa, and sugar beets. Alfalfa was somewhat successful, but yields were low.[29]

The financial condition of the irrigation company was precarious, with expenditures always exceeding income. James Hagerman's dogged determination to make the irrigation enterprise succeed began to wane, and consequently, so did his financial support. The company was forced into receivership in 1898, the same day that the wooden flume again washed away. A reorganization plan placed the company's plant and operation under the authority of The Pecos Irrigation Company, on August 17, 1900.[30]

Under receivership, the fortunes of the company improved temporarily, possibly due to the construction of a rail line to Amarillo, Texas, and the introduction of cotton to the area. Although the irrigation system's canal network leaked like a sieve, enough water was delivered to nourish crops on 9,131 acres. But by 1902, it was painfully obvious to early company

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26. Numerous articles appeared at this time dealing with the merits of rockfill dams. The inability of Avalon's spillway system was cited as the primary culprit for the dam's failure. Other problems were also cited. The earthfill of sandy loam was called into question, as were inoperable headgates, which had to be blown out with dynamite during previous flood scares, causing citizens of Eddy to run for the hills. See *Engineering News*, January 9, 1892, 28, and September 17, 1896, 181.
27. HAER, 41, 42.
28. *Engineering News*, September 17, 1896, 182.
29. HAER, 47.
30. Carlsbad Project, R.G. 115, Box 3, vol. 1, 22; HAER, 51.

directors Francis Tracy and Robert Tansill that massive improvements were necessary to make the system viable for the long term.[31]

The state of disrepair of the entire system was reflected in the reports of chief engineer, B. E. Killough, and W. M. Reed. Killough's report discussed repairing or improving spillways, sluicegates, canal banks, and headgates. Reed's report mentioned severe leakage in McMillan Reservoir and along the canal network.[32]

An obvious feature needing repair was the Pecos River flume, originally built of wood, and soon to be concrete. The new flume, reportedly the largest in the United States, was completed in 1903. Robert Tansill had died in December, 1902, and Tracy became the standard-bearer of the company. Realizing their dire financial situation, Tansill and Tracy had lured to Carlsbad, F. H. Newell, the new chief of Reclamation. Tansill wanted to discuss the possibility of a bailout, under provisions of the Reclamation Act, of 1902. After Tansill's death, Tracy continued to advocate federal assistance for the lower Pecos, while at the same time, criticizing a competing Reclamation project proposed for the Hondo River, near Roswell.

Nature soon made the Hondo dispute irrelevant. At 11p.m., on October 1, 1904, a flood pushed against the earth facing of Avalon Dam, creating a passage for more than 80,000 second-feet of water. The second failure of Avalon in eleven years damaged the flume, swept away three bridges, and cut a new channel around the dam site, twice as wide as it had been.[33]

The story of private reclamation on the lower Pecos is not so different from many such projects across the West. Encouraged by grandiose pseudo-scientific claims about "rain following the plow", or prodding rain clouds into activity with dynamite, many settlers came west.

Proponents of western irrigation, such as William E. Smythe, editor of Irrigation Age, identified the seventeen states west of the ninety-seventh meridian as a utopia, awaiting the secret elixir, water. Smythe heralded the climate, resources, and fertility of the land. Smythe

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31. HAER, 52,53.
32. R.G. 115, Box 3, vol. 1, 22-39.
33. *Engineering News*, " Failures of Lake Avalon Dam Near Carlsbad, N.M.", July 6, 1905, 9, 10.

claimed that the rich soils of the arid West produced four to ten times as much as eastern soils without irrigation.[34]

Such claims aside, over 90% of the private irrigation companies were bankrupt or close to it by 1900. A number of reasons account for such failures. Poor design and construction, short growing seasons, alkali soils, inadequate drainage, and poor assessment of water availability brought substandard results. Canal projects on public lands ran into laws designed to function in humid eastern regions, not in the vast stretches of the arid West. Speculators filing claims under the Homestead and Desert Land acts refused to enter into agreements with irrigation companies for water rights or fee payments, thereby blackmailing companies into purchasing their claims.[35] By the twentieth century, the federal government started playing an increasing role in reclamation of western lands.

