3 Strategic Role in War and Peace

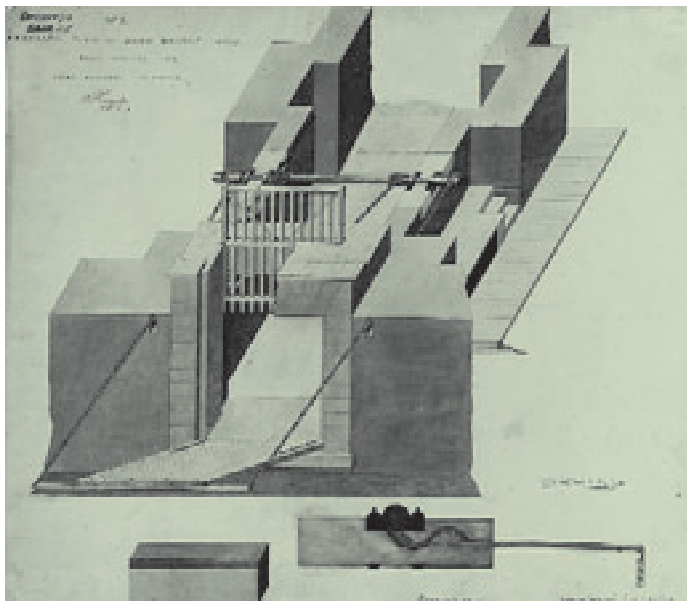
Interior view of the casemates at Fort Jefferson, Fla.

Coast Defense

When the American Revolution began in 1775, numerous coastal fortifications already existed along the Atlantic Coast to protect communities from pirate incursions and enemy raids. The British Royal Engineers, as well as individual colonies and local communities, built these structures, which varied from crude earthen and wooden batteries to strong masonry forts.

During the War for Independence, the combatants rehabilitated many of the existing coastal fortifications and constructed new ones. The small body of Continental Army Engineers accomplished some of the work. When the war ended, the new country abandoned these works, deciding that the local militia could man them if necessary.

A decade later, in 1794, the United States, fearing attacks from other nations, began a construction program to provide fortifications for the protection of the major harbors and northern frontiers of the country. This program and another on the eve of the War of 1812 made only modest progress in strengthening

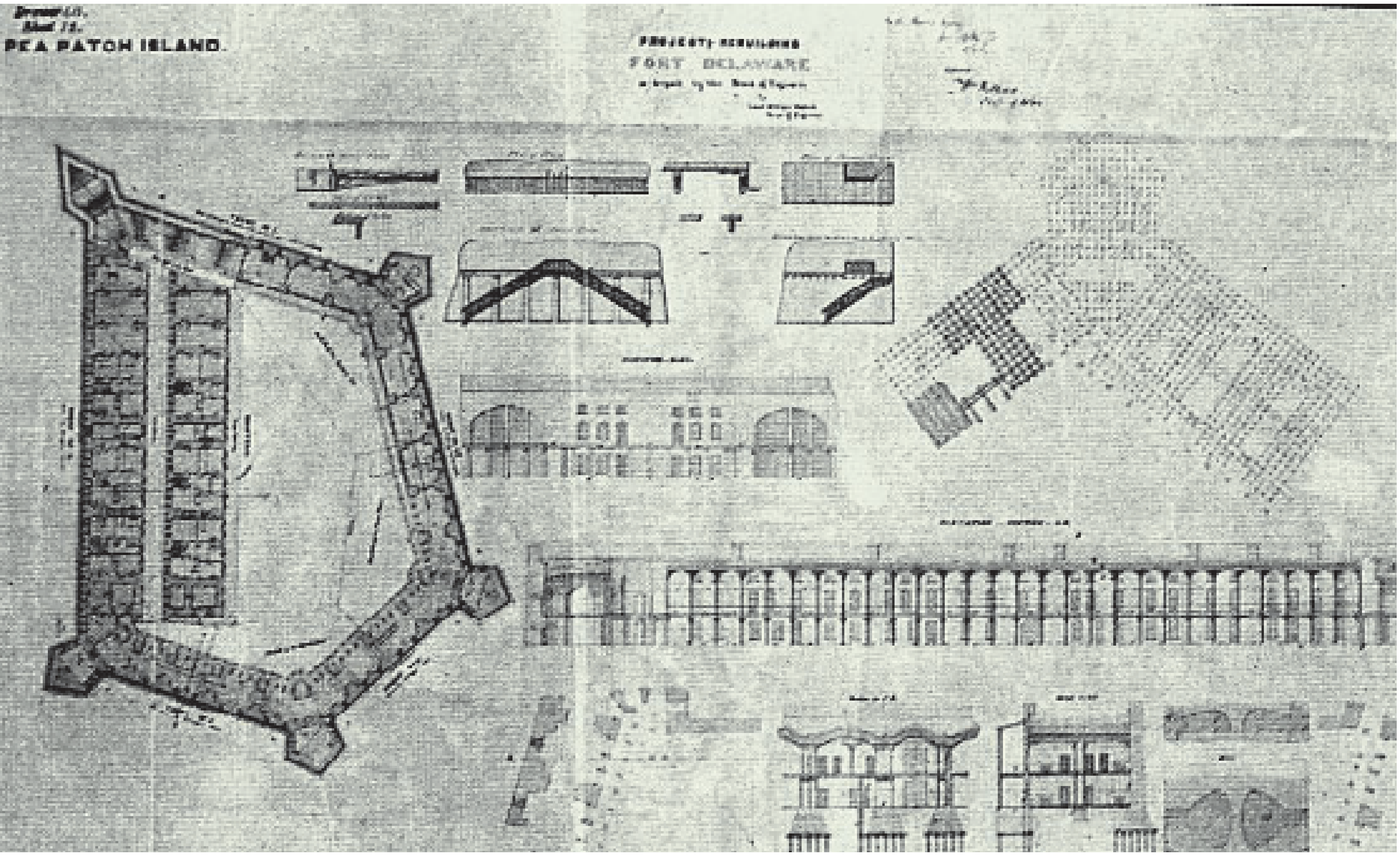


Drawbridge plans for Fort Pulaski, Ga., c. 1846

National Archives

Fort Jefferson in the Dry Tortugas was designated a National Monument in 1935.

National Oceanic and Atmospheric Administration



Plan for the third fort started on Pea Patch Island in the middle of the Delaware River. This design for Fort Delaware from 1839 constructed the fort on a wooden grillage depicted in the upper right.

Brig. Gen. Seth Eastman's oil painting of Fort Sumter, as it looked before the Civil War.

the country's coastal defenses; however, the burning of the Capitol and White House and attacks on other coastal areas led to a more concerted post–War of 1812 effort to build substantial and sophisticated fortifications. Initially Army engineers followed the prevailing design principles taken from the famous seventeenth century French engineer, Vauban, but gradually the engineers adopted a variety of designs, some influenced by the most sophisticated and novel

(top) Ten-inch disappearing gun of the Endicott system in the loading position at Sandy Hook, N.J.
National Archives

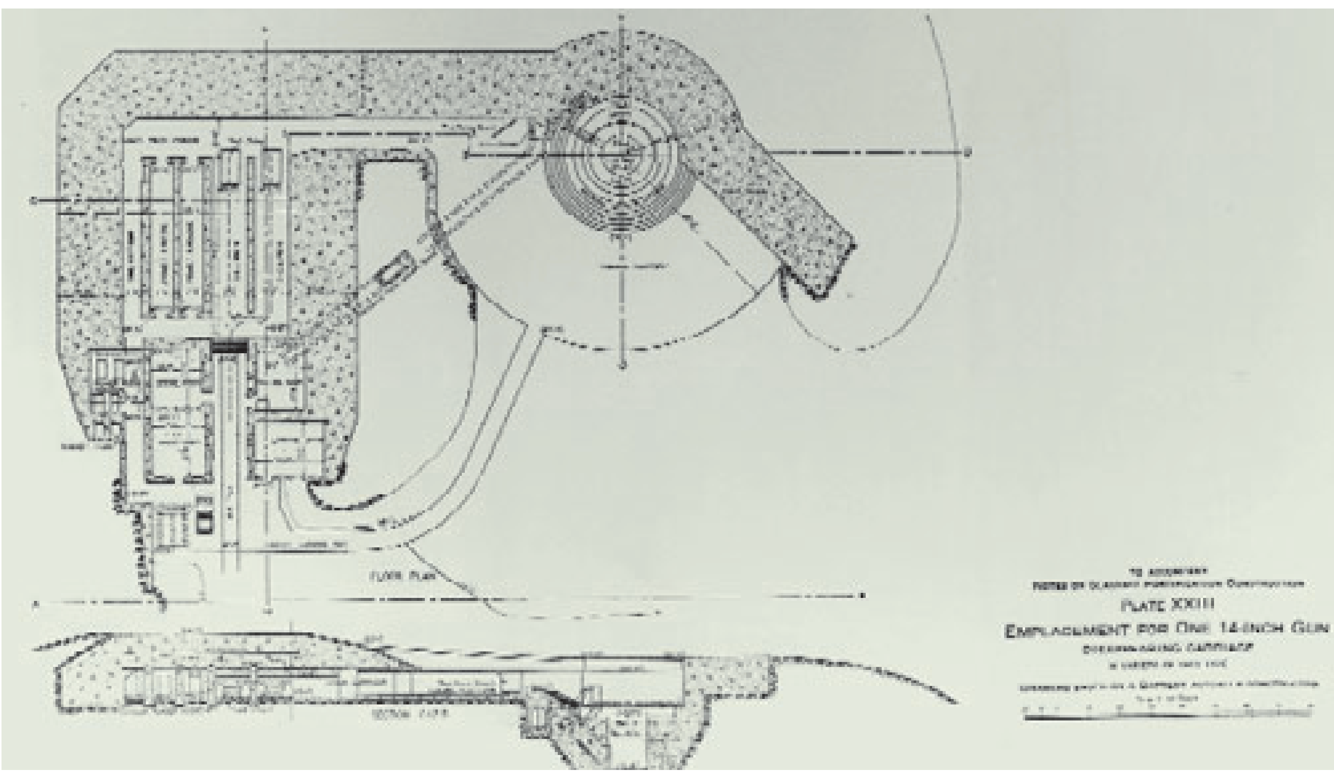
(center) Ten-inch gun in firing position
National Archives

