

THE SOUTHWESTERN DIVISION



50 YEARS OF SERVICE

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SOUTHWESTERN DIVISION

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ANNIVERSARY



U.S. ARMY CORPS OF ENGINEERS



***The Southwestern Division:
50 Years of Service***

by D. Clayton Brown, Ph. D.

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FOREWORD

A word about Divisions before we talk about the Southwestern Division. U.S. Army Corps of Engineers Divisions came into being in 1888, as a middle ground between Districts and the Corps headquarters in Washington, D.C. Divisions supervise Districts, perform technical reviews, and allocate the all-important resources with which the Districts do their jobs—the people's money.

The Corps created the Southwestern Division in 1937. Although it was new, some of the Districts it took over were not. Albuquerque District had begun its mission in 1935. Little Rock District had first been created in 1881, though it had been absorbed for some years by the Memphis District and recreated in 1937. Galveston District, which joined the Southwestern Division in 1941, had its start in 1883. The Division's other Districts, Tulsa and Fort Worth, came into being in 1939 and 1950.

Big (it covers 16 percent of the land area of the United States) and rugged as the region it represents, the Southwestern Division immediately began making its mark on the great Southwest.

The Southwestern Division's 50 years have brought great changes to the eight states its boundaries encompass. Our dams reduce flooding, saving lives and millions of dollars each year for farmers, business people, and homeowners. The lakes behind those dams provide much-needed water for agriculture, industry, and the Southwest's still-growing urban areas. Millions of men, women, and children now spend pleasant hours at Corps lakes, boating, swimming, fishing, hunting, and picnicking. The region's appearance and economy are in sharp contrast to what our first employees saw in the days of Depression and Dustbowl that marked the Division's birth.

The Arkansas River exemplifies those changes. The McClellan-Kerr Arkansas River Navigation System, completed in 1970, has made the inland town of Catoosa, Oklahoma (via Tulsa), one of this nation's largest ports, serving overseas ports via the Mississippi River and New Orleans, Louisiana. Another huge seaport sits at Houston, Texas, 50 miles upstream from the Gulf of Mexico. The Southwestern Division made that port possible with its dredging and harbor and channel improvements—a process that continues today. Division personnel also keep the channel clear for a large portion of the Gulf Intracoastal Waterway, another major shipping route.

The Southwestern Division has also improved the capabilities, facilities, and appearance of military installations in Texas, Oklahoma, New Mexico, Arkansas and Louisiana since before World War II. Soldiers and airmen and their families live in better quarters and spend their leisure time in better facilities, thanks to the labors of our people. The hospitals, recreation facilities, airfields, tank ranges, and other structures we built have improved the morale, health, training, and operations of Army and Air Force units in our area.

The projects tackled by Southwestern Division and its Districts have taken us from sea level to mountain peak to the depths of the earth. Our people have overseen management of some of the nation's strategic petroleum reserves at the edge of the Gulf of Mexico; construction of one of the world's largest telescopes atop the Sacramento Mountains; and excavation of salt caverns for storage of nuclear material nearly a half-mile beneath the ground in New Mexico.

Jobs like these challenge our engineers and make them better able to deal with the sort of complex, large-scale construction that would become necessary in a major military mobilization.

During my tenure as commander of the Southwestern Division I have developed a great respect for the achievements of the Division and for the

men and women who have brought all those projects into being. I am immensely proud of this Division, and look forward to seeing it continue to set the pace in its second 50 years.

J. B. HILMES
Major General, USA
Commanding

PREFACE

This is an official history of the Southwestern Division, U.S. Army Corps of Engineers. To an extent this history is a definition of the Southwestern Division, because there is much confusion about the role and function of the Army Corps of Engineers. The Corps is a complex organization with uniformed military leadership and a military chain of command, but whose day-to-day work is performed by civil service employees, a large portion of whom are professionals. It is the federal agency responsible for the construction of installations for the United States Army and Air Force. It is also the primary federal agency responsible for water development, which includes not only the construction and operation of dams and reservoirs but also the construction of navigable waterways. A large part of the Corps' work is unseen: studies of water sources, flood plain management, lakeshore regulation, regulation of wet lands, and disaster relief.

A three-part chain of command serves as the basis of organization of the Corps. At the top, the Office of the Chief of Engineers directs all activity worldwide. The middle step in organization is the Division, such as the Southwestern Division, which commands the Districts—the “action level” of the agency. Only the Districts engage in the actual construction of projects. There are 13 Divisions and 39 Districts worldwide. The Southwestern Division commands five Districts, headquartered at Albuquerque, New Mexico; Fort Worth and Galveston, Texas; Little Rock, Arkansas; and Tulsa, Oklahoma. It has one of the eight Division laboratories operated by the Corps.

Divisions are the management level of Corps command. They interpret policy and guidelines from the Office, Chief of Engineers and forward them to their respective Districts. Only in rare cases will the Engineer Headquarters deal directly with a District. Divisions also serve as a “reviewer” of District work. Once construction plans for a dam and reservoir are finished at the District, they are reviewed at the Division. A Division may provide support to its Districts in the form of professional expertise. Southwestern Division personnel, for example, handled the engineering plans of all hydro-power installations built in its Districts, and the Economics Branch furnished technical expertise in various economic studies conducted by the Districts. Thus, the Districts prepare plans and specifications, perform project designs, construct projects, and operate completed projects such as recreational areas at federal lakes. On the other hand, the Division allocates resources, provides guidance and assistance as required, exercises general supervision, reviews projects, monitors performance, and provides a forum to hear appeals of District decisions.

Division Engineers nearly always have the rank of brigadier or major general, while District Engineers are colonels. The Division Engineer acts as a liaison with military commanders at defense installations; he serves as the Corps' contact with state governors and other political interests. Furthermore, he testifies before congressional committees on budget and project matters. And he represents the Districts before the Office, Chief of Engineers. District Engineers may also perform these tasks, depending on the particulars of a situation, but the Division Engineer has the primary responsibility in these areas.

The history of the Southwestern Division provides an opportunity to see the evolving responsibilities of the Army Corps of Engineers. In 1937 the Southwest was an agrarian area; some urban centers existed, of course, but agriculture was the way of life for the majority of the population in Arkansas, Texas, Oklahoma, and New Mexico. Flooding on rivers such as the Arkansas, Trinity, and Brazos was a problem in all the states. Although

water supply was also a growing concern to the growing and increasingly urbanized population, flood control was still the principal job of the Corps in the late 1930s. World War II broadened its functions when Congress gave it the responsibility for constructing facilities for the Army Air Corps and later the United States Air Force. The buildup in America's military posture since World War II, partly due to the Korean and Vietnam conflicts as well as the "Cold War" with the Soviet Union, greatly expanded the military functions of the Southwestern Division and its Districts.

The definition of civil works also expanded beyond reservoir and dam construction. Water-related studies increased dramatically; by-products of reservoir construction, such as recreation and lakeshore management, had to be managed. The Corps' role in disaster relief grew, and safety inspection of non-federal dams has become a Corps function. Probably the best-known example of the new civil works is wetlands management, which is essentially a regulatory role. Flood plain management and other non-structural civil works are now a large part of the Corps' work. The Southwestern Division's workload includes many examples of this growth in both military and civil works.

The Division furnishes two rare opportunities to the historian and the interested reader: to observe the socio-economic impact of a large-scale project in the story of the McClellan-Kerr Waterway, and to look at the impact of the cost-sharing doctrine and the influence of environmentalism on the defeat of the proposed Trinity River Waterway. Both projects were supported by local interests through the ideology of economic growth. The McClellan-Kerr project experienced little or no environmental opposition. By contrast, the strong environmental concern that erupted among taxpayers along the Trinity River led to the defeat of the proposed bond election in 1973 that would have funded the local costs of that project. The question of how to alter the natural environment became a new dimension in the Division's activities.

In writing this history, the author determined which topics should be included and how much space should be devoted to them. Drafts of the manuscript were first submitted to the Division's Historical Committee, which judged them for technical accuracy and made recommendations concerning matters of interpretation. Members of the committee and other Division staff members worked closely with the author in drafting portions of the manuscript because documentation was only partially available. Even though the Division's records were available at the Fort Worth Federal Records Center, they consisted mostly of technical and engineering data. Large gaps exist in the records, too. The author had to rely on direct contact with the Division staff for explanations, both written and oral, of many aspects of its operations.

Each of the Division's five Districts has published its own history, and they should be consulted for topics not raised in this work or for more specific elaboration of some topics. The author avoided rewriting or compiling the District histories into one. Since the Division has a management function, the author focused on management decisions whenever possible, but the paucity of documents created serious difficulties in that regard.

Reliance on official Corps records and comprehensive discussions of the nature of the Division's operations have resulted in less critical analysis in this history than might otherwise be the case. Some major public controversies have been included, but many smaller ones dealing with individual projects were not. The author hopes that this work will illustrate the duties and functions of the Army Corps of Engineers in the Southwest as carried out by the Southwestern Division.

Since the research and writing of this history was a team effort by the author and numerous members of the Southwestern Division staff, it seems inappropriate to make acknowledgments. Many of the staff members participated to an extent far beyond the ordinary. Still, the author wants to express his gratitude for the assistance and cooperation provided by many people. Edward Hoff of the Office of Administrative Services (now in the Information Management Office) was my first contact person and one who was involved in the long task of getting this history written. His assistant, Norman Green, furnished administrative assistance. In the Public Affairs Office, Lu DuCharme provided valuable help and was responsible for preparing the manuscript for publication. Her assistant, Anne Keever Cannon, edited the manuscript and shared my responsibility for obtaining photographs and sources, organizing interviews, and other necessary tasks. The Southwestern Division Historical Committee deserves special mention because of its patience and kind suggestions. Some of the committee furnished technical advice that appeared in the manuscripts. Special thanks should be given to John Greenwood, Martin Reuss and the staff of the Office of Chief of Engineers, Historical Division, for their suggestions and guidance.

Retired employees furnished information simply unavailable elsewhere. Selma Sage conducted lengthy interviews of retired employees before this project started, and her work was used in researching the early history of the Division. James Russell and Carl Andrews were critical sources for the years before the Division came to Dallas. Alfred Wehrman was an equally critical source for the chapter on World War II. Robert E. Bell, emeritus professor at Oklahoma University, agreed to furnish information about the early archeological work of the Division. Former Galveston District Engineer Harold C. Brown provided valuable information on the history of the Trinity River project. D. H. Orendorff of the Albuquerque District explained much of the history of the White Sands Missile Range. Hugh Garrison arranged a tour with complete explanations of the operations of the Southwestern Division. Other retired employees such as Madeline Henry and Ivan Hobson provided encouragement and assistance as needed. For the day-to-day work of getting this history written, I must give special thanks to the staff of the Southwestern Division: artist Carol Kupfer and typists Valencia McClure, Faye Sowels, and Debbie Brown. Special thanks must go to those individuals cited in the footnotes who consented to interviews and provided written material. Without their participation, this project could not have been accomplished.

I ORIGIN OF THE SOUTHWESTERN DIVISION

The creation of the Southwestern Division, United States Army Corps of Engineers, in 1937 represented a significant step in the growth of the federal government's responsibility for flood control in the Southwest. Several large river drainage systems were located in the region. They frequently flooded, causing or contributing to some of the worst deluges in modern American history. The Arkansas River, a principal tributary of the Mississippi River, traverses eastern Oklahoma and the heart of Arkansas. It was a major contributor to the famous flood of 1927 in the lower Mississippi Valley. The Trinity, Brazos, Red, White, Rio Grande, and other rivers in the region frequently went out of bounds and inundated farms, towns and portions of cities. By the 1930s, the southwestern states were becoming more urbanized and starting to develop an industrial economy. With the growing population in these river basins, there was a natural demand that the flooding be stopped or at least brought under control.¹

Before the 1930s the U.S. Army Corps of Engineers had dealt with the southwestern rivers on a limited basis, and flood control had not been its primary mission. During the 19th century, the Corps made periodic attempts to clear the Arkansas River for navigation. In 1832, Congress appropriated \$15,000 for the Corps to keep a channel clear in the stream. Periodically, lawmakers provided funding for minor channel modification, dredging and other improvements, but the funds were not appropriated regularly and the work was done sporadically. The *Wichita*, a snag boat commissioned by the Corps, reached Pawnee Agency, Oklahoma, about 65 miles above Tulsa, in 1881.² That year the Corps opened a district office in



The Southwestern Division, 1 July 1937

Little Rock, Arkansas, and gave it responsibility for improving navigation on the Arkansas and White rivers. But in 1923, the Memphis District, part of the Lower Mississippi Valley Division, absorbed the Little Rock District.³

The federal government played a similarly low-key role regarding Texas rivers during the 19th century, exemplified by work on the Trinity River. In 1852, the Corps' New Orleans Engineer Office made a study of the feasibility of navigation on the Trinity. The report concluded that navigation would be possible only in the spring when the water level would be above normal. The Corps District in Galveston, Texas, which opened in 1880, made another survey in 1891. It came to the same conclusion.⁴

Federal activity in the Southwest during the 19th century focused on coastal operations more than river development. Prior to the Civil War the Corps conducted surveys of the Texas and Louisiana gulf coasts and of harbors at the mouths of several Texas rivers. After the war, the New Orleans Engineer Office, one historian wrote, conducted "an impressive array of river and harbor activities in Louisiana and Texas."⁵

The new office in Galveston maintained dredging operations on the Trinity River up to Liberty, Texas. It also maintained navigation on the Sabine and Neches rivers. Improvement of Galveston Harbor was, however, its principal concern. By 1897 the office's efforts had turned the harbor into a deep-water port.⁶

For a brief time, the Corps operated a Dallas District, created in 1905 as part of the New Orleans Division. It had jurisdiction over the drainage basins of several Texas rivers: Trinity, Cypress Bayou, and portions of the Red. In 1907, the Dallas District received jurisdiction over the lower portion of the Brazos, and in 1908 the Sabine and Neches rivers came under its jurisdiction. In 1919, however, the Corps closed down the Dallas District and transferred its responsibilities to the Galveston District.⁷ That District, still administratively under the New Orleans Division, continued to be quite active in developing the Texas coast, but its work on rivers was still comparatively limited. In the early 20th century, it briefly had a navigation project under way on the Trinity River, but that was brought to an end in 1921.⁸

The Southwestern Division's creation in 1937 was a result of the federal government's evolving responsibility for flood control. That duty went back approximately to 1908, when President Theodore Roosevelt's Inland Waterways Commission urged that federal plans for navigation of streams should take flood control into account. The American Society of Civil Engineers stated that same year that the federal government should give flood control equal consideration with navigation.

Further progress toward federal involvement in flood control came in 1917 when Congress appropriated \$45 million to build and repair levees on the Mississippi River between Rock Island, Illinois, and New Orleans. A small appropriation was made for river improvements on the Sacramento River in California, but attention focused on the Mississippi because of its strategic importance to trade and commerce and also its perennial and devastating floods. The Mississippi River Commission handled the levee construction, but the Army Corps of Engineers received instructions that year to conduct preliminary examinations on the great river and its lower tributaries.

In March 1925, one of the most important events leading to the federal program of flood control occurred when Congress instructed the Secretary of War, working through the Corps and the Federal Power Commission, to "prepare and submit estimates of costs and investigations of all navigable streams and their tributaries with a view of formulating plans for the most effective improvement of these streams for navigation, power, flood control,



In the 19th century, U.S. Army Corps of Engineers personnel began to survey the Southwest.

and irrigation.”⁹ Two years later, the Corps reported its estimates, which were published in House Document 308, 69th Congress, First Session. The studies that resulted became known as the “308 reports” and are some of the most important documents for the Army Corps of Engineers. They were the basis of the agency’s work on nearly 200 streams in the United States. Although the 308 reports did not make recommendations for congressional authorization of construction projects, they did indicate whether projects would be cost-effective. Congress turned to the reports repeatedly in later years as it authorized funds for river improvements.¹⁰ Public demand for flood control greatly intensified after the famous Mississippi River flood of 1927, one of the most tragic and dramatic floods in American history and “one of our great national disasters” according to the Mississippi River Commission.¹¹ Large portions of the entire Lower Mississippi Valley were inundated; more than 300 persons died, property damage ran into the millions of dollars, crops were destroyed, towns flooded, and thousands of persons were left homeless.

The pathos of the 1927 flood went beyond description. Witnesses saw thousands of cattle and hogs floating down the river, struggling vainly to reach land as they were swept into the Gulf of Mexico. A vast yellow lake extended from St. Louis to the Gulf, filled with treacherous currents moving in all directions. So great was the water pressure that fountains burst from underground. Half the state of Arkansas was underwater because of overflows on the Arkansas, White, Ouachita, St. Francis, and other streams of the Lower Valley flowing through or originating in that state.

The disaster of 1927 dramatically illustrated the need for a comprehensive plan on a massive scale, particularly in the Lower Mississippi Valley. Local interests organized to press Congress into action. The Pine Bluff,



The railroad station at Trinidad, Colo., suffered from flooding of the Purgatoire River in 1955.

The Albuquerque District built this earthen dam to protect El Paso, Texas, homes from flash-flooding.



Arkansas, Chamber of Commerce organized residents into the Arkansas River Basin Association, and the White and Black River Valley Flood Control Association also fought for federal help in controlling the rampaging rivers in their states. Some interest groups urged canalization of the Arkansas River as far north as Tulsa.¹² The safety and economic future of the Mississippi Valley required some kind of control over the area's rivers, and many thought only the federal government had the resources for such a large task.

In 1932, the Corps' Lower Mississippi Valley Division in Vicksburg, Mississippi, forwarded a Memphis District study on the White River that had begun as a 308 report. In view of the 1927 flood, to which the White River had significantly contributed, the study had much importance. It demonstrated the engineering feasibility of major improvements in the White River Basin that would alleviate flooding and provide water for rice cultivation. The District did not recommend hydropower projects on the grounds that no market existed for the potential power.¹³ Similar studies were made of the Arkansas and Red rivers, showing the feasibility of drastic flood reduction through major improvements.¹⁴

As momentum for federal intervention increased, the economic Depression of the 1930s struck. The election of President Franklin D. Roosevelt in 1932 marked the beginning of massive federal river improvements throughout the United States. Roosevelt espoused a philosophy of relief, recovery, and reform, and flood control presented an excellent opportunity to achieve all three. It could bring relief to the unemployed, stimulate the economy, and also end the disastrous flooding that contributed to hardship. "The climate was right," noted one historian, "for consideration of House Document 308."¹⁵ Under the Emergency Relief Appropriations Act of 1935, Roosevelt authorized funds to begin construction of the Conchas Dam on the South Canadian River in eastern New Mexico, part of the greater Arkansas River Basin. The project was located about 35 miles northwest of Tucumcari, New Mexico. Operation of that project was headquartered in the Lower Mississippi Valley Division.

Approval of the Conchas Dam showed the extent of the pressure in the 1930s to find jobs for the unemployed. Although the Army Corps of Engineers and the state of New Mexico had agreed in 1929 that flood control and irrigation use of the Canadian River were not economically feasible, the Roosevelt administration asked for a study of the project's impact on unemployment. In 1933, the Corps reported that the Conchas Dam project did not meet the usual criteria for economic feasibility, but its construction would provide many jobs in New Mexico.¹⁶ Because of the need to stimulate employment, Congress and President Roosevelt approved the project in 1935 and provided \$4.5 million in emergency relief funds in 1936 to start construction. To build the dam, the Corps created the Tucumcari District on 1 August 1935. A year later it was renamed the Conchas District.¹⁷

The last step leading to the creation of the Southwestern Division occurred when Congress passed the Flood Control Act of 1936, a move recognizing that flood control was a federal responsibility. It authorized 211 flood control projects in 31 states at an estimated cost of \$300 million. The measure also incorporated the concept of multipurpose planning, meaning that federal river basin development would include hydropower, soil conservation, navigation, and water supply. The act thereby increased the factors used to determine the economic feasibility of projects, meaning they could more easily be found cost-effective. For the Army Engineers the act was historic because it gave them the chief responsibility for flood control measures taken by the federal government.¹⁸

The Flood Control Act of 1936 authorized five reservoirs and a variety of levee construction and improvement projects on the Arkansas River drainage basin. The reservoirs were the Great Salt Plains on the South Fork of the Arkansas River, about 12 miles east of Cherokee, Oklahoma; the Caddoa Reservoir (John Martin Reservoir) on the Arkansas River about 18 miles west of Lamar, Colorado; Fort Supply Reservoir on Wolf Creek about 12 miles west of Woodard, Oklahoma; the Hulah Reservoir on the headwaters of the Caney River near Bartlesville, Oklahoma; and Optima Reservoir on the North Canadian River near Hardesty, Oklahoma.

Although most of the levee projects were on the Arkansas and White rivers, some levee construction was also authorized on the Black River between Poplar Bluff, Missouri, and Knobel, Arkansas, and south and east of Pochontas, Arkansas.¹⁹ The act also included the Conchas Dam and Reservoir project that had been started through the provisions of the Federal Emergency Relief Act.²⁰

To oversee these projects, the Army Corps of Engineers established two major offices effective 1 July 1937: the Little Rock District and Southwestern Division. The Division also took over the Conchas District. Conchas' geographic area comprised the watershed of the South Canadian River and its tributaries west of the Texas-New Mexico border. Captain Hans Kramer was the Conchas District Engineer. The Little Rock District included "the Arkansas River and tributaries above and exclusive of the city of Pine Bluff, Arkansas, and also exclusive of that portion of the South Canadian River and tributaries entering the same west of the Texas-New Mexico state line; the White River and tributaries above Peach Orchard Bluff, Arkansas; and the Red River and tributaries above Fulton, Arkansas," according to a report of the Chief of Engineers.²¹ Lieutenant Colonel Stanley L. Scott was the Little Rock District Engineer.

All this territory had previously been part of the Lower Mississippi Valley Division. The Arkansas and White river basins had been under the Memphis District, while the Red River areas had belonged to the Vicksburg District.



(G. O. 4.)

WAR DEPARTMENT
Office of the Chief of Engineers
Washington, April 28, 1937.

General Orders)
No. 4)

By authority of the Secretary of War, and effective July 1, 1937, the improvement of the following rivers is withdrawn from the jurisdiction of the Lower Mississippi Valley Division and assigned to a new river and harbor division to be known as the "Southwestern Division", with headquarters at Little Rock, Arkansas:

The Arkansas River and tributaries above and exclusive of the City of Pine Bluff, Arkansas.

The White River and its Tributaries above Peach Orchard Bluff, Arkansas.

The Red River and its tributaries above Fulton, Arkansas.

The records, property and funds pertaining to the Southwestern Division will be transferred to that division by the Lower Mississippi Valley Division as soon as practicable.

Under the above authority and effective the same date the Conchas, New Mexico, District is transferred from the Lower Mississippi Valley Division to the Southwestern Division, and a new river and harbor

- 2 - (G. O. 4.)

district is established with headquarters at Little Rock, Arkansas, under jurisdiction of the latter division. The territorial limits of this district will embrace that portion of the Southwestern Division not included in the Conchas District.

By order of the Chief of Engineers:

W. F. Heavey,
Major, Corps of Engineers,
Chief, Personnel Section.

The Southwestern Division office began functioning on 14 July 1937. It and the Little Rock District were headquartered in Little Rock. The Division was housed in the fourth floor of the W. B. Worthen Bank Building at Main and Fourth streets, while the District offices were in the Gay Office Building at Third and Center streets.²² Personnel in the new Division came largely from the Memphis District, including the first Southwestern Division Engineer, Colonel Eugene Reybold. As Memphis District Engineer, Reybold headed up the studies of the Arkansas and White rivers, so he was well acquainted with the drainage basin of the new Division. Reybold's small staff included Captain H. A. Montgomery as Executive Officer.²³ The new Division plunged into the task of overseeing the work done by its two Districts. Little Rock District began on three structures authorized by the Flood Control Act of 1938: the Clearwater Dam on the Black River in Missouri, the Nimrod Dam on the Fourche La Pave River in Arkansas, and the Blue Mountain Dam on the Petit Jean River in Arkansas. Congress had appropriated funds for their construction ahead of the four previously authorized reservoirs.²⁴ Work progressed on the Conchas Dam in New Mexico, and the Conchas District began planning studies of Caddoa Dam in September 1939.²⁵

In 1939, the Division's workload increased with the creation of two new Districts. To build the newly authorized Texoma Reservoir on the Red River at Denison, Texas, the Corps established the Denison District on 1 January 1939. The Texoma project, sponsored by House Majority Leader Sam Rayburn, was designed for both flood control and hydropower, the latter primarily to supply the rural area in the surrounding environs with electricity. The District was commanded by Captain Lucius Clay, later military governor of the American Zone in occupied Germany after World War II. Created principally to build the dam, the new District took in the Red River above Fulton, Arkansas. The river's drainage area included "a portion of western Arkansas, the northern portion of Texas, excepting the major portion of the Panhandle, and the southern portion of Oklahoma."²⁶ The Denison District was abolished six years later when the dam was finished, making it the smallest and most short-lived District in the Southwestern Division.

More important was the creation of the Tulsa District in 1939. For nearly a generation local interests, led principally by Tulsa banker Newton (Newt) Graham, had campaigned for a series of projects including flood control, hydropower, and navigation of the Arkansas River up to Tulsa. To accomplish their goals, they wanted a full District established at Tulsa. Congress had approved several projects in Oklahoma, and the time was ripe for a new District to accommodate the workload.

The Tulsa District went into operation 1 July 1939, beginning construction of the Canton and Salt Plains reservoirs in Oklahoma. It also started feasibility studies of a proposed Arkansas River waterway and jointly with the Vicksburg District began a comprehensive study of the entire Red River Basin.²⁷ Captain Harry A. Montgomery, Reybold's Executive Officer in the Southwestern Division, was the first Tulsa District Engineer. Boundaries of the District took in southern Kansas, small portions of western Missouri and Arkansas, northern Oklahoma, the northern Texas Panhandle, and small portions of northeastern New Mexico and southwestern Colorado. Thus, the Tulsa District concentrated mostly on the Arkansas River Basin above the mouth of the Poteau River.

The Conchas District, meanwhile, was undergoing some changes because of the completion of the Conchas Dam. In November 1939, Captain James H. Stratton succeeded Kramer as District Engineer. The District was renamed Caddoa in December 1939, and most employees transferred from

Tucumcari to the Caddoa site offices near Lamar, Colorado, to better manage that project. Although work on Caddoa Dam began in 1939, it was not finished until 1948 due to the shortage of materials imposed by World War II. In June 1940, the project was renamed the John Martin Reservoir in honor of Congressman John Martin from Colorado.²⁸

Along with the actual construction of projects, the Southwestern Division supervised about 30 examinations and survey reports by its Districts on several streams, potential reservoir sites, and flood protection areas during the first year of operation. The reports were forwarded to the Office of the Chief of Engineers in Washington, D.C. Even though the Division at this time dealt exclusively with civil functions, the workload was considerable for the small staff headquartered in Little Rock.²⁹

The outbreak of war in Europe in 1939 and the growing likelihood of American participation brought an increased number of projects to the Army Corps of Engineers. In 1940, the Corps increased its momentum in the transition from civil to wartime objectives. For example, the Caddoa District that year built airports for the Civil Aeronautics Administration at La Junta, Colorado; Dodge City, Kansas; Santa Fe, Hobbs, Clovis, and Las Vegas, New Mexico; and Amarillo, Texas.³⁰ Organizational changes took place throughout the Corps, including the Southwestern Division. In June 1940, Colonel Reybold left his post as Division Engineer and transferred to Washington, where he subsequently served as Chief of Engineers during World War II. Lieutenant Colonel Stanley L. Scott, District Engineer at Little Rock, replaced him as Division Engineer.

Among the organizational changes made preparatory to war was the abolition of the Gulf of Mexico Division office in New Orleans and the transfer of the Districts under its command to other Divisions. The Mobile District went to the South Atlantic Division in Atlanta, and the two New Orleans District offices were consolidated and placed under the Lower Mississippi Valley Division at Vicksburg. The Galveston District, under the command of Lieutenant Colonel Leland H. Hewitt, was transferred to Southwestern Division. These changes became effective on 15 January 1941. Such expansion nearly doubled the Division's territorial area because the Galveston District took in all of Texas below the Red River drainage system, "that portion of western Louisiana in the Sabine and lake drainage



It takes regular dredging to keep rivers in the Little Rock District navigable.



The Tulsa District built Fort Gibson Dam in Oklahoma.

systems, exclusive of the Louisiana section of the Louisiana-Texas Waterway and tributary waterways; and the drainage basin of the Rio Grande in Colorado and New Mexico east of the Continental Divide. It included the Intracoastal Waterway in Texas from the Sabine River to Corpus Christi, Texas."³¹ From a staff of approximately 35, the Division grew to nearly 100 persons.

With the addition of the Galveston District, the geography and topography of the Division ranged from wetlands on its eastern boundary to arid desert on the west. The lowlands of the lower Mississippi Valley contrasted sharply with the high plateaus of the Rocky Mountains. Some of the richest and poorest people in the United States lived in that expanse, from the classic Ozark backwoodsmen to sophisticated urban residents. Only the Missouri River Division, reaching from St. Louis to the northwestern edge of Montana, approached the geographic contrast of the Southwestern Division.

Because the physical properties of the Southwest played such a strong part in the Division's fortunes, they deserve some discussion. The topography of the Arkansas District breaks into three parts: the Ozark Plateaus,

the Arkansas Valley and the Ouachita Mountains. The Ozark region consists of the Springfield Plateau, 1,000 to 1,500 feet high, extending from Missouri into northern Arkansas. Except for some deep valleys, the Springfield Plateau is flat and has some of the state's best farmland.³²

South of the plateaus are the Boston Mountains, about 35 miles wide and 200 miles long, cut through by gorges 500 to 1,400 feet deep. Nimrod Reservoir, completed by the Little Rock District in 1942, now lies in the middle of that range. A series of narrow, paralleled ridges leaving sharp, uneven crests separated by wide basins characterize the Ouachita Mountains, which cover a belt about 50 to 60 miles wide extending into eastern Oklahoma. Rainfall in these mountain ranges, which never rise beyond 2,700 feet, averages about 40 inches per year.³³

In 1941, these Arkansas mountain ranges were inhabited by small farmers and stockmen, descendants of the original settlers. They eked out a living from the soil, sometimes supplementing it with hunting and fishing. Logging was a major industry, though not on the scale found in the northwestern states. Some mining was practiced, particularly of bauxite and stibnite.

Through the heart of the state flows the Arkansas River, 2,000 miles long, with its headwater on the continental divide in west-central Colorado. Fed by snow at 10,000 feet, the Arkansas begins its descent from the Rockies into Kansas, across Oklahoma, and into the northeastern corner of Arkansas. The largest stream in Arkansas and its tributaries were in constant threat of flooding before the Corps began work, but they also had much potential for economic development. This development would become one of the principal responsibilities of the Southwestern Division through the next generation.

As in Arkansas, the landscape in Oklahoma is quite varied, from treeless prairies in the northwest to heavily wooded sections in the Ouachita Mountains and low-lying areas such as the West Gulf Coastal Plain in the southeast. About three-fourths of the state is located in the Osage Plains section of the Central Lowlands. The overall aspect of the area is a plains of low relief, interrupted at intervals by generally north-south hilly escarpments rising for several hundred feet.³⁴

In 1941, Oklahoma was primarily an agrarian state with two principal urban centers, Oklahoma City and Tulsa. Next to agriculture, oil was the predominant industry followed by aircraft and other manufacturing industries. For farmers, including both landowners and tenants in 1941, the slack rains in summer and early fall made water a valuable commodity. Cattle ranching was important, a tradition dating back to the appearance of Texas longhorns in the 1870s. Winter wheat was produced in volume.

Much potential work existed in the Sooner State for the Army Corps of Engineers. Flooding plagued the inhabitants, but they also needed water. The sources of ground water were increasingly inadequate in view of the growing population, making river impoundment the only feasible alternative for obtaining water. The flooding rivers were also possible sources of hydro-power. In fact, some of the local pressure for creation of the Tulsa District in 1939 had been linked to the need for electricity. And many people were talking about a proposed Arkansas River waterway that would make Tulsa a seaport—an idea that would eventually become the Southwestern Division's largest project.

New Mexico's topography sharply contrasts with that of its neighbors to the east. Whereas Arkansas' lowlands elevation was less than 500 feet, the lowest point in New Mexico was 2,817 feet. A mountainous and arid state except for the northern portion where the lower Rockies are found, New Mexico has few rivers, and since rain is scarce, water is precious. The largest



The Galveston District's efforts have made the Port of Houston one of the nation's busiest seaports.

and most important river is the Rio Grande, which starts in the San Juan Mountains of Colorado, flows south through New Mexico and then serves as the border between Texas and Mexico before emptying into the Gulf of Mexico. Other rivers in New Mexico are the Pecos, San Juan, Canadian, and Gila. Some of these flow eastward into Texas and Oklahoma. The Pecos is a tributary of the Rio Grande, and the Canadian feeds into the Arkansas.³⁵

Because of the small number of rivers, New Mexico offered the least potential civil works activity for the Southwestern Division or the Conchas District, other than the Conchas Dam. Military projects before and during World War II, however, soon gave the District reason to expand. New Mexico's isolation was a perfect place for military training and research.

With the acquisition of the Galveston District, the Southwestern Division supervised work in almost all of Texas. The Lone Star State suffered the same problems of flood and drought that plagued the rest of the Division's area of operation. Like Oklahoma, it was part of the "dust bowl" of the 1930s. But Texans had also endured a long history of flooding in several river basins: the Brazos, Trinity, Guadalupe, San Antonio, Neches, Nueces, San Jacinto, and Colorado. These streams flow southeasterly across the west Texas plains and the forests of east Texas, transversing the major physiographic provinces of Texas—the Great Plains, Coastal Lowlands, and Coastal Plain—and empty into the Gulf of Mexico. Many of the rivers terminate in broad, shallow bays lying between the coastline and offshore bars. Rainfall varies from 55 inches on the Texas-Louisiana border to 8 inches at El Paso. The heaviest rainfalls come in spring. Storage of that water would require impoundment of the major rivers at strategic points.

In the Panhandle the traditional flat plains extend southwesterly to the Davis Mountains. In the center of the state the gently rolling prairies provided a primarily agricultural living for the residents. In the eastern portion, however, heavy forests made the area a prominent timber and pulp producer. Toward the southeastern corner, oil was abundant. In 1941, these prairies and forests were occupied by landowners and tenants, farmers and stockmen. Cotton was an important crop, and east Texas suffered the same social and economic problems associated with "King Cotton" found in the Deep South. From the view of an hydrologist, the topography of Texas generally matched that of Arkansas and Oklahoma.

The one exception to that was the Texas Gulf Coast, which came under the jurisdiction of the Galveston District on historic Galveston Bay. This abrupt contact with salt water contrasted strikingly with the wetlands and interior mountain ranges.

Geographic conditions held much significance for the Southwestern Division. The Southwest's broad expanse and clear skies would prove attractive for military installations and defense contractors. The presence of major rivers meant that the Division would face the task of making the region safe from flooding. The growing Southwestern economy would also let the Division benefit from and contribute to the expansionist economic ideology of the region. But before it could become deeply involved in reservoir construction, the Division faced another challenge. Only a few years old and still trying to consolidate itself, it turned to military construction when the Japanese attacked Pearl Harbor on 7 December 1941.



The San Antonio River winds toward the center of the city after completion of the Fort Worth District's work to keep it safely in its channel.



The San Antonio River meanders past shops and through a hotel lobby along the city's Paseo del Rio. The Fort Worth District designed parts of the River Walk. (Photo courtesy of the San Antonio Convention and Visitors Bureau)

II WORLD WAR II

The outbreak of World War II brought a period of remarkable expansion for the Army Corps of Engineers. Previously, the Engineers had generally dealt with navigation and flood control projects, while the Quartermaster Corps handled a large part of the military construction for the Army. In the early 1940s, however, the Engineers began receiving new assignments, primarily for airfield construction. The great importance of air power gave special urgency to creation of bases for the Army Air Corps. For the Southwestern Division, therefore, the war resulted in a new and strenuous workload in military construction. Most civilian projects were either temporarily suspended or went on at a slower rate for the sake of mobilization, although some projects, such as the Denison and Norfolk dams, continued on their regular schedule. As was the case with nearly all federal agencies, the Division underwent administrative adjustments in order to meet the pressing demands of war.

The push started before the outbreak of hostilities. In January 1939, the United States proceeded to strengthen seacoast defenses, modernize arsenals, and enlarge or add military stations. The Quartermaster Corps took steps toward war mobilization by building and improving some 300 structures, including barracks, mess halls, hospitals, and warehouses. At the same time the Army Air Corps wanted facilities to train 7,000 pilots per year and provide for a larger ground support force. In September 1940, Congress passed the Selective Service Act, an indication of commitment to military preparedness. Although the United States was not engaged in the fighting and public opinion was sharply divided over participation in the war, military preparedness nonetheless went forward.¹

The roots of the Corps' wartime construction mission can be traced to September 1940, when Congress assigned it a \$40 million airfield construction program for the Civil Aeronautics Administration. The Army Engineers received responsibility for all Army Air Corps construction in November of that year, with the Southwestern Division being tasked to build facilities on 16 December 1940. This new assignment required an adjustment in organization. In January 1941, the Corps abolished the Gulf of Mexico Division in New Orleans and transferred its Galveston District to the Southwestern Division. Roy G. McGlone of the defunct Division came to the Southwestern Division as chief of engineering. That month also, R. C. Baird, assistant chief of the Division's Engineering Division, and five employees from the Galveston District opened a sub-office in San Antonio, headquarters of the Fourth Air Corps. They were joined by six persons from the Quartermaster Corps, at that point still the principal construction agent for the United States Army.²

Increasing pressure to satisfy military needs, even though the United States remained neutral, forced the Division to find a headquarters location more suitable for its operations. On 1 February 1941, it moved to Dallas, which had better communications and transportation facilities than Little Rock and was more centrally located in its area of operations. Because of the anticipated wartime emergency, the standard feasibility study was not done. The uneventful move into the 11th and 12th floors of the Cotton Exchange Building occurred on a weekend, and the Division resumed business as usual on Monday morning, 3 February 1941.³

Meanwhile, the Army continued the reorganization of its construction program, which had been under way since the Corps of Engineers began work for the Civil Aeronautics Administration. In spite of the Quartermaster Corps' traditional responsibility for construction, congressional support



(G. O. 9)

WAR DEPARTMENT
Office of the Chief of Engineers
Washington, December 23, 1940.

General Orders)
No. 9)

By authority of the Secretary of War, the headquarters of the Southwestern Division is transferred from Little Rock, Arkansas, to Dallas, Texas, effective on or about February 1, 1941.

The Division Engineer, Southwestern Division, will effect the necessary transfer of civilian personnel, property and records.

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By order of the Chief of Engineers:

E. A. Brown, Jr.,
Captain, Corps of Engineers,
Acting Chief, Personnel Section.

had been growing to transfer that function to the Engineers because of their excellent performance with the Air Corps. "Tasks that had cost the Quartermaster Corps a great deal of trouble," one writer concluded, "they [the Engineers] handled with relative ease."⁴ For example, the Real Estate Division's part in reservoir projects had given it experience in dealing with the public and made it well acquainted with land values. Major General Julian L. Schley, Chief of Engineers, could instantly obtain current knowledge of local areas by contacting the appropriate District Engineer. This speed and efficiency and the existence of a field organization dispersed throughout the United States gave the Engineers an advantage over the Quartermaster Corps as America's probable entry into the war drew closer. In December 1941, Congress passed legislation transferring construction responsibilities to the Army Corps of Engineers.⁵

On the 16th of that month the Southwestern Division acquired another District—the San Antonio District, commanded by Colonel E. V. Dunstan. The new office "assumed all construction previously handled by the zone construction quartermaster, in addition to work on army air force projects previously handled by the Galveston district," said an article in the *Dallas Times Herald*.⁶ The San Antonio District covered 90,000 square miles in 77 Texas counties. Its boundaries "roughly extend from Laredo to Midland, Midland to Abilene, Abilene to Bastrop, and Bastrop back to Laredo," the newspaper reported.⁷

The Southwestern Division had been in Dallas about one year when another move appeared imminent because of further reorganization. In March 1942, the Army established three new basic commands: Army Ground Forces, under Lieutenant General Lesley J. McNair; the Army Air Force under General Henry H. (Hap) Arnold; and the Service of Supply Command under Major General Brehon B. Somervell, a career Engineer officer who had been Chief of Construction in the Army Quartermaster Corps. In July 1942, he designated nine service commands covering the United States. The 8th Service Command at San Antonio had authority over the Southwestern Division's military construction. "Division engineers would wear two hats," according to one source, "the customary one for new construction and a second for duties as directors of real estate, repairs, and utilities on the staffs of the service commanders."⁸ The traditional Corps civil works boundaries of Divisions and Districts were altered for military construction. The Denison District, for example, handled military construction in north Fort Worth, which was not in the Red River watershed. Throughout the Corps complaints were heard about the newly imposed superstructure, but Somervell refused to budge. As part of his reorganization, the commanding officer of the 8th Service Command also ordered the Southwestern Division to transfer to San Antonio.⁹

About 25 persons transferred temporarily to San Antonio on 15 August 1942. In the meantime, however, the Division's commander, Colonel Stanley L. Scott, had ordered Captain Howard Langley and James Russel to make a detailed study of the economic justification and suitability of San Antonio and Dallas as headquarters sites. This study included an examination of highways and railroads, air service, communications, and the availability of office space. Langley and Russel reported that the Southwestern Division should stay in Dallas because it had superior communication and transportation facilities. Dallas also had more adequate office and housing space. In fact, from their point of view, the Eighth Army Command should transfer from San Antonio to Dallas.¹⁰

As a result of the study, the idea of transferring was dropped, and the San Antonio contingent returned to Dallas and was put into the newly renovated Santa Fe Building. Their return swelled the Southwestern Division's work

force to approximately 500 employees, because additional personnel had been recruited after the move to Dallas.¹¹ Morale was high among the employees once the question of transfer was resolved, and they "were very much interested in the new type work," one staff member recalled, "new since it was military. With our country at war, each wanted to give his best efforts to ensure that our nation would come through victorious."¹²

As the amount of work increased, with shorter and shorter deadlines, pressure on the staff increased. Quality personnel were difficult to recruit. In some cases wartime commissions brought reversals in authority. A junior engineer in civilian life, when activated in the reserves, might return with a commission and outrank the senior engineer.¹³

To reduce time in handling projects, the employees developed new and unconventional bookkeeping and accounting methods in areas such as purchasing, transferring, and leasing. Contract arrangements with suppliers and building firms were drastically shortened by avoiding the traditional 30-to-40 day interval for soliciting bids. Authority for a project would come by telephone from Washington, enabling the Division to start work while waiting for the arrival of written orders. The traditional practice of advertising projects and awarding contracts to the lowest bidder was sacrificed for the sake of speed. Instead, construction contracts were awarded after negotiations with a contractor who had been screened and selected for the specific capability needed.¹⁴

A good example of the effort to speed operations was the transfer of equipment from the Civilian Conservation Corps, or CCC, to the military. The CCC was a New Deal organization started by the Departments of Agriculture and Interior to provide work camps for unemployed young men. With the start of the war the camps shut down, and the recruits were dispersed into the armed forces and defense industries. Equipment held by the CCC, ranging from hand tools to bulldozers, was badly needed by the military. But property transfers between agencies required the signature of the Secretary of War, who could not be expected to sign the documents for some time. Procurement officer Roy Penix proposed to Colonel Scott that the Southwestern Division disregard the usual procedures. Scott agreed. The Division simply obtained property lists from the CCC regional offices and moved the equipment to the Southwestern Division construction projects. This step enabled them to get by without the signature of Secretary of War Robert Patterson who, one employee recalled, "had a great deal more to do than to sign a receipt for a CCC camp in the Big Bend Country and hundreds of other places."¹⁵

Construction also proceeded swiftly. On 13 April 1942, for example, the Albuquerque District (formerly the Caddoa District) received orders to build an air depot training center at Albuquerque, New Mexico, and to complete it by 20 May 1943. It was finished one day ahead of schedule. An Engineers Railroad Battalion headquarters went up at Clovis, New Mexico, also ahead of schedule. By 16 June 1943, the Albuquerque District had completed and turned over to the military twenty-three airfields, two ordnance depots, five installations for Army ground forces, three prisoner-of-war camps, one Japanese relocation center, two general hospitals, and three civilian war housing projects.¹⁶

The Special Procurement Branch of the Southwestern Division and the Military Supply Division of the 8th Service Command were one and the same. At one time this office was located at Fair Park in the Dallas Jockey Club, which had offered space to the military for the duration of the war. Through its Procurement Branch, the Division purchased equipment, ranging from small hand tools to earth-moving equipment, for combat troops. For example, burlap bags were a mundane but necessary part of America's

airpower support, critical in the rapid construction of small, temporary airstrips near combat zones.

The effects of the Division's war effort were felt far from Texas. A case in point was its procurement of portable fuel pipelines used in North Africa and later by General George Patton's troops in Europe. During the battle of North Africa in 1943 the Allied Forces managed to defeat German Field Marshal Erwin Rommel, the "Desert Fox." One important factor in the Allied success was a portable pipeline designed by Sydney S. Smith, a Shell Oil Company technician. Previously, trucks had to carry fuel to the front and were a favorite target of enemy aircraft. The new pipeline transported gasoline from temporary dock storage tanks to front-line armored combat units. This rather simple system was made up of rigid 20-foot sections weighing 90 pounds each. The spirally welded, six-inch-diameter light steel pipe was laid directly on the ground.¹⁷

Special quick couplings, easily installed with an ordinary wrench, linked the sections. Pumps were installed at 10-mile intervals. The six-inch line could transport 10,000 gallons of gasoline per hour. Once installed, the system was fully automatic. It was an extremely small target, easily camouflaged. But its greatest benefit was easy operation and maintenance. Pumping stations consisted of nothing more than small, portable gasoline engines that could be fully replaced in four hours if destroyed by enemy fire. Each section of line could be replaced in a matter of minutes by two men using wrenches. A company of men, about 200, using a truck could install 20 miles of pipe per day.¹⁸

It became the Southwestern Division's responsibility to procure the pumps. To save time, Division personnel handled preliminary discussions with contractors over the telephone before sending written authorizations. Negotiations also took place by telephone, letter, or across the table in arms-length discussions. The principal supplier of the pumps, Hanlon-Waters Company of Tulsa, had started out with a small plant, but produced \$20 million worth of equipment by the end of the war. The Wheatley Valve Company of Tulsa was the major manufacturer of the valves used in the system. By 1944, the Southwestern Division had awarded contracts totaling \$100 million for the pipeline. After the Allied landing at Normandy, the Army used the pipeline system to supply fuel to armored troops in Europe.



Some American tanks in Europe were refueled via pipelines partially procured through Southwestern Division efforts.

All told, the Southwestern Division acquired about 75 percent of the pipeline pumps used in World War II.¹⁹

Another of the Southwestern Division's wartime tasks was the acquisition of aviation gasoline storage tanks on short notice. In 1944 the Division received orders from Washington to buy \$7 million worth of 10,000- and 5,000-gallon tanks and crate them for shipment to Europe. Division personnel contacted seven manufacturers, but learned they were about to commit their production schedule to the U.S. Navy for approximately six months. At that time the Army and Navy were not coordinated in their procurement, so the Division moved fast to beat its sister service, which also needed storage tanks.²⁰

In fact, two of the companies had representatives on their way to Washington, D.C., by train to negotiate a contract with the Navy. Division employees quickly worked out a production schedule based on the companies' manufacturing capacity, and at 4PM on the same day the orders came to the Division office, telegrams went out to all six manufacturers. The Army Corps of Engineers had authority to invoke the First War Power Act to confiscate plant production, but manufacturers did not respond kindly to its use. The Southwestern Division bypassed the 30-to-40-day negotiation period. The telegrams assigned each firm a contract number and requested that production start immediately. Even under wartime circumstances this move was bold, reported Alfred Wehrman, who worked in the Special Procurement Division. The companies agreed. The men en route to Washington were called back by their firms when the telegrams arrived. One company employee said, "There will never be another requisition like that one. It will be the granddaddy of requisitions for all times."²¹

From pipelines to storage tanks, the Southwestern Division purchased an endless variety of commodities for the Army and Air Corps. The work was not glamorous and did not catch public attention or share the glory of battle. The Division purchased the bulk of materials, for example, used in temporary airfield paving known as prefabricated bituminous surfacing. In 1943 British and Canadian engineers had begun research to find a fast way of installing paving material for aircraft. The Waterways Experiment Station of the Army Corps of Engineers at Vicksburg, Mississippi, also participated in the research. Together they developed the "Hessian Mat," a 300-foot-long strip of common burlap coated with asphalt. It was about one-quarter-inch thick and could be installed at three to four miles per hour.²²

The Waterways Experiment Station designed a special machine, commonly called a "stamplicker," to lay the strips. They were moistened with kerosene to make them adhesive and were then overlapped and rolled down. As the fuel lines in Africa helped defeat Rommel, burlap paving enabled Allied pilots to strike swiftly from fields unknown to enemy intelligence.

Since it was located in the heart of America's petroleum producing area, the Southwestern Division received the job of procuring the prefabricated bituminous surfacing. It was because of the Division's acquaintance with the oil field supply companies in Tulsa that the Office of the Chief of Engineers had given it the responsibility for obtaining the pumps used in the temporary pipeline. For the same reason, the headquarters instructed the Division to purchase the asphalt, burlap, and other items to be used in the Hessian Mats. In addition, the Special Procurement Division had to get road rollers, graders, and other road construction equipment.²³

Obtaining materials did not always go smoothly. Steel, copper, cement, and aluminum were in short supply and controlled by priorities assigned by the War Production Board. One man worked full time in the Procurement Division on priority assistance for contracts. In some cases the Southwestern Division lost items to purchasing agents for the Manhattan Engineer

Before and during World War II, the Southwestern Division did major construction at Fort Hood, Texas.



District in Los Alamos, New Mexico. That District had been specially created in August 1942 as part of the project to build the atomic bomb, and its agents had top priority in acquiring supplies, even greater than the A-1 rating used by the Corps.

“These people would go around with a degree of authority,” a retired Division employee remembered, “to issue priorities of critical materials that would override ours.”²⁴ On one occasion, an agent of the Manhattan District seized two five-kilowatt generators already purchased by the Southwestern Division in Houston and waiting on the dock to be picked up. The Procurement Division was helpless in such cases. It wasn’t until the first atomic bomb was dropped on Hiroshima, Japan, in August 1945 that the Southwestern Division learned why its priorities had been overridden.

Engineer Headquarters in Washington, D.C., had decided early in the war to establish the Manhattan District as a separate organization that would answer directly to the Chief of Engineers. So, although the location of the laboratory and testing site of the first nuclear explosion lay within the geographic boundary of the Southwestern Division, it had little connection with the atomic bomb project. The Division’s Real Estate Division, however, did acquire the land for the offices and laboratories at Los Alamos. It bought the Los Alamos School Ranch and 54,000 surrounding acres in November 1942 through the Albuquerque District. Construction of the laboratory and supportive apparatus started immediately through an area office set up by the District. About 50 District employees worked at the site until it was finished in the spring of 1944. At that point the facilities were released to the Manhattan District, and the Army Military Police assumed responsibility for security.²⁵

The Real Estate Division’s duties exemplified the war’s impact on the Southwestern Division in terms of workload and administrative realignments. In 1937 the office was established as the Land Section of Engineering. Otis M. Page was chief with Herbert E. Cox as his assistant. When the Division moved to Dallas, Chauncy B. Smeltzer became chief of Real Estate. In those early days the Real Estate Division received help, mostly in appraisals, from the Federal Land Bank and the United States Department of Agriculture. When the Army Corps of Engineers took over the operations

of the Quartermaster Corps, the Division's real estate personnel took on a massive and unprecedented workload.

Another change in organization, one that occurred throughout the Corps, was the centralization of real estate functions. In August 1942, Colonel John J. O'Brien, head of the Real Estate Division in Washington, ordered Division Engineers to take over the District real estate sections and reorganize them as Division sub-offices. O'Brien had long been dissatisfied with "the generous prices," reported one observer, "paid for land by District representatives."²⁶ Complaints about the order were heard from both District and Division personnel throughout the United States, but it remained intact. The Southwestern Division complied, but the offices for real estate activities remained in the same cities as the Districts. District Engineers had nothing to do with real estate acquisitions.

