

Colorado River Front Work and Levee System

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Colorado River Front Work and Levee System

Although they provided much needed water to the arid Southwest, the closure of the Hoover and Parker Dams in the 1930s altered the downstream flow of the Colorado River. As one of the most physically developed and regulated rivers in the world, the Lower Colorado River needed special consideration in regard to water management. The Bureau of Reclamation recognized the decreased efficiency in water use and improved the situation through a series of improvements authorized under the Colorado River Front Work and Levee System (CRFW&LS). A multipurpose project, the CRFW&LS constructed numerous structures for the purpose of controlling floods, improving navigation, establishing wildlife and fish sanctuaries, salvaging water resources, and regulating the flow of the Colorado River. For administrative purposes, Reclamation divided the CRFW&LS into ten operational divisions: Mohave, Topock Gorge, Havasu, Parker, Palo Verde, Cibola, Imperial, Laguna, Yuma, and Limitrophe.

Project Location

The CRFW&LS extends about seven-hundred river miles from Lee's Ferry, Arizona (the dividing point between the Upper and Lower Colorado River), to the Southerly International Border between the United States and Mexico. Following the course of the Lower Colorado River, the CRFW&LS traverses through Nevada, Arizona, and California, cutting across Indian Reservations, wildlife refuges, and irrigation districts.

Historic Setting

Prehistoric Setting

Many indigenous groups populated the Lower Colorado Region, including the Quechuan (Yuman), Mohave, Halichidoma, and Kamia. These people practiced agriculture before contact with the Spanish, perhaps as early as 800 C.E. Relying on the periodic flooding of the Colorado

River, the river tribes would plant a profusion of small gardens in the flood plain. When the river overflowed, it deposited water and a layer of silt, providing fertile topsoil for the crops. Crops included maize, melons, black-eyed pea, and a variety of native vegetation.¹

Historic Setting

The Spanish Conquistadors, who explored the Southwest in the mid-sixteenth century in search of God, gold, and glory, were the first White people to see the Colorado River. During the seventeenth and eighteenth centuries the Lower Colorado River region remained relatively unpopulated by European settlers, however, Europeans used the area as an active thoroughway for Mexicans traveling to Alta California. Evidence of this foot traffic is manifested in the name of the river itself - Río Colorado - which was given to the river by journeying Spanish priest Francisco Garcés in 1776 because of the fiery red color of the canyons.²

The United States acquired the land of the Lower Colorado River by the Treaty of Guadalupe Hildago in 1848 and the Gadsden Purchase in 1853. The large cession of new and largely unexplored land piqued the fiscal interest of the United States government because they saw the territory as a possible means of economic expansion. The War Department, eager to find waterways to sustain their southwestern outposts, ordered Lieutenant Joseph C. Ives to sail up the Colorado River to assess its viability. In January 1857, Ives embarked on his journey on his steamboat *Explorer*. Ives and his crew traveled 400 miles upstream from Yuma to the lower end of the Black Canyon, where the *Explorer* was badly damaged after running into a submerged rock. Ives continued upstream in a wooden skiff through the Black Canyon and reached the Las Vegas Wash, three miles past the head of the Black Canyon, before turning around.³ Despite his

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1. Norris Hundley, Jr., *The Great Thirst* (Berkeley: University of California Press, 1992), p. 16-22.
 2. Joseph E. Stevens, *Hoover Dam* (Norman: University of Oklahoma, 1988), p. 4.
 3. Stevens, p. 6-7.

tenacity and perseverance against the stark wilderness, Ives was unimpressed by the desert. Ives believed that river could possibly be used for transportation of goods, though the adjacent land was worthless. In his journal, Ives recorded his impression of the Lower Colorado. “A system of irrigation and an improved method of agriculture would make the valley far more productive, but it is not certain that it could ever be a profitable place for white settlements.”⁴

Not all were as pessimistic about the Lower Colorado Region as Ives. As early as 1850, Oliver Meredith Wozencraft had a vision for a large-scale irrigation system for the area. A medical doctor from New Orleans, 35-year-old Wozencraft headed West to follow his dreams of striking it rich during the Gold Rush. After traveling through the desert near Yuma, Wozencraft suffered from severe sunstroke. During the episode, the doctor had a vision of building canals which would siphon water off the Colorado River to irrigate the adjacent lands. Wozencraft failed at mining, but returned to the Lower Colorado to become one of the region’s first boosters. He petitioned lawmakers about providing land to build his canals. Although local lawmakers passed a land bill in 1859 in support of his projects, Wozencraft was unable to convince Congress of the feasibility of his irrigation project. In 1887, Wozencraft returned to Washington to present his land bill, but once again was turned down. He died three days later, broken hearted and penniless, but successful in planting a seed which would ultimately assuage the thirst of the Lower Colorado Region.⁵

Surveyor and irrigation engineer, Charles Rockwood, continued to follow Wozencraft’s dream. Rockwood had been brought to the Yuma area in 1892 by a land promoter to assess the agricultural potential of some property. Like Wozencraft almost fifty years earlier, Rockwood

4. United States Army, Corps of Engineers, *Report Upon the Colorado River of the West, Explored in 1857 and 1858 by J.C. Ives* (Washington, D.C.: Government Printing Office, 1861,) p. 73.