## Project Authorization

Carlsbad was not high on the priority list, but on November 28, 1905, the Secretary of the Interior approved rehabilitation of the project to prevent its cultivated land from returning to wasteland. The Pecos Irrigation and Improvement Company accepted $150,000 for the remains of their dilapidated irrigation system. Another $450,000 was allocated for its restoration.

Twenty years later, additional storage facilities enhanced the project. Alamogordo (Sumner) Dam was approved by President Franklin Roosevelt on November 6, 1935, with funding appropriated August 14, under the Emergency Relief Appropriations Act of 1935. The Flood Control Act of 1935 specified in section 7 that Alamogordo Dam and Reservoir were to be used first for irrigation, followed by flood control, river regulation, and other beneficial uses.[36] Public Law 92-514 gave Congressional authorization for the Brantley Project, October 20, 1972. Named after a longtime Carlsbad Irrigation District Board Member, Brantley is a multi-purpose dam completed in 1987.[37]

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34. William E. Smythe, *The Conquest of Arid America*, New York: Harper and Brothers, 1909, 21-47; Smythe was highly laudatory when praising the Pecos valley of New Mexico. see pp 31-6, *The Conquest of Arid America*.
35. Michael C. Robinson, *Water for the West: The Bureau of Reclamation, 1902-1977*, Chicago: Public Works Historical Society, 1979, 9, 10.
36. *Ibid*., 113.
37. *Ibid*., 113.

## Construction History

Following the October, 1904 flood, the Pecos Water Users Association, led by F.G. Tracy, launched a massive advocacy campaign. The design of the campaign was to convince the Reclamation Service to purchase and rehabilitate the irrigation system of the lower Pecos. W. M. Reed, former chief engineer for Pecos Irrigation, and B. M. Hall, U.S.G.S. engineer from El Paso, began surveys and investigations into the plant and operations of the moribund company. In a preliminary report, the two men concluded that the system could be temporarily repaired for $20,000 to irrigate crops for the 1905 growing season. Reed and Hall were very sympathetic to the water user's pleas, and Washington responded in a like manner. Work crews and equipment began to arrive in January, 1905, although final approval of long-term renovation did not come until November 28.

As local Hispanics completed the repairs immediately necessary for operation, Reclamation's long-term plans for the project were delayed. Pecos Irrigation Company had accepted the government's offer of $150,000 for its dilapidated plant and lands. Reclamation was prepared to pay an additional $450,000 to rebuild the entire system, but only after the company's abstract of title was examined to establish property boundaries and water rights.[38]

Authorization to begin work was delayed until February 24, 1906. April 12 was the date opening bids for Avalon Dam's reconstruction. No bids were received, so Reclamation prepared to build by force account. Force account meant that Reclamation was in charge of the project, from design to hiring subcontractors and labor to construction. Preparatory work began May 1, 1906, with actual construction beginning June 1.

A portion of the old Avalon dam was incorporated into the new structure. Again, Avalon was built using the earth and rockfill design, stretching 1,025 feet across the Pecos, and standing fifty feet high. A core wall, founded on bedrock, ran 24 feet below dam crest. Designs called for using rubble concrete and steel interlocking channel bar sheet piling. Driving the sheet piling to bedrock proved difficult and expensive, so trenching was used instead. A vertical diaphragm of

38. R.G. 115, Box 3, vol. 1, 1-3.

reinforced concrete extended from the top of the core wall to the crest of the dam.