(bottom) Mortar battery at Sandy Hook, N.J.
National Archives

European principles. Fort Monroe in Virginia, Fort Adams in Rhode Island, and Fort Washington in Maryland exhibit traditional influence, while Fort Delaware in Delaware and Fort Point in California reflect newer concepts.

Although generally ungarrisoned, the country's coastal fortifications were a deterrent to foreign attack until the Civil War, when newly developed weapons and ships rendered them obsolete. Heavy rifled artillery, both land and naval, demolished brick, stone, and masonry fortifications like Fort Sumter, South Carolina, and Fort Pulaski, Georgia. As a result, both Union and Confederate engineers began erecting earth and wood coastal forts and batteries that were much more resilient to artillery fire.

For two decades after the Civil War, America's coast defenses received little attention, but by the mid-1880s the sad state of the defenses led to the appointment of a board, named the Endicott Board, after the Secretary of War. In 1886 the board recommended an ambitious program that was gradually scaled back. Even so, the new defenses incorporated the latest technology including



Plan of an emplacement for a fourteen-inch disappearing carriage gun from Col. Eben E. Winslow, "Notes on Seacoast Fortification Construction," published in 1920 as an engineer Occasional Paper *for instructional use at the Engineer School, Washington, D.C.*

breach loading, disappearing guns arranged in dispersed batteries; heavy mortars whose shells were to penetrate the lightly armored decks of ships; and mines to obstruct waterways. Army engineers sometimes placed the batteries inside or in the immediate vicinity of old coastal forts; they purchased new land for others. With the acquisition of new territories at the end of the century, the engineers began erecting batteries in Hawaii, Panama, and the Philippines. As artillery improved, the Corps constructed new batteries for bigger and more effective guns.

After World War II, new weapons—airplanes and missiles—rendered the coastal batteries obsolete. By 1950, the U.S. Army ceased using them for their original purpose. Today, the remnants of these batteries dot the coasts and from a distance often resemble concrete bunkers.

In conjunction with its fortification and battery construction programs, the U.S. Army Corps of Engineers had other coastal defense responsibilities. In the nineteenth century, the Corps placed obstructions in the bays, rivers, and harbors along the coasts.

Fort Moultrie, S.C., in camouflage during World War II

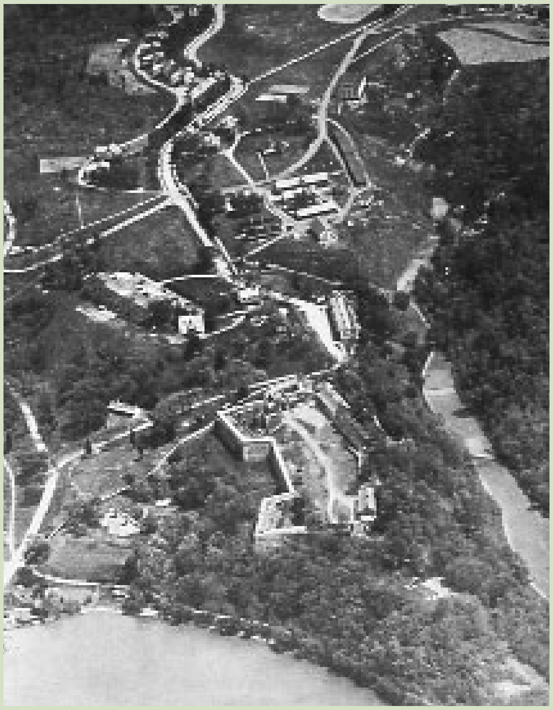
These obstructions—from chains to submarine mines—were intended to slow down or halt enemy vessels. Although the Coast Artillery Corps took over responsibility for submarine mines in 1901, the U.S. Army Corps of Engineers continued to build casemates, storehouses, loading rooms, and other structures for the mine defenses. The Corps also developed a protective concealment program for coast defenses that evolved into the elaborate camouflage nets and paints used during World War II.

Engineering for Posterity

Sound workmanship is a long-standing tradition within the U.S. Army Corps of Engineers and is exemplified in an early project the Corps undertook near the Nation's capital—Fort Washington on the Potomac.

Pierre L'Enfant had only just begun construction of a new fort on the site of an earlier one destroyed during the War of 1812 when he left the project. When construction on the fort resumed in 1815, Colonel Joseph G. Swift instructed Lieutenant Colonel Walker K. Armistead, "Let us have it done for posterity, or not at all." Lieutenant Colonel Armistead replied that he would build a fort "exceedingly strong, of the most durable materials, and executed in the best manner." History has proven that the U.S. Army Corps of Engineers succeeded in that mission.

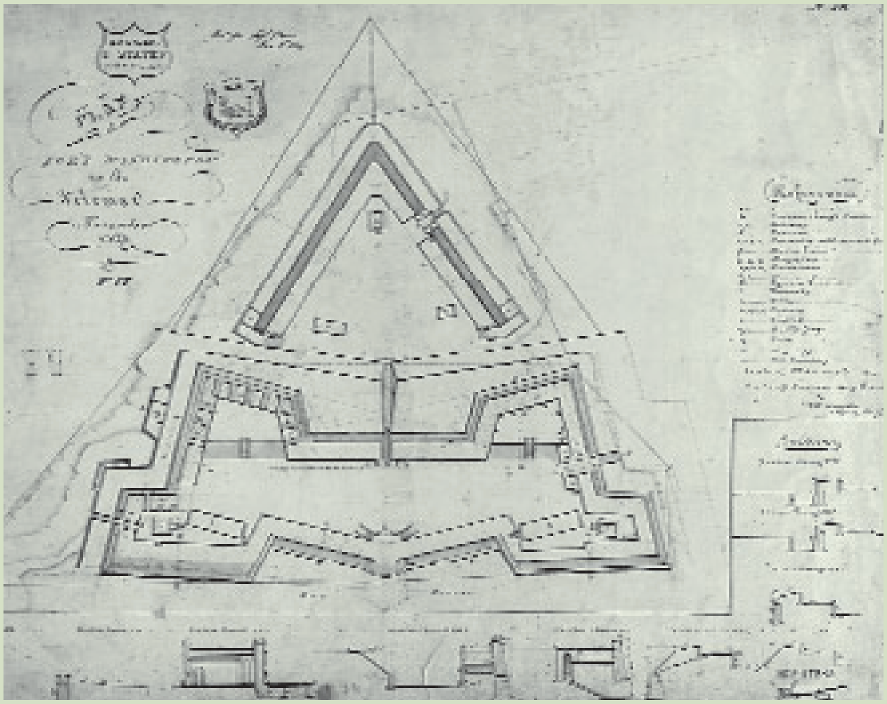
At the outset of the Civil War, Fort Washington was the only defense for Washington, D.C. The U.S. Army continued to occupy the fort as a major defensive post until the eve of World War I. It subsequently served as home to ceremonial units, an officer training school, and the site of a Veterans Administration hospital. In 1946, the fort was turned over to the Department of the Interior and became a national park. The old fort, its fortifications remaining in original form, still stands as a major landmark and a testament to the technical expertise of the U.S. Army Corps of Engineers.



Aerial view of Fort Washington, now part of the National Park Service system

1823 plan of Fort Washington, Md.

National Archives



Civil War ponton bridge
National Archives

Combat Operations, 1846–1916

As the United States developed and expanded throughout the balance of the nineteenth and into the early twentieth centuries, the U.S. Army Corps of Engineers played a key role during times of war. Engineer troops have performed heroically in support of the war-fighting mission, and as a consequence the Corps established a history of wartime service that truly demonstrated the value of military engineering to success on the battlefield.