Most land acquisitions were smaller in size than the New Mexico purchase for the Manhattan Engineering District. Expansion of airfields constituted a large part of the Division's real estate business. "Favorable flying weather prevailing in southern and western Texas [made] this region," wrote one historian, "a desirable site for airfields, flying schools, and bombing ranges."²⁷ In 1942, the Division began acquiring land for 11 new air bases in various Texas cities: Matagorda, Eagle Pass, San Angelo, Blackland, Big Spring, Austin, Victoria, Galveston, Palacios, Bryan, and Brownsville. The Division acquired land for a pilot training school at Enid, Oklahoma, a bombing range on the Oklahoma Great Salt Plains, Davis Airfield at Muskogee, and the expansion of Tinker Field at Oklahoma City. Expansion of existing airfields and the creation of new ones kept the Real Estate Division and its District offices busy during the first year of the war.

Through the Galveston District, the Southwestern Division had a direct role in the defense of the United States with the installation of coastline batteries at harbors such as Brownsville, Port Aransas, Sabine, Cameron, and Burrwood. Emplacements for 155-mm guns were also built at strategically located intervals. Edwin A. Pearson of the Galveston District was in charge of the fortifications. These defenses were intended to protect shipping in the Houston and Galveston ports from possible attacks and also to fend off enemy submarines, which had been active in the Gulf of Mexico.

At Fort Crockett in Galveston, Battery Hoskins had to be modernized and reinforced to withstand an attack of 5,000-pound naval shells. Using special construction crews consisting of District personnel instead of contracting the job to a private firm, Pearson covered the projectile rooms, powder rooms, and plotting rooms with earth and concrete.²⁸ Two heavy casemates were designed with mechanical and electrical equipment to modernize the huge guns. The whole operation was conducted as secretly as possible. Similar fortification sites, but with smaller guns, included the



World War II recruits bedded down in barracks like these at Fort Hood.

construction of two new batteries at Fort San Jacinto and Fort Travis, also in Galveston.

Construction of defense plants, particularly those engaged in manufacturing munitions, was another part of the Division's contribution during the war. The Tulsa District built the Oklahoma Ordnance Works near Chouteau, Oklahoma, about 46 miles east of Tulsa. The contractor for the plant was E. I. du Pont de Nemours and Company. After it opened in November 1943, the plant manufactured smokeless powder, diphenylamine, tetryl, and blocks and flares of trinitrotoluene, or TNT. Other arsenals built in the Southwestern Division's area of operations were Pantex at Amarillo, Texas; Red River and Lone Star near Texarkana, Texas; and Longhorn, near Marshall, Texas. The Denison District built some of the the facilities, accounting for \$350 million in military construction during the war.²⁹

The construction of two bomber modification plants at Tulsa and Oklahoma City showed the speed at which the Southwestern Division and its Districts worked. The Office of the Chief of Engineers ordered two large "hangar-like, fireproof structures of concrete and steel" and wanted them immediately. The price tag for each was \$4 million. Within 24 hours of receipt of the orders, the Tulsa District Engineer, Colonel Francis J. Wilson had signed contracts with two architectural engineering firms. The companies moved with amazing speed. Major General Thomas M. Robins, Assistant Chief of Engineers, described the construction:

Progress on both jobs proceeded at about the same rate, neither job getting more than a few days ahead of the other . . . the methods of attack used by the two contractors on the erection of the buildings, however, were quite different. [One] chose to erect free-standing concrete columns and to start the roof steel almost immediately, while the [other] chose to erect the concrete center portion first, letting the roof steel wait until that part of the work was complete.³⁰

Construction of the two plants, normally expected to take one year, was finished in three months.

Another large bomber plant was built at Fort Worth. It and the Tulsa plant were patterned after aircraft plants in Germany, but with several innovations. Aircraft assembly lines in Germany used pits below the aircraft much like those found in old-fashioned service stations. The Southwestern Division did not use the pits, but installed regular concrete floors, specifying that the concrete be extremely white. With high-intensity fixtures in the ceiling, enough light reflected off the floor that cord lights were not needed. The effect was a less cluttered work area. Exterior walls were insulated by a sandwich-type steel construction. The hangars' clear spans were designed for B-32s, although B-24s were the principal planes finished at these plants. The B-24s could pass through the hangar without touching the walls. When the B-36 came into production, it had to be turned sideways because of its greater wingspan.³¹

The range of military construction in the Southwestern Division's area of operations was impressively large and diversified. Between 75 and 100 installations were built during the war, including prisoner-of-war camps and Japanese internment centers. Altogether, the Division and its five Districts spent approximately \$2 billion. Throughout the war the Division concentrated on speed and cut corners. "We were a brash young outfit," one employee recalled. "If we hadn't the courage to risk mistakes and shortcut orderliness, we could never have produced what the Army had to have in construction."³²

By late 1943 the level of work had begun to taper off as construction finished and troops and civilian employees occupied the premises of the

various installations. Some of the Division's military personnel were transferred overseas. At the peak of its operations the Division had 700 employees, a far cry from the 26 at Little Rock in 1937.

Construction on civil projects nationwide either stopped or crept along at a snail's pace during the war because of the priority given to military needs. There were two exceptions in the Southwestern Division, dams designed to generate electrical power: Denison, on the Texas-Oklahoma border, and Norfolk in Arkansas. Each had been approved in 1938 in response to demands for both flood control and hydropower. Rural electric interests who saw public power as the solution to the lack of electricity in their areas had insisted upon including hydropower in the project plans. For this reason and the planned use of the power in defense plants, construction on Denison and Norfolk dams continued during the war.³³

Construction began at Norfolk in the spring of 1941 and progressed smoothly without interruption in spite of the opposition of some power companies, who felt that scarce materials needed by the military were being used to finish the dam. Proponents of the structure replied that the power to be generated at Norfolk would be used for defense plants as well as for general purposes. Norfolk was a concrete gravity dam with a maximum height of 220 feet. The reservoir created by the dam had a storage capacity of 732,000 acre-feet of water for flood control and 1.25 million acre-feet for the generation of power. Some sacrifices were made in building materials: plywood was occasionally substituted for steel, and temporary equipment was used in the switchyard. The Little Rock District had to install a generator already earmarked for Fort Peck Dam in Montana because of the shortage of such equipment. Emergency power operations began in 1944, and full commercial generation of power commenced on 6 March 1945, with one 35,000-kilowatt generator. More generators were added later. The Division turned the electricity over to the Southwestern Power Administration, which sold it to the Arkansas Power and Light Company.³⁴

During its construction, Norfolk Dam had visible economic benefits in northern Arkansas. The Ozark country had been hit hard by the Depression. So many families had left the area that Mountain Home and other nearby communities resembled ghost towns. Appearance of the work crews and other labor forces connected with the dam helped rejuvenate the area. Prevention of floods on the White River freed farmers from the perennial loss of crops. After the war the recreational opportunities offered by Norfolk Lake spurred the local economy.³⁵

A similar story occurred at Denison, although the area was not as economically depressed as that around Norfolk. The Denison Dam also had a special significance in the development of hydropower because it was the focal point in a debate over the question of public power in the Southwest. Speaker of the House of Representatives Sam Rayburn, in whose congressional district the site was partially located, had sponsored the project since its inception. Rayburn was a leader in the development of public rural electrification and had fought for the dam for that reason as well as for control of floods on the Red River. The Denison District of the Army Corps of Engineers had been established in January 1939 primarily to build the dam.³⁶

Construction started in 1940 and continued during the war. Again, public power critics insisted that the materials were desperately needed by the military. Opponents of the Rural Electrification Administration urged that materiel meant for the dam be diverted directly to defense industries, but these calls had no effect on the construction. Arrangements had been made to sell the power generated at the Denison Dam during the war, through the

Texas Power and Light Company, to a corporation that operated an aluminum plant at Lake Catherine, Arkansas. Again, the Southwestern Power Administration managed the sale of the electricity. Preliminary operation of the dam started in mid-1944, and full commercial operation began on 5 March 1945.³⁷

The only other project in the Division's territory connected with flood control was the completion of Barker Dam in Houston. Buffalo Bayou, part of the Houston Ship Channel, had always been a source of floods, and by 1930 urbanization had worsened the natural drainage of the bayou. In 1935 it inundated part of the city. Congress ordered the Galveston District to make a study of the flooding and, based on its report, authorized Barker and Addicks reservoirs, channel rectification, and two diversion channels.

Construction on Barker Dam began on 2 February 1945 and finished later that year. The 13.6-mile-long earthen structure impounded 207,000 acre-feet of water. Because of the obvious need for protection and regulation of the bayou, and because no strategic materials were used in building the dam, there was no opposition to the project.³⁸ Further growth in the area during the war years eventually forced the Galveston District to redesign the flood control plans for Buffalo Bayou. Work on the second dam, Addicks, began in 1946.

Other reservoir projects in the Southwestern Division had no strategically important hydropower or strong political forces calling for completion. So work on them came to a halt during the war. Typical examples were three dams in the Little Rock District: Clearwater, Blue Mountain, and Nimrod. By 1940 preliminary work had started on all three, but since none had hydropower features, they received low priority. Work stopped on Clearwater in 1942; on Blue Mountain in 1943. The small dam at Nimrod, with a reservoir of 307,000 acre-feet, was finished in 1942, but construction of the administration buildings and cleanup operations were postponed until after the war.³⁹

In March 1943, wartime needs also shut down John Martin Reservoir, which was being built by the Albuquerque District in southeastern Colorado. The dam was 85 percent complete. Some limited operation of the reservoir took place. Storage of water for irrigation was 100,000 acre-feet, and for flood control it was 170,000. Construction resumed in 1946. Other reservoir projects suspended for the duration of the war were Conchas in eastern New Mexico and Canton, Fort Supply, and Great Salt Plains in northwestern Oklahoma.

Although military needs precluded construction of most civil projects, the Arkansas River flood of 1943 was a sharp reminder of the importance of flood control. In the spring of 1943 heavy rains sent the Arkansas River on a rampage; at Fort Smith, Arkansas, it crested four feet higher than in any previous flood. In 1941 the Little Rock District had tried to stabilize the banks at Fort Smith, but the floodwaters swept the stabilization project away. More than 19,000 National Guard troops fought the flood. Even German prisoners of war assisted with the sandbagging. The flood of 1943 amply demonstrated that as soon as all military considerations were over, the Southwestern Division and its Districts had to return to their unfinished business.⁴⁰

Toward the end of World War II the Division began to wind down its operations. To begin with, the Denison District was abolished in April 1945 and made a sub-office of the Tulsa District. The Division transferred Denison's responsibility over the upper Trinity River Basin to the Galveston District and gave the Tulsa District jurisdiction over the Red River above Fulton, Arkansas. Tulsa also received all of Denison's unfinished military projects.

As requirements for war materiel slowed, each District began to withdraw from contracts as specified in the Contract Settlement Act, a measure empowering the Corps to cancel contracts without payment of anticipated profits or damages. Negotiations were conducted over work already completed and for costs already incurred in uncompleted work. A special divisional office in Chicago administered most of these negotiations.⁴¹

When World War II ended, the Southwestern Division was one of the largest Divisions in the Army Corps of Engineers. It had handled about one-fifth of the Corps' total construction expenditures, about \$2 billion. The employee count stood at 700 in 1945. Military considerations naturally had taken precedence over all other considerations; only in the case of the two hydroelectric dams and the flood control project on the Buffalo Bayou had civil works continued. Like all Divisions, the Southwestern Division experienced some reorganizational shifts, and the possibility of a transfer to San Antonio came up. Uncertainty over the future did not cause any interference in operations, for the Division could point to several examples of its speed in meeting its obligations. The war had proved to be a turning point in the Division's history because the Corps now had responsibility for Army construction previously assigned to the Quartermaster Corps in addition to the work associated with the rapidly expanding air power of the United States. The Division's civil functions had taken only a temporary back seat, for the 1943 Arkansas flood was a reminder that the Corps' traditional task of harnessing rivers was still unfinished.



John Martin Reservoir, Colorado, was one of the first built by the Southwestern Division.

III CIVIL WORKS 1945-1986

Reservoir construction has been a major part of federal public works in the Southwest since World War II. By 1986 the Southwestern Division and its five Districts had designed and built a number of reservoirs; many more water improvement projects such as bank stabilizations and channel modifications; and maintenance projects such as harbor dredging. Civil works responsibilities expanded for the Division during these same years to include operation and maintenance of recreational facilities at its projects, regulatory permits, flood plain management, emergency disaster relief following hurricanes and tornadoes, and numerous special water development studies. The latter constitute one of the most important but generally overlooked duties of the Army Corps of Engineers.

Because there was a general conviction that the United States would return to the depressed economic conditions of the 1930s unless preventive steps were taken, the Division began receiving new assignments in civil projects before World War II ended. In 1943 Arkansas Senator John L. McClellan introduced a bill to develop the Arkansas and White River basins. "The federal government will for a time," he stated, "have to supplement any rehabilitation program in the post-war period by providing employment for a large number of people."¹

Senator Robert Kerr of Oklahoma had a similar attitude. In 1948 he published an article, "Plow, Plant, and Pray," calling for an integrated program of flood control, soil conservation, and irrigation to improve Oklahoma's agricultural productivity and, ultimately, farm incomes. About one million acres of superior soil on Sooner bottomlands were not cultivated because of flooding, he wrote. In the western half of the state, rainfall was skimpy, less than 20 inches per year. Kerr wanted to supply farmers in those arid counties with irrigation water. Non-irrigated land produced crops valued at \$22.09 per acre in a normal year, he wrote, but irrigated land in one case had increased the yield in value to \$130.72 per acre. For Kerr the monetary increments were sufficient justification to warrant water development: "If the rain which falls could be stored when abundant and held until needed, there would be sufficient water to produce a good crop yield."² Kerr's interest was responsible for some of the water projects in the Tulsa District.

A similar call was heard in Texas. In early 1945, the *Texas Business Review* published a series of articles on the potential industrial growth of the state. World War II had, of course, acted as a catalyst in the development and diversification of Texas industry, and business leaders sought to continue that growth after the war. Blessed with natural resources, particularly oil, Texas had progressed rapidly. "Industrialization is the core of the evolving regional economy," the *Review* reported, "that currently is giving deserved distinction to Texas and the Gulf Southwest."³ For the future, the Lone Star State could expect even greater growth, but natural resources would have to be conserved. "With the expansion of industries and the extendant concentration of population in industrial areas as well as in metropolitan centers—an expansion which may reasonably be expected in Texas—the problem of insuring adequate and dependable water supplies will become an increasingly urgent one in the state."⁴ Forecasts of growth and the commensurate need for water were common as the war came to a close.

As soon as possible, the Southwestern Division and its Districts renewed reservoir construction that had been interrupted by the war. The Albuquerque District resumed work in 1946 on the John Martin Reservoir, which

was 85 percent complete when construction stopped in March 1943. Originally known as the Caddoa project, it had been renamed after the death of Congressman John Martin in 1940. The remaining work consisted of installation of an elevator in the dam and construction of a stairway, a spillway tower, and some road work. Dedication ceremonies took place in April 1949, with Mrs. Martin in attendance. Irrigation had been one of the principal justifications of the structure, with about 357,000 acre-feet of water, or half of the storage capacity, set aside for that purpose. In 1950, the Albuquerque District released 277,654 acre-feet for irrigation.⁵

In the Little Rock District work resumed on Blue Mountain and Nimrod dams, both of which were completed in 1946, and its Clearwater project was finished in September 1948. In Oklahoma, the Tulsa District proceeded with several reservoirs: Canton, Great Salt Plains, Fort Gibson, Fort Supply, Tenkiller Ferry, Toronto, and Wister. The Galveston District resumed or started work on a large number of reservoirs, mostly in the upper portions of Texas on the Brazos and Trinity rivers. At Whitney one of the few hydro-power plants in the state was under way. The following table illustrates the civil projects authorized during the postwar era, 1945-1950.

Reservoirs Authorized, 1944-1950 Southwestern Division		
District	Reservoir	Authorization Date
Albuquerque	Cochiti	1948
	Jemez Canyon	1948
Galveston	Belton	1946
	Benbrook	1945
	Canyon	1945
	Dam A	1945
	Dam B, Neches River	1945
	Garza-Little Elm	1945
	Grapevine	1945
	Hords	1944
	Lavon	1945
	McGee Bend	1945
	Rockland	1945
	San Angelo	1944
Whitney	1944	
Tulsa	Cedar Point	1950
	Council Grove	1950
	Eufaula	1946
	Heyburn	1946
	Hugo	1946
	Keystone	1950
	Millwood	1946
Strawn	1950	

Source: Chief of Engineers, U. S. Army, *Annual Report, 1950*, Vol. 1, (Washington, D.C., 1951), 1123-1186.

Table 3-1

Indicative of the Division's expansion in the postwar era and the ideology of economic development behind that growth was the creation of the Fort

Worth District in 1950. In 1945 the Galveston District's workload began shifting to north-central Texas as construction began on reservoirs on the Brazos and Trinity. For better management, the District opened a sub-office in Fort Worth. The office, headed by James A. Cotton, was located in the old General Dynamics bomber plant. Personnel numbers grew at the sub-office as more and more projects got under way, and new quarters were set up in the Texas and Pacific Railroad building. But in 1946 the Office of the Chief of Engineers, in a move initiated by President Harry S Truman's budgetary considerations, made preliminary plans to close the sub-office. About 60 of the 100 employees expected to be terminated.⁶ Business interests in north Texas had far different thoughts, however. Led by the Trinity Improvement Association, founded by John W. Carpenter and Amon Carter, they sought instead to have a full-fledged District located near them.

The 1949 Fort Worth flood added a sense of urgency to their pleas. That year a May storm dumped 11-to-12 inches of rain on the Clear Fork of the Trinity River, southwest of Fort Worth. The deluge swept toward downtown, passing, ironically, through the partially completed Benbrook Dam. Eleven people were killed, and property damage was set at \$13 million, making the flood the worst in Fort Worth's history. Members of the Texas congressional delegation delivered speeches in Congress about the disaster. Senator Tom Connally waved newspaper photographs of the floodwaters to get an extra \$500,000 appropriation to speed completion of Benbrook Dam.⁷

In the meantime, a feasibility study ordered by the Division found that the Galveston District had grown too large because of its work in flood control. In 1949 its combined military and civil budget was the third largest in the Corps of Engineers. It was also the third largest District geographically in the United States—larger than the New England, North Atlantic, or Lower Mississippi Divisions.⁸

Creation of a new District in Texas, the report stated, would not jeopardize the Galveston District, since the latter would retain jurisdiction over its military projects. The move would result in an overall personnel reduction of 53 graded and 13 ungraded positions. A new District more centrally located within the area of reservoir operations would also reduce travel and transportation costs by approximately \$20,000 per year. "The estimated travel factor for Fort Worth," according to the report, "is 20 percent less than that for Galveston."⁹

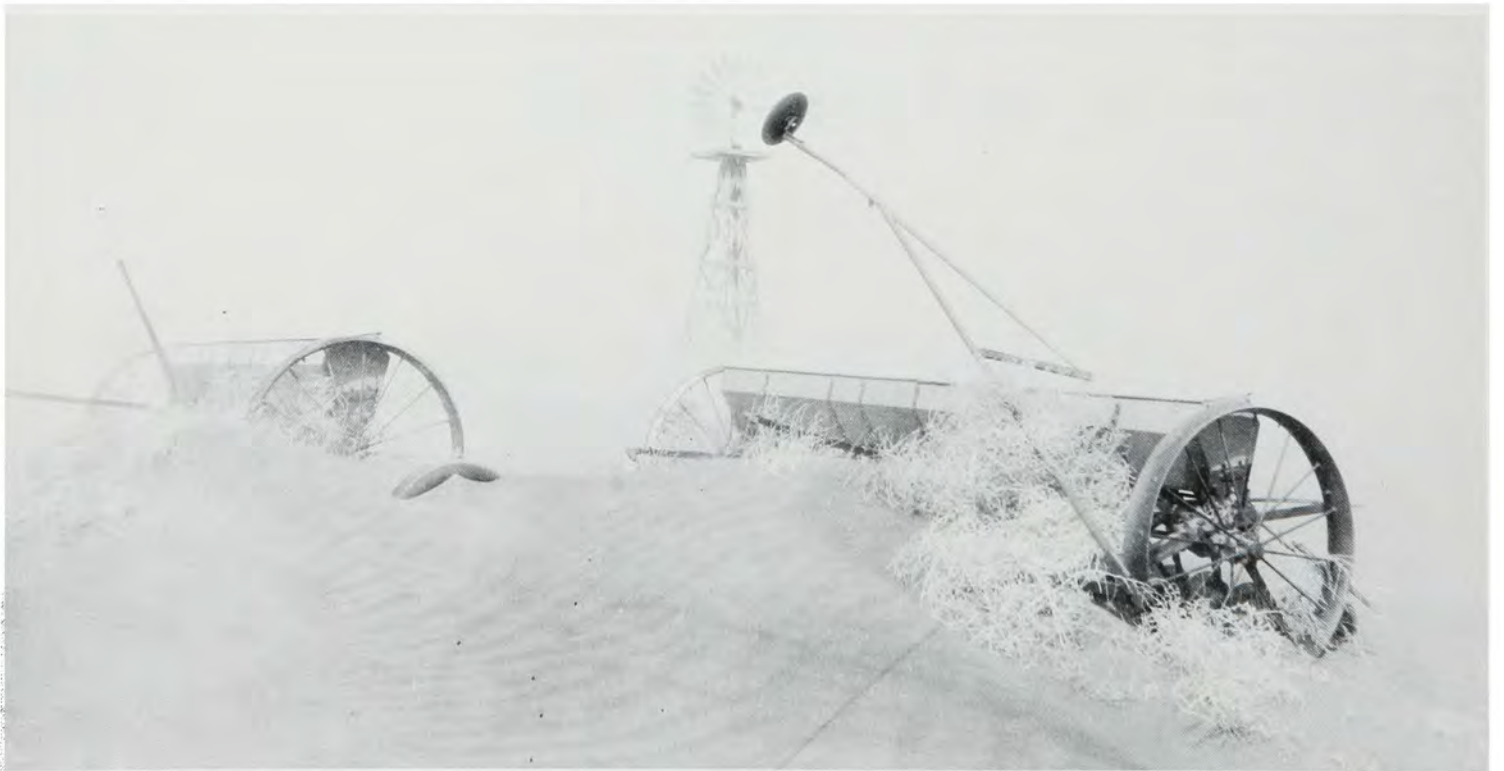
In March 1950, the Southwestern Division Engineer, Colonel Louis W. Prentiss, announced the establishment of a new District at Fort Worth. It took over the flood control and water conservation projects previously handled by the Galveston District in the central and northern portions of Texas. The Galveston District's civil works area was now limited to a stretch along the Texas Gulf Coast approximately 100 miles wide. It would continue, however, to handle military projects within the new District's boundaries. The Fort Worth District's establishment had little impact on Division headquarters, since the organizational move occurred solely within the Division's existing boundaries.¹⁰

The timing of the new District's creation proved to be beneficial to the Galveston District in an unexpected way when the Korean conflict started in June 1950. Relieved of its reservoir projects, Galveston was able to proceed faster with military construction in Texas. So demanding was the military build-up, in fact, that the Fort Worth District received some responsibility for military projects.

Work progressed on civil projects despite the increased amount of military construction assigned to the Division. Indeed, the Southwestern Division had one of the larger civil workloads compared with other Divisions.



A duststorm roils through Oklahoma in the 1930s. (U.S. Soil Conservation Service photo)



1930s duststorms turned productive farms into barren wastelands. (U.S. Soil Conservation Service photo)

Comparison of Costs on New Work
Construction
(in millions)

Division	1950	1951
Missouri River	81.2	69.6
Ohio River	62.7	51.7
SOUTHWESTERN	61.0	50.1
North Pacific	50.9	85.1
Lower Mississippi Valley	47.6	38.8
South Atlantic	25.4	28.0
North Atlantic	25.2	31.8
Upper Mississippi Valley	19.1	17.2
Great Lakes	18.3	16.6
South Pacific	17.5	31.2
New England	6.6	3.7

Source: Office of Chief of Engineers, Operations Division, August 1951, Record Group 77, Box 288, 76A6 Fort Worth Federal Records Center

Table 3-2

In the midst of this construction boom, the Eisenhower administration imposed an austerity program on the federal government. The move did not interfere with funding for civil works projects already started, but it required the Division to trim its operating costs. In 1954, for example, the Office of the Chief of Engineers instructed the Division to eliminate the position of area engineer at Norfolk and Bull Shoals Reservoirs.¹¹ The Division Engineer, Brigadier General Herbert D. Vogel, had already arranged for all soil testing conducted by the District to be handled by the Division Laboratory in Dallas, on the grounds of economy and efficiency.¹² To cope with the workload in view of the austerity program, Vogel next obtained permission from the Chief of Engineers to establish within Division headquarters a branch to oversee budgeting and programming activities. The Chief consented, and Vogel appointed Colonel Robert P. Kline as Military Assistant for programming and construction. He acted for the Division Engineer in investigating and correcting deficiencies in construction, reviewing and approving cost estimates, reviewing the schedule and progress of construction, and reviewing the programming and budgeting of all work, both civil and military. To further improve operations, Vogel obtained permission from Engineer headquarters to realign the civil works boundaries of the Galveston and Fort Worth Districts, giving the latter a portion of Galveston's territory in central Texas. The two Districts had been overlapping, creating public confusion and raising questions of jurisdiction with each other.¹³

Such changes in administrative procedures proved beneficial. In 1956, the Office of the Chief of Engineers made its first full inspection of the Southwestern Division and its Districts. The Chief's inspection team gave a superior rating to the Legal Branch and excellent ratings to Real Estate, Supply, Operations, Engineering, Comptroller, and Provost Marshal. The branches of Safety, Technical Liaison, Office Services, and Personnel were not rated, but the team reported that they were operating with excellent standards. The Division had, furthermore, made satisfactory progress in reducing overhead. The team regarded the quality of construction at Fort

Hood, Texas, and Dyess Air Force Base, Texas, to be above average, especially the concrete work. But it did find that the Division shared in the Corps-wide problem of retaining technically trained personnel. Grade and salary levels were too low to keep highly trained engineers from joining private industry. The Division Engineer, Brigadier General Lyle E. Seeman, had already complained to the Chief's office about the salary scales, and Major General E. C. Itschner, Assistant Chief of Engineers for Civil Works, had acknowledged there was room for improvement. Overall, the inspection team was pleased with the Division.¹⁴

During the years 1950 through 1955, the Division participated in a special study of the Arkansas, White, and Red river basins. This study was conducted by the first of two committees bearing the name Arkansas-White-Red Basins Interagency Committee, better known as AWRBIAC. This comprehensive study was the first to be made cooperatively by several agencies at one time. The Division's part in the study would result in a broadening of its activities in civil works.¹⁵ The study was born in the Flood Control Act of 1950, which directed the Secretary of the Army to make preliminary examinations and surveys, under the direction of the Chief of Engineers, of potential flood control measures for the three river basins. In the same measure, Congress ordered the Secretary of Agriculture to examine and survey runoff, waterflow retardation, and soil erosion prevention in the three basins. Also ordered to participate were the Departments of Labor, Commerce, and Interior, the Federal Power Commission, and the Public Health Service because the study was expected to touch upon areas of interest under their jurisdictions. Governors of eight states were also invited to participate in the meetings. Two days after Congress passed the authorizing legislation, President Truman instructed the federal agencies to organize a committee to conduct the study and designated the Department of the Army to be the chair agency. In essence, this meant that the Chief of Engineers would be responsible for the final report. He ordered the Southwestern Division to carry out the task.

The initial report of the AWRBIAC was due in two years, but it was not finished until 1955. Three Division Engineers served as chairman during that time: Colonel Prentiss, General Vogel, and General Seeman.¹⁶ Headquarters for AWRBIAC were set up in the Tulsa District office building. Colonel James D. Lampert was in charge of the AWRBIAC office, answering directly to Prentiss. In August 1950, soon after AWRBIAC went into operation, Prentiss held a meeting of representatives of those Corps offices that would be involved: the Division's Tulsa, Little Rock, and Albuquerque Districts and the New Orleans, Vicksburg, and Memphis Districts. Prentiss stressed that he did not want other agencies to infringe upon the Corps' portion of the final report. "I haven't emphasized too strongly the fact that it is going to be a COE report and not an Inter-agency report . . . We have an advantage and are so to speak in the driver's seat. There are no reasons for the Corps giving up this position." Prentiss further stated, "We have got to control and to dominate the study and at the same time we can't alienate the other Federal agencies."¹⁷

To learn the public's needs about flood control, drainage, soil conservation, and related matters in the Arkansas, White and Red river basins, AWRBIAC held a series of public hearings. The first meeting took place at Amarillo, Texas. Others were held at El Dorado, Arkansas; Dodge City, Kansas; Oklahoma City, Oklahoma; and Denison, Texas. As AWRBIAC began its work, however, conflict emerged among its representatives. A question arose, for example, between the Bureau of Reclamation and the Corps over the jurisdiction of drainage studies. But the Corps' most serious disagreement occurred with the Soil Conservation Service, or SCS.¹⁸

In essence, the two held opposing views on the principle of flood control. The Corps used large structures to impound rivers, while the Soil Conservation Service built small structures in a river's upper areas. In his August meeting with Corps personnel, Prentiss had warned that such a conflict might occur. He predicted that the SCS would try to justify its small flood control structures, and the Corps would have to disagree with SCS's conclusions or with its criteria.¹⁹

In January 1952, shortly before Prentiss received a new assignment, the Tulsa District Engineer, Colonel Edward G. Herb, complained about SCS's data on the hydrology of its upstream flood control proposals at places such as Sugar Creek, a tributary of the Washita River in Oklahoma. Those proposals, he said, would interfere with the Corps' downstream control measures. Such differences slowed down the committee's progress.²⁰

The disagreement between the Corps and SCS took on a new dimension when the issue hit the newsstands. In May 1952, Elmer Peterson, editorial writer for the *Oklahoma City Daily Oklahoman*, published an article in *Country Gentleman* entitled "Big Dam Foolishness." Peterson presented data comparing Corps of Engineers and SCS flood control measures on the Washita River, arguing that large downstream reservoirs worsened floods and that the SCS's smaller upstream structures were superior. The article engendered much publicity and brought forth criticism of the Corps. One critical element in the discussion was that in his article, Peterson used some accurate tabular data that had originated in the Southwestern Division and the AWRBIAC office in Tulsa. The figures had originally been made public by the Chamber of Commerce of Chickasaw, Oklahoma, at an AWRBIAC hearing in December 1950.

The House of Representatives Subcommittee to Study Civil Works asked the Chief of Engineers to submit information in response to Peterson's charges. The Chief instructed the Division to prepare information for his reply. In a report to Engineer headquarters, the Division, the Tulsa District, and the AWRBIAC's Tulsa office explained that AWRBIAC had selected the Washita River as a test basin for integration of water resource planning. The Corps' AWRBIAC office had supplied technical information to SCS and other members as requested. An important matter in the Peterson incident was the reliability of his data. Some of it had originated in the Division, but in its reply the Division said it did not know how Peterson or the Chickasaw Chamber of Commerce had obtained it. The Division also asserted that Peterson had made comparisons with data that was not comparable; and that while the Corps and the SCS did disagree over flood control strategies, each agency's method was meant ideally to complement the other. The Division also defended large downstream reservoirs by pointing out their contribution to recreation, irrigation and municipal-industrial water supply. Each approach had advantages and disadvantages, the Division explained, saying that "each basin must be studied on its own; river basins, like people, possess individual characteristics requiring varying solutions."²¹ These and other points became part of the Chief of Engineers' response to the House of Representatives' Subcommittee to Study Civil Works, which had asked for information in response to Peterson's charges. Brigadier General Claude H. Chorpening, Assistant Chief of Engineers for Civil Works, also told the subcommittee that any comparison of small and large dams on the Washita River was premature, because the AWRBIAC was still studying the river.²² No further action came from the Peterson article, and AWRBIAC continued its work.

Whatever the significance of the Peterson article, internal friction delayed AWRBIAC's report. In September 1953 the Secretaries of the Army, Interior, and Agriculture issued a "Memorandum of Understanding"



The U.S. Soil Conservation Service was one of several federal agencies that worked to prevent flood damages in the Southwest. This earthen dam is one of its projects in eastern Oklahoma. (U.S. Soil Conservation Service photo)

redefining the objectives of the AWRBIAC. They also recommended that President Dwight D. Eisenhower appoint an impartial advisor to the committee. In March 1954, Eisenhower approved the memorandum and appointed Walter L. Huber advisor. The President wrote, "I have been very much concerned by the disagreements between agency representatives which have handicapped the progress of the Arkansas-White-Red Basins Interagency Committee."²³

The memorandum issued by the three cabinet secretaries established a procedure the AWRBIAC was to use to resolve its differences. With a sense of rejuvenation, the committee continued working, finally filing its report in June 1955. In his letter of transmittal, the acting Chief of Engineers, Major General Charles G. Holle, stated that "with so many widely divergent interests involved, it was natural that differences of opinion arose. In many instances these differences were resolved; in others because of differing methods of approach and insufficient data to arrive at conclusive results, it was not possible to reach agreement."²⁴ As described in its preface, the document was a framework for Congress to use in any development of the three river basins.²⁵ The AWRBIAC did not intend its report to serve as a basis for authorization of any project.

The Southwestern Division's role in AWRBIAC had been administrative. Through the AWRBIAC office in Tulsa, the Division coordinated committee meetings and public hearings and handled budgeting.²⁶ Its experience with AWRBIAC was important in several respects: Committee duties became a major task for the Division, the chair agency, during the five-year study period. The AWRBIAC's data probably resulted in a better report than had previously been prepared on any river basin. The Division also weathered the publicity storm over the Corps' difference with the Soil Conservation Service, but probably most significant was the effect AWRBIAC had in opening the door for similar studies. In 1954, even before the report was finished, the Federal Interagency River Basins Committee, the parent agency of the AWRBIAC, created a new AWRBIAC.²⁷

When the original AWRBIAC filed its report, the members had assumed it would disband. But the experience, despite its trying moments, had demonstrated the advantages of interagency basin studies; thus the second AWRBIAC. The new committee had been organized to encourage smoother operations. It would have a rotating chair, and participation was more limited because each agency was to make its contributions without additional personnel and funding. This arrangement had started during the first AWRBIAC, but was now to be a regular feature. In addition, the new AWRBIAC would not attempt to accomplish so much. Rather, it would examine only certain aspects of basin planning. The new AWRBIAC was essentially a coordinating and limited fact-gathering committee.²⁸

At the first meeting of the new AWRBIAC, the members elected Southwestern Division Engineer Seeman as the chairman, a post Division Commanders had held five times by 1978. The Department of the Interior was designated to be the second chair agency. Two ad hoc committees were established: one to make an economic base study and the other to make a hydrology study. The Division agreed to prepare wall maps of the three river basins and to furnish data on hydrology.

During its first two years of operation, the second AWRBIAC concentrated on the work of the ad hoc committees. New committees were appointed as required, while others were discontinued. By 1961 the group had seven committees and two subcommittees. The Division served on all of them that particular year, although it usually worked on fewer. These committees dealt with data collection, hydrology, exchange of information, and related topics. The second AWRBIAC did not engender publicity, nor did

its work lead to anything outstanding. "It has not been a spectacular year," a report stated in 1961, "but the committee has progressed."²⁹ The AWRBIAC's greatest accomplishment was the friendly and cooperative atmosphere it maintained among its members. Such an atmosphere encouraged the exchange of information among those federal and state agencies with an interest in the three river basins.³⁰

In spite of President Eisenhower's era of fiscal conservatism, severe drought in Texas and Arkansas during the early 1950s persuaded Congress to authorize several new reservoirs in those states. In three years, starting in midsummer 1950, Texas had received only about 25 percent of its regular rainfall. Mandatory water rationing was imposed in many towns and cities, and dustbowl-like conditions forced many farmers off their land. The Rio Grande River dried up in spots. Historian Walter P. Webb wrote at the time: "The drought continues, and it is not difficult to elicit interest in the subject of water. People everywhere are grasping at all possible solutions, and some have even turned to artificial rainmaking."³¹ In northern Arkansas, a farmer wrote Senator John L. McClellan: "Three years of hot, dry weather have put the man who depends on farming alone on the rocks."³² In 1954 Congress authorized five reservoirs in Texas: Navarro Mills, Proctor, Stillhouse Hollow, Somerville, and Waco. In discussions over the authorization, acting Chief of Engineers Bernard L. Robinson referred to "the serious shortage of water...experienced by the City of Corsicana [Texas]," and local interests in the Richland-Chambers Creek area of the state had presented resolutions requesting federal aid to construct a reservoir for water storage.³³

Typically, the severe drought ended with a historic flood. In 1957 heavy spring rains brought damaging floods to many portions of the state. Garza-Little Elm Reservoir (Lewisville Dam) had just been finished and stood empty with a flood storage capacity of 526,700 acre-feet. It filled in seven days. Although the new structure prevented catastrophic flooding in the Trinity watershed, considerable damage occurred nonetheless. The Trinity River levee broke at one point below Dallas, letting water inundate thousands of acres. At peak discharge, water was going over the tops of levees in some spots. Had the reservoirs on the upper Trinity not been available, the Division Engineer, Brigadier General William Whipple, estimated, floodwaters would have reached downtown Dallas. Federal reservoirs on the Brazos had the same beneficial effect. Whitney Dam, completed in 1951, prevented severe flooding in the Brazos River Valley. "There wouldn't have been much Waco today," stated one official of the downstream city, "if it hadn't been for Whitney."³⁴ So great was the flooding, however, that Whitney reservoir sustained some damage. Access roads were covered, a log jam threatened a highway bridge, and several marinas were ruined.

Overall, though, the second AWRBIAC was able to report that the Corps' structures built during the drought had prevented much flood damage. The Annual Report for 1957-1958 said,

For many weeks the flooding situation was truly explosive. That flooding and damage were no greater can be traced to the antecedent drought conditions; many natural and man-made impoundments, waterways, and the soil and underlying structure were dry or at record low levels of water shortage and designated capacities of man-made flood control works were thus augmented initially by a huge additional capacity provided by these drought conditions.³⁵

The drought and the flood brought renewed interest in water development in the Lone Star State, exemplified by the establishment of the U.S. Study Commission-Texas. Approved by Congress in August 1958 at the instigation of Senator Lyndon Johnson, the commission was instructed to make a full-scale survey of water in Texas with an eye toward promoting conservation,

use, and development. The commission had to formulate a comprehensive development plan for consideration by the President and Congress. Each of the major river basins in the state came under review: Neches, Trinity, San Jacinto, Brazos, Colorado, Guadalupe, San Antonio, and Nueces.³⁶

Drawing upon its experience with the first AWRBIAC, Congress carefully designed the Study Commission-Texas to prevent internal friction. Three important provisions were included in the authorizing legislation: The President would appoint the chairman, who would answer directly to him; each participating agency would not lose any of its prerogatives or territorial jurisdiction; and the commission was created to help the state of Texas in its own development of water resources. In other words, Texas would not lose any authority over its water rights to the federal government. Congress provided, furthermore, that the chairman could not be a federal employee. President Eisenhower appointed George Brown of Brown and Root Construction Company in Houston to chair the commission. Other participants were the Southwestern Division; the Soil Conservation Service; the departments of Commerce, Interior, and Health, Education, and Welfare; the Trinity River Authority; the Federal Power Commission; the Texas Water Board; the Texas Game and Fish Commission; and state representatives of each of the major river basins.³⁷ The commission planned to examine flood control, domestic and municipal water supplies, navigation, reclamation and irrigation of land, hydropower, soil conservation, forest conservation, recreation, pollution abatement, salinity control, and preservation of wildlife. Division Engineer Whipple wrote his District Engineers, "In my opinion these procedures are the first workable interagency planned procedures that have been developed in the entire United States and there appear most favorable prospects that they can be made to work."³⁸

Only the Fort Worth and Galveston Districts were involved in the study with the Division. They received no additional funding or personnel. They furnished river basin information on flood damage, determination of flood hydrology for economic evaluation, main drainage outlets, tentative flood control storage requirements, and an inventory and evaluation of physical data for reservoir sites.

The Study Commission-Texas operated quite well. In July 1960, Division Engineer Whipple told the Chief of Engineers, Lieutenant General Emerson C. Itschner, that the study "is proceeding on lines satisfactory to the Corps."³⁹ No major conflicts had erupted, although a basic conflict existed between the water interests in east and west Texas, he continued. Inhabitants of the eastern portions of the state had abundant water supplies and wanted to protect them from the state's western interests. Some question existed over irrigation, but it appeared to be minor. Whipple's successor, Major General Robert J. Fleming, Jr., was also pleased with the study. The final report was filed during his tenure, and in his accompanying remarks to the Chief of Engineers, he wrote:

The report presents an excellent picture of the future needs of the study area and the broad plans for meeting these needs. Although the report does not go so far as to provide an economic evaluation of the plan at this time, it more logically provides the framework for the plan of development and for its accomplishment on an orderly basis as elements of the over-all program are needed and become economically justified.⁴⁰

Because of the experience with the first AWRBIAC, a major consideration for all parties from the beginning had been the question of cooperation. Fleming wrote:

Probably the most amazing thing about the entire investigation was the outstanding cooperation and friendly working relationship

between all the Federal agencies. Every agency evidenced a willingness to give an all-out effort to the development of the report, making concessions where desirable without obvious agency aspirations. The only explanation I have for this is that several agencies operated primarily as individuals without restrictions from their agencies and their attitude carried over into the actual work performed by the agency personnel.⁴¹

The Southwestern Division conducted various studies while Congress and the President wrangled over reservoir authorizations. By the late 1950s many members of Congress throughout the United States were frustrated over the lack of authorizations; President Eisenhower had vetoed several water development measures, much to the chagrin of project sponsors. In a special report, the Senate Committee on Interior and Insular Affairs wrote:

Not the least of the significant reasons for the existence of hiatus in the field of water resources policy was the division of political power between the Republican Party which controlled the executive branch from 1953 to 1961, and the Democratic Party which controlled both Houses of Congress from January 1955 on. Omnibus rivers and harbors legislation had been vetoed in 1956 and again in 1958, and the controversy over water projects and water legislation was to erupt later in Presidential vetoes of the Public Works Appropriations Act for fiscal year 1960, and of proposed amendments to the Federal Water Pollution Control Act in 1960 which would have increased the amount available for Federal grants to municipalities for construction of sewage treatment works.⁴²

In 1959 the Senate created the Select Committee on National Water Resources, the result of a resolution introduced by Senator Mike Mansfield of Montana. But Senator Robert Kerr of Oklahoma was considered the originator of the committee, and he was unanimously elected chairman at the first meeting. The committee intended to make exhaustive studies of the extent to which water resource activities in the United States were related to the national interest and to determine the country's water needs to 1980. It held 23 hearings, taking testimony from 972 witnesses, including public officials and private citizens from 21 states.



Skiatook Lake in Oklahoma was authorized by Congress in 1962. Construction began in 1974, and the lake began to fill in 1984. Some of its parks opened to the public in 1985.

Election of John F. Kennedy in 1960 brought a new White House attitude toward water projects. "The Kennedy Administration's extravagant approach to water policy was a direct contrast," wrote one historian, "to the penury of the Eisenhower years. The new President promised a high level of federal activity in water and power projects and a generous program of appropriations for new starts."⁴³ The following chart illustrates the surge of authorizations of reservoirs in the Southwest.



Boats lock through the Colorado River on their trip up the Gulf Intracoastal Waterway.

Reservoirs Authorized, 1960-1965
Southwestern Division

District	Reservoir	Authorization Date
Albuquerque	Abiquiu	1960
	Galisteo	1960
Fort Worth	Aubrey	1965
	Bardwell	1960
	Blieder's Creek	1960
	Lakeview	1965
	Lavon Modification	1962
	North Fork	1962
	Roanoke	1965
	South Fork	1962
	Tennessee Colony	1965
Little Rock	Pine Mountain	1965
Tulsa	Big Hill	1962
	Big Pine	1962
	Birch	1962
	Candy	1962
	Copan	1962
	El Dorado	1965
	Lake Kemp	1962
	Kaw	1962
	Pat Mayse	1962
	Shidler	1965
	Skiatook	1962
	Towanda	1965
	Waurika	1963

Source: *Annual Report of the Chief of Engineers, U.S. Army on Civil Works Activities, 1965, Vol. 11* (Washington, DC: 1965, pp. 601-778.)

Table 3-3

The Division and its Districts built or maintained a wide variety of civil works projects in addition to the large multi-purpose reservoirs. Galveston District worked to facilitate shipping on the Gulf Coast through a number of deep-draft channelization maintenance projects. These projects enabled ocean-going ships to reach ports through waterways such as the Houston Ship Channel, the best known deep-draft channel in the Southwest.



Construction at Freeport Harbor keeps its waters navigable.

Deep Draft Channelization Projects
Galveston District

Name	Length
Sabine-Neches Waterway	75 miles
Houston Ship Channel	51 miles
Corpus Christi Channel	34 miles
Matagorda Ship Channel	25 miles
Galveston Harbor	14 miles
Texas City Channel	9 miles
Freeport Harbor	7 miles

Source: Files of the Southwestern Division Construction-Operations Division, 7 May 1986.

Table 3-4

Among Galveston District's other routine responsibilities were shallow draft channels, hurricane protection, and levee maintenance. Regular dredging and erosion maintenance along the 403 miles of the Gulf Intracoastal Waterway from the Sabine River to Port Isabel, Texas, made up the District's largest single project.



Traffic in the Houston Ship Channel makes the city the nation's number one port in foreign trade.



This broad basin in Freeport Harbor, Texas, lets large ships turn around.



The Galveston channel on the Gulf Intracoastal Waterway sees diverse traffic such as oil derricks and tankers.

By contrast, the Tulsa District's civil works projects dealt mostly with flood control. Unless otherwise noted, the following were flood-control projects.

Civil Works Projects Tulsa District				
Name	Authorized	Started	Completed	
Skiatook Lake	1962	1973	1984	
Red River Chloride Control, Area VIII (water quality through evaporation ponds)	1974	1977		
Copan Lake	1962	1972	1983	
Sardis Lake	1962	1975	1983	
El Dorado Lake	1965	1973	1981	
Big Hill Lake (Verdigris River development)	1962	1974	1981	
Optima Lake	1936	1966	1978	

Source: Files of the Southwestern Division Construction-Operations Division, 12 May 1986.

Table 3-5

Where lakes full of clean water came into being, boaters, fishers, and swimmers were sure to follow. Thus, construction of so many reservoirs in the Southwest brought a new dimension to the operation and maintenance of the Division's projects: recreation. Throughout the United States the public increasingly used Corps reservoirs for boating, fishing, picnicking, and other leisure-time activities. In the Flood Control Act of 1944 Congress recognized the recreational potential of reservoir projects and the responsibility of the federal government to make these resources available for public use. The act granted general authority to the Corps to construct recreational facilities at its reservoirs. Those facilities included boat launching ramps, access roads, picnic tables and cooking grills, rest rooms, parking areas, water supply and swimming areas, and boat anchorage areas when conditions warranted them. But because the Corps still regarded flood control as its major objective, it placed a low priority on recreation during this time.



The summer sun draws visitors to a beach at Greers Ferry Lake, Arkansas.

So its development of these facilities was slow. Public use of reservoirs, however, grew rapidly. In 1946, the Division recorded 673,000 visitors to its projects; by 1952 the figure had climbed to 11 million.⁴⁴

By 1954, 85 million visitors used Corps facilities nationwide, and the public began to complain about the inadequate recreational facilities at the projects.⁴⁵ In 1960 Division Engineer Whipple believed that the recreational aspects of the Division projects comprised “a very large public park operation.”⁴⁶ In his opinion, the Division had neither the staff nor the budget for recreation. So fast did public use grow that Whipple warned of adverse public relations if the Corps did not take action. “Both General Cassidy [then-Director of Civil Works] and I have expressed our agreement on this point to General Itschner,” Whipple wrote, “and General Cassidy has added that a recreational organization must be created in the Corps.”⁴⁷

This growing public demand and the suggestions by the Corps regarding greater recreational development brought congressional action. In 1962 Senate Resolution 342, commonly referred to in its printed form as Senate Document Number 97, cited outdoor recreation as a project purpose for which costs could be allocated on a par with all other purposes. The resolution also said that recreation as a project purpose should be fully considered in project planning and formulation. Recognition of recreation as a vital part of project operation and maintenance moved forward rapidly after passage of Senate Document Number 97. In 1962 another Division Engineer, Brigadier General Carroll H. Dunn, instructed his District Engineers to make better use of the funds Congress was beginning to appropriate for recreation. He wanted more on-site planning for parks to save trees, to minimize cuts and fills of land, and to minimize disturbance of the natural environment. “The end product should be attractive, natural appearing, quality recreation areas with a finished, professional look,” Dunn wrote.⁴⁸ The Chief of Engineers sent copies of Dunn’s letter to other Divisions as an example worthy of emulation.

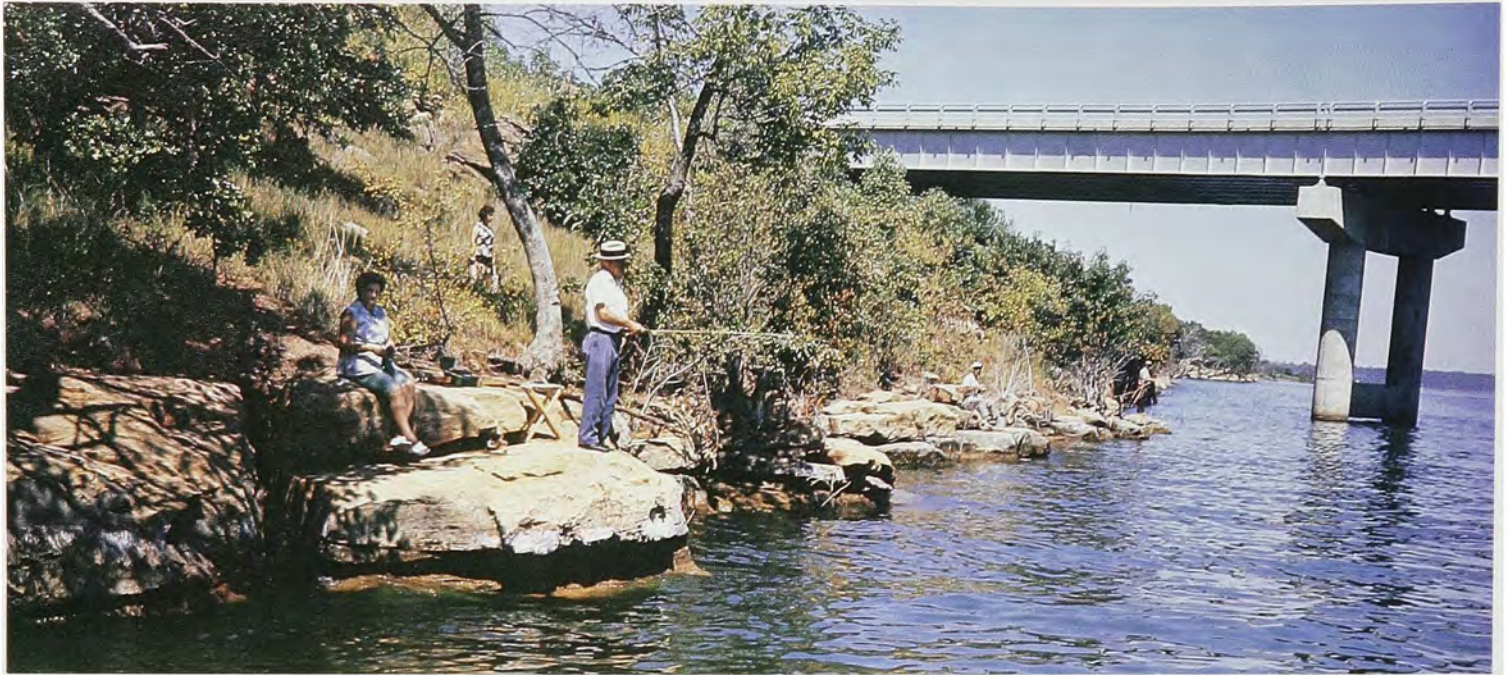
In 1965 Gordon Jones, chief of the Division’s Recreation Planning Section, conducted a seminar in the Tulsa District on recreational development. It was the first seminar of its type held in the Southwestern Division “or any other Division,” he reported.⁴⁹



Sails seek the wind at a Southwestern Division lake.