5. Donald Worster, *Rivers of Empire* (New York: Oxford University Press, 1985), p. 195

saw the potential for irrigated farmland along the Lower Colorado River. In 1894, Rockwood founded the California Development Company (CDC) and traveled the country looking for investors for his irrigation project. After four years, Rockwood convinced financier and fellow engineer, George Chaffey, to underwrite the construction of Rockwood canal for \$150,000. Construction of Rockwood's Imperial Canal began immediately. Drawn by the possibility of inexpensive yet fruitful farmland, homesteaders began to flock to the region. On May 14, 1901, the wooden headgate of the Imperial Canal was opened for the first time, allowing the water of the Colorado to irrigate the land adjacent to the river.⁶ The construction of the Imperial Canal forever transformed the landscape of the Lower Colorado because people now realized that the dreams of Wozencraft and Rockwood were not only possible, but profitable.

The next year the United States government officially threw their hat in the ring of water issues in the West by passing the Reclamation Act of 1902. The Reclamation Act, also known as the Newlands Act, conferred authority upon and appropriated funds to the Secretary of the Interior to locate and construct irrigation works in western United States. Realizing the economic and social benefits of reclamation, the United States Reclamation Service designed a comprehensive plan for controlling the Colorado River. By the 1930s, the United States Bureau of Reclamation⁷ had progressed swiftly toward their goal, building two high-capacity dams - Hoover Dam (1933) and Parker Dam (1941) - on the uppermost reach of the Lower Colorado River.

Prior to the construction of the dams, the Colorado River experienced an annual cycle of

6. Stevens, p. 10-1. For a broader history of the Imperial Valley, see Worster, p. 194-212.

7. On March 9, 1907, the United States Reclamation Service, which had been created under the jurisdiction of the United States Geological Survey, became an independent Bureau within the Department of the Interior and changed its name to the United States Reclamation Service. In 1923, the name changed again and became the United States Bureau of Reclamation. [Bureau of Reclamation History Program, *Bureau of Reclamation Historical Organizational Structure*, p. 1.]

seasonal floods followed by an intense shortage of water. The river flow was sluggish for several months due to a heavy silt load until being washed downstream by the annual floods. To mitigate damage, numerous levees had been constructed in the lower Colorado River under the authorization of the Yuma Project (1904) from 1905 to 1912. These levees served their purpose and were annually maintained until 1934. The closure of the Hoover and Parker Dams helped to effectively control the flow of the water, however, they also exacerbated the natural heavy silt load that plagued the Colorado River, hindering the silt loads from being pushed downstream to the Gulf of Mexico.⁸

Silt build-up quickly began to cause major problems along the Colorado River front. For example, in 1944, because of the immediate threat of a city-destroying flood, Reclamation completed emergency repair work on an insufficient levee in Needles, Arizona. The next year, the silt load grew so heavy that it prevented Colorado River water from flowing into the intake for the Palo Verde Irrigation District. Despite involvement in World War II, on April 1, 1944, Congress allocated \$250,000 for the construction of a temporary rock weir for the Palo Verde Irrigation District.⁹

The Second World War caused the United States economy to boom, especially the West, making money available for funding much needed infrastructure repairs. Although emergency repairs had been done on the Colorado River front, none provided long-term stability. Investigations by the Bureau of Reclamation revealed the need for a comprehensive project to repair and improve the Colorado River front and levee systems.

Project Authorization

8. United States Department of the Interior, Water and Power Resources Service, *Project Data* (Denver: U.S. Government Printing Office, 1981,) p. 342.

9. "The Palo Verde Weir," *Reclamation Era* (February 1961, 47:1), p. 9-12.

Like the project itself, Congress granted authorization for the CRFW&LS over a long period of time through series of affiliated laws. The Bureau of Reclamation originally built and maintained the Yuma Levee under authorization of the Yuma Project (1904). The 68th Congress first gave project authorization for CRFW&LS on March 3, 1925, under Public Law 585. This law appropriated \$650,000 to reimburse Reclamation for prior costs incurred by the Yuma Project for operation and maintenance of the CRFW&LS. The 1925 act also authorized \$50,000 for fiscal year 1926 to use as necessary for the CRFW&LS and an additional \$35,000 for fiscal year 1927 and annually thereafter.¹⁰

On January 21, 1927, under Public Law 560, Congress amended the act of 1925 by increasing the annual appropriation from \$35,000 to \$100,000.

On July 1, 1940, under Public Law 697, Congress amended the act of 1927 by extending the authority of the project to include the cost of other necessary protection works and system along the lower Colorado River between Hoover Dam and the Yuma Project. Despite increased responsibility for Reclamation, the annual appropriation remained the same.

On June 28, 1946, under Public Law 469, Congress clarified the act of 1940 by specifying in detail the purpose of the Colorado River Front Work and Levee System. Although Reclamation had been constructing levees on the lower Colorado for nearly half a century, the 1946 act authorized the CRFW&LS as we know it today.

The final authorization of the CRFW&LS occurred on May 1, 1958, under Public law 85-389. Like those acts passed in 1940 and 1946, the act of 1958 expanded the responsibilities of the CRFW&LS without increasing the budget. In addition to constructing, operating, and maintaining all the levees on the lower Colorado River and other necessary works, the

10. United States Department of the Interior, *Federal Reclamation and Related Laws Annotated*, Volume I of Three Volumes, Through 1942 (Washington, D.C.: United States Government Printing Office, 1972,) p.340-1.