The Mexican War

On May 15, 1846, soon after the Mexican War began, Congress authorized the War Department to raise a company of engineers. This unit, the first regular U.S. Army engineer company fielded, acted as

Siege of Monterey, July 1846
National Archives

Fort Totten was one of the string of forts that surrounded Washington, D.C., defending the Nation's capital from attack during the Civil War.

sappers and miners during the arduous and lengthy marches of the war. It also erected siege batteries at Mexico City, an important contribution to the assault on that capital.

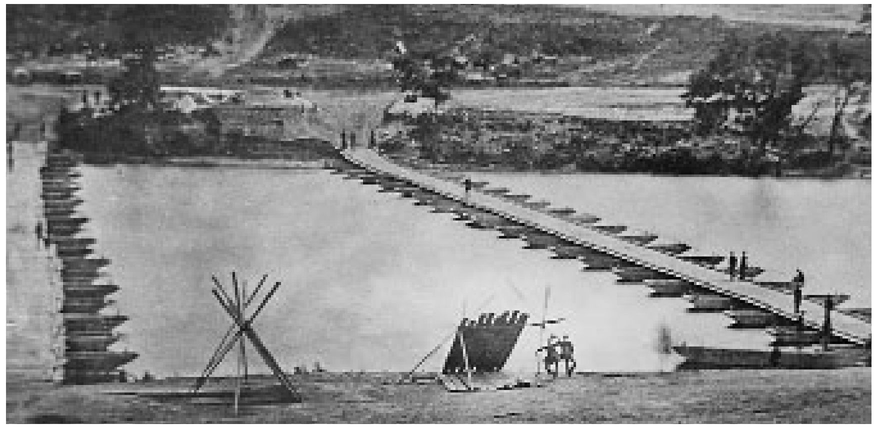
At the Battle of Contreras in August 1847, Lieutenant Gustavus W. Smith, then commanding the engineer company, asked for and received permission to participate in the attack. Lieutenant Smith and his men initially led the assault, but the commanding general halted and rescheduled the assault for the next morning when he observed the arrival of enemy reinforcements. The next morning, the engineer company and a rifle regiment attacked the Mexicans in the rear. Most of the enemy troops fled, but a few remained to fire grapeshot at the Americans from about twenty-five yards. Although partially shaken by the blast, the engineer company chased the fleeing Mexicans for some distance before receiving orders to return to the main army.

In all, forty-four engineer officers served in the Mexican War, including Robert E. Lee, George B. McClellan, P. G. T. Beauregard, and Henry W. Halleck. Practically all of these engineers served on the staffs of general officers and performed reconnaissance and intelligence work, especially around Mexico City.

Following the Mexican War, the engineer officers returned to peacetime duties, including fortification construction; exploration; surveying; and river, harbor, and road work. The engineer company, which spent a good deal of its time at West Point in the postwar period, accompanied some exploration expeditions to the West and performed other tasks in various parts of the country. Although the U.S. Army fought many Indian wars during this period, the engineers were seldom involved.

The Civil War

Less than a decade and a half after the Mexican War, the Civil War erupted. For Civil War service, the War Department increased the number of regular U.S. Army engineer troops to four companies, constituting one battalion. This battalion, along with the various volunteer engineer and pioneer units, cleared obstacles; constructed roads, bridges, palisades, stockades, canals, blockhouses, signal towers, and in one instance, a church; laid down hundreds of ponton bridges; and erected field fortifications, augmenting them with entanglements. Often, these units accomplished their work under extremely adverse conditions. At Fredericksburg, Virginia, in December 1862, they laid six ponton bridges across the



Ponton bridges across the Rappahannock River built by 50th and 15th New York Engineers, 1863.

Ponton bridge under construction at Aiken's Landing on the James River, summer, 1864.

Ponton bridge, held in place by ships, across the James River, June 1864.

Topographical engineers at Camp Winfield Scott near Yorktown, Va., May 1862, before the two corps were reunited in 1863.

Rappahannock River under devastating fire from Confederate sharpshooters. In June 1864, Army of the Potomac engineer troops constructed a 2,170-foot ponton bridge across the James River, one of the longest floating bridges ever constructed in modern times.

When the Civil War began, two engineer corps existed in the Union Army: the Topographical Engineers and the Corps of Engineers. But the exigencies of the war required stricter coordination of engineer activities. Therefore in 1863, the War Department integrated the smaller Corps of Topographical Engineers into the Corps of Engineers under the command of the Chief Engineer.

Pre-war engineers McClellan, Halleck, George G. Meade, William S.

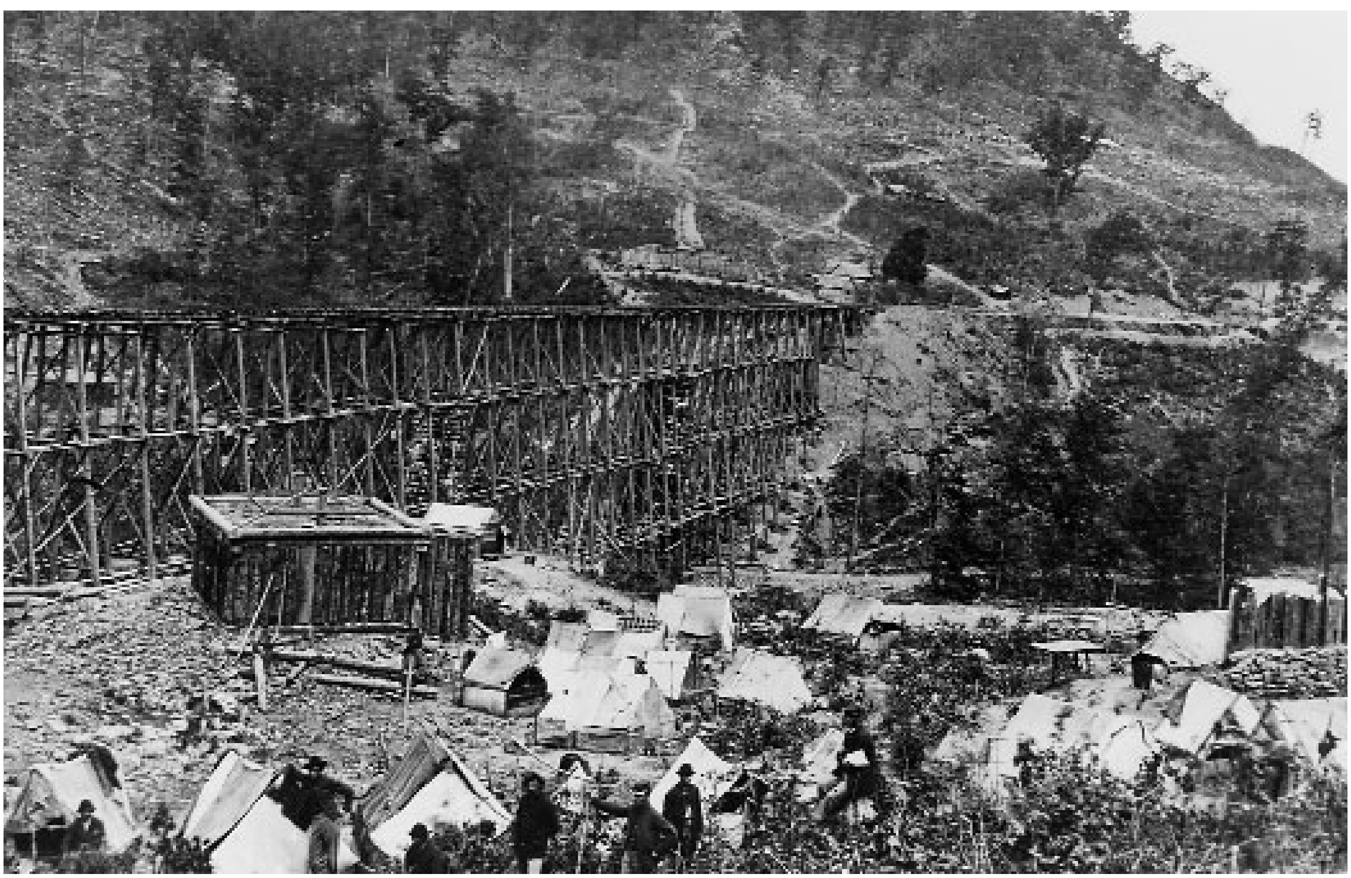
Rosecrans, William B. Franklin, Gouverneur K. Warren, James B. McPherson, and Andrew A. Humphreys did not serve on the battlefields as engineers. Instead they were promoted to general officers commanding combined troops. Likewise, Montgomery C. Meigs became the quartermaster general of the Union Army and furnished the required support and supplies to the troops in the field. By the end of the war, James H. Wilson was a cavalry general.

Their engineering expertise allowed these former Corps officers to excel. As the Battle of Gettysburg unfolded during the summer of 1863,

Company A, Battalion of U.S. Engineers, 1865

1st Michigan Engineers and Mechanics Regiment built this four-tiered, 780-foot railroad trestle bridge, Whiteside, Tenn., 1864.

National Archives



Warren used the talent for assessing terrain he had gained from earlier engineering assignments to discern a weakness in the Union lines along the position known as Little Round Top. He quickly strengthened that position and thereby foiled a key part of the Confederate battle plan.