Trenching for the core wall disclosed a strata of gravel on the west side of the dam which was extremely pervious. Consequently, a six inch thick concrete wall, 129 feet long and eight feet high, was placed upstream, thirty feet from the core wall. Three spillways, considerably larger than their predecessors, were provided for flood control.[39]

Spillway number one featured thirty-nine pairs of wooden emergency gates. One gate of each pair opened upstream, the other, downstream. Each pair was connected by cables and pulleys, allowing both gates to be opened simultaneously by water pressure.

Work at Avalon progressed simultaneously from each bank of the river. According to project reports, construction of the dam progressed smoothly and was completed in November, 1907.[40]

Elsewhere on the Carlsbad Project, workers completed the aborted rehabilitation of the Pecos River Flume. Reclamation spent $18,000 fixing broken concrete, widening and strengthening the footings, and lengthening the flume. A new siphon across Dark Canyon two miles south of Carlsbad was designed to transfer the main canal's water beneath the floor of the canyon to avoid recurring washouts. The concrete siphon was 400 feet long and was built during the winter of 1906-1907.

Canal work emphasized eliminating seepage through subterranean gypsum deposits. Reclamation lined these areas with concrete. During the 1906-1907 winter, workers built new concrete control gates and spillway structures. The new gates replaced the antiquated wooden gates which were inefficient.[41]

**Post-construction History and Settlement**

Concurrent to the construction projects, federal soil surveys were conducted to determine which lands in the lower Pecos valley would be served by reclamation efforts. With proper irrigation and fertilization, first and second category soils might produce a variety of crops,

39. R.G. 115, Box 3, vol. 1, 5-9.
40. *Ibid*., 5-7.
41. HAER, 91-3.

including asparagus, onions, cantaloupes, celery, apples, pears, peaches, plums, cherries, grapes, and sweet potatoes.[42]

Conflict arose among members of the Water User's Association over water rights extended under the previous authority of private irrigation companies. The stipulation of the Reclamation Act that water users own lands not exceeding 160 acres also met with hostility by settlers who had amassed larger acreages under previous regulations.

As a result of soil surveys which ranked the land according to its fertility and productivity, Reclamation added acreage in some areas and took out land previously watered under private irrigation. Pecos Irrigation officials had sold their property cheap in anticipation that Reclamation would naturally include their lands within project boundaries. Another controversy stemmed from Reclamation's need to schedule usage fees as mandated by federal law.

Fees were assigned based on acreage, and included an annual maintenance and operation charge, and a payment to recoup the government's expense in building the project. As a result of rumblings by F. G. Tracy and the Pecos Water User's Association, some lands slated for exclusion, were readmitted, and a graduated fee system was instituted in 1912, after several farmers neglected payments.

Construction costs during the first years of the project had been fixed at $31 per irrigable acre, payable over ten years. Operation and maintenance assessments were around $1.35 per acre. By the fall of 1908, 12,000 acres were under cultivation with water rights applications for 14,000. New settlers were arriving but many were leaving at the same time. By 1912, though, 15,000 acres were being irrigated, and the Carlsbad Project had achieved a semblance of stability.[43]

In 1908, McMillan Dam was renovated. Rotting headgates were replaced, and workers repaired damaged spillways. Reclamation also constructed a 4,000 foot long dike on the eastern

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42. R.G. 115, Box 3, vol. 1, 96-9;110. William E. Smythe also commented on the fertility of the soil and fruits and vegetables which could be grown here, in *The Conquest of Arid America*, 1900, 233, 234.
43. Clark, 89.

shore of the reservoir to block off an extensive gypsum deposit.[44] McMillan was notorious for its diminished holding capacity because it was built over the same porous material which attracted millions to Carlsbad Caverns in later decades.

Political wrangling and dissatisfaction by the Water Association were heightened in 1911, when a flash flood destroyed small sections of spillway and embankment at McMillan and Avalon Dams. Fifty thousand dollars were appropriated to make repairs at both locations. During this same time, unique technology was being designed by Frank Teichman, an engineer for Reclamation who had emigrated from Germany in 1882. Teichman's most important contribution to the Avalon Dam were the "cylinder gate" outlet works, originally used on navigation canals. Such cylindrical valves had been used to fill or empty locks of water. Their big advantage over traditional sliding gate valves was that water pressure was exerted from all directions. Teichman's cylinder gates were first employed on the Yuma Project in Arizona, then modified at Avalon and elsewhere.

