Coolidge Dam
Gila River
Peridot Vicinity
Pinal County
Arizona

HAER No. AZ-7

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

Historic American Engineering Record
National Park Service
Western Region
Department of the Interior
San Francisco, California 94102

HISTORIC AMERICAN ENGINEERING RECORD

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HISTORIC AMERICAN ENGINEERING RECORD

Coolidge Dam

HAER No. AZ-7

Location:	Located on the Gila River Peridot vicinity, Pinal County, Arizona
Date of Construction:	1925-1928
Engineers:	Herbert V. Clotts, J. A. Fraps, H. C. Neuffer, Charles Real Olberg, W. M. Reed, E. L. Rose, Robert H. Rupkey, Clay H. Southworth, and M. R. Trenam of the U. S. Indian Irrigation Service
Present Owner:	U. S. Government
Present Use:	Coolidge Dam presently stores Gila River water for use by the San Carlos Irrigation Project (Gila River Indian Reservation) and the San Carlos Irrigation and Drainage District (anglo community).
Significance:	Coolidge Dam remedied the water need of the Pima and Maricopa Indians on the Gila River Reservation as well as providing water for the neighboring anglo community. Structurally, Coolidge was the first, and perhaps only, dam to use a multiple dome design
Historian:	David M. Introcaso Salt River Project Archives 1986
Transmitted by:	Jean P. Yearby, HAER, 1987

Water Development on the Gila River: The Construction of Coolidge Dam

By

David M. Introcaso

Introduction

Historically, large scale irrigation projects constructed in the arid West have been developed by the U.S. Bureau of Reclamation. The Salt River Project, Arizona's largest water storage program, was built in central Arizona by the Bureau, then known as the Reclamation Service, shortly after the turn of the century. The Bureau's activities, however, did not extend south of the Salt along the Gila River. The compoundment of Gila water was the product of efforts undertaken by a federal agency not typically known for building large storage works. Coolidge Dam, a unique multiple dome dam constructed on the Gila, was built by the U.S. Indian Service.

The flow of the Gila, perennial over a century ago and more substantive than most ephemeral desert streams, historically served the native lands of the Pima and Maricopa Indians. These tribes cooperatively dwelled undisturbed along the river's banks

in central Arizona prior to the initial arrival of the European. With the sustained incursion of anglo settlers, principally American, beginning in the mid-nineteenth century, the Gila's water resources became sought by new and competing interests. Unfortunately, the limited natural flow of the Gila could not adequately serve both Indian and anglo communities, particularly in a desert region of scarce rainfall and virulent heat. Competition for the Gila's flow quickly developed and favored the American settlements since they were established upstream from the Indian lands. These American settlers appropriated an ever-increasing amount of the river's water through the homesteading of public lands. This activity impinged upon Indian water use resulting in persistent shortages for the tribal groups through the turn of the century.

Despite the immediate realizations that the Gila River could not sustain both societies; that the tribes, because of their location, would be the victims; and that additional developed water would be the only practical solution, the Indian Service struggled unsuccessfully to restore the tribes' water supply for sixty years. Coolidge Dam, finally authorized in the 1920s, provided stored water to remedy the Pima and Maricopa tribes' water needs and solved the conflict between water users. The story surrounding the development of water resources on the Gila River was not the typical narrative of reclaiming public lands for settlement.

The Gila River Indian Community and Initial Anglo Incursions

The Pima and Maricopa Indians cooperatively flourished from time immemorial along the Gila River, in what is today central Arizona. Through the centuries, they successfully developed an extensive and complex community predating the Spanish incursion into the region. The Pimas and Maricopas adapted to a region that, until relatively recently, was considered unable to sustain prolonged residence. They developed an extensive irrigation system along both banks of the Gila River. These tribes diverted the water of the Gila through the construction of several brush dams and acequias or irrigation canals. They annually cultivated thousands of acres of riparian land yielding abundant harvests of corn, millet, squash and melons. The Pimas and Maricopas lived along the Gila River leading a peaceful and sedentary agrarian life relatively free from foreign intrusion, pestilence and disease. Their only nemesis, a late arrival into the region, was the predatory Apache Indian.1

The first recorded non-Indian to explore the Gila River region was the Spanish Jesuit, Fray Marcos De Niza. DeNiza's 1539 expedition was followed by additional Jesuit missionary excursions, most noteworthy that of Eusebio Francisco Kino who made four expeditions into the area between 1694 and 1699. Kino was probably responsible for introducing cattle and various

foodstuffs, including wheat, to the Pimas. This had a major impact on the Pima economy because wheat served as a winter crop. The Pimas also became familiar with the use of Spanish metal tools. Despite these influences, however, Spanish culture did not overwhelm the Pimas since no Spanish missions, presidios, colonies or mines were established in Pima territory.2

Through the treaty of Guadalupe Hildalgo in 1848 and the Gadsden Purchase in 1854, Mexico ceded and sold a vast tract of land to the United States. Under the terms of the treaty, Mexico surrendered approximately two-thirds of its pre-war territory, nearly 1.2 million square miles. Much of what is known today as the Southwest - New Mexico, Arizona, California, Nevada, Utah and parts of Wyoming, Colorado, Kansas and Oklahoma - was acquired. The U.S. added another 29,000 square miles to the New Mexico Territory through the Gadsden Purchase. These acquisitions, Gadsden's particularly, were at least somewhat motivated by the need to provide the East with an all-weather route to the West. Although these new lands presented a foreign and severe desert environment, they were not uninhabited. The U.S. had indiscriminately acquired the aboriginal lands of several native American tribes in the New Mexico Territory through these agreements. These acquisitions included the lands of the Pima and Maricopa Indians.

With American suzerainty was established over the region, the federal government, acting under its trust protection duties,

reserved lands for the Pima and Maricopa tribes. Congress authorized the creation of the Gila River Reservation in February 1859. The legislation provided approximately 64,000 acres of land along both banks of the Gila River for the Indian tribes. Water resources were not mentioned, standard practice in acts appropriating lands for Native Americans.3

The first anglos to travel into the Gila River Basin were fur trappers. They entered the region in the 1820s, several decades before the establishment of American dominion. Immediately prior to the war with Mexico (1846-1848), General Kearny's Army of the West travelled through the Gila valley and the Pima lands in 1845. The next year, the Pimas were visited by Philip St. George Cooke and the Mormon Battalion. Following these military expeditions, Americans continued to traverse the area to seek the fortunes of the California Gold Rush.4

The initial American encounters with the Pimas earned the tribe the reputation of being the most civilized Indians in the United States. This distinction was principally earned because the Pimas supplied migrating Americans with food and protection from the Apache Indians. "In fact," one historian has observed, "the Pimas became accustomed to look on the travelers as needy people seeking their charity." The extensive cultivation of their lands was noted by General Kearny, Colonel Cooke and many others. Their reports found the Pima lands to be richly and extensively cultivated and of "luxuriantly rich soil." Early

accounts also characterized the Pimas as being immeasurably honest and virtuous, "perfectly frank and unsuspicious" and adhering to the principles of industry, peace and cheerful contentment.5

Contact with Americans increased and the Pimas began trading their surplus foodstuffs with travelers, military units and a stagecoach line operating from St. Louis to San Francisco. The Pimas cultivated a maximum of approximately 15,000 acres and sold to the Butterfield Overland Mail Line 100,000 pounds of wheat and large quantities of vegetables in 1858. In 1859, 250,000 pounds of wheat were sold to Butterfield as well as beans, squash, melons and corn. In the same year, the Pimas sold an additional 220,000 pounds of wheat to trading posts and actively traded with emigrants and the frontier towns of Sonora. In 1860, more than 440,000 pounds of grain were sold to the mail line while another 40,000 pounds were sold to trader Ammi White to supply Fort Breckenridge. In 1861, White obtained 370,000 pounds in wheat, pumpkins, corn and beans. In 1862, the Pimas supplied General Carleton and the California Column with over one million pounds of wheat and other crops. In 1865, they again furnished one million pounds to the army and 1.5 million pounds in 1866.6

Beyond sustaining various groups by being the only producers of foodstuffs in the territory, the Pimas also served the white by protecting him from the aggressive Apache. From 1858 to 1873 the Pimas fought the Apache, their perennial enemy, either

through direct involvement with the U.S. Army or in independent action. After federal troops were withdrawn from Arizona in 1861, the Pimas were armed by a detachment of California volunteers. In 1864, Territorial Governor John N. Goodwin directly solicited the aid of the Pimas in opposing the Apache. In 1865, the Pimas made up a company of Arizona volunteers. In 1866, they campaigned against the Apache in eastern Arizona. From 1867 through 1871, the Pimas sent out their own war parties against the Apache and served as scouts for General O. O. Howard.7

The initial American experience into the Pima region was, in summary, relatively inconsequential. As transients, the Americans did not impinge upon the Pima lands nor compete for their resources. However, by successfully developing an agrarian community, the Pimas demonstrated that it was possible to flourish in a region that whites had considered to be an uninhabitable, sun-baked, waterless, weary waste. The generosity and early security provided by the Pima in sustaining the American made ultimately and ironically for the tribes' undoing. Gradual intrusion by American settlements in and around Pima lands and encroachment upon their water supply developed despite Pima assistance to pioneer Americans and their aid against the Apaches.8

Beginning of Conflict: American Settlements Along the Gila River, 1859-1885

The establishment of Anglo settlements in the Gila River region began shortly after the federal government reserved land for the Indian communities in 1859. Non-Indian development along the Gila was also the result of federal land policy. Beginning with the Homestead Act of 1862, the federal government promoted the settlement of western lands for agricultural development. The 1862 law and subsequent acts, including the Desert Land and Carey acts, offered any American 160 acres of surveyed public domain for a nominal fee. Federal land policy ran into itself along the Gila River. While the federal government attempted to protect the tribal communities by reserving public lands, it offered upstream sections for non-Indian development.

The first trouble signs concerning the settlement of Americans into the Gila River region and their effects on the Gila tribes was noted as early as 1859. Sylvester Mowry, special agent for the Office of Indian Affairs, stated in his report to the Commissioner of Indian Affairs, Alfred B. Greenwood, that "there are some fine lands on the Gila and any extensive cultivation above the Indian fields will cause trouble about the water for irrigation and inevitably bring about a collision between the settlers and the Indians." Mowry, showing certain

insight regarding the Pima's future, issued an apocryphal warning. In another letter to Greenwood he commented,

> The end of these people, like that of all the Indian tribes, is only a question of time. It is the duty of the government to preserve them, if possible, in their friendly attitude; to encourage and stimulate their industry, and not to hurry them, as long as they are peaceful, to their doom. The idea of civilizing and christianizing them, exposed as they are to all the influences of a frontier people, is the idle dream of a pseudo-philanthropist. The rapid development of the mineral resources of Arizona and the settlement of the Territory will bring them soon enough in contact with "the humanizing and civilizing influence of the white man," and the result will be the same inevitable one that has followed its contact with other tribes: the men will become drunkards, the women prostitutes, and disease will soon leave only the name of their race.9

Mowry's words clearly had no audience. Upstream water diversions on the Gila River began in the mid-1860s, ironically enough by men who would succeed Mowry as Indian agent. In 1864, Ammi White became agent for the Gila River Reservation. Realizing the profit to be made selling crops to miners and soldiers, White actively traded grain and operated a flour mill at Casa Blanca for four years. White also was involved in land speculation which resulted in the founding of the town of Adamsville, three miles west of Florence. White's successor was his commercial rival, Levi Ruggles, who also speculated in land. He founded the town of Florence. Of Ruggles' abilities as Indian agent, Army Assistant Inspector General Roger Jonesstated, "Mr. Ruggles, should be removed, for he has no influence whatsoever

with them, takes no interest in their affairs, except when presents are to be distributed, and is living on a ranch some thirty miles above the reservation." C. H. Lord, Ruggles' successor, attended his duties while residing in Tucson, sixty miles from the reservation. These agents apparently supported their own interests by participating in trade and land speculation while simultaneously ignoring and damaging the Pimas' interests which they were charged to protect.10

While the reservation was being administered by self-aggrandizing agents, the Pimas' interests were also threatened by the Territorial Governor, Richard McCormick. In his annual address in 1868, McCormick stated, "Tens of thousands of acres as valuable and easy of tillage as those now occupied remain unclaimed, and as the region is central, near to the reservations of the friendly Pima and Maricopa Indians, . . . it offers peculiar inducements to settlers . . . ."

By the end of the decade, approximately 500 settlers had settled upstream along the Gila River and were actively engaged in irrigation farming. In 1869, it was reported that settlers had "opened large acequias, with a view of diverting the water of the river for the purpose of irrigation." As a further irritant to the Pimas, these settlers did not permit excess water to reenter the Gila's water course but allowed it to run waste instead.11

In the same year, the reservation came under the military control of Captain F. E. Grossman. Unlike his predecessors, he did not participate in nor encourage upstream water diversions. Grossman gave an accurate assessment of the growing conflict over Gila water. In a report concerning the Pimas' situation dated September 1, 1870, he wrote,

> I found them dissatisfied and complaining bitterly that settlers on the Gila River, above their reservation, who have opened large acequias, were diverting the water of that river, for irrigating purposes, without returning to the river the surplus of this water, thereby greatly diminishing its volume before it reached the reservation. The Indians asserted that years ago they had been promised a settlement of the water question; claimed that the whole Gila River had been the property of their forefathers from time immemorial, and asked that settlers should not be allowed to occupy lands so long considered by the Indians as their property.
> After careful investigation and inspection of the reservation I could not avoid the conclusion that, while an agency had been established since 1859, and though the Government had expended thousands of dollars on behalf of the Pimas and Maricopas, little, if anything, had been done to aid in the education and elevation of these Indians, and, for all practical purposes, the moneys thus expended had been absolutely wasted.

Grossman's report also confirmed Mowry's earlier warning. The extensive amount of travel through the area by settlers had a demoralizing effect upon the Pimas. "They have adopted the worst vices of the white man," Grossman wrote. They "are inordinately fond of gambling and intoxicating drinks, and their women, proverbially virtuous ten years ago, have been debauched by bad men, and attending diseases prevail to an alarming extent."

Grossman, to his credit, instituted several reforms. He required that all traders on the reservation be licensed. He also ordered the construction of permanent agency buildings at Sacaton, at which all subsequent agents would reside. He employed a physician, blacksmith, carpenter, farmer, and interpreter and conducted a census. He also stated that he prevented the sale of liquor to the Indians.12

Upstream appropriations adversely affected the Pimas, resulting in a decline in their agricultural production. Wheat, barley and corn production all began to fall off. Compounding the Pimas' difficulties was the initiation of a dry cycle which began in 1868 and persisted through 1873. The Pimas' reaction to these hardships was predictable. They began to seize American livestock and crops. Grossman reported that, "Settlers who have, during the past four years, cleared and cultivated large tracts of land on the Upper Gila and Salt River are being robbed periodically by marauding bands of Pimas and Maricopas." Grossman stated that 400 Indians moved near Adamsville in November 1869 and harvested the corn and bean crop of settlers and "in one instance attempted to collect some rents from some Mexicans for lands not belonging to the reservation." Pimas were also held culpable for "immense damage" because their livestock, which had never been herded, roamed at will and consequently trammeled settlers' fields.13

While the Pimas drifted into "vagabondism," Grossman proposed that the solution to the Pimas' situation would be to extend the boundary of the reservation. The Pimas had never been satisfied with the boundary limitations established in 1859. They had claimed a far greater territory. Grossman believed extending the reservation would pacify the Pimas.

A new survey of the reservation was undertaken in the fall of 1869. The survey concluded that 81,140 acres should be added to the reservation. These new lands could be obtained by satisfying the claims of only twenty five settlers to the extent of $30,000. These additions, however, did not satisfy the Pimas. They asked for an additional 5,200 square miles. The Superintendent of Indian Affairs for Arizona, Colonel George Andrews, endorsed both extensions because it would remedy the incidences of Pimas depredating non-Indian lands and because the reservation extension would not overly conflict with settlers' claims.

Nevertheless, the reservation extension was not immediately granted. Despite the support by Grossman and his successors, the continuing drought and further Pima incursions onto settlers' lands, neither Congress nor President Grant approved the new boundary. The Territorial governor, A. P. K. Safford, reflected the government's mood when he stated in 1871 that the Indians already had sufficient lands and that "this extension deprives many honest, industrious citizens of their homes and all they have, and throws just so much more land open to uncultivation."14

Because of governmental indifference, the extension of the reservation did not take place for several years. In the interim, the Indian Affairs Office neglected the Pimas' water need. While maintaining that "the Government manifests in every way a desire to care for and protect those Indians . . ." and emphasized that the question of the supply of water remained "paramount to almost every other consideration," the Indian Service did nothing to ensure an adequate supply. The Pimas adopted their own solution. They began to leave the Gila River and move north to lands near the Salt River. Several hundred Pimas moved to lands near those of white settlers. Once again they plundered anglo fields and in several instances actually took possession of settlers' homes and destroyed them.

By 1872, 1,000 Indians were living on the Gila above the eastern boundary of the reservation and 1,200 more were residing in various places outside the lines of the reserve. Only 3,200 Pimas still farmed on the reservation, in part because the government supplied them with barley seed. But Grossman stated that these Pimas also would soon have to leave the reservation due to insufficient water.15

The dispersal of the Pimas from the reservation brought them into more frequent and intense conflict with settlers. Two Pimas were murdered by whites in 1872. One, who had moved to the Pima settlement on the Salt River, was killed while he slept in his hut. The other was killed five or six miles east of the

reservation. A year later, the son of Antonio Azul, chief of the Pimas, was stabbed in the heart while attending a dance at Adamsville. The Pimas retaliated the next day, fatally clubbing the detained suspect.16

In 1871 and 1872, further petitions for relief were made to Washington, but no solutions were forwarded. Brigadier General O. O. Howard, on an inspection tour of Arizona and New Mexico, suggested three options as solutions to the Pimas' water shortage. He proposed that the government should acquire lands in the vicinity of Adamsville, extend the reservation above Florence and take in both Florence and Adamsville, or construct two canals high enough up river so that a government agent could make a fair division of Gila water. None of Howard's proposals were approved.

By 1873, with no remedy forthcoming, even the Pima agent began to express his frustration. Grossman's successor, J. H. Stout, commented, "The water question is with us an almost threadbare subject." In a few years, he stated, upstream users would appropriate all the water the river afforded. With the boundary extension as yet unapproved, Stout recommended that the Pimas be removed to the Indian Territory where they could be furnished an adequate water supply.17

Pima Chief Antonio Azul and a delegation of Pimas agreed to visit a resettlement site in the Indian Territory. Despite being "much pleased with the visit," the Pimas refused to move because

of the objections of the older Indians. The decision to remain on the Gila may have also been due to an adequate amount of rainfall in 1874 and 1875. The Pimas were able to produce 50,000 bushels of wheat, 4,000 bushels of barley and 500 bushels of corn in 1874. The sufficient water supply encouraged many of the Pimas who had left the reservation to return and no raids on settlers' lands were recorded. Unfortunately, the brief respite from drought did not last and the Pimas' predicament soon returned.18

On August 31, 1876, President Grant finally annexed 9,000 of the 81,000 acres requested for the reservation. These lands, located at Blackwater just above the previous reservation boundary, were better-watered and Agent Stout commented that Grant's executive order, "was an act of justice and wisdom which came none too soon." Grant's action, however, had a negligible effect. It provided the tribes neither a solution nor relief to their water needs.

The Pimas were already occupying the Blackwater lands. The situation grew much worse because the region was experiencing its second drought in a decade. As a result, the Pimas were forced to completely abandon the western reach of the reservation as it became, as Stout reported, "a dry, barren waste." Stout added that half the Pimas, approximately 2,500, had now left the reservation. Some had taken employment with American and Mexican settlers or resorted to hauling wood from the reservation north

to Mesa, Tempe or elsewhere to earn a living. Those who had remained on the reservation scarcely had enough water to drink, "much less afford them the means of producing food." Stout wrote that the Pimas were reduced to either foraging for mesquite beans or were engaged in begging and petty pilfering, managing "to eke out a precarious existence."19

By the mid-1880s, external pressures on the Pimas had become even more complicated and threatening. The settlers of Adamsville and Florence had constructed twelve ditches and were irrigating 6,000 acres. Mormons began to colonize the Upper Gila River Valley in Graham County in the Solomonville-Safford Valley. As early as 1873, they had appropriated Gila River water and, by 1890, had approximately 16,000 acres under irrigation. The construction of a railway line through the Gila River Basin by the Southern Pacific Railroad in 1878 encouraged the influx of settlers, particularly in the Casa Grande area. Mining development in the region also contributed to competition for water. The Desert Land Act of 1877 had also attracted widespread land speculation in the territory. Pima existence on the Gila now became precarious as developing settlements of anglos continued to exacerbate the situation.20

With no real solutions forthcoming from the Indian Office, Washington again attempted to provide relief to the Pimas by extending the reservation boundary. In January 1879, President Hayes added lands to the reservation which included parcels south

of the towns of Phoenix and Tempe. President Hayes revoked parts of his order five months later, however, after the Arizona legislature sent a message to Congress condemning the original action. Hayes returned all lands to the public domain except for an area on the Salt River which the Pimas had recently inhabited. These lands were reserved for the Pimas as the Salt River Reservation. In 1882 and again in 1883, President Chester Arthur enlarged the Gila River Reservation, bringing the total area to 357,120 acres. Despite these good intentions, annexing desert lands to the Gila Reservation did not solve the Pimas' water shortage.21

After years of water shortages, Pima society had degenerated to its lowest point. Agents' reports were replete with evidence of social deterioration. By 1877, intemperance among the Pimas had already become "too deep-rooted to be easily eradicated." Agent Stout reported in 1878 that,

> With the increasing settlements which are springing up on our borders, and the growing difficulty, from want of water, of earning a living by honest labor, it is not surprising that some of the Indians should yield to the evil influences by which they are surrounded.

With the abuse of whiskey and tiswin, fermented cactus fruit, other undesirable behaviors, including prostitution, followed. Stout wrote that the "evil of intemperance," became a "more terrible foe than the dread Apache was." He added that,

> . . . it brings lasting misery and degradation to this people. No village or settlement is free from

> its curse. It robs women and children of the necessities of life, and murder follows in its train. Human beings are transformed into demons. It brings about in part the prostitution of the women of the tribes, an evil scarcely less terrible in its moral and physical effects.

It was difficult to get the Indians to inform on the illicit traders and no convictions against whiskey peddlers were obtained until 1884. Along with drunkenness, other offenses including adultery, abandonment, assault and theft were recorded. Special Agent Townsend, in an effort to control the situation, instituted an Indian Police force in 1883. The force's success was marginal. Disease among the Pimas also became prevalent. Consumption, conjunctivitis, scrofula and syphilis were "prevailing." Pima social demoralization and disorganization can best be exemplified by the Blackwater War of 1878-1879 in which the Pima settlements at Blackwater and Casa Blanca fought a "pitched battle" over water supplies.22

Relief came to the Pimas in the first half of the 1880s with the end of the second dry cycle in 1881. The Pimas' condition generally improved during these years as they were able to cultivate enough acreage to sustain themselves. By 1885, it was reported that the Pimas had brought 15,200 acres under cultivation.23

The Florence Canal and Federal Investigations, 1886-1895

The fortunes of the Pimas rapidly changed in 1886 as the residents of Florence, under the Florence Canal and Land Company, planned to divert the entire flow of the Gila River approximately fifteen miles above the reservation. Pima Agent Roswell Wheeler reported to the Department of Interior that if the diversion occurred it "would practically destroy the farms of the Pima and Maricopa Indians living on the river." The Department of Interior, under Secretary John D. C. Atkins, responded by referring the matter to the Justice Department. The Attorney General's Office in turn instructed the Geological Survey to investigate the canal's construction.

The Survey issued their report in June 1887. They made six determinations. Briefly, they found that the Pimas' water supply was no longer sufficient; that if the Canal Company realized its plans it would effectively control all the waters of the Gila; that the lands which could be supplied by the new canal greatly "exceed in area the amount that the river is capable of supplying" and if they established a water right the government would have to compete for water rights to supply the reservation; that the reservation would become "uninhabitable" without water; that if the dam and canal were constructed they could supply the needs of the reservation; and that if the Pimas were to have

"normal growth" the "greater part" or "perhaps the whole" of the Gila's supply would be necessary. The report concluded that the U.S. Attorney General's Office should take the necessary steps to prevent the canal company from diverting the waters of the Gila River.24

The Geological Survey's investigation made no observations that were not already apparent. However, the findings finally formalized the Pimas' predicament which the reservation agents had witnessed and reported for years. Despite the determinations made by the Geological Survey, the government did not take the necessary steps to prevent the Florence Canal Company from appropriating Gila River water. Instead, the matter remained unresolved between the Indian Office and the Attorney General for more than eight years.