Division projects made scenes like this possible in much of the dry Southwest.



Anglers try their skills at Keystone Lake near Tulsa, Oklahoma.

Visitors of Beaver Lake's Prairie Creek Park have a variety of activities to choose from.



In 1970 the Office of the Chief of Engineers created Recreation Branches, later renamed Recreation-Resource Management Branches, throughout the Corps. That action gave recreation full status in the Corps' organization. In 1971 the Southwestern Division hired two full-time staff members to handle recreation.⁵⁰ They had responsibility for 70 projects with an annual visitation of about 100 million. That same year the Division started a ranger-training program to teach personnel to assist the public. These rangers learned fish and wildlife management, recreation administration, and conservation. They could not carry weapons, but they were authorized to issue citations for violations of the rules and regulations governing the lands and waters administered by the Corps.

Another aspect of recreation management that developed during this time was the construction of visitor centers to interpret various aspects of a project for the public. The visitor center at Greers Ferry Lake, Arkansas, in the Little Rock District exemplified the efforts of the Division and its Districts to promote special recreation facilities whenever funding was available. The center houses interpretive exhibits, similar to those in natural-history museums, of past cultures and wildlife in the Greers Ferry area.



An exhibit at Table Rock Lake Visitor Center tells of the area's wildlife.

The exhibits focus on geology, native Americans, early American exploration and settlement, regional development, and construction of the dam. Other visitor centers at Division projects have specialized displays such as archeological and wildlife exhibits, but few can compare with the elaborate exhibits at Greers Ferry and Table Rock lakes.⁵¹ The immense popularity of the many Corps projects in the Southwest intensified the Division's concern for recreation. Its five Districts have at times accounted for nearly 30 percent of the Corps' total annual visitation. The following tables illustrate this great public demand and the Southwestern Division's large share of project visitation.



Hikers try a trail at Greers Ferry Lake, Arkansas.

Visitation to Southwestern Division Projects

Year	Visitors	Year	Visitors
1973	97,745,200	1980	131,280,000
1974	100,569,400	1981	145,398,900
1975	111,380,800	1982	145,141,300
1976	121,380,600	1983	140,472,800
1977	128,767,800	1984	135,457,700
1978	132,624,700	1985	137,482,400
1979	134,866,900	1985 (Corps-wide)	502,163,700

Source: Files of the Southwestern Division Recreation-Resource Management Branch.

Table 3-6

Summary of Recreation Attendance in 1985 at Completed Corps of Engineers Projects

Division	Recreation Days (millions)		Percent of Corps Total
	1984	1985	
Lower Mississippi Valley	36.29	37.68	7.50
Missouri River	53.24	55.04	10.96
New England	6.05	6.00	1.19
North Atlantic	4.81	5.06	1.01
North Central	30.91	31.13	6.20
North Pacific	15.89	16.31	3.25
Ohio River	82.56	91.81	18.28
South Atlantic	100.21	105.41	20.99
South Pacific	15.42	16.24	3.24
SOUTHWESTERN	135.46	137.48	27.38
National Total	480.84	502.16	100.00

Source: Files of the Southwestern Division Recreation-Resources Management Branch.

Table 3-7

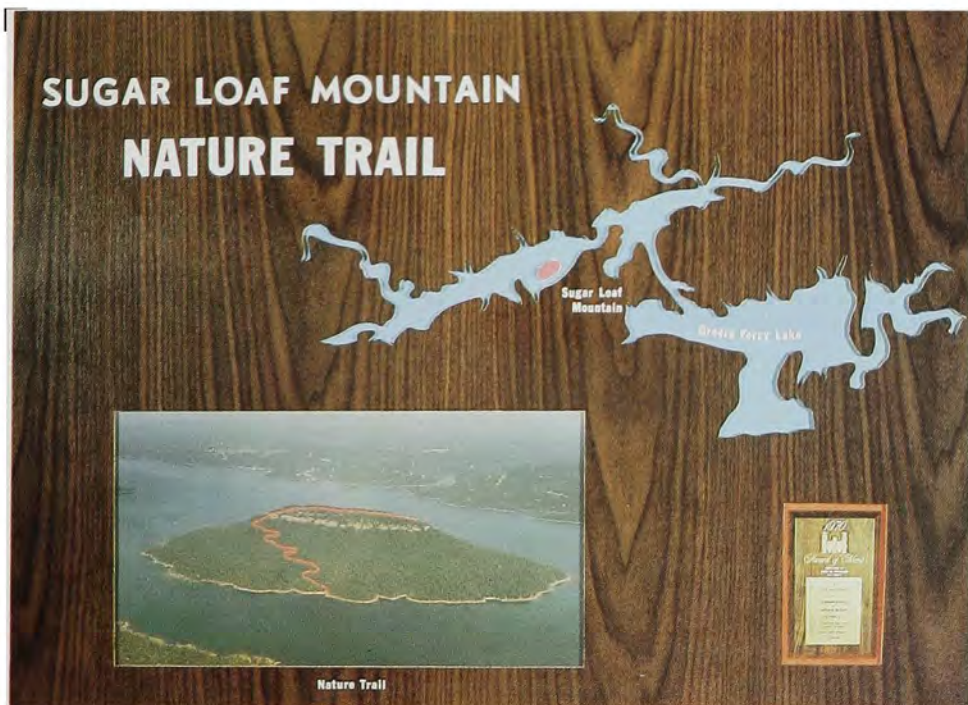
The Division attributes the decline in visitor numbers since 1981 to more accurate accounting methods and high fuel prices. Another reduction occurred in the manpower available for recreation-resource management at projects. Prior to the 1980s, the Division was able to hire 500-to-600 part-time employees during the summer. But a revised system for allocating manpower resulted in a reduction in summer hiring in the 1980s. Contracting out of operation and maintenance activities has taken up some of the slack. At some projects, all such work has been contracted.⁵²

Closely allied to the Corps' recreation activity was its Lakeshore Management Program. One outgrowth of the increased recreational use of reservoirs was increased demands by adjacent landowners for exclusive use of facilities such as boat docks and other floating structures. When the reservoirs had first been built, there had been more than enough land, water, and shoreline to accommodate requests for private use. But mushrooming growth around many lakes created problems with pollution and other environmental impacts, encroachment on public land, law enforcement, and the need for adequate public facilities. The situation forced the Army Corps of Engineers to develop a program for managing its shorelines.

A series of laws established the basis for administration of public lands and waters. Section 4 of the 1944 Flood Control Act provided the authority, and the Flood Control Act of 1962 broadened that authority. The National Environmental Policy Act of 1969 declared that the federal government should create and maintain conditions under which man and nature could exist in productive harmony “and fulfill the social, economic and other



A ranger at Fort Gibson Lake, Oklahoma, talks to Boy Scouts.



Greers Ferry Lake visitors can check nature trail routes at the visitors center.

requirements of present and future generations of Americans."⁵³ The Southwestern Division formulated guidance for its five Districts, carefully weighing the following considerations:

1. Provisions for public use of and unimpaired access to Corps properties.
2. Protection of public land against environmental degradation.
3. Prevention of private possession of public land.
4. Protection of people who had already made investments under authority granted by the Corps.

In 1969 the Corps issued its first guidance for more effective lakeshore management. But requests for private use of public lands continued to mount so fast that revisions were soon necessary. In 1974, the policy was revised and set forth in Engineer Regulation 1130-2-406, published in the Federal Register and distributed to the interested parties. Among other things, the regulation said that residents who already had permits for various facilities could keep them as long as they passed annual inspections and the ownership did not change.⁵⁴ It also imposed an administrative fee. Most of the reaction to the new regulation was favorable, although the Corps received 186 petitions with more than 4,000 signatures from residents of the area around Tenkiller Ferry Lake, Oklahoma, who opposed the regulations. Two other petitions with about 200 signatures of residents in the Bull Shoals Lake area in Arkansas and Missouri supported the regulation but opposed the fee.

In 1975, the Districts in the Southwestern Division started to develop their own lakeshore management plans for projects with privately owned floating boat docks or similar facilities. In every plan, the foremost objective was to encourage maximum storage of boats and related equipment at commercial concession areas. The Districts had three motives for directing the boat-owning public to such areas. They wanted to minimize the number of aesthetically distracting shoreline developments; prevent damage to the environment; and limit use of federal property by the general public. But considerable opposition to such plans developed throughout the Division and at some lakes in Georgia. The Southwestern Division Engineer, Major General Charles McGinnis, had several meetings with representatives of Congress, state officials, and residents around the lakes to explain the lakeshore management program and try to minimize concerns. However, public



Canada geese stop in Southwestern Division waters on their annual migration.



Hunters can track deer at many Southwestern Division lakes.



An egret shows off its plumage.

An alligator looks for prey in a protected wetland on a Southwestern Division project.





Children search for trash at Greers Ferry Lake during the Great Arkansas Cleanup.

opposition became so strong that the Corps' Director of Civil Works, Major General Ernest Graves, set up a conference in Little Rock, Arkansas, on 27-29 January 1976 for all Districts and Divisions that had lakeshore management programs. At the conference Graves reiterated that the goals and objectives of lakeshore management policy were to hold and manage lands under Corps jurisdiction in the public trust. Later that same year, however, he directed the Southwestern Division to use the full flexibility of the regulations to reduce opposition to the program, especially in eastern Oklahoma.⁵⁵

After most of the lakeshore management plans were completed, it became evident that the Division needed a policy that provided for review and revision. As development around the lakes increased, public pressure again grew for areas to be rezoned to allow for the construction of private floating facilities. But continual rezoning would destroy a plan's credibility. To



Volunteers fill collection bags and scour the rocks to keep Greers Ferry Lake looking clean.



The Division's Lakeshore Management Program regulates the safety and appearance of private floating facilities like these at Whitney Lake and ensures access for all to public lands.

provide for reviews but still maintain a workable plan, General McGinnis issued the following policy statement on 4 May 1977:

Lakeshore management plans should be reviewed at intervals of not less than five years from date of approval to determine the need to revise and update the plan. If such review reveals that revisions to the plan may be necessary or desirable, the District Engineer will announce an "Open Season" during which comments from the public will be received and the District will promote public participation in reviewing and revising the plan to the maximum practicable extent as required by ER 1130-2-406. During this open season, a moratorium will be placed on accepting applications or reviewing permits for private floating facilities. Equal consideration should be given to reducing as well as expanding the number and size of limited development areas.⁵⁶

Another Division Engineer, Brigadier General Robert J. Dacey, revised this policy in 1984 by allowing for reviews upon request.

The program became controversial again in 1985 when a few residents around Lake Eufaula, Oklahoma, pressured their congressional officials to direct the Army Corps of Engineers to increase significantly the area zoned for private floating facilities and to liberalize the policy on allowing adjacent property owners to mow public lands between the shoreline and their property. As a result, the Tulsa District agreed to allow the floating docks on about 130 miles of the shoreline and permitted mowing of public lands except in recreation and wildlife management areas.

After reviewing the problems at Lake Eufaula, the Assistant Secretary of the Army for Civil Works in 1986 instructed the Corps to revise its regulations on lakeshore management. The revision included emphasis on more public involvement and a better balance between private exclusive use and public use.

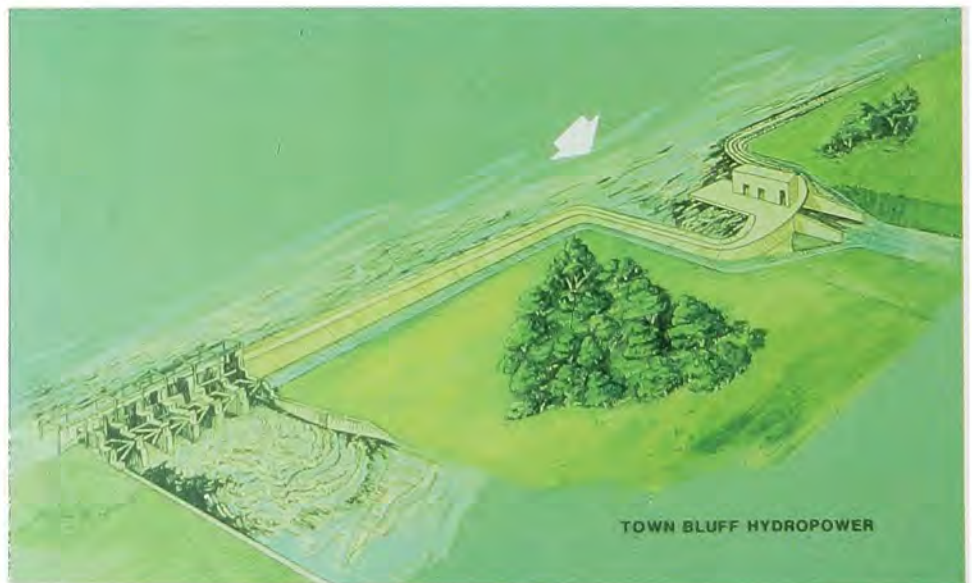
Another of the Corps of Engineers' major responsibilities over the years had been the construction and operation of hydropower plants at many of its water projects. In the 1970s a new twist appeared in the field of hydropower, or at least in the role played by the Corps: construction of such plants at Corps dams by a non-federal sponsor. The Reagan administration's mandate to promote privatization carried this development forward



Non-federal interests now construct hydropower facilities at Corps dams, as in the excavation on the far side of the Arkansas River at Murray Lock and Dam.

into the 1980s, but it was originally spurred on by the search for more energy. In 1976 Congress authorized the Army Corps of Engineers to conduct a study of the potential sites for installing hydroelectric plants at existing Corps dams that had not originally been designed for hydropower. No legislation came out of this study, but upon its completion, various parties around the nation showed an interest in developing the dams themselves as a source of electrical energy. The Office of the Chief of Engineers encouraged the use of the dams for this purpose. On 14 December 1982 the Division Commander issued a Civil Works Criteria Letter on the subject to all Divisions and Districts. The Federal Energy Regulatory Commission could issue a license to a qualified party to build a plant at a Corps project.⁵⁷ Thus, the construction of non-federal hydropower plants at Corps of Engineers dams began.

By 1986, the commission had issued 28 permits or licenses within the Southwestern Division's geographic area. Two projects were under construction on the McClellan-Kerr Waterway in Little Rock District in 1986; design was under way on projects in other Districts. The Corps does not



Hydropower facilities (at arrow) to be built at Town Bluff on B. A. Steinhagen Lake mark the beginning of a new era of cooperation between the Corps of Engineers and non-federal electric interests.



build these projects. But its design and construction criteria are used, and the Corps must review and approve designs, plans, and specifications and inspect the construction at the licensee's expense. Plants built at navigation sites must furnish free electricity to that project. Most of the licensees were public bodies such as rural electric cooperatives and municipalities. The city of North Little Rock, Arkansas, for example, was building a plant on the Murray Lock and Dam on the Arkansas River.⁵⁸

A similar but independent project occurred at the Town Bluff Dam at B. A. Steinhagen Lake near Jasper, Texas, in the Fort Worth District. Town Bluff, originally called Dam "B," was one segment of a four-part structure authorized by Public Law 14, 79th Congress in 1946. The other elements were McGee Bend (Sam Rayburn) Dam and Reservoir, Rockland Dam and Dam "A." During Town Bluff's construction in 1951, provisions had been made for future installation of hydropower facilities, but funding for power had never been appropriated. In 1975 the Jasper-Newton Electric Cooperative at Kirbyville, Texas, saw the possibility of obtaining another source of electrical energy at the dam. Representatives of the cooperative approached the Fort Worth District about installation of a hydro-generator by the Corps. Colonel Joe. H. Sheard, the District Commander, told them that funding still was not available.⁵⁹

In October 1979 the cooperative hired the Stone and Webster Engineering Corporation of Denver, Colorado, to make a preliminary evaluation of the feasibility of installing a hydro-generator at Town Bluff. It reported that such an installation could produce 34.4 million kilowatt-hours of electricity annually. With that favorable report, the cooperative applied to the Federal Energy Regulatory Commission for a permit to make a full feasibility study of the proposed project. At this point, the Fort Worth District began a reconnaissance study to determine the feasibility of government-generated hydropower at Town Bluff.⁶⁰

The move disappointed the cooperative. It feared that since the Corps had no funds for construction, the project would never get built. "What money is available to them without several years of delay in trying to get Congress to appropriate public funds for the project?" the cooperative asked.⁶¹ The Fort Worth District went ahead with its work, completing a

Powerhouses like this one provide pollution-free electricity to thousands in the Southwest.



Workers relocate Turner Turnpike at Arcadia Lake as construction nears completion in 1986.

design analysis report in April 1982 and a feasibility report in September 1983. The estimated cost of the project was \$18.3 million.

Two other parties were interested in seeing hydropower at Town Bluff: the Lower Neches River Valley Authority and the Sam Rayburn Municipal Power Agency, both of which had preferred customer status. The Fort Worth District, acting through and in cooperation with the Southwestern Power Administration and the Southwestern Division, opened funding negotiations with the Sam Rayburn representatives. They said the agency would pay for the installation of the hydropower unit in return for guaranteed use of the energy for 50 years. The power agency agreed to deposit the construction funds in escrow at the Texas Commerce Bank in Houston. The escrow and construction agreements were concluded in June 1985. The Division and the Fort Worth District assumed responsibility for construction.⁶²

The financing arrangements for this project were unique. Non-federal funds had never before been used in the construction of a federal hydropower plant. In essence, the Sam Rayburn Power Agency will pre-pay the construction costs, but the hydro-generator will remain the property of the United States government. Actual construction will be accomplished with two contracts. A turbine-generator contract was awarded in July 1986, and the powerhouse construction contract was scheduled for award in early 1987.⁶³

Construction of traditional reservoir projects continued into the 1980s, but at a slower pace. It is unlikely that the Southwestern Division and its five Districts will see much work in such projects again. Within the Fort Worth District two such "concrete and dirt projects" were Joe Pool Lake and Ray Roberts Lake. The former is in Dallas, Ellis and Tarrant counties, Texas, on a tributary of the West Fork of the Trinity River. When completed, the project will encompass 17,313 acres and impound 304,000 acre-feet of water. It will supply 14.2 million gallons of water daily. The flood gates at

Joe Pool closed in early January 1986 and by September it was about one-third filled. It was scheduled for completion in 1989.⁶⁴

Only a short distance away and very similar in purpose is Ray Roberts Lake in Cooke, Denton and Grayson counties, Texas. The lake was to be much larger, however, encompassing 48,566 acres and 1,064,600 acre-feet of water. It, too, was to furnish water, 74.3 million gallons daily. Completion of Ray Roberts Lake around April 1990 was to allow an eventual rise in the water supply pool in Lewisville Lake, 30 miles downstream. An interesting feature of this project is the plan by the city of Denton, Texas, to install a hydropower unit on the dam, for which the Federal Energy Regulatory Commission approved a license on 20 March 1985.⁶⁵

In the metropolitan area of Oklahoma City and Edmond, Oklahoma, another multi-purpose project, Arcadia Lake, was 80 percent complete in mid-1986. It may be the last large flood control project in the Southwestern Division. Seeking a source of fresh water, the city of Edmond has sponsored about 57 percent of the estimated \$84.3 million cost. Non-federal interests are required to reimburse the federal government an estimated \$37 million for water supply and \$10 million for recreation.⁶⁶

This decline in reservoir construction in the Southwestern Division is apparent in the funds allotted to it over the past 10 years.

Fiscal Year	Construction Funds (in millions)	
	Real Dollars	Constant Dollars
1974	126.9	126.9
1975	125.9	114.0
1976	138.4	116.8
1977	129.9	97.9
1978	140.4	99.4
1979	141.5	95.4
1980	173.4	108.2
1981	164.8	95.2
1982	176.4	96.0
1983	154.5	78.2
1984	110.9	52.4
1985	117.1	52.2

Source: Mona Sanders, Southwestern Division Resources Management Office, 18 July 1986. Constant dollars are calculated at 1974 levels.

Table 3-8

As the Southwestern Division approached its 50th anniversary, its work on the traditional dam and reservoir projects was drawing to a close, and no new ones were anticipated. Even the Corps' practice of building hydropower plants in its own dams was changing. In contrast, the large number of visitors to the many existing reservoirs and anticipated visitation at those under construction had made recreational maintenance and operation a major task. This development occurred throughout the United States, but the Division's significantly large percentage of the total Corps visitation level gave it one of the larger recreational and lakeshore management programs in the Corps.

IV NON-STRUCTURAL CIVIL WORKS

Although dams and dredges come quickly to mind at the mention of the Army Corps of Engineers, water-related projects make up just part of the Corps' civil works mission. The studies done by the Southwestern Division for the U.S. Study Commission-Texas and the two AWRBIACs were typical assignments, but the definition of civil works—and the duties of Army engineers—expanded greatly during the Division's first 50 years.

Few things demonstrate the Division's changing role better than the growth of the regulatory program. The Army Corps of Engineers began regulating the nation's waters in the 1890s with the primary purpose of protecting navigation. The Rivers and Harbors Act of 1899 prohibited the obstruction or alteration of navigable waters without a permit from the Corps and gave the Corps other regulatory responsibilities. Starting in the 1960s, as a result of various court decisions and the National Environmental Policy Act of 1969, the regulatory program was broadened to include many additional public interest factors affecting protection and use of water resources. In 1972 Congress passed the Marine Protection, Research, and Sanctuaries Act, commonly referred to as the Ocean Dumping Act. Section 103 of this act charged the Corps with regulating the transportation of material dredged from navigable waters of the United States for the purpose of discharging them into the ocean waters.¹ That same year the legislators passed the Federal Water Pollution Control Act (later amended to the Clean Water Act) to restore and maintain the chemical, physical, and biological integrity of the nation's waters. Section 404 of this act authorized the Secretary of the Army, acting through the Chief of Engineers, to regulate the discharge of dredged and fill material into navigable waters. In 1974 the Corps published regulations implementing this new law but restricting its scope to the same waters covered by the Rivers and Harbors Act. After the court case known as *National Resources Defense Council v. Calloway*, the scope of the Section 404 permit program was broadened to include the entire surface tributary system, including adjacent wetlands, and all other waters whose degradation could affect interstate commerce. Regulations implementing this program, published in 1975, greatly expanded the workload of all the Southwestern Division's Districts.

The regulatory program established by all this legislation has been and continues to be one of the more visible and controversial of the Corps' responsibilities. Because permit decisions may constitute a major federal action, they fall within the scope of the National Environmental Policy Act and require consideration of the direct, indirect, and cumulative effects of a proposal as well as its alternatives. So activities proposed by state and local governments and the private sector require the same in-depth environmental review given to federally sponsored projects. Examples of such controversial projects within the Division include the Baker's Port Marine Terminal near Corpus Christi, Texas; Las Colinas Floodplain Reclamation near Dallas; Limestone, Choke Canyon, Richland Creek, Applewhite and Stacy reservoirs, all in Texas; the Corpus Christi landmass project; various Metroplex Trinity River floodplain reclamation projects and the regional environmental impact statement; and the issues surrounding regulation of bottomland hardwood wetlands. Permit decisions may require public hearings that give persons in favor of and those opposed to a project the chance to provide the Corps with information with which to balance possible benefits of a proposal against its reasonably foreseeable detriments. Since project proponents, usually commercial developers, are already convinced of the merits of their proposal, they often resent the Corps' need for such an



The Corps of Engineers Regulatory Program oversees boat ramps.



Boat docks required permits from the Department of the Army.

evaluation. The evaluation process must comply with a host of other environmental laws and regulations such as Executive Order 11988 on floodplain development, the Endangered Species Act, the Fish and Wildlife Coordination Act, the National Historic Preservation Act, the Wild and Scenic Rivers Act, and the Coastal Zone Management Act.²

The regulatory program has continued to grow in scope through litigation, changes in administration, new policy, interagency agreements, and changes in the implementing regulations. These changes have increased the role of the Division Engineer in the program by transferring authorities formerly reserved for the Chief of Engineers and creating new program requirements. In 1977 Division Engineers first received authority to determine navigability for purposes of jurisdiction under Section 10 of the 1899 Rivers and Harbors Act. Southwestern Division Engineers have completed studies and made such determinations on 19 rivers in their area. Regulations in 1982 delegated to the Division Engineer discretionary authority to establish conditions for or to override nationwide permits issued by the Chief of Engineers for some activities regulated under Section 10 or Section 404 of the Clean Water Act. Additionally, the Division Engineer was authorized to approve the use of special emergency permit processing procedures, decide permit cases contrary to the official position of the state governor, and decide other cases on his own initiative or where there was a question of law or policy.

In 1985, Southwestern Division Engineer Robert Dacey used this authority to elevate to the Division level a decision involving a request by the Central Power and Light Company to build an aerial power line across Laguna Madre on South Padre Island, Texas, to serve the city. The controversy involved the federally endangered Eastern brown pelican's potential for colliding with power lines and being injured or killed. Since these birds routinely migrate through the area, the United States Fish and Wildlife Service insisted on extensive marking of the lines to prevent or reduce such collisions. Initially, Central Power and Light was reluctant to provide such marking, but at the urging of the Corps it agreed to a modified plan acceptable to both the Corps and the Fish and Wildlife Service.³

In 1984 conditions were incorporated into several nationwide permits requiring the Division Engineer to determine the appropriate permit-processing procedures for all cases referred by the Districts. These cases included projects affecting more than one acre of small streams or isolated waters. This last modification greatly increased the Division's regulatory

workload in fast-growing metropolitan areas where channelization and reclamation projects on small tributaries were common. The Department of the Army in 1985 signed new Memoranda of Agreement with the Fish and Wildlife Service and the Environmental Protection Agency. These memoranda also increased the Division's workload. A similar agreement was signed with the Department of Commerce and the National Marine Fisheries Service in 1986. These memoranda provided that the Division Engineer would review District permit decisions that were contrary to the other agency's recommendations. The first test of these procedures occurred in 1985 when the Fish and Wildlife Service asked the Division Engineer to review the Galveston District Engineer's decision to allow the City of Corpus Christi, Texas, to build its "landmass" project. Landmass was to be an eight-acre filled area in Corpus Christi Bay that would include a "festival marketplace" shopping area, a breakwater, boat mooring facilities, and a site for a regional aquarium. A private developer would foot the bill. The goals were to enhance development in that area of the city, provide additional jobs in a depressed economy, and provide an additional attraction for the hotel and convention district. The project was strongly supported by the mayor, part of the city council, and others but just as strongly opposed by environmentalists and a coalition of taxpayers. The Fish and Wildlife Service appealed the District's decision primarily because of the non-water-dependent nature of the development and the availability of upland alternatives. The Division Commander, Brigadier General J. B. Hilmes, conducted a rigorous review of the 12 market alternatives examined by the District and four additional ones developed by his staff before sustaining the original decision. Although the memorandum of agreement provides for a further appeal of this decision to the Assistant Secretary of the Army for Civil Works, no such appeal was made. The workload generated by responsibilities such as these required an additional personnel space in the Division.⁴

The Division's Flood Plain Management Services Program provides yet another example of its varied civil works responsibilities. As defined in Engineer Regulation 10-1-3, this program has five goals.⁵ It provides flood-plain information to engineers for planning activities on rivers and coastal flood areas. It gives flood-hazard information on sites to individuals, public mortgage companies, and federal, state, and local officials. It makes available technical advice and planning assistance on flood-plain land use, land adjustments to flooding evacuation, and flood-proofing to local government officials and planners. The program also provides state and local officials with guidance regarding flood-plain regulations and technical assistance in



Retaining walls come under the Regulatory Program.

delineating regulatory flooding and conducts flood insurance studies for the Federal Insurance Administration.

In other words, the Army Corps of Engineers provides free technical data upon request to both public and private parties about flooding or its probability in known flood plain areas. In return, requesters are encouraged to furnish information such as field survey data maps, historical flood information and similar material. Most of the Corps' flood-plain work deals with areas in the path of urban growth and development.

The major metropolitan areas of Little Rock, Tulsa, and Dallas-Fort Worth account for most of the requests. The Albuquerque District's semi-arid conditions and the Galveston District's physical separation from the large city of Houston account for their lower rates. Most requests come from private parties such as lending institutions of all types, real estate companies, and developers. The following table illustrates the level of activity among the Division's five Districts.⁶

Technical Services Responses			
District	1982	1983	1984
Albuquerque	886	517	807
Fort Worth	5,853	11,826	8,432
Galveston	958	753	1,570
Little Rock	9,770	8,653	10,463
Tulsa	9,694	10,253	11,500
Total	27,161	32,002	32,772

Source: Southwestern Division Planning Division, Program Management Section

Table 4-1

Within the Army Corps of Engineers, the Southwestern Division since 1980 has received a large percentage of the funds appropriated for flood insurance studies.

Egrets flourish on a Corps of Engineers-protected wetland.



Flood Insurance Studies Funds
(in millions)

Year	Corps	Division	SWD's Percentage
1978	4.27	.184	4.3
1979	6.03	.340	5.6
1980	1.44	.650	45.1
1981	1.21	.657	54.3
1982	3.58	1.464	41.0
1983	10.12	2.710	26.8
1984	12.04	4.363	36.2
1985	4.64	1.636	35.2
1986	2.87	.936	32.6
Total	46.20	12.940	28.0

Source: Southwestern Division Planning Division, Program Management Section

Table 4-2

Division personnel review and coordinate the Districts' activities in this area. They review all flood data and insurance reports and provide assistance and guidance on flood hazards. They allocate Flood Plain Management Services funds from the Office, Chief of Engineers to the Districts, which enables the Flood Plain Branch at headquarters to function with a small staff. And the Division coordinates all District activities with the Federal Emergency Management Agency. The Division represents the Army at meetings on flood plain issues with other government representatives. It analyzes and coordinates flood-plain-related research conducted under the direction of the Office, Chief of Engineers. Such research activities include improvement of methods and procedures and preparation of guidance and



The Corps of Engineers' regulatory program protects hardwood trees and bottomland wetlands.

pamphlets pertaining to flood proofing, flood plain regulations, flood plain occupants, and economies of flood regulations.⁷

The Southwestern Division's list of civil works responsibilities grew again as the result of two major non-Corps of Engineers dam disasters. In June 1976 the Bureau of Reclamation's Teton Dam in Idaho collapsed, sending 80 billion gallons of water, a four-foot rampaging wall, onto six rural towns and unsuspecting farmers and campers. Nine people were killed and 30,000 left homeless. Seventeen months later the municipal Kelly Barnes Dam at Toccoa, Georgia, also collapsed, carrying a smaller but deadlier torrent onto a small Bible college, killing 37.⁸

The first incident brought some tightening at the planning and design stages of federal dam construction, although the Corps felt no special effects. But the Georgia failure spurred President Jimmy Carter to order the agency to inspect all potentially hazardous non-federal dams in the United States. In a national inventory, the Corps counted 49,422 dams of 25 feet or more in height. About 39,000 had never been inspected due to inadequate or nonexistent state and local requirements. The Corps further reported that new dams were being built at the rate of five per day, mostly by private developers and often with no sound engineering. With a sense of urgency it recommended that precautions be taken on all types of dams to prevent future disasters.⁹

The inventory of non-federal dams in the Southwestern Division's area counted 1,104 structures, of which 374 were found unsafe. At first the Division handled the job of inspecting non-federal dams in Texas, Oklahoma, Arkansas, and New Mexico. Texas assumed its inspection role in about six months, but the others needed about one year. The Division assisted the states by acquainting them with architectural-engineering firms and training state personnel. As each state took over its responsibilities for dam inspection, the Division acted as coordinator. Funding for the program came from Congress; \$10.75 million went to the Southwestern Division. Enforcement for the inspection program rested with the states.¹⁰

Because of the disastrous nature of floods, the Army Corps of Engineers' civil works responsibilities since World War II have expanded to include disaster relief. As natural disasters occurred in the United States, it became obvious that federal aid aimed at debris removal, structural rebuilding, and damage surveys was needed. Rules regulating federal assistance required that before the Corps or other agency could assist communities directly, the President had to declare the stricken area a federal disaster area. The Southwestern Division and its Districts have assisted the public in recovering from a variety of disasters since 1937. In 1970, for example, the Fort Worth District organized debris removal crews for the city of Lubbock, Texas, when a tornado hit the downtown section.

The Division reviews and approves the Districts' emergency management plans, which go into effect in the event of hurricanes, tornadoes, and floods. If a flood or other emergency hits an area covered by two Districts, the Division must also decide which one has primary jurisdiction. In the case of levee damage during a flood, the Division and the appropriate District make a damage survey and draw up repair plans.

As expected, the Division furnishes mostly supervisory oversight to the Districts in the area of disaster relief. Some Division personnel were, however, directly involved in relief efforts after Hurricane Carla struck the Texas coast.¹¹ Major General Robert J. Fleming was Division Engineer in September 1961 when Carla hit at Galveston Bay. He quickly grabbed Roy Penix, Milton Martin, and Orval Dowdy, and they all piled into a panel truck loaded with radio equipment and headed for the coast. They drove into the storm, and, Penix recalled,



I had no idea that any kind of a vehicle, particularly a panel truck, could withstand the kind of winds we found. We had reports of 125 mile-per-hour winds ahead of us and behind us . . . The wind would pull the windshield wipers clean off . . . The thing that bothered me most was the pieces of sheet metal that were flying around and the flashing as the power lines broke . . . And it wasn't raining down, it was raining up . . . A gust of wind would pick up big sheets of water from the sea that had moved in and hit you with practically 100 percent water.¹²

Despite the odds, Fleming was able to maintain radio communications in the truck and offered the services of the Southwestern Division to Texas Governor Price Daniel. Once the storm ended, the Galveston District made property damage assessments.

In 1980, at the direction of the Chief of Engineers, the Emergency Operations function of the Operations and Maintenance Branch in the Construction-Operations Division was expanded to become the Emergency Management Branch. Functions of the new branch included natural disaster preparedness and a national emergency preparedness program.

The natural disasters section of the branch has responsibility for preparations for major catastrophes; implementation of flood assistance as provided by Public Law 84-99; assistance to the Federal Emergency Management Agency under Public Law 93-288; and participation with the Environmental

Tornadoes like this one put Southwestern Division disaster experts on alert.

Division Emergency Operations personnel surveyed tornado damage at this lumber yard in Cabot, Arkansas, on 29 March 1976.



Protection Agency and U.S. Coast Guard on the Regional Response Team for hazardous spills. Another part of the branch takes responsibility for military mobilization preparedness. Its duties include continuity-of-operations plans, mobilization plans alert notification, emergency relocation sites, and assistance to U.S. Army installations in preparing mobilization master plans and installation support books.

In 1983 the branch was expanded again. Its new duties included coordination with the Federal Emergency Management Agency for flood hazard mitigation and participation in Regional Response Committees. In 1984 the branch assumed the additional functions of macro-analysis and emergency water preparedness as directed by Executive Order 11490.



Division officials surveyed the aftermath of a tornado that ripped through Mesquite, Texas, in December 1984.

The Emergency Management Branch is thus the focal point for all of the Division's natural disaster and national mobilization preparedness. It provides management, guidance, and assistance to the Division Commander and his staff in maintaining mobilization preparedness and readiness for the Army.¹³

In 1955 Congress had passed Public Law 71, which provided for hurricane studies along the East and Gulf coasts of the United States. For the Galveston District the statute resulted in a study to determine the feasibility of providing protection for individual localities from hurricane tidal flooding. Two projects in Texas came out of the 1955 act: Port Arthur and the Vicinity Hurricane Flood Protection Project. But Carla wrought such damage that Congress also provided funds for the Texas Gulf Coast Hurricane Study. In 1964 the Galveston District began looking for ways to reduce flood damage along the Texas coastline with a barrier-protection system along the shoreline. The newer measure replaced the earlier system of providing protection on a localized basis.¹⁴

The Galveston District divided the coastline into five areas, centering each on a major bay area: Galveston Bay, Matagorda Bay, Corpus Christi, Sabine Lake, and Laguna Madre. Attention was focused on Galveston Bay, the most populous area. The Waterways Experiment Station at Vicksburg, Mississippi, built a model of the bay. For the most part, the study consisted of measuring flood surges and preparing designs for levees, stone barriers, and similar protective devices. Because of the lack of the required 20 percent funding by local interests, no structures were built as a result of the study. But the project, wrote one reporter, "generated a wealth of data regarding storm surges, waves, winds, and foundation conditions."¹⁵

Because of its capability in particular areas, the Army Corps of Engineers sometimes provides services for other federal agencies. An example was the agreement of March 1978 between Region VI of the Environmental Protection Agency, or EPA, and the Southwestern Division. Congress had provided funding to assist municipal governments when they constructed wastewater plants. The EPA put new construction specifications into effect to ensure that new plants did not release hazardous pollutants and "hired" the Corps of Engineers to make sure that the standards were met until the states could assume responsibility for the program. Some 50 Division and District personnel began spending part of their time making monthly inspections at 255 sites in Texas, Oklahoma, Arkansas, and New Mexico.

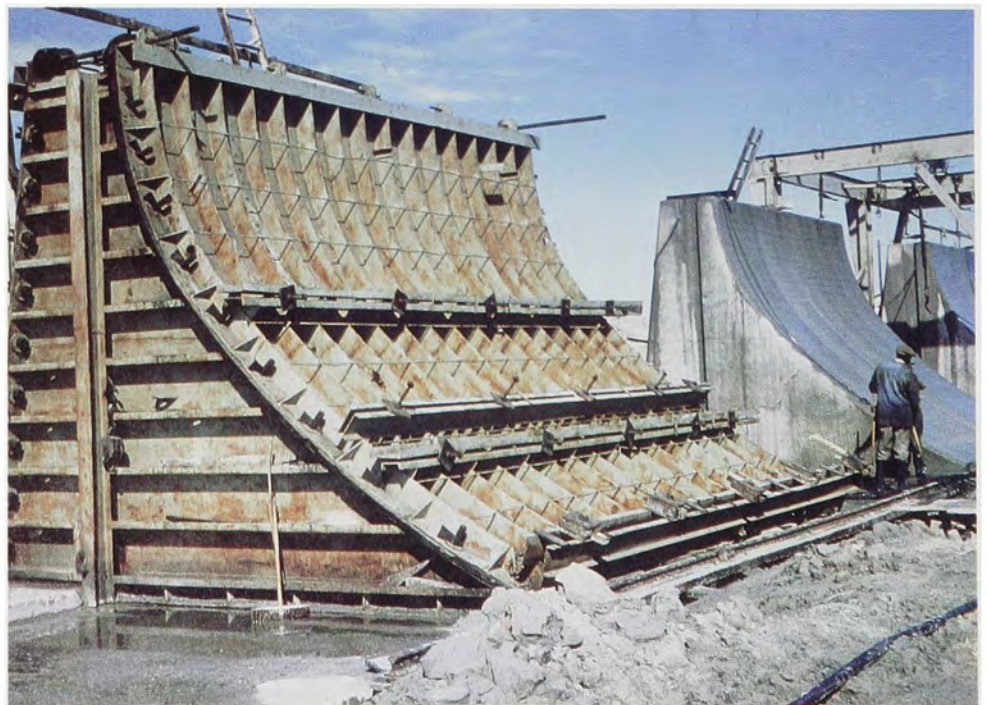
In general that plan was followed. The state of Texas took over all work by October 1980. Oklahoma assumed the inspection duties on 31 January 1983. Arkansas signed a delegation agreement in September 1981 and assumed the Corps' work in September 1984. New Mexico took over about half of its work in April 1984 and the rest the following July.¹⁶

The Lower Rio Grande Basin Study also shows how the Southwestern Division lends its capability to another agency. This project began when, in 1969, the Soil Conservation Service released a pre-authorization report calling for a three-phase plan of improvement for three counties near the mouth of the Rio Grande River: Willacy, Hidalgo, and Cameron. This 3,400-square-mile subtropical area known for production of citrus fruits, cotton, vegetables, grain sorghum, and sugar cane suffered periodic setbacks from heavy rains.

The smooth, nearly flat coastal plain slopes to the northeast away from the Rio Grande River toward the Gulf of Mexico. The landscape is dotted with shallow depressions, called potholes, that have no natural drainage outlets. Without natural streams through which excess water can drain away, these holes capture and hold rainwater until it evaporates. After heavy rains, the area sometimes remains unusable for up to six months.¹⁷



The Division's Galveston District constructed part of the seawall that protects the city from hurricane-spawned waves like this one.



The curve in the Galveston seawall turns waves back on themselves and away from the land.

The Soil Conservation Service proposed solving the water and land problems with a three-phase plan that included three major floodwater channels in Willacy and Hidalgo Counties with outlets to the Laguna Madre; about 1,400 miles of smaller multipurpose channels to drain the farmlands to the major outlets; and on-farm land treatment measures.

When Texas Senator Lloyd Bentsen became aware of the Soil Conservation Service's concerns about the engineering complexity of the project and the impact of the cost on its total annual budget, he decided that the Army Corps of Engineers would be a logical choice to construct part of the project.

Bentsen authored Section 68 of the Water Resource Act of 1974, which "... authorized the Chief of Engineers to undertake the Phase I design memorandum stage of advanced engineering and design of the project" That choice of words ultimately led to some severe disappointment for the senator. His objective had been to have the Corps construct Phase I of the project. Unfortunately, the act also implemented a new two-phase pre-construction process for the Corps that specifically authorized many projects for phase-one planning only.¹⁸ The Lower Rio Grande project fell victim to this new process and was limited to conducting a Phase I general design memorandum evaluation, study, and report of the first phase of the Soil Conservation Service plan.

The Phase I report completed by the Corps in 1979 differed from the preliminary Soil Conservation Service plan in several ways. The agency had focused on agricultural drainage improvements, but the Corps planned to improve the region's economic development through urban flood protection. The soil experts had estimated that all three phases of their plan would cost \$68 million. The Corps' urban flood protection increased the estimate for Phase I alone to \$160 million. The Corps' version of the plan also included environmental mitigation and enhancement costs required by the National Environmental Policy Act of 1970. It eliminated one major outlet and did not include any improvements for Cameron County, which upset county leaders. They sought a separate Corps study for their area, which was under way in 1986.¹⁹

In September 1982 the Division Engineer, Major General Hugh Robinson, forwarded the Galveston District Engineer's report to the Board of Engineers for Rivers and Harbors in Washington, D.C. The board looked favorably at the proposal but added one requirement: before construction could begin on Phase I, Phases II and III either had to be authorized for federal construction or sponsored by non-federal interests. The Lower Rio Grande project was included in the 1986 Water Resources Development Act. When construction funds are authorized, the Division Engineer will direct the Galveston District toward quick construction.²⁰

Beginning in the late 1970s under the administration of President Jimmy Carter, the Army Corps of Engineers was once again instructed to reduce costs and trim the size of operations without any loss of quality in its work or any loss of its mission. During Carter's tenure as President, the Corps became involved in privatization to cut costs. In privatization, the government lets contracts to private companies for services previously performed by federal employees. Regular surveys determine which activities can be contracted out at a savings to the government. One example of privatization during the 1970s in the Division's operations was channel dredging in the Galveston District. Public Law 95-269, passed in 1977, opened up entrance-channel dredging to private industry and mandated a sharp reduction of the Corps hopper dredge fleet.

The first job under the Test of Market or Industry Capability Program, as it came to be known, was a \$776,633 contract awarded on 6 September 1977

to Bean Dredging Company for dredging the Port Mansfield, Texas, channel entrance. Ironically, the first competitive entrance channel contract was performed by a pipeline dredge because the company's hopper dredge sank when it was caught on the open sea during a storm. The five-year program ran through 1982.²¹

In January 1979 the Galveston District's dredging program nearly came to a halt when a new regulation issued by the Engineer headquarters said that local interests had to provide containment levees themselves or pay in advance for them. Reaction to the regulation by local sponsors was so negative that it was eventually rescinded. In August 1983, the Galveston District was temporarily enjoined from dredging on the Intracoastal Waterway in East Matagorda Bay by a local fishermen's group and federal and state wildlife agencies. The initial court order alleged that the bay was being damaged by the disposal of dredged material in open water. The injunction was eventually lifted by a federal court that recognized the Corps' compliance with both environmental laws and procedures stipulated in the environmental impact statement.

Since 1985, the Galveston District has witnessed a significant decrease in the cost of dredging, due partly to increased competition by contractors for work. Unit prices for dredging are similar to those of 10 to 15 years ago.

The Galveston District had owned and operated dredges from the late 19th century until 1981. For many of those years, the District had two seagoing hopper dredges. But in 1974 the dredge *A. Mackenzie* sank off the northeast end of Galveston Island and was not replaced. The last dredge, the *Gerig*, was retired, stripped, and mothballed in 1981. The Southwestern Division no longer has any dredges in its inventory.²²

The use of private contractors for dredging shows how the election of Ronald Reagan as President in 1980 and again in 1984 had a profound impact on the Southwestern Division. Reagan was firmly committed to reducing both the cost of government operations and the size and role of the federal government in American life. During his first presidential campaign in 1980, he expressed his position before an International Business Council meeting in Chicago:

We must recognize that the problem with the U.S. economy is swollen, inefficient government, needless regulation, too much taxation and too much printing-press money. Through a comprehensive assault on waste and inefficiency, I am confident that we can squeeze and trim two percent out of the budget in fiscal 1981, and that we will be able to increase this gradually to seven percent of what otherwise would have been spent in fiscal year 1985. We must move boldly, decisively and quickly to control the remaining growth of federal spending.²³

President Reagan's economic philosophy was popular in spite of some vociferous critics, and other political leaders espoused the same point of view. In 1985 Congress passed the Gramm-Rudman-Hollings law, which required automatic, across-the-board spending cuts whenever annual deficits were incurred in the federal budget. For 1987, at least \$50 billion in cuts were needed to meet the law's requirements. Reagan's initiatives in cutting the cost of the federal government touched nearly all phases of life in the United States; the Army Corps of Engineers was not alone. As described by an editorial writer, the list of potential sacrifices included the Job Corps, the Small Business Administration, housing loans, highway safety funds, public health, Amtrak subsidies, "and on and on and on."²⁴

To meet reductions mandated by the Reagan administration to reduce spending and balance the federal budget, the Corps imposed reductions throughout its Divisions and Laboratories. The Southwestern Division had

to cut 391 full-time employee spaces between October 1980 and September 1982.²⁵ It made internal boundary changes to better align its civil-works and geographic boundaries and centralized finance and accounting activities within the Fort Worth and Tulsa Districts. They did all upward reporting, updating of the automated accounting system, and disbursing activities. Small staffs at the remaining Districts handled funds control, cost analysis, and revolving fund management activities.²⁶

The role of the Division's Real Estate Division, on the other hand, changed little over the last quarter century. It still conducts planning, appraisal, acquisition, and management and disposal. The government still acquires real estate through negotiations or condemnation procedures under the power of eminent domain. However, inflated land values and the increased knowledge and sophistication of landowners sometimes hamper and lengthen the process of land acquisition. The unpredictability of inflation over the years has significantly increased the complexity of estimating,



One of the Division's last dredges, the A. Mackenzie, sank off Galveston in 1974.



The Southwestern Division no longer operates dredges like the McFarland.

programming, budgeting, and funding projects. Overestimation of projected inflation rates results in an overabundance of funds, whereas underestimation of the rates leads to fund shortages and can consequently delay the completion of projects.

The volume and content of real estate activities reporting has not changed significantly, but manpower restraints have altered the way those reports are done. In 1978 Districts and the Division still did their reports primarily manually. By 1986, however, the task was almost exclusively computerized. The greater initial effort required in automated reporting was offset by the computer's greater capability in manipulating data.

Manpower restraints affecting the Real Estate Division have also significantly affected the planning and scheduling of real estate work. Manpower availability has dropped at a much greater rate than workload. Real estate managers have therefore had to rely increasingly on contracting out some of their work. They have also developed innovative approaches to accomplish tasks, reduced regulatory requirements, and been less strict on quality control.²⁷

Appraisal of real estate for the Corps of Engineers' military and civil works projects and its "Work for Others" program underwent significant changes in the 1970s and 1980s. Fluctuations in interest rates, the prevalence of innovative financing, the formation of real estate investment trusts and the creation of tax shelters favoring such trusts created new dimensions in valuing real estate. A much deeper study of the market data was required to come up with accurate real estate values. Provisions in the 1986 tax reform law promised to again change the rules of the real estate game.

The federal government is the nation's largest landowner. It also leases more property from others and to others than anyone else. These factors make it a foregone conclusion that the management of government-controlled lands is an enormous undertaking. Such is the case in the Southwestern Division's area. Since 1978, the Division has tried both to improve management efficiency and to obtain lands at the least possible cost to the government. These goals have often been difficult to achieve because of a piece of land's location and climate, regulatory requirements, divergence of management responsibility within the Corps, and nationally organized special interest groups in the private sector.

Private individuals in 1986 held approximately 10,000 outgrants on military installations and civil projects administered in the five Districts. They involved everything from wildlife licenses and power-line easements to more than 150 land and water site leases on reservoirs for commercial marinas. Investments in these owner-operated marinas varied from \$50,000 to more than \$7 million. Other activities such as timber disposals, primarily on military installations, and agricultural and grazing leases generated approximately \$1 million annually for the United States Treasury.²⁸

Initiated by President Richard Nixon's Executive Order 11508 on 10 February 1970, a trend began in the early 1970s to reduce the government's holdings in real estate. The order set up a uniform policy for identification of excess real property holdings and release of holdings that were no longer essential. Successive administrations have continued the effort, most recently seen in President Reagan's Executive Order 12512 of 29 April 1985. The question is still open on how significant these land reductions have been.²⁹

By 1986 the greater variety of responsibilities thrust upon the Corps had to an extent offset the decline of dam and reservoir construction in the Southwestern Division. Non-structural projects had grown in number, and the Division had, through the Flood Plain Management Services Program, moved into the area of flood plain zoning, a contrast to its traditional role of

structural flood control. Other examples of non-structural civil works such as the Section 404 Regulatory Program, dam safety inspections and hurricane studies held out the promise that the Division's role would continue to change. Gone were the days of constructing large-scale dams and reservoirs. In view of the federal government's continuing strong emphasis on cost reduction, the Corps' non-structural projects could eventually become the dominant side of its civil works missions.

Southwestern Division Civil Works Budgets
(in millions)

Fiscal Year	Construction		Other Civil Works	
	Real	Constant 1974	Real	Constant 1974
1974	\$126.9	\$126.9	83.9	\$ 83.9
1975	125.9	114.1	81.8	74.1
1976	138.4	116.8	94.3	79.6
1977	129.9	97.9	107.9	81.3
1978	140.4	99.4	121.6	86.1
1979	141.5	95.4	169.7	114.3
1980	173.4	108.2	139.6	87.1
1981	164.8	95.2	166.9	96.5
1982	176.4	96.0	169.7	92.3
1983	154.5	78.2	202.7	102.6
1984	110.9	52.4	195.7	87.1
1985	117.1	52.2	195.3	86.9

Source: Southwestern Division Resource Management Office, 12 September 1986.

Table 4-3

V MILITARY CONSTRUCTION, 1945-1986

The conclusion of World War II eliminated the need to complete much of the military construction then in progress, and the federal government decided to conclude the work in the most advantageous manner and as quickly as possible. Projects that were nearly finished and would eventually serve a useful purpose were completed. Most military projects, however, were stopped. As the Army and Air Force decided which bases would remain active, the Corps of Engineers became involved with the disposal and dismantling as required. This process, which occurred in the Southwest as well as the rest of the United States, resulted from a natural inclination to reduce the nation's armed forces and return to a normal peacetime economy. As the military workload of the Southwestern Division declined, some personnel were shifted to civil projects. The military branch of the Engineering Division was put into the Construction-Operations Division.¹

The Southwestern Division engaged in some postwar military construction, reaching about \$25 million per year until the outbreak of the Korean conflict. In 1947 Congress authorized construction of several Veterans Hospitals in the Division's area of operations, at Big Spring, Bonham, Houston, El Paso, and Dallas, Texas; Little Rock, Arkansas; Norman, Oklahoma; and Poplar Bluff, Missouri. Division and District personnel designed the hospitals through contracts with different architectural-engineering firms. When Kirtland Air Force Base, New Mexico, was designated an Air Force research center in 1947, the Albuquerque District built its new facilities. From 1948 to 1958 that District worked on Manzano Base near Albuquerque. The Galveston District started a program to replace temporary wartime buildings with permanent structures at several air bases. Carswell Air Force Base near Fort Worth underwent expansion to prepare for the B-36 bomber, considered at the time to be a giant. The Division's military construction,

An M-1 Abrams tank fires at night on a range at Fort Hood, Texas.



however, was much smaller than its civil works mission. On the eve of the Korean conflict, the Tulsa District, for example, had a \$17 million civil works program compared with \$1 million in military projects.²

A sudden change occurred with the Korean conflict. The armed forces were not prepared to sustain conventional warfare in Korea, since that country had not officially been given strategic importance. President Harry S Truman's decision to defend Korea put the United States into a conventional war, and the Army Corps of Engineers immediately felt the impact. Indicative of the increase was the military budget of the Tulsa District: it placed \$150 million under contract by the end of 1953.³ The Galveston District renovated air bases at Victoria, Harlingen, Ellington, Laredo, and Laughlin, Texas, and Lake Charles, Louisiana.