CRFW&LS was now responsible for the “protection and drainage works and systems within a non-Federal reclamation project when need for such systems results from irrigation operations on Federal reclamation projects.”¹¹

Construction History

From 1905, when first levees were built in Yuma, the Bureau of Reclamation accepted responsibility for the construction of improvements along the Lower Colorado River. However, the office in charge of the project changed several times. Initially, the Office of River Control of Region Three located in Boulder City, Nevada, was responsible for the CRFW&LS. As major construction of the project began, an on-site headquarter office opened in Needles, California, on February 10, 1954. The CRFW&LS office moved back to the Boulder City on August, 28, 1964, when responsibility shifted the Lower Colorado River Control Office, which was part of the Regional Division of River Control. Four years later, on February 12, 1968, the CRFW&LS office traveled back into the field when the Lower Colorado River Control Office relocated to Blythe, California. Finally, on August 20, 1968, the Blythe office merged into the Yuma Area Project Office.¹²

For construction and operational purposes, Reclamation divided the CRFW&LS into ten sections, extending from the bottom of Parker Dam to south of the international boundary between the United States and Mexico. The divisions, from north to south, are as follows: Mohave, Topock Gorge, Havasu, Parker, Palo Verde, Cibola, Imperial, Laguna, Yuma, and Limitrophe. Based on how the annual project histories were recorded, the following

11. United States Department of the Interior, *Federal Reclamation and Related Laws Annotated*, Volume II of Three Volumes, 1943-58 (Washington, D.C.: United States Government Printing Office, 1972,) p. 1414.

12. “Annual Project History, Combined Histories for the Gila Project, Yuma Project, Yuma Auxiliary Project, Delivery of Water to Mexico, and Colorado River Front Work and Levee System, Arizona-Colorado, 1972.” This was the first project history to synthesize all of construction office information. It appeared in all subsequent annual project histories.

construction history is organized by division and not in chronological order.

Mohave Division

The uppermost portion of the CRFW&LS is the Mohave Division, a 32 miles reach located between the Davis Dam and Topock, Arizona. There are two major reaches in this division: Needles to Topock and Big Bend Needles.

Construction of the Needles to Topock reach began in 1944, when emergency relief measures commenced in Needles to save town from flooding. Although the enlarged existing levee system saved Needles from immediate destruction, Reclamation realized that an improved levee system would have to be constructed to prevent future emergencies. With both the funding and authorization from the act of June 18, 1946, the Bureau of Reclamation geared up for the long-term construction of the CRFW&LS. In May of 1947 the Bureau of Reclamation established an operating yard in Needles that remained the center of construction activity for the CRFW&LS until its closure in 1969. On July 24, 1947, Reclamation awarded the first of several contracts for a dredge. The new dredge, named *The Colorado*, arrived in Needles on January 28, 1949, and began dredging the Needles to Topock reach in April of 1949. The main purpose of this channelization was to stabilize the river banks and prevent flooding. *The Colorado* worked continuously from July until November 4, 1949, when it sank due to poor navigation. Recovery began on December 12, 1949, and by June 26 of 1950, *The Colorado* returned to the channelization of the Needle-Topock reach. Except for its annual maintenance during the peak summer months, *The Colorado* dredged continuously, completing the Needles to Topock channel on April 21, 1951. While *The Colorado* dredged the channel, numerous other contractors performed associated work such as bank stabilization, levees, and access road construction. All work associated with Needles to Topock reach was completed by January 3,

1953.¹³

Construction of the channel from Big Bend to Needles began on January 5, 1953. Being the only available dredge on the project, Reclamation shifted *The Colorado* from maintenance duty to once again being the primary dredge. The main purpose of this channelization was to straighten the natural channel to decrease the silt load. On January 8, 1957, *The Colorado* completed the cut from the dredged to the natural channel, allowing for the old river channel to be permanently closed off on February 18-20, 1957. Because of the change in the river flow, Reclamation subsequently closed several other abandoned channels.

As the work load on the CRFW&LS increased, Reclamation realized the need for additional equipment. *The Colorado*, a large and cumbersome piece of machinery, required a tugboat to maneuver it through the narrow reaches of the Colorado River. On April 23, 1956, Reclamation awarded a contract to Gunderson Bros. Engineering Corp. of Portland, Oregon, for the construction of a tugboat at a cost of \$157,327.¹⁴ The contractor delivered the tugboat, named *Havasu*, to the operating yard in Needles on March 22, 1957. After completing 30 days of operating tests, *Havasu* was assigned to *The Colorado*. Although the *Havasu* improved the mobility of *The Colorado*, the tugboat had its own share of problems on the river. On December 8, 1959, *Havasu* rammed into a docked changing barge. Although no people were injured and the tugboat survived unscathed, the incident served as a reminder as to the close quarters and intricate work being executed by the CRFW&LS.¹⁵ On July 22, 1960, *The Colorado* completed the channelization from Needles to Big Bend and afterwards returned to the Needles operating

13. "Annual Project History, Colorado River Front Work and Levee System, Arizona-California-Nevada, Volume II, 1955." Because there were no annual project histories of the CRFW&LS recorded prior to 1954, all of the earlier history must be gleaned from the introduction and chronology located in the preface.