Other able officers—like Henry Brewerton, John G. Barnard, and Nathaniel Michler—were engineers throughout the war. These men conducted surveys and reconnaissances to provide intelligence reports and maps, directed siege operations, and oversaw the operations of engineer troops. Competent volunteer engineer officers, like William G. Margedant, who developed a process for duplicating maps in the field, also greatly aided the Union war effort.

Three young engineer lieutenants —William H. H. Benyaurd, John M. Wilson, and George L. Gillespie—received Medals of Honor for gallantry under fire, and the latter two concluded their U.S. Army careers as Chief of Engineers. Lieutenant Wilson received the Medal of Honor for his actions at the Battle of Malvern Hill in 1862; Lieutenant Gillespie received the Medal of Honor for actions at the Battle of Cold Harbor; and Lieutenant Benyaurd won his medal at the Battle of Five Forks, Virginia.

The Confederacy gladly accepted the services of fifteen engineer officers who had resigned their commissions in the U.S. Army. Former engineer officers such as Lee, Beauregard, and Joseph E. Johnston became Confederate Army commanders. Edward P. Alexander was the Confederate artillery commander in the Army of Northern Virginia. To

Students at Willets Point building a ponton bridge, 1889 accomplish the necessary engineer work, the Confederacy commissioned many former civilians and raised engineer and pioneer units.

Post-Civil War Period

Between the end of the Civil War and the outbreak of the Spanish-American War, engineer combat experience was minimal. Most engineer officers returned to civil works or fortification construction duty, although they attempted to stay abreast of new military engineering methods and innovations.

Soon after the Civil War ended, Congress abolished the U.S. Army Corps of Engineers' supervision of the U.S. Army Military Academy at West Point, New York. Therefore the Corps, unofficially at first, established an Engineer School at Fort Totten at Willets Point in New York Harbor in 1866. The school's staff instructed students—both officers and enlisted men—in civil and military engineering and provided practical training in mapping, military photography, and laying submarine mines and bridges, both ponton and trestle. In addition to teaching, the staff, especially Superintendent Henry L. Abbot, experimented with and developed new equipment.

Some engineer officers served with the "Indian-fighting army" on the western frontier. A few, like William Ludlow, accompanied the troops on reconnaissance missions and scouting expeditions. Generally, though, these officers' main duties were surveying and mapping.

Underwater mine testing at the Engineer School, Willets Point, N.Y.

Other officers, such as Barton S. Alexander, Cyrus B. Comstock, Peter S. Michie, John M. Wilson, William Craighill, and William E. Merrill, traveled abroad, sometimes as military attachés. Often they had the chance to observe foreign engineer troops' equipment and techniques. A few, including Francis V. Greene, actually witnessed engineer operations in battle.

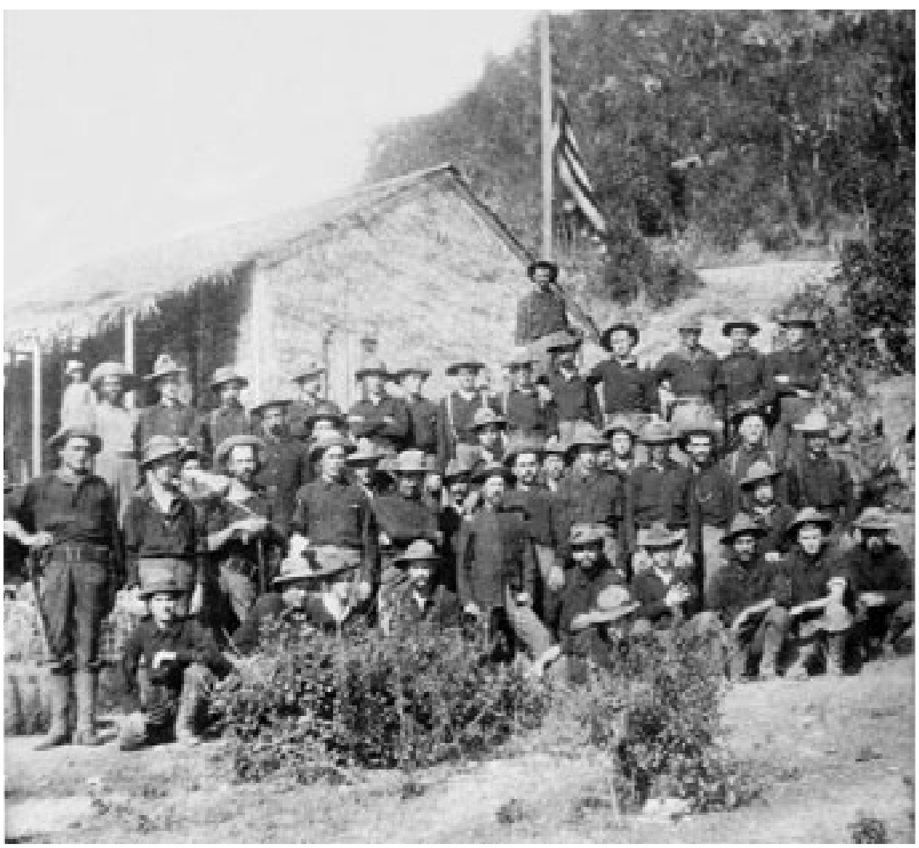
The War Department created a fifth regular Army company of engineers in December 1865. Between the Civil War and the Spanish-American War, the five companies of the battalion, usually understrength, performed a range of duties, from serving at engineer depots in New York Harbor, St. Louis, and San Francisco to riot control during the 1877 railroad strikes. Individual engineer soldiers assisted at numerous civil works and fortification sites throughout the country.

The Spanish-American War and the Philippine-American War

In 1898, the United States went to war with Spain, and the engineers provided extensive combat support. In the far-flung theaters of the war, from Cuba and Puerto Rico to the Philippines, the engineers aided the U.S. Army by erecting landing piers, constructing bridges, building and maintaining roads, laying mines off-shore, and repairing and operating railroads. Young but capable lieu-tenants like Lytle Brown, Eben E. Winslow, and William D. Connor led engineer detachments on dangerous reconnaissance missions, sometimes in the midst of combat. Volunteer engineer units, often commanded by regular U.S. Army officers, also

Engineers' train in the Philippines, 1899 served in the war. Former engineer officers, such as Francis V. Greene and William Ludlow, were brigade and higher unit commanders.

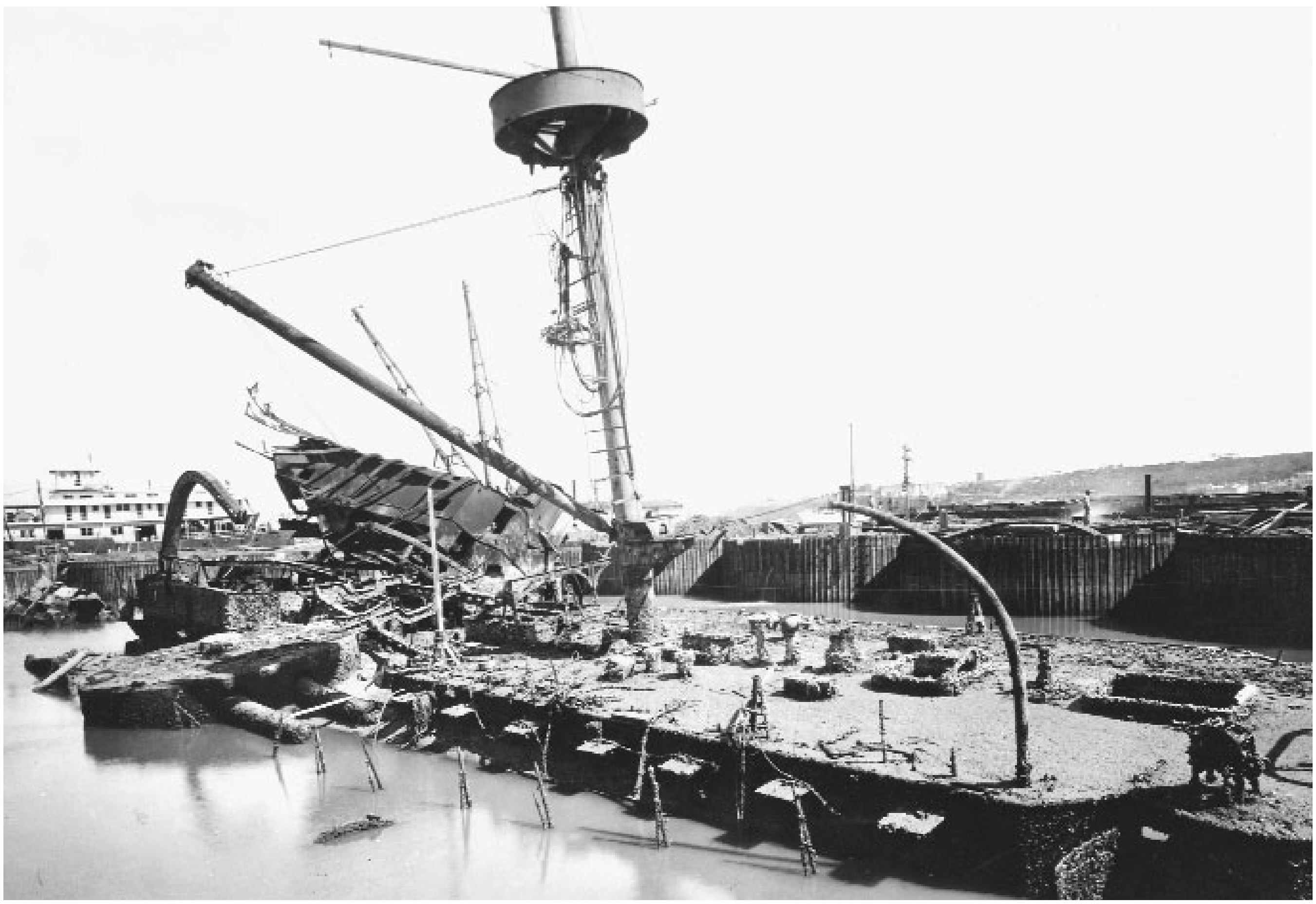
Following the Spanish-American War, an insurrection broke out in the Philippines. Companies A and B of the Engineer Battalion served in the initial stages of the conflict. The insurrectionists' guerrilla warfare tactics necessitated rapid movements by the U.S. Army. Thus, engineer detachments, commanded by William Sibert, John Biddle, John C. Oakes, and Harley B. Ferguson, among others, had to repair roads, build bridges, and perform reconnaissance rapidly over difficult jungle and mountain terrain. Frequently, the engineer troops, who carried rifles as well as picks and axes, joined the infantry in fighting off an attack before completing work on a road or bridge. The requirements of combat, especially in the Philippines, influenced the 1901 reorganization of the engineers into three battalions of four companies each. Although the fighting subsided in the Philippines in the early twentieth century, it did not cease, and engineer troops served in the islands, often in combat, for many years afterward.