At Avalon, Teichman designed a new spillway, incorporating two vertical cylinder gates. When the gates were closed, they kept the spillway crest similar to flows over the other spillways. When raised, the gates allowed a rapid lowering of reservoir waters in anticipation of flooding. The two cylinder gates were positioned above downward-discharging tunnels in the headworks channel. The old gate openings along the dam crest were filled with concrete.

Twenty one feet in diameter, the new gates were made of braced steel and stood eight feet high. L-shaped tunnels carried water to a horizontal tunnel, which diverted water away from the base of the dam. Without electricity, Avalon utilized counterbalances so that an operator might raise the eight ton gates by using a hand crank. Teichman added a small water-driven turbine to each gate to make raising them easier. In late November, 1911, the gates were fully operational.

After their success at Avalon, similar gates were used on other projects, including Elephant Butte Dam, Franklin Canal, Sherburne Dam, and within the intake towers at Hoover

44. HAER, 107, 108. W. M. Reed, engineer for the project, had noted an extensive hole in the gypsum formation at McMillan in June, 1904; see R.G. 115, Box 3, vol. 1, 122.

Dam. Avalon's adaptation of counter-balanced hoisting, and water driven turbines remained unique features to the Carlsbad Project.[45]

Reclamation continued to improve the irrigation system's water delivery and holding capacity along the lower Pecos. In 1914, a study to determine the feasibility of building a third reservoir was conducted. Water Users had long supported the concept, which they thought might increase irrigated acreage by 20,000 acres. The major problem concerning such an idea was water loss due to seepage.[46] In 1914, construction focused on lining the main canal with concrete. Labor for the project was largely drawn from the local Mexican population.[47]

While plans to improve the efficiency of water holding and delivery progressed, project reports for the early part of the century typically portrayed the Carlsbad area as stagnant, in terms of population and economic growth. The city of Carlsbad showed limited growth, its population hovering between 2,750, and 3,000. Other cities within the project were much smaller.

Total irrigable lands for 1914 were 20,261 acres on 390 farms. Actual irrigated acreage was between 13,000 and 17,000 acres during the early 1900's. One hundred ninety-three owners and 110 tenants occupied these lands. Cotton and Alfalfa were the two leading crops for the first decades of the century. The more prosperous of the settlers supplemented their income by raising livestock.[48]

In 1915, Reclamation extended the Dark Canyon Siphon 200 feet to prevent further erosion and flood damage to the structure.[49] Reclamation continued to improve efficiency of the canal system by lining the Black River Canal during 1915 and 1916, and by carrying out siltation and storage assessments. McMillan had long experienced siltation problems. Each year, the Pecos River deposited layers of silt in the reservoir, which by 1916 amounted to some 3,900,000 cubic yards. In another 20 years, the reservoir would be filled with silt.

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45. HAER, 112-5.
46. R.G. 115, Box 4, vol. 2, 1914, 30.
47. *Ibid*., 40, 41.
48. *Ibid*., 77-81; see also R.G. 115, Box 4, vol. 3, 1915, 61, and 1916, 11-8; Box 5, vol. 4, 1917, 16.
49. R.G. 115, Box 4, vol. 3, 1915-7, 34, and 1916, 61-6.