In August 1887, the Indian Office reported to the Department of Interior that the canal company "had promised to enter into such stipulations as the Government might propose not to diminish the quantity of water then used by the Indians." In the following year, the Indian Office stated that if the canal company would not operate so as to deprive the Pimas of needed water, an army engineer would be dispatched to make such measurements to determine the amount of water needed to maintain the Pimas. According to the evidence, this was never accomplished.

Nothing was done to remedy the situation partly because the Indian Office, having instructed the Justice Department to apply for an injunction against the canal company, believed that the matter was now a legal one and "out of the hands of the Interior Department." Three years later the Indian Office inquired into the matter and asked the Justice Department what measures had been taken. The Acting Attorney General stated that legal action had been delayed "awaiting the arrival of the president of the company" in Washington.

The Justice Department did not file to stop the canal company because the department also held that they needed to make a scientific assessment of the injury done to the Pimas. The Justice Department stated that, "information was needed as to certain physical features connected with the actual amount of water theretofore used by the Indians, and as to what part of them the canal would cut off; that as matters then stood they were not by any means in such shape as to proceed summarily to a suit . . . ." In March 1891, the Indian Office ordered Agent C. W. Crouse investigate the canal company's plans. A year later Agent Crouse was directed to report his findings. For unexplained reasons, no report was made.25

The Justice Department thought legal action would be ineffective because, they argued,

> . . . although such a suit might result in a favorable decision, there would be no real benefit to the Indians, for the reason that there is no

> water in the Gila River within 30 miles of the reservation lands, and that even when there is water at the head of the Florence Canal, if the same were allowed to flow down the river it would sink into the sandy bed thereof, and never reach the Indian canal.

The government's reluctance to file suit against the Florence Canal Company was probably the result of the position taken by O. T. Rouse, U.S. Attorney for Arizona. Rouse thought that the construction of the canal would have no "perceptible effect on the flow of the water in the bed of the river," even though the canal company planned on irrigating 60,000 to 65,000 acres. Rouse apparently never visited the reservation nor spoke to its agent. Rather than pursuing the legal question of the reservation's water need, he recommended that the Pimas become dependent upon the canal. Rouse's position was markedly different in 1888. When he learned in that year that another company was attempting the construction of a canal on the Gila across the reservation, he promptly issued arrest warrants and initiated court action. Rouse's incongruous behavior suggests that he sympathized with the Florence Canal Company, or as one historian concluded, "was either in on the enterprise, offering advice, or both."26

By the mid-1890s, the Pima's condition was again deplorable. Indian Agent J. Roe Young wrote that the Florence and other canal companies, "like parasites," had completely exhausted the river's flow and that the only water to reach the reservation was small

amounts of subsurface water which naturally flowed to the surface in some places. In 1893, Agent Crouse reported that, "We are almost in the midst of a war. The Indians of the villages of San Tan and Sacaton Flats - about 1,000 Indians are determined to fight in regard to the use of the water of the north branch of the Gila River." In 1896, Agent Young reported in frustration to the Indian Office

> Nothing new can be said on this important subject. It has been discussed and viewed from every reasonable standpoint, and enough has been written about the need of water for the starving Indians to fill a volume. It has been urgently presented to your honorable office time and again, and yet the need of water is just as great and the supply no greater than in past years. Until the time comes when the government is ready and willing to come to the assistance of its wards I consider any further discussion of the subject unnecessary.

Indian Inspector C. C. Duncan issued a report on the Florence Canal Company in 1894 and found that the company had not honored its resolution to protect the Pimas. Duncan learned that the company had gone into receivership and that the receiver would neither agree to supply water to the Pimas nor admit that the canal's diversion deprived the Pimas, arguing instead that the diverted water would never have reached the reservation in any case.

By 1895, the Pimas were unable to raise a crop and were issued 225,000 pounds of wheat to prevent starvation. Indicative of the Pimas' situation was the criminal case of Wee Paps, convicted of theft. At his trial Paps stated, "I will not beg,

but my wife and children were hungry, and I must either steal or they must starve. So I took the horses and traded them for grain, and the hunger of my family was satisfied. You can do with me what you will, I have spoken." Appropriations of Gila water became so complete that even the Florence Canal Company had begun to run short of water owing to upstream diversions in Graham County.27

Further Investigations, 1886-1901

In the spring of 1895, Agent Young again recommended that the Indian Office dispatch a competent engineer to determine whether an adequate water supply could be obtained and retained permanently for the Pimas and, if so, to recommend the most practicable and economical method. Unlike previous similar attempts, Young's petition was accepted. In the fall of that year, the Indian Office approved $3,500 for an investigation to be made by the Geological Survey under hydrologist Arthur Powell Davis.28

The Survey's report was issued in November 1896. Davis found it "unquestioned" that the Pimas' water supply was "materially decreased by the construction of the Florence Canal." He concluded that the construction of a dam at a site called the Buttes would be the best remedy to restore water to the Pimas.

Davis preferred a storage dam rather than a submerged dam or a groundwater pumping system. The idea of a submerged dam was thought to be "chimerical." His study showed that a pumping system would not "furnish sufficient water to be of relatively great importance to irrigation." This fact should be well noted considering events that would follow. Davis wrote, "The cost of pumping from wells is so very much greater per acre foot than the cost of either of the two storage propositions that it is considered prohibitive." "There is therefore no question," Davis concluded, "but that, for the provision of this quantity of water, the construction of the Buttes reservoir is by far the cheapest method in the end." Davis recommended that $221,000 should be made immediately available for the construction of a storage dam.29

Davis' report also included transmittal comments by Frederick H. Newell, hydrographer for the Geological Survey and later the Commissioner of Reclamation. Newell's statement is of particular interest because it outlines a popular position of the period which justified upstream appropriations. Newell stated that "some decisive step must be taken" to remedy the Pimas' water crisis. He argued, however, that upstream users had been appropriating water for years, thus acquiring a right to Gila water because they had put the water to use improving lands above the reservation. It would be "the height of injustice," Newell held, to deprive these users of their rightful allocation. He

also stated that it would not be commonsense to allow water to pass upstream to reach downstream users because a significant amount of water would be wasted by evaporation and seepage. Newell concluded that, "several acres well tilled by white men would thus be destroyed for the benefit of one acre poorly worked by the Indian."30

The Geological Survey authorized an additional study in 1898 because Davis was unable to conduct an adequate exploration of the bedrock at the Buttes site, having returned to work on the Nicaragua Canal Committee. This investigation, conducted by Joseph B. Lippincott, found the depth of bedrock at the Buttes site to be too deep, up to 122.6 feet, to excavate for foundation work. As a result, he searched for additional dam sites further upstream. Four sites were found: Riverside, twelve miles above Buttes; Queen Creek, eighteen miles above Riverside; San Carlos, forty-two miles above Queen Creek; and Guthrie, thirty miles northeast of the town of Solomonville.

The San Carlos site was found to be the most favorable because of the character of the foundation, the type of dam planned for the site and the economy of construction the canyon afforded. The dam was planned to be one hundred and thirty feet high and to impound 241,396 acre feet of water. Its construction cost would be approximately one-third the cost per acre of the proposed Buttes Dam. Lippincott concluded that a large reservoir

should be built because of the excessive amount of silt that the Gila carried.

Lippincott thought that the government should deliver water to the Pimas free of charge and sell the remainder of the impounded water. He stated that,

> The argument in favor of the construction of a reservoir for the storage of the waters of the Gila River by the United States Government is stronger, perhaps, than for any other project in the country. In the present case we have a tribe of Indians who have for centuries been engaged in agriculture by irrigation, and who were until recently the only successful irrigators in Arizona. These Indians have been deprived of their water supply through the agency of the white man, directly encouraged by the U.S. Government.

"It is," he concluded "an imperative obligation of honor that their supply should be restored to them . . . ." Lippincott recommended that the San Carlos Dam be built; that the water impounded be delivered free of charge to the Pimas; and that the government form a federal irrigation district for the diversion of the water and the construction of a delivery system.31

Three additional studies were conducted subsequent to Lippincott's effort. James D. Schuyler, consulting engineer to the government, made eighteen recommendations. He found that it was not feasible to build at the Buttes site because of the "rotten quality of the rock, the great depth to bedrock and the excessive height of dam required to obtain a storage of 174,000 acre feet." Because of silt, the Buttes site would only have an effective life of eighteen years. The San Carlos site, however,

could provide a dam with a storage capacity of 550,000 acre feet with a probable life of sixty three years. Therefore, Schuyler also recommended that the San Carlos Dam be built. The second study determined the total runoff of the Gila and the amount diverted by the canal companies above the reservation. The third study was conducted by the Indian Office's Inspector of Irrigation, Walter H. Graves, who was experienced in Indian irrigation, having supervised work on the Crow Indian Reservation in Nebraska. Graves was ordered to determine the feasibility of an irrigation ditch system for the Pimas in the event that Congress passed legislation authorizing its construction. Graves' findings, surprisingly, were in complete opposition to the previous studies. He stated that the San Carlos plan was impracticable and the cost enormous. Concerning a system of irrigation ditches, Graves stated that they would be useless without a storage dam. Graves recommended a groundwater pumping scheme instead.32

By 1899, considerable resources had been allocated to study the Pima issue and all but Graves had arrived at the same conclusion, build a storage dam. The necessity for government intervention was more apparent than ever as relief for the Pimas was now costing the government approximately $70,000 annually. Legislation for the construction of a dam was finally presented to Congress in December 1899 by Arizona delegate John F. Wilson as House Resolution No. 3733.

Wilson's motive in presenting the legislation was not based on a newly-found altruism on the part of the territorial government, but rather on a realization by territorial officials that excess water would be available to non-Indians. The bill was supported by various groups including the influential National Irrigation Congress which had supported the construction of a dam on the Gila as early as 1896. The bill was favorably endorsed by the Office of Indian Affairs in April of 1900 and many others believed it would be successful. One observer commented that "the dam is bound to be built." Nevertheless, the bill failed. Its most vocal opponent was Senator Platt of Connecticut. The eastern senator saw the legislation as a simple matter of special interests. His attitude was most evident in regard to the Geological Survey's investigation under Lippincott. He stated, "This is the 33rd paper which the Geological Survey has inflicted upon Congress in pursuance of their determination that the Government shall engage in the business of national irrigation." Platt preferred Graves' recommendation to install a groundwater pumping system because it would not require the federal government to finance a water storage project.33

Graves' report destroyed the consensus on constructing a dam at San Carlos. He created sufficient doubt regarding the dam's feasibility despite his statement that he actually did not object to the project. Regardless, both engineers A. P. Davis and Frederick Newell blamed him for the dam's defeat. The Indian

Office, maintaining that Graves was a "thoroughly skilled engineer," authorized him to test, on a small scale, a pump system on the reservation at Sacaton.34

As the Interior Department continued to investigate the Pima water shortage, the Casa Grande Canal Company, previously the Florence Canal and Land Company, proposed the sale of their canal along with the Picacho Reservoir, "the largest reservoir for storage of water in the West," to the government for the benefit of the Pimas. In May of 1901, Oren B. Taft, the company's president, in a letter to William A. Jones, Commissioner of Indian Affairs, stated that the canal company had "the lawful right . . . of taking from the Gila River practically all of the water that the river will carry." "There is no possible way to put water onto this Indian reservation," Taft stated, "except through the channel of this canal." He concluded, "We are convinced that it is the cheapest and only practicable way of furnishing the Pima Indian and their reservation with water." The sale of the canal for $150,000 to $200,000 would, in Taft's words, "undoubtedly relieve the Government at once of the charge that is now, and will continue to be made against it, of permitting its Indians to starve or be degraded to mendicants."35

The sale of the Florence Canal and Picacho Reservoir was rejected by the Indian Office. Taft only proposed the sale of the canal because it was dry due to increased appropriations further upstream. Agent Crouse recognized this fact in 1900,

commenting, "if the Florence Canal were valuable property it would not be for sale," adding sarcastically, "if the Whites, with their superior intelligence, can not make it profitable we ought not expect the Indians to do so." Beyond attempting to defraud the government, Taft's legal claim to Gila water was completely spurious. Appropriating Gila water for ten years, as he boasted, did not demonstrate the legality of the activity. In addition, Taft was partially responsible forthe unfortunate condition of the Pimas.

Authorization of the Federal Reclamation Act: Salt River Versus the Gila River

In 1902, the federal government committed itself to a program of federal reclamation with the passage of the Hansbrough-Newlands bill as the National Reclamation Act. The act provided for the federal construction of irrigation works in the seventeen states and territories west of the 100th meridian funded through the receipts from sales of public lands in those states. With the federal government now committed to national irrigation, many believed the San Carlos Project would certainly be selected. Proponents were confident that Secretary of Interior Hitchcock would choose it as one of the government's first irrigation projects because he had favorably reviewed the project in 1900.

The Geological Survey also maintained consistent support. Even detractor Graves "recanted his opposition" to the San Carlos project. Evidence that the project might come to fruition came with the Secretary's restriction against settlement on 100,000 acres between Florence and Casa Grande in the same year.36

In 1903, Hitchcock selected four reclamation projects located in Montana, Nebraska-Wyoming, Nevada and Arizona. Arizona's project, however, was not on the Gila River. The Secretary chose to approve the Salt River Project by authorizing a masonry dam to be built on the Salt approximately sixty miles northeast of the Phoenix valley. The Gila Project's defeat, bitterly received by the residents of Florence, should not have been a surprise in light of the political nature of Hitchcock's decision. Hitchcock chose the Salt River site because the residents of Phoenix simply outmaneuvered the farmers of Florence by effectively organizing themselves and "campaigning" for approval.

Phoenix farmers, organized as the Salt River Valley Water Users Association (SRVWUA), actively and eagerly sought passage of the Reclamation Act and authorization of their project. The Water Users retained George H. Maxwell, an irrigation specialist from California, to lobby their cause with officials in Washington. Maxwell's role should not be underrated. His work extended through several Congresses and he has generally been credited with successfully persuading Congress to include "private lands" in the Reclamation Act. Although the residents

of the Gila Valley had formed the Casa Grande Valley Water Users Association in November 1902, nine months after the formation of the SRVWUA, they were too late to be politically effective and did not have a representative with Maxwell's persuasive abilities.

In addition, since construction costs would have to be repaid, the farmers of the Salt River mortgaged approximately 200,000 acres of their land against the costs of a Salt River Project. Maxwell, Association President Benjamin A. Fowler and Maricopa County officials were very effective in promoting and finally convincing the federal government to investigate the Salt River site and eventually select their project.37

Several additional interpretations have been suggested to explain the defeat of the San Carlos Project. The only strong argument seems to be that the Reclamation Service wanted their first massive project, the Salt River Dam, to showcase the Service's engineering expertise and the significance and necessity of the Reclamation Act. Building an irrigation project for Phoenix would therefore best illustrate the Service's ability to conquer arid America. Other explanations include Arthur Davis' investigation of 1901 which concluded that the Salt River site was "especially favorable" for a dam because the Salt did not present the sedimentation problems that the Gila suffered. The Salt River Valley had a more developed canal system, while their water rights did not seem to be as muddled as rights to the

Gila. Finally, it has been argued that the Reclamation Act stipulated that projects were to be selected in relation to the amount of monies deposited in the federal treasury from the sale of public lands in each state. Since Arizona had contributed little money in relation to other public land states, Arizona residents could only be certain of having one project selected. Therefore, the Service selected the "better" site in Arizona.38

Water Development Through Groundwater Pumping and the Sacaton Contract, 1903-1911

In August 1903, all investigations by the Reclamation Service along the Gila ceased. Work there "was relegated to a secondary project pending further investigation." Inasmuch as the San Carlos Project was defeated, Graves' replacement, Chief Irrigation Inspector William H. Code, was authorized to construct five wells at the Indian School farm at Sacaton. Code, like his predecessor, believed that a dam for the Pimas would be "wasteful and unsuitable to the needs of the Indians."39

Meanwhile, legal measures to restore a water supply to the reservation were again considered in 1903. In a change of policy, the Indian Office now desired to take an active role in any potential adjudication. They stated that, "any course of procedure determined upon by the district attorney would meet the

approval of this Office, and that it would recommend the payment of any expenses connected therewith approved by him and the superintendent in charge of the Pima Agency."

However, litigation was again discouraged, most directly by Pima Agent J. B. Alexander. In 1904, Alexander, after conferring with the District Attorney, stated that regardless of a favorable judgment which could be expected, the costs of adjudication, $20,000 to $30,000, were too high and a court opinion would not bring the Pimas any water because the court could not enforce its ruling. Alexander apparently saw no need to restore the Pimas' water supply. In his 1904 annual report, he found that despite no rainfall in over a year, resulting in no agricultural achievements, the Pimas had been making steady progress, finding employment working on the railroad, on farms, and in adjacent towns. He found no starvation on the reservation, concluding, "While it has been reported that the Pima are starving, it is not true, for every destitute Indian on this reservation is fed by this office, and the howl comes from the imposter."40

Well drilling on the reservation at the Indian School farm was declared a success by Code in February of 1904. The five pumps, powered with mesquite wood, cost $15,000 and could irrigate 250 to 600 acres depending on how long they were run each day. In the same year, Code recommended further development of his pumping scheme. He envisioned ten wells drilled to irrigate 10,000 acres on the reservation. After consulting with

Reclamation engineers, who were designing the Roosevelt Dam for the Salt River Project in Phoenix, Code announced that there was potential for constructing a power dam on the Salt River, thirty two miles downstream from Roosevelt Dam, which could produce hydropower which would be transmitted to the pumps on the Gila River Reservation. If the power dam became inoperative due to the impounding of the entire flow of the Salt River by Roosevelt Dam, an auxiliary 500 kilowatt steam plant built on the reservation could be brought into service.

The financing of this project, Code believed, could be arranged by offering to the public the sale of 180,000 acres of reservation lands. The 180,000 acres would be surplus lands that had not been individually allotted to the Indians. The construction cost of Code's scheme would be $540,000, with an annual maintenance fee of $30,000. Code believed his plan to be an "extremely favorable" proposition for the Pimas. Congress approved Code's idea and made an initial appropriation of $50,000 on March 3, 1905. In January, 1906, John J. Granville was dispatched to make preliminary surveys for the pumping project which he completed in April of the same year. On June 21, 1906, Congress approved another $250,000 for continuation of the work.41

Code's pumping scheme, albeit very limited, was the first construction effort made by the government to restore the Pimas' water supply. It is ironic, however, that the Pimas objected to

the pumping solution and generally rejected this improvement. The Pimas refused the pumping system based on their fear that the groundwater had high salt concentrations and would therefore ruin their lands. Despite several tests conducted by the Indian Office to disprove this, the Pimas found in their own experiments enough evidence to satisfy their concerns. Presbyterian Minister C. H. Cook, missionary to the Pimas, strongly objected to the well system and Pima Chief, Antonio Azul, informed the Commissioner of Indian Affairs, Francis E. Leupp, that the Pima experience at Gila Crossing, where groundwater was used, resulted in poor crops or total failures. The Pimas, instead, began to argue for an apportionment of stored Salt River water which could be carried, via canal, to Pima lands north of the Gila.42

Code did not endorse a plan to carry water to the Pimas from the Salt River nor did he recommend that the Pima lands be included into the SRVWUA. Instead, Code abandoned his power dam scheme in favor of purchasing power from the Salt River Project and transmitting it to the reservation. His plan was realized under the terms of the Sacaton Contract negotiated between the Reclamation Service, the SRVWUA and the Secretary of Interior, James Garfield, who represented the Pimas' interests.

Signed on June 3, 1907, the Sacaton Contract provided for the sale of 1,000 horsepower to the Pimas for $300,000. Under the terms of the contract the power from the Salt River Project would not be directly available because it would be provided only after

the needs of the Association were met. The $300,000 was the amount the government had already approved under Code's previous scheme and was thus to be transferred to the Reclamation Service, $100,00 to be deposited immediately into the Reclamation fund. The government would construct, as part of the Salt River Project, the transmission line to the reservation. The contract also held that the Pimas were responsible for paying part of the total cost of the Salt River Project since their 10,000 acres would be viewed as a percentage of the total number of shares within the Water Users Association. The Pimas would also be responsible for payment of a percentage for any repair costs to the project's works. The agreement did not make the Pimas members of the Water Users Association, although it did state that when and if they acquired fee simple title to their lands, their 10,000 acres, with the Secretary of Interior's approval, would be incorporated into the Salt River Project.43

As outlined in the Sacaton Contract, the Reclamation Service constructed a transmission line to the Gila Reservation. The nineteen-mile line branched from the Roosevelt Dam to Phoenix line northeast of Mesa and travelled south to the reservation.

Additional work was begun on the reservation by the Reclamation Service under the Act of April 30, 1908, which gave the Secretary of Interior the discretion to make arrangements with the Reclamation Service to construct irrigation works on reservation lands for the benefit of the Indians. Under this

legislation, the Reclamation Service initiated the Sacaton Project. The project consisted of three canals. One canal would carry flood waters west from the Gila at a point 3.5 miles east of Sacaton and north of the river. The canal would serve 10,000 acres. The second canal system, also north of the river, would be supplied water from ten wells and run in a northwesterly direction. The third canal, south of the Gila near Casa Blanca, would also be supplied by well water. The project included lateral works and necessary electrical equipment.44

Congressional Investigations, 1911-1912

By 1911, the Commissioner of Indian Affairs reported that 4,500 acres of reservation lands were benefiting from the pumping system. However, objections to the use of groundwater by the Pimas persisted. The House Committee on Indian Affairs therefore conducted an investigation of Reclamation work on the reservation in December of 1911.

In two hearings, the most damaging evidence to Reclamation's activities was presented by Herbert Martin, financial clerk for the Indian Office's Pima Agency. Martin testified that the entire pump system had been incredibly expensive and served only twenty percent of the reservation's population. Martin stated, "A few pumps have been installed all on one small corner of the

reservation, which furnish a limited supply of underground water," which he added, "chemical analysis show contains sufficient alkali to be injurious to the land it is applied to." As to the expense of the work, Martin computed that despite an appropriation of $500,000 to date, an additional $1,020,000 would be needed to complete the project, along with the annual maintenance fee to operate the pumps which would cost $30,000 annually.

Martin did not understand the wisdom of the project. He commented that, although the government was now paying for the system, the Pimas would have to assume payments when they received title for their allotted acres. At that point, Mr. Martin concluded, "instead of being made self-supporting, as the government contemplates, they are likely to be pauperized and ruined under this well and pump system . . . ." Martin believed that the pumping scheme seemed, "to have been arranged more in the interests of the Water Users Association than of the government or the Indians." It would have been equally feasible and at no greater cost, Martin argued, to carry developed Salt River water to the reservation through the Consolidated Canal which approached the northern boundary of the reservation. As a result of these hearings, the Reclamation Service's work on the reservation was suspended.45

Three months after the House Indian Affairs Committee investigated the Reclamation Service's efforts on the

reservation, the subcommittee to the House Committee on Expenditures in the Interior Department conducted an investigation in April and May of 1912 on the activities of the Reclamation Service. The committee was chaired by Walter L. Hensley from Missouri and Oscar Callaway and Louis B. Hanna from Texas and North Dakota respectively, both reclamation states. After taking testimony from over forty witnesses, the committee reached several startling conclusions.46

The committee learned, again from Martin and several others, that the average cost of each well was about $10,000 and that only seven were constructed. The Pimas were refusing the groundwater because they feared the water's alkali content and believed that if they used the water their lands would be sold to repay the cost of the pumps. In addition, the wells only had an expected life of ten years. Mr. Martin stated that the alkalinity from the wells had increased fifty percent at Sacaton over the past five years. He stated, "During the four years that well water has been applied to the Pima Agency farm and garden the garden has been practically ruined."47

The committee also examined the necessity of the flood canal's construction. The canal, excavated north of the Gila, forked curiously, the larger fork heading in the direction of the Chandler Ranch. Alexander John Chandler, for whom the present town is named, operated an 18,000-acre ranch which bordered the reservation to the north. Regarding the fork in the canal, Mr.

Martin stated, "It is a very peculiar circumstance and a matter which cannot be understood." The Indian's impression of the reason for the canal's split, Mr. Martin explained, "is that the Chandler Ranch having a large area of land, it was with difficulty irrigated, and would get a large supply of water by means of the Indian ditch through the large fork of the canal where it branches."

Mr. Martin also explained that the Pimas already had a flood water canal in this area but at a lower elevation. It supplied the Indians at Santan and was named consequently the Santan Ditch. Mr. Martin testified:

> Then in place of using that canal which fully covered all the Indian bottom lands which they were cultivating the Reclamation Service took this higher-line canal out of the river at great expense over very difficult territory, until they came to the forks that I have mentioned, and then by a series of very expensive drops back again, some 20 feet to the lower level, and reached the alluvial lands again. Why they went to such great expense and took the canal through such very difficult territory when they might have utilized the old canal the Indians already had and covered practically the same area of land and almost the same bottom lands is not apparent.