Company H, 1st Provisional Battalion of Engineers, near Guánica Bay, where U.S. forces landed on the southern shore of Puerto Rico, July 1898.

The Mexican Punitive Expedition

In 1916, the U.S. Army Corps of Engineers formed three regiments of six companies each from the battalions. In the same year, the United States launched a punitive expedition to Mexico to chastise the "bandits" under Pancho Villa, who had raided American territory. The use of cars and supply trucks required better roads and bridges than ever before. Lytle Brown, now a major, was one of many engineer officers who served in Mexico. These officers gained experience that became especially valuable after April 1917, when the United States entered World War I.



The sinking of the U.S.S. Maine *in 1898 inflamed public opinion and pushed the U.S. into war with Spain. After the Spanish-American War, the Corps of Engineers built caissons in 1911 around the* Maine *in Havana harbor and pumped out water so the ship could be examined before it was towed to deep water and sunk in its final resting place. The USACE Museum Collection has the* Maine's *ship's wheel that the Corps received in appreciation for its work in raising the famous ship.*

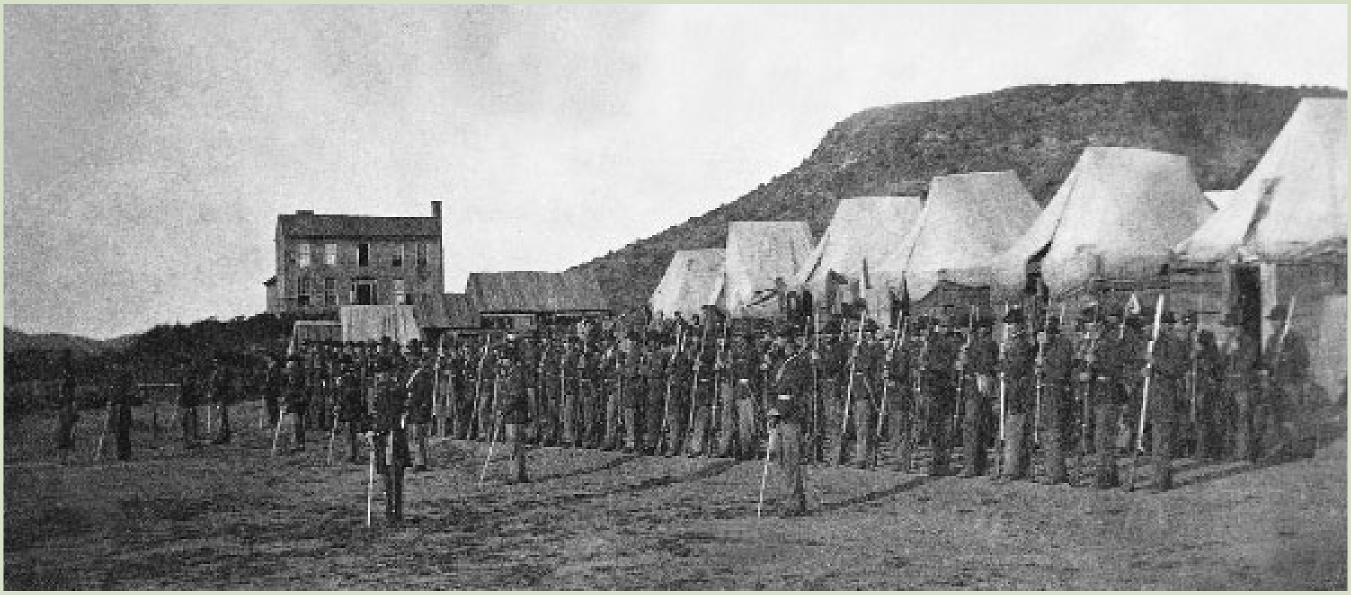
We Don't Surrender Much!

At the end of 1862, Colonel William P. Innes and 391 men of the 1st Michigan Engineers were repairing roads and railroads at the rear of the Union Army near Murfreesboro (Stone's River), Tennessee, when a Confederate cavalry division, commanded by General Joseph Wheeler, flanked the Union Army to strike hard at supply trains on the way from Nashville to Murfreesboro. The surprise attack left Colonel Innes and the engineers without time to escape the gray-clad troopers, and Innes rushed his unit up a nearby hill.

From the top of the hill, Colonel Innes could see the advancing Confederate columns and realized he had no time to entrench his position. But the hill was covered with clumps of red cedar trees, and Innes quickly decided to use this resource. He sent the engineers scrambling around the hill, slashing down the small trees to open a field of fire and piling the cedars in a waist-high circle around the crest of the hill.

Confederates, in greatly superior force, soon surrounded the hill. An officer under a flag of truce advanced to demand surrender from the engineer detachment and was surprised by Colonel Innes' acerbic reply: "Tell General Wheeler I'll see him damned first." Innes continued, "We don't surrender much. Let him take us."

Confederate cavalry soldiers swept up the hill toward the engineers' position, but a volley of Union fire hurled them back pell-mell. The Confederates then unlimbered field artillery and began pounding the hill. The engineers scraped shallow foxholes and held their place. A second cavalry assault followed, and then a third. In all, the cavalry made seven attempts to take the hill, yet the engineers stood their ground until the Confederates concluded the effort was not worth the cost. The engineers suffered eleven casualties, the Confederates nearly fifty.



1st Michigan Engineers and Mechanics Regiment, Company D, on dress parade

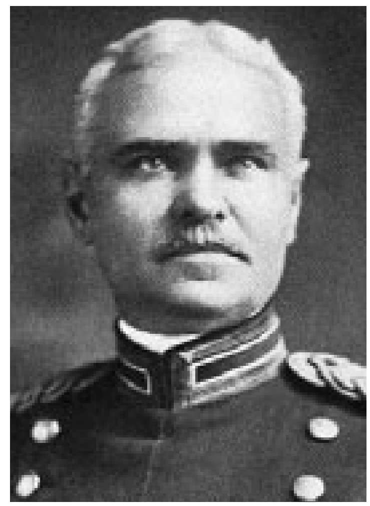
West chamber of the Gatun Upper Locks, March 1912
U.S. Military Academy Library

The Panama Canal

In the early morning of May 4, 1904, a young lieutenant from the U.S. Army Corps of Engineers crisply walked into the old French Hotel in Panama City. He exchanged brief greetings with officials of the new French Panama Canal Company. The new company, which had succeeded Ferdinand de Lesseps' bankrupt enterprise in 1894, had been no more successful than its predecessor in the effort to build a canal across the Isthmus of Panama connecting the Pacific and Atlantic Oceans. Its workers ravaged by malaria and its equipment in disrepair, the company was ready to sell all of its assets to the U.S. government for $40 million. The lieutenant carefully read the document of transfer. Then, following the directions of the U.S. Secretary of War, he signed his name to the receipt: "Mark Brooke, 2nd Lieutenant, Corps of Engineers." The long years of the French effort to construct an isthmian canal were over. The American attempt was about to begin.