Reclamation dismissed the idea of dredging the reservoir's floor as technologically impractical. Periodically raising the height of McMillan Dam would become expensive. Reclamation decided on a stopgap measure. Spillway construction at McMillan began in the fall of 1916, enlarging reservoir storage capacity to 42,000 acre feet. Crews completed the work on May 26, 1917.[50]

Detractors such as Tracy and the Water Users continued to launch scathing attacks against engineering and fee policies. A 1914 federal study had reinforced claims that the entire Carlsbad system was riddled with seepage and drainage problems, and recommended lining much of the canal system with concrete.[51] In 1915, a joint study was conducted by a representative each from the Water Users Association, Reclamation, and an outside consultant from the University of Texas. Scott Etter, from Water Users, and Professor Taylor, from Texas, lambasted Reclamation for what they perceived were gross errors in managing the project, and assigning fees.[52]

Ironically, at the same time dissatisfaction was being voiced so ardently against Reclamation and the federal government, the Water Users Association, Carlsbad Commercial Club, Santa Fe Railroad, and New Mexico territorial and state governments were conducting a massive advertising campaign. The campaign was directed at attracting prospective settlers to the area, and gave glowing depictions of abundant water and verdant fields, well into the 1920's. Few land sales resulted from such propaganda.[53]

The controversy over fee payments was not limited to Carlsbad. Most Reclamation projects suffered from the inability of water users to repay the costs of construction and reclamation within the repayment schedule of ten years. The 1914 Extension Act, which increased the ten year repayment period to twenty years, also established a graduated schedule for smaller payments during the initial operating years of a project.

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50. R.G. 115, Box 4, vol. 3, 1916, 67-8, and 84, 85-119, 120-36; 1917, 13.
51. HAER, 115,116.
52. R.G. 115, Box 4, vol. 3, 117-25; see "Reports of Central and Local Board of Cost Review, Carlsbad Project".
53. *Ibid*., 115-7.

In 1924, the Second Deficiency Act classified all project lands "according to their potential to support a family and pay water charges". Repayments were based on land productivity. The twenty-year repayment plan was dismissed in favor of establishing annual construction charges at five percent of the average per-acre yearly gross income.

In 1926, Congress reduced the burden of construction repayments further with passage of the Omnibus Adjustment Act, suspending or writing off obligations on land unsuited for crop production. $14 million of debt on 185,000 acres of land was eliminated. The 1924 repayment schedule was scrapped in favor of a new forty-year maximum repayment period.[54]

Studies as far back as 1904, 1915 and 1916 entertained the notion of constructing a new dam to supplement McMillan's poor storage. Tracy and the Water Users were in favor of such an undertaking, as well as raising the height of Avalon in anticipation of McMillan's possible failure. Original proposals called for construction of a new dam between the two existing structures.

Reclamation, for the time being, decided against the location. Because of the porous nature of the cavernous limestone and gypsum in the region, there was no way to insure that a new dam below McMillan would fare any better. Reclamation engineers also disapproved of heightening Avalon Dam, and converting the lake into a storage, rather than distribution reservoir, for fear that the structure could not withstand the increased volume of water.

Little construction activity occurred between 1917 and 1934. Emphasis in this period was placed on improving the existing canal network. Maintenance required routine clearing of algae and mosses which thrived during summer months. Engineers calculated as much as a 65 % loss of total diverted water due to bothersome plants forcing water outside the canal banks.[55] A shortage of labor to clean the canals developed when almost all workers contracted a virulent form of influenza in 1917 and 1918. At least 100 persons died of the illness, according to undertakers' records.[56]

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54. Robinson, 42, 45, 46.
55. R.G. 115, Box 5, vol. 5, 1918, 42, and 1920, 48.
56. R.G. 115, Box 5, 1918, 17.