The flood canal's construction cost, as given in the testimony, was $286,126. Chandler's lands were located adjacent to the 180,000 acres proposed to be opened to the public as payment for Chief Irrigation Inspector Code's scheme.48

The Reclamation Service's activities were also examined under the terms of the Sacaton Contract. It was apparent to all that

the contract's terms were very inequitable. The contract, which no Pima signed, stipulated that the Indians would bear a proportionate share of the Salt River Project's entire expense and future repairs while not providing them with a single drop of stored water. The Indian Office had appropriated $500,000, of which $100,000 was paid in advance for a nineteen-mile power line which would provide 1,000 horsepower only when the Water Users had that amount in excess of their demands. This contract would require the Pimas to sell 180,000 acres of the reservation to pay for the Reclamation Service's work and assess the 10,000 acres served by the pumping scheme a percentage of the cost of the Salt River Project. The committee members concluded,

> The effect of the contract is to render all of the reservation, with the exception of 10,000 acres, entirely valueless to the Indians so that they will in self-defense have to sell this excess. The water in the Gila has been taken from the Indians. This contract prohibits their getting any water from the Salt River and prevents them getting water by the Salt River power for more than 10,000 acres, and then only in case there is sufficient excess power. It practically cuts the reservation down to 10,000 acres and mortgages these 10,000 acres for a proportionate share of the cost of the Salt River project, and in addition an exorbitant illegal maintenance charge . . . . It is a burden the Indians cannot bear, and it would only be a question of time until the 10,000 acres would be taken from them under this plan.

The contract's terms were so prejudiced that Joesph H. Kibbey, legal counsel for the Water Users, admitted that no non-Indian would have signed the contract.49

The committee also questioned the Reclamation Service's recommendation, made in a meeting on December 7, 1905, to abandon San Carlos as a reservoir site. In a letter to Frederick H. Newell, then chief engineer of the the Reclamation Service, engineers Arthur Davis, George Y. Wisner, W. H. Sanders, Louis C. Hill and Albert E. Chandler recommended that the San Carlos project no longer be considered because of the silting problem, the depth of bedrock and the dip of the foundation. The committee questioned the Service's change in opinion because previously, under the Geological Survey, they argued that the dam was "eminently suited to the erection of a masonry structure of the highest type." The Service's judgment, the committee suggested, may have been corrupted by Epes Randolph, President of the Southern Pacific Railroad in Arizona. The Southern Pacific had right of way interests in lands that the San Carlos Dam would inundate. The committee stated, "It has been charged that Epes Randolph . . . was present at this meeting and dictated the decision signed by the reclamation engineers." Randolph denied the accusation. The railroad right of way was granted in April 1906.50

Of all the witnesses appearing before the committee, Mr. Code was never subpoenaed. He resigned from his position as Chief Irrigation Inspector for the Indian Service at about the time the committee was to begin its investigation. Although Mr. Code moved from Arizona to his home in Hollywood, California, he

retained his position as vice-president of the Mesa City Bank of which A. J. Chandler was president. Louis Hill, the Service's supervising engineer for the Salt River Project and a stockholder in the Mesa City Bank, gave testimony, as did Mr. Chandler. Agent Alexander had been removed from his position due to accusations of falsifying vouchers and forging checks. The committee found that the Justice Department had secured seven indictments embracing ninety one counts against him. Alexander had been acquitted of one indictment while awaiting to be tried on the remaining six.51

The committee concluded that the Interior Department handled the Pimas' water problem, "like a juvenile effort at administrative government." The committee's final recommendations requested in part that $25,000 be made available for a "thorough investigation of the Reclamation Service and all its transactions," and that during the investigation Interior Department Assistant Secretary Samuel Adams, Reclamation Service Commissioner F. H. Newell, and Supervising Engineer Louis C. Hill be removed from office. Pending the construction of a dam on the Gila, the committee recommended that the Consolidated Canal be extended to the Gila River Reservation and the Indians be furnished with water from the Salt River Project.52

Criticism of the Hensley investigation came swiftly. A minority opinion, attached to the investigation's report, was issued by Charles Henry Burke, representative from South Dakota,

and Franklin Wheeler Mondell, representative from Wyoming. These men expressed their regret "that the majority members of the committee should, after an examination so brief and fragmentary . . . have felt justified in making such sweeping and emphatic statements." Frederick Newell found the hearings contemptible and accused the official stenographer of drunkenness resulting in "largely faked-up" testimony. Subsequent evaluations of the investigation by two historians have tended to dismiss the investigation and to conclude that the Hensley hearings were "rather like a political show," and that, "Representative Hensley, for some reason, seemed to bear the Reclamation Service ill will, the charges and witnesses for the investigation seemed to be selected for the purposes of embarrassing the Service."53

Small-Scale Irrigation Systems and the Passage of the San Carlos Irrigation Project, 1913-1924

In March 1913, the Indian Irrigation Service acquired the irrigation features of the Sacaton Project from the Reclamation Service. When the Reclamation Service abandoned the work, it had completed eight of ten wells and constructed nine miles of both the flood water canal and well ditch. The Indian Irrigation Service improved the system by repairing the flood canal headgate, sluicing the canal of silt and constructing a brush

diversion works. The Irrigation Service also completed two of the ten pumping plants that the Reclamation Service had not completed. The Service estimated that with these improvements the Sacaton Project could water 3,300 acres.

The Irrigation Service also initiated several small-scale irrigation systems. The Little Gila River Project, begun in February 1913, consisted of rehabilitating a prehistoric canal which formerly supplied an area south of the Gila both to the east of Sacaton and in the vicinity of Casa Blanca. Work also included establishing a headgate at its point of diversion from the Gila River and reconstruction of the Blackwater Island Ditch. The Sacaton Flats Project consisted of repairing embankments of a canal which served lands above the Agency headquarters in Sacaton. The Blackwater Project served 2,500 acres in the eastern part of the reservation. Finally, the Casa Blanca Canal Project served lands south of the Little Gila River and west of the Agency. By 1916, eight miles of the Casa Blanca Canal had been constructed.54

Regardless of the number of separate projects developed by the Indian Irrigation Service, the desire for the San Carlos Dam persisted because it would still provide the most comprehensive remedy for irrigating reservation and anglo lands. Yet another investigation was begun in 1912. To eliminate bias, the Secretary of War, Lindley M. Garrison, was assigned to conduct the study. Garrison appointed Corps of Engineers' officers, Lt.

Col. William C. Langfitt, Lt. Col. Charles H. McKinstry and Major Harry Burgess to make the investigation.

The report, issued in February of 1914, found that the most suitable plan to develop the Gila would be to build a masonry dam at San Carlos 180 high, impounding 770,000 acre feet of water, with an expected life, due to silt accumulation, of seventy seven years. The engineers argued that the project should include 40,000 acres of reservation lands and 55,000 acres of private lands near Florence. The private lands would probably include the lands of the Pinal Mutual Irrigation Project (formerly the Casa Grande Canal Company) and the Casa Grande Valley Water Users' Association which formed in April 1911.

The cost of the project would be approximately $6.3 million or seventy dollars per acre. This expense would include the impounding dam, a diversion dam near Florence, lining canals, and rerouting fourteen miles of the Arizona Eastern Railroad (a Southern Pacific subsidiary), which would be inundated by the reservoir. The costs also included compensation to the Apaches of the San Carlos Reservation for the same reason. The board recommended that the repayment should be spread out over twenty years and not ten as the Reclamation Act provided. The officers concluded that the San Carlos irrigation project be built by the United States as described in the report and at no greater cost than seventy dollars per acre; that an adjudication suit be immediately brought to U.S. district court; that no additional

water rights be vested beyond those now existing; and that in case the project was delayed due to adjudication proceedings, a diversion dam on the reservation be constructed to improve the irrigation system for the Pimas.55

The engineers' report gave renewed vigor for another attempt to pass federal legislation authorizing construction of a dam at the San Carlos site. Arizona representatives Henry Ashurst and Carl Hayden requested authorization in June 1914. The bill was not successful as it faced tacit opposition from western congressmen who believed that Arizona had already received its share of reclamation funding. Authorization became additionally difficult as Congress grew increasingly preoccupied with events in Europe and World War I.

By May 1916, Ashurst and Hayden were able to claim a partial victory, as Congress appropriated $75,000 under the Indian Appropriation Act. The money was authorized for the construction of a concrete, nine feet high, 375 foot long diversion dam with bridge superstructure on the Gila, eight miles east of Florence.

The Corps of Engineers' report also provided the final evidence to begin an adjudication of Gila River water. In June 1914, Judge A. C. Lockwood of Cochise County began water rights proceedings. Two years later, the Lockwood Decree was issued clarifying Gila River appropriations between 1868 and 1919. The decree determined to which lands a water right belonged and fixed a priority right to those lands.56

The 1916 appropriation was the beginning of the Florence Casa Grande Project. Although actual construction was delayed due to U.S. involvement in World War I, additional appropriations for the Florence Casa Grande Project were made for ten successive years. By 1926, almost two million dollars had been appropriated for the Florence Diversion Dam, controlling works and necessary canals and structures. In March 1917, another diversion dam with bridge superstructure was authorized. The Sacaton Diversion Dam, four miles east of Sacaton, would divert water to tribal lands.57

The Florence Casa Grande Project was planned to irrigate with flood water a total of 62,000 acres of land: 35,000 on the Gila River Indian Reservation and 27,000 acres at Florence and Casa Grande for non-Indians. Water for the reservation was planned to be diverted by the Sacaton Dam and channeled into the San Tan and Casa Blanca Canals. To prevent seepage losses for the thirty five miles between the two diversion works, when water flow in the Gila was slight, reservation water would be obtained from the Florence Diversion Dam via the Florence Casa Grande Canal and the Pima Lateral. Water for the Pimas was also acquired through the North Side Canal which obtained water from the Florence Diversion Dam. Commissioner of Indian Affairs, Charles H. Burke, dedicated the Florence Diversion Dam on May 10, 1922, renaming it the Ashurst-Hayden Dam. The Sacaton Diversion Dam was not completed until June 1925.58

Despite the improvements made by the Florence Casa Grande Project, support for legislation remained active for the San Carlos Dam. Representative Hayden continued to lobby for this dam's construction. He favorably impressed influential congressmen by conducting two visits to the dam site. He argued that the success of the Salt River Project could be duplicated on the Gila River and thus add significant tax monies to the federal treasury. Moreover, Hayden used the plight of the Pimas to argue for passage. In the winter of 1923-1924, he compiled a pamphlet of historical accounts which documented Pima agricultural development,trade and their gradual loss of water due to American settlement. Hayden also included an estimate of the cost the government expended to subdue the Apaches. He argued, "It is safe to say that the warlike Apaches have cost the American Government more than ten times the money necessary to build the San Carlos Dam for the benefit of the peaceful Pimas." Hayden's pamphlet was printed by the government and used to influence members of the House Committee on Indian Affairs. Interest in the Pimas was further sparked when it was learned that the first Arizonan to die in World War I was a Pima volunteer.59

The significant amount of funding authorized by Congress for the Florence Casa Grande Project since 1916 had, by 1923, committed Congress to the sensible conclusion to authorize the construction of a storage dam at San Carlos to complete the project. In December, Arizona Senator Ralph Cameron introduced a

bill "to continue construction of the San Carlos Federal Irrigation Project." In April, 1924, the Senate unanimously passed the legislation, and six weeks later, the House, also unanimously, approved the bill. The Arizona delegation, perhaps fearful of not receiving the support of President Coolidge, presented the bill as authorization for the construction of Coolidge Dam. President Coolidge signed the legislation into law on June 7, 1924.60

The construction of Coolidge Dam would finally restore an adequate supply of water to the Gila River Pimas. The authorization came more than thirty years after Pima Agent Crouse had first suggested a storage dam and sixty years after non-Indians began appropriating Gila River water. Interestingly, the success of the legislation, although apparently brought on by redressing damages suffered by the Pima and Maricopa tribes, was largely the result of non-Indian interests. However legitimate and longstanding the Pima cause was, it had not proven sufficient by itself in winning relief for the tribe. This was made evident in 1903 when the Reclamation Service considered the matter. Pima water needs were only restored when they coincided with white demands. Florence agricultural concerns clearly realized the benefits of a storage dam on the Gila. Carl Hayden lobbied Congress for ten years for the "Hayden Bill" simply as a response to his non-Indian constituency. Will Rogers, the social satirist, explained the political reality of the legislation best

when he succinctly quipped at the dedication, "You folks got this dam built by using the Indians as an alibi."61

The Construction of Coolidge Dam

After many decades of recognizing the need for developed water on the Gila River and countless surveys, reports, investigations and remedial efforts undertaken towards that end, water storage on the Gila was to become a reality. After the approval of authorizing legislation,the Indian Office assigned its Irrigation Service to begin planning studies for the construction of Coolidge Dam at San Carlos.

Preliminary Activities: Dam Design, Railroad Relocation and Apache Compensation

The initial design study for Coolidge Dam was undertaken by Charles Real Olberg, Assistant Chief Irrigation Engineer for the Irrigation Service. Olberg completed a very detailed investigation in November 1925. He considered six types of dam structures for the San Carlos site: two types of curved gravity designs with differing radii, rock fill, variable radius, multiple arch and multiple dome. Since Congress stipulated that funding for the construction of Coolidge could not exceed $5.5 million, the only cost-feasible designs were the multiple arch and the multiple dome. The multiple arch dam was estimated to

cost $2,881,000 and the multiple dome $2,836,000, while all other designs were estimated to cost over three million dollars. Olberg recommended that plans for both the multiple arch and mulitple dome dams be drawn since the cost difference between the two was negligible. Olberg favored the multiple dome because it would almost eliminate uplift pressure and cantilever action, while requiring considerably more concrete, thus making the structure more massive and rigid with a "probability of greater stability and permanence." Olberg also recommended that a proposed transmission line from San Carlos to Hayden be constructed to provide power to facilitate the construction.62

The emphasis on limiting the construction costs was necessary because Coolidge Dam would inundate a stretch of railroad line as well as flood the lands of another Native American tribe, the Apache Indians. These losses would require compensation. As previously noted in the Army Corps of Engineers' report, the Coolidge Dam site at San Carlos would flood fourteen miles of the Arizona Eastern Railroad and submerge Apache lands on the San Carlos Indian Reservation.

The Arizona Eastern Railroad ran from Bowie, in Cochise County, through the San Carlos Apache Reservation to the Gila County mining towns of Globe and Miami. It formed the only means of rail transportation for the agricultural region in the Solomonville Valley. The cost in rerouting the Arizona Eastern was considerable. Olberg estimated that reconstructing the line

at a higher grade would cost approximately $1.7 million. The new railroad line, surveyed by the Irrigation Service, would run north of the river and would be shorter in distance and have a less adverse grade. Despite these favorable conclusions, the Southern Pacific claimed that the new line would cost more to operate and maintain. They subsequently conducted their own survey. Although the government was not obligated to compensate the railroad because of a provision in the legislation authorizing the line's construction, the government negotiated a settlement with the railroad. The terms of the agreement stipulated that the Southern Pacific would reroute the line at a flat cost to the U.S. of one million dollars or the government would pay half of the actual cost not to exceed 1.2 million dollars. By October 1928, the new eighteen-mile line was in service. Because of the construction of two bridges, one over the Gila River and one over the San Carlos River and the rough country encountered, resulting in the construction of several high trestles and fills, the final cost for the work was over two million dollars.63

Compensation to the Apaches on the San Carlos Reservation was significantly more complicated. The Apaches opposed outright the construction of Coolidge Dam because it would flood approximately 400 Indian graves. The Apaches objected to disinterment for religious reasons. Their objection was given little or no consideration. In February 1926, a three-member committee

composed of Assistant Chief Irrigation Engineer Olberg, James B. Kitch, Superintendent of the San Carlos Reservation, and Morgan Toprock, an Apache, were appointed to determine the amount of compensation owed the Apaches. They found that compensation was required for Indian lands, tribal roads, individual Indian improvements, damages to holding of private white owners, San Carlos Agency buildings, three pumping plants within the flooded area, Indian graves and state highway bridges. The committee concluded that these damages would amount to $303,493. In December 1927, Congress appropriated $163,452 for compensation to the Apaches. This amount satisfied the committee's recommendation because it excluded $50,000 for the reconstruction of state highway which would be undertaken in connection with the construction of Coolidge, and $90,000 for the Agency buildings which had been replaced in Rice, Arizona.64

The issue of compensation for the Apaches arose again when Congress authorized the development of hydropower at Coolidge. Under the Act of March 7, 1928, Congress approved $350,000 for the construction of a hydropower plant at Coolidge Dam. Under the same act, Congress also directed the Federal Power Commission to determine if any additional compensation should be paid to the Apaches for the generation of power at Coolidge Dam. John Collier, Executive Secretary of the American Indian Defense Association, and later Commissioner of Indian Affairs, represented the Apaches' interests. Collier argued that, as

stipulated by the 1920 legislation creating the Federal Power Commission, all proceeds from power sites on Indian reservations should be deposited to the credit of the tribe. Collier stated that "the language of the power act in its regulations is that the Indians are entitled to a rental equal to the value of the land for the most profitable purpose, including power development." The Power Commission disagreed and found that no additional compensation should be paid to the Apaches. They held that,

> . . . such earnings as arise out of the combined development cannot, therefore, be attributed so much to the natural conditions of the site itself as to the artificial conditions created by the investment made in the dam and other structures for the primary purpose of irrigation. The estimated annual earnings of $16,000 are not, therefore, earnings of the site alone, or to be attributed even to the site plus the investments in power structures and equipments, but to the entire investment in the project as a whole.

The Commission added that the reservation would, in a sense, receive compensation because power from the dam would be sold to the Apaches at a discounted rate. According to the Commission, this would save the Apaches a significant sum per kilowatt hour.65

Despite financial compensation, the Apache relocation was not a success. The Apaches were resettled on lands near Rice through the use of using the $70,000 dollars deposited in their tribal fund. An electrical transmission line was constructed from Coolidge Dam to Rice for the purpose of furnishing power for

groundwater pumps and for the newly constructed Agency school and buildings. Eleven wells were drilled for domestic and irrigation purposes but only three produced sufficient water to justify the installation of pumping plants. The relocation left the Apaches practically destitute since their compensation allowance was expended and an inadequate water supply was obtained. Commenting on the Apaches position, Charles Rhoads, Commissioner of Indian Affairs, wrote in 1930,

> Practically their entire condemnation allowance has been used and they have no actual benefit resulting therefrom. Or in other words, their giving up of the Coolidge Reservoir and subsequent payment . . . has availed them nothing, this money having been used in an attempt to locate them elsewhere, which attempt through lack of water failed. Unless some arrangement can be made . . . their lands . . . have been given up for nothing.

The Apaches received no additional compensation.66

Design Approval and Construction Bidding

Assistant Chief Irrigation Engineer Olberg's report on Coolidge Dam was reviewed by consulting engineers Fred A. Noetzli and Louis C. Hill, the former Reclamation Service engineer. In December 1925, they approved the multiple dome design. They concluded, "This type of dam involves most of the good features of the multiple arch type. Furthermore the dome action would appear to add materially to the safety of the structure. The

forces of uplift under the dam are practically eliminated in this type of structure."

A second review board was appointed by Congress to evaluate Olberg's plans. Army General W. C. Langfitt and A. J. Wiley, formerly with the Reclamation Service, also approved the multiple dome design on April 30, 1926, stating that it was "admirably suited to the local conditions." Langfitt and Wiley also recommended the installation of electrical equipment as part of the construction since they believed that energy receipts would materially relieve the operation and maintenance charges of the water users. The review board also endorsed the transmission line from Hayden to the dam site because power could be sent to market over the same line after construction. With the approval of both boards, Secretary of Interior Hubert Work approved the multiple dome design on May 8, 1926.67

Specifications for the construction of Coolidge Dam were published on September 28, 1926. Eight sealed bids were obtained, and on November 10, bids were opened at the Federal Building in Los Angeles. Since the scheduled room was too small to accommodate all the contractors, the opening was moved to another office. At two o'clock in the afternoon, Olberg inquired if any bids had not yet been delivered. Receiving no response, he directed Mr. C. L. Shotwell, Special Disbursing Agent, to begin opening the bids. According to Olberg, in a letter to Commissioner of Indian Affairs Charles Burke, "Mr. Shotwell had

slit the envelope of the first bid when Mr. Lynn Atkinson of the firm of Atkinson Spicer Co. of Los Angeles appeared in the door, with his sealed bid in his hand, and inquired if his bid would be accepted." Atkinson's bid of $2,268,525.50 was opened and was the lowest bid received.

Acceptance of the Atkinson bid was immediately contested by the Utah Construction Co. of Ogden, Utah, which had the next lowest bid at $2,451,329.00. Vice-president of the Utah Construction Co., E. O. Wattis, in a letter addressed to Commissioner Burke, requested that Atkinson's bid be refused. Olberg argued that "it was evident that Mr. Atkinson had been in the proper office . . . with his bid at 2 o'clock," and therefore his bid should be accepted. Commissioner Burke agreed and the co-partnership of Atkinson, Kier Bros. and Spicer was awarded the contract.68

Preconstruction Activities

Actual construction of Coolidge Dam by Atkinson was preceded by preconstruction activity under the supervision of Clay H. Southworth, Construction Engineer for the Indian Irrigation Service. Beginning in May 1925, government work consisted of making an additional topographic survey, constructing a transmission line from Hayden to the dam site, constructing a

highway road to transport materials and machinery from the railroad at San Carlos and erecting a government camp with a water and sanitary system.69

The government obtained electrical power at the dam site from the Nevada Consolidated Copper Company at Hayden. Location surveys, plans and specifications for the transmission line were completed in August of 1926. Seven bids were received to construct the line. The contract was awarded to the Bert L. Perry Company of Los Angeles the following month. The work was to be completed in ninety days, but because of the rough terrain, the line was not finished until February 1927. The work consisted of erecting a twenty-mile, single-circuit, three-wire, forty-four kilovolt steel tower transmission line with a switching station at Hayden and a transformer station at the dam site. The general layout of electrical equipment at the dam site included sixteen miles of primary and secondary wire, with twenty-four transformers and over fifty motors. The contractor used General Electric equipment exclusively. Despite several safety precautions taken by Atkinson in the set up of electrical equipment, one death was incurred when Ted Wright, a civil engineer for Atkinson, was electrocuted when he came in contact with a fallen live wire.70

Road work consisted of extending the state highway, building a temporary road and a service road. Work began, under government forces employing Apache laborers, in June 1925. Road

construction was completed by the end of 1926. Nine miles of temporary road were constructed below the flow-line or inside the reservoir area. One mile of service road was built from the temporary road to the power house and transmission line and .9 miles of state highway were constructed. The road work was difficult because of several steep grades and heavy rock excavation which required blasting. Bridges, galvanized iron and concrete culverts, drainage works and retaining walls were all necessary. The cost for all three roads was $135,000.71

Government camps were constructed at San Carlos and at the dam site. The temporary camp at San Carlos was used only while road construction was carried forward. The camp at the dam site, located on the west side, consisted of an office with a laboratory, four, three-room cottages, a bunk house for eighteen men, three tent houses, garages and warehouses. Domestic water was obtained from a spring 1.5 miles northwest of camp. An additional water supply was obtained from a spring one-quarter mile south of the dam site. The additional water supply was stored in an 80,000 gallon tank located on the west hillside. The water was used for testing the spillway gates and supplying pressure for operating valves in case of an emergency.72

Atkinson arrived at the dam site and immediately began establishing his offices adjacent to the government's camp in January 1927. Atkinson constructed facilities to accomodate up to 650 men. Housing consisted of fifty wood frame family

dwellings with running water and electricity. Single men were housed in bunk houses and tent houses with washrooms and showers. A T-shaped mess hall was constructed with a capacity of handling 300 men. It included a kitchen, four storage rooms and clerical and engineering offices. The mess hall also included an ice plant which had a daily capacity of 8,000 pounds. Atkinson also operated a commissary, first aid station, a three-room schoolhouse for approximately seventy-five pupils, and a guest house for the visitors and government officials. A completely separate camp with a mess was maintained for over one-hundred men at the gravel plant below the dam site .73

Early Construction Activities

Initial construction work consisted of river diversion, excavation work and dewatering the foundation. Since the Gila River fluctuated in flow from 200 cubic feet per second (cfs) to 100,000 cfs, diversion works could not possibly handle any quantity approaching the maximum. It was decided therefore that a 450-foot flume carrying 10,000 cfs would be constructed to channel the river between the two coffer dams. The diversion flume was built on the east side of the canyon, and consisted of watertight heavy timber bulkhead, fourteen-feet high and twenty-seven feet wide. The coffer dams were constructed of double

walled piling with silt and gravel fill. At the time, it was generally believed that this system provided minimum protection to the foundation excavation work, but because the river flow through the construction period was slight and the silt in the gravel made the coffer dams impervious, river diversion was made without incident. The river diversion work was accomplished with seven power shovels, including Link Belt, Bucyrus, and Brownhoist dragline shovels.74

Excavation work was conducted at both the foundation and the spillway channels. The spillway work began in January 1927 and required the removal of 277,000 cubic yards of material. Excavation in the river bed to a depth of twenty three feet began in October. This work removed 33,000 cubic yards of earth. Excavation below the river bed to the quartzite, quartzitic sandstone and limestone bedrock removed 10,000 cubic yards of material for the cut-off trench for the dome footings and the upstream end of the domes. During this work a natural spring was encountered in the foundation of the east buttress. The spring was tapped and piped to the central dome behind the power house. Removal of the earth and rock was accomplished with the use of jackhammers, various dragline shovels and dump trucks specially designed to withstand rough usage. Material was spoiled 1,000 feet above the dam site in the reservoir. Explosives were used in the excavation effort to make rock cuts up to 165 feet. Dynamite was placed in six inch diameter holes ranging in depth

up to ninety feet. The holes were drilled with a portable electric well rig outfit which was operated continuously for over three months.75

Excavation work also encompassed the drilling of 241 grouting holes. Grout holes were drilled twenty feet deep to tighten and fill the foundation and reduce uplift hydrostatic pressure. The holes were placed near the upstream face of the domes and buttresses, under the spillway weirs and wherever the bedrock appeared to have seams. Inserted into the holes were pipes set in calk. As the concrete was formed, the pipes were extended to protrude to the downstream side. Pressure grouting was done at the completion of the construction period. The cement grout was forced into the pipes by compressed air under one hundred pounds of pressure.76

Dewatering the foundation was conducted by the use of four, seventy five horsepower vetical centrifugal pumps. The pumps were suspended from hoists attached to a cableway which crossed the canyon. Flexible twelve-inch pipe lines carried the pumped water to the flume and out of the foundation area. The pumps were suspended so that they could be rescued in the event that the river control works failed.77

Multiple Dome Design and Patent Challenge

Coolidge Dam was the first water storage facility ever constructed using a multiple dome design. Described simply, the design consists of two buttresses supporting three inclined egg-shaped domes. The small end of the dome rests on the foundation, while the wider end, where the curve has a longer radius, is above. The domes are heavily reinforced with steel bars placed in the planes of the inclined arches from abutment to abutment. The buttresses are nearly triangular in shape. They are sixty-feet thick at the base, twenty-four feet thick one hundred feet below the crest and sixty-two feet thick at the top. They are flared toward the upstream side of the dam to properly support the domes. The buttresses are reinforced with horizontal steel bars. There are two inclined contraction joints in the lower part of each buttress to prevent irregular cracks due to concrete shrinkage.78

The dam was designed by the Indian Irrigation Service under Chief Engineer W. M. Reed, his successor Herbert V. Clotts, and Charles Real Olberg, Assistant Chief Irrigation Engineer. The work was under the general direction of H. C. Neuffer, Designing Engineer; J. A. Fraps and M. R. Trenam served as Assistant Designing engineers, Clay H. Southworth as Construction Engineer,

Robert H. Rupkey, as Assistant Engineer in charge of field surveys, and E. L. Rose as Electrical Engineer.