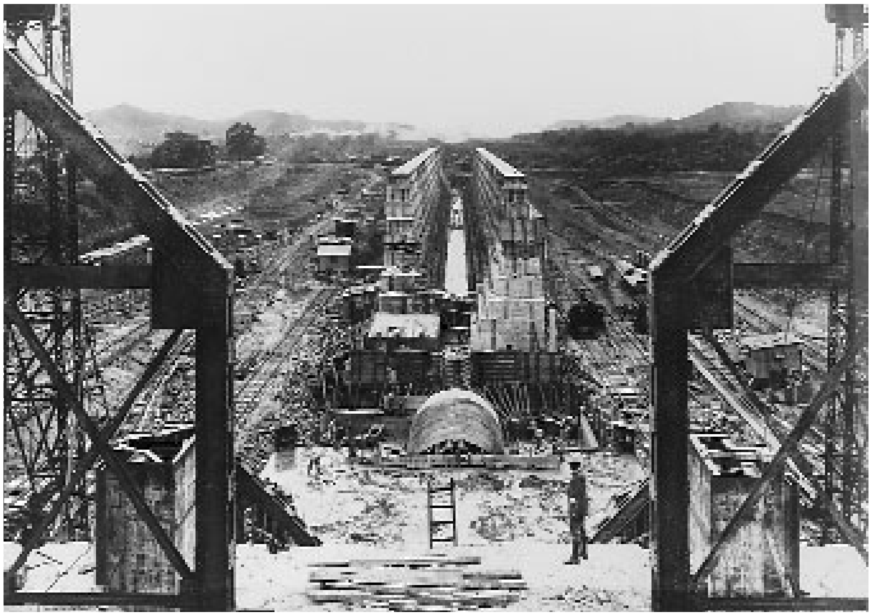
Building the Panama Canal required the assistance of the foremost engineers of the day. Major William M. Black, who later became Chief of Engineers, supervised early engineering activities at the canal. John F. Wallace, the first civilian chief engineer on the project, brought railroad construction and operations expertise to the isthmus. His successor, John F. Stevens, continued his endeavors and established the basic plan for the construction of the canal. Stevens resigned, however, in 1907 when he was severely criticized in the United States.

Frustrated by his inability to find a civilian willing to see the project through to completion, President Theodore Roosevelt turned for help to the U.S. Army Corps of Engineers. "We can't build the canal with a new chief engineer every year," he said. "Now I'm going to give it to the Army and to someone who can't quit." He requested the Panama Canal Commission to appoint engineer officer Lieutenant Colonel George W. Goethals as Chief Engineer and commission chairman. Engineer officers Major William L. Sibert and Major David D. Gaillard, both West Point graduates like Lieutenant Colonel Goethals, also served on the commission. All



Lt. Col. George W. Goethals

Maj. David D. Gaillard



Construction of Pedro Miguel Lock, 1911

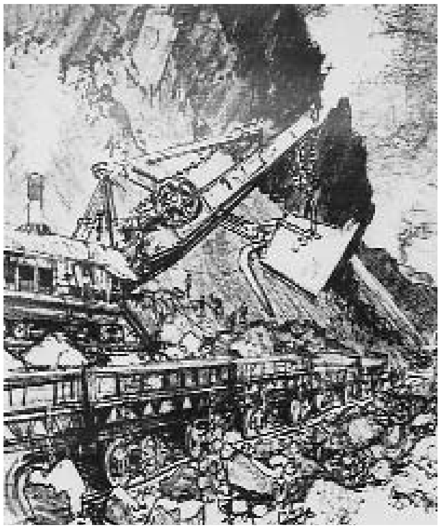
U.S. Military Academy Library

three men received several promotions during the time they worked on the canal.

Within a year, Lieutenant Colonel Goethals reorganized canal operations into three geographical divisions. Major Sibert took charge of the Atlantic Division, and Major Gaillard took the Central Division. To head the Pacific Division, Goethals selected Sydney B. Williamson, a civilian engineer who had won Goethals's respect when the two had worked together earlier at Muscle Shoals. The civilian engineers under Williamson engaged in a spirited competition with the military engineers. Lieutenant Colonel Goethals encouraged this competition to achieve maximum economy while speeding construction. Rear Admiral Harry H. Rousseau, chief of the Bureau of Yards and Docks of the Navy, assumed responsibility for the design and construction of terminals, wharves, docks, warehouses, machine shops, and coaling stations. Civilian engineer Ralph Budd directed the relocation of the Panama Railroad from 1907 until 1909, when he was succeeded by Lieutenant Frederick Mears, an Army cavalry officer.

Miraflores Locks under construction, August 1912

U.S. Military Academy Library



Steam shovel at work in the Culebra Cut; a lithograph in a series on the Panama Canal by Joseph Pennell, noted American artist and illustrator.

USACE Museum Collection

A rail line assisted the canal's construction.

In the 1880s, the French had learned, after several years of effort, that a sea-level canal across Panama was an impossibility. Locks were absolutely necessary. Benefiting from French experience, the Americans never seriously considered anything other than a canal using locks. They erected a monumental dam across the Chagres River, thereby creating Lake Gatun. At each end of the lake, the engineers constructed locks. The Gatun Locks lead to the Atlantic. The Pedro Miguel Locks lead to Miraflores Lake and, farther on, Miraflores Locks. From these locks, ships travel on to the Pacific.

Major Gaillard directed the huge engineering task of completing the Culebra Cut through the continental divide, which required the excavation of 96 million cubic yards of rock and dirt. Spectacular landslides at the cut were the greatest engineering difficulty. The amount of earth that had to be removed was nearly double the original estimate. More than 100 steam shovels removed most of the soil, and flatcars hauled it out. Trains departed at thirteen-minute intervals to keep pace with the steam shovels.

Construction of the Panama Canal was the responsibility of the Panama Canal Commission, but having Army engineer officers supervising the project enabled problems to be resolved more easily and quickly. Engineer officers worked effectively and completed the canal well within estimates. Going beyond mere construction, they also helped

Drilling at Culebra Cut, January 1912
U.S. Military Academy Library

eradicate disease and vastly improved sanitation in the areas adjoining the canal. The organization, administration, and implementation of this massive building effort remain a model for subsequent large-scale construction projects.

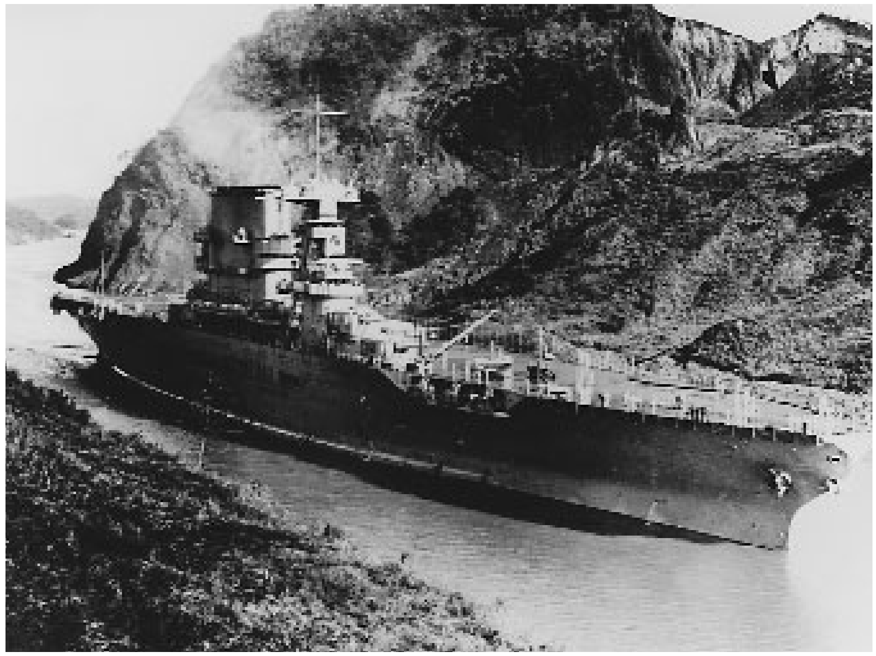
Culebra Cut
U.S. Military Academy Library

The Panama Canal opened ahead of schedule on August 15, 1914. The total excavation for the channel exceeded 200 million cubic yards of earth, of which almost half was taken from the Culebra Cut, later renamed Gaillard Cut in honor of the officer who conquered it. Tragically, Lieutenant Colonel Gaillard died of a brain tumor in 1913 without seeing the canal's completion.

U.S. Army engineers retained a unique relationship with the Panama Canal after the canal was opened. Engineer officers traditionally served as the governor and lieutenant governor of the Panama Canal Zone. The governor also served as president of the Panama Canal Company, which was actually responsible for canal operations. Goethals himself was the first civil governor of the Canal Zone and received a promotion to major general during his tenure. The last military governor of the Canal Zone was Major General Harold R. Parfitt, a U.S. Army engineer officer, whose tenure ran from 1975 to 1979.

In the years immediately after the canal's completion, the U.S. Army Corps of Engineers accepted responsibility for dredging the channel, which continued to be frequently blocked by landslides. Engineers finally determined the proper incline for the banks to provide the greatest assurance against slides. In the 1920s, the Corps further strengthened the banks by developing a system of drainage control. Still later, U.S. Army engineers helped enlarge the canal. The original locks are still in use.