The year, 1919, was uncharacteristically prosperous for the project, as unusually large runoff into the Pecos provided farmers with water to produce the largest yields of alfalfa and cotton in the history of Carlsbad. The torrent of water from upstream runoff breached part of the Main Canal, but it did not cause major shortages of irrigation water.[57]

The routine maintenance of cleaning out canals and laterals, building weirs and improving culverts, and lining the Black River Canal with concrete continued into the 1920's.[58] Crews also began coating the metal flume on the Black River with tar to prevent oxidation.[59] In 1922, salt cedars were added to the list of nuisances, as were silt bumps and Bermuda grass clumps growing in some of the canals. The problem of salt cedars, or tamarisks, made the already inefficient system of canals and reservoirs even worse by stealing as much as 50 % of the water intended for irrigation.[60]

By the mid-1920's, cotton was the most prevalent crop on the project, followed by alfalfa. Reports for 1925, a dry year, show some 18,324 acres devoted to cotton and 4,311 acres of alfalfa[61], a huge increase over the 15,000 irrigated acres just 13 years before. Some years in the 1930's were very dry. In 1934, rainfall of only 6.79 inches caused the Pecos River disappear during August. Weak cattle had to be destroyed, while others were sold to the federal government. During the dry spell, the Federal Emergency Relief Administration took advantage of the low reservoir at McMillan, extending the east embankment 1600 feet, using 18,000 cubic feet of rip-rap and gravel.[62]

By the 1930's, Reclamation and the project water users had carried on a sort of love-hate relationship for twenty-five years. Reclamation greatly improved the total irrigation facilities of the lower Pecos. At the same time, they had not endeared themselves to locals who despised their loss of autonomy.

On June 30, 1932, voters of the Water Users Association voted unanimously for the

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57. R.G. 115, Box 5, 14, 15, 54-60.
58. R.G. 115, Box 5, 1920, 31, and 1921, 11.
59. R.G. 115, Box 6, vol. 6, 1922.
60. John H. Koogler, and O. J. Lowry. "Taming the Tamarisk", *Reclamation Era*, February, 1951, 37, 38.
61. R.G. 115, Box 6, vol. 6, 1925, 17.
62. R.G. 115, Box 7, vol. 8 1934, 14-6.

creation of the "Carlsbad Irrigation District". The newly created district had the authority to operate the government's physical plant, issue bonds for improvements to the system, and collect fees from landowners for use of the system. A transition period for operation and maintenance of the project between 1932 and 1938 was part of the understanding between Reclamation and the new district.[63] Yet, actual transfer of power did not occur until October 1, 1949, because local irrigation officials were reluctant to assume responsibilities.[64]

New Deal commitment to public works projects led to improvements at both McMillan and Avalon Dams. The Civilian Conservation Corps (CCC) established a camp just north of Carlsbad in August, 1934. During 1934 and 1935, the CCC was employed to upgrade McMillan's east embankment to arrest some of the seepage of water through gypsum formations. The CCC placed 43,000 cubic yards of earth, and 9,400 cubic yards of rock along McMillan's east bank by hand.

In late 1935, the CCC began work to raise the height of Avalon Dam six feet. The channel at spillway number two was widened and strengthened.[65] In November, 1937, CCC crews returned to McMillan following a 1937 flood, and added compacted earth fill to the dam's upstream slope. Three feet of rock riprap were placed on top of the fill. A concrete apron was poured below the dam's headgates, with most work completed by spring of 1938.[66]

As work commenced at Avalon and McMillan, plans were finalized for construction of Alamogordo Dam upstream to supplement water supplies for the Carlsbad Project. The state of Texas expressed concern over the proposed project, fearing the loss of water for their own project at Red Bluff, just south of Carlsbad, in Texas. An early water agreement, the Pecos River Compact of 1925, caused more dissent between the two states than cooperation. Before Carlsbad could get its new dam, Texas must be appeased.

The Alamogordo Agreement signed August 2, 1935 between interested parties in Texas and New Mexico was never formally signed by either state legislature, but it allowed

63. HAER, 147.
64. HAER, 157.
65. R.G. 115, Box 7, vol. 8, 1935, 4.
66. *Ibid*., 151.

construction on Alamogordo to begin. The agreement stipulated that no more than 76,000 acres of the Pecos Basin would be irrigated in New Mexico. Texas would receive any surplus flood waters. Following this agreement, the Alamogordo Dam was formally authorized in late 1935 as a work relief project financed with $ 1,000,000 from the Emergency Relief Appropriations Act. The Carlsbad Irrigation District approved an additional $ 2,500,000.