The contractor's work was under the charge of Atkinson and E. L. Kier, resident co-partner. J. G. Tripp became General Supervisor at the death of E. A. "Ted" Wright. Mr. Tripp designed the concrete placing layout, developed the details for the formwork and the construction plan generally. Others involved in the construction were: Charles G. Clapp, Assistant Supervisor; H. Festich, Excavation Superintendent; James F. Hurst, Concrete Superintendent; Earl M. Hassell, Steel-Placing Superintendent; John C. Moore, Carpentry Superintendent; Ellis M. Shimel, Gravel Plant Superintendent; Ernest Wallin, Rigging sSperintendent; and Henry Alger, Engineer for the contractors. Office management was under the supervision of S. S. Atkin. H. H. Shattuck was Chief Bookkeeper, and Neil Gibbons served as Chief Timekeeper.79

Although Coolidge was the first multiple dome dam, its design was challenged on the grounds of patent infringement. George Sydney Binckley received a patent, after seven rejections, in 1913 for a dam design which primarily applied cone or conoidal principles to dam construction. Although this application was not new, Binckley claimed his design differed and merited patent protection because in each horizontal curvature of the upstream face, the radius would increase "downwardly through a portion of

the height thereof." Binckley filed suit against the Indian Service in the U.S. Court of Claims.

Binckley's petition was dismissed by the court in 1936 chiefly on the ambiguity of the phrase "through a portion of the height thereof." The court wrote, "What portion, the upper, the center, or the lower, is to be increased in radius?" The court concluded, "An analysis of the claim in suit . . . leads inevitably to the conclusion that it does not define invention. The addition of an indefinite phrase to a rejected claim, which does not in any way result in some functional advancement, will not save the same from a contention that it is invalid."80

Atkinson's Construction Plant Layout

The contractors' preconstruction activities also consisted of erecting various material processing facilities. This work involved of the construction of a gravel plant, mixing plant and concrete placing plant or tower. Particular attention was paid to the layout of the contractor's plant so that manual labor would be minimized. The unique feature of the plant's design was the use of an aerial tramway which transported aggregate from the gravel plant to the mixing plant. The tramway eliminated the need for the contruction of a bridge to permit trucks to reach the mixing plant. The careful design of the contractor's plant

resulted in a successfully integrated and mechanically coordinated operation.81

The gravel plant was constructed during the excavation work at the dam site at a cost of approximately $110,000 dollars. The plant was located on the east or south side of the river about .5 miles downstream from the dam site. Suitable material for concrete aggregate was found in large eddy beds at the plant site and up to one mile downstream. The material was excavated by the use of a two cubic yard dragline and a one and one-fourth cubic yard shovel. The material was loaded in four cubic yard side-dump cars and hauled by a gasoline driven locomotive to the gravel plant. At the plant the material was crushed, screened and washed to remove sand, silt and mud. The material was then stockpiled in an 11,000 cubic yard storage bin. The plant had total daily production on double shift of over 4,000 tons, or enough for 2,000 cubic yards of concrete. The processed aggregate was transported to the mixing plant by the 2,000 foot overhead tramway which carried twenty seven buckets of twenty cubic foot capacity. The tramway had a capacity of conveying 150 tons per hour.82

The four-story mixing plant consisted of the tramway discharge terminal, a cement silo, storage sheds, aggregate bunkers, and concrete mixing plant. The plant was located just south of the west spillway to facilitate cement unloading from the service road. The first floor of the plant housed two mixers

which discharged concrete to the main chute leading to the placing tower. Hoppers of aggregate and cement were located on the second or batching floor. The third floor held the aggregate bunkers for all four sizes of aggregate. The bunkers had a total capacity of 2,000 cubic yards. The top floor was used for the tramway discharge terminal. The cement silo, fifty feet high, with a storage capacity of 12,000 sacks, was located behind the mixing plant to permit direct loading from trucks to the silo's hopper. The mixing plant was designed to transfer the aggregate from the bunkers to the mixers through the use of gravity. It was designed by engineers for the tramway company, L. T. Hayes and M. P. Morrison of Trenton, New Jersey and the Garlinghouse Brothers, of Los Angeles, who supplied the batching and measuring equipment.83

The concrete placing plant or tower was located midway between the two buttresses and was sixty feet downstream from the top of the dam. The tower, chute lines, booms and counter balances were constructed of steel. The plant was one of the largest such structures built to that date. The tower was constructed to a height of 400 feet because it would have to deliver concrete over a radius of 440 feet. The foundation of the tower was grounded on bedrock and had a base of ten-feet square and forty-feet high. Concrete travelled through the tower on a two-yard skip from the receiving hopper at the base to the various chute lines. The tower had the capacity to pour 2,000

cubic yards of concrete per day but because of the intricate form work, this was never realized. The maximum amount placed for one day of two shifts was 1,560 cubic yards with a monthly maximum of 35,000 cubic yards. Concrete for the construction of the spillway bridges, two water outlet tower bridges, roadway, hand rails and enrichments was delivered by one-yard buggies called "Hoopies" on a timber track. A total of 201,406 cubic yards of all classes of concrete was used in the construction.84

The extensive shop facilities needed for plant construction and maintenance included carpentry, blacksmith, welding, machine and reinforcing steel shops. The carpentry shop included a variety of table and band saws. Timber was used extensively in the river diversion works and exacting concrete form work. The blacksmith shop housed two large forges for primarily metal repair work. The welding shop handled all types of welding and cutting work necessary to maintain and operate the various plants. The machine shop fitted metal work employing drills, a thirty-inch lathe and a threading machine for pipe, bolt and rod threading. The steel reinforcing shop prepared all steel rebar necessary for the concrete reinforcing work.85

Beyond positioning pumps during the excavation work, the cableways were used to place 3,000 tons of reinforcing steel along with 700 tons of structural iron used in the power house and 500 tons of gates and valves in the penstock system. The two Lidgerwood cableways spanned 1,200 feet across the canyon and

were capable of transporting material up to fifteen to twenty tons. One cableway was located directly above the central axis of the dam while the other was positioned upstream twenty five feet away. The cableways also served to transport all workmen to and from the various areas in the canyon, river bottom and on the dam itself.86

The construction plan for Coolidge consisted principally of three classes of work. The buttress and the "top work", or roadway work at the top of the dam, presented no unusual difficulties. However, the success of the construction plan hinged on the concrete form work for the domes. The domes rose on a vertical plane from bedrock for fifty feet. From that elevation they began to curve downstream for 212 feet in horizontal distance while rising another 195 feet to the top of the dam. The domes grew in width from ninety-four feet at bedrock to 160 feet at mid-height to 126 feet at the top. The adjustable wood panel forms were designed to adapt to the changing curvature of the domes. The panels were held in place by wires attached to anchors which were embedded into the concrete. At the top sections of each dome, the forms were supported by wood trusses which in turn were supported by rods projecting from the face of the concrete already poured.87

Construction of Coolidge Dam and Power House

Actual construction of Coolidge began appropriately on Thanksgiving Day, November 24, 1927, when concrete was poured at the downstream end of the east buttress. The river's flow was diverted to the west side of the canyon until December 25th when the east buttress, east half of the center dome and the east dome had been completed to a point above the river diversion works. The river was then diverted through an opening in the east dome which measured thirty-two feet wide and twelve-feet high. Uncovering bedrock at the west side was then begun and on January 10, 1928, the first concrete was poured in that portion of the structure.88

Work proceeded very rapidly after the initial concrete pours. By the end of January, the contractor was assured safety from flooding because all areas of the dam were well above the river diversion opening. Work on the power house also began with the activity at the west dome. From December 1927 to April 1928, Atkinson was able to place an average of 1,000 cubic yards of concrete per day. By June 1928, the dam had reached 196 feet above the river bed or to the top of the buttresses.89

Work in the spring also involved spillway construction. Located at each side of the dam, the spillways had a weir width of 150 feet which decreased to sixty feet in the spillway

channel. The weirs, floors and walls of the spillways were concrete paved. The spillway floors were paved to a depth of two feet with anchor bars placed four feet into the floors' foundation. Drains were provided under the floors for carrying away seepage. The floors were also steel reinforced. At the lower end of the spillways, a cut-off trench was excavated and filled with concrete to prevent scouring. An additional cantilever lip was extended beyond the cut-off to further protect against scouring. The spillway walls varied from fifteen to twenty feet in height and their thickness from three to four feet. The walls were also fastened to the excavated rock by the use of anchor bars. The spillway gates were provided by the firm Stauwerke of Zurich, Switzerland. Three gates, each measuring ten-feet high and fifty-feet long, were provided for each spillway. Combined discharge capacity for the spillways was computed at 120,000 cfs. The concrete work for the spillways was completed in October 1928, however the gates were not in place until October 1931.

While the last concrete forming of the domes was completed on September 30, 1928, the "top work" of the dam consisted of constructing the walls over the domes and buttresses, the bridge piers for the roadway over the spillways, the roadway arches, the roadway and sidewalks, the outlet towers and the parapet walls and decorative eagles. To support the roadway on the top of the dam, walls were constructed on the dome spandrels and over the

tops of the buttresses. The walls were tied to the domes and buttresses and expansion joints were provided for the changes in load and temperature. Copper water stops were also used to prevent leakage. A restroom was incorporated into the space over one buttress under the roadway and a switchboard room in the other space. Cross walls were also provided to support the roadway and the eagles. Three piers, eight-feet wide, supported the roadway arches over the spillways. The central piers in each spillway were divided into compartments to house the mechanism for the automatic operation of the spillways. The roadway arches, reinforced concrete arch barrels, were poured into forms which were supported by posts resting on the spillway floor. The arches at each spillway were poured symmetrically to insure stability to the piers. The roadway slab over the spillways was twenty feet wide and constructed over gravel fill with longitudinal expansion joints at the sidewalks. The roadway over the dam was supported by the walls over the domes and buttresses. The roadway slab, steel reinforced like all components, measured nine to eleven inches in thickness over the spillways and ten to twelve inches in thickness over the dam from crown to sidewalk.

Water outlets for the reservoir were provided through two identical cylindrical towers at the upstream face of the buttresses. The towers' inlets consisted of eight openings measuring two feet, eight inches by five feet. Each inlet was faced with a galvanized steel trash rack. Water entering an

inlet was channeled into an eight-foot diameter penstock which could be operated by an emergency gate operated by a hydraulic mechanism installed at the top of the tower. Access to the towers was provided by bridges, each supported by two arch ribs from the buttresses.90

The decorative parapet walls at the top of the dam required special form work. Each wall panel required a separate Plaster of Paris waste-mold since the panels and remainder of the walls were cast from a wet concrete mix. The downstream face of the dam was embellished with two art deco overhangs above each buttress with two huge concrete bald eagles mounted to the facades. The forms for the eagles were cast in full size Plaster of Paris molds and were also fabricated with wet concrete.91

Although begun in January 1928, work on the power house was postponed the following month because of the difficulty of work being conducted overhead. Construction of the power house was restarted in September. The power house, located in the central dome, extended to the buttresses which formed the structure's end walls. The design of the plant was changed substantially from the contract plans due to the decrease in size of the draft tubes from twenty eight to twelve feet in order to provide for better turbine efficiency. As a result, the building was raised to two stories to provide room for the three sections of switchboard equipment and storage batteries. The power house was connected to the outlet towers by the two penstock tunnels. The penstocks,

which entered the power house diagonally, were constructed of two-inch thich cast iron in seven-foot sections. When the penstocks reached the back of the power house, they bifurcated into two, six-foot diameter branches, one going to the turbine and the other extending through the power house as an irrigation bypass.

The generating equipment in the power house consisted of two 6,250 K.V.A. (kilovolt amperes), 6,000 volt, sixty cycle, vertical generators. They were driven by two 7,500 horsepower Francis-type hydraulic turbines with necessary governors and oil pressure sets. Water released through the turbines and for irrigation was measured by two venturi tubes, one in each penstock, by meters in the switchboard gallery and by a Geological Survey gaging station 300 yards below the power house. A seventy-two inch butterfly valve was installed in each of the penstock branches just after the pipes extended into the power house. Needle valves were set at the end of each bypass branch of the penstocks. These valves could be controlled by motor drive as well as hand operation. Equipment within the power house was installed with a forty-ton crane with a ten-ton auxiliary hoist. The crane runway extended the entire length of the building. Seven 2,000 K.V.A., single phase, sixty-cycle, oil insulated transformers were located under the central dome behind the power house. A track was laid to the rear of the power house to transport any of the transformers into the power house in case

of repairs. Two transmission lines above the power house led to the Nevada Consolidated Copper Company at Hayden and to the Apache Indian School and Agency, thirteen miles away at Rice. Work on the power house was completed in December 1928.92

The final step in completing the dam was the application of gunite or a stiff cement grout to the upstream face of the domes. The purpose of this work was to decrease the permeability of the concrete which could lead to an alkali-aggregate reaction and to improve the appearance of the structure. The gunite was sprayed by a pneumatic gun onto mesh wire which was tied to the dam by wires which were left in the domes for this purpose. A one-and-one-half inch layer of gunite was applied to the domes in two coats.93

Coolidge Dam was essentially completed by November 1928. As stated earlier, various gates and valves would not be installed for several more months. Water was first stored behind Coolidge Dam on November 15, 1928 when the river control gate through the east dome was closed. The opening was completely concreted five days later.

The construction of Coolidge Dam presented a variety of problems, including the unique form work for the domes, the remoteness of the location, the complexity of the construction plant and the necessity of an unexpected addition of ten percent of materials needed to complete the job. Despite these difficulties, Atkinson was able to complete the project

practically one year ahead of the specified contractual period. Due to the arrangement of an integrated construction plant, Atkinson completed Coolidge with a relatively small working force ranging widely from forty to 700 men. At the height of the construction period, between one hundred to 300 Apache Indians, many having attended Carlisle or other Indian schools, were employed performing unskilled to highly skilled labor.94

Dedication Ceremonies

The dedication ceremony for Coolidge Dam was held on March 4, 1930. In attendance were former President Calvin Coolidge and his wife, Arizona Governor John C. Phillips, California Lieutenant Governor H. L. Carnahan, Edgar B. Meritt, Assistant Commissioner of Indian Affairs, who represented the Secretary of Interior Ray Wilbur, and social satirist Will Rogers. Neither Senator Carl Hayden nor Charles Olberg attended the dedication. Approximately 3,000 people witnessed the smoking of a peace pipe between the Apaches and the Pimas and heard speeches by both President Coolidge and Rogers. Coolidge's remarks were unmemorable while Rogers made some cleaver extemporaneous observations. Referring to the competing interests of Arizona and California for developed water, Rogers stated that he was attending the dedication "to see that California gets its pro-

rata share of this dam." However, the best remembered comment from the dedication was Rogers' statement concerning the new growth of thick vegetation in the reservoir. He remarked, "if this was my lake, I'd mow it."95

Operation of the San Carlos Irrigation Project

Water stored behind Coolidge Dam in the San Carlos Reservoir provided developed water for the Pima tribal communities and for adjacent lands under anglo ownership. Under the operation of the Indian Service, Coolidge Dam regulates, to date, the Gila River for lands within the San Carlos Irrigation Project which are located ninety miles downstream. With a rated storage capacity of 1.2 million acre feet, the San Carlos Reservoir serves a maximum of 100,546 cultivated acres. Of these acres, 50,000 are within the reservation with the remainder privately owned.96

Water delivered to both reservation and anglo lands is diverted at the Ashurst-Hayden Dam into the Florence-Casa Grande Canal about twelve miles east of Florence. Known as the Main Canal, the Florence-Casa Grande flows southwesterly for twenty two miles to a point near the Picacho Reservoir. Water either can be stored at Picacho through a "Y" connnection in the canal or continue into the Florence-Casa Grande Canal Extension which runs west for five miles towards Casa Grande. The Old Florence

Canal, which runs west and parralel to the Florence-Casa Grande, is fed by the Main Canal and turns water into a lateral distribution system for anglo lands under the Florence-Coolidge district. The Casa Grande Canal, also part of the original landowners system, conveys water from its head at the Picacho Reservoir to the Casa Grande district.

Water for the Gila River Reservation is carried from the Main Canal through the Pima Lateral. The lateral runs in a general west and northwest direction for twenty three miles. It terminates at the Sacaton Dam where it delivers water into a conduit which crosses the river on the dam and feeds the San Tan Canal. The San Tan, which was originally constructed by the Reclamation Service, runs northwesterly for an additional fifteen miles. The Pimas' San Tan Canal branches from the Service's canal and terminates in the river.

Both Indian and non-Indian lands on the north side of the Gila are served by the Northside Canal. For these lands, water is taken out of the Florence Canal and piped under the river bed. The canal then runs in a westerly direction, parallel to the river for fifteen miles at which point it enters the reservation where it then continues northwesterly for approximately four more miles.

Several additional canals serve reservation lands within the project. The Casa Blanca Canal, which extends from the Pima Lateral, one mile south of Sacaton Dam, serves the reservation

community with the same name. The Southside Canal, also an extension of the Pima Lateral, crosses the McClellan Wash through a one mile siphon and provides water for tribal acreage. The southside of the reservation is also provided with intermittent stormwater from a twelve mile flood drainage canal which protects the Southside area under the Southside Canal and the Casa Blanca lands.

Water delivery to both Indian and non-Indian users is dependent upon the total amount of stored water behind Coolidge Dam minus calculated seepage into the river bed and evaporation losses. Equal apportionment to all acreage within the project is typically determined at the beginning of each year although historically water apportionments can come as late as March. Beginning of the year apportionments are not final due to the continual fluctuations in precipitation.97

The San Carlos Irrigation Project is operated by three agencies. Water for the Gila River reservation lands is administratively controlled by the Bureau of Indian Affairs (formerly the Indian Service) through the office of the San Carlos Irrigation Project in Coolidge and the Pima Ageny office in Sacaton. Water for the anglo lands is delivered through the San Carlos Irrigation and Drainage District. Because Indian and non-Indian lands are contiguous, they share various facilities of the water distribution system. These features, called joint works, are cooperatively used, however, they are maintained and

operated by one or the other agency. The joint works include: the Florence Casa Grande Canal, the Pima Lateral and the Picacho Reservoir, all maintained and operated by the Bureau and the Northside Canal, operated by the District but maintained by the Bureau. The Florence and Casa Grande canals are District works while the San Tan, Casa Blanca and Southside canals are operated and maintained by the Bureau.98

The cost incurred in the construction of the San Carlos Project, which was set under the authorization act, were initially to be borne equally by Indian and non-Indian users. However, under the Act of July 1, 1932, construction charges against Indian owned lands were cancelled as long as the land remained in Indian ownership. Repayment by anglo users began in 1935. Originally charges per acre carried an interest rate of five percent per annum with interest at four percent for deferred payments. By the Act of June 5, 1934, the interest on deferred payments was dropped and the repayment schedule was extended from twenty to forty years. Under the recommendation of the Reclamation Repayment Commission, repayment was deferred in 1937. In 1945, the moratorium on repayments was lifted. Under the Act of June 14, 1945, annual repayments were changed from fixed to being based on the number of acre feet of water stored in the reservoir on March 1st of each year. Through fiscal 1983, indebtedness to the District has increased due to rehabilitation

projects. Total reimbursable construction costs as of 1983 stand at approximately $13,146,000 or about $263 per acre.

Subsequent to the completion of Coolidge Dam, two principle additions were quickly made to the San Carlos Irrigation Project. To supplement developed surface water, a well drilling program was initiated in the early 1930s within the project boundary. Wells were drilled by the Bureau principally on canal banks adjacent to both reservation and anglo lands. Although the program was run by the Bureau, pumped groundwater was distributed equally between Indian and non-Indian users.

For the first five years of operation, hydropower developed at Coolidge Dam went entirely to the Nevada Consolidated Copper Corporation at Hayden, Arizona. Power lines were also constructed to the San Carlos Indian Agency at Rice, Arizona, from Hayden to Mammoth, Arizona and from Casa Grande to the Papago Indian Reservation. Following the extremely dry year of 1934, it became very obvious that Coolidge power could not supply these demands along with extending the system to provide energy for the operation of groundwater pumps. To assure continuity of service for all demands, the project constructed a diesel powered generating station near Coolidge. The plant became available for service in August 1935 and consisted of two, 1,300 horsepower engines. Another 2,700 horsepower unit was added to the Coolidge plant in 1939. Additional power was obtained from the purchase of a small generating station from the Christmas Copper

Corporation at Christmas, Arizona in 1942. The project also began to purchase power from the Bureau or Reclamation's Parker Dam in 1943.99

Summary

When Spanish and American explorers ventured into the northern Sonoran Desert, intermittently from the sixteenth century, they found along the Gila River an established aboriginal society. These peoples, the Pima and Maricopa Indians, successfully developed a sedentary and peaceful community. By utilizing the natural flow of the river, the Gila tribes prospered as an agrarian society, producing an abundant amount of foodstuffs. Early pioneers, traversing the territory, benefitted from the Pima experience, receiving grain and protection from the hostile Apaches.

In the mid-nineteenth century, the United States established authority over the Gila region, having acquired a vast tract of land from Mexico. Shortly after dominion was established, sustained incursion by settlers began to occur. Because of the aridity of the region, competition for the river's water began immediately. The Indian tribes, located downstream from white appropriators, quickly began to have their supply of Gila water significantly diminished.