U.S. Army engineer officers have also periodically assisted in studies on other canal routes across Central America. Engineers conducted a survey for a route across Nicaragua in the 1930s. In the 1960s, they were heavily involved in studies on an alternate Panamanian route that would accommodate larger vessels. Although the United States turned over control of the canal to Panama on December 14, 1999, the strategic fifty-mile waterway remains a lasting testament to the skill of U.S. Army engineering.



U.S.S Saratoga *in Gaillard Cut, February 1928*

Engineers built Fort de Lesseps in 1911 to protect the canal.

National Archives

Emergency Nuclear Power for the Panama Canal

One of the most unusual ways U.S. Army engineers assisted canal operations occurred in 1968 when the Corps sent the *Sturgis,* the world's first floating nuclear power plant, to the Canal Zone to alleviate dangerous reductions of electrical power caused by necessary curtailment of operations at the Gatun Hydroelectric Station.

The weather had been so dry that there was not enough water to operate the locks as well as supply the turbines. Because of the increased traffic in the Panama Canal resulting from the Vietnam War and the closing of the Suez Canal, such vast amounts of water were required to operate the locks that the water level on Gatun Lake fell drastically during the dry season. Serviced by hyrdoelectric plants with a combined output of approximately 100 megawatts, the Canal Zone had insufficient reserve capacity to shut down its largest generator without interrupting power supply to military or civilian consumers.

In this emergency the U.S. Army Corps of Engineers dispatched the *Sturgis* to Gatun Lake. The 10-megawatt floating power plant had been designed by the Philadelphia Engineer District and christened in 1964 in memory of Lieutenant General Samuel D. Sturgis, Jr., the former Chief of Engineers who had died that year. Home port for the *Sturgis* was at Gunston Cove on the Potomac River, and its crew trained at Fort Belvoir, Virginia.

Towed to the canal, the *Sturgis* was connected to the Panama Canal Company's power grid and began producing electricity on October 5, 1968. An additional barge with greater capacity was deployed the following month to assist the mission.

The *Sturgis* fulfilled a critical power need. It also helped save more than one trillion gallons of water for lock operations that otherwise would have been used for electrical generation. The ingenuity of the U.S. Army Corps of Engineers had paid off.

(top) U.S.S. Sturgis, *housing the MH-1A nuclear power plant, in the Panama Canal, 1970*

(above) Lt. Gen. Samuel D. Sturgis, Jr.

U.S. Army Engineers in World War I

During World War I, the U.S. Army Corps of Engineers was called upon to provide a much more diverse range of military services than ever before. Not only did the engineers provide American combat divisions with the officers and men to staff the 1,660-man engineer regiments that were part of each combat division, they also built the port facilities, roads, and railroads needed to bring essential war materiel to the front; harvested timber for military construction; employed searchlights in antiaircraft defense; organized the first U.S. Army tank units; and developed chemical warfare munitions and defensive equipment. So important were these last pursuits that, in 1918, the Army created a separate Tank Corps and a Chemical Warfare Service, the latter headed by an engineer officer.

The U.S. Army engineers who served in World War I brought with them varied amounts of military experience. Most senior engineer officers were graduates of the U.S. Military Academy and had previously served with U.S. Army units abroad, primarily in Cuba or the Philippines. A few of them had accompanied General John Pershing in his expedition to northern Mexico in 1916–1917, which had unsuccessfully attempted to capture the Mexican revolutionary Pancho Villa after his raid on Columbus, New Mexico. Some engineer commanders had been civilian engineers, members of the National Guard, or Officers Reserve Corps engineer units organized a few years before the United States' entry into the war. But most of the 240,000 engineers who served in Europe during the war had no prior military service.

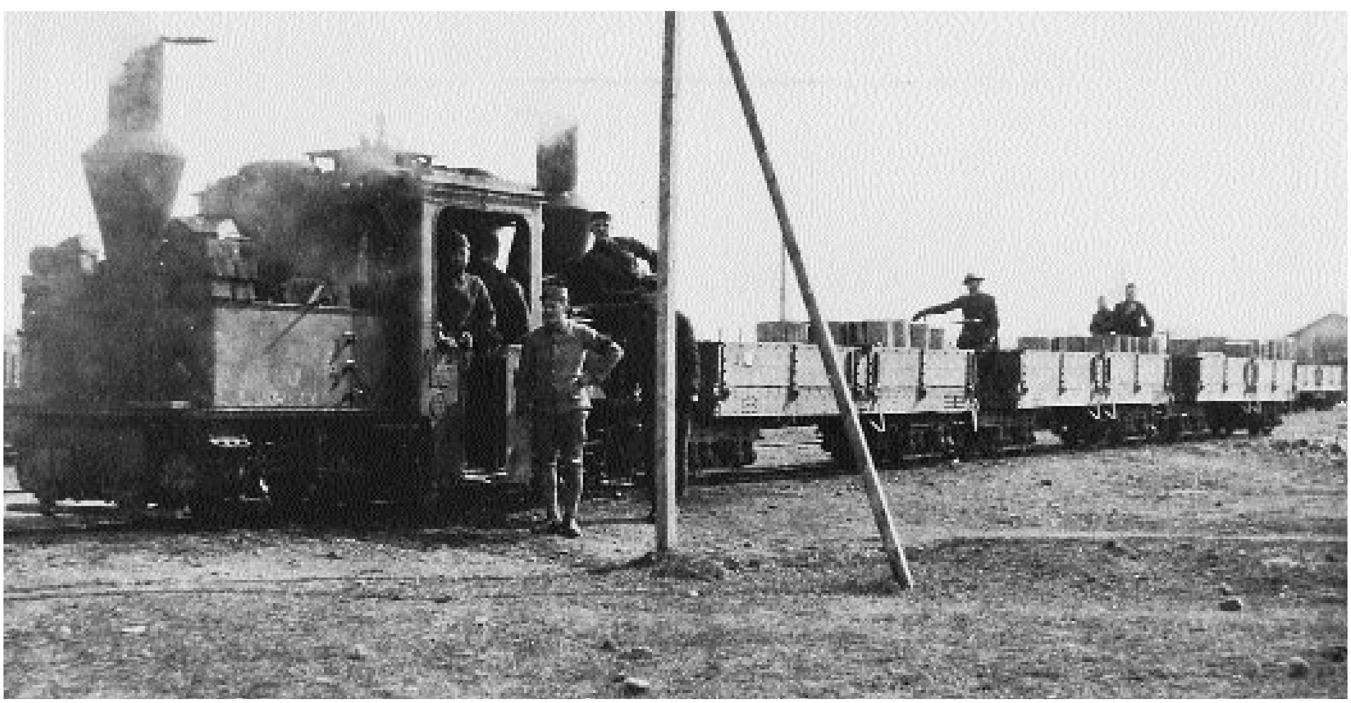
The British and French governments made the arrival of American

Company D, 11th Engineers, building a road near the Aire River
U.S. Military Academy Library

engineers in France their top priority after the United States declared war on April 6, 1917. Thus, by the end of August 1917, nine newly organized engineer railway regiments, together with the engineer regiment of the 1st Division, had crossed the Atlantic and arrived in France. Several of the railway regiments were assigned to British or French military formations pending the arrival of larger numbers of American combat troops in the summer and autumn of 1918. It was while serving with the British near the village of Gouzeaucourt, southwest of Cambrai, France, on September 5, 1917, that Sergeant Matthew Calderwood and Private William Branigan of the 11th Engineers were wounded by artillery fire, becoming the first U.S. Army casualties of the war. When the Germans launched a counteroffensive in late November 1917 to regain territory they had just lost to the British near Cambrai, the men of the 11th Engineers abandoned their railway work and assisted the British with constructing new defensive positions, which stopped the German advance.

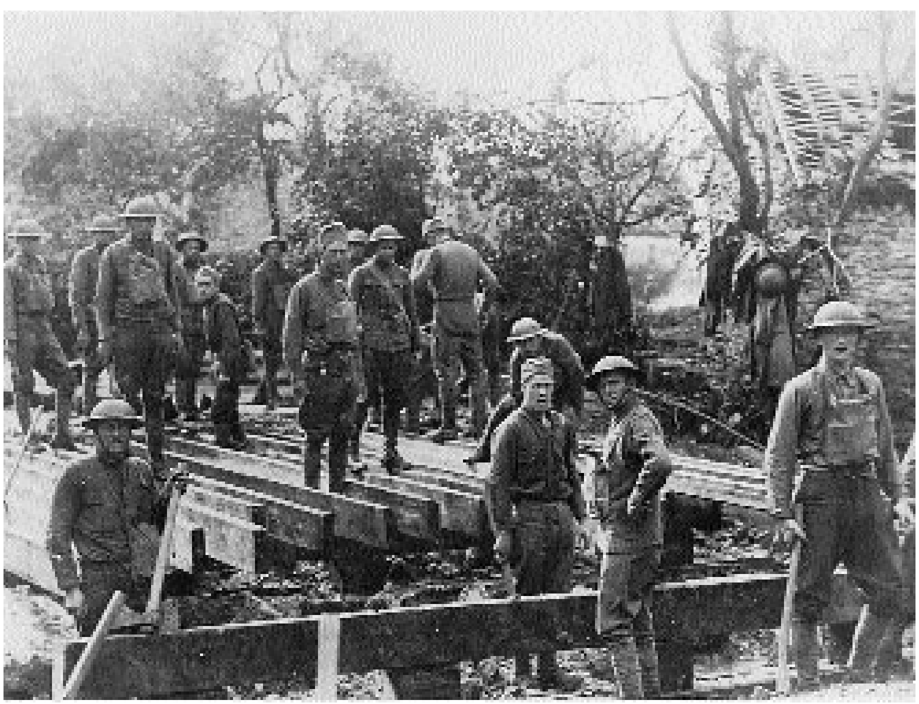
During 1918, U.S. Army engineers served in combat from the Vosges Mountains near the Swiss border north to Oudenaarde, Belgium. One battalion of the 310th Engineers served in the Murmansk area of northern Russia in a mission to assist Czech troops to rejoin the fighting on the Western Front after Bolshevik Russia had left the war in March 1918. Most of this combat service consisted of constructing

Company E, 21st Engineers, operating a train near Menil-la-Tour, France, March 1918



bridges, roads, and narrow-gauge railroads at or immediately behind the front, but engineer units also engaged in direct combat.