Speed and unusual demands were often considerations for the Division during the Korean conflict, as they had been in World War II. A good example of the often-changing situation was the Michoud Ordnance Plant operation at New Orleans, Louisiana, in 1951. When the fighting started, stepped-up manufacture of tanks was an immediate consideration. The Chrysler Corporation received a contract to manufacture tank cylinder heads in a government-owned, contractor-operated facility that during World War II had been a former aircraft assembly plant covering 47 acres under one roof. Most notable among a number of uncommon experiences during plant preparation was the complete dismantling and relocation of a foundry from Chicago to New Orleans. The reconstructed foundry was the first such to be established in the South. After the pilot line for manufacturing the tank cylinder heads became operable, the workers successfully produced a small quantity; but due to changed requirements, not unusual in

such times, the production line never went into action. Another interesting effort was the design, procurement, and installation of several hundred tons of humidity control equipment for the 47-acre structure. The large size of this project was extraordinary even by today's standards.⁴

Exemplifying the Korean conflict buildup and subsequent military preparedness was Fort Hood, at the time the largest single military installation in the United States and one of the Division's most important projects. Like most installations in the Division, this 340-square-mile area of rolling hills and plains had reduced its activity at the end of World War II. But with the outbreak of fighting in 1950 it was reactivated and expanded. Geographic and atmospheric conditions make the area ideal for training armored troops, particularly tank units. Some permanent construction had occurred in 1948, but with its new permanent status in 1950, plans for extensive construction began.⁵

Art Brown went to Fort Hood in July 1950 as resident engineer. Not until the Korean truce in 1953, however, did construction begin. Brown recalled that 387 permanent officer and enlisted men's quarters were built, consisting of 32 brick barracks and bachelor officer quarters. Two hundred family housing units also went up, along with an elementary school, a water supply system, a post exchange, and an enlisted men's club. In 1954, with the development of larger tank guns, Fort Hood was expanded by 54,000 acres. The Real Estate Division at the Fort Worth District handled the acquisition of the land.⁶

Fort Hood owed this expansion after the Korean conflict to the continuing Cold War. In 1961 the Southwestern Division and its Districts, in support of the Fourth U.S. Army and its installations, began an intensive and comprehensive master-planning program to serve as the basis for developing Army installations in the Southwest. This pacesetting program marked the first time that photogrammetry, large digital computers, and composite photographic techniques were combined with then-conventional engineering and planning processes. With the assistance of consultants a small staff, primarily in the Fort Worth District, made comprehensive studies of existing and future requirements for land use, buildings, airfields, roads, utilities, and drainage systems. The plans that resulted from these studies became the basis for development into the 1980s. Although the Office of the Chief of Engineers considered the growth factors used in developing the plans overly bold, time has shown they were very conservative.⁷

Using the master plan for Fort Hood, the Division began constructing 1,000 houses in 1961, plus a theater, library, and a post field house that could handle three basketball games at one time and enclosed an Olympic-sized swimming pool. Another 23 barracks and bachelor officers quarters were also built, along with 8 battalion tactical equipment shops and a dental clinic. In 1963 ground-breaking ceremonies were held for the installation's Darnall Army Hospital.⁸

During the 1970s construction continued at Fort Hood for the new Volunteer Army. Troop housing erected 30 years earlier was demolished and replaced with modern and more private quarters. Other construction included 1,280 family housing units, a commissary of 126,000 square feet, and repair and maintenance shops. By 1975 Fort Hood had a combined military and civilian population of 63,500. These projects have not been spectacular for the Southwestern Division, but they have made Fort Hood its single largest continuing military effort.

Similar but later development occurred with Fort Polk, Louisiana, another armored division training center. After World War II, it was deactivated and put on a stand-by basis, serving as a summer training base for National

Guard members and reservists. In September 1950, the fort reopened to train troops for the Korean conflict. At first only renovation and rehabilitation of the existing buildings went on. But starting in 1952 new temporary buildings were constructed: 200 prefabricated temporary housing units and trailer parking areas were prepared. Fort Polk was closed in 1959 again and reactivated in 1961 during the Cuban crisis. In October 1968 it received permanent status as part of the Vietnam War preparation, and permanent construction finally began. New barracks and family housing units were constructed along with a theater, a chapel, dental clinic, post exchange, classroom facilities, and a wide variety of other structures. By 1978 Fort Polk was becoming one of the most modern posts in the Army.⁹

Construction of Air Force bases accounted for a large part of the Division's military program. Dyess Air Force Base at Abilene, Texas, exemplified the build-up in defense during and after the Korean conflict. In 1953, after negotiation with the city of Abilene, ground-breaking ceremonies took place. Dyess was designated part of the Strategic Air Command and became a home for B-47 and, later, B-52 bombers. Because of the large size of these aircraft, the runway had to be the maximum length set by the Air Force. Enough buildings went up to make the base a fully contained small city: aircraft hangars, warehouses, barracks, educational and training facilities, water and sewage plants. Built by the Fort Worth District, Dyess Air Force Base was the single largest construction project in the Southwestern Division at the time. Bergstrom Air Force Base at Austin, Texas, was designated a Strategic Air Command base for B-52s and KC-135 tankers. Construction of runway overlays and new runways there started in 1957 and was completed in 1960.

The fast-paced construction caused some administrative headaches for the Southwestern Division, especially after the federal government began an austerity program that included defense construction. In 1953, the Office of the Chief of Engineers complained that too many projects in the Corps' military program were exceeding cost. The headquarters complained about nonessential items in building construction, and it warned about cost overruns in mechanical and electrical construction.¹⁰

The Division Engineer, Colonel Herbert D. Vogel, instructed his District Engineers to exercise every measure possible to hold down costs. The Air Force had also complained of cost overruns by the Corps, but the latter said the Air Force's criteria changes were the cause. "As you know," an official at headquarters wrote Vogel, "the Air Force has consistently claimed that Government costs on their military construction assigned to the Corps of Engineers have been excessive."¹¹ The Chief's office instructed Vogel to prepare a tabulation of costs on Air Force projects that had design criteria changes.

From the Division's point of view, Air Force personnel interrupted and interfered with construction. Vogel reported to Chief of Engineers Lewis A. Pick that the Air Force was attempting to assume the functions of his office and the Districts. The sister service, Vogel continued, tried to specify such things as the size of distribution lines and construction materials to be used. In some cases it made unsolicited recommendations in selecting architectural-engineering firms and had made checks on field construction without authorization from the Division. Air Force personnel were also making changes in plans and specifications. "The extra expense in such procedures is evident," he told Pick, "in that not only are the plans and specifications being subject to unnecessary and repetitious reviews, but the time of District and Division office engineering personnel is consumed unnecessarily"¹²



Soldiers at Fort Hood enjoy an improved quality of life through Southwestern Division military construction projects.

Barracks rooms like this one at Laughlin AFB, Texas, make the military life seem a little more like home.



Tots play in a child care center designed by the Fort Worth District for Fort Hood.

The Southwestern Division's military construction projects include this helicopter washrack at Fort Hood.



The Air Force also insisted that the Corps was falling behind schedule with projects. Vogel believed that such slippages in the Southwestern Division were due to delays in receiving information about design, real estate directives, and the like either from the Air Force or the Office, Chief of Engineers. To avoid future criticisms, he instructed his District Engineers to prepare a careful analysis of scheduled dates "for all phases of military construction . . . prior to establishing the schedule."¹³

Quality control was another area of concern in military construction. The Fort Worth District Engineer, Colonel Walter J. Wells, suggested that the Southwestern Division and the District personnel review military projects as a team. Wells asked for a greater number of visits by technical specialists from higher headquarters to the project offices. On the same subject, the Little Rock District Engineer, Colonel Staunton Brown, thought military construction needed improving for three reasons: architectural-engineering firms were not publicly identified with the projects; Corps personnel were not present at the original design of structures; and payment to the firms was not enough of an incentive for them to pay close attention to details and quality work.¹⁴ Resolution of these problems and others like them, Vogel thought, would require a coordinated effort by the Districts, Division, and Engineer headquarters.

In 1958 the Chief of Engineers, Major General E. C. Itschner, instructed the Southwestern Division Engineer, Brigadier General Lyle E. Seeman, to make maximum use of architectural-engineering firms in both design preparation and reviews. Itschner also wanted Corps personnel to be used in overtime when it would help. That same year, the Air Force received funding of \$1.8 billion, a very large amount for the time. It asked Seeman to expedite work on several projects in the Southwestern Division. Air Force Colonel Ivan H. Iverson requested that to speed things up, the engineers award contracts timed to provide companies with a maximum of good weather. He also complained about discrepancies in information caused by hastily prepared reports in the Districts.¹⁵ Thus, conflict existed between the Corps and the Air Force as soon as the Corps began building the air bases. The Southwestern Division's experiences were no different from those found in other Divisions. The North Pacific Division had also complained to Engineer headquarters about interference. Deletion and reinstatement of projects in the Air Force budget accounted for much of the problem. Such was the case in 1958 with the erection of a fire station at Cannon Air Force Base, New Mexico; hangars at Webb Air Force Base, Texas; and rocket storage buildings at Kirtland Air Force Base, New Mexico.¹⁶



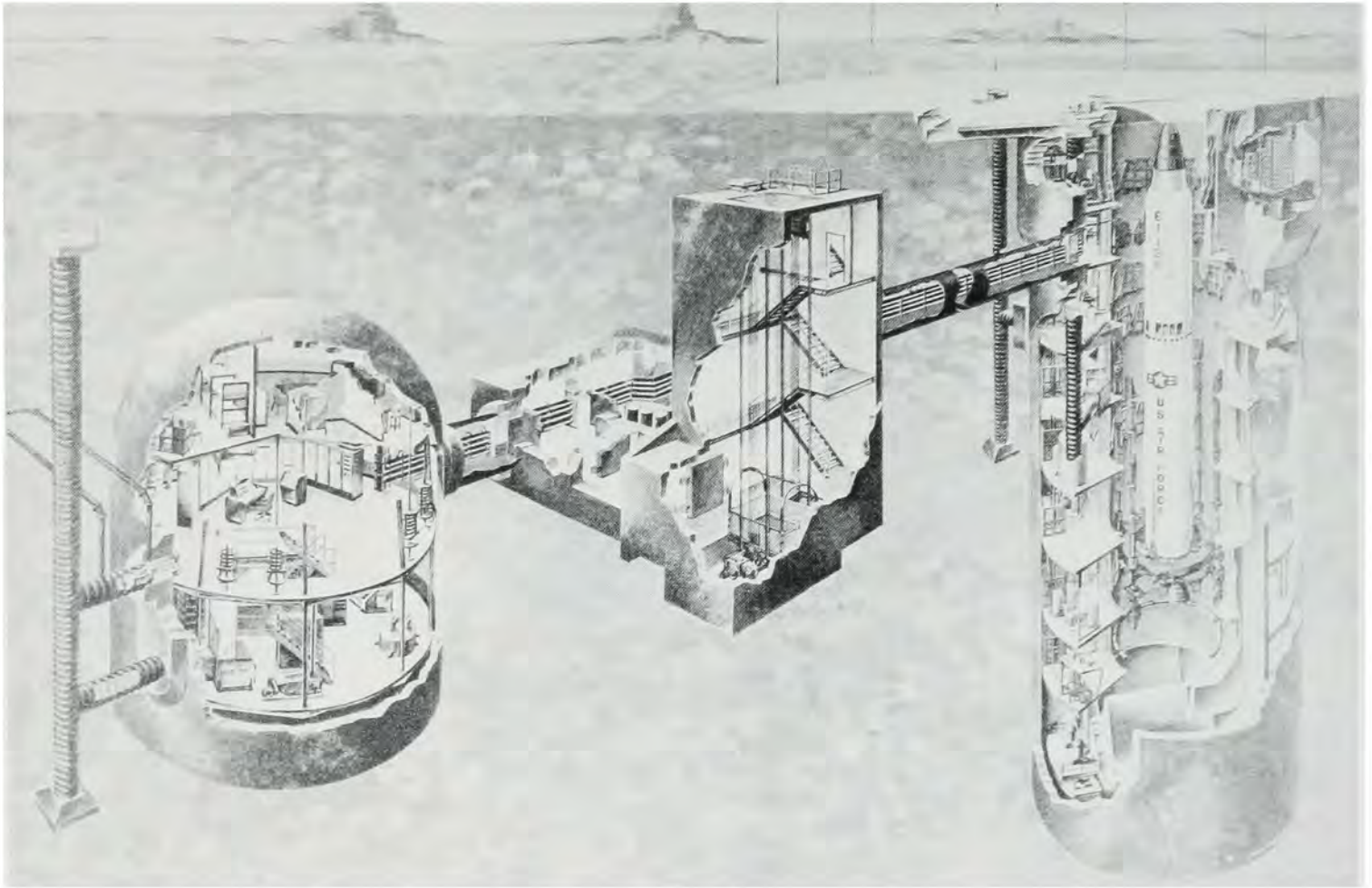
Floodlights (left) illuminate terrain (right) in this helicopter flight simulator at Fort Hood.

The Southwestern Division and its Districts entered the era of guided missiles in 1957 when the Department of Defense began erecting surface-to-air missile sites around major metropolitan areas. The Division, through its Fort Worth District, constructed four Nike-Hercules ground-to-air launching sites near the Dallas-Fort Worth metroplex, at Terrell, Alvarado, Denton, and Mineral Wells. The Nike was designed solely as a defensive weapon to knock down invading aircraft. Each site had three underground storage buildings 30 feet deep and made with reinforced concrete. Included were radar equipment and living quarters for about 100 men at each installation. These defensive weapons were short-lived, however, and were soon abandoned for a larger and more complex missile defense system—the intercontinental ballistic missile, or ICBM.¹⁷

Over the years, the Division would be involved in building several types of intercontinental missile support facilities: for the Atlas F, Atlas D, Atlas E, Titan I and Titan II.¹⁸ One of the most demanding military projects for the Division and its Districts was the construction of silos and launching pads for the Atlas F, the nation's first ICBM. The Atlas F had a 9,000-mile range and could deliver an atomic warhead at a speed of 16,000 miles per hour. Elaborate ground facilities had to be built to supply, maintain, and fire the weapon. Three of the Division's Districts—Fort Worth, Tulsa and Albuquerque—were involved in the program, which began in 1960.

Defense plans called for 75 launching sites in the United States. Each underground unit consisted of a silo 174 feet deep and 52 feet in diameter. An underground bunker housed a crew of five, plus communications equipment, fuel, and other supportive apparatus. Specifications called for concrete walls 12 feet thick and reinforcing rods as large as a man's arm. Entrance doors were 2.5 feet thick and made of solid steel.

Major responsibility for building the missile silos went to the Army Corps of Engineers Ballistic Missile Construction Office, or CEBMCO, located in Los Angeles. But the regular Divisions and their respective Districts handled the preliminary work so construction could get started until CEBMCO could take over. The Department of Defense gave the missiles high priority, and the Chief of Engineers reviewed construction progress daily. The Southwestern Division Engineer, Colonel Stanley G. Reiff, told Colonel John Arfman, the Albuquerque District Engineer, that he expected the



One of Little Rock District's military missions in the 1980s was to dismantle Air Force missile silos like this one.

District to “go beyond the normal” on the ICBM program and exercise the leadership required to do the job.¹⁹ And to Brigadier General Albert C. Welling, commanding officer of CEBMCO in Los Angeles, Reiff wrote:

The staffing of the Altus, Dyess and Walker Atlas silo jobs has been given the highest priority. A large percentage of the best qualified people in the Division are now in these Area Offices. The construction is in early stages, and minor problems inherent in new-type, tight-schedule construction are arising and being solved daily. I believe that these three jobs are off to a good start, but increasing efforts will be exerted to insure that they will be in the best possible shape for you to take over.²⁰

So fast did the Corps want the silos built that Chief of Engineers Itschner made a personal inspection of the projects. In August 1960, only a short time after the Southwestern Division received its ICBM assignment, Itschner visited the project sites in its area. During a briefing at Walker Air Force Base, New Mexico, he instructed Reiff and the project engineer to get the excavation work done faster, and he asked Reiff to relocate crib steel from project to project as needed to speed construction. Itschner was not worried about cost at that point, but speed. Contractors established three eight-hour, seven-day work crews. The Districts needed additional personnel to carry the added workload, so Reiff asked for and received permission from the Engineer headquarters to recruit new employees.²¹

The Fort Worth District built 12 Atlas F silos at Dyess Air Force Base, Texas. It also had responsibility for nationwide procurement for the Atlas Fs and the missile's Propellant Loading System. This complex apparatus

used a hydrocarbon that had to be oxidized or regulated with liquid oxygen and helium. Because temperatures in the system ranged from 297 degrees below zero Fahrenheit to 6,000 degrees above zero, constant monitoring was required for successful launches. Liquid oxygen, helium, and the hydrocarbon were injected into the engine for combustion when the rocket was fired. The District staff decided to prefabricate the fuel systems and then install them in the silos.²²

The Division's efforts to speed construction paid off. In December 1960, Division Engineer Robert J. Fleming told Itschner that the missile projects were progressing well, and that one was finished ahead of schedule. He was pleased with the ICBM program in the Southwestern Division and would soon be turning the sites over to CEBMCO.²³ In April 1961, Fleming told a regional meeting of the Society of American Military Engineers that "the transfer of missile base construction . . . from the Divisions and Districts to a separate ballistic missile construction unit has lessened our work load considerably."²⁴

The Corps' experience with missile silo construction brought some changes in the Division's administrative arrangements. In 1961 the Corps headquarters decided to realign the military construction boundaries of all the Districts in the United States, restricting military construction to 17 Districts. The Southwestern Division's Galveston, Tulsa, and Little Rock Districts lost their responsibility for constructing air bases, army posts, and other military projects. The Fort Worth District gained the most. Effective 1 June 1961, it handled military construction in the states of Arkansas, Oklahoma (except Altus Air Force Base and Fort Sill), Louisiana, and that part of Texas east of a somewhat irregular line running south from the southwest corner of Oklahoma. The Albuquerque District handled projects west of that same line in Texas and New Mexico.²⁵ In its official announcement, the Department of the Army stated that the large amount of military construction transferred to CEBMCO had reduced the workload in many Districts and, therefore, necessitated the realignment.²⁶

The change produced some concern among the public. Division Engineer Fleming had to correspond with several members of Congress who requested information about it. Most of the requests dealt with the Galveston District, because it also lost some administrative, engineering, and technical personnel not directly tied to military construction. The Fort Worth District was expected to provide support to Galveston in those areas. The transfer had come about because officials considered Fort Worth to be more centrally located and able to absorb the military responsibility. Fleming told Vice President Lyndon B. Johnson that in spite of the cutbacks in Galveston, the number of Corps employees in Texas would increase due to a heavy workload in civil projects.²⁷ Such reshuffling would "permit more effective use of available manpower and still maintain full responsiveness to and support of local interest and needs. Such an organizational arrangement also retains in those Districts a nucleus staff upon which to expand should the workload increase in the future."²⁸

Of all the armed forces research facilities the Corps of Engineers has worked on, one of the most unusual was the White Sands Proving Ground—now White Sands Missile Range—in New Mexico. This installation has been one of the principal testing sites for weapons since World War II, when the first atomic bomb was exploded there on 16 July 1945. The entire testing range lies in the Tularosa Basin of south-central New Mexico and—in its early days—within the geographic territory of the Southwestern Division's Albuquerque District. Division and District personnel received the responsibility to handle real estate acquisitions for the installation and design and construction of numerous buildings and testing facilities.

Southwestern Division engineers constructed Atlas missile facilities in the 1950s; in the 1980s engineers in the Little Rock District dismantled the sites.



When World War II ended, several of the leading German rocket scientists, including Wehrner Von Braun, were brought to White Sands.²⁹ They lived in tents for a short time until more substantial quarters were erected. The Corps' first construction there was the relocation of a prewar civilian wooden truss aircraft hangar from what was to become Sandia Base near Albuquerque. "This was considerably shorter time wise," recalled one engineer, "than constructing a new hangar because at the time there was a shortage of construction material and it appears that the hurry to complete facilities was forever a problem."³⁰

The next major item was the V-2 launching facility that became known as the "Army Blockhouse." This massive concrete structure was designed to withstand an explosion of V-2—or even a direct impact by the missile. Lieutenant Colonel Herbert Kaish, retired ordnance officer and assistant to the site commander, Lieutenant Colonel Harold R. Turner, furnished sketches of the construction criteria to the Corps, with further information from Von Braun—all in metric dimensions. Corps personnel had to transcribe them into English equivalents. Temporary living quarters, administrative facilities, mess halls and other buildings all went up, usually as Quonset huts. Over the years these buildings were gradually replaced with permanent structures.

One of the first major technical facilities at White Sands was a 100,000-pound engine test stand. It was built on a granite slope of the Organ Mountains at a 45-degree angle. At the time it was the largest engine test stand ever built, but an even larger, 250,000-pound stand was already in design. The smaller unit was never used for its intended purpose, but was connected to a vertical stand and used in production tests for the Redstone engine.

In the early 1950s the first of the family housing units were authorized for construction. The base commander decided to rely on the wives of the top-ranking officers for advice in designing the rooms. Kaish said that if criteria were to be decided in that manner, he would resign, and he did. A very chaotic period for design followed, because there was no designated person or office in charge, and "almost everybody was furnishing criteria: logistics people, operations people, post engineers and even a missile contractor."³¹ Sometimes the Corps received conflicting requirements for the same facility. This situation continued until the proving ground became a subordinate of the Army Missile Command at Redstone Arsenal, Alabama. As the United States continued missile research, White Sands was designated one of three national missile ranges and renamed White Sands Missile Range.

In 1958, plans were made to test elements of an anti-ballistic missile system, Nike-Zeus, at White Sands. The Mobile, Alabama, District was designing these facilities in collaboration with the Army Missile Command and a weapons systems contractor. It would be the responsibility of the Albuquerque District to install the facilities, which consisted mostly of radar units and launching pads. The schedule and nature of construction required employees of the weapons manufacturer to work alongside regular construction personnel. These two work forces proved to be incompatible. A "joint occupancy agreement" was made so the two groups could work peacefully at the same time.

During the late 1960s the Advanced Research Projects Agency entered into a contract with the Raytheon Company to study missile re-entry characteristics in an effort to develop methods to assure destruction of incoming missiles. The project required the design and construction of a radar tower to very exacting conditions. The Raytheon Company wanted to handle the design, but the agency refused. Responsibility for the design of the tower went to the Albuquerque District.

Beginning in 1965, the Corps also built research facilities at White Sands for the National Aeronautics and Space Administration. The work included a Little Joe II launcher, an Apollo Command Module engine test facility and the Lunar Excursion Module test facility. The Albuquerque District had to build a steam-operated electrical generator to handle the large amounts of electricity used in the NASA tests.

Exemplifying the state-of-the-art construction at the missile range was the Upper Air Research Station, or solar observatory. Air Force scientists needed a special telescope for space research and chose to locate it in the Sacramento Mountains in New Mexico. The site, commonly known as Sac Peak, had an elevation of 9,240 feet. A shaft 232 feet deep was blasted out of the rock and a cone-shaped reinforced-concrete tower 150 feet high was built. A 200-ton, 328-foot vacuum telescope was set 193 feet deep in the shaft with the remaining 135 feet protruding above ground. The suspension system for the telescope, an 11-ton pool of mercury, sat 90 feet above ground in the tower. In 1971 the Albuquerque District received the Award of Merit in Architectural Competition from the Chief of Engineers for design and construction of the project.³²

These examples of scientific research at White Sands Missile Range demonstrate how the Southwestern Division and its Districts have been called upon at various times to design and construct highly technical and complex facilities. These projects contrasted sharply with the Division's more routine military construction of barracks and air fields.

Like the Korean conflict, the war in Vietnam initially brought a surge of military construction to the Division. Fort Wolters at Mineral Wells, Texas, for example, saw an increased mission that required rapid construction to support it. With helicopters becoming the standard mode of transportation in the war zone, the demand for "chopper" pilots could only be satisfied by additional training facilities. The Fort Worth District obtained the necessary real estate and performed construction with troop labor transferred to Fort Wolters from the Army's second helicopter pilot training center. The fort soon had stagefields similar in both name and layout to stagefields in Vietnam. There was also some expedited construction of semi-permanent metal buildings at Fort Polk, Louisiana, Fort Sam Houston, Texas, and Fort Sill, Oklahoma.

But the net effect of the Vietnam War was a reduction in funding for military construction. In one instance, Secretary of Defense Robert McNamara withdrew the funds for a 3,300-man barracks complex at Fort Hood. Although the funds were later restored, the deferment of the project adversely affected the housing of troops there for several years. At that, Fort Hood was fortunate compared to Fort Wolters, which was closed and disposed of at war's end.³³

Diversion of research and development and military construction money to support the war directly affected the lives of personnel in the Albuquerque District, which lost funding for the bulk of its military programs. In March 1970, the Chief of Engineers, Lieutenant General Fredrick J. Clarke, transferred the military construction and civil defense functions of the Albuquerque District to the Fort Worth District. When General Clarke sent the order, the Albuquerque District had 471 employees. The transfer reduced that number to 245, including temporary workers. Typically, not all the people affected went to Fort Worth: 95 went there, but 34 retired, 14 resigned, 62 found jobs in other federal agencies, and 21 were "terminated for various reasons."³⁴ By 1971, therefore, Fort Worth District handled all military construction in the Southwestern Division.

The switch to an all-volunteer Army in 1972 meant that the armed forces would have to provide more comfortable and attractive living quarters for



Family housing at Fort Polk, Louisiana, features solar panels to heat water.

their personnel. The Southwestern Division and Fort Worth District designed and constructed new barracks at several bases. They designed a module plan that gave each soldier 90 square feet of living space, exclusive of bath, toilet, and storage. New buildings were three stories high with quarters for 24 persons on each floor. Each building had a service area of laundry facilities, mail service, and vending machines. Each barracks complex included dining facilities, a gymnasium, a chapel, and a headquarters and supply building. These projects were rather large—at Fort Sill alone the Corps constructed 57 buildings.³⁵

Similarly, the Division and Fort Worth District carried out the responsibility for the Air Force Relocatable Industrial Construction Program. The aim of this program was to design structures that could be picked up and moved to another site as missions changed or units relocated. The project consisted mostly of housing units, with as many as ten buildings per base in some cases. The housing structures' rectangular composite units had rooms accommodating two persons with a sleeping area of 100 square feet. The project was finished in 1973, but the mobility of the structures has never been tested.³⁶

Military construction in the late 1970s reflected the policies of President Jimmy Carter's administration. The Pentagon received approval for only a few new weapon systems or military operations. Instead, the programs were heavily flavored with energy and environmental projects. The emphasis on energy projects and the climate in the Southwestern Division's geographic area gave the Division much experience with solar projects.

Solar energy was used to cool as well as heat reserve centers at Albuquerque, New Mexico; Seagoville, Texas; and Greenville, Mississippi. The impetus for these projects was the expected continued rise in fuel costs projected by the Departments of Defense and Energy, based on the exponential price hikes for oil and gas in the mid-1970s. Those high prices never came to pass, but concern about them spurred numerous projects, such as storm window installations, not normally seen in the sunbelt. Congress didn't hesitate to fund such projects when the computed returns on investments showed amortization periods of less than five years.³⁷

The Army also looked for other sources of fuel. The Red River Army Depot, Texas, had been disposing of enormous quantities of scrap lumber from shipping crates. It also generated large quantities of waste rubber from tank track pads and other sources. The service ordered a study of the possibility of using this material as an energy source. The studies showed it

would be economically feasible to use the scrap lumber along with coal to fuel the depot's central boiler plant. But because of technological problems and costs, it would not be not practicable to use the waste rubber as fuel. Based on these studies, the depot programmed an \$18 million boiler project that was authorized and appropriated by the Congress and constructed by the Fort Worth District in 1985.³⁸

One of the more interesting aspects of the energy crisis was the revelation of the parochial viewpoints of some policy makers. The criteria they recommended for energy savings boiled down to four general items: place windows on a building's south side to gather in the sun's rays; place skylights on roofs to reduce the amount of electricity required for lighting; use fuel oil in lieu of natural gas on medium sized projects; and use coal as a fuel on very large projects. These recommendations were fine for projects in the country's northern climates. But they did not fit the conditions in the Southwestern United States. Southern window exposures and skylights would be counter-productive in most instances in the South, which needed cheaper ways to cool, not heat or light, buildings. The criteria for heating fuel also caused problems at southern installations. The first major building designed to use oil only, the Fort Hood Commissary, ultimately required a major change order to bring in and modify the heating system to use natural gas. Neither Fort Hood nor other installations had contracts for heating oil and could not obtain bids for it.³⁹

Major coal-producing states also gave Army engineers headaches. Congress, with the backing of West Virginia and Pennsylvania representatives, passed a law requiring coal to be the fuel on projects requiring more than 5 million Btu (British thermal units) per hour. The statute would have required the new \$500 million Brooke Army Hospital on Fort Sam Houston near downtown San Antonio, Texas, to set up a coal system. The system would require construction of railroad spurs for the coal trains, coal storage and handling yards, ash disposal systems, specialized pollution abatement equipment, and a new organization to operate it all. Blowing coal dust and exhaust pollutants would drift over the nearby downtown area. When the local congressman heard what could happen, he put the word out that the Army could and should waive the requirement for coal fuel. If it didn't, he

Enlisted-personnel barracks at Holloman Air Force Base, New Mexico, got a facelift and interior renovation through Division efforts.



said, he would get a special law passed to prohibit coal as a fuel on the project. The criteria were changed to allow design of a gas/oil co-generation plant that would be more cost-effective for the area.⁴⁰

The Carter administration also began emphasizing environmental projects, particularly the cleanup of hazardous waste sites. This emphasis has continued to affect Army operations well into the 1980s. Environmental experts began finding hazardous waste dumps—some of them now leaking—on military installations as well as on private lands. Many of these sites dated back to World War II, when they had not been considered dangerous. For example, at Pine Bluff Arsenal in Arkansas, the Army Chemical Corps spent much of the early part of World War II trying to develop a nerve gas in large quantities. The production line, however, first produced large amounts of dichlorodiphenyltrichloroethane, shortened to DDT. This substance, an insecticide later discovered to be highly toxic to humans and animals, was simply stored at the arsenal as waste matter. Eventually the Chemical Corps solved its manufacturing problems and began to produce nerve gas in lieu of DDT.

In the meantime, the Germans had developed successful nerve gas production facilities that yielded only small quantities of DDT. When German officials learned of the large amount of DDT stored at the arsenal, they mistakenly concluded that the United States had large stores of nerve gas as well. So, luckily for soldiers on both sides, they chose not to initiate its use in war. The Southwestern Division is still working with the Pine Bluff Arsenal to contain and neutralize such wastes after more than 40 years.⁴¹

Another program the Carter administration initiated was a formalized system of intergovernmental coordination of plans and programs. This program's roots stemmed from an action the Corps took in Georgia when Carter was governor, without clearing it with him. When Carter became President, he ordered that federal agencies coordinate their plans and programs with regional and state planning organizations set up for the purpose. Because the Corps is organized on a geographical basis, the Army selected its Divisions to represent the whole service for this coordination. When the Reagan administration took over, it simplified matters by having the Divisions coordinate only with the states. The states may notify local or regional authorities of Army plans and programs.⁴² After Ronald Reagan's election in 1980, the Army started developing plans for new weapons systems it could not obtain during the Carter years. The B-1 bomber was a case in point. After Reagan's inauguration, the Department of Defense added \$2.4 billion to its budget for fiscal year 1981 for development of the B-1B, which Carter had shelved. The program still had opponents, but they were overridden when Congress in 1981 approved the funds requested by the President.⁴³

For the Southwestern Division, Reagan's victory in this political issue meant a construction program at Dyess Air Force Base, Texas, which was to be the first in the nation to receive the B-1B. The Division began constructing facilities for the new aircraft in 1984. Some \$90 million worth of projects were scheduled for Dyess in the areas of maintenance, weapon security, training, and operations. Construction was supposed to proceed quickly because of the anticipated completion date of 1988, a shorter-than-normal schedule for a project of this type.

But design, and consequently construction, started a year late because of funding delays. Once design began, the lack of complete criteria became as much a problem as time. Designers had to base much of their work for fiscal year 1984 on "the best available criteria," and some modifications in construction were later necessary. The double problem of time and changing criteria demanded fast thinking. Change orders on three critical projects



The Southwestern Division's Fort Worth District built facilities at Dyess Air Force Base, Texas, for the B-1B bomber.



This hangar and other facilities built by the Fort Worth District at Dyess Air Force Base, Texas, house the Air Force's first operational B-1B squadron.

bought back time instead of giving contractors additional days for weather delays or for any additional work.⁴⁴

Preparation for the B-1B soon began to change the appearance of Dyess Air Force Base. The Three-Bay Hangar, the largest building constructed, covers 89,000 square feet and includes offices and shops. It was scheduled for completion in October 1986. One critical phase of the project was the Centralized Aircraft Support System, which was designed for on-apron maintenance to provide start-up compressed air, electrical power, aviation fuel, and cooling for the aircraft and its equipment. Each of these systems had outlets at 21 aircraft parking places on the flight line apron. The centralized system was to replace the individual pieces of ground equipment usually found on flightlines. The contractor had to cut through up to 16 inches of concrete on existing runways to construct trenches as deep as 21 feet for the underground conduit and fuel lines. The B-1B buildup at Dyess



A welder's torch sparked a blaze at Tinker Air Force Base, Oklahoma, that destroyed one-third of a major aircraft repair facility in November 1984.

must be regarded as one of the principal military projects in the Southwestern Division during the 1980s.⁴⁵

Similar to the B-1B buildup, but not as large or dramatic, was the commitment to the Air Force's C-5A Program at Kelly Air Force Base in San Antonio. Construction projects were scheduled to allow the transfer of 16 C-5A Galaxy aircraft to be stationed at an Air Force Reserve unit there. Five aircraft had already been transferred by mid-1986. Twelve related projects were under way in 1986, ranging from fuel storage facilities to construction of a hangar. Phase I, an apron and hydrant fueling system, was finished in 1985 at a cost of \$2.1 million. The other projects were still under way in 1986, with completion scheduled for 1987. The total program cost was expected to be \$48.5 million.



A crash program spearheaded by Southwestern Division and Air Force officials reconstructed the damaged Building 3001 at Tinker Air Force Base in ten months.

Speed has often been a critical factor in Southwestern Division military projects, as illustrated by the reconstruction of the roof of the 54-acre Building 3001 at Tinker Air Force Base near Oklahoma City. The structure has solid masonry walls, high single-story maintenance bays and a large two-story administrative area. It houses a major center for depot-level maintenance on Air Force aircraft and jet engines. "All the stops were pulled," reported one writer, "to re-open a fire-damaged Air Force plant considered critical to U.S. defense."⁴⁶ In November 1984, a blaze, ignited by a workman's torch, destroyed 17 acres of the giant building's roof. It burned for 40 hours and took 400 firemen from 21 towns and cities to control. About 2,000 tons of structural steel and roof decking were ruined, along with utility lines and 12 major aircraft engine repair stations. Two days after the fire started, the Air Force asked the Army Corps of Engineers for help. "We approached this job as if we were at war," one construction company executive said later.⁴⁷

The Southwestern Division, working through its Tulsa District (which had regained military construction responsibilities in 1981), coordinated the \$63.5 million repair job. The Air Force's target date for completion was September 1985—only ten months away. The tight schedule forced a number of changes in the way engineers would normally handle such a rebuilding job. For one thing, the Division and District elected to use a cost-plus-fixed-fee contract, which gives the contractor a set amount over the exact cost of the job, for the major reconstruction work.⁴⁸ Engineer headquarters approved the request in December 1984, and the contract was awarded the following February. Before that, though, the District went to work cleaning up the damaged area. Between November 1984 and March 1985, several firm fixed-price contracts, totaling \$8.1 million, were let to stabilize the structure, remove asbestos, and accomplish demolition necessary to prepare the building for reconstruction. As this work and even the early construction went on, engineers determined how much structural steel could be rehabilitated and how much new material was needed.

Another decision caused by the tight timetable was to begin construction in early March, before the design work was done—even before the scope of the work was completely known. Such an action had risks. A design that was rushed to completion before construction began could result in changes down the line that would cost both time and money. But the decision paid off. Construction was completed in August 1985, except for some items added to the contract by change orders.

The Air Force Regional Civil Engineer and the major command involved, Air Force Logistics Command, had been invited to participate with the Corps in selecting the major contractor. Both had members on the selection board during the evaluation of proposers and selection of the contractor. They also had representatives co-located with the Corps Resident Engineer Office during construction. The resident engineer, as team leader, the Air Force engineering representative, the Logistics Command representative, and the contractor jointly managed the rehabilitation. This team approach eliminated communication problems, misunderstanding, and criticism by the Oklahoma City Air Logistics Center, the building's user. The selection of the right contractor was critical to the success of a cost-plus-fixed-fee contract because the contractor plays a different role from a firm fixed-price contractor. The government in effect buys the management expertise of the contractor, who joins the government representative in managing the contract, thus eliminating the potential adversary role. The Southwestern Division insisted that the eventual contractor have a good record in handling fast-track construction, the ability to handle subcontracts, and a management team willing to dedicate all the necessary resources to accomplish the

job. The Division, after jointly reviewing the potential firms with the Tulsa District, awarded the contract to the Hensel Phelps Construction Company of Greeley, Colorado.⁴⁹

During the work, the cost-plus-fixed-fee contractor was able to manage subcontractors with more freedom than would have been possible under a firm fixed-price contract. Hensel Phelps invited only proven performers to bid competitively on firm fixed-price subcontracts and materials for about 85 percent of its total contract. These subcontractors were brought into the management plan, thereby coordinating all work. The company itself only performed tasks for which a clear scope of work could not be determined. Structural steel was an example; the exact extent of damage could not be determined on many pieces until demolition and cleaning was complete.

In summary, the team effort between the contractor and its subcontractors, the Tulsa District, other Corps entities, and the Air Force resulted in the reconstruction of Building 3001 coming in on time and within budget.⁵⁰

Hospital construction has played another major part in military projects for the Southwestern Division and its Districts since the late 1970s. In 1978, when the Fort Worth District had the sole responsibility for military construction in the Division, it began a rather large project, expansion of Wilford Hall Medical Center at San Antonio, Texas. Located on a 100-acre site on the northern end of Lackland Air Force Base, it would be the largest Air Force hospital once it was finished. Wilford Hall was originally established in 1942 as a 100-bed hospital for the San Antonio Aviation Cadet Center. During its first ten years it absorbed responsibility for medical care at Kelly and Brooks Air Force Bases as well as for Lackland Air Force Base. The original wooden frame structure later underwent some improvements, but they were soon inadequate. In 1961 a 500-bed addition was completed. By the late 1970s more improvements were necessary; plans called for an increase of floor space from 480,722 to more than 1.2 million square feet. The project included construction of a south wing containing a nine-story hospital tower and a three-story clinic addition. A one-story north wing would house a helicopter pad, food service facilities, and physical therapy units.⁵¹

Because of its size and the decision to equip it with innovative features, Wilford Hall numbered among the largest military construction projects in the Southwestern Division. The initial demolition phase of construction occurred in 1976. By its 1981 completion, the Army Corps of Engineers had spent \$100 million on the expansion and construction work.

Wilford Hall had special features such as an automated material handling system; an energy monitoring and control system; a detection and alarm system; a state-of-the-art telephone system; a pneumatic tube system; and an automated medical record system. Its numerous other features included isolation beds on all wards; an automated pharmacy; an automated laboratory for rapid evaluation of diagnostic tests; highly specialized operating rooms for specialties such as eye, ear-nose-throat, neurological, cardiovascular, orthopedic, general, and ambulatory surgery; and classrooms in support of medical education programs.⁵² The hospital deserves special mention not only for its size and innovations, but also because at the time it accounted for a considerable portion of the Division's military construction budget.

In June 1983, the Division began construction of another Air Force hospital, a 140-bed facility and boiler house rehabilitation at Carswell Air Force Base near Fort Worth, Texas. Scheduled for completion in 1988, this project will refurbish about 206,000 existing square feet, and add about 155,000 square feet that will house a new clinic with 61 emergency-preparedness beds and 23 dental treatment rooms.

Dentist and hygienist in a Division-designed clinic at Fort Hood, Texas, treat a patient.





For the United States Army, the Southwestern Division designed and built three hospital expansion projects: Darnall Army Hospital at Fort Hood, Bayne-Jones Hospital at Fort Polk, Louisiana, and the Bradley Annex of the William Beaumont Hospital at Fort Bliss, Texas. The Darnall Army Hospital work started in 1979 and was completed in 1984. It consisted of a new five-story addition encompassing 252,000 square feet and rehabilitation of 200,000 square feet in the existing hospital. The work included utilities, parking areas, a new ambulance garage, boiler plant additions, and a solar-booster hot water heating system that provides 50 percent of the hospital's hot water needs. Costing \$47 million, the project tripled the amount of clinic space and provided additional operating and recovery rooms. A nuclear medicine and occupational therapy clinic was also added.

Darnall Army Hospital, Fort Hood, Texas.

At Fort Polk the Division started a new seven-story, 169-bed hospital in 1978 and completed it by 1983. Costing a total of \$40 million, the total project had a roof-mounted solar energy system, a central plant for boilers, refrigeration, and emergency power generators, an ambulance shelter, and a helicopter pad. Near El Paso, another expansion project got under way in 1980 at the William Beaumont Hospital. It consisted of a new clinic annex with complete outpatient treatment, a new central data processing center,

Wilford Hall Hospital, Lackland Air Force Base, Texas.





USAF Regional Hospital, Carswell Air Force Base, Texas.

an ear, nose, and throat clinic, and a new loading dock for clinic and medical supplies. This three-story facility cost \$28 million and was finished in 1982.⁵³

Another project at Fort Polk, less innovative but larger in dollar terms, was a tactical equipment shop and auxiliary structures. These eight buildings replaced old, dilapidated ones constructed during World War II. The total cost was \$49 million.

Fort Hood continued to be a source of major military projects for the Southwestern Division and the Fort Worth District during the 1980s. None were spectacular or exotic, but they nonetheless accounted for a large sum of money. The following chart shows the type of projects and their cost.

Southwestern Division Construction Projects
at Fort Hood, Texas, 1980-1985

Type	Amount (in millions)
Vehicle and Maintenance Shops	\$ 18.00
Aircraft Hangars with Shops	33.00
Headquarters and Operations Bldgs.	19.00
Flight Simulator	4.00
Training and Mobilization Facility	10.24
Direct Support Maintenance Shop	7.63
Tactical Vehicle Wash Facility	6.46
III Corps and Fort Hood Headquarters	26.14
Total	\$124.47

Source: Southwestern Division Construction-Operations Division, 1986.

Table 5-1

Another aspect of military construction for the Southwestern Division and its respective Districts was the Army Range Program. As weaponry

became more sophisticated, Army installations needed facilities for training soldiers in up-to-date equipment. At Fort Hood, new range construction begun in 1983 was still in progress in 1986. The work cost \$32 million through 1985. The ranges would have moving armor targets with supporting targets, ammunition docks, briefing buildings, and control towers. For Fort Bliss, the Army requested a variety of range projects. Two of them were designed to train infantry rifle marksmanship, one project was for short range air defense systems, and one was a complete multi-purpose range that would provide moving and stationary targets for tanks and also allow aerial gunnery training for helicopter gunships. All three of the Fort Bliss projects were done in 1986, at a total cost of \$25 million.

Other range projects were still under way in 1986. At Fort Polk, a multi-purpose range with an potential cost of \$27 million was scheduled to begin construction in late 1986. And at Fort Sill, an Artillery Training Center and an Infantry Remote Target System were under way. The former was 75 percent complete in July 1986, and the latter was scheduled to be about 40 percent complete by August 1986.⁵⁴

Because of the large number of military projects mandated by the Reagan administration, the Fort Worth District was being overwhelmed. In contrast, by 1981 the Tulsa District's large Engineering Division was facing a reduction in force. The Southwestern Division suggested to the Office, Chief of Engineers that Tulsa be allowed to resume military responsibilities. The headquarters agreed, and the Tulsa District took over the states of Oklahoma and Arkansas. The transition began in mid-1981 under the direction of the Division Engineer, Major General Hugh G. Robinson. The engineer headquarters had arranged a schedule of implementation, in which Robinson found one drawback. "Some of the target dates cited in the OCE schedule," he informed the Tulsa District Engineer, "are earlier than those contained in our plan. Since this is an intradivision transfer, I have informed the OCE that we will follow our time schedule. Your plans and actions should be made accordingly." The transfer was completed on 1 May 1982.⁵⁵

In 1980 the Fort Worth District began awarding contracts, which by 1986 amounted to \$40 million, to build a High Energy Laser System Test Facility. Located on the White Sands Missile Range, it was designed to provide



Tanks get a bath in a mechanized wash facility at Fort Polk, Louisiana.

Construction workers at Fort Polk build an igloo for ammunition storage.

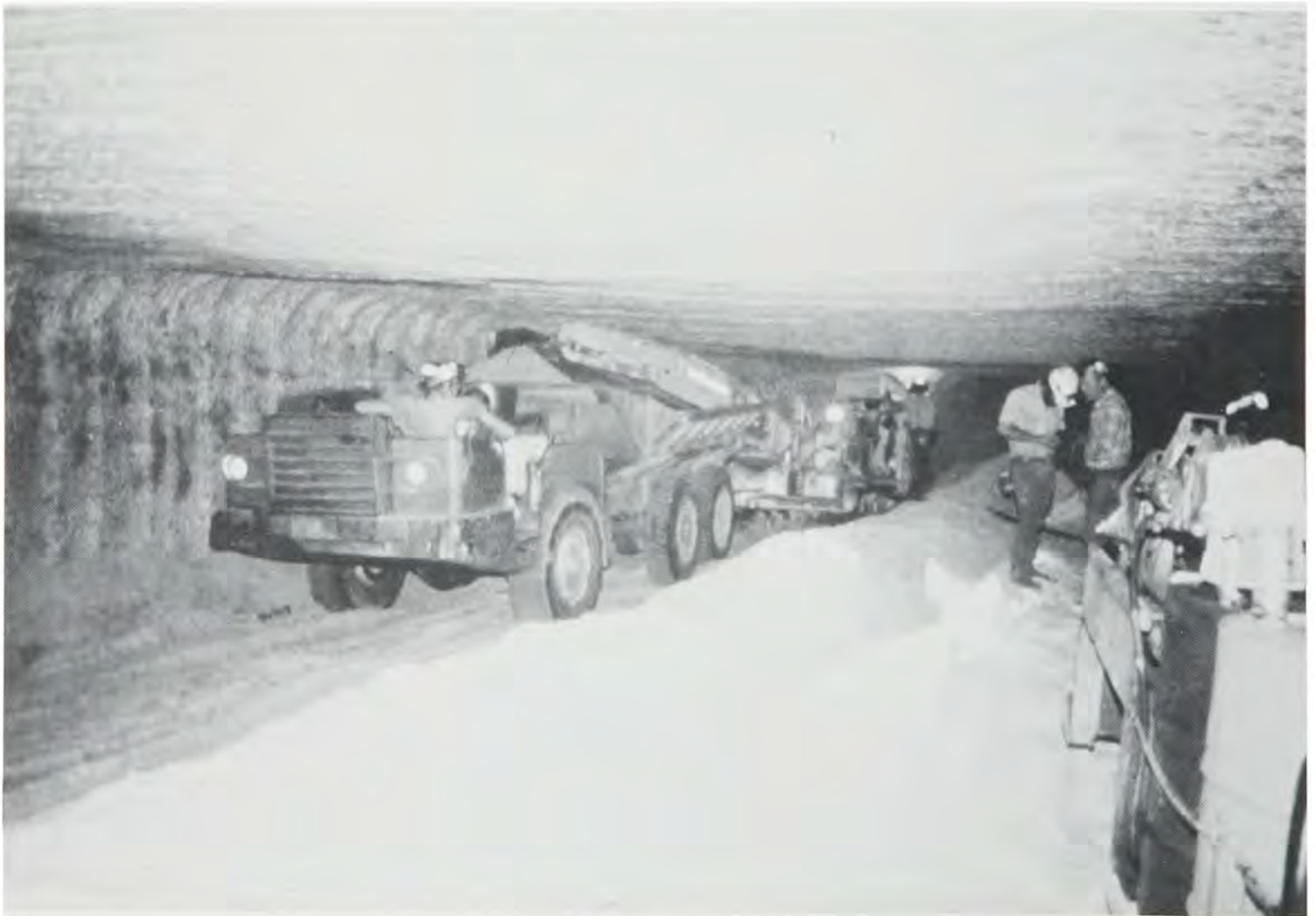


both Army and Navy with a complete facility to test high energy lasers and their effects on various materials both confined in the main facility and on other target areas downrange. This project served as a basis for President Reagan's Strategic Defense Initiative, known as the "Star Wars" initiative.

With the continued decline in civil works, it became apparent that the non-military Districts would soon have little engineering to perform. The Districts' expertise in the various engineering disciplines was being lost over the years. Some small civil works projects were overseen by personnel trained as foresters or biologists. Often these people had no training or background in engineering or construction. The Division became concerned with this situation. To correct it, the Tulsa and Fort Worth Districts were directed to "broker" some of their military engineering and design work to the other Districts. This action was necessary to help the civil-works-only Districts prepare to take over the military mission within their boundaries in the event of mobilization.⁵⁶

Other events further expanded the roles the Albuquerque and Little Rock Districts would take in the military program. A Department of Defense initiative gave certain local commanders increased authority over their activities as a test. Under this Model Installation Program, Kirtland Air Force Base, New Mexico, chose to bypass the Air Force Regional Civil Engineer office and the Fort Worth District for execution of some of its military projects. They chose instead to have the Albuquerque District help them. In 1986 the Division also transferred design and construction responsibility for Fort Wingate and Holloman and Cannon air force bases, all in New Mexico, to the Albuquerque District.

Waste Isolation Pilot Program, Department of Energy, Carlsbad, N.M. The conveyor belt of this continuous mining machine loads salt into a dump truck. The machine's action produces the uniform appearance of the salt cavern's wall and ceiling. (Photo by U.S. Department of Energy)



Some less-conventional projects increased the Southwestern Division's military workload and affected the realignment of construction responsibilities among its Districts. In May 1982, the Army signed an interagency agreement with the Department of Energy, and the Albuquerque District began construction of the Waste Isolation Pilot Plant near Carlsbad, New Mexico. It was to be the first permanent repository in the world for storage of the by-products of the nuclear defense industry. Scientists had determined earlier that underground salt formations were the safest storage areas for such by-products. Some suitable deposits were found a short distance below Carlsbad. This project was a great benefit to the Albuquerque District, which had "faced [an] uncertain future," according to one source.⁵⁷ The Albuquerque District Engineer, Lieutenant Colonel Julian Pylant, was anxious to get the assignment to build the plant because of a 1979 Division realignment study. Division Engineer Robinson, faced with the possibility of closing the Albuquerque District, wanted to examine all possible alternatives for it. He had urged the Office, Chief of Engineers to be more aggressive in handling construction projects from other agencies. Robinson and Pylant together sold the headquarters on the logic of giving the waste storage project to Albuquerque District. The Energy Department, which had already engaged in preliminary discussions with Pylant, welcomed the Army Corps of Engineers as its construction agent. Thus, the plant enabled the Albuquerque District to add employees and survive what had apparently been a real possibility of closure.⁵⁸ The project was scheduled for completion in 1986.

The Fort Worth and Tulsa Districts jointly worked on another unusual project currently being built for the Department of Energy—a \$43-million addition to the Pantex Plant, located 21 miles northeast of Amarillo, Texas. The plant, originally built to fabricate chemical explosives, is now the nation's only operating final assembly point for nuclear weapons. The basic interagency agreement between the Energy Department and the Army Corps of Engineers, signed in November 1981, defined the overall responsibilities and authority and the scope of the project. Essentially, the Fort Worth District was responsible for awarding and managing construction projects, while Energy retained control of design contracts and design assistance to projects under construction.