As anglo settlers became more numerous and homesteading increased, the Gila's water shortage became exacerbated. The U.S. Indian Service, because of its federal trust protection obligations, became responsible for securing and maintaining an

adequate water supply for the Gila tribes, who were now located on the congressionally authorized Gila River Reservation.

From the 1860s through the turn of the century, living conditions on the reservation became increasingly jeopardized due to the lack of sufficient water. The Indian Office and reservation agents made a variety of attempts to remedy the situation. But every effort was negated due to persistent drought and more sophisticated methods by upstream settlers to divert additional Gila River water.

By the beginning of the twentieth century, several actual construction projects were initiated to bring water to the Gila tribes. The newly created U.S. Reclamation Service considered constructing a storage facility on the Gila, but the solution to satisfy the needs of both societies, however, was not reached until 1924, when the construction of Coolidge Dam was authorized.

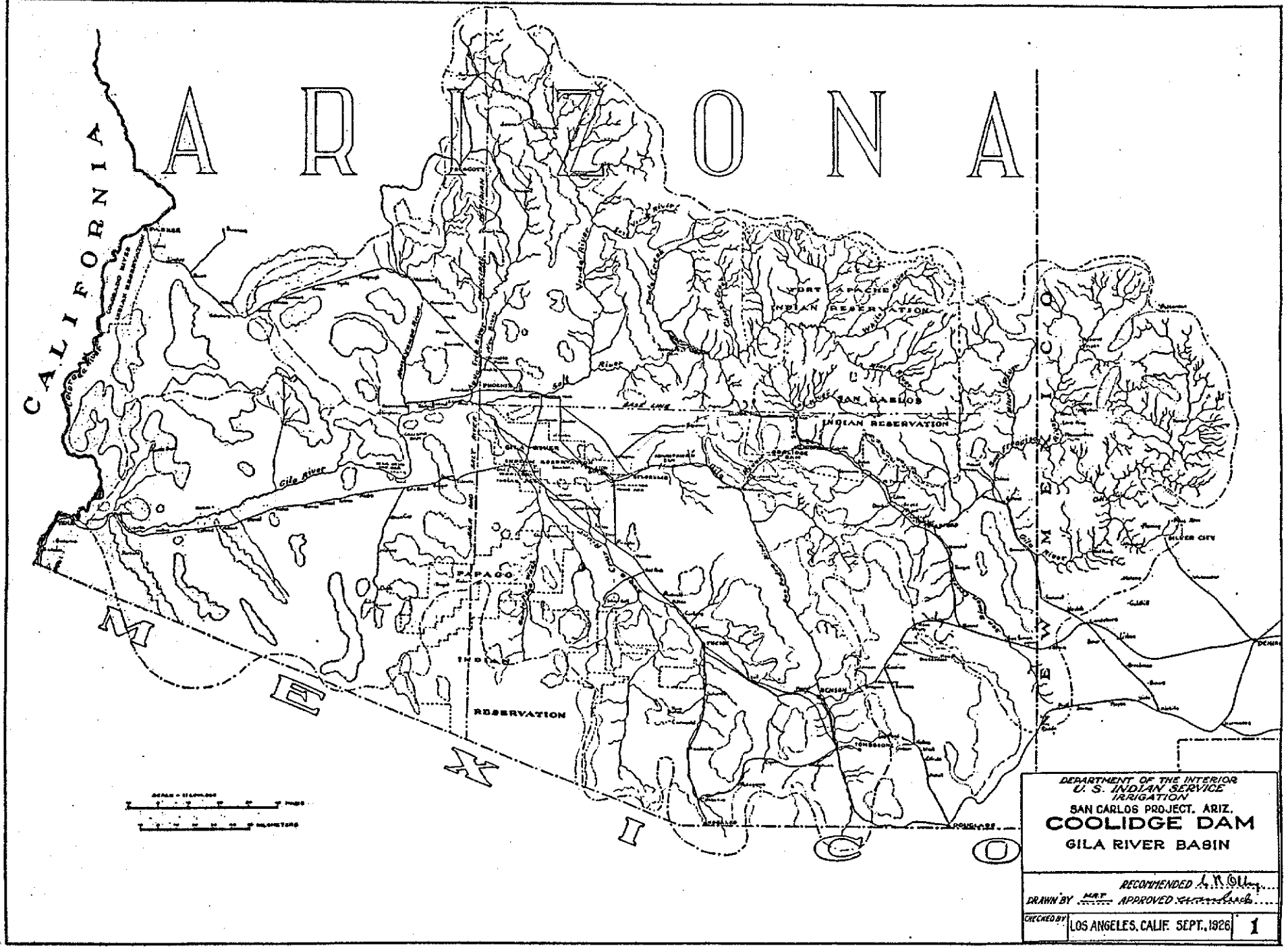
Coolidge Dam, a unique multiple dome structure, was designed by the Indian Office and constructed by the co-partnership of Atkinson, Kier Brothers and Spicer of California. The dam is unique in that its design employs a variation on the successive arch design. Three large domes, anchored by two buttresses, stand approximately 250 feet, impounding the Gila River for twenty three miles when full. Because of the unique design, construction required the fabrication of special form work to carry the domes vertically and then flaring downstream. The dam's construction plant layout design was also innovative using

a tramway to convey aggregate to the mixing plant which used a gravity flow system to process concrete to the placing tower. Combined with a dual cableway system, the construction design made good use of available technology and provided an integrated system limiting excessive labor. Because of the several novel elements used to construct the dam, it was completed one year ahead of schedule.

Today, Coolidge Dam supplies developed Gila River water to the Pima and Maricopa Indian tribes on the Gila River Indian Reservation under the San Carlos Irrigation Proejct and to anglo lands under the San Carlos Irrigation and Drainage District. Both entities, under adjudicated rights, can cultivate up to 50,000 acres depending on available storage behind Coolidge. Although water delivery is administered by two independent agencies, both share an integrated water transmission and delivery system.

APPENDIX I

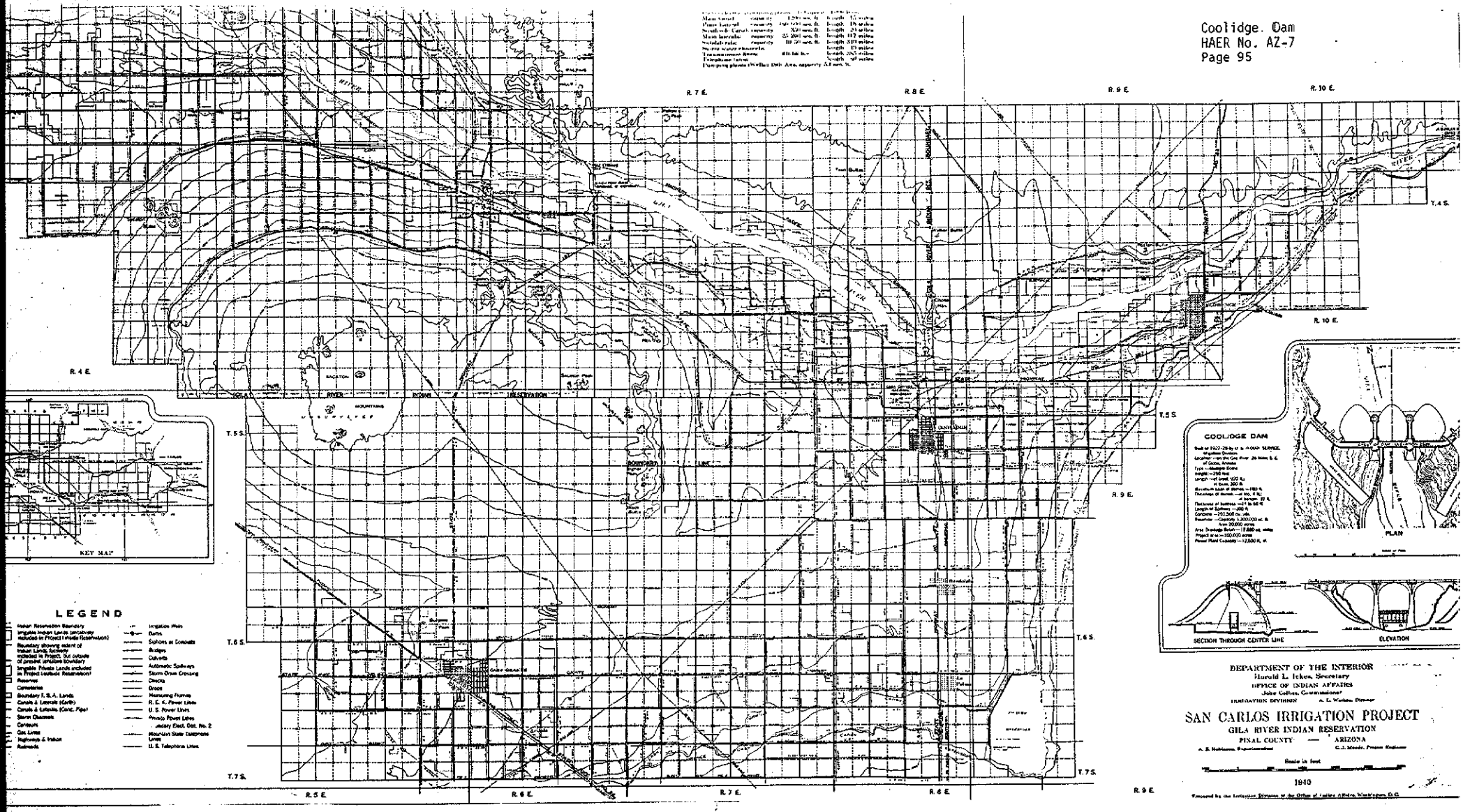
Indian Irrigation Service map showing the Gila River through Central Arizona.


ARIZONA
CALIFORNIA
NEW MEXICO
Gila River
Salt River
San Carlos Indian Reservation
Fort Apache Indian Reservation
Papago Reservation
DEPARTMENT OF THE INTERIOR
U. S. INDIAN SERVICE
IRRIGATION
SAN CARLOS PROJECT, ARIZ.
COOLIDGE DAM
GILA RIVER BASIN
RECOMMENDED
DRAWN BY MRT
APPROVED
CHECKED BY
LOS ANGELES, CALIF. SEPT., 1926
1

APPENDIX II

Indian Irrigation Service map showing the San Carlos Irrigation Project.

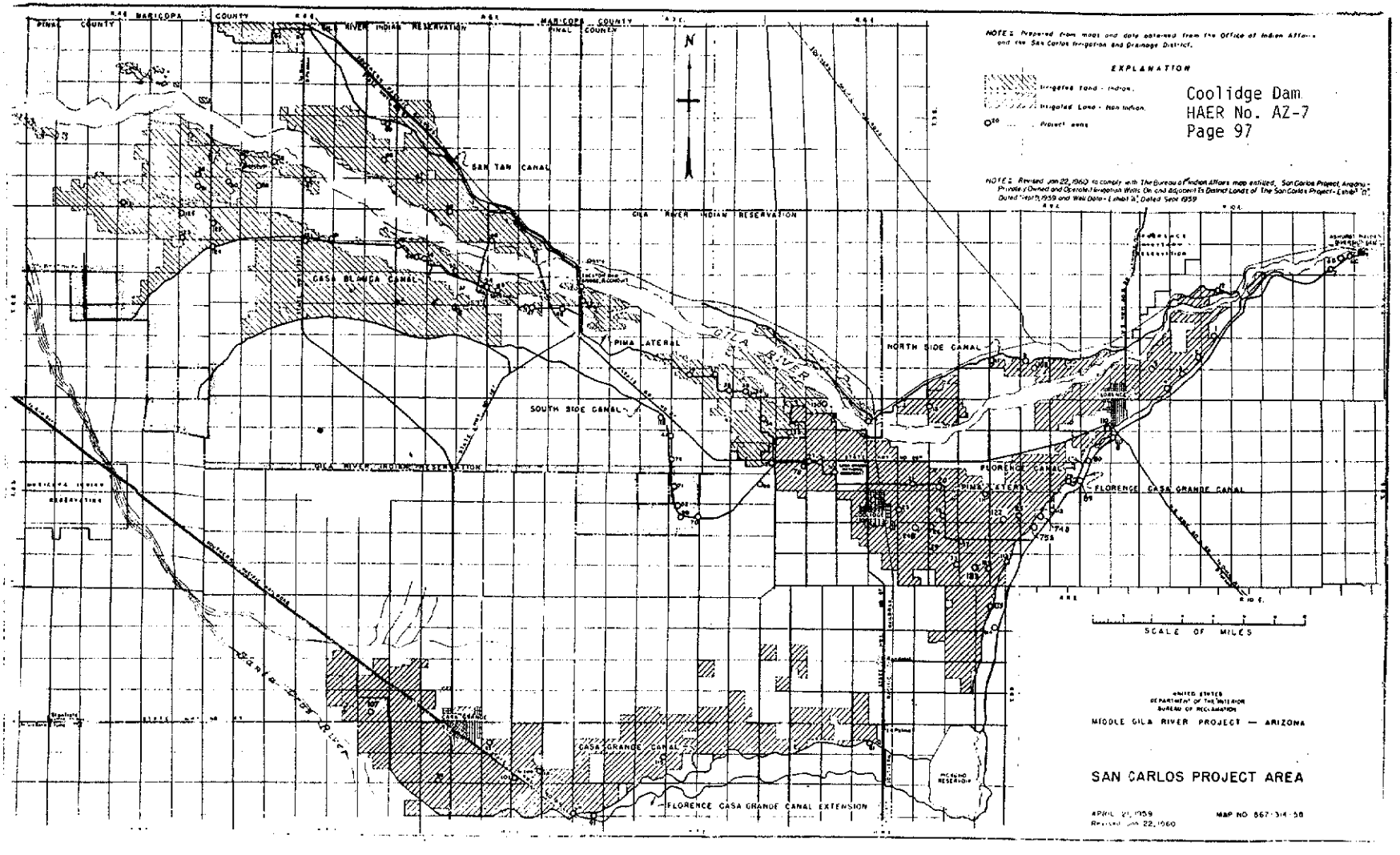
Coolidge Dam
HAER No. AZ-7
Page 95



APPENDIX III

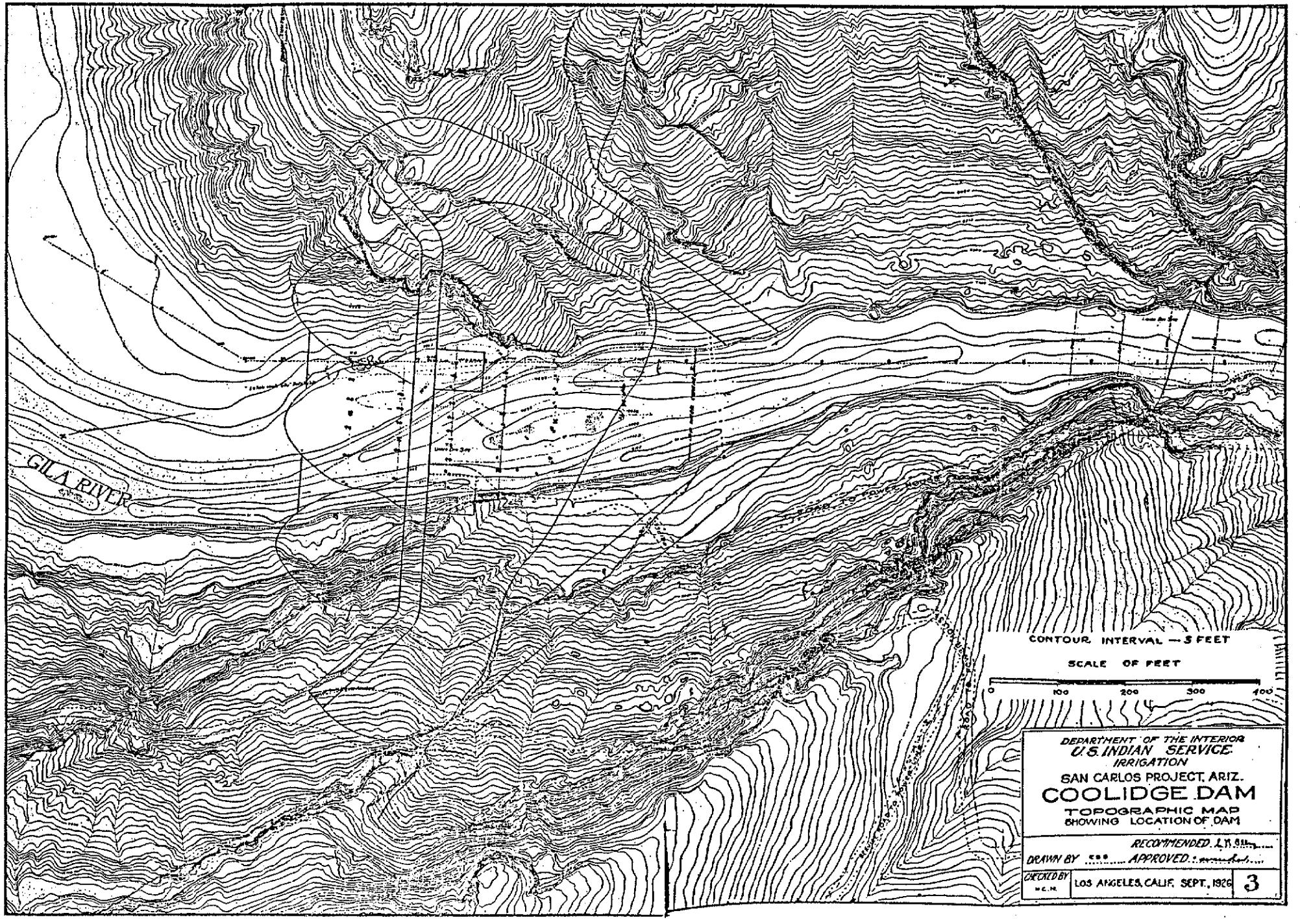
Bureau of Reclamation map showing Indian and non-Indian irrigated lands and wells within the San Carlos Project.

Coolidge Dam
HAER No. AZ-7
Page 97



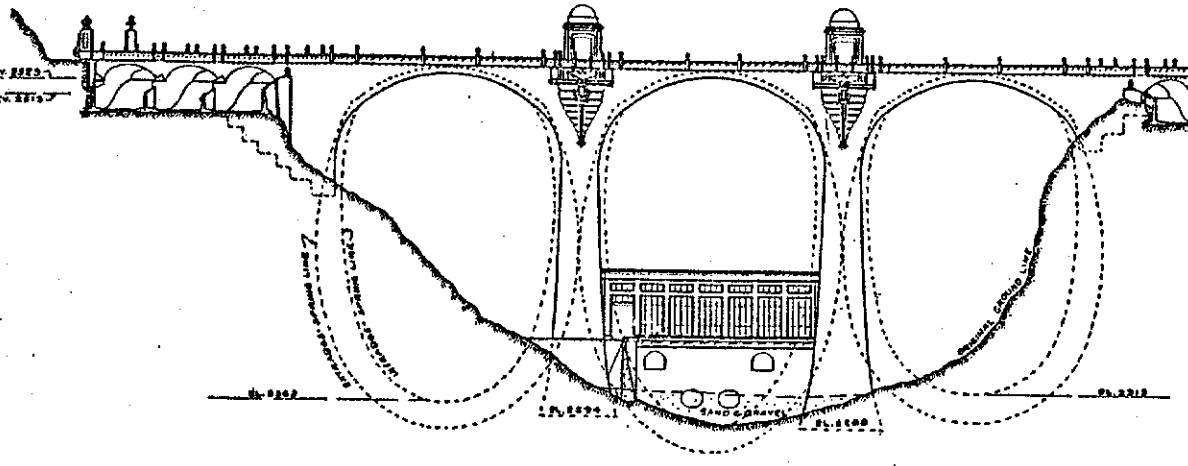
APPENDIX IV

Indian Irrigation Service topographic map showing location of Coolidge Dam.

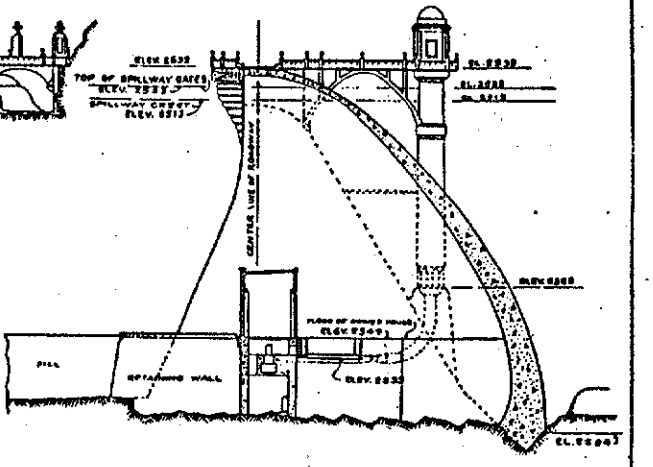

GILA RIVER
CONTOUR INTERVAL — 5 FEET
SCALE OF FEET
0
100
200
300
400
DEPARTMENT OF THE INTERIOR
U.S. INDIAN SERVICE
IRRIGATION
SAN CARLOS PROJECT, ARIZ.
COOLIDGE DAM
TOPOGRAPHIC MAP
SHOWING LOCATION OF DAM
RECOMMENDED
DRAWN BY
APPROVED
CHECKED BY
LOS ANGELES, CALIF. SEPT., 1926
3

APPENDIX V

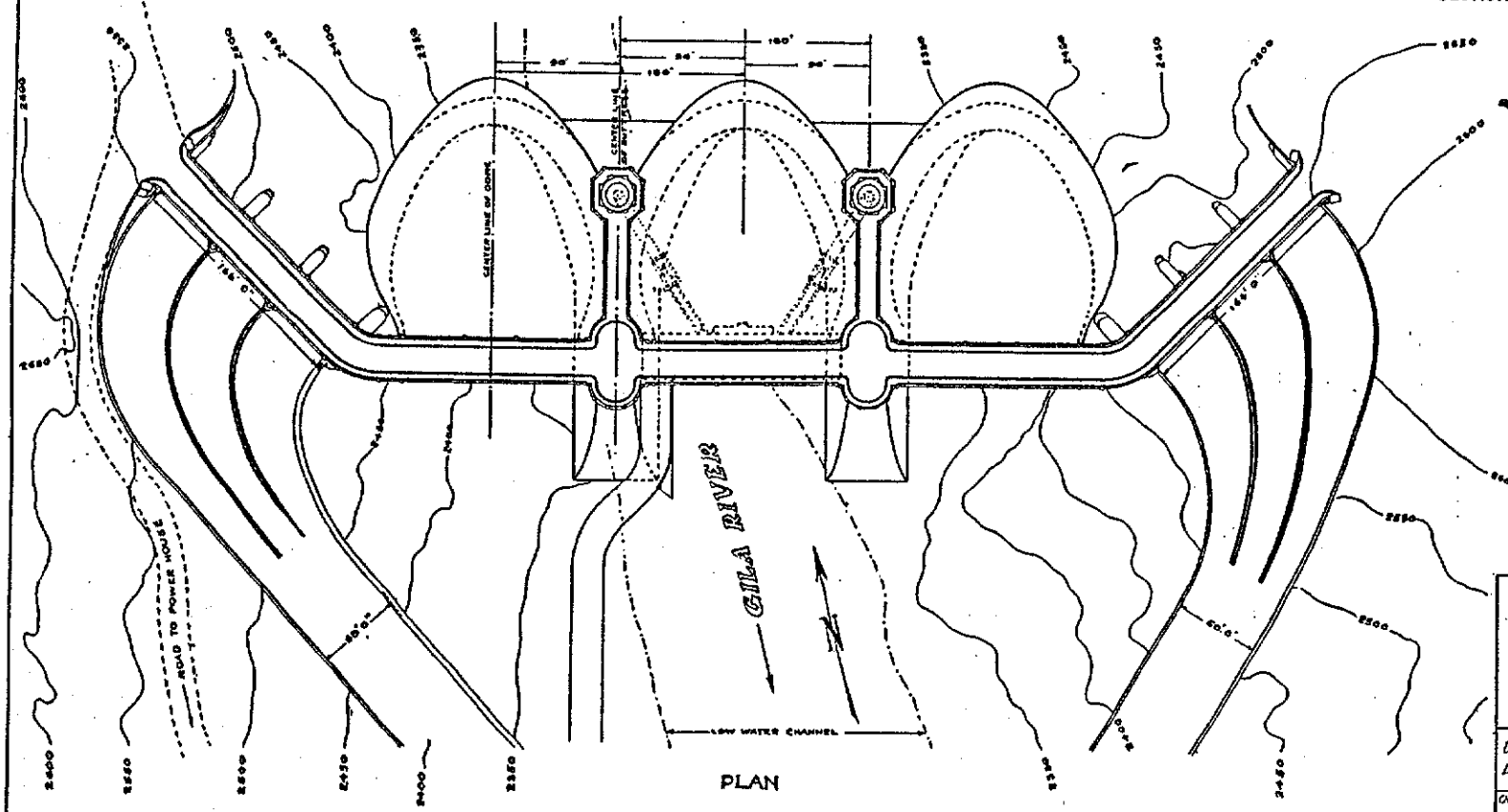
Indian Irrigation Service drawing showing plan, elevation and section of Coolidge Dam.