Construction of Alamogordo Dam began on March 5, 1936 with the employment of 900 men, under contract to Hallett Construction Company, of Crosby, Minnesota. Work was largely completed in mid 1937, allowing CCC crews downstream at McMillan to finish their work while Alamogordo filled up. The dam was of earth and rockfill design, 149 feet high and 1600 feet long. Features of the structure included an open concrete spillway and primary outlet works, a sixty-nine foot high intake tower and 581 foot long diversion tunnel.[67] Upon completion, the reservoir was 15 miles long, with a capacity of 157,000 acre-feet. As the primary storage facility of the Carlsbad Project, Alamogordo released water one to five times per year, depending upon rainfall and drought conditions. Water was then held at McMillan or Avalon to be released into the canal system.

Work elsewhere on the project continued. The CCC continued their renovations, improving the Pecos River Flume and lining numerous canals and laterals with concrete.[68] The previous year, their assistance was vital in reinforcing the McMillan Dam with sand bags following floods in May and September.[69]

In the 1940's, the Bureau of Reclamation addressed the long standing problem of water loss at McMillan Reservoir. One of the problems that had developed over the years, besides seepage into porous rock, was siltation at the reservoir's inlet. Additionally, salt cedars, or tamarisks had inundated this end of the reservoir and were stealing large amounts of the lake's water through transpiration. In 1940, the National Resources Planning Board estimated that 14,000 acres of salt cedar in the McMillan Reservoir Delta consumed 54,000 acre-feet of water

67. For a detailed description of the construction project at Alamogordo (Ft. Sumner), see R.G. 115, Box 7, 1936, 14-71.
68. *Ibid*., 152-5.
69. R.G. 115, Box 7, vol. 8, 1937, 9.

each year. Given the water usage of the time , the amount added up to ½ the amount project farmers used to irrigate crop lands.

By 1948, the situation was so bad near McMillan Reservoir, that Reclamation made the area an outdoor laboratory to eliminate the pests. The particular species of tamarisk causing so much trouble was imported into the western United States from the Mediterranean at the turn of the century. The shrub, which grows to 15 feet and resembles a dozen tightly packed Christmas trees, invaded the Southwest, taking over grasslands, river channels, and reservoir deltas.[70]

The Bureau of Reclamation conducted a study from 1948 to 1951 to determine how to deal with the tamarisk situation. Crews sprayed herbicides from the air and on the ground in 1949, discovering the former method to work best. In the study, "Carlsbad Salt Cedar Control and Water Conservation Project", Reclamation concluded that selected herbicides could be used in fighting the trees, but that precautions should be taken so that crop lands were not affected by the chemicals.[71] In October, 1948, Reclamation decided to go around the problem, literally. By April, 1949, crews had rerouted the river channel almost five miles to accommodate the trees.

In October of 1949, the irrigation district assumed operation and maintenance responsibility for the project's plant and operations, excepting Alamogordo Dam at Fort Sumner. District officials launched an aggressive repair and upkeep program in 1950. Reclamation continued to advise the district, conducting numerous field studies related to water conservation and storage in 1950, 1957, 1960, and 1964. In 1964, Reclamation released a "Safety Evaluation Study" which evaluated the safety of Avalon and McMillan Dams. The study concluded that major floods would exceed McMillan's spillway capacity, resulting in flood waters overtopping the dam's crest. Neither McMillan nor Avalon could withstand such an onslaught of water, and failure was an unacceptable possibility.[72]

For almost 100 years, irrigation advocates and water users in the lower Pecos River