Realignments continued into 1985, when the Division transferred all the military projects in the state of Arkansas from the Tulsa District to the Little Rock District. The move resulted from pressure from the Arkansas congressional delegation, which feared the Corps was planning to close the District. In September 1985 the Division also transferred the Fort Worth District's Northwestern Area Office to Tulsa to make up for its loss and to relieve Fort Worth of some of its heavy military workload. "FWD had an extremely complex military construction program for both the Army and the Air Force," stated the Division Engineer, Major General Robert Dacey, "and was also dealing with some very tough civil works problems. I felt the District was very heavily loaded and had a very difficult program to execute."⁵⁹

In July 1984, the Division received a new assignment in the area of military construction, the Defense Environmental Restoration Program. During the Carter administration, the Department of Defense had begun to realize that many of its current installations and formerly used properties contained dumps or storage sites containing hazardous materials, often dating back to World War II or earlier. As was the case with the DDT at Pine Bluff Arsenal, officials at the time had not known how dangerous these materials could be. The Defense Environmental Restoration Program was the department's first coordinated effort to clean up the sites. Each branch

of the service was responsible for its own active installations, but the Army Corps of Engineers received the responsibility to determine and correct any problems found on former Department of Defense sites. The Corps defined three types of hazardous materials: debris, ordnance, and hazardous or toxic waste.

The Southwestern Division received responsibility for sites in Texas, New Mexico, Oklahoma, and Arkansas. Its first job was to locate, from real estate searches and other records, all formerly used property. By July 1986, the Division had found 720 sites. Ninety-three had been inspected and reports submitted. The first cleanup contract involved the removal of an old sewage treatment plant that was formerly part of Fort Hood near Killeen, Texas.⁶⁰

By 1986 military construction in the Southwestern Division was large and varied, ranging from mundane projects to some of the most exotic in the United States. The large military workload had offset the decline in civil works construction. Military projects will certainly remain an important part of the Division's work because of the advantages of the Southwest for defense installations. Military construction will also probably serve to keep all the Districts active. "It was in the national interest to have a diversified, fairly equal representation of Corps District offices around the country," said a former Division Engineer, retired Brigadier General Robert Donovan. "It would just not be in the national interest to phase out a bunch of Districts and close them up and say operate eight-to-ten Districts where previously we had some 40 to 42."⁶¹

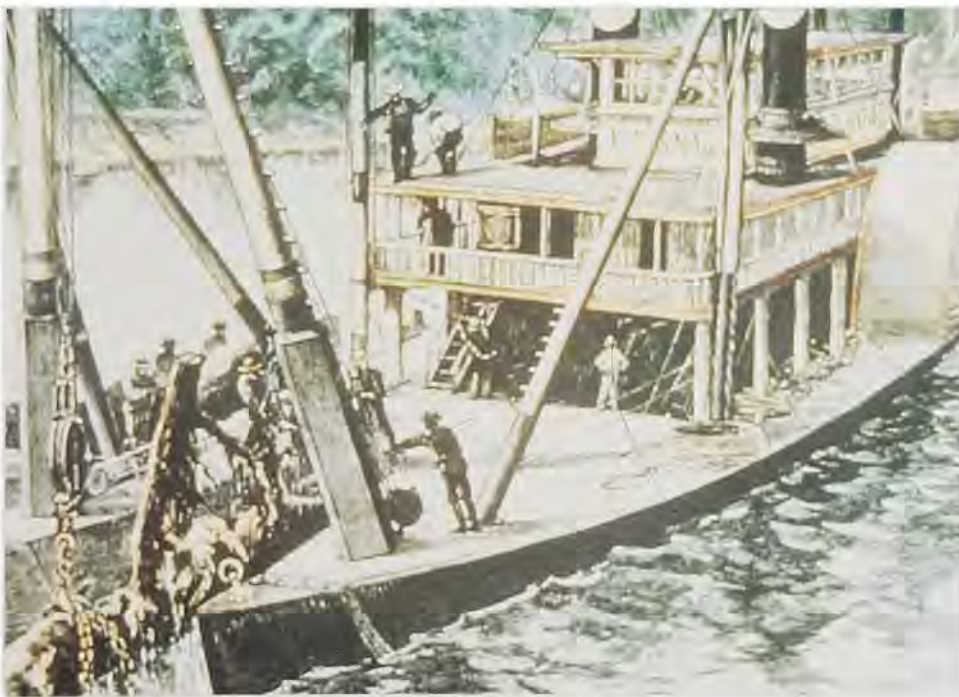
VI THE McCLELLAN-KERR WATERWAY

When it was finished in 1971, the McClellan-Kerr Arkansas River Navigation System was the largest civil project ever built by the Army Corps of Engineers. From its beginning on the Mississippi River, the system runs for 448 miles to Catoosa, Oklahoma. It has 17 locks and dams with a total lift of 420 feet. Several large reservoirs were built on the Arkansas River and its tributaries as part of the navigation project. Some of the dams generate hydroelectric power; total generating capacity of the system is 394 megawatts. The waterway cost \$1.2 billion when it opened, the largest amount spent up to that time by the United States on a water development project.

When the Southwestern Division was created in 1937, the Arkansas River had long been regarded as a natural resource useful for the economic development of its entire watershed. In 1820 the riverboat *Comet*, the first to enter the river, arrived at Arkansas Post, Arkansas, some 60 miles from the junction with the Mississippi River. That same year the steamboat *Maid of Orleans* also reached Arkansas Post, and two years later the *Eagle* paddled up to the small village of Little Rock. Shallow water prevented the regular use of steamboats beyond Little Rock during the 19th century. But during high water, light draft boats traveled as far as Fort Gibson in Indian Territory.

Snags—submerged logs and tree trunks—were another hazard that claimed many vessels. In 1832 Congress appropriated \$15,000, authorizing the Corps to maintain a channel on the Arkansas. But snag clearance was irregular because of the uncertainty of congressional appropriations. In 1881 an Army Corps of Engineers office opened at Little Rock, concentrating on river use between there and the Mississippi. But in 1921 that District was deactivated and absorbed by the Memphis District, where it remained until 1937.¹

During the 19th century Little Rock and the state of Arkansas played leading roles in promoting a waterway to make the whole river navigable by steamboats. In 1907, however, Oklahoma was admitted to the Union, and the Sooner State began to play an important part in the affairs of the river. The first white settlement at what would become the city of Tulsa,



The government and private companies used snag boats to remove obstacles to navigation on the nation's rivers.

Oklahoma, had been established in 1882, with incorporation in 1898. Oil was discovered there in 1901. Tulsa grew rapidly; by 1910 it was on the way to becoming the mid-continental oil center of North America. Business interests there saw the Arkansas River as a link to the Gulf of Mexico and international ports.²

A brief success with navigation had occurred in Oklahoma in 1906 when Muskogee businessman Charles N. Haskell and five friends bought the riverboat *Mary D* and operated it between Muskogee and Fort Smith, Arkansas, for several years. Savings in freight rates prompted them to build the *City of Muskogee*, which was launched in 1908. Oklahoma interests were quite enthusiastic over navigation, and the 1907 Trans-Mississippi Commercial Congress held in Muskogee urged Congress to improve the river for navigation between Tulsa and Fort Smith. The state's first legislature did the same. The Tulsa Commercial Club, later known as the Chamber of Commerce, established a Deep Water Committee for the express purpose of making the Arkansas a navigable stream.³ By 1915 the Tulsa promoters had convinced their Muskogee counterparts that navigation should extend to the oil city. Interest in making the river a navigable waterway had also continued to grow in Arkansas.

Two persons strongly interested in making the river a navigable waterway were Clarence Byrnes and Newton "Newt" Graham. Byrnes edited two newspapers in Fort Smith and used them to promote the navigability of the Arkansas. Though many people at the time questioned the engineering feasibility of his idea, Byrnes insisted the project could be accomplished. For the next generation he would appear before congressional committees and other appropriate bodies on behalf of the navigation plan. "Mr. Byrnes was more than any other private citizen," concluded one writer, "identified with the navigation project."⁴

"Newt" Graham was Byrnes' counterpart in Oklahoma. In 1927 he was appointed to the Waterways Committee of the Tulsa Chamber of Commerce, which according to Charles Gannaway, one-time chairman of the board of the Arkansas Basin Development Association, was "probably the most important move that took place in the long fight to make the Arkansas River navigable . . ."⁵ Graham gave top priority to the project until his death in 1957. His primary interests lay in navigation, flood control, and bank stabilization of the river; he favored power production only when it enhanced the economic feasibility of a particular project.

In response to the 1927 flood in the Mississippi Valley, Congress in 1928 ordered another survey of the Arkansas River basin. Under the command of George Shepherd, a field crew from the Memphis District began in January 1929 to survey the Canadian and Cimarron rivers, Oklahoma tributaries of the Arkansas. Their study pointed up the water-shortage problem—in particularly dry years the stream ran too low to handle traffic. In early 1929 Major Francis B. Wilby of the Memphis District conducted a public hearing in Tulsa at which citizens presented their views on Arkansas navigation and flood control. Representatives from Oklahoma stressed navigation on the grounds that a waterway would bring substantial savings in freight rates. Representatives from Kansas, however, were more concerned about flood control of tributaries such as the Verdigris and Neosho rivers.⁶

The year 1929 was eventful in other respects. For one thing, Congressman W. W. Hastings of Tahlequah, Oklahoma, introduced a bill that would appropriate \$20 million for improving the Arkansas River up to Tulsa. The bill included navigation features. Although the Memphis District had not yet concluded its study, Hastings was confident the report would recommend that the river be made navigable. But Congress refused to pass the measure.⁷ Even more significant was the creation that year of the Arkansas

River Association, a collection of business interests in Oklahoma and Arkansas that wanted to see navigation on the river. The organization affiliated with the Mississippi Valley Association, a conglomerate of individuals and groups seeking flood control measures for the whole Mississippi River Valley. In 1931 Newt Graham headed the Arkansas River Association, using it as a base as he fought his long crusade for the waterway.⁸

In July 1935, the Corps' comprehensive study of the Arkansas River and its tributaries was finally transmitted to Congress. It was published as House Document 308, 74th Congress, First Session, and commonly known as the Arkansas 308 report. A thorough three-volume study, it identified the sites for potential dams on the Arkansas and its tributaries. It also reported that a navigation channel as far north as Tulsa was feasible but not economically justifiable. The estimated cost of building a nine-foot channel to Catoosa, Oklahoma, was \$192 million. Annual operating costs were estimated at \$18.7 million, but annual estimated savings in freight came only to \$10.2 million. The Memphis District Engineer, the Lower Mississippi Valley Division Engineer, the Mississippi River Commission, the Board of Engineers for Rivers and Harbors, and the Chief of Engineers all agreed with these findings. But they also agreed that some flood control features of the report had merit.⁹ Proponents of navigation were unhappy with the Corps' report and continued to work for a navigation waterway.

Graham, for example, charged that in estimating benefits and costs of the proposed canal, the Corps had discriminated against the Arkansas when compared with similar studies of the Tennessee and Missouri rivers. In February 1936 he addressed the Tulsa Chamber of Commerce, presenting a brief he had prepared in opposition to the 308 report. The group agreed with him and declared the report to be prejudicial. The chamber officials added that the report would prevent economic development of the Arkansas River basin. They formally instructed Graham "to take such steps as may be reasonable and necessary to effect changes in said No. 308 Report...to the end that justification be shown and recommended by the U.S. Army Engineers in their final report to Congress."¹⁰

Meanwhile, Congress took steps to begin the fight against floods on the Arkansas. The Flood Control Act of 1936 authorized six flood control reservoirs on the upper basin: Caddoa, Optima, Fort Supply, Great Salt Plains, Hulah and Conchas. Some levee and bank control works were also authorized. A devastating flood in 1937 on the Ohio and Mississippi rivers reminded Congress again of the urgent need to tame America's rampaging rivers. So when the Chief of Engineers that year recommended another seven reservoirs in the Arkansas Basin to reduce flooding in the lower Mississippi Valley, the lawmakers authorized \$21 million for them in the Flood Control Act of 1938. The new reservoirs were Mannford, Oologah, Tenkiller Ferry, Wister, Blue Mountain, and Nimrod. Local agitation for these projects had helped persuade Congress to approve them, but the natural tendency during the Depression to inaugurate public works for the sake of relief and employment also played a part. Navigation facilities on the river, however, had not been authorized in either package.¹¹

Thus, when the Division was established in 1937 with Colonel Eugene Reybold as Division Engineer, the Arkansas waterway was still quite some distance from reality. For the most part it was still a dream of business interests in Arkansas and Oklahoma, who envisioned linking the commercial and manufacturing centers of Little Rock and Tulsa with the Gulf of Mexico. Physical barriers stood in the way—primarily the occasional lack of water to sustain barge traffic and the vicious nature of the river's floods. An engineering plan to overcome these contrasting difficulties would be costly.



Low water and sandbars prevented regular navigation on the Arkansas River before the McClellan-Kerr system was built.

And the problem of proving a navigation waterway economically feasible still remained.

Reybold's earlier experiences qualified him to serve as the Southwestern Division Engineer. As District Engineer at Memphis, Tennessee, he had directed the most recent surveys and examinations of the Arkansas River Basin and so was well acquainted with the technical and engineering aspects of the flood control plan. In 1938 Reybold and the Little Rock District Engineer, Lieutenant Colonel Stanley L. Scott, accompanied Major General Julian Schley, Chief of Engineers, on a week-long tour of project sites in Oklahoma. Newt Graham joined the group. No particular decision came out of this tour. But in 1939 the Office, Chief of Engineers established the Tulsa District. Graham and Reybold had developed a close friendship, and the latter allegedly favored Tulsa as the location of the new District.

In 1939, Colonel Reybold established the Arkansas River Survey Board to conduct a full study of the river. This report became the basic document for the navigation project when Congress finally authorized it in 1946. The board consisted of the Little Rock District Engineer, Lieutenant Colonel Scott; the Tulsa District Engineer, Captain Harry Montgomery; and a civilian employee of the Southwestern Division. Charles H. Henriquez and H. G. Doke of the Engineering Branch frequently represented the Division at the board meetings and assisted the two Districts. They provided information,

for example, on the potential hydropower capability of the area, since hydropower design was exclusively a Division responsibility.¹²

While this study was under way, two men important in the development of the project were elected to public office: Arkansas Senator John L. McClellan and Oklahoma Governor Robert S. Kerr. McClellan had served in the House of Representatives and won the Democratic primary for the Senate, which was tantamount to final victory. During his first year as senator he introduced Senate bill 1519, providing for the construction and operation of flood control and navigation improvements in the basins of the Arkansas and White rivers. President Franklin Roosevelt described McClellan's plan as "an important forward step in effectuation of the policy of multipurpose development of our great river basins and the prudent conservation of our vast public resources."¹³ The bill failed, but McClellan continued to fight for water development in his state. Indicative of his interest in the subject were his 10 years as president of the National Rivers and Harbors Congress and his term as president of the Mississippi Valley Flood Control Association.

In 1942 oilman Robert S. Kerr was elected governor of Oklahoma. His interests had centered on petroleum and Democratic politics; he co-founded the Kerr-McGee Oil Company and had served on the Democratic National Committee. Born near Ada, Oklahoma, in 1896, he went to the East Central Oklahoma Normal School and set up law practice in his hometown. In 1926 he started a drilling business, marking his entry into the oil industry. He served as governor from 1943 through 1946 and was elected to the United States Senate in 1948. He was a close friend of Senate Majority Leader (later President) Lyndon B. Johnson of Texas. Kerr became chairman of the Senate Public Works Subcommittee for Flood Control and Rivers and Harbors and was an ex-officio member of the Appropriations Committee for related projects. He thus occupied a particularly strong position to fight for the Arkansas waterway. Throughout his political life Kerr espoused resource development and used the slogan "Land, Wood and Water."¹⁴

In 1945 the Arkansas River Survey Board, now chaired by Southwestern Division Engineer Robert R. Neyland, Jr., forwarded its report on a multipurpose plan for the Arkansas River to the Board of Engineers for Rivers and Harbors. It made three basic recommendations: that the flood control features of the plan be authorized; that the navigation aspects of the plan be delayed until the Federal Power Commission made a study of the power market in the basin; and that a study be made of the sedimentation problem associated with the plan. But the Board of Engineers disagreed about the navigation features and recommended that they be deferred until better assurance could be made about the benefits of navigation. Reybold, now Chief of Engineers, did not see it that way. "The navigation features comprise the principal part of the plan of improvement and will provide the greatest benefit to the area," he said.¹⁵ "We believe that the Chief has a vital interest in this report," Graham told Kerr, "as he served a few years as Division Engineer for the Arkansas Basin and probably knows the possibilities better than any other man . . ."¹⁶

In reality, three separate plans were contained in the Survey Board report. One considered only navigation at a cost of \$373 million. Of that, \$28 million would be spent on the Mannford and Oologah reservoirs already approved by Congress. Benefits expected from the waterway were the annual savings in freight rates and the rental from part of the land acquired for the Taft and Eufaula reservoirs that were then part of the plan. Annual expenses were estimated at \$19.5 million. The estimated savings in transportation costs were \$19.6 million. There would also be \$134,000 revenue from



Senator John L. McClellan



Senator Robert S. Kerr

land rental, making a total annual income of \$19.74 million and a navigation-only benefit-cost ratio of 1.01-1.00.¹⁷

A second plan dealt only with hydropower. Its cost was estimated at \$373 million, of which \$59 million would go to reservoirs already approved: Oologah, Tenkiller Ferry, Markham Ferry, and Fort Gibson. Annual costs were estimated at some \$15.5 million with benefits at \$13.4 million, for an annual benefit-cost ratio of .86-1.00. The Board of Engineers did not consider this plan justifiable, especially since much well-developed land would be inundated, making a considerable impact on the social and cultural life of the area.¹⁸

The third plan had the most significance, for it incorporated the concept of multipurpose planning. It included navigation, hydropower, flood control, and recreation. The waterway would require 27 locks and dams: 3 on the Verdigris River and 24 on the Arkansas. It also called for four new reservoirs—Dardanelle, Ozark, Webbers Falls and Short Mountain, which would be used for power development—making 13 in all. The cost was estimated at \$523 million, including \$77 million for projects already approved. The benefit-cost ratio was 1.08-1.00.¹⁹ This was the plan that was finally submitted to the lawmakers.

The ultimate decision belonged to Congress. The Oklahoma congressional delegation generally supported the project, although Congressman A. S. Mike Monroney tried to persuade the House not to approve it. He emphasized the marginal benefit-cost ratio and the opposition of the Board of Engineers for Rivers and Harbors. Monroney offered an amendment to eliminate the Arkansas River project from the 1946 Rivers and Harbors bill, but it was voted down. The Senate also approved the waterway. So when President Harry S Truman signed the bill in 1946, the Arkansas River navigation project became reality.

Proponents had emerged victorious in two respects. Not only had they won approval for a navigation waterway, but the timing was right. Throughout the country there was fear that the United States would fall into another economic depression when defense spending stopped at the end of World War II, so there was a natural inclination to plan public works for the war's end. In 1944 Graham and Don McBride, chairman of the Oklahoma Planning and Resources Board, had urged Governor Kerr to call upon President Roosevelt and convince him of the merits of the navigation project.

But public jobs were not necessarily enough to ensure a project's passage. There also had to be a package of solid research showing the need for a dam and the feasibility of the work. The Fort Peck Dam on the upper Missouri River had not been approved in 1933, when public works were fashionable, because of the lack of research data on it. "Certainly we don't want to be in the same position if public works must come in the post war period," Graham and McBride told Kerr.²⁰ Thus, the willingness to instigate public projects only partly accounted for the project's approval. So the proponents had worked with a sense of urgency during World War II in order to have all necessary information and studies by the Corps and other parties completed by the end of hostilities.

Despite its 1946 authorization, the waterway still faced an uphill struggle. In 1951 Congress took action that was not aimed at the project but which, nonetheless, affected it directly. The House Public Works Committee created a special subcommittee to examine federal water project policies and procedures. No particular project was targeted; Congress wanted an analysis of the procedures and operations by which projects were approved and built. The subcommittee filed four major documents showing that the Corps of Engineers had more than 900 authorized projects that had not been started. It was obvious that a system of priorities had to be established. The Public

Works Committee ordered the Corps to review its civil works projects and recommend which should be put into active and which into inactive status.²¹

Some projects went into a third category, "deferred for further study." That was where Brigadier General Claude H. Chorpening, Assistant Chief of Engineers for Civil Works, placed the Arkansas River waterway in 1954. For political sponsors of the project like Kerr, McClellan, and Graham, this decision was a real setback. So the Southwestern Division and the Tulsa District began immediately to re-examine the navigation project. In December 1954, the Southwestern Division Engineer, Brigadier General Lyle E. Seeman, told the Chief of Engineers that the "project should be reinstated in the active category . . . its restitution to an active project is necessary due to the comprehensive nature and its relation to other individually authorized projects and in view of the interest of Arkansas and Oklahoma leaders."²²In 1955 the Chief of Engineers, Lieutenant General Samuel D. Sturgis, informed the Public Works Committee and the director of the Bureau of the Budget that the Arkansas navigation project should be reactivated. In the revaluation, the Corps raised the benefit-cost ratio to 1.20-1.00. Sturgis still had some reservations about that figure, however, because the new ratio depended on the future economic development of the Arkansas River Basin. The Corps had calculated the anticipated savings in freight rates based on the foreseen use of barges by manufacturing and industrial firms. Engineer officials were also concerned about how the heavy silt in the Arkansas River might affect navigation. Sturgis recommended that bank stabilization begin immediately and that Oologah Reservoir, on which construction had started in 1950, be completed.²³

The major difficulty engineers faced in designing the waterway was the 100 million tons of sediment that they estimated flowed down the Arkansas River each year. The earliest studies of the proposed waterway had recognized that "silt trap" dams would have to be built to stop the sand. Most of this material came from the Canadian, North Canadian and Cimarron Rivers, all in Oklahoma. Some silt also came from other tributaries of the Arkansas—Verdigris, Deep Fork, Poteau, and Illinois. To combat the silt, the Tulsa District had proposed construction of Eufaula Reservoir on the Canadian River and Keystone Reservoir where the Cimarron joined the Arkansas. The Dardanelle Lock and Dam, one of the largest single projects on the waterway, could not begin operations until these two upstream lakes were finished.²⁴ In 1956, however, the Bureau of the Budget approved \$3 million for Oologah but omitted funds for Keystone, Eufaula and Dardanelle. And the Office, Chief of Engineers withheld approval of the entire project until engineering problems with the silt were resolved.

The Oklahoma and Arkansas congressional delegations sought to counter the Bureau of the Budget. Statements on behalf of the waterway also came from congressmen in other states, showing a carefully arranged display of support. Lobbying strongly on behalf of the project was Oklahoma Senator Robert S. Kerr, who won election and re-election to the United States Senate in 1948 and 1954. In 1956, Kerr became chairman of the Senate Public Works Committee. He managed to obtain funding for the three reservoirs, which were vital parts of the navigation project, because of an even larger public works project under discussion, the Interstate Highway System. This proposed road project had national appeal: it would alleviate much overcrowding on America's roads, greatly improve transportation for civilian and military needs, promote the recreation industry, and generally enhance the quality of life in the United States.

The plan's wide-ranging benefits made it popular with many individuals, but special interests like the trucking industry also lobbied on its behalf. Kerr promised to push the highway program through the Senate in return

for votes for the Arkansas waterway. The Federal Aid Highway Act passed in 1956 provided for a 41,000-mile continuous four-lane road connecting 209 cities in 48 contiguous states. Its estimated cost was \$27.5 billion dollars, 90 percent of which would be funded by the federal government. That same year funds for the three critical reservoirs were voted: \$1.5 million for Keystone; \$1.25 million for Eufaula; and \$650,000 for Dardanelle. This all came about even though neither Appropriations Committee in Congress had taken action; the Bureau of the Budget had not recommended them; and the projects were still on the inactive list at Engineer headquarters.²⁵ Further questions by the Chief of Engineers on engineering or costs were useless; Congress had declared its intention to build the waterway, and the Corps of Engineers had to comply.²⁶

An unexpected boost for the waterway came the next year with the economic recession of 1957-1958. Unemployment rose to its highest level since 1945, pressing the federal government to stimulate the economy. Oklahoma Congressman Edward Edmundson urged the Tulsa District Engineer, Colonel John D. Brister, to expedite construction of Eufaula Reservoir because of unemployment in eastern Oklahoma.²⁷ In 1958 Division Engineer Seeman appeared before the Senate Subcommittee on Appropriations, and was asked if he could use extra funding for the reservoirs already started and for the still-incomplete studies of the navigation project. Democratic Senator Allen J. Ellender, a close friend of Kerr, seemed willing to provide more funds for fiscal year 1959 than Seeman had requested. "What I would like to do," Ellender said, "is to get many of these projects planned so that if this little recession we are suffering now goes deeper, we will have projects of lasting benefit ready for initiation of construction."²⁸ Seeman answered that the Division had enough funds to carry out projects scheduled for the next year, although there had been a six-month slippage on Oologah Reservoir due to insufficient funds. Ellender blamed the President for the slippage, and Seeman was careful not to make a statement that might have political overtones. He answered the questions in a "matter of fact" tone while the committee criticized President Eisenhower.²⁹

Construction of the waterway began in 1957. Ironically, the newly appointed Southwestern Division Engineer, Brigadier General William Whipple, Jr., had opposed the project in his previous job as Executive of Civil Works in the Office of the Chief of Engineers. He still had questions about the silt in the river. His friend, ally, and former boss, Lieutenant General Emerson C. Itschner, was the new Chief of Engineers. Whipple later wrote that Itschner "considered the Southwestern Division his most difficult Division; both because of its size and huge construction program and on account of the Arkansas River Navigation Project."³⁰

Itschner chose Whipple for the Southwestern Division because of his knowledge of sediments. "Don't let anybody tell you that the basic engineering for this project has been worked out," the chief of the Engineering Section at Engineer headquarters told Whipple. "It has not and that will have to be your first priority in Dallas. The existing plans cannot be relied upon."³¹

Whipple's first task was to end the suspicion concerning his commitment to the canal. Shortly after taking command, he spoke to the Tulsa Chamber of Commerce, the single most active group for channelization. "I think you ought to know," he said, "that I was one of the group that put the Arkansas Navigation Project on the shelf some years ago." There were audible gasps, he recalled. "Now the Congress has decided on its construction, there is to be no further discussion or delay. My mission is to build the project just as well and as rapidly as I can. You can count on me for that." By discussing

the subject openly, Whipple eased the apprehension of the audience. In his memoirs, he wrote, "I was over a major hurdle."³²

Whipple had changed his mind about the project for two reasons: Congress had directed the Corps to build the waterway; and he was confident about finding a solution to the sediment problem. He moved quickly on the latter.

Whipple hired three consultants to analyze the relationship between slopes, depths, and widths of contracted channels. From the engineering point of view, the area downstream of Dardanelle to Arkansas Post was the "problem area," a distance of 190 miles. That section of the river had no tributaries. The slope averaged eight-tenths of a foot per mile, and variations in slope were local. Flood flows were uniform. Peak discharges were less downstream, and the main stem was alluvial—the river flowed over beds of its own sediments. "It appeared that by taking full advantage of sediment characteristics of the river, it might be possible to eliminate more of the dams," Whipple believed, "in spite of practical limitations on pool elevation."³³ Essentially, Whipple had to determine if the reservoirs built on the upper stem of the Arkansas River would trap the silt as originally conceived. The test would be the 190-mile-long stretch below Dardanelle.

Whipple organized the consultants as the Arkansas River Sediment Board, acting as an unofficial fourth member himself. He gave the board some publicity and predicted it would manage to eliminate the construction of three or four proposed dams in the navigation plan. In essence, the board tried to control the meandering river and let it cleanse itself. First it discovered that if the upper end of each navigation pool were deepened, the river channel would maintain a greater depth, which was necessary to control the main stem. The board also called for the use of training dikes—lines of rock and sometimes timbers extending into the river perpendicular to the bank. It suggested stacking rocks along the bank parallel to the flow to make revetments. The effect of both was to squeeze the channel and make it deeper and less meandering, and consequently give it greater velocity.³⁴

With its channel confined to a prescribed route, the river would cleanse itself of the sediment, eliminating the need for constant dredging. That was exactly what the board wanted. The Waterways Experiment Station at Vicksburg, Mississippi, built a model to test the ideas; the plans worked.



Construction at Lock and Dam No. 4 near Pine Bluff, Arkansas, made up one part of the McClellan Kerr-Arkansas River Navigation System.

The results came as a relief to Whipple, because the Engineer headquarters had never been satisfied with the engineering plans. Now the headquarters could rest easily. In fact, since Whipple had managed to eliminate three dams at a savings of \$31 million, the Chief of Engineers was quite pleased. The elimination of three structures, and later a fourth one, was not unusual. That frequently occurs between the initial studies and completion of final project plans. "The detailed design and construction of all the structures could now go forward," Whipple wrote, "as fast as funds were provided and the necessary engineering was done."³⁵ To the Chief of Engineers, Whipple wrote: "This project, or rather program, appears to be over the hump politically and from an engineering viewpoint, on the basis of current criteria."³⁶ Whipple made that statement just as he stepped down as Division Engineer.

Speed suddenly became essential to the project, and the next Division Engineer was ideally suited for it. Major General Robert J. Fleming took over in November 1960. He spoke to the Arkansas Basin Development Association, the principal lobbying group for the project, soon after taking command. Toward the end of his speech, he commented that completion of the waterway was now a matter of economics rather than engineering. It was expected to be completed by 1972 or 1973. "Nuts," he added, "if you give us the money we will expedite the program and could finish it in 1967."³⁷ When Senator Kerr received news of Fleming's remark, he moved quickly.

Kerr asked the Office, Chief of Engineers to discuss an early completion date with Fleming. B. Joseph Tofani, chief of the Programs Division in Civil Works at the headquarters, soon conferred with Fleming, who was adamant about 1967. Tofani said it couldn't be done until 1970-1971. Fleming accepted 1970 after Tofani reminded him of the workload and the need to have funding available. A delegation from the headquarters then visited Kerr and explained the agreement. Tofani did not attend. The Oklahoma senator accepted 1970 as a completion date and promised to obtain funding. Fleming started a race against the clock.³⁸

During Fleming's tenure at the Southwestern Division, a major reshuffling of District responsibilities occurred. In 1961 the Tulsa and Little Rock Districts lost their functions in military construction; the Fort Worth and Albuquerque Districts assumed them. In the shifting of personnel that followed, seven men left Tulsa for Fort Worth.³⁹ The Office, Chief of Engineers had originated this consolidation after pressure from the White House to trim costs. For the Arkansas waterway, the changes had importance. Fleming issued an order in April 1961 that gave the Tulsa District responsibility for planning and designing all the locks and dams except for Dardanelle. A memo detailed the changes, including reimbursement of Tulsa District by the Little Rock District for the design work within Little Rock.⁴⁰ The Vicksburg District, part of the Lower Mississippi Valley Division, was at the same time relieved of its responsibilities for work downstream from Pine Bluff, Arkansas.

Even before the pressure began for a 1970 completion date, the construction schedule became sacrosanct. To speed things up, for example, General Whipple brought extra design engineers into the Tulsa District and created two design branches in its Engineering Division. Chief of Engineers Itschner approved the arrangement, and Whipple later recalled, "The two design branches became competitive, and completed plans and specifications began to pour out in fine shape."⁴¹ Fleming's successor at the Division, Brigadier General Carroll H. Dunn, intensified the pace even more by incorporating a principle new in the Corps—the Critical Path Method.

Before joining the Southwestern Division, Dunn had been assigned to the Corps of Engineers Ballistic Missile Construction Office, a special military construction and installation program office for the Atlas F missile system.

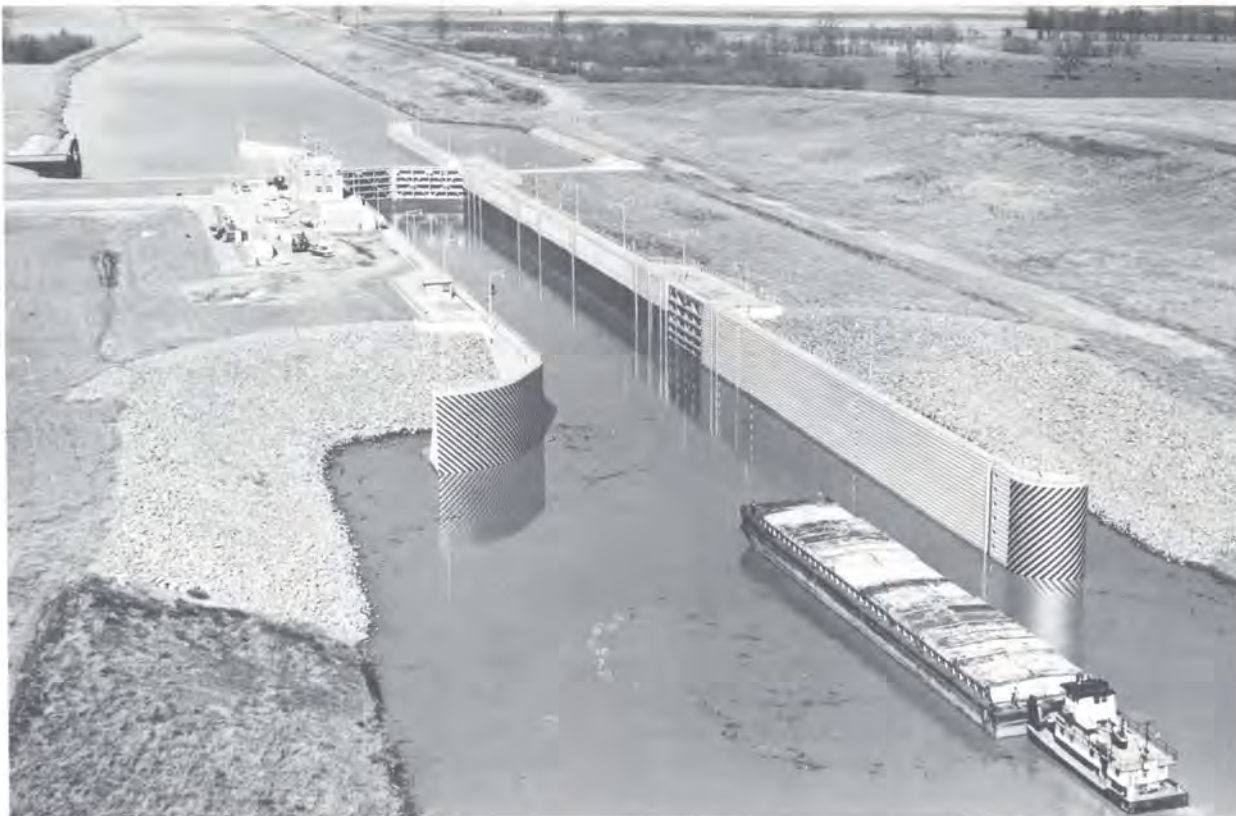
To speed construction, this agency developed a comprehensive plan involving a schedule of congressional appropriations; research; design and engineering; bidding by architectural-engineering firms; contracting; supplying building materials; and all other elements required for installing the missiles. Each step had to be carefully prepared for the next to maintain a continuous flow of both the research data and the materials that would become the missile site. This elaborate plan and schedule became known as the Critical Path Method.⁴²

When General Dunn reached Dallas in March 1962, he established a three-man executive office team to make high-level management decisions. The team included Dunn; his Deputy Division Engineer, Colonel E. W. Fischer; and Executive Assistant Roy Penix. This team told Richard D. Field, chief of the Southwestern Division Engineering Branch, to create a Critical Path Method for the waterway. Directed to hire a private contractor to work up the plan, Fields brought in Ling-Temco-Vought, which drew up a comprehensive schedule. This eight-year plan comprised 5,000 event items that encompassed congressional funding, design and engineering, real estate acquisition, relocation, construction and all other aspects of the waterway.⁴³

The Critical Path Method proved to be a wise undertaking. When Senator Kerr died in 1963, an unexpected loss for the canal's proponents, Senator McClellan took his place in getting congressional appropriations. McClellan used the Critical Path Method plan to show his colleagues the importance of assured funding. Dunn later recalled the method as essential to the successful scheduling of the \$1.1 billion project.⁴⁴



This dedication sign on the McClellan Kerr-Arkansas River Navigation System notes some of those responsible for its completion.



The first commercial towboat to use the Chouteau Lock on the Verdigris River pushes its barges towards the gates in 1971. The McClellan-Kerr system leaves the Arkansas River near Muskogee, Oklahoma, to travel the final 50 miles on the Verdigris to the Port of Catoosa.

Construction progressed smoothly, although President Johnson scared the waterway boosters in 1964 when he cut \$40 million from the project's budget. After some haggling with the congressional delegations from Arkansas and Oklahoma, he reinstated the cut. Major portions of the navigation project were already operating as work continued on the locks and dams. Oologah was finished in 1963, Eufaula in 1965, and Keystone in 1968. The gigantic Dardanelle Lock and Dam opened in 1969, and others soon followed.

On 30 December 1970, the waterway was ready for use. The next day the Southwestern Division Engineer, Brigadier General Harold R. Parfitt, and the Tulsa District Engineer, Colonel Vernon W. Pinckey, sent the following telegram to the Chief of Engineers: "Mission accomplished. Arkansas-Verdigris River System declared open for navigation at Catoosa on 31 December 1970."⁴⁵ Three weeks later, on 21 January 1971, the first cargo of freight, 650 tons of newsprint, arrived at Catoosa. Born from an idea that began a half century earlier, the Arkansas River was navigable.

The Southwestern Division's principal role in the development of the waterway ended in 1970. It soon began work on another significant phase of the project, the study of its impact. A serious difficulty arose as soon as the idea of a study emerged: the near-impossibility of ascertaining the value of the items to be measured. What is the monetary value, for example, of the recreational benefits? Or to what extent do manufacturing companies locate along a waterway solely for advantage of freight rates? Nevertheless, the Corps had justified construction of the Arkansas waterway on its anticipated economic benefits, particularly savings in freight rates and the expected relocation of industries and manufacturers to riverside sites. In March 1969 the Chief of Engineers, Lieutenant General Frederick J. Clarke, announced before the Arkansas Basin Development Association the Corps' intention "to use the project as the best laboratory we have ever had for the clinical observation of a major project through all stages of its development . . . to learn many lessons from its performance . . . to determine where we are going in the field of water resource development, and how we are going to get there."⁴⁶

The machinery for making a study was available via the Institute for Water Resources, a special branch of the Army Corps of Engineers created by Congress in 1969. Located at the Humphreys Engineer Center at Fort Belvoir, Virginia, the institute serves as a research and data gathering arm of the Corps and provides information used by the Corps and Congress for policy decisions on civil works. It makes studies on water resources, environment, economic growth, social well-being, public opinion, planning, and, occasionally, alternative policies. The institute communicates the results of its work through reports, pamphlets, papers, bulletins, seminars, conferences, and training courses. Very often it delegates studies to other parts of the Corps, and it awards contracts to private individuals. The institute authorized the Southwestern Division Economics Branch to conduct and supervise some of the studies on the Arkansas waterway.

The first study of the waterway began in 1972 as a year-long look at commodity shipments. Five Division economists gathered data in Oklahoma and Arkansas pertaining to the use of rail, barge, and truck shipments. They examined freight rates, handling costs, transit distance, shipment size, and the type of items shipped. In August 1974, the Division submitted the study report to the Institute for Water Resources, which published it under the title, *Discriminate Analysis Applied to Commodity Shipments in the Arkansas River Area*. In its conclusions, the Division stated that "shipments were found to flow from or to the Arkansas River study area from at least 33 states and a few foreign countries during 1971."⁴⁷

But the study was made too early to determine fully the impact of the waterway on shipping.

The Economics Branch, working jointly with the Institute for Water Resources, had awarded contracts to universities and consulting firms for 16 studies of the waterway by 1979. The Southwestern Division and the institute reviewed these studies, but their final publication was not regarded as an official position of either one. It was obvious that manufacturers steadily increased their use of the waterway in the 1970s, as seen in the following table.

McClellan-Kerr Arkansas River Navigation System						
Tonnage Date, 1975-1985						
(figures in millions of tons)						
Year	1975	1976	1977	1978	1979	1980
Grain	.686	.891	1.039	.997	1.064	1.481
Iron & steel	.208	.278	.378	.464	.416	.464
Sand, rock, & gravel	2.276	2.281	2.745	2.947	2.806	2.173
All other commodities	1.987	3.088	4.984	5.444	4.125	4.343
Total for all commodities	5.157	6.538	9.146	9.852	8.411	8.461
Year	1981	1982	1983	1984	1985	
Grain	.545	.215	1.908	2.610	1.840	
Iron & steel	1.665	1.871	.418	.785	.704	
Sand, rock, & gravel	1.651	1.507	1.771	2.701	2.604	
All other commodities	3.813	4.230	3.471	2.425	3.187	
Total for all commodities	7.674	7.823	7.568	8.521	8.335	

Source: Southwestern Division Economics Branch.

Table 6-1

The spurt of activity in 1977 came from the generally improved economic conditions in the basin and the opening of some new port facilities. By contrast, the decrease of total tonnage in 1979 stemmed from a decline in the shipment of petroleum products due to the discovery of natural gas in both states. A slump in construction accounted for a reduction in sand, gravel, and rock tonnage. The decline in iron and steel corresponded with changes in American trade agreements with manufacturers in the Far East who had supplied metal fabricators in the river basin.

In 1977 the Southwestern Division awarded a private contract for a study of industrial development in the river basin. The contractor reported that "manufacturing activity had grown in the areas of Arkansas and Oklahoma contiguous to the waterway since its completion," but that access to water transportation was important to only 21 percent of the companies surveyed. Low-cost transportation was a factor for 37 percent of the same companies. Availability and cost of labor were the principal considerations for 51 percent. About 8 percent of the firms listed the canal as the primary reason for relocation.⁴⁸

Those manufacturers whose location was influenced by the waterway were metal fabricators and publishers of printed materials—the raw materials for



The locks at Ozark Lake, Arkansas, help make the Arkansas River navigable.

iron, steel, and newsprint are heavy and costly to ship. For this group, located mostly in Tulsa, Little Rock, and Fort Smith, the availability of labor, nearby sources of raw materials, and relatively inexpensive land costs were the principal considerations that lured them into the area. Availability of the waterway was, nonetheless, a significant factor.

From 1969 through 1975, 374 manufacturing plants located in or expanded in Arkansas. Little Rock accounted for 152 firms, Fort Smith for 81, Conway for 31. Most of the corporations told the Division that availability of labor and its lower cost were the first considerations in locating or expanding. The waterway was a factor for more than 25 percent of the companies, and low transportation rates influenced 35 percent to come to Arkansas.⁴⁹

However difficult it may be to assess the waterway's impact on shipping and industry, the study of social change, particularly demographic patterns, is even more difficult. In 1977 the Institute for Water Resources published the findings of the Department of Sociology at the University of Missouri on the demographic impact of the McClellan-Kerr Waterway. The researchers discovered that the outward migration from the Arkansas River Basin had reversed, but that the welcome changes could not be wholly attributed to the waterway. For instance, migration into the basin started before the navigation system became operable. Young whites left non-metropolitan areas from 1960 to 1970, but they began to return from 1970 to 1975. "Migration was found to have been largely to small cities and towns, with some suburb migration in a few places, and some settlement of elderly in rural areas," the University of Missouri report said.⁵⁰

Few of the migrants surveyed in the study had negative attitudes toward the waterway. About 70 percent reported that jobs and recreation were its greatest assets. Few people planned to leave the area. Migrants were better educated and a larger portion were white-collar workers than non-migrants. But those persons displaced by the reservoirs and other aspects of the navigation system were forgotten by the general public. Half of the displaced persons interviewed thought the land settlement was fair, but partial, nonetheless, to large landowners. Many of the relocatees had lived on subsistence or marginal incomes. "The attitudes of the relocatees reflected numbness and resignation, the desire to forget that the relocation had ever happened, and the recognition that some have to suffer for the good of

many,” the survey report noted.⁵¹ It was apparent that the waterway affected the size, distribution, and composition of the population, and that the principal reasons were job opportunities and recreational benefits.

In its report the University of Missouri concluded that the McClellan-Kerr project had drawn people to the Arkansas River Basin, and the “composition of the population is changing in favor of higher educational, occupational, and income levels as migrants move to the area. This has resulted in greater economic diversity, availability of labor, and in many cases, improved roads, etc”⁵²

By the late 1970s, the waterway was no longer in the public eye. Since the disastrous floods of early years no longer occurred, much of the drama and preoccupation with the Arkansas River disappeared. Barges lazily traveled the stream, going through the locks and dams routinely. Towns and cities along the banks grew, and their inhabitants continued to come closer to the national average in per capita income. By 1975 they had reached the 90-percent mark.

For the Southwestern Division, however, the project only occasionally demanded attention beyond the usual operations, mostly by the Economics Branch. Few people questioned the project’s impact; the questions dealt with whether its nature was more apparent in industrial development, agriculture, or recreation. Harry Ashmore, well-known editor of the *Arkansas Gazette*, said, the “fickle Arkansas, which scourged the countryside with floods and shrank to a trickle in seasons of drought, now runs in bank for the year round, controlled by locks and dams that open up navigation back into what used to be Indian country and lace the great valley with clear lakes. The quality of life has visibly improved.”⁵³

A large part of the nation’s commerce, like this tow and its barges, moves along the McClellan-Kerr system.



VII TRINITY RIVER WATERWAY

In 1973 voters in 17 Texas counties turned down a tax proposal that would have provided local funding for construction of the Trinity River Waterway, a 360-mile multi-purpose navigation project from Fort Worth to the Gulf of Mexico. The controversial election raised an issue of national concern: to what extent should the environment be altered for the sake of economic development? The Trinity River project, even though it was never built, had much significance for the Southwestern Division. To begin with, the Division and two of its Districts, Fort Worth and Galveston, had worked on the project for more than ten years. More important, however, was the evolution of the public's view toward navigation projects in the Southwest. Environmentalists expressed strong opposition to alteration of the environment, while other opponents worried about the costs, because a significant portion of such projects would require local funding. The Trinity River Waterway was a focal point for these questions, and must therefore be regarded as a significant chapter in the Division's history.

When the Southwestern Division went into operation in 1937, the Trinity River had already received considerable attention from the Army Corps of Engineers. Since the earliest families had settled in the Dallas-Fort Worth area, the river had been visualized as a link between the north Texas prairie and the Gulf Coast. Steamboat traffic dated back to 1836 when the *Scioto Belle* traversed part of the river. Other steamboats traveled the river throughout the 19th century, some reaching the Dallas area, but the traffic was sporadic. The river had two major drawbacks to navigation, noted in two early reports by the Corps. In a survey authorized in 1852, the Corps reported that steamboats could use the Trinity only in spring, when the water level was usually high, and in 1891 it said that only the lower portions of the river were navigable because of logjams in its upper stretches.¹

Business interests envisioned, nonetheless, a waterway on the Trinity and attempted to establish a profitable shipping company. In 1891 investors founded the Trinity River Navigation Company and purchased a snag puller, the *Dallas*, and a steamboat, the *S.S.J.H. Harvey, Jr.* With the snag puller going in front, the *Harvey* completed a trip from Galveston to Dallas in 1893. Further trips proved impossible because of numerous log jams. The river remained undefeated, and in 1898 the company sold its vessels.²

In 1899 Congress authorized \$7,000 for a preliminary survey of the Trinity. The Corps was instructed to estimate the feasibility of dredging the river to three depths: four, five, and six feet. Lieutenant Colonel Charles S. Richie, who conducted the survey, reported that construction of a waterway would require 37 locks and dams at an estimated cost of \$4.65 million.³ Congress appropriated funds to begin construction in 1902. Additional funding came and some work began. At the peak of construction, 170 men worked on the project, and several locks and dams were partially built.

World War I interrupted construction, which never resumed. The availability of modern railroad service in the Dallas-Fort Worth area was one cause. In 1921 the seven railroads serving Dallas built a large, modern railroad station. To discourage further construction of a waterway, they located their terminal on what would have been the best site in Dallas for a navigation terminal. That same year, furthermore, the Corps made another study to determine the feasibility of finishing the project. It determined that, except for the area below Liberty, Texas, navigation was not economically feasible. The study again cited the shortage of water as the major drawback. By 1921, therefore, the first construction program ended with a few locks and dams partially built.⁴



Logjams on the Trinity River in Texas prevented navigation in spite of constant work by snag boats like this one.

Despite these setbacks, some business interests in Dallas still hoped to get congressional authorization for a waterway. In 1925, civic and business leaders in Dallas and Fort Worth founded the Trinity River Canal Association. To get things moving, the association persuaded the Texas legislature to establish the Trinity River Canal and Conservancy District in 1931. The District was to become a legal agency that would administer the activities involving the canal, but it needed voter approval to carry out its various responsibilities. An August 1935 election resulted in a defeat for the canal proponents. Without local support, congressional interest in reviving the waterway project did not seem likely.⁵

Passage of the 1936 Flood Control Act, however, once again enhanced the chances of a Trinity River project being termed economically feasible. By incorporating the principle of multipurpose development, the act broadened the criteria by which water projects could be measured and declared economically possible.⁶ Thus, at the time of the Southwestern Division's 1937 creation, the proposed Trinity River Waterway already had a long history.

In 1938 proponents of the waterway formed the Trinity Improvement Association. The first step toward renewed construction came in 1945, when Congress appropriated funds for several reservoirs in the river's upper basin—Benbrook, Grapevine, Garza-Little Elm (now Lewisville), and Lavon. The Trinity Improvement Association had continued to fight for approval of the project, and in 1955 persuaded the Texas legislature to create the Trinity River Authority. This political subdivision comprised all the territory contained in Tarrant, Dallas, Ellis, Navarro, and Chambers counties, plus those portions of other counties that lay within the Trinity watershed. The Trinity River Authority was required to develop a river master plan that had to include navigation, and it was empowered to levy a property tax of two cents per \$100 of county evaluation. Remembering the fate of the Conservancy District in 1935, the authority's directors waived their right to collect fees and expenses and did not submit a tax proposal.⁷

Both the improvement association and the river authority believed that the project would prove to be economically feasible if the Corps conducted another study. To prove its position, the Trinity Improvement Association in 1957 commissioned a special study of the river, conducted by private consultants. The study showed a benefit-cost ratio of 2.90-1.00.⁸



Paddle-wheeled snagboats like this one tried unsuccessfully to make the Trinity River navigable in the 19th century.

In view of the renewed interest in a waterway, Congress in 1958 authorized a full-scale study of the Trinity by the Corps of Engineers. The responsibility fell to the Southwestern Division and two Districts, Galveston and Fort Worth. Completed in June 1962, the survey recommended the construction of a multipurpose channel for flood control, water transportation, and recreation; four multipurpose reservoirs: Tennessee Colony, Aubrey (now Ray Roberts), Lakeview (now Joe Pool), and Roanoke. Five local protection projects were also part of the plan: West Fork Floodway, Elm Fork Floodway, Dallas Floodway Extension, Duck Creek Channel Improvement, and Liberty Local Protection. Total construction cost was estimated at \$900.7 million, with an annual operation, maintenance, and replacement cost of \$8.4 million. Total annual charges were set at \$38.9 million and annual benefits estimated to be \$62.4 million. The ratio of benefits to cost was 1.60 to 1.00.⁹

Navigation features of the plan included a 362.8-mile-long channel 12 feet deep by 150 feet wide. Spur channels and turning basins at Fort Worth and Dallas were also included. The project would need 23 navigation locks and 19 dams. Nineteen of the locks below Dallas would be 84 feet wide by 600 feet long. The remaining four would be 54 feet wide by 400 feet long. Alterations to bridges and utilities would be required. In the Corps' customary review process, the report was examined by the Southwestern Division, the Board of Engineers for Rivers and Harbors, the Office of the Chief of Engineers, and the Public Works Committee of the House of Representatives.