ELEVATION



SECTION ON CENTER LINE BETWEEN BUTTRESSES



PLAN

DEPARTMENT OF THE INTERIOR
U. S. INDIAN SERVICE,
IRRIGATION
SAN CARLOS PROJECT, ARIZ.

COOLIDGE DAM

PLAN, ELEVATION & SECTION

DESIGNED BY C.R.O. RECOMMENDED [illegible]
DRAWN BY H.A.T. APPROVED [illegible]
CHECKED BY H.C.H.
LOS ANGELES, CALIF. SEPT., 1926
4

APPENDIX VI

Coolidge Dam construction plant layout. Reprinted from, H. B. Hull and Henry Algert, "Coolidge Dam Construction Plant," Western Construction News (September 25, 1928): 584.

CONSTRUCTION PLANT
USED BY
ATKINSON KIER BROS SPICER CO
FOR BUILDING
COOLIDGE DAM
SAN CARLOS PROJECT ARIZ

GRAVEL DEPOSIT

GRAVEL DEPOSIT

PLAN & LAYOUT OF CONSTRUCTION PLANT

SECTION A-A
DETAIL OF RUNNERS AND MIXING PLANT

PROFILE ON FLOW LINE FROM GRAVEL PIT TO PLACING PLANT

APPENDIX VII

Layout of a concrete plant for Coolidge Dam. Reprinted from, J. G. Tripp, "Construction Methods and Plant Layout at Coolidge Dam, in Arizona," Proceedings, American Society of Civil Engineers 55 (November, 1929): 2351.

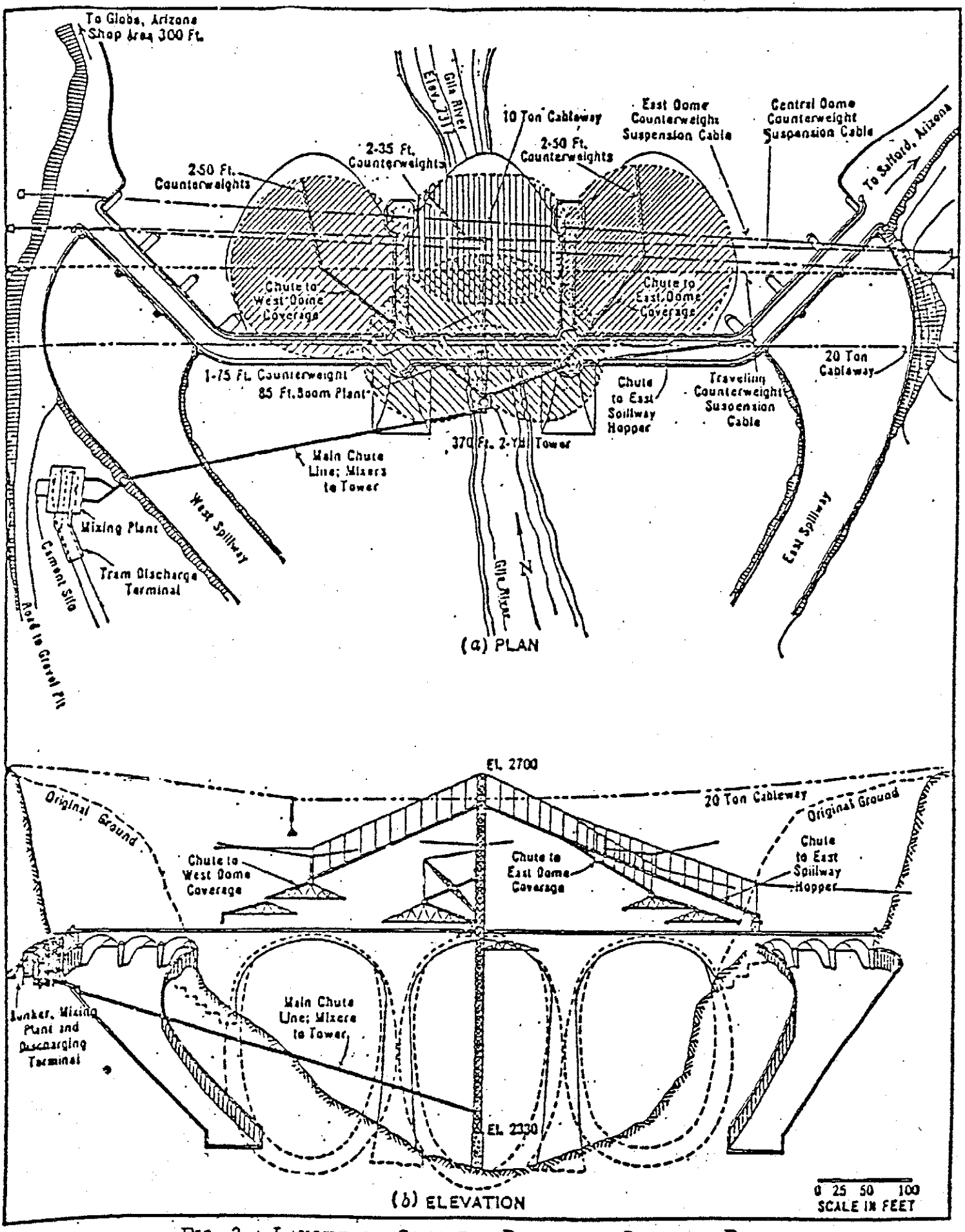
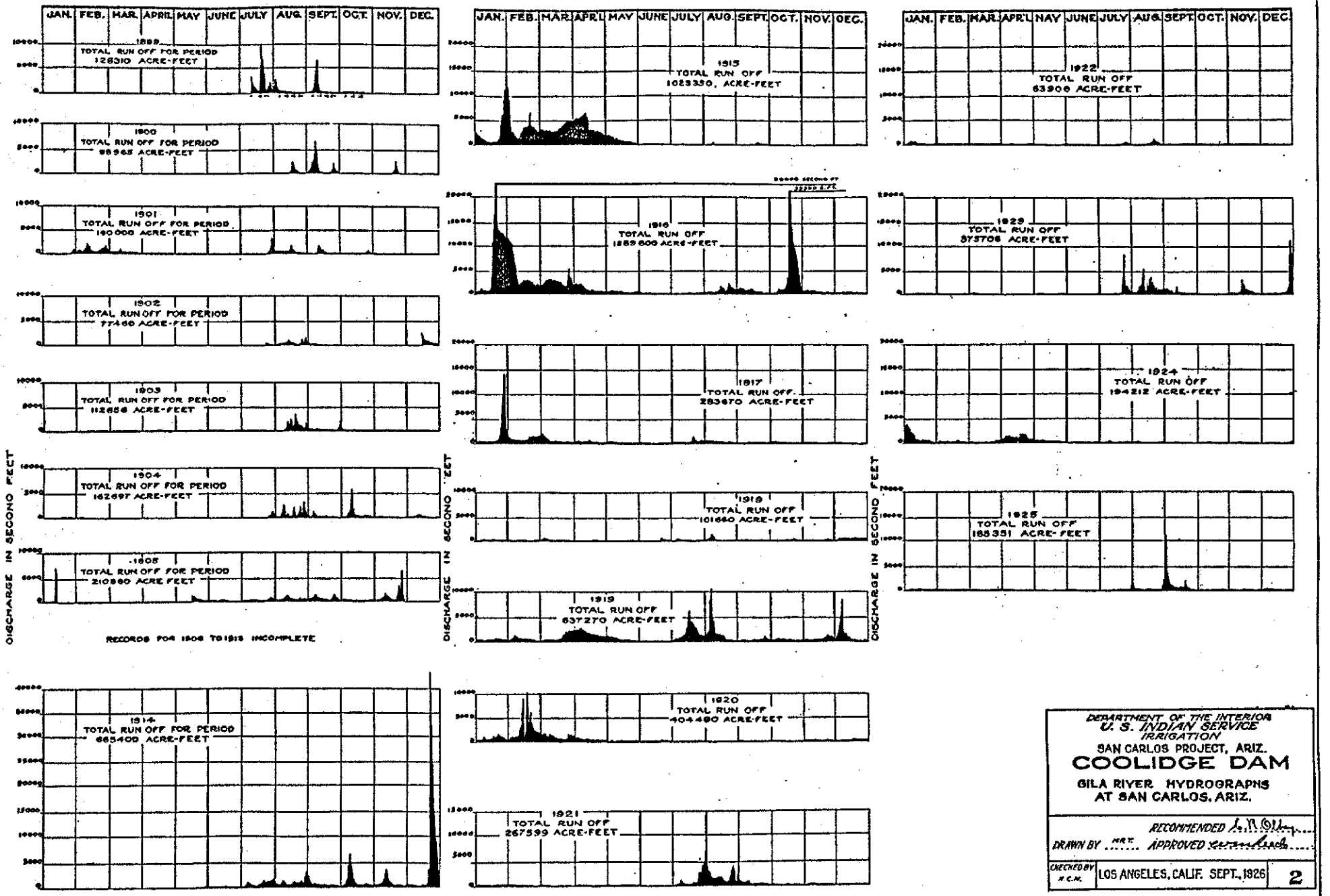


FIG. 3.—LAYOUT OF CONCRETE PLANT FOR COOLIDGE DAM.

APPENDIX VIII

Indian Irrigation Service hydrographs at San Carlos, 1899-1925.



DEPARTMENT OF THE INTERIOR
U. S. INDIAN SERVICE
IRRIGATION
SAN CARLOS PROJECT, ARIZ.

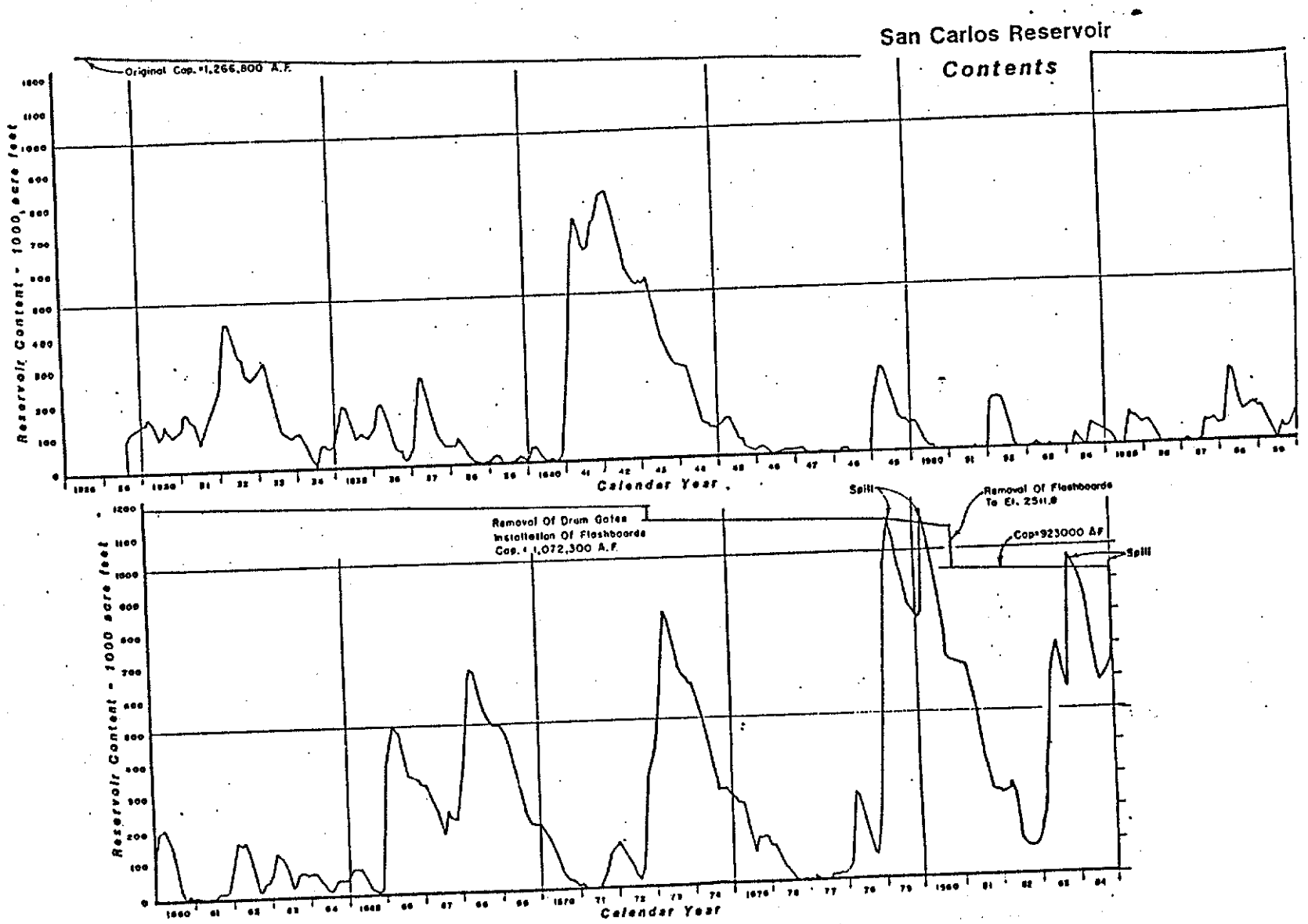
COOLIDGE DAM

GILA RIVER HYDROGRAPHS
AT SAN CARLOS, ARIZ.

RECOMMENDED [illegible]
DRAWN BY H.R.T. APPROVED [illegible]
CHECKED BY H.C.M. LOS ANGELES, CALIF. SEPT., 1926 2

APPENDIX IX

Reservoir content behind Coolidge Dam, 1929-1984.


San Carlos Reservoir
Contents
Original Cap. =1,266,800 A.F.
Reservoir Content - 1000 acre feet
Calender Year
Removal Of Drum Gates
Installation Of Flashboards
Cap. = 1,072,300 A.F.
Spill
Removal Of Flashboards
To El. 2511.0
Cap=923000 AF
Spill
Reservoir Content - 1000 acre feet
Calender Year

End Notes

1. Edward H. Spicer, Cycles of Conquest (Tucson: University of Arizona Press, 1962), 12-14, 118-152; Albert H. Kneale, Indian Agent (Caldwell, Idaho: The Caxton Printers, 1950), 23-29, 86-89, 164; J. Walter Fewkes, "Prehistoric Ruins on the Gila Valley," Smithsonian Miscellaneous Collection 52 (1909): 434-435.

2. U.S. Congress, Senate, A History of the Pima Indians and the San Carlos Irrigation Project, by Carl Hayden, 89th Cong., 1st Sess., 1965, S. Doc. 11, 4-15; Robert A. Hackenberg, "Economic and Political Change Among the Gila River Pima Indians," (Tucson: University of Arizona, Department of Anthropology, March, 1955. (Typewritten), 22-23, 29; Spicer, Cycles of Conquest, 146; History of Reservation (Phoenix, Bureau of Indian Affairs, n.d.) (Typewritten), 9; Marvin D. Young, "Bureau of Indian Affairs, History of the San Carlos Irrigation Project, Coolidge, Arizona." (Phoenix: Bureau of Indian Affairs, March, 1967). (Typewritten), 9.

3. 11 Stat. 401. For a good discussion on the establishment of the Gila River Indian Reservation see Stephen A. Langone, "The Considerations and Intent of Congress In Authorizing the Establishment of the Gila River Reservation For the Pima and Maricopa Indians by Act of Congress, February 28, 1859, (11 Stat. 401)," Library of Congress, August 7, 1968. (Typewritten.) Copy of report available at the Salt River Project Archives, Tempe, Arizona. The population of the Gila River Reservation at the time of its creation was estimated at 3,770 Pimas and 472 Maricopas. In the Spanish period the Maricopas were known as the Opas and Cocomaricopas. For convience, this paper will refer to both groups collectively as the Pimas. The reservation, as originally established, constituted a strip of land four miles wide and 2.5 miles long along the Gila River beginning six miles east of Sacaton and extending west to the western part of Snaketown. Section five of the act provided for an appropriation of $10,000 to be expended on presents for the Pimas, mostly farm implements, in gratitude for their loyalty and aid to the federal government. The reservation was eventually enlarged by nine executive orders between 1876 and 1915 so that at present its size is 372,022 acres. The government's trust protection duties to the Indian were chiefly outlined in John Marshall's Supreme Court decisions, Johnson and Graham's Lessee v. William M'Intosh, 8 Wheaton 543 (1823), Samuel A. Worcester v. The State of Georgia, 6 Peters 515 (1832), and The Cherokee Nation v. The State of Georgia, 5 Peters 1 (1831). For information concerning Indian water rights which are defined by the reserved rights doctrine see Winters v. U.S.,

207 U.S. 564 (1908), Conrad v. United States, 161 F. 831 (1908), and Arizona v. California, 373 U.S. 600 (1963). In regard to Winters, see Arrell Morgan Gibson, "Philosophical, Legal and Social Rationales for Appropriating the Tribal Estate, 1607 to 1980," American Indian Law Review 12 (1984): 3-37; Norris Hundley, Jr., "The Dark and Bloody Ground of Indian Water Rights: Confusion Elevated to Principle," Western Historical Quarterly 9 (October 1978): 454-482; Norris Hundley, Jr., "The 'Winters' Decision and Indian Water Rights: A Mystery Reexamined," Western Historical Quarterly 13 (January 1982): 17-42; Daniel G. Kelly, Jr., "Indian Title: The Rights of American Natives in Lands They Have Occupied Since Time Immemorial," Columbia Law Review 75 (1975): 665-686; Francis Paul Prucha, The Great Father, 2 vols. (Lincoln: University of Nebraska Press, 1984), 1:xxviii, 2:1202-1206. Western surface water rights are primarily based on the legal principle of prior appropriation and beneficial use. Simply explained, the first user or appropriator of water has the most senior claim and is therefore first in right to the use of water. See Frank J. Trelease, Water Law: Cases and Materials (St. Paul: West Publishing Company, 1979), 18-32; Robert A. Hackenberg, Pima-Maricopa Indians: Aboriginal Land Use and Occupancy of the Pima-Maricopa Indians, 2 vols. (New York: Garland Publishing Inc., 1974), 1:301-302; History of Reservation, 1; U.S., Department of Interior, Office of Indian Affairs, Report of the Commissioner of Indian Affairs . . . 1859, (Washington: George W. Bowman, 1860), 353-362.

4. Richard Batman, American Ecclesiastes: The Stories of James Pattie, (New York: Hardcourt Brace Jovanovich, 1984). See also Daniel E. Conner, Joseph Reddeford Walker and the Arizona Adventure, (Norman: University of Oklahoma Press, 1956). Spicer, Cycles of Conquest, 147; Hayden, A History of the Pima Indians and the San Carlos Irrigation Project, 4-15; Young, "Bureau of Indian Affairs, History of the San Carlos Irrigation Project, Coolidge, Arizona," 9; U.S. Congress, House, The History of Irrigation Along the Gila River, by Clay H. Southworth, contained in Committee on Indian Affairs, Indians of the United States, Apendixes A, B, and C, The Condition of Various Tribes in Indians. Hearings Before the Committee on Indian Affairs. 66th Cong., 1st Sess., 1919, 113; William H. Goetzman, Army Exploration in the American West, 1803-1863, (Lincoln: University of Nebraska Press, 1979), 114; Edwin Corle, The Gila, River of the Southwest, (Lincoln: University of Nebraska Press, 1951), 187-271.

5. Spicer, Cycles of Conquest, 147; Hayden, A History of the Pima Indians and the San Carlos Irrigation Project, 19-45.

6. Lewis William Wetzler, "A History of the Pima Indians" (Ph.D. diss., University of California, 1949), 238-239; U.S., Department of Interior, Office of Indian Affairs, Irrigation Division, Agricultural Economics Unit, Report on Economic

Conditions Existing on the San Carlos Irrigation Project and the Gila River Indian Reservation, Arizona, by A. L. Walker, May 1944. (Typewritten), 25; U.S. Congress, Senate, San Carlos Federal Irrigation Project in Arizona, 68th Cong., 1st Sess., 1924, S. Rept. 129, 3-4. In 1853, it was estimated that the Pimas had cultivated a stretch of land along the Gila fifteen miles long and two to four miles in width.

7. Hackenberg, "Economic and Political Change Among the Gila River Pima Indians," 33; U.S. Congress, House, Pima Indians and the San Carlos Irrigation Project. Hearings Before the Committee on Indian Affairs on S. 966, 68th Cong., 1st Sess., 1924, 39.

8. Hackenberg, "Economic and Political Change Among the Gila River Pima Indians," 31, 41; U.S. Congress, House, Hearing Before the Subcommittee of House Committee on Appropriations, 69th Cong., 2nd Sess., 1911, 173.

9. The Office of Indian Affairs did not officially become the Bureau of Indian Affairs until 1947, however, it was sometimes referred to as the Bureau since the early 19th century. Report of the Commissioner of Indian Affairs . . . 1859, 359-362.

10. Hackenberg, "Economic and Political Change Among the Gila River Pima Indians," 38-39; Southworth, The History of Irrigation Along the Gila River, 115; History of Reservation, 6; Walker, Report on Economic Conditions Existing on the San Carlos Irrigation Project and the Gila River Indian Reservation, Arizona, 7, 26; Andrew Hudanick, "The Pima Indians and Arizona Water Policy, 1840-1907" (Ph. D. diss., University of Northern Arizona, 1983), 62; U.S., Department of Interior, Office of Indian Affairs, Report of the Commissioner of Indian Affairs . . . 1869, (Washington: Government Printing Office, 1870), 220. Adamsville was established in 1866 and named after farmer, saloon and store owner Charles S. Adams. Florence was founded in the same year and was named after Territorial Governor Richard McCormick's sister. Florence is the county seat for Pinal County.

11. Message of Richard McCormick, Journal of the Arizona Territory, 1868, 37; Report of the Commissioner of Indian Affairs . . . 1869, 219-220.

12. U.S., Department of Interior, Office of Indian Affairs, Report of the Commissioner of Indian Affairs . . . 1870, (Washington: Government Printing Office, 1870), 118-128.

13. Hackenberg, "Economic and Political Change Among the Gila River Pima Indians," 42; Hayden, A History of the Pima Indians and the San Carlos Irrigation Project, 47; Report of the Commissioner of Indian Affairs . . . 1870, 125-126.

14. Report of the Commissioner of Indian Affairs . . . 1870, 126; Wetzler, "A History of the Pima Indians," 264-268; Journals of the 6th Arizona Territorial Assembly, 1871, 42-43. The

Territorial government was consistent in furthering the interests of the whites at the expense of the Pimas.

15. U.S., Department of Interior, Office of Indian Affairs, Report of the Commissioner of Indian Affairs . . . 1871, (Washington: Government Printing Office, 1872), 349, 354, 359; U.S., Department of Interior, Office of Indian Affairs, Report of the Commissioner of Indian Affairs . . . 1872, (Washington: Government Printing Office, 1872), 317.

16. Report of the Commissioner of Indian Affairs . . . 1872, 317; U.S., Department of Interior, Office of Indian Affairs, Report of the Commissioner of Indian Affairs . . . 1873, (Washington: Government Printing Ofice, 1874), 281.

17. Report of the Commissioner of Indian Affairs . . . 1871, 359; Report of the Commissioner of Indian Affairs . . . 1872, 153, 316-317. This report also stated, "These two tribes are poorer today than ever. The settlements above this reservation, on the Gila River, are rapidly increasing in population, and a greater supply of water is needed to meet their wants, and, as a natural consequence, the more water used by the settlers the less there is for the Indians." Report of the Commissioner of Indian Affairs . . . 1873, 281.

18. U.S., Department of Interior, Office of Indian Affairs, Report of the Commissioner of Indian Affairs . . . 1874, (Washington: Government Printing Office, 1874), 60, 293. The Indian Office also considered moving the Pimas to the Colorado River Reservation. U.S. Department of Interior, Office of Indian Affairs, Report of the Commissioner of Indian Affairs . . . 1876, (Washington: Government Printing Office, 1876), 8.