14. "Annual Project History, Colorado River Front Work and Levee System, Arizona-California-Nevada, Volume III, 1956," p.2.

15. "Annual Project History, Colorado River Front Work and Levee System, Arizona-California-Nevada, Volume VI, 1959," p.15.

yard for a major overhaul. No other construction except for maintenance occurred on the Big Bend-Needles until 1969 when the CRFW&LS built a new training structure along the bank of the Big Bend to guide the flow the river.

Another feature of the Mohave Division is the Topock Settling Basin, also referred to as the Topock Desilting Basin. Reclamation constructed the Topock Settling Basin to prevent sediment from being carried downstream into the Topock Gorge. *The Colorado* dredged the Topock Settling Basin from December 1955 until November 1956. Because of the multiple demands on *The Colorado*, the CRFW&LS purchased a new dredge. On November 6, 1956, Reclamation awarded a contract for a 12-inch hydraulic suction dredge to Commercial Steel Fabricators for \$234,700. Almost a year later, in September of 1957, the contractor delivered the new dredge, named the “Little Colorado,” to the Needles operating yard. On November 14, 1957, the *Little Colorado* began to dredge the Topock Settling Basin. Because of the naturally high silt load in this area, intermittent maintenance always occurs.¹⁶

In 1961, the County of San Bernadino, California, hired the J.H. Pomeroy and Company, Inc., to build the Park Moabi Marina. Within three years of its initial construction, the Park Moabi Marina needed a minimum of an additional three feet dredged to be fully developed. The Colorado River Front and Levee System Act obligates the Bureau of Reclamation to assist in the preservation of public works on the Colorado River. Thus, on December 8, 1964, the *Little Colorado* commenced excavating in the Park Moabi Marina, completing the work by February 28, 1965. Dredging of the Park Moabi Marina again became necessary and occurred from December 1971 until January 1972.¹⁷

16. “Topock Settling Basin, Colorado River Front Work and Levee System, Arizona-California, June 1974,” p.4.

17. “Feasibility Report on the Park Moabi Marina, Colorado River Front Work and Levee System, San Bernadino County, California, November 1974,” p.1-3.

The backwater that resulted from the closure of Parker Dam forms the Topock Marsh. In 1941, the majority of Topock Marsh became part of the Havasu National Wildlife Refuge that President Franklin D. Roosevelt created to provide habitat and protect wildlife within the newly established area. To support wildlife and fish mitigation efforts in Topock Marsh, the CRFW&LS built inlet and outlet structures, a canal, and dikes to maintain a constant water level in the marsh and permit diversion of water through the marsh to the Colorado River. The *Little Colorado* dredged the Topock Marsh from March to November of 1965, while other Reclamation contractors completed the inlet structure for the Topock Marsh on March 11, 1966. In 1974, the CRFW&LS began a series of fish and wildlife mitigation improvements, but because of several issues including Native American land claims and environmental concerns, the improvements have not been completed.¹⁸

In the mid-1960s, land developer Robert Chesney proposed to construct a marina facility near Needles, California, called Verde Shores.¹⁹ In October of 1966, the Bureau of Reclamation agreed to permit Chesney to build his project, also referred to as the Riverside County Marina or the Needles Marina. Like with the Park Moabi Marina, the Bureau of Reclamation needed to make public works accessible. The Bureau of Reclamation aided in the construction of the Needles Marina by dredging from July 5 to December 3, 1967. Although Chesney built all of the recreational facilities, Reclamation continues to periodically dredge the marina to maintain its accessibility.

Topock Gorge Division

Topock Gorge Division starts at Topock, Arizona, and extends 12 miles downstream to

18. "Report of the Task Force, Review of the River Management Program, Colorado River Front Work and Levee System, July 1971," p.39-46.

19. "Annual Project History, Colorado River Front Work and Levee System, Arizona-California-Nevada, Volume XIII, 1965," p.19.

Lake Havasu. Like the Topock Marsh, Topock Gorge is part of the Havasu National Wildlife Refuge, and has the primary purpose of fish and wildlife mitigation. The closure of Parker Dam forced the water level to rise from 443 feet above sea level to nearly 452 feet above sea level in 1948 and effectively drowned much of the vegetation and wildlife. In addition, the Bureau of Reclamation discovered that the high sediment deposits in the Topock Gorge caused high water levels upstream in the Mohave Division. On October 20, 1967, the *Little Colorado* began dredging the upper Topock Gorge. After only dredging 1.7 miles, Secretary of the Interior Stewart Udall suspended the dredging of the Topock Gorge on June 22, 1968, because of objections from environmental agencies. After conducting additional studies, Reclamation determined that little stood to be gained by continuing to dredge.²⁰ Since 1968, the Topock Gorge Division has been left in its natural state.

Havasu Division

The Havasu Division encompasses all of Lake Havasu and the portion of the Colorado River, known as the Parker Strip, that spans from Parker Dam to Headgate Rock Dam. A navigational hazard of submerged trees existed in Lake Havasu because the area had not been properly cleared prior to being filled by the closure of Parker Dam. Large tree branches, referred to as snags, interfered with many of the recreational activities that took place on Lake Havasu, often causing injury and even death. Beginning in December 1965, the CRFW&LS began a snag removal operation, which entailed the underwater cutting, clearing, and disposal of snags. By June of 1971, the completion of three intermittent contract had removed most of the snags.