Congress authorized the full plan, but before appropriating any funds for construction of navigation features, it ordered the Corps to submit a new review of the navigation cost. The completed re-evaluation in 1968 showed a benefit-cost ratio of 1.5 to 1.0, based on 1967 price levels. In the re-evaluation the Fort Worth District had widened the proposed channel to 250 feet and added more locks. To promote water purity in the river, the District also included in the modification an 84-inch pipeline from the proposed Tennessee Colony Lake to Benbrook Lake. With strong political support for the waterway and an estimate of navigation benefits, the project seemed destined to become a reality.¹⁰

But the Trinity project became instead the center of one of Texas' major environmental controversies, engendered by a rising public concern over large

projects that altered the environment. It began with the National Environmental Policy Act of 1969, which required all public bodies to conduct studies of the impact any proposed projects would have on the environment. In response, the Southwestern Division advised the Fort Worth District to start a series of environmental studies on the Trinity River project. Private contractors such as Stephen F. Austin State University in Nacogdoches, Texas, and Texas Tech University in Lubbock conducted some of them. But the District did the primary environmental impact study. The results of these and privately funded studies had great impact on the waterway's future.

Some opposition to the waterway had surfaced in the mid-1960s, but real dissention did not appear until the 1970s. In April 1972, opponents founded COST—Citizens Organization for a Sound Trinity. Their chief concern was



Shallow waters on Southwestern rivers like the Trinity often caused riverboats to go aground.

the benefit-cost ratio reported in the Corps survey. COST claimed that the ratio was unrealistic. It reported a ratio of .60-1.00, or only 60 cents' return for each dollar invested. Meanwhile, environmentalists focused on the possible effects of the project on the natural habitat of fish and wildlife; some types of wildlife in the Trinity basin were on the endangered species list. The environmentalists were also concerned about channelization of the stream that would reduce the 550-mile river to 360 miles. On the other hand, this group approved of the results of a private study authorized by the Southwestern Division. This study proposed a greenbelt along the Trinity between Dallas and Fort Worth—a line of parks, bike paths, and hiking trails.¹¹

The controversy came to a climax when the Trinity River Authority announced an election for March 1973 to authorize the \$150 million required by law as the local contribution to the project.¹² Waterway proponents chose Dallas attorney Thomas C. Unis, a former city council member, to head their campaign. Unis proceeded to organize the Trinity Opportunity Development Committee and recruit as many supporters as possible, preferably well-known political and business leaders. He focused the group's efforts on formal groups such as Rotary Clubs and rounded up young businessmen to campaign by telephone. The message of the sponsors remained the same: a waterway would greatly enhance the economic development of the Dallas-Fort Worth area; construction of the project would provide numerous jobs; and the public would have recreational benefits and a clean river.¹³

Opponents used a different strategy. They concentrated on rank-and-file voters. Campaign volunteers were expected to show up at rallies and other activities for the sake of ecology. Single-page leaflets were circulated en masse, and, instead of seeking endorsements from well-known figures, the campaigners furnished the public with detailed information about benefit-cost ratios, claims about adverse aspects of barge traffic, and concerns about water quality in the Tennessee Colony Reservoir. They also reminded taxpayers of the probable increased tax burdens and mentioned their concern that new reservoirs, ports, and other items would be added to the original project.

The Division watched all this activity in frustration because from its standpoint the controversy was raging over waterway information that was by now outdated. For example, the Division and its Districts were bound by law to use certain rates in their calculations of benefit-cost ratios, even though the figures were below the "going market rate." Again, the original plan calling for extensive channelization was outdated because of the results of an environmental impact study. The Division and Fort Worth District were working on new engineering plans that would reduce the channelization, include the greenbelt, and establish additional wildlife refuges. Colonel Floyd H. Henk, the District Engineer, had tried to persuade the Trinity River Authority to postpone the election until the upcoming study was completed and released to the public. The Division conducted public hearings in an effort to communicate the new plans to the public. But in the heat of the controversy, the new plans were not sufficiently understood.¹⁴

One critical part of the fight involving the waterway centered on a proposed reservoir some 240 miles southeast of the Dallas-Fort Worth area—Wallisville Reservoir, south of Liberty, Texas. As the drive for a Trinity River Waterway project gained momentum in the 1950s, rice growers and other landowners living in the area between Liberty and the Anahuac National Wildlife Refuge became concerned about the possible effects a 9-foot-deep channel would have on their lands. They feared that the channel to Liberty would allow the salty tidewater to flow up the river and flood the 40,000 acres of rice fields. The possible loss of income derived from rice cultivation could have disastrous effects on the economy of Chambers County. Hoping to protect themselves, the landowners contacted the Galveston District and explained their predicament.

The District studied the problem and finally suggested that the best solution would be another reservoir. An interim report in April 1960 recommended construction of a lake at river mile 3.9, the conjunction of the Trinity and Old River Lake. The new lake, Wallisville Reservoir, would prevent intrusion of salt water into the area once the navigation project was in operation.¹⁵

The proposed multipurpose project featured navigation, water supply, fish and wildlife enhancement, and recreation; but it had one rather unusual feature—its depth. A long earthen dam, 39,200 feet, would impound water to an elevation of only about two and a half feet above mean sea level. The deepest point would be four feet. To accommodate barges, an 84-by-600-foot navigation lock would be included. The benefit-cost ratio was 2.80 to 1.00.¹⁶

Another feature of the project was a 2,000-acre waterfowl refuge proposed by the Fish and Wildlife Service of the Department of the Interior. The Texas Game and Fish Commission also endorsed the idea, but some area residents had questions about the refuge. So, pursuant to instructions from the Chief of Engineers Office, Colonel Harold C. Brown, the new Galveston District Engineer who had arrived after much of the planning for the reservoir was finished, scheduled a one-day public hearing on the subject to take place at Liberty on 15 December 1960. Because the turnout was greater than expected, the hearing was extended for another day. Three hundred twenty-one persons attended on 15 December and 130 on 16 December. One hundred



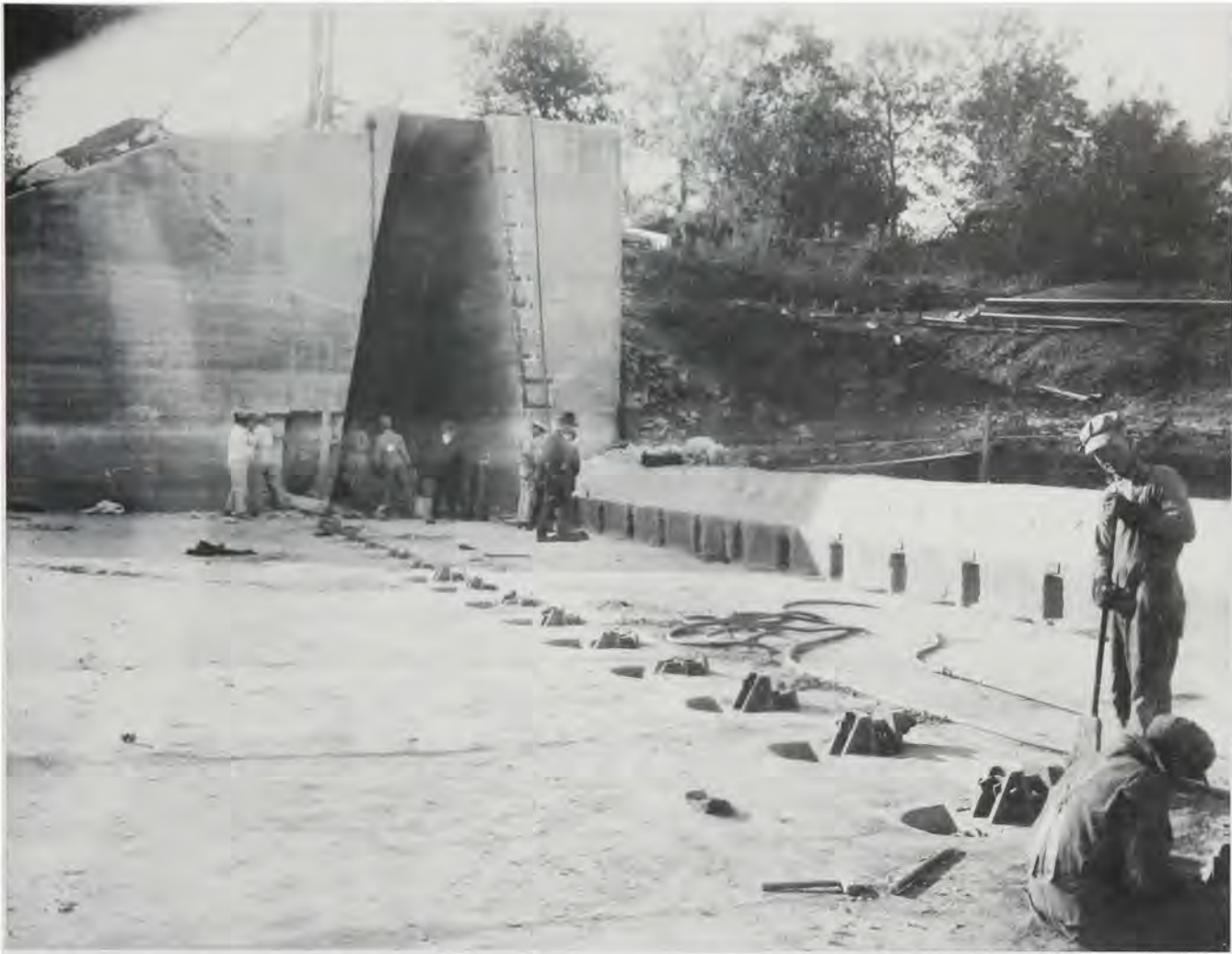
Workers labor at partially finished Lock and Dam Number 1 on the Trinity River near Dallas on 30 Oct. 1917. (Reprinted with permission of the Dallas Historical Society.)

and sixteen briefs were submitted and made a permanent part of the hearing record. Opposition to the refuge was overwhelming.¹⁷

Taking these complaints under consideration, Brown re-evaluated the interim report and forwarded his own internal report, dated 8 February 1961, to the Southwestern Division Engineer, Major General Robert J. Fleming, Jr. This 18-page report reviewed each of the objections set forth at the hearing and included his own comments and recommendations. In regard to the wildlife refuge, Brown agreed that its benefits were minimal, that opposition was too strong, and the cost too great to warrant its inclusion in the project. But then he went on to discuss significant problems with the water-supply plans for the reservoir itself. He used new data to determine that the Wallisville project would be "without merit" as a water conservation storage lake. Brown's analysis showed a considerable difference in the evaporation rates and the dependable firm yield of the reservoir's water flow.¹⁸ He also differed with the interim report on the potential recreation benefits, saying:

The estimates of benefits from recreation as given in the interim report are considered to be realistic if the reservoir is operated to maintain a full reservoir as much as possible; however, consideration is given to the feasibility of operating the reservoir as a component with Livingston. This type of operation would dewater the Wallisville reservoir about 63 percent of the time. If this type of operation prevails, recreational benefits accruing to the reservoir would be negligible.¹⁹

In his conclusions, the District Engineer said he saw two flaws in the interim report. First, the evaporation rates were wrong. Correct data showed



a lower yield of water from the proposed water supply project than anticipated in the interim report. Second, the space required for a four-foot-deep water supply reservoir would cost too much in human terms, specifically, the dislocation of citizens occupying the reservoir area. "There is no question . . . of the need for a project that would meet the requirements for navigation, for salinity control, and for . . . a sump for the city of Houston in its transportation of water from Livingston to the city of Houston. I believe," he continued, "the optimum project in this area would be one with a maximum water surface elevation of 2 or 2-1/2 feet."²⁰ Colonel Brown asked Division Engineer Fleming to return the interim report so the Galveston District could re-study the alternatives and see if a better plan could be designed.²¹

Fleming chose not to forward Brown's report to the Chief of Engineers. In his letter to headquarters, he maintained that the opposition to the wildlife refuge "was obviously led by the residents within the project area who strongly objected to loss of their land . . ." He was convinced that all the other questions raised "have been given full previous consideration," and recommended "that the Chief of Engineers process the report without further delay."²²

Brown, who was disappointed that his report was not forwarded to Washington, was re-assigned after one year as District Engineer, although the normal tour was three years. Some people suspected that he was prematurely transferred because of his actions on the Wallisville project. But his stand had to that point been only an internal disagreement, and the momentum for the Trinity waterway remained unchecked.²³ In October 1962, Congress authorized the Wallisville Reservoir, and construction began in 1968.

Lock and Dam Number 1 on the Trinity River near Dallas was never to be completed. (Reprinted with permission of the Dallas Historical Society.)



In April 1942 Trinity River floodwaters put Dick Himes' service station, at South Haskell and Parkdale Drive in Dallas, out of business.

But in April 1971, when the reservoir was approximately three-fourths finished, six parties—the Sierra Club, the Houston Sportsmen's Club, the Audubon Society, the Texas Shrimp Association, and two fishermen—filed suits against the Corps in hopes of stopping the project. They insisted that completion of the reservoir would destroy breeding and nursery grounds for shrimp, crabs, and a fish known as menhaden. They estimated fish losses at seven million pounds per year. The plaintiffs further asserted that the Galveston District had violated the 1969 National Environmental Policy Act by starting construction before the results of the Corps' environmental study of the project were known. Work should stop, they said, either temporarily or indefinitely, depending on the results of such a study.²⁴ This suit was of great interest to the Trinity waterway supporters because, even though Wallisville was funded separately from the rest of the project, it was a vital link in the master plan.

The suit suddenly engendered much publicity for Colonel Brown's 10-year-old report and his unusual transfer. Congress had ordered publication of the original interim report and some additional data in July 1961, but the order did not include Brown's report, though he had filed it five months earlier. In preparing their case for Judge Carl Bue, the plaintiffs tried to obtain copies of the report to use as evidence of the Corps' alleged disregard for the environment. But, on advice from the United States Attorney General's office in Houston, neither District nor Division would release it. Local newspapers also tried to obtain the report, even telephoning the now-retired Brown in Seattle, Washington. In a phone interview with the *Houston Post*, Brown acknowledged that he had not been "in favor of the project as recommended" and had filed the report with the Southwestern Division stating his reasons. "Let me clarify," he continued. "My task at that time was to make an impartial appraisal of the various benefits and costs of the various plans being considered. My appraisal led me to believe the benefits did not justify the cost of Plan C (the plan under construction), and we should re-study the alternatives to see if there might be a better plan."²⁵ He refused to comment about the benefit-cost ratio of the Wallisville project because he was not sure in 1971 about details he had written ten years earlier.

As these matters became public, critics of the Corps believed Brown's report was being suppressed. But the controversial report was solely an internal document that was never intended to be released or circulated to other agencies for comment. Brown agreed.

For Judge Bue, in any case, the real question was not the internal actions of the Corps, but the plaintiffs' contention that the Galveston District had violated the 1969 law by not making a comprehensive study of the environmental impact of the Wallisville Reservoir. Even though the design and planning of the project had occurred about ten years before the act's passage, opponents wanted an injunction halting construction until a new environmental study was made, one that conformed with the National Environmental Policy Act. In February 1973, Judge Bue ruled against the Corps and suspended construction of the reservoir.²⁶

On election day, 13 March 1973, voters in Dallas turned out in high numbers, nearly five times more than in a recent junior college bond election. The same was true in Fort Worth. For the proposal to carry, it needed a majority in the total number of votes, and it had to carry in 9 of the 17 counties. It lost on both counts. Seven of the downstream counties approved the project, but they were overwhelmed by the large turnout in the metropolitan areas. The final tally showed 54 percent of the ballots against the waterway; but in some Dallas and Fort Worth precincts, voters rejected the proposal by more than six to one.²⁷ Judge Bue's Wallisville injunction and the defeat at the polls put the proposed Trinity River Waterway in a state of

limbo. Nevertheless, some portions of the plan went forward. By December 1977, Congress had provided funding for further planning for the Tennessee Colony Reservoir, Aubrey (Ray Roberts) and Roanoke lakes, the Duck Creek and Dallas Extension floodways and the protective levees for the city of Liberty. Congress had funded Lakeview Reservoir (Joe Pool Lake), and land acquisition for it began in 1977.

In August 1979, the Corps released a draft phase I general design memorandum and an environmental impact statement on the Trinity River project for public review. Those documents described an altered plan consisting of three elements: the Dallas Floodway Extension, Tennessee Colony Reservoir, and a multiple-purpose channel from the Houston Ship Channel to river mile 45 near Liberty. No plan of improvement was recommended for the Trinity River from mile 45 to Fort Worth because such work was considered economically infeasible at that time. The documents, filed with the Environmental Protection Agency in 1980, contained recommendations for fish and wildlife mitigation. A report elaborating on the mitigation plans was published in 1981.²⁸ Since that time, President Reagan's policies regarding local cost-sharing for project funding and lack of a suitable benefit-to-cost ratio at 1986 interest rates have made the possibility of a navigable Trinity River even more remote.

Meanwhile, the Southwestern Division tried over the years to get Judge Bue's injunction on the Wallisville Reservoir lifted. In 1974 the Circuit Court left the injunction in place pending submission of a revised or supplemental environmental impact statement and a new determination by the District Court. Subsequent studies by the Division resulted in preparation of a post-authorization change report in 1981. The new proposal included an earthen dam across the Trinity River that would create a shallow freshwater impoundment of about 5,600 acres to the east of river and recommended that the United States keep the lands it had acquired west of the river for fish and wildlife management. It would salvage the existing navigation lock, freshwater diversion works, and lock access road on the east side of the river. It included two recreational areas and three structures to control salinity intrusion and regulate freshwater flows to the salt-water marsh west of the river. The final supplement to the environmental impact statement for this modified plan was submitted to the Environmental Protection Agency on 21 September 1983.²⁹ It estimated the tangible and intangible effects the work would have on the fish and wildlife on the government-owned lands. Ironically, the modified project was essentially one that the U.S. Fish and Wildlife Service had recommended in the early 1970s as an alternative to the 19,700-acre project originally proposed.³⁰

Before the Office, Chief of Engineers had taken any action on the supplemental information report, Congress authorized the 5,600-acre version of the project for construction. This law called for the lands to be kept in public ownership with the intention of working out plans at a later date for fish and wildlife management—preferably by the Texas Parks and Wildlife Department. The United States Attorney and Intervenor then again requested the court to lift the injunction.³¹

Judge Bue issued an opinion in March 1986 that found no fault with the environmental aspects of the Wallisville Project. But he ruled that Congress's authorization had been "improper" and that the Corps was remiss in failing to complete actions required by the environmental law. The Division planned to file an appeal with the Fifth Circuit Court in New Orleans.

Proponents of a navigable Trinity can still be found in Texas. They point to the McClellan-Kerr Navigation System in Arkansas and Oklahoma as proof that such a waterway could be successful in Texas. Comparison of the two projects is hazardous, however, because conditions like those that existed



Onlookers in Oak Cliff watch the Trinity flow over the Forrest Avenue Bridge approach during the April 1942 flood.



These two wrecked cars on East Exchange Avenue in Fort Worth show the force of the flooded Trinity River in April 1942. (Fort Worth Star Telegram)

before and during construction of the McClellan-Kerr are no longer found in the Lone Star State. For one thing, the early drive to develop the north Texas economy had succeeded. Dallas had ranked as the 31st largest city in the United States in 1940; by 1980 it was the seventh largest. In the 1980s Dallas was the third largest fashion center in the country and an international leader in electronics. Fort Worth was a well-known center for defense manufacturers. As an attractive “sunbelt” metropolis, the two cities and their surrounding environs had attracted a steady flow of migrants. New industry flowed into the area. Such expansion amidst nationwide inflation brought an accelerating increase in the cost of living in the two-city metroplex. The low-cost labor that had attracted industry to Tulsa and Little Rock after the McClellan-Kerr Waterway was built was not available in Texas.

When the push for the waterway had begun early in the 20th century, road travel to the Gulf of Mexico had been slow and troublesome. But a new interstate highway meant the Houston shipyard was only four or five hours away. Petroleum products probably would not travel on the Trinity because the state’s oil fields lay too far east or west. The major industries in Fort Worth and Dallas—banking, insurance, fashion, defense, and electronics—did not need a waterway. Some grain would travel on the stream, but the McClellan-Kerr Waterway had already captured much of the agricultural shipping originally anticipated on the Trinity. Some recreational benefits would accrue with the Tennessee Colony Reservoir, but the recreational

Some business interests in Texas would still like to see the Trinity River carrying barges like this one at Murray Lock on the Arkansas River.



carrying capacity of the Trinity River project had in many cases already been reached or exceeded.

Texans could not be aroused by the threat of flooding, compared with their counterparts in Oklahoma and Arkansas. Flooding in the latter states was severe—the Arkansas River had been at least partly responsible for some of the worst floods in American history in 1927 and 1943. Even though the McClellan-Kerr Waterway was not technically a flood control project, it nonetheless helped keep the waters in control. Flooding on the smaller Trinity had, fortunately, never been as dangerous, and by the early 1950s reservoirs and levees were in place to protect the densely populated parts of the flood plain.

But the greatest differences between the Trinity and the McClellan-Kerr were the appearance of environmentalism and public concern over cost. The McClellan-Kerr project had been entirely federally funded, but local governments were expected to pay for parts of the Trinity waterway. Protection of the environment had become a popular cause, and its adherents took disciplined stands against projects such as the Trinity waterway. No such attitude had previously existed in the Southwest. That new attitude, plus the concern over the cost of local funding, defeated the Trinity River Waterway.

VIII TECHNICAL SERVICES

In its capacity as a supervisory agent, the Southwestern Division assigns missions to its five Districts and coordinates their execution. It also, of course, processes and reviews the work of the Districts and exercises the power of approval over District recommendations. To some extent, however, the Division also provides services to its Districts, performed wholly at the Division headquarters in Dallas, which complement the Districts and support them. Three examples of these services are the Division Laboratory, the Hydroelectric Power Design Branch, and the Economics and Social Analysis Branch. The first two, which belonged to the Engineering Division, emerged during the post-World War II era, while the latter, a part of the Planning Division, did not go into operation until 1965.

The Southwestern Division Laboratory's origins go back to World War II and the Denison Dam, built by the Denison District. The District erected a small construction control laboratory a short distance downstream from the dam site, a regular procedure at most Corps of Engineer reservoir projects at the time. Only three employees worked at the lab, and their expertise was limited mostly to soil testing. Although they had some experience with concrete, little concern was given at that time to concrete aggregates.¹

That practice began to change at the close of World War II, when Congress authorized and approved funds for a large number of dams in the United States. By that time the Corps' Central Concrete Laboratory at Mount Vernon, New York, and the concrete industry had realized the value of air entrainment in increasing the resistance of concrete to cycles of freezing and thawing. Prior to World War II the Mount Vernon facility had been testing the measurement of the ratio of force to the elasticity of concrete. But the Office, Chief of Engineers decided that the laboratory's postwar workload increase, plus the increased testing of concrete aggregates, required a new location. In 1946 it was moved from Mount Vernon to Clinton, Mississippi, and renamed the Concrete Research Division. That was later changed to the Concrete Division, Waterways Experiment Station. The new laboratory developed a freeze-thaw test for evaluation of concrete aggregates and tried to handle the demand for such tests from all Districts in the United States.²

As the only Corps facility equipped to conduct such tests, the lab was soon inundated with work. It was obvious that decentralization was necessary to handle the volume of tests. In 1947, the headquarters chose six additional labs to help out; the old Denison laboratory was one. A new building downstream from the Denison Dam was designated the Southwestern Division Laboratory. Its mission was to conduct both concrete and soil tests for Division projects. While at Denison, the laboratory held two one-week "school" sessions for 15 to 20 concrete technicians. Laboratory personnel at this time included Director Frank Van Auken, Assistant Director Ken Coen, and Charles McKeogh. In July 1948, when Hugh Garrison, later the lab director, arrived there, the lab had three sections: Chemistry, Petrography, and Physical Tests.³

The 75-mile distance from Denison to Dallas soon made the cost of operating the laboratory too expensive due to travel and communication. So in 1949 the Southwestern Division Engineer, Colonel Louis Prentiss, moved the operation to an old warehouse at 4815 Cass Street, where it remains today. The newly equipped space measured 200 by 200 feet. Until this time, the Districts had still been doing a limited amount of soil testing, but Prentiss ordered that all such testing for Division projects be transferred to the lab to reduce duplication and cost.⁴

Materials used in dam construction—soils, concrete, and riprap (protective rock coverings of earthen dams)—accounted for the preponderance of tests. The outbreak of the Korean conflict, however, brought an increase of testing involved with military construction, particularly paving materials for air-strips. Use of the California Bearing Ratio, a test of subgrades and airstrip base courses, began at that time. The staff also tested paint and building materials such as roofing, caulking compounds, concrete masonry, and ceramic tiles. The defense build-up associated with the Cold War of the 1950s also accounted for the increased testing. Dyess Air Force Base near Abilene, Texas, a major installation of the Air Force's Strategic Air Command, was built in that period, as were numerous pilot training schools and other air bases. Toward the end of the decade construction of missile silos started, and the laboratory tested materials used in that work to ensure that they met Corps specifications. The government's practice of awarding contracts to the lowest bidder often meant that construction materials furnished tended to meet only minimum standards. So it was important to maintain constant surveillance on quality. Because of this increased workload, the lab's staff expanded to almost 70 at the peak of military construction during the Korean conflict.⁵

Soil testing still accounted for a large portion of the laboratory's work. New techniques were devised for detecting the characteristics of soils and foundation materials. During the 1950s engineers realized the need for a test that could evaluate a soil's strength and its resistance to sliding of thin, weak layers of shale that are common in foundation materials. In 1961, the Division Laboratory designed and constructed a machine that not only tested such layers, but also determined the strength of the weakest of these layers in the section of the sample being tested. In 1962, the Southwestern Division Laboratory was the first in the Corps to develop the apparatus and procedures for back-pressure saturation of strength-test specimens. The strength of a soil is greatly affected by its ratio of air-filled to water-filled voids. Since this ratio varies over a wide range in both natural and compacted materials, it is necessary to test soil samples that are fully water-saturated to provide a consistent basis for comparison. Prior to back-pressure tests, technicians would try to saturate specimens by percolating water through them to dislodge and replace air. Near-saturation could occasionally be achieved; more frequently it was not even approached. In the back-pressure procedure, water is forced into the specimen, dissolving and compressing the air without changing the volume of the soil. Tests done on completely saturated soil samples gave engineers reliable information on the shear-strength of soils used in dam construction. Descriptions of the procedures and apparatus were circulated to other Corps laboratories and put into use.⁶

The Division Laboratory also conducted research on problems associated with clay-shale foundations. Occasionally, dams must be located on such foundations, which tend to slide under pressure and create a potential for failure. The Waco dam slide of 1961 graphically illustrated this danger.⁷ Before the Waco slide, clay-shales were usually treated like soils, both in the laboratory and in design. After the slide, the Division Laboratory established a basis for consistent evaluation procedures, including identification of problem materials. It also worked out tests and methods for defining engineering properties such as how soil reacts to pressure. Again, the Division shared research in this area with other Corps laboratories, including the Waterways Experiment Station at Vicksburg, Mississippi. The laboratory also demonstrated that the plastic and liquid limits of some highly structured soils materials such as hard clays and clay-shales were caused by sample preparation in a laboratory, rather than being a fundamental "constant" property. That information was also shared with other Corps laboratories.

In 1966 the laboratory performed the first tests ever conducted by the Army Corps of Engineers to determine the absolute minimum strengths of clay shales. It also discovered how to achieve a consistent maximum density of sands. Other Corps laboratories were instructed by the Office, Chief of Engineers to conduct maximum density tests of sands using the Southwestern Division procedures. Determination of consistent maximum densities is a matter of concern because sand underlies a wide variety of Corps structures, including dams, roadways, buildings, and airstrips. A small variation in maximum sand density can result in a large error in calculating the relative density.⁸

Characteristic of the laboratory's role as an arm of the Southwestern Division was the research conducted on the protective rock covering, known as riprap, on earthen dams. Special care must be taken to prevent wind and wave erosion of the upstream face of a dam. Normally, several layers of rock are laid on top of the embankment with only the largest boulders visible and the smallest rocks resting on the soil. Surfacing the embankment with concrete had proved ineffective because the clay soil underneath would still erode and allow the concrete to collapse.

The laboratory tests the durability of the various types of rock used as riprap. One important property of the rock is its ability to withstand repeated cycles of freezing and thawing, a process that produces fractures and splits in the rock. Care must be taken to select rock able to withstand such cycles. At the laboratory, sample rocks are sliced in sections, frozen in water for 16 hours and thawed for 8. Each sample undergoes about 25 cycles, enough to observe the fracturing characteristics. Magnified photographs of the rock show the extent of fracturing. Absorption tests of the rock must also be conducted, since the amount of moisture a rock absorbs determines its longevity and resistance to fracturing. The laboratory also tests the magnesium sulfate soundness of the riprap. Experimentation on testing riprap still continues, because the rock covering of dams is quite vital to maintenance and safety.⁹

To a limited extent the Division Laboratory trained other Corps personnel. Since 1968 it has conducted a paint inspection course as part of the Corps Construction Training Program. The one-day course consists of a lecture and demonstrations. The purpose of the course is to teach inspectors and other Corps personnel the characteristics and qualities of paint, an item used extensively in construction.¹⁰

A unique feature of the laboratory is its program for the procurement of diamond drilling tools for its own five Districts, all other Corps Districts in the United States, and other federal agencies such as the Tennessee Valley Authority and Bureau of Reclamation. The Corps of Engineers uses drill bits because of the large amount of rock and foundation sampling involved in its projects, especially dams. To ensure that a dam, whether concrete or earthen, will perform satisfactorily, it must be constructed to avoid sliding, slippage, or other movement under the great pressure exerted by the impounded water and by its own weight. Natural ground movement must also be taken into account. Therefore, design engineers must know the nature and characteristics of what will be the foundation of a proposed dam. This same information is needed for construction of building foundations and airstrips. Consequently, the Corps does a rather large amount of drilling. That means it uses a lot of drill bits, the part of a drilling machine that wears out and must be replaced regularly. Nearly all major drilling companies, including oil companies, use diamond bits since they cut better and last longer.

The laboratory's procurement program began in 1951 when Robert Nesbitt, staff geologist at the Office, Chief of Engineers, concluded that the Corps should be able to write its own specifications on diamond bits. Up to that



Specialists at the Southwestern Division Laboratory sort and grade industrial diamonds for use in drill bits.

point, individual Districts had been purchasing bits from various manufacturers. They were not always pleased with the quality or cost. To improve both, the headquarters, through Guide Specification CE-1205, instructed the Southwestern Division, Ohio River Division, and North Pacific Division to draw up specifications for diamond bits and procure them for the Corps. Through coordination with the Bureau of Mines and the diamond tool industry, a set of comparative standards for industrial diamonds was developed for three grades of West African diamonds and two grades of Congo diamonds for the Corps of Engineers.¹¹

An important part of the diamond tool procurement program is the recovery or salvage of used diamonds. By re-using the diamonds, the Corps saves considerable expense. When bits are returned to the Laboratory, the diamonds are removed by an electrolytic de-plating process whereby the binder metal in the bit crown is removed, releasing the tungsten carbide matrix and the diamonds. After being removed the diamonds are cleaned, placed in plastic vials, and scheduled for grading.

The Laboratory built a simple machine to process some of its used diamonds, graded D-1 and D-2. The advantages of in-house processing were soon clear. The final processing technique resulted in diamonds that gave improved performance over unprocessed ones. These grades have been used in various ways for several years, both in blends with new diamonds and by themselves in selected tools.

As the three Division laboratories conducted operations to procure diamond bits, it became apparent that further standardization and additional examination and test facilities would be required to provide more uniform and equitable control. These shortcomings prompted numerous conferences and studies that resulted in a revision of the original guide specification. In 1959, the Southwestern Division Laboratory was designated as the central facility for all testing and examinations pertinent to diamond drilling tool evaluation in the Army Corps of Engineers. It was instructed to install the necessary equipment for the reclamation and salvage of diamonds from new and used drill bits. Dallas' central location and transportation facilities gave the Division the advantage. In 1963 the laboratory also received the responsibility to handle diamond bit procurement for the entire Corps, the result of a decision by the Secretary of Defense to cut costs. Since that time the Southwestern Division has had responsibility for technical control of the program, including design, inspection, warehousing, and salvage operations. The Fort Worth District provides accounting support.¹²

These diamond drill bits are used by the Districts to obtain rock and foundation samples for testing. But to gain full understanding and knowledge of an underlying foundation, engineers also needed to examine the holes these samples come from. To achieve that, the laboratory has used the latest advances in photography. In 1959, it purchased a bore-hole camera to photograph the walls of the drill holes, sometimes as deep as 5,000 feet. Developed and manufactured by Eastman Kodak, the camera is cylinder shaped, about six inches in diameter and three feet long. As it is lowered into the bore hole, it takes donut-shaped photographs every three-quarters of an inch. These photographs enable technicians at the lab to examine the rock structures better, particularly the fracturing characteristics. That information is used in the design and planning of dams. Occasionally another agency will borrow the camera; the Atomic Energy Commission once used it for a project.¹³ In 1985, the laboratory bought a television version of the bore-hole camera. Only 1.5 inches in diameter, this instrument furnishes a continuous videotape of the walls of a core boring up to 200 feet deep. It provides an instant on-the-job picture and has been used several times to investigate seepage. The superior resolution is particularly valuable in examining fractures, cavities, the inflow of water, and the character of materials. The videotape can be used at conferences and in design revisions to acquaint engineers and geologists with subsurface details.¹⁴

Other examples of exotic equipment at the laboratory include the Atomic Absorption Spectrophotometer, the Gas Chromatograph, the Total Organic Carbon Analyzer and the Specific Ion Analyzer. These devices are often referred to as examples of "black box chemistry." This equipment was necessary to meet the increasing demands for testing water and soil samples for various toxins and hazardous materials. Many such materials must be detected in concentrations as small as a few parts per billion. Thus, the black box equipment was essential to handle the workload accurately and economically. The microcomputer revolution also hit the laboratory, so test data is now monitored, stored, computed, and plotted electronically. Whole test reports are transmitted to the Districts via computer networks. All this equipment helped the lab meet the needs for both routine and new testing as manpower resources continued to shrink.¹⁵

The Division Laboratory also provided several new services to improve the efficiency and accuracy of testing. These services included a management system whereby a District deals only with the laboratory, even if portions of a particular test are sent to one or more commercial laboratories. The lab also furnished various sample containers required to meet specifications for water and soil tests. On request, special schools and instructions for field testing and inspection were provided both in the field and at the laboratory.

In 1982 the lab reorganized its personnel into two technical sections covering broad categories of work. The Field Services Section included diamond tool services, bore hole and television camera field work, and petrography. The Physical Testing Section included all soil, rock, chemistry, concrete, asphalt, and materials testing. This more open organization encouraged efficiency and enabled the laboratory to accomplish the fluctuating workload with fewer employees. Workers moved from job to job with fewer restrictions and in the process learned more and became more versatile. By 1986 there were 23 full-time employees.

In addition, a number of engineering and science students from the University of Texas at Arlington and other schools were employed on a temporary basis. This number contrasts sharply with the 60-to-70 employees during the 1950s and the 1960s. Part of the drop stemmed from the drop in the number of large civil works projects in the Southwestern Division in recent years, and part was related to the continuing emphasis on reduction of the federal payroll. Fortunately, automated equipment and innovative technology such as black box chemistry made it possible to accomplish the work with no loss of quality or time.¹⁶

In 1986 the laboratory's testing functions and diamond tool services were added by the Office of Management and Budget to the list of functions within the Southwestern Division that were to be studied for possible contracting to the private sector. That office mandates such studies to identify tasks done with government resources that can be performed more economically by private enterprise. The studies at the laboratory were scheduled for completion by 1987. Since a large part of the laboratory's work requires strict quality assurance, a function that cannot be contracted, it was not known what effect the studies would have. "The future is quite uncertain," reported one laboratory employee.¹⁷

The bore-hole cameras and other technical apparatus illustrate the role the laboratory plays as a quality control arm of the Southwestern Division. Its testing of materials used in construction of projects from large concrete dams to small buildings provides critical information for the design and planning of projects. It ensures that building materials as common as paint and caulking meet minimum quality standards. The procurement of industrial diamonds and the quality assurance program associated with it are one of the laboratory's primary contributions to the Corps. Its program of grading and salvaging diamonds has saved the taxpayers hundreds of thousands of dollars. The laboratory's work is not exotic, but it is essential to the Southwestern Division and the Corps in general.

Through the Hydroelectric Power Design Branch, the Division provided another service to its Districts. The Southwestern United States is not usually envisioned as having hydroelectric power plants. But within the Division's five Districts, the Army Corps of Engineers had built 17 hydroelectric structures by 1971. Only the North Pacific Division had more, 21. In view of the region's relative aridity, the number of plants in the Southwestern Division is indeed high. That number seems even more significant because, to be considered economically feasible, the Division projects had to compete with the cost of privately owned steam generating plants. The private plants were fueled with natural gas, which used to be relatively cheap at about 20



A technician at the Southwestern Division Laboratory prepares a sample to be analyzed in the gas chromatograph for organic substances such as pesticides.

The atomic spectrophotometer at the Southwestern Division Laboratory can determine the amount and type of heavy metals in a prepared sample.



cents per hundred cubic feet. But the Little Rock and Tulsa Districts contained a number of sites suitable for hydropower plants. These projects had significance for the Division because through its Hydroelectric Power Design Branch it was able to provide the technical expertise used in the design and construction of the plants.

In 1945, when the Denison District was closed down, the Southwestern Division created the branch as part of the Engineering Division. To minimize staff fluctuations from variations in workload, the Division staffed it with enough manpower to design only one or two plants at a time. The branch had three major sections: Architectural-Structural, Mechanical, and Electrical. When there were not enough people on board to handle the workload, the Division hired architect-engineer firms to help with the design details of plants.¹⁸

When a District had a dam with a power plant in the works, it “hired” the Hydroelectric Design Branch. The branch drafted contracts with architect-engineer companies, prepared the government estimates, and negotiated the final contracts. The appropriate District Engineer acted as contracting officer, since funds for the project went to the Districts from congressional appropriations. In essence, this meant that the District handled administrative responsibilities and delegated to the branch authority to manage the technical details. After the contract was awarded, the branch, on behalf of the District Engineer, supervised the activities of the architect-engineer firms in performance of the design contract. It also supplied expertise for the procurement of power plant components such as turbines, generators, switchgear, and similar equipment. The Districts advertised and awarded construction contracts. During construction the branch provided technical support for resolution of any problems.¹⁹

Whitney Dam and Reservoir on the Brazos River was the first hydropower project the branch designed. A combined earthen and concrete structure, Whitney Dam is 17,695 feet long. Two penstocks carry water to two generating units, each having a 15,000 kilowatt capacity at maximum power pool level. Whitney had no unusual design or construction features. The power plant uses two Francis turbines installed vertically. In 1953, power production began.²⁰

The Hydroelectric Design Branch encountered its heaviest workload in the 1960s during construction of the McClellan-Kerr Waterway. Five of the system's dams incorporated hydropower units. Three of these were conventional vertical axis units. However, engineers chose an innovative axial-flow inclined axis design for use at two of the power plants, Ozark and Webbers Falls. The branch decided to use the slant-axis units after studies showed that these units, which had been used in Europe on a smaller scale, would be the most economical. The economy resulted from the reduced overall size of the power house. This decision was important for the Southwestern Division because only vertical-axis Kaplan or Francis units had been commonly used within the United States. It was necessary for the Branch to locate manufacturers who could design and fabricate components for a slant-axis unit of this size.²¹

The smaller size of the power house led to another problem for the branch—a corresponding drop in the diameter of the generators. To achieve the same power output as in the earlier designs, the branch used a speed increaser to boost the turbine's revolutions per minute from 60.2 to 514.²² Webbers Falls and Ozark dam designs were similar, except that Webbers Falls had fewer units because of the smaller amount of water available. Head conditions—the difference in elevation between the water surfaces above and below the dam—were much alike, as were all the electrical and

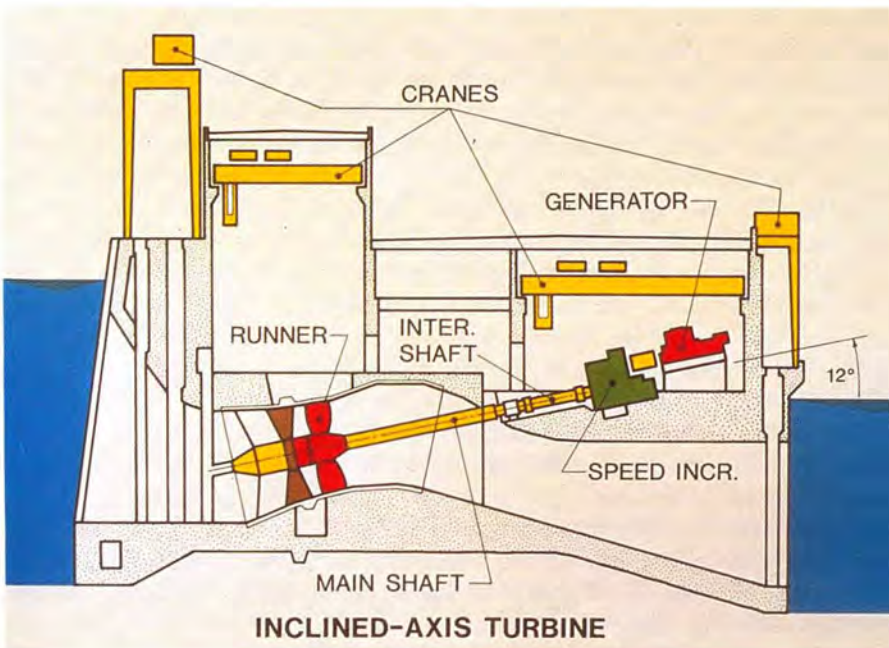
mechanical features. Ozark went into operation in 1971, and Webbers Falls became operational the next year.

The only unusual feature of these projects was their size. Slant-axis turbines had been used in Europe, and the generators with their speed and size requirements were not uncommon. "The pioneering," one engineer claimed, "consisted in the belief that these components in large sizes could be adapted into an efficient whole suitable for generation."²³

Because Congress had authorized no new hydropower plants, the Hydroelectric Design Branch went out of existence in December 1972. At the peak of its operations in the mid-1960s, about 35 employees worked in the branch. They reviewed designs for two hydropower plants in the Fort Worth District, seven in Little Rock, and eight in Tulsa. The Corps of Engineers has no control over the distribution of the power its dams generate. Electricity



Slant-axle turbines in the Ozark powerhouse on the Arkansas River.



The Southwestern Division's Hydropower Design Branch determined that slant-axis turbines were more economical than the traditional designs.

produced at all the Southwestern Division sites is marketed by the Southwestern Power Administration, an agency of the Department of Energy, to public and private entities. The revenue realized from the sale of electricity goes into the United States Treasury. By law, the Southwestern Power Administration must set its rates to recover the costs of power plant capital investment and operation and maintenance.

Starting in 1975, failures began to appear in some of the slant-axis turbines. The shaft, 55 feet long by 5 feet in diameter, developed a very slight bow in the middle from the pull of gravity, something that does not happen to vertical turbines. As the shaft rotated, the top of the bow repeatedly stretched while the bottom was compressed, similar to what happens to a coat-hanger that is repeatedly bent. Extremely small cracks appeared in the metal shaft. The high salt content of the Arkansas River accelerated the cracking process until the shaft became inoperable.²⁴

The same process occurred in the three-inch-diameter stud bolts connecting the turbine runner hub to the adapter cone and the five-inch-diameter bolts connecting the turbine runner hub to the shaft. The three-inch bolts in Unit Number 4 at Ozark failed after 10,349 hours of service. At Unit Number 5, the five-inch bolts gave out after 11,062 hours. After 10,000 hours of service the Ozark Number 2 turbine shaft had cracked. The Webbers Falls Number 1 turbine shaft cracked after 30,000 hours.

When the breakdowns appeared, tests made by the Army Corps of Engineers Research Laboratory on the three-inch bolts showed that metal fatigue, abetted by corrosion, was the cause. In 1976, the Allis-Chalmers Advanced Technology Center and the Corps of Engineers Research Laboratory studied the five-inch bolts and discovered the same pattern. Because of confusion among the various parties, further tests took place in 1976 and 1977. Based on these, the Southwestern Division contracted with Allis-Chalmers for a conceptual design for rehabilitating the turbines. "Studies from these contracts," reported the Southwestern Division, "indicated that the failures resulted from cyclical bending stresses caused by rotation of the shaft and runner in a deflected position."²⁵

The confusion resulted from incorrect test conditions during the initial design. The tests had been conducted with a shaft suspended in air, whereas the real shaft was to be in water. That led to a too-conservative strength estimate in the design of the slant-axis turbines. The redesigned shafts had steel twice as strong as in the original. The Corps consulted on the problem with Robert Padden, retired chief of the Shafting Design Section of the United States Navy, because the Navy had experienced a similar situation with propeller shafts. It had learned to make shafts twice as strong as what was recommended by tests.

All the shaft modifications were made in the Allis-Chalmers shop. Originally, the shafts had been installed before the speed increasers. But removing, reinstalling, and realigning these items would be a major undertaking. To remove and reinstall the shafts without moving the speed increasers, the engineers cut the turbine shafts in half and provided additional flanged connections at that point.

To make the turbines operable for a reasonable time, it was necessary to reduce the level of stress in the shafts and bolts and to protect highly stressed parts from the effects of river water. The turbine shafts are hollow with forged end sections welded on, with flanges for coupling the shaft to the turbine wheel at one end and to the generator (through the speed increaser) at the other. The turbine ends of the shafts were cut off and new forgings were welded on. Stresses in the new forgings were reduced by designing out all sharp grooves and edges, which can act as stress concentrators. To discourage the surface cracks that start the failure process, the shafts were cold rolled to

compress their outer layer. Where the rollers could not reach, the compression was done by peening with shot. The shaft was protected from water by covering it with a fiber-glass reinforced epoxy coating. On the flange faces and other areas not suitable for coating, the metal was covered with a welded inlay of corrosion-resistant metal. The coupling bolts were redesigned; stress was shifted away from the threads by reducing the diameter at the middle. Threads were compressed by cold rolling or shot peening. Three-inch studs were substituted for the three-inch capscrews and made longer to reduce the concentration of stress near the threaded ends.²⁶

At first, considerable effort was made to keep the turbines in operation until modification. Workers frequently inspected bolts, replacing broken ones until all could be modified. But when the Number 1 turbine shaft at Webbers Falls broke, it was discovered that an ultrasonic test had not detected a crack that was now visible. A new test was developed that could see such cracks. Other turbines still operating at Webbers Falls and Ozark were soon tested. The results showed that continued operation was unsafe, and all turbines with unmodified shafts were shut down.

As of 14 April 1986, Turbine Number 1 at Webbers Falls had accumulated more than 17,565 hours of generation with the modified shafts with no indication of failure. No failures have occurred since the last modified turbine went into service in December 1984. However, no one in the Southwestern Division claims the shafts will be trouble-free. The state of the art with respect to slant axle turbines of this size operating in salty water is such that shaft life cannot be accurately predicted.²⁷

In addition to the Division Laboratory and Hydroelectric Power Design Branch, the Southwestern Division at one time provided another special service to its Districts, a service that in some cases was used by Districts outside the Division—the Economics and Social Analysis Branch of the Planning Division. In 1965, the Office, Chief of Engineers created Planning Divisions in field Divisions throughout the Corps. The Economics Branch was created as an integral part of the newly established offices. At the time, the Division had one professional economist, Ivan L. Hobson. He became chief of the new branch, whose principal purpose was to give increased emphasis to planning in the pre- and post-authorization stages of the Division's civil works studies. Because the Districts could not afford individual specialists at their own offices, the Division wanted to hire such people and make them available to the Districts. Soon after its establishment, the Economics Branch employed a transportation-marketing specialist.²⁸

The branch had several functions. One of the most important was the review of all economic, or feasibility, studies made by the Division's Districts. It interpreted policy from headquarters in Washington, D.C., as it related to economics and social studies, and it provided input to the headquarters in economics-related policy-making matters. Other Divisions of the Army Corps of Engineers provided similar services. Hence, the Economics Branch, like the laboratory, should not be described as a unique organization in the Corps.

In reviewing feasibility studies, the Economics Branch examined a wide variety of economic information. It had to determine if a District made proper application of interest rates; it had to look at the value of land and capital improvements; and it examined commodity movements and the anticipated savings that might be made with a waterway as opposed to truck or rail service. Navigation studies included both inland projects and deep-water ports. In essence, the branch checked the accuracy and interpretation of data used in feasibility studies as well as adherence to evaluation guidelines.²⁹

As an interpreter of higher headquarters policy, the branch applied economic study procedures in analyzing the possible benefits derived from the development or improvement of navigation systems. Sometimes it addressed

the question of regional versus national benefits of a particular project. If the branch saw that a project had national benefits that exceeded its costs, it would recommend the project for authorization.³⁰

Beginning in 1968, the Southwestern Division's Economic Branch assumed the functions of the five Districts in making area economic studies. Branch Chief Hobson had recommended this setup in 1966 at a District Engineers' Conference. He had pointed out that much duplication of services was occurring, involving two-thirds of the Districts' economic specialists. "The right hand in one section is unaware of what the left hand in another section is doing," he reported.³¹

In February 1968, the Division Engineer, Brigadier General William T. Bradley, notified the District offices of the centralization. This action was to be completed by the end of fiscal year 1970 to avoid an impact on personnel and allow a smooth transfer of functions. Many of the studies then under way were immediately transferred. The centralization was to establish a unified system for economic projections such as population, income, and employment. It also allowed for increased standardization in presenting base studies. During the early days of these studies, the branch concentrated its effort toward the development of regional economic statistics because such data were not at that time available to any District staff. The centralization also allowed for a unified position in dealing with outside agencies. Lieutenant General William F. Cassidy, Chief of Engineers, commended the Southwestern Division in March 1968 for the centralization move. He further stated, "This will provide better use of our limited technical resources and insure uniformity in projections of the economic growth among studies in a given region. We are considering this approach for other Divisions."³²

During this time, many new technical requirements were being placed on economic studies. They principally involved navigation analysis (including benefit determinations) and land-use analysis as applied to flood control studies. These changes required additional techniques and application of economic principles. The Economics Branch also undertook several special studies. One of these, the "Inflationary Aspects of the Interest Rate," was submitted to the Office, Chief of Engineers and the Institute for Water Resources for their consideration.

In March 1969, the Economics Branch submitted a research proposal to the Chief of Engineers for a study to be titled "Arkansas River Tributaries System—Economic Impact Study." The study would look at the effects of the newly opened McClellan-Kerr Navigation System. It would be the first time the Army Corps of Engineers tried to make this type of analysis on one of its operating projects. In a speech Major General Frederick J. Clarke, the Deputy Chief of Engineers, made to an Arkansas River group, he recognized the accelerated economic effect the system would have on the entire basin. In addition, he said,

The Arkansas Basin Project for many reasons is the best laboratory we have ever had for the clinical observation of a major project through all stages of its development and on through the years of the fulfillment of its purposes. We are going to learn many lessons from its performance which will be of immeasurable future value to our whole country in determining where we are going in the field of water resource development, and how we are going to get there. I don't need to urge you to do all you can to assure the fullest success of this project. However, I do ask that you insure a broad appreciation of the full range of social benefits which water resource development provides. It will help in meeting the challenge of the future.³³

In March 1969, Robert E. Jordan, general counsel and special assistant for Civil Functions, Department of the Army, expressed his interest in Clarke's

comments and in the Corps' desire to evaluate the effects its projects had on a geographic area. The Office, Chief of Engineers asked the Institute for Water Resources to play a responsible part in planning this research study; however, the principal action was delegated to the Southwestern Division in its Economics Branch. The institute has printed a series of these evaluation reports, which are referred to for guidance in measuring other water resource projects in the nation.³⁴

In mid-1976, the Economics Branch acquired responsibility for water-supply needs studies conducted for the Southwestern Division's Districts. These studies had previously been done by another branch in the Planning Division. The move was made to save money and maintain centralization. Water supply studies involved the following topics: municipal water needs, urban and commercial; rural water needs; industrial water needs; electric power cooling needs; and water conservation.³⁵

This mid-1970s centralization of the various economic studies produced two advantages: it provided the Districts with an experienced professional staff that had expertise in areas requiring specialized skills, and it permitted flexibility and economics of scale in using personnel. At the time, no other Division maintained this centralization. In 1982, the branch, confident of its services, proposed that it be designated the center for competence for water-supply needs studies for the Army Corps of Engineers. The justification for the request rested on the branch's unique qualities: the training of its staff, its flexibility in handling projects, and the savings in personnel costs for the Corps.