19. U.S., Department of Interior, Office of Indian Affairs, Report of the Commissioner of Indian Affairs . . . 1877, (Washington: Government Printing Office, 1877), 32; U.S., Department of Interior, Office of Indian Affairs, Report of the Commissioner of Indian Affairs . . . 1878, (Washington: Government Printing Office, 1878), xxxix, 3-4; David R. Wilcox, Thomas R. McGuire, and Charles Sternberg, "Snaketown Revisited," (Tucson: Arizona State Museum, Archaeological Series No. 155, October, 1981), 29. The drought continued in greater or lesser severity throughout the remainder of the 19th century. Clark S. Knowlton, Indian and Spanish American Adjustments to Arid and Semiarid Environments, (Lubbock: Texas Technological College, April 28, 1964), 12; Thomas Glen Alexander, "The Federal Frontier: Interior Department Financial Policy in Idaho, Utah, and Arizona, 1863-1896" (Ph. D. diss., University of California, 1965), 230. Dissertation later published as, A Clash of Interests, Interior Department and The Mountain West, 1863-1896, (Salt Lake: Brigham Young Press, 1977).

20. History of Reservation, 6; Hackenberg, Pima-Maricopa Indians, Aboriginal Land Use and Occupancy of the Pima-Maricopa Indians, p. 203, 217; Hackenberg, "Economic and Political Change

Among the Gila River Pima Indians," 46; Hudanick, "The Pima Indians and Arizona Water Policy, 1840-1907," 79-81. Spicer, Cycles of Conquest, 149; O. A. Williams, "Settlement and Growth of the Gila Valley as a Mormon Colony, 1879-1900" (M.A. thesis, University of Arizona, 1937).

21. Hackenberg, Pima-Maricopa Indians, Aboriginal Land Use and Occupancy of the Pima-Maricopa Indians, 186-195; Wetzler, "A History of the Pima Indians," 274-276; History of Reservation, 1.

22. Report of the Commissioner of Indian Affairs . . . 1877, 32-33; Report of the Commissioner of Indian Affairs . . . 1878, 4; U.S. Department of Interior, Office of Indian Affairs, Report of the Commissioner of Indian Affairs . . . 1881, (Washington: Government Printing Office, 1881), 5; U.S. Department of Interior, Office of Indian Affairs, Report of the Commissioner of Indian Affairs . . . 1883, (Washington: Government Printing Office, 1883), 6; U.S. Department of Interior, Office of Indian Affairs, Report of the Commissioner of Indian Affairs . . . 1884, (Washington: Government Printing Office, 1884), 6; U.S. Department of Interior, Office of Indian Affairs, Report of the Commissioner of Indian Affairs . . . 1890, (Washington: Government Printing Office, 1890), 6; U.S. Department of Interior, Office of Indian Affairs, Report of the Commissioner of Indian Affairs . . . 1891, (Washington: Government Printing Office, 1891), 217; Spicer, Cycles of Conquest, 149. Concerning the medical treatment provided for the Pimas it was stated, "We find the medical situation on the Pima and Papago Reservations in a deplorable condition. Doctors are often inefficient and indifferent; refuse to go out to look after sick Indians at distant points, have diagnosed cases of childbirth as tumor of the stomach; cases of pneumonia as tuberculosis; broken bones set in such a manner that the victim is a cripple for life; seldom if ever visiting outlying districts, and unwilling to go out when called." U.S. Congress, Senate, Improvement of Conditions of Indian Reservation in Arizona, 71st Cong., 1st Sess., 1929, S. Doc. 16, 8.

23. Report of the Commissioner of Indian Affairs . . . 1881, 5; U.S., Department of Interior, Office of Indian Affairs, Report of the Commissioner of Indian Affairs . . . 1882, (Washington: Government Printing Office, 1882), 8-9; Report of the Commissioner of Indian Affairs . . . 1883, 6; Report of the Commissioner of Indian Affairs . . . 1884, 6; U.S., Department of Interior, Office of Indian Affairs, Report of the Commissioner of Indian Affairs . . . 1885, (Washington: Government Printing Office, 1885), 370; U.S., Department of Interior, Office of Indian Affairs, Report of the Commissioner of Indian Affairs . . . 1886, (Washington: Government Printing Office, 1886), 38.

24. U.S., Department of Interior, Geological Survey, Storage of Water on Gila River, Arizona, by J. B. Lippincott, Water Supply and Irrigation Paper No. 33, (Washington: Government

Printing Office, 1900), 10-12; U.S. Congress, Senate, Report on the Irrigation Investigation for the Benefit of the Pima and Other Indians on the Gila River Indian Reservation, Arizona, by Arthur Powell Davis, 54th Cong., 2nd Sess., 1897, S. Doc. 27, 7-8; Wetzler, "A History of the Pima Indians," 286-288; U.S., Department of Interior, Office of Indian Affairs, Annual Reports of the Department of the Interior . . . Indian Affairs. Part I. Report of the Commissioner . . . , (Washington: Government Printing Office, 1905), 8. A history of the Florence Canal and Land Company can be found in, Southworth, The History of Irrigation Along the Gila River, 147-152.

25. Annual Reports of the Department of Interior . . . Indian Affairs. Part I. Report of the Commissioner . . . , 7-9; Alexander, "The Federal Frontier: Interior Department Financial Policy in Idaho, Utah and Arizona, 1863-1896," 264.

26. Hudanick, "The Pima Indians and Arizona Water Policy, 1840-1907," 99-122; E. A. Hitchcock to William A. Jones, June 6, 1904, Record Group 75, National Archives, Washington D.C., copy of letter available at the Salt River Project Archives, Tempe, Arizona.

27. Lippincott, Storage of Water on Gila River, Arizona, 11; Annual Reports of the Department of Interior . . . Indian Affairs. Part I. Report of the Commissioner . . . , 10; Hudanick, "The Pima Indians and Arizona Water Policy, 1840-1907," 142, 155. There were eighteen canals irrigating 67,000 acres above the reservation in 1891. Paps was sentenced to one year of confinement at the territorial prison in Yuma.

28. Lippincott, Storage of Water on Gila River, Arizona, 12; Annual Reports of the Department of Interior . . . Indian Affairs. Part I. Report of the Commissioner . . . , 10. A. P. Davis would later become Commissioner of the U.S. Reclamation Service in December 1914.

29. Davis, Report on the Irrigation Investigation for the Benefit of the Pima and Other Indians on the Gila River Indian Reservation, Arizona. The Buttes Dam was planned to be 235 feet high from bedrock to top and impound 208,000 acre feet of water. (An acre foot is approximately 325,000 gallons.) It would cost a total of $2,244,000 or $30 per acre irrigated. In an 1894 survey made by Lt. W. A. Glassford, U.S. Army Corps of Engineers, the Buttes Dam site was endorsed. Hudanick, "The Pima Indians and Arizona Water Policy, 1840-1907," 150-151.

30. Davis, Report on the Irrigation Investigation for the Benefit of the Pima and Other Indians on the Gila River Indian Reservation, Arizona, 3-6.

31. The Nicaragua Canal Committee investigated what became the Panama Canal. Davis' report only conducted soundings at the Buttes site in determining depth of bedrock. See Lippincott, Storage of Water on Gila River, Arizona. Cyrus C. Babb, hydrologist for the Geological Survey, was responsible for

discovering the San Carlos dam site. See U.S. Congress, Senate, Report of James D. Schuyler, Consulting Engineer, On the General Conditions and Cost of Water Storage for Irrigation on the Gila River, Arizona for the Benefit of the Indians Occupying the Gila River Reservation, by James D. Schuyler, 56th Cong., 1st Sess., 1900, Doc. 152, 11.

32. Schuyler, Report of James D. Schuyler . . ., 11-12; U.S. Congress, Senate, Report of Indian Inspector Walter H. Graves Relating to Irrigation for the Pima Indians, by Walter H. Graves, 56th Cong., 2nd Sess., 1901, Doc. 88.

33. The Territorial legislature also supported the Indian allotment plan as outlined in General Allotment Act (Dawes Act) of 1887. 24 Stat. 388. This act would allot a certain amount of acres to each Indian depending upon their status. The effect of the legislation would open to white settlement much of the Gila River Reservation. The Arizona legislature memorialized Congress to take allotment measures in 1896. Hudanick, "The Pima Indians and Arizona Water Policy, 1840-1907," 151, 178, 206 at note 9; Karen Smith, "The Campaign for Water in Central Arizona, 1890-1903," Arizona and the West 23 (Summer 1981): 138; Hackenberg, "Economic and Political Change Among the Gila River Pima Indians," 54; Wetzler, "A History of the Pima Indians," 310. When House Resolution No. 3733 failed, Congress appropriated $30,000 as temporary relief for the Pimas.

34. Annual Reports of the Department of Interior . . . Indian Affairs. Part I. Report of the Commissioner . . ., 12-13; Alexander, "The Federal Frontier: Interior Department Financial Policy in Idaho, Utah and Arizona, 1863-1896," 361; Hudanick, "The Pima Indians and Arizona Water Policy, 1840-1907," 197.

35. Oren B. Taft to William A. Jones, May 22, 1901, Record Group 75, National Archives, Washington D.C., copy of letter available at the Salt River Project Archives, Tempe, Arizona. The Picacho reservoir is located at the end of the Florence Canal. It serves as an equalizing or regulating reservoir and for flood water storage. It has a storage capacity of 18,375 acre feet. The reservoir is located in the McClellan Wash and impounds water because of a dike constructed around part of its perimeter. It was constructed in 1890 at an estimated cost of $125,000. Taft's claim that it was the largest water storage facility in the West, at that time, is probably inaccurate. The reservoir, due to silt accumulation, has been reconstructed at least three times. Annual Reports of the Department of Interior . . . Indian Affairs. Part I. Report of the Commissioner . . ., 13-14; Wetzler, "A History of the Pima Indians," 312-314; Hudanick, "The Pima Indians and Arizona Water Policy, 1840-1907," 196-197; C. W. Crouse to William A. Jones, November 12, 1900, Record Group 75, National Archives, Washington D.C., copy of letter available at the Salt River Project Archives, Tempe, Arizona.

36. 32 Stat. 388; Hudanick, "The Pima Indians and Arizona Water Policy, 1840-1907," 310, 348.

37. Hudanick, "The Pima Indians and Arizona Water Policy, 1840-1907," 335-336, 346-436. The defeat of the San Carlos Project in 1903 is still viewed with acrimony by the residents of Florence and Coolidge. Residents point to an investigation of the Salt and Gila River Valleys by Geological Survey Director Charles D. Walcott prior to the selection of a reclamation site in Arizona. Walcott remained in Phoenix for three weeks under the chaperonage of George Maxwell and B. A. Fowler. Walcott only visited the Gila Reservation when he crossed the land by rail under the cover of darkness on this way to Tucson. For a good discussion on the SRVWUA's "campaign" for water see Smith, "The Campaign for Water in Central Arizona." Maricopa County partially funded Davis' Geological Survey investigation of the Salt River and Phoenix, Tempe and Mesa helped pay for part of the Salt River Project by floating bonds to pay for part of the construction of the Mesa to Roosevelt Road, commonly known today as the Apache Trail. For a discussion on George H. Maxwell, see Hudanick, "The Pima Indians and Arizona Water Policy, 1840-1907, 263-309. Concerning repayment under the Reclamation Act, see, U.S., Department of Interior, Reclamation Service, First Annual Report of the United States Reclamation Service, 1902, (Washington: Government Printing Office, 1903), 69-70.

38. The enthusiasm, or more appropriately the fanaticism, in "conquering arid America" can best be seen in William E. Smythe, The Conquest of Arid America, (New York: Young People's Missionary Movement of the United States and Canada, 1899). For an excellent apprasial of the reclamation movement see Stanley Roland Davison, "The Leadership of the Reclamation Movement, 1875-1902," (Ph.D. dissertation, University of California, 1952). First Annual Report of the United States Reclamation Service, 65-66, 91. The excessive sedimentation problem on the Gila River is due in part to the overgrazing on the watershed in Graham County. See Hayden, A History of the Pima Indians and the San Carlos Irrigation Project, 59-75; Norris Soma, "San Carlos Irrigation Project - The Promise of 1924," paper presented at the 15th Annual Arizona Watershed Symposium, September, 1971, (typewritten), 10; U.S., Department of Agriculture, Soil Conservation Service, Sedimentation in San Carlos Reservoir Gila River, Arizona, by Eldon M. Thorp and Carl B. Brown, February, 1951, (typewritten). See also Earl Zarbin, Roosevelt Dam, A History to 1911, (Phoenix: Salt River Project, 1984) 51-72. Zarbin essentially repeats the explanation for the selection of the Salt River site offered by Colonel Weedin, editor of the Florence newspaper The Daily Tribune. Weedin stated that since Territorial Governor Brodie was a personal friend of President Roosevelt, having been a Major in a Rough Rider regiment, the president directed Secretary Hitchcock to do what Governor Brodie

wanted done. See, U.S. Congress, House, Report in the Matter of the Investigation of the Salt and Gila Rivers - Reservations and Reclamation Service, 62nd Cong., 3rd Sess., 1913, Rept. 1506, 54-55.

39. U.S., Department of Interior, Reclamation Service, Third Annual Report of the United States Reclamation Service, (Washington: Government Printing Office, 1905), 50-52, 55-56; Annual Reports of the Department of Interior . . . Indian Affairs. Part I. Report of the Commissioner . . . , 15; Hackenberg, "Economic and Political Change Among the Gila River Pima Indians," 55. The Office of Chief Engineer was formally created under the Act of March 3, 1905 (33 Stat. 1049). However, this position was actually a continuation of the position of Inspector of Irrigation which Graves held.

40. Annual Reports of the Department of Interior . . . Indian Affairs. Part I. Report of the Commissioner . . . , 15, 17-18, 146-148. Alexander's comments on the cost of an adjudication are interesting in light of present legal proceedings. In 1981, a general stream adjudication of the Gila River including the tributaries of the Salt, Verde and San Pedro rivers was initiated in Arizona. Many believe the Gila River Adjudication will be the largest single legal proceeding ever in the U.S. The case will impact approximately 2.5 million people, cost tens of millions of dollars and last at least ten to fifteen years.

41. Annual Reports of the Department of Interior . . . Indian Affairs. Part I. Report of the Commissioner . . . , 16-20; U.S., Department of Interior, Office of Indian Affairs, Annual Reports of the Department of the Interior . . . Indian Affairs. Part I. Report of the Commissioner . . . , (Washington: Government Printing Office , 1906), 74-75; U.S., Department of Interior, Office of Indian Affairs, Report of the Commisssioner of Indian Affairs . . . 1906, (Washington: Government Printing Office, 1906), 93; William Code to E. A. Hitchcock, April 19, 1904 and June 30, 1904, Record Group 75, National Archives, copy of letters available at the Salt River Project Archives, Tempe, Arizona. The 180,000 acres would be reservation lands not allotted to the Pimas under the Dawes Act. These lands would be located at the western half of the reservation but would exclude 5,000 acres at Gila Crossing, 12,000 acres at Casa Blanca and 1,500 acres at Maricopa. These three communities received seepage water or water from the Salt River. 33 Stat. 1048; 34 Stat. 325.

42. William Code to James R. Garfield, June 19, 1907, Record Group 75, National Archives, Washington D.C.; Chief Antonio Azul to Francis E. Leupp, March 1, 1906 and July 30, 1906, Record Group 75, National Archives, Washington D.C., copies of all three letters can be found at the Salt River Project Archives, Tempe, Arizona.

43. U.S., Department of Interior, Office of Indian Affairs, Report of the Commissioner of Indian Affairs . . . 1907, (Washington: Government Printing Office, 1907), 57. A copy of the Sacaton Contract can be found at the Salt River Project Archives, Tempe, Arizona. Authorization for the transferral of the $300,000 was approved by the 1908 Indian Appropriation Bill (34 Stat. 1022). The legislation stated, "That the Secretary of the Interior may, in his discretion, use such part of the three hundred thousand dollars heretofore appropriated for an irrigation system for the Pima Indians in the payment of such Indians' proportionate part of the construction of the Salt River project, and such funds may be transferred to the reclamation fund, to be expended by that service in accordance with its rules and regulations, the Indians to receive a credit upon the reclamation charge assessed against their lands under the Salt River project for the amount so transferred." The $300,000 would be an advance by the government until the 180,000 acres were sold.

44. U.S., Department of Interior, Reclamation Service, Eight Annual Report of the United States Reclamation Service, (Washington: Government Printing Office, 1910), 46. See 35 Stat. 70. U.S., Department of Interior, Reclamation Service, Ninth Annual Report of the United States Reclamation Service, (Washington: Government Printing Office, 1911), 66; U.S., Department of Interior, Reclamation Service, Tenth Annual Report of the United States Reclamation Service, (Washington: Government Printing Office, 1912), 66-67; U.S., Department of Interior, Reclamation Service, Eleventh Annual Report of the United States Reclamation Service, (Washington: Government Printing Office, 1913), 49.

45. U.S., Department of Interior, Office of Indian Affairs, Report of the Commissioner of Indian Affairs . . . 1911, (Washington: Government Printing Office, 1911), 17; U.S. Congress, House, House Resolution 330, Authorizing Suspension of Work in Construction of the Irrigation System, Pima Indian Reservation, Arizona, December 21, 1911 and January 5, 1912. The $500,000 that Mr. Martin stated was appropriated to date was the $300,000 plus appropriations made on April 4, 1910 for $75,000(36 Stat. 269) and $125,000 appropriated on March 3, 1911 (36 Stat. 1058).

46. Report in the Matter of the Investigation of the Salt and Gila Rivers . . ., 3; Wetzler, "A History of the Pima Indians," 318-342.

47. Report in the Matter of the Investigation of the Salt and Gila Rivers . . ., 148-161, 182.

48. Ibid., 171-176. Chandler acquired 18,000 acres, despite the Reclamation Act's limitation of 160 acres per individual, principally through the system of dummy entry. Concerning Chandler see also, Sylvia Lee Bender-Lamb, "Chandler, Arizona:

Landscape as a Product of Land," (M.A. thesis, Arizona State University, 1983).

49. Report in the Matter of the Investigation of the Salt and Gila Rivers . . ., 9-10, 162-170. Kibbey's testimony begins on page 323. Most of the terms of the Sacaton Ccntract have never been sustained. The ninteen-mile power line was constructed by the Reclamation Service to the Gila River Reservation. The Pimas, however, have never paid a percentage of the construction cost of the Salt River Project nor a percentage of any repair costs. Their lands have not been incorporated into the SRVWUA. The financial aspects of this arrangement are less clear. One hundred thousand dollars was deposited into the Reclamation fund. The remaining $400,000, though appropriated, seemingly was never allocated. The cost for the transmission line to the Gila Reservation is unknown.

50. Ibid., 24, 27. U.S. Congress, Senate, Committee on Indian Affairs, Pima Indian Reservation, 62 Cong., 2nd Sess., March 14, 1912, 8-9, 14-15. Having failed to construct a line through the reservoir site by August 1909, the Southern Pacific's right of way expired. Although the railroad petitioned for several years to have their right of way renewed, their efforts were rejected because they failed to demonstrate that the route through the reservoir area presented financial and engineering advantages.

51. Report on the Matter of the Investigation of the Salt and Gila Rivers . . ., 11, 19-20, 175. Specifically, Alexander was accused of misappropriating Indian paychecks after contracting to obtain jobs for them off the reservation and for employing relatives in positions as government farmers, ditch supervisors, etc., where they proved worthless.

52. Ibid., 5, 25. The committee's recommendations were not adopted.

53. Ibid., 735-736. Frederick H. Newell, Autobiography, (American Heritage Center: University of Wyoming, n.d.), 85, copy available at the Salt River Project Archives, Tempe, Arizona. Peggy Heim, "Financing the Federal Reclamation Program, 1902-1919, The Development of Repayment Policy" (Ph.D. dissertation, Columbia University, 1954), 122; Karen Smith, "The Magnificent Experiment: Building the Salt River Reclamation Project, 1890-1917" (Ph.D. dissertation, University of California, Santa Barbara, 1982), 219.

54. History of Reservation, 4-5; U.S. Indian Irrigation Service Report, 1913, 4, 16-19, 44-47, U.S. Indian Irrigation Service Report, 1914, 5-10. The administrative history of the Indian Irrigation Service is confusing. The Irrigation Service is the collective term used for all the Indian Service's irrigation activities. More formerly, the office was known as the Irrigation Division. The Division was formed in 1924. Before 1924, irrigation works were under the Land Division until

1907. From 1907 to 1909, the Field Work Division or the Cooperation Division existed under the Chief Clerk. In 1909, irrigation work was under the Uses Section of the Land Division. In 1910, a separate Irrigation Section was briefly established in the Land Division until it was combined with the Forestry Section in the same year to form the Field Section. In 1912, the two sections became independent and no longer part of the Land Division. Irrigation districts were formerly established (Arizona was district four) in 1918 and superintendents of these districts becamse supervising engineers. See Edward E. Hill, Preliminary Inventory of the Records of The Bureau of Indian Affairs, vol. 1, (Washington: The National Archives and Records Administration, 1965),186-188.

55. U.S. Congress, House, Report to the Secretary of War of a Board of Engineering Officers, U.S. Army, Under Indian Apropriations Act of August 24, 1912, on the San Carlos Irrigation Project, Arizona, 63rd Cong., 2nd Sess., 1914, Doc. 791. This report provides a good general account of all prior investigations. See pages 9 thru 22. The Casa Grande Water Users' Association formed for the purpose of developing the Florence Casa Grande Valley. The Association located a larger canal above and parallel to the old Florence Canal and began construction in April, 1912. They abandoned the work in July, 1915 due to lack of funds. At that time, they had constructed twelve of the planned twenty two miles of canal. The Indian Irrigation Service purchased the canal on March 16, 1920 for $50,000. The Reclamation Act was later admended to extend repayment to new projects to twenty years.

56. Arizona became a state in February, 1912. Jack August, "Carl Hayden and the Politics of Water in the Southwest, 1877-1932," (Ph.D. dissertation, University of New Mexico, 1985), 145-205; Indian Appropriation Act, May 18, 1916, 39 Stat. 123. The impetus for a bridge superstructure was the result of the 1915 flood which prohibited crossing the Gila by teams for four months and by car for nine months. The Lockwood decision settled the case Lobb v. Avenente on April 6, 1916. Judge Lockwood's water rights decisions also included the Arizona Supreme Court's decision in Maricopa County Municipal Water Conservation District v. Southwest Cotton (1931).

57. See Indian Appropriation Acts of: March 2, 1917 (39 Stat 969); May 25, 1918 (40 Stat. 561); February 14, 1920, (41 Stat. 408); March 3, 1921 (41 Stat. 1225); May 24, 1922 (42 Stat. 552); July 1, 1922 (42 Stat. 767); January 24, 1923 (42 Stat. 1174); April 2, 1924 (43 Stat. 33); June 5, 1924 (43 Stat. 390); March 3, 1925 (43 Stat 1141); and May 10, 1926 (44 Stat. 453). Both diversion dams are known as floating or Indian Weir type.

58. History of Reservation, 9. Authorization for the irrrigation of 27,000 acres for non-Indians was signed by the Secretary of Interior on April 22, 1920. Marvin Young, "Bureau

of Indian Affairs, History of the San Carlos Irrigation Project, Coolidge, Arizona," March, 1967, (typewritten), 13. See also U.S. Congress, Senate, Committee on Indian Affairs, Diversion Dam on the Gila River at a Site Above Florence, Arizona. Excerpts To Be Used by the Committee on Indian Affairs, 64 Cong., 1st Sess., 1916; Charles Real Olberg, "Revised Report on Proposed Sacaton Diversion Dam and Bridge, Gila River Project, Arizona," (Phoenix: Bureau of Indian Affairs, Trust Protection Division, May 1923), copy available at the Salt River Project Archives, Tempe, Arizona; Charles Real Olberg, "History of the Construction of Ashurst - Hayden Dam," (Phoenix: Bureau of Indian Affairs, Trust Protection Division, March 1, 1922), copy available at the Salt River Project Archives, Tempe, Arizona. The Sacaton Diversion Dam was never used as intended. With the completion of the Ashurst-Hayden Dam and headgates, the Florence Casa Grande Canal and the Pima Lateral, water was delivered to the reservation through this system. Sacaton Dam did divert some water for 8,400 cultivated acres through the San Tan Canal.

59. Hayden saw the Pimas' water shortage primarily as the result of overgrazing on the watershed not as the result of upstream appropriations. Hayden also did not favor a general stream adjudication. See Hayden, The History of the Pimas Indians and the San Carlos Irrigation Project, 47-75, 83-86. The estimated cost of the Apache wars, Hayden fixed at $42 million. U.S. Congress, Senate, San Carlos Federal Irrigation Project in Arizona, 68th Cong., 1st Sess., 1924, Rept. 129, 6; U.S. Congress, House, San Carlos Irrigation Project, 68th Cong., 1st Sess., 1924, Rept. 618, 3.