In the early 1970s, the Colorado River Indian Tribes Reservation requested that Reclamation consider the development of Lake Moovalya located below the Headgate Rock

20. "Report of the Task Force, Review of the River Management Program, Colorado River Front Work and Levee System, July 1971," p.46-9.

Dam in the Parker Strip for recreation. The tribe wanted to build a marina, a boating race course, and other recreational facilities, to bring more tourism and income to their reservation. In May 1972 Reclamation published a report on the plans for the Lower Moovalya Recreational Development and concluded that although constructing the recreational area would destroy a wildlife mitigation area, it would also bring enormous economic potential to the Colorado River Indian Tribes Reservation.

Parker Division

The Parker Division begins at Headgate Rock Dam and extends 33 miles downstream to the Palo Verde Diversion Dam. Although the CRFW&LS traverses through several Indian Reservations, the Parker Division is the only one which lies almost wholly in the reservation land of the Colorado River Indian Tribes.²¹ This reach of the Colorado River bears the brunt of the scouring action caused by clear water releases from Parker Dam and consequently suffers from severe flooding. In 1942, to alleviate the scouring, Reclamation, in conjunction with the Bureau of Indian Affairs, built the Headgate Rock Dam to stabilize the river channel below the Parker Dam. Headgate Rock Dam successfully improved the flood control problem, however, increased bank stabilization and ongoing maintenance remained necessary.

Reclamation divided the plan for development of the Parker Division into two sections. Section I begins at Headgate Rock Dam and spans 11 miles downstream to Alligator Dam. Section I consolidates the braided reaches of the Colorado River into a single channel, correcting the misalignment of the river, and reducing active bank erosion. Construction for the first set of specifications began on January 27, 1966; construction for the second set of specifications began

21. The Colorado River Indian Tribes Reservation that was established by an act of Congress and approved by the President Ulysses S. Grant on March 3, 1865. The Colorado River Indian Tribes Reservation is now home to members of the Mojave, Chemehuevi, Hopi, and Navajo tribes. Veronica E. Velarde Tiller, ed., *Tiller's Guide to Indian Country* (Albuquerque, New Mexico: Bow Arrow Publishing Company, 1996), p. 200-1.

on October 18, 1966. Both were completed by early 1967.²²

Section II stretches 22 miles from Alligator Bend to the Palo Verde Diversion Dam. On September 19, 1969, the Bureau of Reclamation approved a plan for Section II of the Parker Division to correct the misalignment, sharp bends, over-wide channels, and eroding banks of the Colorado River. However, the CRFW&LS indefinitely deferred construction because of concerns raised by the Colorado River Indian Tribes Reservation and environmental agencies.

In addition to channelization and recreational development, Reclamation also performed some wildlife mitigation in the Parker Division. For example, in 1968 and 1969, Reclamation deepened the backwater area downstream from the Headgate Rock Dam, known as Deer Valley. In 1987, Reclamation awarded a contract to re-vegetate 60 acres near No Name Lake on the Colorado Indian Tribes Reservation to provide wildlife mitigation.

Palo Verde Division

The Palo Verde Division includes a 28 mile reach of the Colorado River from Palo Verde Diversion Dam to Taylor's Ferry. Even prior to the closure of the large upstream dams, the heavy silt load of the Colorado River had adversely affected the Palo Verde Division by eroding the banks and clogging the headworks to the irrigation districts. To alleviate this problem, the CRFW&LS dredged the Palo Verde Division and built training structures from 1962 until 1968. By 1966, six contracts for channel control works and one contract for fish and wildlife mitigation had covered a majority of the work. Disputes over land title agreements prevented further wildlife mitigation work in the Palo Verde Division.

Perhaps because much of the infrastructure had been installed during the construction of the Palo Verde Diversion Dam, recreation became a major feature in the Palo Verde Division.

22. "Annual Project History, Colorado River Front Work and Levee System, Arizona-California-Nevada, Volume XIV, 1966," p.98-100.

The County of Riverside, California, decided to build a marina on the Colorado River to tap into the river economy. With a loan of \$465,000 from the Division of Small Craft Harbors of the California State Department, Riverside County proposed to construct a fourteen-acre boating facility known as the Riviera Shores Blythe Marina. The Bureau of Reclamation assisted in the construction of the Blythe Marina by performing sandsucking operations from July 9 to December 16, 1966.²³ Five years later another marina facility, the Peter McIntyre Park, was constructed with the help of the Bureau of Reclamation.