But the suggestion came to naught as the Army Corps of Engineers, taking its lead from the Office of Management and Budget in the administration of President Ronald Reagan, acted to reduce costs. In 1982 the Economics Branch began to trim its services. That year, social studies evaluation was returned to the Districts, and when the person handling those studies at the Division retired, he was not replaced. Area economic studies were returned to the Districts in September 1985. And water supply studies were expected to be returned to District level sometime during 1986.³⁶ Personnel dropped to a third of its mid-1970s peak. This decentralization caused no traumatic results. The workload in civil works had dropped, and economists at the District level could conduct the studies previously handled at the Division level. The availability of computers at the Districts also increased their capability to do the work. On the eve of the Division's 50th anniversary, therefore, the Economics Branch was returning to its traditional review position.³⁷

As this change came about, the Economics Branch developed a new tool to interpret policy from Washington. To comply with the Reagan administration's desire for a cutback in the number of regulations, the Army Corps of Engineers had begun issuing fewer and fewer engineer regulations and engineer circulars. The Economics Branch put together a planning-guidance notebook, an accumulation of orders, to replace the regulations. The branch uses the notebook to interpret principles and guidelines from higher headquarters. It does not follow a rigid and hard rule, but does strive for consistency. The book, for example, helps planners determine cost-sharing arrangements for projects—something vitally important because of the new emphasis on local funding.³⁸

Examination of these special services demonstrates that the Southwestern Division, although in the command position, furnished technical and engineering support to its five Districts when needed. To an extent, these services came about as a result of the large workload in civil projects from the end of World War II until approximately the mid-1970s. The end of federally funded hydroelectric projects meant the end of the Hydroelectric Power Design-Branch in 1972. The future promised to bring changes as well to the Division

Laboratory and the Economics Branch. Already the latter had fallen back into its traditional review role. The Laboratory in 1986 faced a possible reduction of its functions, depending on the outcome of a commercial activities study. If the federal trend toward "privatization" continues, the Southwestern Division will probably furnish less and less of this type of technical assistance.

IX ARCHEOLOGY

Since the mid-1960s the Army Corps of Engineers has developed a strong interest in archeology, a development related to the rise in environmentalism and the general public interest in American ethnic culture. The Southwestern Division was the forerunner among the Corps' Divisions in archeological activity. Its interest originated during World War II in the Tulsa District. As time passed, the Division broadened its archeological capabilities.

Prior to the 1930s, federal involvement in archeology was sporadic and disorganized. During the 19th century, the Army Corps of Engineers conducted archeological explorations as part of the Geographical Survey. Engineers on expeditions collected some environmental data similar to that required by law today.¹ The Corps had made suggestions for the preservation of areas such as Yellowstone, Yosemite, and Sequoia National Parks. Federal archeological activity, however, remained small overall.²

Through the public works programs of the 1930s, federal archeological activity took a great step forward. To employ people, the government initiated a fact-gathering program through the Works Progress Administration, or WPA. The archeological portion of this program was coordinated by the Smithsonian Institution. The WPA worked on a large scale, and much of the information it gathered still remains unanalyzed and unreported. To a considerable extent, WPA oriented its work toward reservoir salvage in conjunction with the Tennessee Valley Authority, which was conducting a massive construction program at the time. The WPA hired a few archeologists to supervise a labor force, supplying them with military field equipment. The overall program launched many archeologists on their careers, thus giving the field a valuable boost. The "most encompassing and long-term archeological projects," Larry Banks, an archeologist with the Southwestern Division, said, "resulted from water resource development, dominated by the Corps of Engineers."³

But the Corps' involvement in archeology still remained minimal and perfunctory. Cultural resource management was totally unknown; economic development took precedence over environmental considerations, as it did throughout the United States in both the public and private sectors. During World War II, however, this condition changed in the Tulsa District, partly by chance, partly by direction, and perhaps due to the wealth of archeological sites in Oklahoma.

In southeastern Oklahoma, Spiro Mounds, one of the most significant archeological sites in North America, had been discovered in the late 19th century. Located in Le Flore County along a bend of the Arkansas River, the 100-acre area included a ceremonial center and village once occupied by the Caddoan Indians. Nine prominent burial mounds were discovered; the largest contained the remains of 725 persons. Archeologists believe the mounds show evidence of the presence of a priestly hierarchy and class structure among the inhabitants. Prominent persons such as priests were buried on cedar log litters and provided a variety of artifacts such as conch shells, hammered copper plates, freshwater pearls and other exotic trade goods. Beneath them were buried members of the lower class. The largest mound was approximately the length of a football field and 33 feet tall.⁴

Archeologists believe the Spiro Mound inhabitants were associated with the Southern Cult of the Mississippian tradition. Tribes with similar religious beliefs were spread from Oklahoma to Florida and from the Great Lakes to the Gulf of Mexico. About the mid-15th century the Spiro site was abandoned for unknown reasons; perhaps neighboring tribes drove them away or internal friction ended the group. At any rate the Spiro Mounds were one of



Spiro Mounds in Oklahoma gave the Southwestern Division's Tulsa District its first experience in archeological study.

the richest archeological finds of the 20th century and are listed in the National Register of Historic Places.⁵

J. B. Thoburn, the first state archeologist of Oklahoma, initially visited the Spiro site about 1900. He excavated two mounds between 1917 and 1920. As time passed the more prominent mounds were looted and plundered by “pothunters.” In 1933 six men formed the Pocola Mining Company and purchased a two-year lease of the site. They commercially excavated Craig Mound, the largest, and found a wealth of Indian relics and a hollow chamber containing a crematorium, an altar, and wall-hung tapestries. Artifact buyers worldwide came to purchase them, so that most of the riches of Spiro were gone in a short time. When satisfied that the commercial value of the site had been fully exploited, the company dynamited Craig Mound in an effort to destroy it.⁶ University of Oklahoma archeologists excavated what remained in 1936 as a WPA project and housed some relics at the university.

Perhaps it was the excitement—and tragedy—of Spiro Mounds that first generated an awareness of archeology within the Tulsa District. Certainly, the interest of the District Engineer, Colonel Claude C. Chorpeneing, in the subject had something to do with it. The District's first foray into the archeological arena began with the Flood Control Act of 1944. Section 4 of the act specified that the “Chief of Engineers . . . is authorized to construct, maintain, and operate public parks and recreational facilities in reservoir areas under the control of the War Department, and to permit the construction, maintenance and operation of such facilities.”⁷ The act did not authorize archeological activity as such, but when Charles Smith of the Tulsa District's Planning Branch saw the new requirement, he suggested that it could include archeological sites along with parks and boating facilities. Accordingly, the District contacted the Smithsonian Institution for advice about several known Indian mounds located on the site of two District reservoirs already in the planning stages—Fort Gibson and Tenkiller Ferry on the Grand and Illinois rivers, respectively.⁸ Smithsonian officials in turn contacted the University of Oklahoma, which had just hired its first full-time archeologist, Dr. Robert Bell. He agreed to conduct a survey of the two projects. The Tulsa District's role in archeology had started.⁹

At the end of World War II, conditions were ripe in the Tulsa District for archeological work. Most civil works construction had been curtailed during



Southern Methodist University archeologists discuss postholes from a 1,000-year-old house with a news reporter at Joe Pool Lake near Dallas in 1985.

the war. But when District employees could spare time from military projects, they worked on plans for civil projects associated with the proposed McClellan-Kerr Waterway. The wartime District Engineer, Colonel Francis J. Wilson, wanted to have the waterway ready for congressional authorization when the hostilities ended. This had significance for archeology: it meant that the Tulsa District had one of the largest reservoir workloads at the end of the war, and that it was ready to begin work on them. No other District in the Southwestern Division, or probably in the United States, was in that position.¹⁰

Thus, the District was ready in 1946 for Bell to make a preliminary examination of sites at Fort Gibson and Tenkiller Ferry. Bell spent approximately two weeks at the sites, making no excavations and finding nothing of significance at the time. He later conducted a summer field study with university students. The District furnished the field group with transportation, meals, lodging and some equipment.

Tulsa had better luck with excavation at Wister Reservoir on the Fourche Maline River in southeastern Oklahoma, not far from the Spiro Mounds. In 1946, the District hired professional archeologist Virginia Watson to make a survey of the project. The following year Bell conducted a thorough excavation of the sites at Wister, and one, the Scott site, proved to be significant. It yielded a variety of evidence suggesting the presence of one group of inhabitants and the later appearance of a second group.¹¹ Since 1948 more than 60 archeological sites have been located on the project's grounds.

Archeological activity in the Tulsa District remained limited, however. Under the Historic Sites Act of 1935, the National Park Service received responsibility for archeological surveys and excavations under the federal aegis. The Corps as a whole and the Tulsa District in particular had to

depend on the Park Service for funding and completion of all necessary archeological studies before a project was finished. This situation made other Districts reluctant to show much interest in archeology. During the 1950s, furthermore, archeologists essentially practiced "crisis archeology." That is, they made a quick excavation at a site, salvaging what they could before it was flooded by a reservoir. There was relatively little advance archeological planning, and that was cursory at best. That was the case with most excavations, whether federal or private, because of the limited funds and the state of the art of archeology. Some early excavations were as thorough as any using today's standards, but it was not until the 1960s that advances in other sciences allowed detailed and more sophisticated examinations to be made. Funding was especially poor for Tulsa District projects in the 1960s and early 1970s because most of the limited money Congress allocated to the National Park Service for archeology went to higher-priority projects in the Missouri River Valley. Only a pittance went to other river basins. In view of all these difficulties, the Tulsa District's efforts were indeed remarkable.¹²

Interaction like that between the the Tulsa District and the National Park Service was not required by law until the passage of the Reservoir Salvage Act in 1960. That act required construction agencies to notify the Park Service of impending planning and construction that could endanger archeological sites. But funding remained inadequate; as late as 1973 the Park Service's annual appropriation for archeology was about \$3 million. That figure included salaries for staff archeologists as well as for research grants. The Historic Sites Preservation Act of 1966, which established the Presidential Advisory Council on Historic Preservation, improved things somewhat. Section 106 of the act stipulated that prior to approval of expenditure of funds for a project, all construction agencies had to provide the Council with an opportunity to comment. But it was not until 1973 that the Council began to take an active role in archeology. And its regulations were not published for implementation until 25 January 1974. In the meantime, the Tulsa District continued its work. It began to purchase the land at the Spiro site and the Deer Creek archeological site. Deer Creek is the only site within the Southwestern Division that has the status of a National Historic Landmark. Between 1966 and 1972 the District worked closely with the state of Oklahoma and the National Park Service to determine the most appropriate use and management of these two sites. Spiro was leased to the state in 1972 for development as an interpretive center.¹³

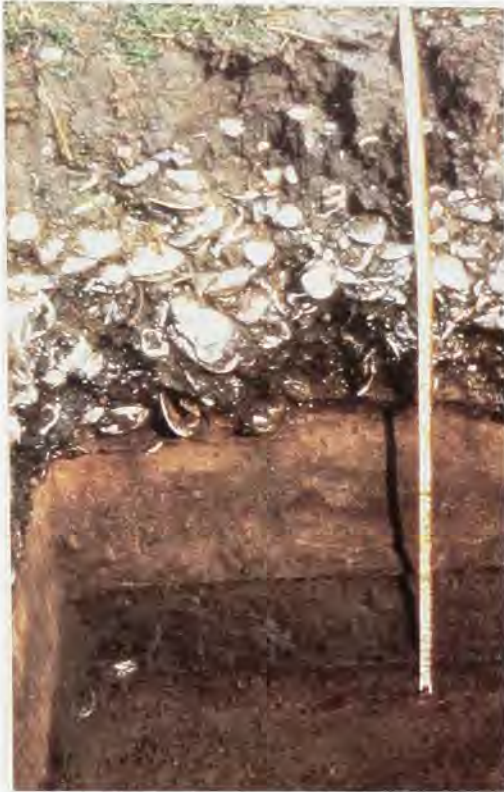
With the passage of the National Environmental Policy Act in 1969, archeological sites on federal projects received more consideration than in the past. Because the funding authority under the Reservoir Salvage Act was still vested in the Department of the Interior, however, many agencies, including the Corps, interpreted the law to mean that archeology was still the responsibility of the National Park Service. In 1971 the Department of the Interior drafted Executive Order 11593, signed by President Richard M. Nixon. It laid down specific instructions that other agencies had to follow to inventory sites potentially able to qualify for the National Register. The order also required the agencies to protect and preserve those sites as much as possible.¹⁴ But still no funds were provided, so the order was relatively ineffective. Finally, Congress passed the Archeological Conservation Act in 1974 as an amendment to the Reservoir Salvage Act of 1960. This new law had been initiated by Charles R. McGimsey at the University of Arkansas and Carl Chapman at the University of Missouri. It gave agencies and departments the authority, but not the mandate, to expend up to one percent of a project's total construction cost on archeological work at that project. It also expanded coverage of the 1960 act to include all federal or federally assisted or licensed undertakings.¹⁵



The Los Esteros archeological site in Santa Rosa, New Mexico, features room foundations and oven outlines.

Archeologists observe outlines of an Indian settlement at the Los Esteros site in Santa Rosa, New Mexico.





This prehistoric Indian shell midden was found on the lower Trinity River near Wallisville, Texas.

After enactment of the Archeological Conservation Act, the Corps began to place archeologists within its Districts in the United States. Again the Tulsa District was a step ahead. The District had continued since the late 1940s to provide for and assist with the excavation of sites on reservoir projects. Professor Bell of the University of Oklahoma usually directed the excavations. This activity increased with the creation of the Environmental Resources Branch in 1967, preceding the National Environmental Policy Act by two years. Robert M. Black was the first chief of the new branch. Buell Atkins, a biologist who had worked for the state of Oklahoma, coordinated the archeological activities.¹⁶ Black retired in 1970 and was replaced by Jerry Greer. After passage of the National Environmental Policy Act, Myron De Geer, the chief of the Engineering Division and an amateur archeologist, decided the Environmental Resources Branch should obtain a professional archeologist.

Consequently in August 1970, Larry Banks, assistant chief of the District Soils Laboratory, was brought into the branch. Although a geologist, Banks, president of the Tulsa Archeological Society, also met Civil Service requirements as an archeologist. With the change in job classification, he became the first officially recognized full-time—and until 1974 the only—archeologist in the Army Corps of Engineers. Banks assumed responsibility for coordinating surveys and excavations still being done in cooperation with the National Park Service. In 1975 he became the consulting archeologist for the Southwestern Division. But he remained in the Tulsa District until taking the position in 1976 as the first Division-level archeologist. By 1978, each of the five Districts had at least one archeological position and a combined program of more than \$3 million annually—the same amount as the National Park Service's total 1973 archeological budget.¹⁷

Attempting to keep Division projects in compliance with the National Environmental Policy Act, archeological statutes, and current Corps regulations was difficult because of the inconsistencies among the three. Tulsa District and the Southwestern Division often had to refer field problems and requests for needed policy changes to the Office, Chief of Engineers for resolution. In turn, the headquarters and other Districts and Divisions sought the expertise of the Tulsa District and the Southwestern Division. Gordon



A Fort Worth District employee excavates a burial near Corsicana, Texas.

Jones, who was chief of Environmental Resources in the Southwestern Division, also became very much involved in archeological matters. His presence and participation in several regional and national archeological meetings enhanced the Corps' image in the archeological community. Participation of individuals such as Jones was a real revelation to academic archeologists, who realized the Corps was now placing a higher priority on the archeological aspects of civil works.¹⁸

In December of 1974 Jones and Banks were asked to go to the Chief of Engineers Office to draft archeological regulations implementing the new laws. Banks was the only archeologist on the four-member task force chaired by Richard Leverty of the headquarters. The other member was Jim Sears, chief of Environmental Resources in the South Pacific Division Office.

In 1976 the Southwestern Division began conducting annual workshops on archeology to provide a greater uniformity in application of policy and to provide the Districts with a forum for discussing policy issues, technical problems, contracting techniques, and coordination procedures. When the workshops started, the Division had only three archeologists. So the chiefs of environmental resources of all the Districts also took part. By 1986, 12 archeologists worked within the Division. But the chiefs of environmental resources and at times the chiefs of planning continued to participate in these events. Since 1980, the Chief of Engineers Office has sponsored one- or two-day workshops for Corps archeologists in conjunction with the annual meetings of the Society for American Archeology. The workshops are very effective in keeping Corps archeology reasonably well organized within the Corps organization. In 1985 the North Central Division Office began its own Division-wide workshops, stimulated by the transfer of Tulsa District archeologist Cheryl Smith.¹⁹

In 1984 Barry Rought, the Southwestern Division chief of planning, presented a paper at the annual meeting of the Society for American Archeology in Pittsburgh, Pennsylvania. His paper, "A Management Perspective of an Archeological Program in the Corps of Engineers, Southwestern Division," marked the first time that a senior executive of the Army Corps of Engineers participated in a national archeological conference.²⁰

More important, however, was the Division's role as co-sponsor, with the Organization of American States, Southern Methodist University, and several federal agencies, of the Second New World Conference on Rescue Archeology held in Dallas in November 1984. Rescue archeology deals with the study of sites that face damage or destruction from either natural or man-made causes. The international conference attracted 250 men and women—business people, international financiers, government administrators and archeologists—from 19 countries. The conference had a two-fold purpose: to consider some of the deficiencies of the cultural preservation program in the United States and possible solutions to these deficiencies; and to develop an increased awareness of the threat that rapid economic development poses to the cultural heritage of the western hemisphere, especially in Latin America.²¹

Southern Methodist University President Donald Shields and the commander of the Southwestern Division, Brigadier General Robert Dacey, welcomed the participants. The true core of the conference was a series of roundtable discussions. The first was entitled "Rescue Archeology and its Interface with Engineering." All the discussions focused on the difficulty of cultural preservation in the midst of economic development, a particular problem in Latin America. To conclude the meeting, delegates toured an archeological site at the Richland-Chambers Creek Project, a water supply reservoir being constructed under a Fort Worth District permit by the city of Fort Worth. The site was one of the largest rescue archeology projects in the United States



Southwestern Division archeology specialists try to preserve artifacts like this human effigy stone pipe from the Craig Mound at the Spiro archeological site in Oklahoma.

and has been cited as one of the best-managed such projects in the country. The archeological work was performed by Southern Methodist University.

One reason the organizers chose Dallas as the site was the Division's recognized position as a leader in rescue archeology. Dr. Fred Wendorf, chairman of the organizing committee and head of the Anthropology Department at Southern Methodist, wrote, "It was a most successful meeting, and it brought real credit to the Corps as the leading agency in the organization of the Conference."²² Through the New World Conference on Rescue Archeology, which is a continuing series of international activities under direction of the Organization of American States, the Southwestern Division's archeological program brought international recognition to the entire Corps.

One of the Division's most important contributions to archeology within the Army Corps of Engineers concerns development of policy and regulations at the Office of the Chief of Engineers. As mentioned previously, Division personnel assisted in the preparation of the first major engineering regulation on archeological activities, ER 1105-2-460. In 1980 that regulation was rescinded and replaced with one pertaining only to archeology's part in the planning of a project. The critical areas of construction and operations were not mentioned. In the absence of such regulations, the Southwestern Division developed policy guidance and directions for its five Districts. Several other Divisions and Districts requested copies of this guidance. In the fall of 1985, archeologists from the Division Office and Galveston District served on different task groups at the Chief of Engineers Office to prepare new and separate regulations for construction and operations and to implement the Archeological Resources Protection Act of 1979. But the Southwestern Division still routinely responds to inquiries and requests for assistance from other Division offices and Districts for policy guidance and, less often, for technical assistance.²³

In 1984 the Southwestern Division began a comprehensive archeological overview of its entire territorial jurisdiction. This type of project on a smaller scale dated back to the late 1960s, when archeological overviews were recognized in the Corps as a means of providing guidance and direction in planning civil works projects. The comprehensive 1970 report, *Red River Below Denison*, edited by Hester Davis, exemplifies this program. However, the Corps has not made effective use of overviews as tools for developing or giving direction to archeological management programs.

There are four basic reasons for this apparent oversight. First, after the enactment of the Archeological Conservation Act, the Corps' funds for archeological investigation were project-specific. So the Districts did not have the prerogative to use such funds on regional overviews. Since enactment of the law, the Corps has been hard pressed to accomplish necessary archeological work on individual projects with available funds. Second, the treatment of individual site needs, usually for mitigation or preservation techniques, has had a higher priority in funding. Third, the costs of and effort needed for regional overviews were too much for the Districts to handle. The fourth factor concerns the tremendous amount of archeological data that has been accumulated within the past 15 years. Without access to well-designed computer programs, compilation and accurate interpretation and maintenance of the data itself were almost impossible.²⁴

But work is under way to change this situation. In 1981 Dr. John Belshe, chief of environmental resources at the Office, Chief of Engineers, initiated funding for two overviews as potential pilot studies. One was conducted by the Nashville District. The other was the Division-wide survey in progress since October 1984 through a contract with the Arkansas Archeological Survey. Five individual study units are to report on the Division's physiography, drainage basins, and culture areas (the ranges of particular prehistoric and

historic groups of people). Each study unit will include broadly defined reconstructions of the environmental conditions that different cultures adapted to at different times; a technical review of all previous archeological work accompanied by an annotated bibliography; a review and assessment of remote-sensing applications for archeological uses; and a state-of-the-art assessment of bioarcheology. All of the information will be placed in a computerized data bank and can be updated as necessary.²⁵

The final, and perhaps most important, part of the overview will be an executive summary that will outline critical geographic and topical areas of sensitivity, data gaps, and management recommendations. District and Division Engineers and other non-archeologists such as project engineers involved with managing the archeological program will use this information. The overview will provide a common point of reference for future archeological studies and District and project management plans. It will also provide a more uniform, dynamic, and cost-effective method of managing the archeological programs. If the project meets the current expectations, the Division overview will become a model for application throughout the Army Corps of Engineers.

Completion of the overview will benefit not only the civil works side of the Corps but will also help it assist military installations with background data for developing their own cultural resource management programs. The Southwestern Division has worked closely with the military installations within its boundaries since the mid-1970s. Through its recommendations, Forts Hood and Bliss, Texas, established staff archeological positions and management programs. These programs, developed and managed respectively by Drs. Fred Brieur and Glen De Garmo, have become national models for Army installations.²⁶ Archeological work has also been on-going at most of the other military installations located within the Southwestern Division's boundaries since the late 1970s.

Arrangements for the military exercise Border Star '85 at White Sands Missile Range, New Mexico, took archeological concerns into consideration. Before the exercise began, Pete Eidenbach and Bob Burton, Fort Worth District archeologists, directed archeological surveys that located some 1,200 sites within the 54-square-mile area on which the tank maneuvers were to be conducted. They marked the sites as "hot spots" for tank commanders to avoid, even in nighttime maneuvers. Portions of only two sites were damaged.²⁷ The archeology program in the Southwestern Division involves decisions, work, and support by Corps personnel including project managers, rangers, resident engineers, and staff elements throughout the Districts and the Division office. Through the efforts of Division personnel and others, archeology has become an integrated element of all Corps activities from initial planning, design and construction through the operation and maintenance of completed projects.

The Division's leadership in the area of archeology is clearly recognizable. Its interest in the subject can be traced back to World War II, when the Tulsa District extended the provision of the Flood Control Act of 1944 to justify the expenditure of funds on a few digs. From that first step, whether taken by chance or design, cultural preservation has grown in importance in the Division, and it has furnished much leadership at the Washington level. Archeology may well be the best example of why the Southwestern Division calls itself the Pacesetter.



Native American artifacts teach visitors in a display at Table Rock Lake, Missouri.

X PAST AND FUTURE

The Southwestern Division came into existence in the midst of the Depression, when the federal government was seeking to increase employment through public works. Focusing at first strictly on flood control, the new Division inherited the Conchas Dam, already under construction, and began planning studies on several new reservoirs authorized by Congress. With the creation of the Tulsa District in 1939 and the shuffling of Districts by the Office, Chief of Engineers preparatory to World War II, the Southwestern Division's territorial jurisdiction quickly expanded, eventually reaching from the Colorado Rockies to the Gulf of Mexico. Shortly before the United States entered World War II, the Division moved its headquarters from Little Rock to Dallas to take advantage of a location more central to its area of operations. The war became a turning point for the Division and the whole Army Corps of Engineers when Congress shifted the bulk of Army and Air Force construction from the Quartermaster Corps to the Engineers. During the war, the Division's concentration on military considerations brought its civil works program almost to a standstill.

But the war's end brought a renewed push in civil works construction, so much so that the Fort Worth District was created in 1950 to accommodate the large workload. Twenty-one reservoirs were authorized for the Division during the post-war years. There was a definite trend towards a broader approach to project planning and development. Comprehensive river basin planning replaced the single-project approach of the past. Initial evidence of this trend was seen in the results of the early Arkansas-White-Red Basins Interagency Committee and U.S. Study Commission studies conducted in this region. The trend continued into an era in which Corps planning has resulted in proposed non-structural solutions to many of the problems presented by local interests rather than the "concrete and dirt" solutions demanded in the earlier years. The surge of authorizations in the 1960s and the many study completions in the 1970s and the 1980s showed that traditional multipurpose projects, however, continued to have great importance and support throughout the Southwestern Division's area.¹

The McClellan-Kerr Waterway partly accounted for the Division's large civil works operations. On the other hand, the public's failure to support construction of the proposed Trinity River Waterway furnished an opportunity to observe a shift in public ideology and attitude in the Southwest away from large-scale water developments. Business and political interests promoting the channelization of the Arkansas River espoused a philosophy of economic growth and development and saw the Arkansas as a means to encourage the industrialization of Oklahoma and Arkansas. In some circles, opposition to projects promising economic growth was tantamount to treason. These proponents continuously fought for construction of the waterway. When it was finished in 1971, they had reached a long-sought goal.

The different outcome of the proposed Trinity River Waterway reflected a shift in public opinion. Proponents of the project had used almost identical justification: economic growth and industrialization. Yet strong opposition arose during the campaign for the 1973 bond election that would have provided local funding. Opponents expressed a dislike for such growth, claiming that the north Texas metropolitan area would be better served by avoiding such projects on the grounds of both expense and environmental preservation. Failure of the Trinity River Waterway had deep significance for the Army Corps of Engineers overall—it meant that future political support for multipurpose projects involving navigation could not be assured. The public did not wholly oppose water projects, however. Joe Pool and Ray Roberts lakes,

both originally part of the waterway plan, were nearing completion in 1986 as water supply, flood control, and recreation reservoirs. Opinions differ over the reason for the 1973 bond election defeat in Texas, but public support for river navigation projects has definitely diminished in the Southwest, and the economy has moved in the direction of defense and high-tech industries.²

As new starts for multipurpose projects declined in the region, the Division's activity in civil works moved in other directions, exemplified by the 404 Regulatory Permit Program and the Flood Plain Management Program. Both have proved to be extremely important in maintaining environmental standards and reducing the need for structural flood prevention measures. Lakeshore management will continue to grow in importance as the population increases and the use of reservoirs for recreation expands. Thus, a visible trend by the mid-1980s was a shift from the large project to the small, a shift in civil works from construction to studies, technical services, and advice to the public.³

Privatization—the practice of turning government tasks and programs over to private enterprise—and the current emphasis on deregulation, if continued, will have a significant impact on the Southwestern Division as it moves into its second 50 years. Already, in the Galveston District, hopper dredges owned by private firms work on contract. Other examples of privatization may appear; the commercial activities study under way for the Division Laboratory may turn some of its functions over to civilian contractors. The Army Corps of Engineers will not, of course, lose all its responsibilities to the private sector. But an increased portion of those responsibilities and functions not associated with regulatory legislation, review, or quality control will probably at some point go to private firms.

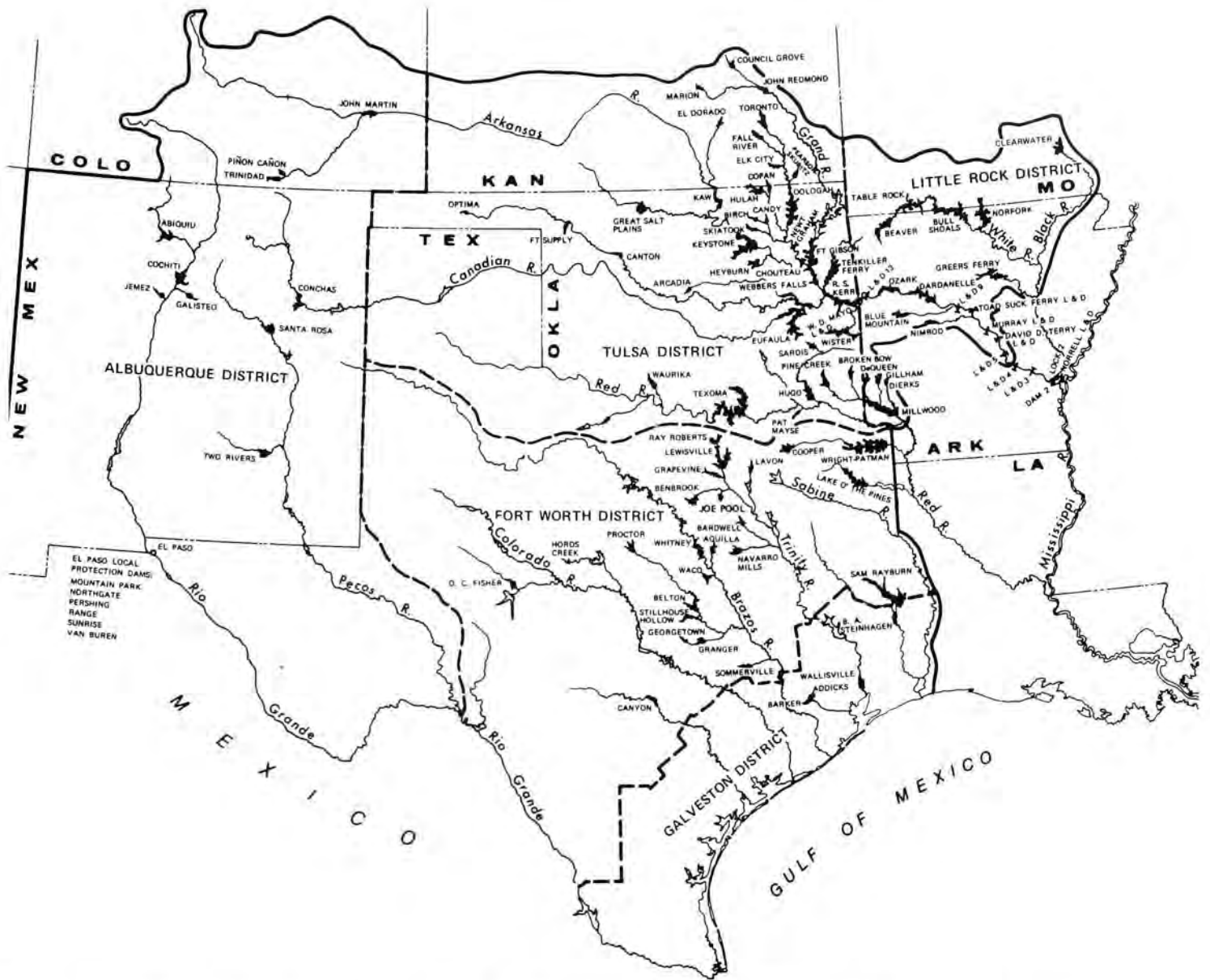
Another role that may change for the Corps lies in the area of water supply. The Dallas-Fort Worth metroplex depends upon reservoirs for its water. About one-third of its water supply comes from federally owned and operated multipurpose projects.⁴ The Reagan administration has emphasized water supply as a local rather than federal responsibility. This policy has caused a growing concern in northern Texas about adequate sources of water for the future, particularly in view of the region's population growth. These future water demands could be met either by continued efforts to develop multipurpose reservoirs or by development of single-purpose water-supply lakes.

The question of water supply versus flood control had arisen before through the Arkansas-White-Red Basins Interagency Committee and the U.S. Study Commission-Texas. A Southwestern Division Engineer, Major General Charles I. McGinnis, predicted in 1975:

The challenge [of water supply] thus presented is one which...will sustain the Corps well into the future. SWD had, furthermore, gone far toward development of the economically suitable sites for impoundment structures. We have reached the point where future projects addressing flood damage reduction are less and less likely.⁵

Retired Major General Hugh Robinson, reflecting on his own experiences as Southwestern Division Engineer, agreed and added another dimension. He thought the process of de-federalization would continue, regardless of who became the next president, and that the role of the Army Corps of Engineers in civil works would get smaller. A move might develop in Congress, he predicted, that would give smaller reservoir projects, those wholly contained in one political entity, to local governments. "It wouldn't surprise me a bit," he stated.⁶ Such a move might be partly justified on the need for water.

If the current trend toward fewer civil works projects in the Southwestern Division continues, just the opposite is the case with military projects. If anything, the Division's role in keeping the armed forces prepared for war will



increase. The Division has responsibility for a large portion of the country's Army and Air Force bases. As space-related research continues, the Division will also have a hand in further construction of facilities at White Sands Missile Range. In contrast to some aspects of civil works, military construction engenders little public furor. Indeed, if de-federalization continues in civil works, military construction will eventually play the dominant role in the Division's workload.

The Southwestern Division, 1986

Closely allied with military projects is the "Work for Others" program, which had a significant impact on the Division via the Waste Isolation Pilot Plant and the Pantex Plant. The Department of Energy's nuclear waste plant became a significant part of the Albuquerque District's program in the 1980s. But as the decade went on, a new factor emerged. Events such as the 1979 accident at the Three Mile Island nuclear plant in Pennsylvania and the unfortunate disaster at Chernobyl in the Soviet Union in 1986 increased public opposition to nuclear generating plants. That attitude came to include fear of and opposition to any sort of nuclear facility. Only a few years ago, the electrical industry planned to intensively develop nuclear energy as a major power source, but those expectations have not materialized. If anything, the trend has reversed due to public concern over safety and the cost of building

nuclear generating stations. The Southwestern Division's opportunities to increase its work in nuclear-related projects may be short-lived. The next 50 years will certainly see a different role for the Southwestern Division, a change that will be brought on by both local and global events.



Engineers working in the Southwestern Division as it enters its second 50 years use infrared photography and other technological improvements to aid their calculations.

FOOTNOTES CHAPTER I

1. "Southwest" in this study will mean the following states or portions thereof: Arkansas, Louisiana, New Mexico, Oklahoma, and Texas. Population growth in the states of the Southwestern Division's area of operations were as follows:

	1920	1930	1940
Arkansas	1,752,204	1,854,482	1,949,387
Louisiana	1,798,509	2,101,593	2,363,880
New Mexico	360,350	423,317	531,818
Oklahoma	2,028,283	2,396,040	2,336,434
Texas	4,663,228	5,824,715	6,414,824

Source: *Statistical Abstract of the United States, 1950* (Washington, DC: Bureau of the Census, 1950), pp. 34-35.

2. William B. Settle, Jr., *The Dawning: A New Day for the Southwest, A History of the U. S. Army Corps of Engineers, Tulsa District* (Tulsa, OK: U.S. Army Engineer District, 1975), p. 14.

3. Report, "Formation of the Southwestern Division," [n.d.], p. 9. Typescript copy in Historical files, SWD Office of Administrative Services, Dallas, TX.

4. For another discussion of these early surveys, see D. Clayton Brown, *Rivers, Rockets and Readiness: Army Engineers in the Sunbelt*, (Fort Worth, TX: U.S. Army Engineer District, 1979), p. 87.

5. Lynn Alperin, *Custodians of the Coast* (Galveston, TX: U.S. Army Engineer District, 1977), p. 21.

6. *Ibid.*, p. 55.

7. *Ibid.*, pp. 68-75.

8. Brown, *Rivers, Rockets and Readiness*, pp. 87-97.

9. William G. Hoyt and Walter B. Langbein, *Floods* (Princeton, NJ: Princeton University Press, 1955), p. 173.

10. Luna B. Leopold and Thomas Maddock, Jr., *The Flood Control Controversy: Big Dams, Little Dams and Land Management* (New York, NY: Ronald Press, 1954), p. 100.

11. Hoyt and Langbein, *Floods*, p. 174.

12. Settle, *The Dawning*, pp. 28-36.

13. U.S., Congress, House, *White River, Missouri and Arkansas*, 73rd Cong., 1st sess., House Document 102 (Washington, 1933). Less than five percent of the farms in the White River Valley, however, had electricity.

14. Interview, Selma Sage with Roy Penix, executive assistant, typescript, [n.d.], p. 2. Copy in SWD Office of Administrative Services historical files, Dallas, TX. Hereafter cited as Penix interview.

15. Floyd M. Clay, *A History of the Little Rock District, Corps of Engineers* (Little Rock, AR: U.S. Army Engineer District, 1971), p. 25.

16. Louis C. Tulga and Nathan J. Sewell, *The First Thirty-Six Years: A History of the Albuquerque District, 1935-1971* (Albuquerque, NM: U.S. Army Engineer District, 1973), p. 8.

17. Report, *History of Authorizations, Organizations and Responsibilities*, (Albuquerque, NM: U.S. Army Engineer District, [n.d.]), p.1. Typescript copy in Historical files, SWD Office of Administrative Services, Dallas, TX. Hereafter cited as *History of Authorizations*.

18. David Temple, "Our Evolving National Water Policy," *American Forests* (September, 1956), pp. 34-41; Leopold and Mattock, *The Flood Control Controversy*, pp. 101-102.

19. Descriptions of these projects are found in U.S., Army, Corps of Engineers, *Report of the Chief of Engineers, U. S. Army, 1938*, Vol. 1, pt. 1 (Washington, DC: U.S. Government Printing Office, 1938), pp. 961-1007.
20. *Ibid.*, p. 957.
21. *Ibid.*, p. 961.
22. Interview, author with Carl Andrews, Dallas, TX, 14 Apr. 1983. Andrews was one of the original employees of the Southwestern Division. He had worked earlier in the Memphis District.
23. *Ibid.*
24. U.S., Army, Corps of Engineers, *Report of the Chief of Engineers, U.S. Army, 1950*, Vol. 1, Part 1 (Washington, DC: U.S. Government Printing Office, 1951), pp. 1281-1284, 1296.
25. *History of Authorizations*, p. 2.
26. U.S., Army, Corps of Engineers, *Report of the Chief of Engineers, U.S. Army, 1940*, Vol. 1, Part 1 (Washington, DC: U.S. Government Printing Office, 1941), p. 1047.
27. *Ibid.*, p. 1101.
28. *Ibid.*, p. 1057. Caddoa District was renamed the Albuquerque District in 1941.
29. Selma Sage, "History of the Southwestern Division," SWD historical files, part III, p. 1. This typescript history of the Division was researched and written in 1971 by a retired employee. It provided needed information on the early years of the Division.
30. *History of Authorizations*, p. 3.
31. U.S., Army, Corps of Engineers, *Report of the Chief of Engineers, U.S. Army, 1941*, Vol. 1, Part 1 (Washington, DC: U.S. Government Printing Office, 1941), p. 952.
32. C. Langdon White, Edwin J. Foscue, and Tom F. McNight, *Regional Geography of Anglo-America* (Englewood Cliffs, NJ: Prentice-Hall, 1964), pp. 136-137.
33. *Ibid.*
34. Ruth Kent, *Oklahoma: A Guide to the Sooner State* (Norman, OK: 1945), pp. 9-17.
35. Works Progress Administration, *New Mexico: A Guide to the Colorful State* (New York, NY: 1940), pp. 9-34.

CHAPTER II

1. Ellis Armstrong, ed, *History of Public Works in the United States, 1776-1976* (Chicago, IL: American Public Works Association, 1976), p. 596.
2. Historical notes, typescript, SWD Office of Administrative Services, Dallas, TX, June 1955.
3. *Dallas Morning News*, 2 Feb. 1941. Carl Andrews and James Russel remembered that the SWD personnel in Little Rock had to transfer trains in Dallas when they went to Houston or San Antonio; Interviews, author with James Russel and Carl Andrews, Dallas, TX, 13 Apr. 1983. Hereafter cited as Russel and Andrews interviews. Russel, resident engineer at the Norfolk, AR, reservoir, was told by Col. Stanley L. Scott to find buildings in Dallas to house the Southwestern Division. He chose the Cotton Exchange Building because it had just been remodeled.
4. For a thorough study of the transfer, see Lenore Fine and Jesse A. Remington, *The Corps of Engineers: Construction in the United States*, (Washington, DC: Office of the Chief of Military History, USA, 1972), pp. 440-472; quote on p. 456.
5. *Ibid.*, pp. 467-472.
6. *Dallas Times Herald*, 16 June 1943, Section 3, p. 2.

7. Ibid.
8. Fine and Remington, *The Corps of Engineers*, p. 495.
9. Ibid., pp. 495-497; Settle, *The Dawning*, p. 70.
10. Russel and Andrews interviews. Col. Scott, Little Rock District Engineer, replaced Reybold. Scott commanded the SWD until 13 Oct. 1942.
11. Interview, author with Alfred Wehrman, Dallas, TX, 25 Mar. 1983. Hereafter cited as Wehrman interview. A large part of the Santa Fe Building was warehouse space. It was renovated into offices where more Division employees were put.
12. Penix interview, pp. 15-16.
13. Ibid.
14. Wehrman interview.
15. Penix interview, p. 12. See Fine and Remington, *The Corps of Engineers*, pp. 522-561, for a discussion of this kind of problem on a national scale.
16. Dallas *Times Herald* (16 June 1943).
17. *Business Week* (7 August 1943), pp. 95-96.
18. *Scientific American*, 170 (May 1940):220; Wehrman interview.
19. Wehrman interview.
20. Ibid.
21. Ibid.
22. Gordon A. Cotton, *A History of the Waterways Experiment Station, 1929-1979* (Vicksburg, MS: U.S. Army Engineer District, 1979) pp. 41-43.
23. Wehrman interview.
24. Ibid.
25. Tulga and Sewell, *The First Thirty-Six Years*, pp. 23-27; Clyde M. Smith furnished information about the purchase of land for the Manhattan Project.
26. Fine and Remington, *The Corps of Engineers*, pp. 393-407, 493.
27. Alperin, *Custodians of Coast*, p. 189.
28. Ibid., p. 196.
29. Settle, *The Dawning*. p. 71.
30. Fine and Remington, *The Corps of Engineers*, p. 597.
31. Russel interview. Special rolling at the steel mills ensured that the steel beams met specifications to span more than 300 feet. The flanges and webs in the structural steel beams exceeded 2 1/2-to-3 inches in thickness.
32. Penix interview, p. 19.
33. Construction of Denison and Norfolk dams during the war was largely a political matter, and SWD was not involved in the decision-making process. For an explanation of the dams' construction, see D. Clayton Brown, *Electricity for Rural America: The Fight for the REA* (Westport, CN: Greenwood Press, 1980), pp. 99-111.
34. D. Clayton Brown, "Sam Rayburn and the Development of Public Power in the Southwest," *Southwestern Historical Quarterly*, 73 (October 1974):140-156.
35. *Moody's Manual of Investments: Public Utility Securities* (New York, NY: Moody's Investment Service, 1945), p. A32.
36. Brown, "Sam Rayburn and the Development of Public Power," pp. 140-141.
37. For further discussion, see Marquis Childs, *The Farmer Takes a Hand: The Electric Power Revolution in Rural America* (Garden City, NJ: Doubleday, 1952), p. 174.
38. Alperin, *Custodians of the Coast*, p. 215.
39. Clay, *History of the Little Rock District*, pp. 31-33.
40. Ibid., p. 38.
41. Settle, *The Dawning*, p. 75.

CHAPTER III

1. *Congressional Record*, 78th Cong., 1st sess., 89, pt. 7:9322.
2. Robert S. Kerr, "Plow, Plant and Pray," *The Reclamation Era* (March 1948), p. 84, in Robert S. Kerr Papers, Box 131, Folder 17, Western History Collection, University of Oklahoma.
3. Elmer Johnson, "Recent Industrial Advances in Texas," *Texas Business Review*, 18 (January 1945):9.
4. *Ibid.*, p. 18. For further discussion of Texas' postwar water problems, see John R. Stockton and Stanley A. Arbingast, *Water Requirements Survey, Texas High Plains: A Study of Resource Utilization, Industrial Development Potential, Population Growth and Water Use*, Bureau of Business Research, University of Texas, Austin, TX, (March 1952).
5. Tulga and Sewell, *The First Thirty-Six Years*, pp. 18-19.
6. Brown, *Rivers, Rockets and Readiness*, pp. 18-19.
7. *Ibid.*, pp. 9, 19.
8. "Analysis on Establishment of Fort Worth District," [n.d.], typescript, SWD Office of Administrative Services historical files, pp. 1-4.
9. *Ibid.*, pp. 6-9; Fort Worth *Star-Telegram*, 5 Apr. 1950.
10. News release, 6 Mar. 1950, SWD Office of Administrative Services historical files.
11. Office of the Chief of Engineers to the SWD Engineer, 9 Mar. 1954, Box 307, 76A6, RG 77, FWFRFC, Fort Worth, TX. Hereafter cited as Box 307, RG 77, FWFRFC.
12. SWD Engineer to District Engineer, 1 Jan. 1953, Box 307, RG 77, FWFRFC.
13. Herbert D. Vogel to the Chief of Engineers, 27 Apr. 1954; Office, Chief of Engineers to Vogel, 26 May 1954, both in Box 307, RG 77, FWFRFC.
14. Chief of Engineers Inspection of the Southwestern Division, typescript, 22 Mar. 1956, Box 335, 76A6, RG 77, FWFRFC, Fort Worth, TX.
15. Robert H. Pealy, "Comprehensive River Basin Planning: The Arkansas-White-Red Basins Inter-Agency Committee Experience," Institute of Public Administration, University of Michigan, typescript [n.d.], p. 2, Box 314, 76A6, FWFRFC, Fort Worth, TX.
16. Memorandum, typescript [n.d.], Box 271, 76A6, FWFRFC, Fort Worth, TX.
17. Report, AWRBIAC Conference in the SWD Office, typescript, 14 Aug. 1950, Box 273, 76A6, RG 77, FWFRFC, Fort Worth, TX. Hereafter cited as AWRBIAC Conference Report.
18. Louis W. Prentiss to Major General Lewis A. Pick, 15 Sept. 1950, Box 307, RG 77, FWFRFC. The Bureau of Reclamation agreed to let the Corps of Engineers have rights over drainage in the three basins.
19. AWRBIAC Conference Report.
20. Edward G. Herb to Louis Prentiss, 8 Jan. 1952, Box 287, 76A6, Record Group 77, FWFRFC, Fort Worth, TX; Pealy, "Comprehensive River Basin Planning," p. 71. Hereafter cited as Box 287, 76A6, RG 77, FWFRFC.
21. "Excerpts from Transcript of Regional Joint Public Hearing, Oklahoma City," 11 Dec. 1950; quote in "General Discussion," typescript [n.d.], both in Box 14, RG 77, C25-049-1-1, FWFRFC, Fort Worth, TX. Hereafter cited as Box 14, RG 77, FWFRFC.
22. C. H. Chorpening to Charles D. Curran, 21 Sept. 1952, Box 14, RG 77, FWFRFC.
23. Dwight D. Eisenhower to Walter L. Huber, 5 Mar. 1954 (copy), Box 287, 76A6, RG 77, FWFRFC.

24. U.S., Congress, Senate, Document No. 13, *Development of Water and Land Resources of the Arkansas-White and Red River Basins*, 85th Cong., 1st sess., 1957, p. xvii.
25. The topics studied by AWRBIAC were hydropower, water pollution, water resources, fish and wildlife, recreation, mosquito control, agriculture, and mineral resources.
26. Pealy, "Comprehensive River Basin Planning," p. 47.
27. AWRBIAC received criticism. In 1955 the second Commission on Organization of the Executive Branch of the Government found numerous faults with it: departmental jealousies, lack of funds and personnel among participating agencies, incompatible goals among the participating agencies and lack of congressional direction. See *Commission on Organization of the Executive Branch of the Government, Task Force on Water Resources and Power*, III (June 1955): 1395-1472. For examples of dissatisfaction with the Southwestern Division, see C. W. Seibel to Herbert D. Vogel, 4 Mar. 1954, Box 287, RG 77, FWFR.
28. E. C. Warkentin to Dennis Chavez, 2 Sept. 1958, reprinted in *Annual Report of the Arkansas-White-Red Basins Interagency Committee, 1958-59* (1 July 1959), p. B4, in Box 314, 76A6, RG 77, FWFR, Fort Worth, TX. Membership in the new AWRBIAC consisted of the following: Departments of the Army, Interior, Agriculture, Commerce, and Labor; Federal Power Commission, and Public Health Service. State members were Louisiana, Texas, Kansas, Arkansas, Colorado, Oklahoma, New Mexico, and Missouri.
29. Arkansas-White-Red Basins Interagency Committee, *Annual Report 1961-62* (Sept. 1961), p. 14.
30. Interviews, author with William Pearson and Tom Kincheloe, both in SWD Planning Division, Dallas, TX, 22 June 1983. Copies of the AWRBIAC annual reports are available in the SWD Planning Division.
31. Walter P. Webb, *More Water for Texas: The Problem and the Plan* (Austin, TX: University of Texas Press, 1954), p. v.
32. L. B. Wooten to John McClellan [n.d.], John L. McClellan Papers, Box 23, file D, John L. McClellan Library, Quachita Baptist University, Arkadelphia, Arkansas.
33. U.S., Congress, House, Document No. 498, *Examinations of Rivers and Harbors*, Vol. 15, 83d Cong., 2d sess., pp. 9, 33.
34. Brown, *Rivers, Rockets and Readiness*, pp. 38-39.
35. *Arkansas-White-Red Basins Interagency Committee Annual Report 1957-58*, (30 June 1958) pp. 11-12.
36. United States Study Commission-Texas, Part I, *The Commission Plan* (March 1962), p. 1.
37. "Guide for United States Study Commission-Texas," 8 Dec. 1958, typescript, Box 366, 76A6, RG 77, FWFR, Fort Worth, TX. Hereafter cited as Box 366, RG 77, FWFR.
38. William Whipple to District Engineer, 13 Nov. 1959, Box 366, RG 77, FWFR.
39. William Whipple to E. C. Itschner, July 7, 1960, Box 265, 76A6, RG 77, FWFR, Fort Worth, TX. Hereafter cited as Box 265, RG 77, FWFR.
40. Robert J. Fleming to William F. Cassidy, 1 Dec. 1961, Box 366, RG 77, FWFR.
41. Ibid.
42. U.S., Congress, Senate, Committee on Interior and Insular Affairs, *History of the Implementation of the Recommendations of the Senate Select Committee on National Water Resources*, 86th Cong., 1st sess., 1959, p. 7.
43. Morgan, *Robert S. Kerr, The Senate Years*, p. 172.
44. "Responsibilities for the Various Segments of the Recreational Spectrum," p. 4, paper presented by Gordon H. Jones, Chief, Southwestern

Division Recreation Planning Section, 3 Feb. 1964, files of Southwestern Division Planning Division. At an earlier meeting, Jones stated: "The day when recreation was treated simply as an incidental or corollary benefit of our reservoir projects is past." See Gordon H. Jones, "Park Planning Concepts for Water Resource Projects," typescript, (17 Nov. 1965), p. 1, files of Southwestern Division Recreation Planning Branch.

45. U.S., Congress, Senate, Subcommittee of the Committee on Appropriations, *H.R. 12858, Civil Functions, Department of the Army*, pt.1, 85th Cong., 2d sess., p. 762.

46. William Whipple to Field, Southwestern Division Engineering Division, 26 Feb. 1960, Box 265, RG 77, FWFRC.

47. Ibid. Visitations to SWD projects in 1960 totaled 39.6 million, about 36 percent of the total in the Corps of Engineers. That large number undoubtedly accounted for Whipple's attention to recreation. See paper, "The Planning and Development of Reservoir Lands for Public Use," presented by Gordon H. Jones, chairman, Military Lands Division, ASA, 1961, p. 4, files of SWD Recreation Planning Branch.

48. Jones, "Park Planning Concepts for Water Resource Projects," pp. 3-4.

49. Ibid., p. 4.

50. In 1974 SWD established a Recreation-Resource Management Branch in the Construction-Operations Division.

51. Eugene P. Levy to Homes Rafjohn, 28 Aug. and Walter L. Brown, "Interpretive Prospectus for the Visitor Center, Greers Lake, Little Red River, Arkansas," both in files of SWD Recreation Branch.