60. Jack August, "Carl Hayden and the Politics of Water in the Southwest, 1877-1932," 184-189; Hackenberg, "Economic and Political Change Among the Gila River Pima Indians," 65. The Senate passed the legislation on April 23rd and the House on June 4, 1924. The initial legislation authorized no funds for construction. The first funds allocated for construction were made available on March 3, 1925 (43 Stat. 1141) when $450,000 was appropriated. In 1927, $1.5 million was appropriated, in 1928, $3.45 million was appropriated and in 1929, $263,000 was appropriated for a total of $5,638,000. The power plant at Coolidge cost $412,000. August states that President Coolidge was opposed to the legislation while Hackenberg found that the bill passed the House through the "personal intervention" of President Coolidge. The legislation to construct Coolidge did not designate lands to be irrigated, did not apportion the water and did not specify a repayment policy, all of which hindered the administration of the project. With the passage of the San Carlos Irrigation Project (SCIP) legislation, the Florence Casa Grande Project was incorporated into SCIP on March 7, 1928 (45 Stat. 200).

61. Phoenix, Arizona, The Arizona Republic, March 5, 1930; Tucson, Arizona, The Arizona Daily Star, March 5, 1930.

62. U.S., Department of Interior, Office of Indian Affairs, Irrigation Division, "Report on Coolidge Dam, San Carlos, Arizona," vol. 1, by Charles Real Olberg, November 1925. (Typewritten.) Olberg had previously worked for the Reclamation Service. He surveyed the Roosevelt Power Canal which supplied hydropower for the construction of the Salt River Project's Roosevelt Dam. The town of Olberg, north of Sacaton, is named after him. For cost per acre for Coolidge Dam see pages 286-292. Hayden is twenty miles downstream from Coolidge Dam. Olberg had previously investigated the San Carlos Project in 1915. The geographic location of Coolidge Dam is Section 17, Township 3 South, Range 18 East. The river bed at the dam site is at an elevation of 2,308 feet above mean sea level.

63. Olberg, "Report on Coolidge Dam, San Carlos, Arizona," 11, 252, 266, 283; U.S., Department of Interior, Office of Indian Affairs, Irrigation Division, "Final Report, Design and Construction of the Coolidge Dam, San Carlos Project, Arizona," vol. 1, by H. C. Neuffer, January, 1930,(Typewritten), 38-40; U.S., Department of Interior, Office of Indian Affairs, Irrigation Division, "San Carlos Project," by Fisher, 1920, (Typewritten), 171; Jack August, "Carl Hayden and the Politics of Water in the Southwest, 1877-1932," 167. The Southern Pacific opposed the construction of Coolidge Dam. Based on a 1910 study conducted by M. O. Leighton, Chief Hydrographer of the Water Resources Branch of the Geological Survey, the railroad argued that only 43,000 acres could be irrigated by Coolidge and that by utilizing other sites equal water storage could be created without the expense of rerouting the rail line. The Arizona Eastern Railroad was authorized under 28 Stat. 688. On December 22, 1927 (45 Stat. 2), Congress appropriated one million dollars to pay for the relocation. Most of the rerouting work was completed by Apache laborers.

64. Some Indian graves may have been removed. Most of them, however, were covered with a concrete slab with side walls extending down three to four feet. About 645 Apaches lived within the reservoir area, irrigating 322 acres. The reservoir would extend twenty-three miles and flood 21,754 acres. Its capacity was calculated to be 1.2 million acre feet. The Apaches received no water storage rights to the reservoir. Olberg, "Report on Coolidge Dam, San Carlos, Arizona," 267-273; Charles R. Olberg to Charles H. Burke, February 4, 1926, Record Group 75, National Archives, Washington D.C., copy of letter available at the Salt River Project Archives, Tempe, Arizona. U.S. Congress, Senate, Proposed Development of Hydroelectric Power at The Coolidge Dam, 70th Cong., 1st Sess., 1928, Doc. 93, 2-3; 45 Stat. 2.

65. Secretary of Interior Franklin Lane reserved the Coolidge site as a power site on February 2, 1917 under the Act of June 25, 1910 (35 Stat. 855). The power plant was authorized on March 7, 1928 (45 Stat 200). The Federal Power Commission became the Federal Energy Regulatory Commission in 1977. Collier would later become the Commissioner of Indian Affairs from 1933 through 1945. Proposed Development of Hydroelectric Power at The Coolidge Dam, 11. The Federal Power Act and Commission were authorized by 66 Stat. 285. U.S. Congress, Senate, Hearings on H. R. 9136, A Bill Making Appropriations for the Department of the Interior for the Fiscal Year Ending June 30, 1920, and for Other Purposes, January 28, 1928 and January 30, 1928, 70th Cong., 1st Sess., 1928, 103. Collier also disagreed with the Commission's statement that the Apaches would receive cheap power. He stated that the cost for developing the power would be .5 mills to produce and therefore buying it at 2 mills presented no savings. A mill is .10 of a cent.

66. Charles Rhoads to A. L. Wathen, August 14, 1930, Record Group 75, National Archives, Washington D.C., copy of letter available at the Salt River Project Archives, Tempe, Arizona.

67. 1926 Appropriation Bill, 176; Neuffer, "Final Report, Design and Construction of the Coolidge Dam, San Carlos Project, Arizona," 28-32.

68. Neuffer, "Final Report, Design and Construction of Coolidge Dam, San Carlos Project, Arizona," 32-33. A copy of the specifications for Coolidge Dam is available at the Salt River Project Archives, Tempe, Arizona. Charles Olberg to Charles Burke, November 12, 1926 and November 27, 1926, Record Group 75, National Archives, Washington D.C., copy of letters available at the Salt River Porject Archives, Tempe, Arizona. Atkinson, E. L. Kier, W. E. Kier and L. A. Spicer were located at 1315 Edwards-Wildey Building, Los Angeles. Lynn Atkinson also constructed the multiple arch, flood control, Cave Creek Dam north of Phoenix in 1922-1923. Lynn Atkinson should not be confused with Guy F. Atkinson of San Francisco. Guy F. Atkinson built the Hassayampa Dam in Arizona as well as more recently conducting the rehabilitation work at Glen Canyon Dam. For a biographical sketch on Lynn Atkinson see, Lynn Atkinson, "Construction of Coolidge Dam in Retrospect," Western Construction News 4 (January 25, 1929): 35-37.

69. Neuffer, "Final Report, Design and Construction of Coolidge Dam, San Carlos Project, Arizona," 34-35.

70. Ibid., 43-45; H. B. Hull and Henry Algert, "Coolidge Dam Construction Plant," Western Construction News (September 25, 1928): 589-591; Graydon Oliver, "Dirt Flies for Coolidge Dam," Modern Irrigation 13 (June 1927): 29. Power needed for the construction of Coolidge Dam was estimated at 800 horsepower. Power from Hayden was obtained at 1.6 cents per kilowatt hour. Power provided through the use of oil engines would have cost two

cents per kilowatt hour. Charles Real Olberg, "Report on Coolidge Dam, San Carlos, Arizona," vol.1, (Department of Interior, U.S. Indian Irrigation Service, November 1925), (typewritten), 27. Perry's successful bid was for $124,811.70. Oliver stated that power was obtained from the Ray Consolidated Power Plant at Hayden. A telephone line was erected in May through July 1927 which paralleled the transmission line.

71. Neuffer, "Final Report, Design and Construction of Coolidge Dam, San Carlos Project, Arizona," 34-37.

72. Ibid., 41-42.

73. Ibid., 54-55; H. B. Hull and Henry Algert, "Coolidge Dam Construction Plant," 585; Graydon Oliver, "Dirt Flies for Coolidge Dam," 28.

74. Neuffer, "Final Report, Design and Construction of Coolidge Dam, San Carlos Project, Arizona," 59-63; H. B. Hull and Henry Algert, "Coolidge Dam Construction Plant," 587-589; Graydon Oliver, "Dirt Flies for Coolidge Dam," 29.

75. Neuffer, "Final Report, Design and Construction of Coolidge Dam, San Carlos Project, Arizona," 63-65; Hull and Algert, "Coolidge Dam Construction Plant," 587; J. G. Tripp, "Construction Methods and Plant Layout at Coolidge Dam, in Arizona," Proceedings, American Society of Civil Engineers (November 1929): 2353; J. G. Tripp, "Symmetry of Design and General Economics in Construction," Western Construction News (November 10, 1929): 581-585; Charles Olberg, "The Coolidge Multiple-Dome Dam," Western Construction News (December 25, 1926): 33-37. Trucks could handle seven to ten tons per load.

76. Neuffer, "Final Report, Design and Construction of Coolidge Dam, San Carlos Project, Arizona," 66-69.

77. Hull and Algert, "Coolidge Dam Construction Plant," 589; Tripp, "Construction Methods and Plant Layout at Coolidge Dam, in Arizona," 2353.

78. For a thorough description of the multiple dome design see, Charles Real Olberg, "Features of Design, Coolidge Multiple-Dome Dam," Engineering News-Record (September 13, 1928): 396-399; A. Floris, "Do Multiple Dome Type Dams Develop Dome Action?" Western Construction News 5 (March 10, 1930): 132-136; F. A. Noetzli, "Tests on Coolidge Dam," Arch Dam Investigation. vol. 3. (New York: The Engineering Foundation, May 1933), 139-146. "The Coolidge Dam in Arizona," The Engineer (January 18, 1929): 66; Neuffer, "Final Report, Design and Construction of Coolidge Dam, San Carlos Project, Arizona," 25. The buttresses are spaced 180 feet on centers. Although steel reinforcement would not be required when the reservoir was full because the tension stresses on the domes are negligible, steel is needed when the reservoir is empty to provide for temperature deformations and to tie the structure together. Steel was employed in the buttresses to provide for the possible effect of shrinkage.

79. Atkinson, "Construction of Coolidge Dam in Retrospect," 35, 37; Hull and Algert, "Coolidge Dam Construction Plant," 595. For a complete list of the government's engineers and the contractor's staff see, Neuffer, "Final Report, Design and Construction of Coolidge Dam, San Carlos Project, Arizona," 46, 133-137. The government divided its forces into three groups: design, construction and clerical.

80. Binckley's suit was settled by the Court of Claims of the United States on June 1, 1936, No. K-494. Binckley's design was probably preceded by the Six Mile Creek Dam in Ithaca, New York.

81. Neuffer, "Final Report, Design and Construction of Coolidge Dam, San Carlos Project, Arizona, 48-49.

82. Ibid., 49-51; Hull and Algert, "Coolidge Dam Construction Plant," 591, 593. Mounds of aggregate are still visible at the gravel plant location today. M. P. Morrison, "Aerial-Tramway Development for Construction Haulage," Engineering News-Record (May 30, 1929): 860.

83. Neuffer, "Final Report, Design and Construction of Coolidge Dam, San Carlos Project, Arizona," 51-52; Hull and Algert, "Coolidge Dam Construction Plant," 593-594.

84. The concrete moved in the tower skip at 350 feet per minute. The skip was powered by a 175 hoist with a General Electric motor. The detailed concrete roadway work required the employment of 200 men "constantly." Neuffer, "Final Report, Design and Construction of Coolidge Dam, San Carlos Project, Arizona," 47-49, 52-53, 84; Hull and Algert, "Coolidge Dam Construction Plant," 594-595; Tripp, "Construction Methods and Plant Layout at Coolidge Dam, in Arizona," 2352. Two classes of concrete were used in the construction. Class A, for the domes, had a strength of 2,200 pounds per square inch. Class B, for the buttresses, had a strength of 1,800 pounds per square inch. One barrel of cement was needed per cubic yard of concrete for Class A work and .9 barrels of cement was needed per cubic yard of concrete for Class B work. "A Construction Achievement," Engineering News-Record (September 20, 1928): 422; "The Coolidge Dam in Arizona," 65. The compression strength of the concrete was established at 587 pounds per square inch in the domes and 400 pounds per square inch in the buttresses. Pressure in the buttress foundations was established at twenty tons per square foot. All concrete was tested by government inspectors at the government camp's lab.

85. Hull and Algert, "Coolidge Dam Construction Plant," 587.

86. Ibid., 589.

87. "The Coolidge Dam in Arizona," 65; "Construction Features, Coolidge Multiple-Dome Dam," Engineering News-Record (September 20, 1928): 439-441. For a description of the panels see pages 440 to 441. Tripp, "Construction Methods and Plant Layout at Coolidge Dam, in Arizona," 2354-2355; Tripp, "Symmetry

of Design and General Economics in Construction," 584; Neuffer, "Final Report, Design and Construction of Coolidge Dam, San Carlos Project, Arizona," 91-92. When the domes began to angle at thirty degrees (one hundred feet above the base) they were held in place by a wishbone-and-wailing piece method. This method was used until the angle reached fifty four degrees. At that point the trusses were employed. The domes were twenty-feet thick at bedrock and tapered to four-feet thick at the top. The dam is 251 feet in height from bedrock to roadway.

88. Neuffer, "Final Report, Design and Construction of Coolidge Dam, San Carlos Project, Arizona," 55-56, 115-116; Hull and Algert, Coolidge Dam Construction Plant," 583; Tripp, "Construction Methods and Plant Layout at Coolidge Dam, in Arizona," 2353. The diversion opening in the east dome was equipped with a sliding gate to control flow. The original design plans provided for inspection and drainage galleries at the base of the dam. Because the dome action would effectively eliminate uplift pressure and because of the excellent bedrock, the galleries were not incorporated into the construction plan.

89. Embedded into the domes and buttresses were forty electric telemeters which were placed to measure compression and tension in the concrete. The telemeters failed to provide any valuable information because many of them failed before the dam was loaded appreciably. Data that was obtained was not sufficient to provide any interpretation. Neuffer, "Final Report, Design and Construction of Coolidge Dam, San Carlos Project, Arizona," 56-57, 127-128.

90. Ibid., 57, 92-94; Edward H. Wegmann, The Design and Construction of Dams, 8th ed. (New York: John Wiley and Sons, 1927), 522-523. The outlet towers were positioned sixty feet above the river bed. The trash racks were connected with cables carrying counterbalance weights which enabled the racks to be raised and cleaned. The outlet gates were installed by the Consolidated Steel Corporation. They completed the work on December 19, 1931. Although the contract was for $11,763, the total cost for the gates was $23,525. Fred A. Noetzli assisted in the design of the spillway gates. The gates were installed by the firm of Bent Brothers for $87,000. History of Reservation, 11.

91. Neuffer, "Final Report, Design and Construction of Coolidge Dam, San Carlos Project, Arizona," 57, 95-100. The central piers also had a tunnel compartment "through which the water to be used for operating the gates is to be discharged when the gates are lowered." The roadway with detailed railings, the cornice and the overhangs with eagles were all expensive ornamental enrichments. They were added because the Indian Office wanted the dam to symbolize their finest efforts.

92. Ibid., 101-102, 105-114. The maximum head of water through the turbines was calculated at 205 feet with an

operational discharge rate of 2,000 cfs for both penstocks. Discharge capacity is rated at 3,860 cfs. The penstock branches were constructed of riveted plate steel and cast in blocks of concrete. Section one of the switchboard held the generator voltage regulators. The second section held the auxiliary power panel board and the switches for the plant auxiliary and camp circuits. The third section held the control switches for manual operation of the generators, exciters, circuit breakers, valves and power house equipment. The Pelton Water Wheel Company supplied the turbines for the power house. The electrical machinery and equipment was furnished by General Electric. Government forces did all the concrete work in the power house including the turbine scroll case, draft tubes, generator bases and foundations for the transformers and switching stations. Government forces also installed the turbines while General Electric installed its own equipment.

93. Ibid., 102; "The Coolidge Dam in Arizona," 65.

94. Neuffer, "Final Report, Design and Construction of Coolidge Dam, San Carlos Project, Arizona," 58. For changes in the original specifications for Coolidge, albeit minor, see Neuffer, pages 114-120. "A Construction Achievement," 422; Hull and Algert, "Coolidge Dam Construction Plant," 595. The contractors payroll for the project varied anywhere from $60,000 to $100,000 per month.

95. Jack August, "Carl Hayden and the Politics of Water in the Southwest, 1877-1932," 190-192; B. F. Thum, "Coolidge Dam and the Great San Carlos Project," Progressive Arizona and the Great Southwest, 10 (May 1930): 19-20; Wetzler, "A History of the Pima Indians," 352; "Dedication of Coolidge Dam," Arizona Historical Review, 3 (April 1930): 12-14. The Gila River is a tributary of the Colorado River having its confluence at Yuma, Arizona.

96. Above Coolidge Dam, the Gila is fed by the San Carlos, San Simon and San Francisco rivers. The reservoir collects water from a 12,880 square mile drainage area. Before stored water reaches project lands, additional water from the San Pedro River drains into the Gila near Winkelman and Hayden, Arizona. Walker, Report on Economic Conditions Existing on the San Carlos Irrigation Project and the Gila River Indian Reservation, Arizona, 9, 68.

97. Ibid., 68-71; History of Reservation, 12-16.

98. Interview with Norris Soma, formerly District Manager for the San Carlos Irrigation and Drainage District, Coolidge, Arizona, April 28,1986.

99. 47 Stat. 564; 48 Stat. 881; Walker, Report on Economic Conditions Existing on the San Carlos Irrigation Project and the Gila River Reservation, Arizona, 71-73, 189-196; Interview with Norris Soma, April 28, 1986. The San Carlos Project diesel plant at Coolidge is no longer in operation. Presently the Project is

considering the sale of its power system.

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Addendum to

HAER No. AZ-7

Coolidge Dam
Gila River
San Carlos Apache Indian Reservation
Peridot Vicinity
Pinal County
Arizona

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PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

Historic American Engineering Record
National Park Service
Western Region
Department of Interior
San Francisco, California 94102

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HISTORIC AMERICAN ENGINEERING RECORD

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NOTE: Photographs were taken by Bob Knotts, photographer, January and June 1991

Photographs No. AZ-7-1 through AZ-7-129 were previously submitted to the Library of Congress.

AZ-7-130	VIEW OF COOLIDGE DAM, FACING SOUTH, SHOWING THE THREE-ARCHED DOMES OF THE INTAKE TOWERS (June 1991)
AZ-7-131	CLOSE-UP VIEW OF RIGHT INTAKE TOWER, FACING EAST (January 1991)
AZ-7-132	CLOSE-UP VIEW OF LEFT INTAKE TOWER WITH RIGHT INTAKE TOWER IN BACKGROUND, FACING WEST (January 1991)
AZ-7-133	VIEW OF RIGHT (WEST) SPILLWAY GATES, FACING WEST. GATES ARE DOWN AND INOPERATIVE. (June 1991)
AZ-7-134	VIEW OF LEFT (EAST) SPILLWAY GATES, LOOKING EAST. GATES ARE DOWN AND INOPERATIVE. (June 1991)
AZ-7-135	VIEW LOOKING SOUTH (DOWNSTREAM) DOWN THE SPILLWAY, SHOWING TOP OF RIGHT SPILLWAY (January 1991)
AZ-7-136	VIEW, TAKEN FROM BASE OF SPILLWAY, LOOKING UP RIGHT (WEST) SPILLWAY, FACING NORTHWEST (January 1991)
AZ-7-137	VIEW, TAKEN FROM WEST SIDE OF GILA RIVER, LOOKING UP LEFT (EAST) SPILLWAY, FACING NORTHEAST (January 1991)
AZ-7-138	VIEW OF WESTERN APPROACH TO THE DAM, SHOWING DECORATIVE LAMP PYLONS FLANKING THE ENTRANCE AND THE PARAPET WALLS ON TOP OF DAM, LOOKING SOUTH (January 1991)

AZ-7-139 VIEW OF THE COMPLETE LEFT (EAST) DECORATIVE LAMP PYLON AND PORTION OF PARAPET WALL ON THE WESTERN APPROACH TO THE DAM, LOOKING EAST (January 1991)

AZ-7-140 CLOSE-UP VIEW SHOWING THE LOWER PART OF THE RIGHT (WEST) DECORATIVE LAMP PYLON ON THE WESTERN APPROACH TO THE DAM, LOOKING SOUTHEAST (June 1991)

AZ-7-141 VIEW OF LAMP FIXTURE ON TOP OF RIGHT (WEST) DECORATIVE LAMP PYLON ON THE WESTERN APPROACH TO THE DAM, FACING NORTHWEST (June 1991)

AZ-7-142 CLOSE-UP VIEW OF LAMP FIXTURE ON TOP OF RIGHT (WEST) DECORATIVE LAMP PYLON ON THE WESTERN APPROACH TO THE DAM, FACING WEST (June 1991)

AZ-7-143 VIEW OF PARAPET WALL WITH ONE OF THE LAMP COLUMNS (WITH LAMP REMOVED). PARAPET WALL FLANKS ROAD ACROSS TOP OF DAM. THIS SECTION OF PARAPET WALL IS ON THE SOUTH SIDE OF THE DAM, LOOKING SOUTHWEST (January 1991)

AZ-7-144 VIEW SHOWING A SECTION OF THE PARAPET WALL ON SOUTH SIDE OF THE TOP OF THE DAM, LOOKING WEST (January 1991)

AZ-7-145 DETAIL VIEW OF SECTION OF PARAPET WALL, SHOWING DECORATIVE CONCRETE WORK, LOOKING WEST (January 1991)

AZ-7-146 DETAIL VIEW, LOOKING STRAIGHT ON, OF CAST IRON LAMP STANDARD. THIS AND OTHER LAMP STANDARDS WERE REMOVED FROM THE LAMP COLUMNS ON THE PARAPET WALLS DURING WORLD WAR II AND STORED INSIDE THE DAM (January 1991)

AZ-7-147 DETAIL VIEW OF CAST IRON LAMP STANDARD, VIEWED AT AN ANGLE, ONE-FOOT RULE INCLUDED FOR SCALE (January 1991)

AZ-7-148 VIEW OF DOWNSTREAM FACE OF COOLIDGE DAM, SHOWING THE CONCRETE EAGLES LOCATED ON THE SIDES OF THE TWO TURNOUTS. THE WESTERN TURNOUT IS ON THE LEFT, AND THE EASTERN TURNOUT IS ON THE RIGHT (June 1991)

The following views are 4" x 5" enlargements from 2-1/4" x 2-1/4" negatives.

AZ-7-149	VIEW OF THE WESTERN TURNOUT AND EAGLE, TAKEN FROM THE DOWNSTREAM SIDE OF DAM (January 1991)
AZ-7-150	VIEW OF THE EASTERN TURNOUT AND EAGLE, TAKEN FROM THE DOWNSTREAM SIDE OF DAM (January 1991)
AZ-7-151	VIEW SHOWING THE LEFT SIDE OF THE EAGLE LOCATED ON THE WESTERN TURNOUT (January 1991)
AZ-7-152	VIEW SHOWING THE RIGHT SIDE OF THE EAGLE LOCATED ON THE EASTERN TURNOUT (January 1991)
AZ-7-153	CLOSE-UP VIEW OF THE LEFT SIDE OF THE EAGLE LOCATED ON THE EASTERN TURNOUT (January 1991)
AZ-7-154	VIEW LOOKING SOUTH FROM THE TOP OF DAM, SHOWING THE DOWNSTREAM CONTEXT OF THE DAM (June 1991) (From 4x5 negative)

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This is an Addendum to 138 data pages previously transmitted to the Library of Congress.

The Bureau of Reclamation (BOR) has been authorized to make Safety of Dams (SOD) modifications to Coolidge Dam. Some of these modifications could affect certain architectural details on the dam, such as the parapet walls across the top of the dam, the ornamental pylons at either end of the dam, and the concrete eagles located on the downstream face of the dam. In addition to the various SOD modifications, the Bureau of Indian Affairs (BIA), who own and operate the dam, have requested the BOR to make additional modifications to the dam that do not fall under SOD authorization. Specifically, the BIA would like to have new spillway gates installed so that the dam can operate at its full capacity. The original spillway gates became inoperable shortly after the dam was completed in 1928. The non-SOD modifications also will affect certain architectural elements of the dam, such as the spillway gate openings and pylons.

The various architectural details mentioned above were not well represented in the 1986 Historic American Engineering Record report (HAER No. AZ-7). Consequently, the BOR, in consultation with the BIA, the Arizona State Historic Preservation Office, and the Advisory Council on Historic Preservation, developed a cultural resource plan to address potential impacts to certain architectural elements of the dam from SOD and non-SOD modifications. Additional HAER quality photographs of the parapet walls, entrance pylons, concrete eagles, lamp standards, spillways, spillway gates and pylons, and intake towers were taken to supplement the original HAER photographic documentation of the dam.