Cibola Division

The Cibola Division is located in the upper portion of the Cibola Valley, sandwiched in between the Palo Verde Diversion Dam and the Imperial Dam. This reach is about 24 miles long and runs from below Taylor's Ferry to Adobe Ruin. Prior to any reclamation work, the Cibola Division was characterized by a degraded river bed and an unstable silt load that was constantly being washed downstream toward the Imperial Dam. The closure of the dams exacerbated this condition. By the 1960s the Cibola Division needed extensive dredging, channel stabilization, and new levees. The location of the central operating yard in Needles, California, posed a logistical problem for construction in the Cibola Division. As operations moved downstream from Needles, it did not serve as an effective central location. To compensate for the movement of the CRFW&LS, on July 16, 1962, construction of the Cibola Valley Operating Yard began, to replace Needles as the Project headquarters. On October 2, 1962, after completing 60 percent of the yard, the Bureau of the Reclamation Regional Headquarters in Boulder City, Nevada, learned that Congress had not appropriated enough funds to finish construction. Reclamation immediately halted construction and returned all of the equipment to the Needles Operating

23. "Feasibility Report on Blythe Marina, Colorado River Front Work and Levee System, Riverside County, California, May 1965," p.1-2.

Yard.

Corrections of the Colorado River channel began in June of 1964. Dredging alleviated many of the problems caused by the sandwiching effect of the silt load between dams. In addition, the CRFW&LS built 32 miles of levees to restrain the river and prevent flooding. The majority of dredging was completed by December 1969.

The Palo Verde Drain, which allows the area groundwater to flow back into the Colorado River, was situated at the exact point between where the river bed degraded and aggraded, thus causing the groundwater table in the Palo Verde Valley to rise. In 1947 the Bureau of Reclamation moved the Palo Verde Drain down the river about 2 miles, into the Cibola Division. The move helped to lower the water level at the drain, allowing more water to flow out, however, it did not completely solve the problem. On March 10, 1970, the Bureau of Reclamation made the final dry cut extending the Palo Verde Drain even further to an outfall in the newly dredged river channel near Adobe Ruin.

In addition to flood control, the Cibola Division also features several fish and wildlife mitigation sites. In 1970, the CRFW&LS dredged the Palo Verde Oxbow Lake, a backwater feature formed in April 1967 by a bypassed reach cut off by the realignment of the Colorado River in the Cibola Division. From May 20 to November 17, 1971, the Bureau of Reclamation built supplemental bank line structures to allow for the installation of recreational facilities such as a boat ramp. Today, the Bureau of Land Management manages Palo Verde Oxbow Lake. The Bureau of Land Management also managed another site in the Cibola Division, Walter's Camp, which the Bureau of Reclamation dredged in 1974 to provide boating access.

Established in August 1964 to protect wintering grounds for migratory birds and other wildlife, the Cibola National Wildlife Refuge was partially formed by dredging in the Cibola

Division of CRFW&LS. In 1974, the Bureau of Reclamation installed an inlet and outlet structure on Cibola Lake to stabilize the water elevation, completing the work on June 24, 1975. In December of 1986, the U.S. Fish and Wildlife Service, which manages that Cibola National Wildlife Refuge, and the Yuma Area Office of the Bureau of Reclamation, which has handled all affairs the CRFW&LS since 1968, signed a Memorandum of Agreement regarding the maintenance of the Cibola National Wildlife Refuge. Similar to other sites on the lower Colorado River, the Cibola National Wildlife Refuge filled with silt that retarded the flow of water. The Bureau of Reclamation agreed to purchase the equipment necessary to clear and maintain the area, as long as the Refuge would operate and maintain the equipment.

Imperial Division

Located at the lower end of the Cibola Valley, the Imperial Division spans 36 miles from Adobe Ruin to the Imperial Dam. The Imperial Division collects all of the silt that washes downstream from the Cibola Division and therefore is characterized by an aggraded river bed. In the 1950s, over half of the sediment load that flooded the Imperial Division deposited in the backwater lakes, filling them to capacity, and formed sandbar levees which diverted the water flow. The remainder of the sediment was diverted at the Imperial Dam to the All-American Desilting Works, which had been completed in July 1938 under the Boulder Canyon Project, All-American Canal System.²⁴ The Desilting Works removes the sediment from the river and returns the cleaned water to the river below the Imperial Dam. Even with the Desilting Works in use, the enormous amount of silt in the Imperial Division continued to cause problems. For instance, the sediment load in the diversion pool immediately upstream from the Imperial Dam became so heavy that it clogged the headworks into the Gila Gravity Main Canal. In 1969 the

24. *Project Data*, p. 67-74.

Bureau of Reclamation had to conduct intermittent dredging in the diversion pool to correct this problem.

A more complete method of sediment maintenance was necessary in the Imperial Division. In 1963, the CRFW&LS authorized the construction of the Senator Wash Dam and Regulating Reservoir. Reclamation awarded the entire contract to M. M. Sundt Construction, Co., who began construction on February 24, 1964. The principal features of the project are an earth dam, two dikes (the Squaw Lake Dike and the North Dike), a spillway, an outlet works, a pumping generating plant, a switchyard, and access roads. Senator Wash Dam is an earth embankment structure 2,342 feet long, with a maximum height of 93.6 feet. Squaw Lake Dike is also an earth embankment structure 3,795 feet long, with a maximum height of 95.3 feet; North Dike is a 613 feet long, with a maximum height of 67.2 feet. A small single-zone rolled earth embankment structure is constructed in a small saddle on the right abutment of Senator Wash Dam and is included in the dimensions of all the earth embankments. An 18-mile long 60-watt transmission line, completed on March 15, 1966, was constructed separately under the authorization of the Parker-Davis Project. One of the largest expenditures of the CRFW&LS, the Senator Wash Dam and Regulating Reservoir is a off-stream pumped storage facility that aids in the relief of sedimentation by diverting up to 13,840 acre-feet of water from the river and holding it in the reservoir until needed downstream.