52. Interview, author with Mark King, SWD Construction-Operations Division, Dallas, TX, 21 May 1986. Hereafter cited as King interview.

53. Mark King, "Lakeshore Management," files of SWD Recreation Branch.

54. Ibid.

55. Ibid.

56. Ibid.

57. U.S., Army, Corps of Engineers, Institute for Water Resources, *National Hydroelectric Power Resources Study: Executive Summary* (May 1983), p.1; Interview, author with William Johnson, SWD Engineering Division, Dallas, TX, 14 Aug. 1986. Hereafter cited as Johnson interview.

58. Johnson interview.

59. Carl Morgan to John Tower, 25 Feb. 1980, files of Southwestern Division Planning Division.

60. Ibid.

61. Ibid.

62. Contract, "Escrow Agreement for Construction of Town Bluff Hydropower, Texas, Project, files of the SWD Planning Division.

63. Interview, author with Glen Combs, SWD Planning Division, Dallas, TX, 5 May 1986.

64. Fact sheet on Joe Pool Lake, TX, 20 Mar. 1986, files of the SWD Planning Division.

65. Fact sheet on Ray Roberts Lake, TX, 20 Mar. 1986, files of the SWD Planning Division.

66. U.S., Army, Corps of Engineers, ER 105-1-5, 21 Mar. 1986.

CHAPTER IV

1. Interview, author with Larry Buck, SWD Construction-Operations Division, Dallas, TX, 7 Apr. 1986. Hereafter cited as Buck interview.

2. Ibid.

3. King interview.

4. Buck interview.
5. U.S., Army, Corps of Engineers, ER 1105-2-10; Interview, author with Patrick Witherspoon, SWD Planning Division, Dallas, TX, 16 Apr 1986.
6. Interview, author with Jerrell Sartor, SWD Planning Division, Dallas, TX, 30 May 1986.
7. "Flood Management Program," Job No. 2927-5, files of the Southwestern Division Recreation Branch.
8. *New York Times*, 6 and 7 June 1976 and 7 Nov. 1977.
9. Gaylord Shaw, "The search for dangerous dams—a program to head off disaster," *Smithsonian*, 9(April 1978):37-38.
10. Interview, author with Chester Berryhill, SWD Engineering Division, Dallas, TX, 27 Jan. 1981.
11. Interview, author with James D. Harrison, SWD Construction-Operations Division, Dallas, TX, 27 June 1983.
12. Sage, "History of the Southwestern Division, 1937-1970," p. 44.
13. Interview, author with J. D. Harrison, SWD Construction-Operations Division, Dallas, TX, 7 Apr. 1986.
14. Telephone interview, author with Sid Tanner of Galveston District Planning Division, 4 Mar. 1981; Chester L. Pawlik, John W. Keith and John H. Armstrong, "Texas Coast Hurricane Flood Protection Studies, *Journal of the Hydraulic Division, ASCE*, 93(Nov. 1967):147-151.
15. Alperin, *Custodians of the Coast*, p. 230.
16. Interview, author with Chet Taylor, SWD Construction-Operations Division, Dallas, TX, 7 Apr. 1986.
17. Preliminary Working Papers, "Rio Grande Basin, Texas," Board of Engineers for Rivers and Harbors, 22 Feb. 1983, files of Ronald DeBruin, SWD Planning Division. Hereafter cited as "Rio Grande Basin" papers.
18. Interview, author with Ronald De Bruin, SWD Planning Division, Dallas, TX, 14 Apr. 1986.
19. Ibid.
20. "Rio Grande Basin" papers.
21. Notes, "Dredging - Galveston District," files of the SWD Environment Resources Branch.
22. Ibid.
23. *Vital Speeches*, 46 (1 Oct. 1980):739.
24. *Fort Worth Star-Telegram*, 30 Dec. 1985.
25. Interview, author with Ernest Jungblut, chief, SWD Resource Management Office, Dallas, TX, 26 Mar. 1986.
26. Ibid.
27. Interview, author with Thomas R. Brogdon, SWD Real Estate Division, Dallas, TX, 3 Apr. 1986.
28. Ibid.
29. Ibid.

CHAPTER V

1. Wehrman interview.
2. Ibid.
3. Ibid.
4. Interview, author with John Brigance, chief, SWD Procurement and Supply Division, Dallas, TX, 8 Aug. 1982.
5. Fort Hood files, Box 746, Fort Worth District Record Management Branch, Fort Worth, TX. Hereafter cited as Fort Hood files.
6. Ibid.
7. Interview, author with Thomas Powell, SWD Engineering Division, Dallas, TX, 16 Apr. 1981. Hereafter cited as Powell interview.

8. Fort Hood files.
9. Ibid.; Powell interview; Interview, author with Sam Aiken, SWD Engineering Division, Dallas, Texas, 8 Aug. 1982. Hereafter cited as Aiken interview.
10. A. C. Welling to Division Engineers, 6 Jan. 1953, Box 5/32, RG 77, C25-049-1-1, FWFRC, Fort Worth, TX. Hereafter cited as Box 5/32, RG 77, FWFRC.
11. David H. Tulley to the SWD Engineer, Box 5/32, RG 77, FWFRC.
12. Herbert Vogel to Lewis A. Pick, 15 Oct. 1952, Lewis A. Pick Papers, Historical Division, Office, Chief of Engineers, Washington, DC.
13. Herbert D. Vogel to District Engineers, 29 Sept. 1953, Box 5/32, RG 77, FWFRC.
14. Walter J. Wells to Lyle Seeman, 20 Sept. 1957; Staunton Brown to Seeman, 20 Sept. 1957, both in Box 346, 76A6, RG 77, C25-049-1-1, FWFRC, Fort Worth, TX. Hereafter cited as Box 346, 76A6, RG 77, FWFRC.
15. Ivan H. Impson to Lyle E. Seeman, 21 Jan. 1958, Ltrs. Recd., Box 356, 76A6, RG 77, C25-049-1-1, FWFRC, Fort Worth, TX. Hereafter cited as Box 356, 76A6, RG 77, FWFRC.
16. David H. Tulley to the SWD Engineer, 10 Sept. 1953, Box 5/32, RG 77, FWFRC; George W. Coin to SWD Engineer, 28 Feb. 1958, Box 356, 76A6.
17. Brown, *Rivers, Rockets and Readiness*, pp. 46-47.
18. "ICBM Operational Bases Under Construction or Planned as of August 1, 1960," typescript, Box 265, RG 77, C25-049-1-1, FWFRC, Fort Worth, TX. Hereafter cited as Box 265, RG 77, FWFRC.
19. Stanley G. Reiff to John Arfmann, 25 Aug. 1960, Box 265, RG 77, FWFRC.
20. Reiff to A. C. Welling, 4 Aug. 1960, Box 265, RG 77, FWFRC.
21. "Briefing Conference—Walker Air Force Base," 27 Aug. 1960, typescript; Reiff to Howard Penny, 30 Sept. 1960; John Carroll to Arthur M. Jacoby, 16 Sept. 1960; Reiff to W. C. Hall, 24 Aug. 1960, all in Box 265, RG 77, FWFRC.
22. Brown, *Rivers, Rockets and Readiness*, pp. 51-52.
23. Maj. Gen. Robert J. Fleming to E. C. Itschner, 15 Dec. 1960, Box 265, RG 77, FWFRC.
24. "Remarks of Major General Robert J. Fleming, Jr., to the Society of American Military Engineers, Southwestern Regional Conference, Oklahoma City, Oklahoma, April 7, 1961," typescript, Office of History Files, Office, Chief of Engineers, Fort Belvoir, VA.
25. Fleming to Joe M. Kilgore, 31 Mar. 1961, Box 310, 76A6, Record Group 77, C25-049-1-1, FWFRC, Fort Worth, TX. Hereafter cited as Box 310, 76A6, RG 77, FWFRC.
26. "Department of the Army: Office of the Secretary of the Army," 30 Mar. 1961, typescript, Box 310, 76A6, RG 77, FWFRC.
27. Fleming to Lyndon B. Johnson, 6 Apr. 1961, Box 310, 76A6, RG 77, FWFRC.
28. "Department of the Army," Box 310, 76A6, RG 77, FWFRC.
29. Interview, author with James Russel, Dallas, TX, 26 Mar. 1983.
30. Personal notes, Darden L. Orendorff to author, Albuquerque, NM., July 1983. Orendorff spent 22 years in the Albuquerque District and then worked as chief of the Engineering Division in the Fort Worth District until he retired in 1974. His notes served as the basis for this discussion of WSMR.
31. Ibid.
32. Ibid.
33. Aiken interview; Interview, author with Tom Powell, Dallas, TX, 8 Aug. 1982. Hereafter cited as Powell 1982 interview.

34. Sewell, *The First Thirty-Six Years*, p. 63.
35. Brown, *Rivers, Rockets and Readiness*, p. 152.
36. *Ibid.*, pp. 152-153.
37. Aiken and Powell 1982 interviews; Interview, author with retired Brig. Gen. James Donovan, Dallas, TX, 13 May 1986.
38. Interview, author with Tom Powell, Dallas, TX, 2 June 1986. Hereafter cited as Powell 1986 interview.
39. *Ibid.*
40. *Ibid.*
41. *Ibid.*
42. *Ibid.*
43. *Forbes* 125 (23 June 1985):157; *Aviation Week and Space Technology*, 114 (16 Feb. 1981):21 and 115 (23 Nov. 1981):27-28.
44. Notes, Robert Roll, SWD Construction-Operations Division, to author, 30 May 1986.
45. *Ibid.*
46. *Engineering Review* (22 Aug. 1985), p. 13.
47. *Ibid.*
48. Notes, Robert Roll to author, 31 May 1986.
49. *Ibid.*
50. *Ibid.*
51. Wilford Hall Medical Complex, copy in files of the Southwestern Division Military Construction Branch, Dallas, TX, 7 Apr. 1986.
52. *Ibid.*
53. *Ibid.*
54. Notes, Robert Roll to author, 31 May 1986.
55. Maj. Gen. Hugh G. Robinson to the commanders of the Fort Worth and Galveston Districts, Implementation of Military Program Responsibility, 15 Dec. 1981; Lt. Gen. Joseph K. Bratton to Rear Adm. William M. Zobel, 3 Nov. 1981, attachment to letter from Bratton to Robinson, Implementation of Reassignment of Responsibility for Military Programs, 3 Nov. 1981, all in files of Southwestern Division Resource Management Office, Dallas, TX.
56. Powell 1986 interview.
57. Michael Welsh, *A Mission in the Desert* (Albuquerque: U.S. Army Engineer District, 1985), p. 205.
58. *Ibid.*, pp. 205-207; Interview, author with retired Maj. Gen. Hugh G. Robinson, Dallas, TX, 15 May 1986, hereafter cited as Robinson interview; Thomas R. Clark to Lt. Gen. J. K. Bratton, 23 Nov., 1981, files of SWD Resource Management Office, Dallas, TX.
59. Interview, author with Maj. Gen. Robert J. Dacey, Washington, DC., 21 May 1986.
60. Interview, author with William Johnson, SWD Engineering Division, Dallas, TX, 10 July 1986.
61. Interview, author with retired Brig. Gen. James Donovan, Dallas, TX, 13 May 1986.

CHAPTER VI

1. U.S., Army, Engineer District, *The Arkansas: Renaissance of a River*, pamphlet (Little Rock, AR: 15 Jan. 1971), pp. 1-8; R. Kay Greenwell and Anthony Huxley, *Standard Encyclopedia of the World's Rivers and Lakes* (New York, NY: 1965), pp. 38-39. For a detailed description of the Arkansas River, see U.S., Congress, House, Document 758, 79th Cong, 2d sess., 1947, pp. 24-26. Hereafter cited as H.D. 758.
2. Kent, *Oklahoma* pp. 214-221.
3. Settle, *The Dawning*, pp. 18-19.

4. Institute for Water Resources, *A River, A Region and a Research Problem*, IWR Report 71-6 (Washington, DC: 1971), p. B-3. Hereafter cited as IWR Report 71-6.
5. Ibid.
6. Settle, *The Dawning*, pp. 25-28.
7. IWR Report 71-6, p. A-3.
8. Settle, *The Dawning*, p. 28.
9. IWR Report 71-6, p. A-4.
10. Settle, *The Dawning*, p. 30.
11. Ibid., p. 33.
12. "Memorandum, Comments on Survey Report on Arkansas River and Tributaries," Box 2/15, 71A1228, RG 77, C-25-049-1-1, FWFRC, Fort Worth, TX. Hereafter cited as Box 2/15, RG 77, FWFRC. Hydropower design had been increasingly confined to Division offices, a move that was formalized in 1945.
13. Franklin D. Roosevelt to Sen. John L. McClellan, 14 Jan. 1944, John L. McClellan Papers, File 46, Drawer E, John L. McClellan Library, Ouachita Baptist University, Arkadelphia, AR.
14. For a review of Kerr's life, see Ann Hodges Morgan, *Robert S. Kerr: The Senate Years* (Norman, OK: Oklahoma University Press, 1977) and Robert S. Kerr, *Land, Wood and Water* (New York: 1960).
15. H.D. 758, p. 3.
16. Confidential Memorandum, Newt Graham and Don McBride to Kerr, 7 Aug. 1944, Box 2/15, RG 77, FWFRC. Reybold instructed the Southwestern Division to make a special study of a navigation route below Little Rock because of the tortuous route of the river below that city. A special board chaired by the SWD Engineer, Brig. Gen. Edwin H. Marks, thought the navigation channel should follow the general course of the river. See H.D. 758, p. 126.
17. IWR Report 71-6, p. A14.
18. Ibid.
19. Ibid., p. A15.
20. Confidential Memo, Graham and McBride to Kerr, Box 2/15, RG 77, FWFRC.
21. U.S., Congress, House, Committee on Public Works, Subcommittee to Study Civil Works, *Hearings, Study of Civil Works, Part 1, Corps of Engineers, U.S. Army*, 82d Cong., 2d sess., 27, 28, 30 Mar. and 2, 3, 29, Apr. 1952.
22. Quoted in Settle, *The Dawning*, p. 94.
23. IWR Report 71-6, pp. 18-19.
24. Clay, *A History of the Little Rock District*, p. 73.
25. *Congressional Record*, 84th Cong., 2d sess., 102, pt. 2:2571-2572.
26. William Whipple, "Unpublished Memoirs," pp. 347-348. General Whipple shared portions of his recollections with me. The full set of his memoirs was later donated to the Office of History, Office, Chief of Engineers, Fort Belvoir, VA. Hereafter cited as "Memoirs"; Mark H. Rose, *Interstate: Express Highway Politics 1941-1956* (Lawrence, KS: Kansas University Press, 1979).
27. Edward Edmundson to John Brister, 20 Feb. 1958, Box 43, Corps of Engineers Files, 156430, FWFRC, Fort Worth, TX; Harold G. Vatter, *The US Economy in the 1950's* (New York, NY: W. W. Norton, 1963), pp. 115-120.
28. U.S., Cong., Senate, Committee on Appropriations, *Public Works Appropriations, 1959, Hearings before the Subcommittee*, 85th Cong., 2d sess. pt. 1, p. 729.
29. Ibid., p. 752.
30. Whipple, "Memoirs," p. 343.

31. Ibid., p. 344.
32. Ibid., p. 346; Telephone interview, author with William Whipple, 27 Oct. 1980.
33. William Whipple, "Arkansas River Plan," *Journal of the Waterways and Harbors Division, Proceedings of the American Society of Civil Engineers*, (September 1980), p. 17.
34. Telephone interviews, author with Robert James and Tasso Schmidgall, 6 Nov. 1980.
35. Whipple, "Memoirs," p. 349.
36. Whipple to General E. C. Itschner, 7 July 1960, Box 265, 76A6, RG 77, FWFR. Whipple's problems were, frankly, more political. Arkansas interests wanted funds appropriated for Ozark Reservoir before that for the two locks and dams below Dardanelle. That would delay construction of the waterway by one year. Whipple to Colonel Arthur M. Jacoby, Tulsa District Engineer, 15 Mar. 1960, Box 265, 76A6.
37. Quoted in Settle, *The Dawning* p. 133. For the original statement see Kerr Papers, Box 857, Folder 24, University of Oklahoma, Norman, OK. The Arkansas Basin Development Association was started in 1946.
38. Telephone interview, author with Robert J. Fleming, 9 Oct. 1980; Telephone interview, author with B. Joseph Tofani, 2 June 1986.
39. Telephone Interview, author with Richard D. Field, retired chief of the SWD Engineering Division, 11 Nov. 1980.
40. Settle, *The Dawning*, p. 142.
41. Whipple, "Memoirs," p. 350.
42. Telephone interview, author with Brig. Gen. Carroll H. Dunn, 7 Nov. 1980.
43. Ibid.; Telephone interview, author with Roy Penix, 12 Nov. 1980. Some questions were expressed by SWD and District personnel over the value of the Critical Path Method, but most liked it. See material in Box 310, 76A6, RG 77, C-25-049-1-1, FWFR, Fort Worth, TX.
44. Telephone Interview, author with Brig. Gen. Dunn, 6 Oct. 1980. Dunn spent his childhood at Lake Village, AR, on the Mississippi River, 50 miles from the mouth of the Arkansas. His hometown was inundated by the 1927 flood.
45. Settle, *The Dawning*, p. 148.
46. Quote in George Antle, "The McClellan-Kerr Arkansas River Basin Navigation System—Who Takes Care of Economic Development and Environmental Quality?", paper presented at Arkansas-White-Red Research Symposium, Gatlinburg, TN, May 1980, p. 5.
47. Institute for Water Resources, *Discriminate Analysis Applied to Commodity Shipments in the Arkansas River Area*, IWR Research Report 74-R2 (August 1974), p. 31.
48. U.S. Army Corps of Engineers, SWD, *Recent Development in the McClellan-Kerr Arkansas River Navigation System Area*, IWR Research Report 77-R1 (April 1977), pp. 65-67.
49. Ibid., p. 68.
50. Rex R. Campbell, et al., *Population Change, Migration and Displacement Along the McClellan-Kerr Arkansas River Navigation System*, Contract Report 77-5 (December 1977), p. 3.
51. Ibid., p. 6.
52. Ibid., p. 54.
53. Quoted in Antle, "The McClellan-Kerr Arkansas Basin Navigation System," p. 1.

CHAPTER VII

1. Robert E. Mills, "Navigation of the Trinity River" (unpublished master's thesis, Sam Houston State Teachers College, TX, 1943), pp. 11-13, 20-25.
2. E. H. Brown, *Trinity River Canalization* (Dallas, TX: Trinity River Association, 1930), p. 41; John W. Rogers, *The Lusty Texans of Dallas* (New York, NY: 1951), pp. 128-129.
3. Mills, "Navigation of the Trinity River," p. 27.
4. Ibid., pp. 32-34; Floyd Durham, *The Trinity River Paradox: Flood and Famine* (Wichita Falls, TX: Nortex Press, 1976), p. 91; Brown, *Trinity River Canalization*, p. 53; T. H. Jackson, "The Trinity River Survey," *Professional Memoirs*, 7 (July-August 1915):491.
5. *Dallas Morning News*, 1 Oct. 1935.
6. David Temple, "Our Evolving National Water Policy," *American Forests*, (September 1956), pp. 34-41.
7. "Importance of Continuance of Construction on the Flood Control and Water Conservation Projects of the Upper Trinity Basin," typescript (11 July 1950), SWD Files; "Remarks of Major General S. D. Sturgin, Jr., before TIA," Dallas, Texas, 15 Apr. 1950, SWD Files; *Progress Report, Trinity River Authority of Texas*, 1 June 1962 through 31 Dec. 1963, pamphlet, Southwestern Division files; Durham, *Trinity River Paradox*, p. 105.
8. Durham, *Trinity River Paradox*, pp. 105-106; U.S., Congress, Senate, Doc. No. 111, *Water Development and Potentialities of the State of Texas*, 85th Cong., 2d sess., June 1958, pp. 106-121.
9. U.S. Army Engineer Districts, Fort Worth and Galveston, *Comprehensive Report on Trinity River Tributaries, Texas* (June 1962); Trinity Improvement Association, "The Trinity River: A Historical Perspective," typescript, pp. 15-16, TIA files, Irving, Texas.
10. U.S., Congress, *A Report of the Chief of Engineers, Department of the Army, together with the Report of the District and Division Engineers on Reevaluation of the Navigation Features of the Projects for the Trinity River, Texas, Pursuant to the Provisions of the Rivers and Harbor Act of 1965*, 90th Cong., 2d sess., 18 July 1968, pp. 2-3.
11. Interview, author with Walter Gallaher, SWD Planning Division, Dallas, TX, 8 Feb. 1983. Hereafter cited as Gallaher 1983 interview.
12. *Dallas Times Herald*, 3 Feb. 1973.
13. *Dallas Morning News*, 15 Mar. 1973.
14. Gallaher interview.
15. Interview, author with Thomas Anderson, Galveston District Planning Division, Galveston, TX, 17 July 1980.
16. U.S., Army, Corps of Engineers, *FY 1978 Annual Review of the Chief of Engineers on Civil Works Activities*, 2 (Washington, DC: Government Printing Office, 1978):15-11. Hereafter cited as *FY 1978 Annual Review*.
17. *Houston Post*, 22 July 1960; Col. Harold C. Brown to Division Engineer, 8 Feb. 1961, files of Galveston District Design Branch, Galveston, TX, hereafter cited as Brown letter; Harold Brown to Robert J. Fleming, Jr., 2 Dec. 1960, Box 265, 76A6, RG 77, FWFRC.
18. Brown letter, p. 5.
19. Ibid., p. 10. Lake Livingston was to be used by the city of Houston for water supply. To gain the maximum storage of water, Houston wanted to rely on Wallisville to capture the runoff from Livingston. Wallisville would have to be empty of stored conservation water about 63 percent of the time. Wallisville, Brown wrote, "would be mud flats."
20. Ibid., pp. 17-18.
21. *Houston Post*, 3 Oct. 1971.
22. Robert J. Fleming, Jr., to Chief of Engineers, 17 Feb. 1961, files of Galveston District Design Branch, Galveston, TX.

23. *FY 1978 Annual Review*, pp. 15-32. The reservoir was quite controversial. Joe E. Matthews, vice-president of the Wallisville Landowners Association, wrote President John F. Kennedy, "I believe you are getting wrong information on the project." See *Houston Post*, 8 Oct. 1971.
24. Trinity River Authority, "Trinity River Basin Master Plan," pamphlet, 22 Feb. 1977, p. H1; *Houston Chronicle*, 29 Apr. 1972.
25. *Houston Post*, 3 Oct. 1971.
26. Dave McNully and Tyke Thompson, "The Unholy Trinity Incident," *Texas Monthly*, 1(June 1973):47.
27. *Dallas Morning News*, 14 Mar. 1973.
28. Interviews, author with Walter Gallaher, Gene Sikes and Jerrell Sartor, all in SWD Planning Division, Dallas, TX, 11 Apr. 1986.
29. Notes, Walter Gallaher to author, 30 May 1986.
30. *Ibid.*
31. *Ibid.*

CHAPTER VIII

1. "Appendix A, History of the Southwestern Division Laboratory," typescript, SWD Laboratory files [n.d.], p. 1.
2. I am deeply indebted to Hugh Garrison, retired director of the the SWD Laboratory for explaining its history and technical operations of the laboratory. Interview, author with Hugh Garrison, Dallas, TX, 25 May 1980, hereafter cited as Garrison interview; Cotton, *A History of the Waterways Experiment Station*, pp. 55-56.
3. Garrison interview.
4. "Appendix A, History of the Southwestern Division Laboratory," p. 1.
5. Garrison interview.
6. "Appendix A, History of the Southwestern Division Laboratory," p. 3. I am also indebted to Robert James, chief, Geotechnical Branch, for explanations of the laboratory's operations. The laboratory forwarded information to other labs through routine correspondence. In some cases another lab might request information of a specific nature.
7. For a discussion of the Waco dam slide, see Brown, *Rivers, Rockets and Readiness*, pp. 141-144.
8. "Appendix A, History of the Southwestern Division Laboratory," p. 7.
9. Garrison interview.
10. *Ibid.*
11. *Ibid.*; "Appendix A, History of the Southwestern Division Laboratory," p. 3.
12. *Ibid.*
13. Garrison interview.
14. Notes, Robert James, chief of the SWD Geotechnical and Materials Branch, to author, 19 May 1986.
15. *Ibid.*
16. *Ibid.*
17. Notes, Arthur Denys, chief of the SWD Engineering Division, to author, 7 Apr. 1986.
18. Galveston District Regulation No. 1110-2-1, Reporting of Evidence of Distress of Civil Works Projects (Galveston, TX: U.S. Army Engineer District, 30 Nov. 1964).
19. Much of the information about the Hydroelectric Power Design Branch was furnished in a series of interviews by author with Edward Westmeyer, John Hodge, and Wright V. Lewis, Dallas, TX, Feb.-Mar. 1983. Hereafter cited as Westmeyer, Lewis, and Hodge interviews.
20. Brown, *Rivers, Rockets and Readiness*, p. 31.

21. Westmeyer, Lewis, and Hodge interviews; *Hydropower: The Role of the U. S. Army Corps of Engineers*, Engineer Pamphlet 1165-2-317 (September 1979), p. 13, files of the SWD Engineering Division, Dallas, TX.
22. Asa V. Shannon and Charles H. Fogg, "The Advantages of Inclined-Axis Hydroelectric Units," *Water Power Conference*, Section C2, Paper 79, 1968, p. 10, files of the SWD Engineering Division, Dallas, TX.
23. *Ibid.*, p. 23.
24. Notes, Edward Westmeyer to author, Dallas, TX, 18 Apr. 1986. Hereafter cited as Westmeyer notes.
25. Arthur Denys and Thomas Plunkett, "Synopsis: Ozark-Webbers Falls Turbine Repairs," 7 Apr. 1986, files of the SWD Engineering Division, Dallas, TX.
26. Westmeyer notes.
27. *Ibid.*
28. "Brief History of the Economics Branch, Planning Division, the Southwestern Division," typescript, [n.d.], p. 3. Historical files of SWD Office of Administrative Services, Dallas, TX. Hereafter cited as "Brief History of the Economics Branch."
29. Interview, author with Ivan L. Hobson, Dallas, TX, 25 Mar. 1983. Hereafter cited as Hobson interview.
30. *Ibid.*; "Economic Workshop, Corps of Engineers, the Southwestern Division," 11-12 Sept. 1967, unpublished proceedings, files of SWD Economics Branch, Dallas, TX.
31. "Remarks of Ivan L. Hobson, Chief, Economics Branch at District Engineers Conference, SWD, November 14, 1966," typescript, Southwestern Division Records, Box 15, 182749, FWERC, Fort Worth, TX.
32. Quote in "Brief History of the Economics Branch," p. 2.
33. *Ibid.*, p. 4.
34. Hobson interview.
35. "Centralization of Economic Base Study and Water Supply-Demand Studies; Southwestern Division," typescript [n.d.], file of Southwestern Division Economics Branch, Dallas, TX.
36. Notes, Robert Summitt to author, Dallas, TX, 14 Apr. 1986.
37. *Ibid.*; Notes, Kenneth Cooper, chief, SWD Economics Branch, to author, Dallas, TX, 16 May 1986.
38. *Ibid.*

CHAPTER IX

1. Larry Banks, "Archeology and the Corps of Engineers," *The Great Plains Journal*, 15 (Spring 1976):144.
2. *Ibid.*, p. 145.
3. *Ibid.*
4. Kenneth G. Orr, "The Archeological Situation at Spiro, Oklahoma; a Preliminary Report," *American Antiquity*, 11 (April 1946): 228-256.
5. Alice Marriot, *The First Corner: Indians of North America's Dawn* (New York, NY: Longmans, Green, 1960), p. 122.
6. Mary Ann Holmes and Marsha Hill, "The Spiro Mounds Site," pamphlet, (Norman, OK: University of Oklahoma, 1976), p. 5.
7. *U.S. Statutes at Large, 1944*, (Washington, DC: U.S. Government Printing Office, 1945), p. 889.
8. Interview, author with Charles Smith, Tulsa District, Tulsa, OK, 2 June 1980.
9. Interview, author with Robert E. Bell, University of Oklahoma, 3 June 1980. Hereafter cited as Bell interview.
10. Interview, author with Buell Atkins, Tulsa District Planning Division, Tulsa, OK, 3 June 1980. Hereafter cited as Atkins interview.

11. Robert E. Bell, "The Scott Site, Le Flore County, Oklahoma," *American Antiquity*, 18 (April 1953): 331.
12. Atkins interview; Bell interview.
13. Interview, author with Bobby Black, Tulsa District, Tulsa, OK, 3 June 1980. Hereafter cited as Black interview. The Oklahoma Indian Mounds Commission played a large role in getting these leases arranged.
14. Thomas F. King, Patricia P. Hickman, Gary Berg, *Anthropology in Historic Preservation: Caring for Culture's Clutter* (New York: Academic Press, 1977), pp. 35-37.
15. *Ibid.*, pp. 38-39; Interview, author with Larry Banks, SWD Planning Division, Dallas, TX, 8 May 1980. Hereafter cited as Banks 1980 interview.
16. Black interview; Settle, *The Dawning*, p. 128.
17. Banks 1980 interview; Interview, author with Larry Banks, Dallas, TX, 16 Feb. 1983.
18. Notes, Larry Banks to author, 14 Apr. 1986.
19. Report, "Annual SWD Workshop on Historic Preservation, Tulsa, Oklahoma," 9-10 Nov. 1982, files of the SWD Planning Division, Dallas, TX.
20. Larry Banks to Clayton Brown, 23 May 1986.
21. "A Report to the National Science Foundation on the Second New World Conference on Rescue Archeology," by Dr. Fred Wendorf, files of the SWD Planning Branch, Dallas, TX.
22. Fred Wendorf to Brig. Gen. Robert Dacey, 27 Dec. 1984, files of the SWD Planning Branch, Dallas, TX.
23. Larry Banks to Clayton Brown, 23 May 1986.
24. *Ibid.*
25. Interview, author with Larry Banks, Dallas, TX, 21 Apr. 1986.
26. *Ibid.*
27. *Ibid.*

CHAPTER X

1. Interview, author with William R. Pearson, SWD Planning Division, Dallas, TX, 10 Apr. 1986. Hereafter cited as Pearson interview.
2. *Ibid.*; D. Clayton Brown, "A Comparison of the Trinity and McClellan-Kerr Navigation Projects," *National Waterways Roundtable Proceedings: History, Regional Development, Technology, A Look Ahead* (Norfolk, VA: Institute for Water Resources, 22 Apr. 1980).
3. Pearson interview.
4. The amount of water pumped by local interests from Corps lakes varies from area to area. The city of Fort Worth draws a small portion from Lake Benbrook, but Dallas and the North Texas Municipal Water District receive about one-third of their water from Corps lakes.
5. Charles I. McGinnis to John W. Morris, 25 Aug. 1975, files of Office of History, Office, Chief of Engineers, Fort Belvoir, VA.
6. Robinson interview.

SELECTED BIBLIOGRAPHY

BOOKS

- Alperin, Lynn. *Custodians of the Coast: History of the United States Army Engineers at Galveston*. Galveston, TX: U.S. Army Engineer District, 1977.
- Armstrong, Ellis, ed. *History of Public Works in the United States, 1776-1976*. Chicago: American Public Works Association, 1976.
- Brown, Clayton D. *Electricity for Rural America: The Fight for the REA*. Westport, CN: Greenwood Press, 1980.
- . *Rivers, Rockets and Readiness: Army Engineers in the Sunbelt*. Fort Worth, TX: U.S. Army Engineer District, 1979.
- Brown, E. H. *Trinity River Canalization*. Dallas, TX: Trinity River Improvement Association, 1930.
- Carson, Rachel. *Silent Spring*. Boston, MA: Houghton Mifflin, 1962.
- Childs, Marquis. *The Farmer Takes a Hand: The Electric Power Revolution in Rural America*. Garden City, NJ: Doubleday, 1952.
- Clay, Floyd M. *A History of the Little Rock District*. Little Rock, AR: U.S. Army Engineer District, 1971.
- Cotton, Gordon A. *A History of the Waterways Experiment Station, 1929-1979*. Vicksburg, MS: U.S. Army Engineer District, 1979.
- Droze, Wilman H. *High Dams and Slack Waters: TVA Rebuilds a River*. Baton Rouge, LA: Louisiana State University Press, 1965.
- Durham, Floyd. *The Trinity River Paradox: Flood and Famine*. Wichita Falls, TX: Nortex Press, 1976.
- Ellis, Clyde T. *A Giant Step*. New York, NY: Random House, 1966.
- Fine, Lenore and Remington, Jesse A. *The Corps of Engineers: Construction in the United States*. Washington, DC: Office of the Chief of Military History, USA, 1972.
- Fletcher, John Gould. *Arkansas*. Chapel Hill, NC: University of North Carolina Press, 1947.
- Fox, Irving K. and Picken, Isabell. *The Upstream-Downstream Controversy in the Arkansas-White-Red Basins Survey*. University, AL: University of Alabama Press, 1960.
- Grubbs, Donald Cry *From the Cotton: The Southern Tenant Farmers Union and the New Deal*. Chapel Hill, NC: University of North Carolina Press, 1971.
- Hoyt, William G. and Langbein, Walter B. *Floods*. Princeton, NJ: Princeton University Press, 1955.
- Haveman, Robert H. *Water Resource Investment and the Public Interest: An Analysis of Federal Expenditures in Ten Southern States*. Nashville, TN: Vanderbilt University Press, 1965.
- Heuvelmans, Martin. *The River Killers*. Harrisburg, PA: Stackpole Books, 1974.
- Huxley. *Standard Encyclopedia of the World's Rivers and Harbors*, New York, NY: 1965.
- Kent, Ruth. *Oklahoma: A Guide to the Sooner State*. Norman, OK: 1945.
- Kerr, Robert S. *Land, Wood and Water*. New York, NY: 1960.
- King, Thomas F., Hickman, Patricia P., and Berg, Gary. *Anthropology in Historic Preservation*. New York, NY: Academic Press, 1977.
- Knight, Oliver. *Outpost on the Trinity*, Norman, OK: University of Oklahoma Press, 1953.
- Leopold, Luna B. and Maddock, Thomas Jr. *The Flood Control Controversy: Big Dams, Little Dams and Land Management*. New York, NY: Ronald Press, 1954.

- Maass, Arthur. *Muddy Waters: The Army Engineers and the Nation's Rivers*. Harvard University Press, 1951.
- Marine, Gene. *America the Raped: The Engineering Mentality and the Devastation of a Continent*. New York, NY: Simon and Schuster, 1969.
- Marriot, Alice. *The First Comers: Indians of America's Dawn*, New York: Longmans, Green, 1969.
- Mazmanian, Daniel A. and Nienaber, Jeanne. *Can Organizations Change? Environmental Protection, Citizen Participation and the Corps of Engineers*, Washington, DC: Brookings Institution, 1980.
- Moody's Manual of Investments: Public Utility Securities*. New York, NY: Moody's Investment Service, 1945.
- Morgan, Ann Hodges. *Robert S. Kerr: The Senate Years*. Norman, OK: Oklahoma University Press, 1977.
- Morgan, Arthur E. *Dams and other Disasters: A Century of the Army Corps of Engineers in Civil Works*. Boston, MA: P. Sargent, 1971.
- Peterson, Elmer T. *Big Dam Foolishness: The Problem of Modern Flood Control and Water Storage*. New York, NY: Paul B. Jearn, 1954.
- Petulla, Joseph. *American Environmentalism: Values, Tactics, Priorities*-College Station, TX: Texas A&M Press, 1980.
- Rose, Mark H. *Interstate: Highway Politics, 1941-1956*. Lawrence, KS: Kansas University Press, 1979.
- Schumacker, E. F. *Small is Beautiful: Economics as if People Mattered*. New York, NY: Harper and Row, 1973.
- Settle, William B. Jr. *The Dawning, A New Day for the Southwest*. Tulsa, OK: U.S. Army Engineer District, 1975.
- Sewell, Nathan J. *The First Thirty-six Years: A History of the Albuquerque District, 1935-1971*. Albuquerque, NM: U.S. Army Engineer District, 1973.
- Smith, Frank E., ed. *Conservation in the United States: A Documentary History: Land and Water 1900-1979*. New York, NY: Chelsea House, 1971.
- Vatter, Harold G. *The US Economy in the 1950's*. New York, NY: W. W. Norton, 1963.
- Vance, Rupert B. *All These People*, Chapel Hill, NC: University of North Carolina Press, 1935.
- Webb, Walter P. *More Water for Texas: The Problem and the Plan*. Austin, TX: University of Texas Press, 1954.
- Welsh, Michael. *A Mission in the Desert*. Albuquerque, NM: U.S. Army Engineer District, 1985.
- White, Langdon C., Foscue, Edwin J., and McKnight, Tom F. *Regional Geography of Anglo-America*. Englewood Cliffs, NJ: Prentice-Hall, 1964.
- Works Progress Administration. *New Mexico: A Guide to the Colorful State*. New York, NY: 1940.

ARTICLES

- American Journal of Public Health*. 18(Jan. 1928):145.
- Annals of the American Academy of Political and Social Science*. Sept. 1979, p. 205.
- Audubon*. 64(Sept. 1962):250-253.
- Banks, Larry. "Archeology and the Corps of Engineers." *Great Plains Journal*. 15(Spring 1976):144
- Bell, Robert E. "The Scott Site, LeFlore County, Oklahoma. *American Antiquity*. 18(Apr. 1953):314-331.

- Brown, D. Clayton. "Sam Rayburn and the Development of Public Power in the Southwest." *Southwestern Historical Quarterly*. 73(Oct. 1974):140-154.
- Business Week*. 7 Aug. 1943, pp. 95-96.
- Christie, Jean. "The Mississippi Valley Committee: Conservation and Planning in the Early New Deal." *The Historian*. 32(May 1970):449-469.
- Crook, Wilson W. Jr. and Harris, R. K. "A Pleistocene Campsite Near Lewisville, Texas." *American Antiquity*. 23(Jan. 1958):233-246.
- Drew, Elizabeth. "Dam Outage: The Story of the Army Engineers." *The Atlantic Monthly*. 225(Apr. 1970):51-62.
- Douglas, William O. "The Public be Damned." *Playboy*. July 1969, pp. 188-202.
- Droze, Wilman H. "TVA and the Ordinary Farmer." *Agricultural History*. 53(Jan. 1979):188-202.
- Florman, Samuel C. "Hired Scapegoats: In Support of the US Army Corps of Engineers." *Harper's*. 254(May 1977):26-29.
- Hayes, Dennis. "Limits to Growth: A Look at No-Growth Economics." *National Parks and Conservation Magazine*. 96(Oct. 1972):23-25.
- Houck, Oliver A. "New Roles for the Old Dam Builder?" *National Wildlife*. 13(Aug. 1975):13-15.
- Jackson, T. H. "The Trinity River Survey." *Professional Memoirs*, 7 (July-Aug. 1915):490-506.
- Johnson, Elmer. "Recent Industrial Advances in Texas." *Texas Business Review*. 8(Jan. 1945):9-18.
- Kerr, Robert S. "Plow, Plant and Pray." *The Reclamation Era*. Mar. 1948. (Reprint in Robert S. Kerr Papers, Box 131, Folder 17).
- Mackenzie, Bennett. "Region Building in River Valleys: Upstream Community vs Downstream Slum." *Survey Graphic*. 29(Feb. 1940):107-108.
- McNeely, Dave and Thompson, Tyke. "The Unholy Trinity Incident." *Texas Monthly*. 1 June 1973.
- Maas, Arthur and de Roos, Robert. "The Lobby That Can't be Licked: Congress and the Army Engineers." *Harper's*. 149(Aug. 1949):21-30.
- Miller, Leslie A. "The Battle That Squanders Millions." *Saturday Evening Post*. 14 May 1949, pp. 30-31, 160-162.
- Moser, Don. "Dig They Must: The Army Engineers, securing Allies and acquiring enemies." *Smithsonian*. 7(Dec. 1976):40-51.
- New York Herald-Tribune Book Review*. 11 Nov. 1951, p. 16.
- Orr, Kenneth G. "The Archaeological Situation at Spiro, Oklahoma; a Preliminary Report." *American Antiquity*. 11(Apr. 1946):228-256.
- Person, H. S. *Little Waters: A Study of Headwater Streams and other Little Waters, Their Use and Relations to the Land*. Nov. 1935.
- Political Science Quarterly*. 95(Spring 1980):158.
- "San Antonio Engineer District Covers Vast Territory." *Dallas Times Herald*. 16 June 1943, sect. 3, p. 2.
- Scientific American*. 170(May 1940):220.
- Shaw, Gaylord. "The Search for Dangerous Dams—a program to head off disaster." *Smithsonian*. 9(Apr. 1978):37-45.
- Slade, Steve. "Caught in Mid-stream." *The Nation*. 221(6 Sept. 1975):179-181.
- Temple, David. "Our Evolving National Water Policy." *American Forests*. September 1956, pp. 34-41.
- Tindall, George B. "Business Progressivism: Southern Politics in the Twenties." *South Atlantic Quarterly*. 62(Winter 1963):92-106.
- U.S. News and World Report*. 25(24 Sept. 1948):32.
- Webb, Walter Prescott. "Billion Dollar Cure for Texas' Drought." *Harpers*. 207(Dec. 1953):73-79.

- Whipple, William. "Arkansas River Plan," *Journal of the Waterways and Harbors Division, Proceedings of the American Society of Civil Engineers*. Sept. 1980.
- Zeldin, Marvin. "Corps' new look in flood control: no dams, levees." *Audubon*. 77(July 1975):103-104.

ARCHIVAL MATERIALS

- Norman, OK. University of Oklahoma Western History Collections. Page Belcher Papers.
- Norman, OK. University of Oklahoma Western History Collections. Robert Kerr Papers.
- Arkadelphia, AR. Oachita Baptist University. John McClellan Papers.
- Fort Worth, TX. U.S. Army. Corps of Engineers. Fort Worth District. Official Files.
- Galveston, TX. U.S. Army. Corps of Engineers. Galveston District. Official Files.
- Dallas, TX. U.S. Army. Corps of Engineers. Southwestern Division. Official Files.
- Washington, DC. National Archives. Record Group 77.
- Fort Worth, TX. Fort Worth Federal Records Center. Record Group 77.

INTERVIEWS

- Aiken, Sam. Interviewed by the author. Dallas, TX. 16 Apr., 1981.
- Anderson, Thomas. Interviewed by the author. Galveston, TX. 17 July 1980.
- Andrews, Carl. Interviewed by the author. Dallas, TX. 14 Apr. 1983.
- Antley, George. Interviewed by the author. Dallas, TX. 18 Nov. 1980.
- Atkins, Buell. Interviewed by the author. Tulsa, OK. 3 June 1980.
- Banks, Larry. Interviewed by the author. Dallas, TX. 8 May 1980.
- Bell, Robert. Interviewed by the author. University of Oklahoma, Norman, OK. 3 June, 1980.
- Berryhill, Chester. Interviewed by the author. Dallas, TX. 27 Jan. 1980.
- Black, Bobby. Interviewed by the author. Tulsa, OK. 3 June 1980.
- Dacey, MG Robert J. Interviewed by the author. Washington, DC. 21 May 1986.
- DeBruin, Ronald. Interviewed by the author. Dallas, TX. 3 Mar. 1981.
- Donovan, BG James, USA Retired. Interviewed by the author. Dallas, TX. May 1986.
- Gallaher, Walter. Interviewed by the author. Dallas, TX. 27 Jan. 1980.
- Garrison, Hugh. Interviewed by the author. Dallas, TX. 25 May 1980.
- Penix, Roy. Interview in historical files, Dallas, TX. U.S. Army. Corps of Engineers. Southwestern Division, Office of Administrative Services.
- Pearson, William. Interviewed by the author. Dallas, TX. 22 June 1983.
- Robinson, MG Hugh, USA Retired. Interviewed by the author. Dallas, TX. 15 May 1986.
- Russel, James. Interviewed by the author. Dallas, TX. 14 Apr. 1983.
- Storey, Dee Ann. Interviewed by the author. University of Texas, Austin, TX. 4 June 1980.
- Smith, Charles. Interviewed by the author. Dallas, TX. 2 June 1980.
- Tanner, Sid. Interviewed by the author. Galveston, TX. 2 June 1980.
- Wehrman, Alfred. Interview in historical files, U.S. Army. Corps of Engineers. Southwestern Division, Office of Administrative Services.

PAMPHLETS, PAPERS, AND THESES

- Antle, George. "The McClellan-Kerr Arkansas River Basin Navigation System—Who takes care of Economic Development and Environmental

- Quality?" Gatlinburg, TN. Paper presented at AWR Research Symposium, May 1980.
- Coster, Jack E., ed. "A survey of the Environmental and Cultural Resources of the Trinity River." Nacogdoches, TX. Stephen F. Austin State University, 1 Sept. 1972.
- Holmes, Mary Ann and Hill, Marsha. "The Spiro Mounds Site." Pamphlet. Norman, OK, 1976.
- Mills, Robert E. "Navigation of Trinity River." Unpublished master's thesis. Huntsville, TX. Sam Houston State Teachers College, 1943.
- Stockton, John R. and Arbingast, Stanley A. *Water Requirements Survey, Texas High Plains: A Study of Resource Utilization, Industrial Development Potential, Population Growth and Water Use*. Austin, TX. University of Texas Bureau of Business Research, Mar. 1952.
- Trinity Improvement Association. "The Trinity River: A Historical Perspective." Typescript. TIA files, Dallas, TX.
- Whipple, William. "Unpublished Memoirs."

GOVERNMENT DOCUMENTS

- Badger, Daniel D., et al. *Analysis of Expenditures for Outdoor Recreation at the McClellan-Kerr Arkansas River Navigation System*. Institute for Water Resources Contract Report 77-4, Dec. 1979.
- Campbell, Rex R., et al. *Population Change, Migration and Displacement Along the McClellan-Kerr Arkansas River Navigation System*. IWR Contract Report 77-5, Dec. 1977.
- Commission on Organization of the Executive Branch of the Government. *Task Force Report on Water Resources Projects [Appendix K]: Certain Aspects of Power Irrigation and Flood Control Projects*. Pamphlet. Jan. 1949.
- Commission on Organization of the Executive Branch of the Government. *Task Force Report on Water Resources and Power*. 3(June 1955): 1395-1452.
- Department of Commerce, Bureau of Foreign and Domestic Commerce, Inland Waterways Section of Transportation Division. *Economic Survey of the Trinity River Texas, Vol. 1*. Files of the Trinity Improvement Association. 1 Sept. 1933.
- President's Water Resources Commission. *A Water Policy for the American People, Vol. 1*. Washington, DC. 1950.
- Stockton, John R. and Arbingast, Stanley A. *Water Requirements Survey, Texas High Plains: A Study of Resource Utilization, Industrial Development Potential, Population Growth and Water Use*. Bureau of Business Research, University of Texas. Mar. 1952.
- U.S. Congress. House. Committee on Public Works, Subcommittee to Study Civil Works. *Hearings, Study of Civil Works, Part I, Corps of Engineers, U.S. Army*. 27, 28, 31 Mar. and 2, 3, 29 Apr. 82d Cong., 2d sess, 1952.
- U.S. Congress. House. Subcommittee to Study Civil Works. *The Civil Functions Program of the Corps of Engineers, United States Army*. House Committee Print No. 21. 82d Cong., 2d sess., 1952.
- U.S. Congress. Senate. Committee on Interior and Insular Affairs. *History of the Implementation of the Recommendation of the Senate Select Committee on National Water Resources*. 86th Cong., 1st sess., 1959.
- U.S. Congress. Senate. *Water Development and Potentialities of the State of Texas*. Senate Document No. 111. 85th Cong., 2d sess., June 1958.
- U.S. National Water Commission. *Water Policies for the Future: Final Report to the President and the Congress by the National Water Commission*. Post Washington, NY. 1973.

United States Study Commission, Texas. *The Commission Plan*. Mar. 1962.

CORPS OF ENGINEERS DOCUMENTS

- A Report of the Chief of Engineers, Department of the Army*. Together with the "Report of the District and Division Engineer on Reevaluation of the Navigation Features of the Project for the Trinity River, Texas Pursuant to the Provisions of the Rivers and Harbor Act of 1965, 90th Congress, 2d Session." 18 July 1968.
- Banks, Larry. "Remarks before First Annual Meeting on Historic Preservation, Command Staffs, US Army Bases." U.S. Army. Corps of Engineers. Southwestern Division. Typescript. SWD files, Environmental Resources Branch. 15 Sept. 1977.
- Barbee, Gene A. "Review of Historical Documentation Related to the Early Commerce on the Trinity River and Tributaries." U.S. Army. Corps of Engineers. Fort Worth District. Exhibit 14. Apr. 1975.
- Craft, Robert. "History of the Fort Worth District." U.S. Army. Corps of Engineers. Fort Worth District. Typescript. 4 Mar. 1975.
- Fact Sheet on White Sands Missile Range. U.S. Army. Corps of Engineers. Southwestern Division. Public Affairs Office Files.
- Research and Planning Consultants, Inc. *Social-Economic Impact Assessment Trinity River Project, Trinity River, Texas*. Contract No. DACW63-77-C-0080-P00002. U.S. Army. Corps of Engineers. Fort Worth District Planning Branch. Dec. 1978.
- Sage, Selma. "History of the Southwestern Division." Typescript. U.S. Army. Corps of Engineers. Southwestern Division. SWD historical files, Dallas, TX.
- U.S. Army. Corps of Engineers. Fort Worth District. *After-Action Report: Lubbock Tornado, 11 May 1970*. Oct. 1970.
- U.S. Army. Corps of Engineers. Fort Worth District. *Navigability Study: Trinity River, Tributaries, River Mile 182.7 to 715.0*. Exhibit 20.
- U.S. Army. Corps of Engineers. Fort Worth and Galveston Districts. *Comprehensive Report on Trinity River and Tributaries, Texas*. June 1962.
- U.S. Army. Corps of Engineers. Institute for Water Resources. *A River, A Region and a Research Problem*. IWR Report 71-6. Washington, DC, 1971.
- U.S. Army. Corps of Engineers. Little Rock District. *The Arkansas: Renaissance of a River*. Pamphlet. 15 Jan. 1971.
- U.S. Army. Corps of Engineers. Southwestern Division. *Recent Developments in the McClellan-Kerr Arkansas River Navigation System Area*. IWR Research Report 77-RI, Apr. 1977.
- U.S. Army. Corps of Engineers. Southwestern Division. *Trinity Authority of Texas*. Progress Report. 1 June 1962 through 31 Dec. 1963. Pamphlet. SWD files, Dallas, TX.

GALLERY OF DIVISION COMMANDERS



*Colonel Eugene Reybold
1 July 1937-29 July 1940*



*Colonel Stanley L. Scott
30 July 1940-12 October 1942*



*Colonel Robert R. Neyland, Jr.
13 October 1942-8 June 1944*



*Brigadier General Edwin H. Marks
15 June 1944-12 March 1946*



*Colonel Henry Hutchings, Jr.
13 March 1946-23 March 1949*



*Colonel Louis W. Prentiss
13 June 1949-10 May 1952*



*Brigadier General Herbert D. Vogel
23 June 1952-31 August 1954*



*Brigadier General Lyle E. Seeman
1 September 1954-18 May 1958*



*Brigadier General William Whipple
16 June 1958-31 July 1960*



*Colonel Stanley G. Reiff
1 August 1960-13 November 1960*



*Major General Robert J. Fleming,
Jr.
14 November 1960-31 January 1962*



*Brigadier General Carrol H. Dunn
1 March 1962-24 July 1964*



*Brigadier General Richard H. Free
24 July 1964-1 June 1966*



*Brigadier General William T. Bradley
15 June 1966-15 March 1968*



*Major General Clarence C. Haug
1 April 1968-31 July 1969*



*Major General Harold R. Parfitt
1 December 1969-31 August 1973*



*Brigadier General Harry A. Griffith
1 September 1973-31 July 1974*



*Major General Charles I. McGinnis
1 August 1974-16 June 1977*



*Brigadier General James C. Donovan
1 July 1977-31 July 1980*



*Major General Hugh G. Robinson
1 August 1980-28 July 1983*



*Major General Robert J. Dacey
29 July 1983-16 August 1985*



*Major General J. B. Hilmes
30 August 1985-present*

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