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70. John H. Koogler, and O. J. Lowry. "Taming the Tamarisk", *Reclamation Era*, February, 1951, 37, 38.
71. U.S. Dept. of the Interior, Bureau of Reclamation, *Salt Cedar Control and Water Conservation*, Soil and Moisture Conservation Operations, Carlsbad, New Mexico, March 1, 1953.
72. U.S. Dept. of the Interior, Bureau of Reclamation, "Brantley Project, New Mexico: Definite Plan Report." Amarillo, Texas: Bureau of Reclamation, Southwest Region, 1982.

valley had clamored for what had been long referred to as " Reservoir Number Three". For years, the proposed location of such a reservoir was between Avalon and McMillan Dams. A 1967 report containing the results of exhaustive studies on the shortcomings of the Carlsbad Project proposed replacing McMillan Dam and Reservoir with a new structure. Authorization for "Brantley Dam and Reservoir" followed the voluminous 1967 report, with an initial appropriation of $45,605,000 on October 20, 1972.[73]

Planning for Brantley continued throughout the 1970's. The project provided for several benefits besides irrigation. Designed to withstand siltation from the Pecos River, Brantley would provide flood control, recreation, and a haven for wildlife. By 1982, cost estimates had spiraled to $218,300,000, but Carlsbad Irrigation District's costs were limited to increased irrigation waters. Land acquisition, site clearing, archaeological studies, relocation of highways and utilities proceeded into the decade. Monterrey Construction Company began work in 1984. Concrete work was completed by 1987.[74]

Brantley utilized a concrete gravity center section flanked by rolled earth-fill wings. The concrete section reached 143.5 feet in height and was 760 feet long. The wings reached a height of 118.5 feet and had a crest width of 30 feet. Adding the wing length to each end of the dam brought the total dam length to four miles. A central overflow spillway controlled by six radial gates, allowed a maximum discharge of 352,000 cubic feet per second. The outlet works consisted of double four by four foot conduits capable of discharging 1,230 cubic feet per second.[75]

The completion of Brantley marked a milestone in the evolution of the Carlsbad Project. Thoroughly modern in design and construction, Brantley's concrete center and earthen wings added to the eclectic mixture of features on the project. Nineteenth century canals lined with twentieth century concrete, Avalon Dam, with its myriad improvements; McMillan, the reservoir built on a sieve; the 1937 Alamogordo Dam; and Brantley Dam reflect over 100 years of

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73. *Ibid.*
74. *Ibid.*
75. *Ibid*., II-4.

persistence in the face of adversity.

## Uses of Project Water

The Carlsbad Project was originally designed as an irrigation project. To that end, some 155 farms are irrigated on more than 25,000 acres, producing primarily cotton and alfalfa, but also wheat, barley, oats, and vegetables. Brantley and Sumner Dams are instrumental in controlling seasonal flooding along the Pecos River. Avalon Dam continues to serve as a distribution dam, providing water for irrigation and also for urban and suburban, residential, commercial, and industrial lands. The Carlsbad Project serves more than 30,000 persons on such lands.[76] The project also provides recreation at Sumner and Brantley. The latter was authorized by Congress "for 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." Also mandated as part of the original plans for Brantley, the State Parks and Recreation Commission operates recreational areas around the reservoir. A waterfowl mitigation area was established and is operated by the State Game and Fish Department.[77]

## Historical Significance

Carlsbad represents the evolution of American reclamation technology. Avalon and McMillan exemplified the rockfill composite design popular at the turn of the century, and were among the first in the United States with an earthfill facing. Avalon's cylinder gates, first used in 1911, represent a technological application which would be used in subsequent dams across the West, including Hoover. Carlsbad displays not only the transition from nineteenth to twentieth century technology, but also the evolution of private irrigation efforts into public-sponsored reclamation, and the creation of water districts. This evolution was not as tranquil as the waters trapped behind Brantley Dam, but the project's ultimate success helped to make a small portion of the "Great American Desert" bloom.

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76. U.S. Dept. of the Interior, Water and Power Resources Service, *Project Data*. Denver: U.S. Govt. Printing Office, 1981, 114.
77. Katz, and Katz, 3.

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