In 1941, the Federal Government established the Imperial National Wildlife Refuge about 40 miles northeast of Yuma to protect local fish and wildlife. Although managed by the United States Fish and Wildlife Service, a 30 mile reach of the Colorado River maintained by the CRFW&LS bisects the Refuge. On September 8 and 20, 1980, the United States Fish and Wildlife Service and the Bureau of Reclamation signed a Memorandum of Agreement

delineating the responsibilities of Reclamation in the refuge. As a result, from January 15 through October 15, 1984, a major dredging project in the Imperial National Wildlife Refuge was performed.²⁵

Laguna Division

The shortest reach of CRFW&LS, only 4.7 miles between the Imperial and Laguna Dams, the Laguna Division was built in response to a complaint issued by Mexico regarding the increased salinity of Colorado River water being delivered from the United States. In 1944 the United States and Mexico signed a treaty which guaranteed Mexico 1.5 million acre-feet of Colorado River water per annum. The treaty contains no specific requirements regarding the salinity. In 1961, the salinity of the water being delivered to Mexico increased dramatically causing Mexico to issue a formal complaint. In response to the grievance, the United States began to modify some of their river operations, most of which were located in the Laguna Division of the CRFW&LS, to decrease the sediment in the river.

The major feature of the Laguna Division is the Laguna Settling Basin. Built to work in conjunction with upstream Senator Wash Dam and the adjacent Wellton-Mohawk drainage system, the Laguna Settling Basin collects and holds excess sediment until it can be mechanically dredged out of the river. In 1963, Reclamation awarded six principal contracts for construction of the settling basin. Since the majority of the work would be dredging, on February 4, 1963, the Bureau of Reclamation purchased a new 12-inch hydraulic dredge from the Ellicott Machine Corporation of Baltimore, Maryland.²⁶ Construction of the Laguna Settling Basin began on May 1, 1963. By the time of its completion in 1965, about 1.2 million cubic

25. "Annual Project History, Combined Histories for the Gila Project, Yuma Project, Yuma Auxiliary Project, Delivery of Water to Mexico, and Colorado River Front Work and Levee System, Arizona-Colorado, 1984."

26. "Annual Project History, Colorado River Front Work and Levee System, Arizona-California-Nevada, Volume XI, 1963," p. 93. Although the Annual Project History makes no mention as to the name of the dredge, most likely it was the dredge called the "Red Bluff."

yards of material had been excavated.

The Gila Gravity Main Canal continued to have problems with blockage even after being dredged in the Imperial Division in 1969. In 1970, the Bureau of Reclamation dredged the Gila Sluiceway which parallels the original river channel from the Gila Gravity Main Canal to the California Sluiceway. Reclamation completed supplemental dredging in 1973.

The closure of Laguna Dam formed Mittry Lake, located on the east side of the Colorado River, extending from the dam upstream to within one mile of the Imperial Dam. Dredging of Mittry Lake occurred from 1970 to 1973, reducing the total acreage from 1,200 to 725 acres. Reclamation deepened the lake and applied herbicide sprays to and burned floating vegetation to clear the shores. In 1984, additional features for fish and wildlife at Mittry lake were installed under the authorization of the Colorado River Basin Salinity Control Project.

Yuma Division

The Yuma Division is a 17.4 mile reach from the Imperial Dam to Morelos Dam on the United States-Mexico border. As early 1893, according to some sources, the War Department constructed a short levee in the Yuma area to protect the city from floods of the Gila River. Under the authorization of the Yuma Project, the Bureau of Reclamation began constructing levees in the Yuma Division in 1905 and continued through 1912. From May 1951 through May 1952, the CRFW&LS raised and improved the original levee system. Finally, from June 28 through December 22, 1976, Harmon and Associates, Inc. constructed a new Yuma Levee to replace the original structure.²⁷ As with all of the other divisions, the Bureau of Reclamation continually executed maintenance and repair on the Yuma Division. In 1985, Reclamation purchased a 12-inch dredge named the *Mohave* and a dredge tender work boat named the *Yuma*

27. "Annual Project History, Combined Histories for the Gila Project, Yuma Project, Yuma Auxiliary Project, Delivery of Water to Mexico, and Colorado River Front Work and Levee System, Arizona-Colorado, 1976."

for \$753,763 and \$107,000, respectively, to assist in these efforts.²⁸

The Gila River flows into the Colorado River from the east about nine miles downstream from the Laguna Dam. The confluence of the Gila River brings excess drainage waste water and sediment to the Colorado River. A design flood study conducted in 1948 by the International Boundary and Water Commission, the Army Corps of Engineers, and the Bureau of Reclamation established the maximum amount of water that could flow through the river channel without being destructive. The acceptable design flood for the reach between the Imperial Dam to the mouth of the Gila River was 103,500 cubic feet per second and 140,000 cubic feet per second for below the Gila River.²⁹ As upstream improvements increased the water flow and converged with the Gila River surplusage, the water flow overreached the prescribed design flood and improvements had to be made to prevent flooding.

To provide additional flood protection, the CRFW&LS constructed the Gila Levees and the Main Outlet Drain. The Gila Levee and South Gila Levee prevent aggradation at the mouth of the Gila River, maintain water flow within the established design flood, and prevent flooding. Construction of these levees began on October 10, 1960. By February 7, 1961, approximately 9 miles of earthwork had been completed.³⁰

The Gila River serves as the primary outlet for excess water from the numerous irrigation districts located between Phoenix, Arizona, and the Colorado River. To alleviate some of the physical and chemical pressure from the Gila River, the Bureau of Reclamation built the Main Outlet Drain. The Main Outlet Drain is a concrete-lined canal that parallels the Gila River from the Gila River Siphon, where it draws from the Gila River, to a half-mile upstream from the Gila

28. "Annual Project History, Combined Histories for the Gila Project, Yuma Project, Yuma Auxiliary Project, Delivery of Water to Mexico, and Colorado River Front Work and Levee System, Arizona-Colorado, 1985."

29. *Project Data*, p. 339.

30. "Colorado River Front Work and Levee System, Arizona-California-Nevada, Supplements to Annual Project Histories, Volumes VI-XII, Calendar Years 1959-1965," Section 1961, p.4.

River and Colorado River confluence. Construction of the 8 mile Main Outlet Drain began on January 6, 1961. Construction of the drain and the appurtenant works, including siphons, farm ditch crossings, and inlet/outlet structures, was completed on December 7, 1962. Due to the change in international law in 1965 regarding the salinity of the water being delivered to Mexico, the majority of the water being drained into the Colorado River via the Main Outlet Drain had to be diverted. From 1963 to 1965, Reclamation added an extension to the Main Outlet Drain, extending the end of the drain to below the Morelos Dam located in the International Boundary Area. In the mid-1970s, under the authorization of the Colorado River Basin Salinity Control Project, a bypass drain was added onto the Main Outlet Drain Extension allowing the United States to completely bypass the Colorado River, and the legal salinity standards, when sending high-salinity water directly to the Gulf of California.

In conjunction with the other precautionary measures taking place in the Yuma Division, a ground-water recovery program was also underway. Irrigation resulted in much of the water being lost to either evaporation or to being soaked into the ground-water table. The installation of properly placed drainage pumps, which could pull the water back up from the ground and put it back into the Colorado River for reuse, made possible the recovery of ground-water.

Reclamation installed the first of these drainage systems in the South Gila Valley from 1961 to 1964. The South Gila Valley Well Field and Conduit consisted of 24 drainage wells and four drain pump outlet channels that discharged the pumped drainage into the Colorado River. At its peak, each well could recover up to nine cubic feet of water per second.³¹ In 1965, CRFW&LS constructed the Yuma Valley Drainage Well Field, which consisted of six pumping units.

The ground-water recovery was successful in two ways. First, it provided adequate

31. *Project Data*, p. 340.

drainage for agricultural fields which were otherwise water logged. Second, the recovered ground-water made available thousands of extra acre-feet of water for delivery to Mexico. Mexico, however, opposed the ground-water recovery program because it added to the increased salinity of the water being delivered. Mexico did not want the United States' excess brine and in November 1961, Mexico formally protested to the United States regarding the high salinity of the water. Although the United States did not terminate drainage pumping, in response to Mexico, the United States redesigned the recovery program to minimize the downstream impact. From 1968 to 1971, the CRFW&LS constructed the Yuma Mesa Well Field and Conduit. This project consists of 12 wells and a 14.7 mile conduit line. Unlike their predecessors, Reclamation packs the Yuma Mesa wells with gravel and adds a 16-inch stainless steel screens which filter out the saline and sediment. Although this improved the salinity problems, perhaps more beneficial to the plight of Mexico was the 1973 change in international law that specified exactly the maximum salinity of the water being delivered from the United States.

Limitrophe Division

The Limitrophe Division of the Colorado River reaches from the Morelos Dam to the Southerly International Boundary between the United States and Mexico. Since reclamation of water began in this area in 1901, this reach has been beset with excessive sedimentation. However, because of the physical location of the adjacent a canals in Mexican Territory, the Bureau of Reclamation does not have the legal authorization to make improvements. Thus, the International Boundary and Water Commission is responsible for all maintenance, operations, and construction in the Limitrophe Division.

Conclusion

The CRFW&LS is still in progress, constantly repairing and improving the river front

and levees systems on the lower Colorado River. The CRFW&LS provides a stable supply of river water for a plethora of uses, including irrigation, wildlife mitigation, and for delivery to Mexico. Unlike most other Bureau of Reclamation projects, the CRFW&LS is understated, in the sense that no giant edifice stands in its honor. This project consists of a series of levees, pumps, wells, dredged areas, and other structures that blend almost sight unseen into the river landscape. Despite its understated features, the CRFW&LS permits people to live and near the river by effectively controlling the Colorado River.

About the Author

Lara Bickell received her B.A. and M.A. from Pepperdine University. She wrote her M.A. thesis on newspaper publisher Eugene C. Pulliam and his influence as a booster in post-World War II Phoenix, Arizona. She is currently working on her doctorate in American history at Claremont Graduate University. Lara lives in Los Angeles with her husband and a menagerie of animals.

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