Two companies of the 6th Engineers ceased their construction of heavy steel bridges to join British and Canadian forces in frontline trenches. Together they successfully defended Amiens from a heavy German assault in March and April 1918. These two engineer companies suffered a total of 77 casualties. During June and July 1918, troops of the 2d Engineers fought as infantry in their division's bitterly contested capture of the Belleau Woods and the nearby village of Vaux in the Aisne-Marne campaign. A battalion of the 1st Engineers fought as infantry in the capture of Hill 269 in the Romagne Heights along the Hindenburg Line on October 8, 1918. It was for his action during this battle that engineer Sergeant Wilbur E. Colyer of South Ozone, New York, received



(above) 21st Engineers maintaining a narrow gauge rail line to supply ammunition to the front, April 1918

(left) 107th Engineers building a bridge, Cierges, France, August 1918

the Medal of Honor. Sergeant Colyer volunteered to locate a group of German machine-gun nests that were blocking the American advance. He used a captured German grenade to kill one enemy machine-gunner, turned his machine gun against the other enemy nests, and silenced each of them.

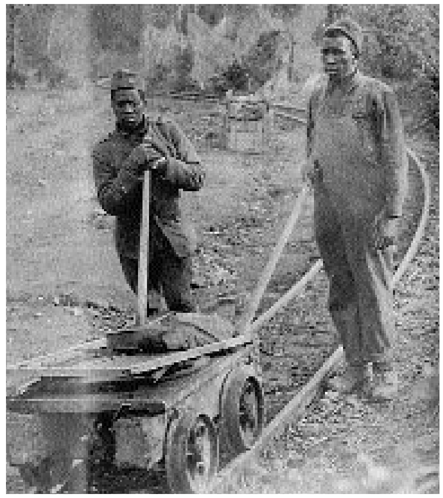
First ponton bridge over the Marne, July 20, 1918

Other U.S. Army engineers won personal recognition for their actions in bridging the Meuse River. Major William Hoge, Jr., a West Pointer serving with the 7th Engineers, 5th Division, won a Distinguished Service Cross for his heroism in reconnoitering a site for a ponton bridge across that well-defended waterway north of Brieulles, France. Major Hoge selected the bridge site during the daylight hours of November 4, 1918, while under enemy observation and artillery fire, and he directed the construction of the bridge that night. After German artillerists destroyed three ponton boats supporting the bridge, engineer Sergeant Eugene Walker, Corporal Robert Crawford, and Privates Noah Gump, John Hoggle, and Stanley Murnane jumped into the icy river

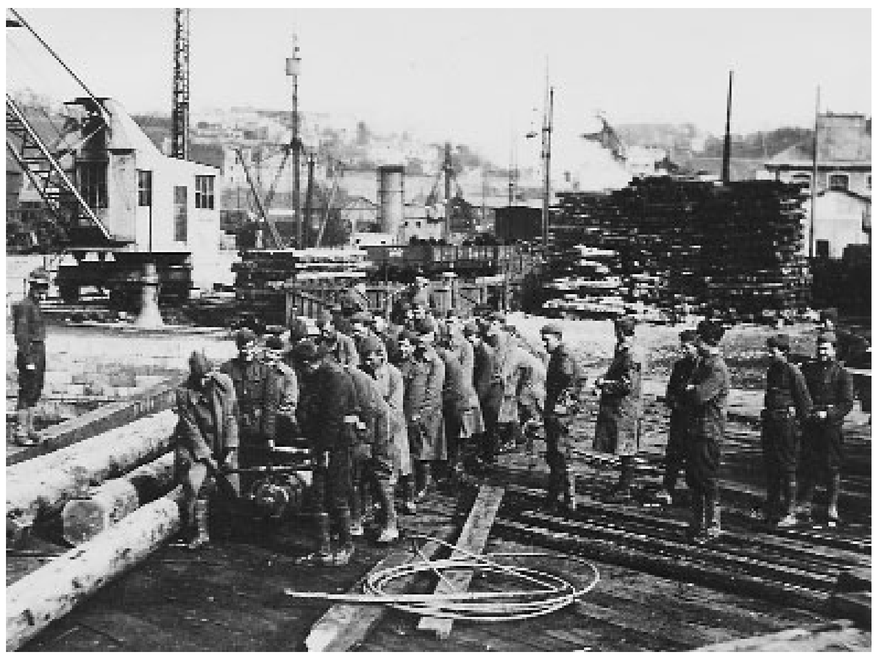
Engineers build a corduroy road

and held up the deck of the bridge until replacement pontons could be launched and installed. These enlisted men were also awarded the Distinguished Service Cross. This bridge was one of thirty-eight constructed by U.S. Army engineers during the critical Meuse-Argonne offensive, which ended with the German military collapse.

U.S. Army engineers also made essential contributions to ultimate victory well behind the front lines. The forestry troops of the 20th Engineers, the U.S. Army's largest regiment, produced roughly 200 million feet of lumber in France, together with some three million standard-gauge railroad ties and one million narrow-gauge ties. American troops, under the technical supervision of U.S. Army engineers, used the lumber to construct new and expanded port facilities for American ships, including berths for deep-draft vessels at Brest; storage depots containing more than fifteen million square feet of covered storage space; new hospitals with more than 140,000 beds; and barracks capable of housing 742,000 men. Engineer troops constructed 950 miles of standard-gauge rail lines, primarily at docks and storage yards; water supply facilities at several French ports and communications centers; and ninety miles of new roads.



African-Americans, here moving a rail cart, made a significant contribution to the Army Engineer war effort. Of the 240,000 Army engineers who served in World War I, 40,000 were African-Americans.



(above) 33rd Engineers carry a thirty-foot section of mast for a stevedore derrick, western France

(left) French officers training American engineer troops

Road construction, France

During the war, U.S. Army engineers also drew and printed maps, conducted geological studies with an eye to underground water supplies, installed and operated electrical lines and mechanical equipment, and experimented with the use of tractors and trailers for hauling ponton bridging equipment in the absence of sufficient draft animals. American engineers also operated seven cement plants in France. These varied operations permitted the U.S. Army to field and support a force of nearly two million men in France within twenty months of the U.S. entry into the war.

Engineers laying foundation for barracks and hospital in France

Maintaining High Standards: The 2d Engineers in France

The 2d Engineers had their start during the Civil War and saw action during many major battles in that conflict. The unit also participated in the Spanish-American War and the Punitive Expedition against Mexico.

During World War I, the 2d Engineer Regiment of the 2d Indian Head Infantry Division, commanded successively by Colonels James F. McIndoe and William A. Mitchell, was considered one of the best regiments in the American Expeditionary Forces (AEF) in France. Because of its bloody engagements at Belleau Wood, Ch teau Thierry, Soissons, and Meuse-Argonne, the division s infantry units sustained the highest percentage of major casualties among all AEF units its 30.38 percent casualty rate just edging the 30.08 percentage of the Big Red 1, the 1st Infantry Division.

The 2d Engineers, moreover, stood 15th in the list of casualties with 12.73 percent, by far the highest of any U.S. Army engineer unit. The reason was simple: the trench war was preeminently an engineers war cutting barbed wire entanglements; putting them up; digging dugouts, machine-gun positions, and trenches; and all too often fighting as infantry.

Throughout its time in combat, the regiment maintained high morale and unexcelled performance in all its assignments. A major reason for its excellent performance was the high standards its officers and men required of themselves and each other. These standards applied throughout the regiment and were vigorously enforced.

An unnamed American general officer reinforced this assertion by noting that the 2d Engineers is the best regiment I ever saw. . . . The regiment has assisted the artillery, has helped the tanks, built railroads, manned machine guns, and fought time after time as infantry. That regiment can do anything.

The 2d Engineers lived up to their motto, Ardeur et Tenacite. The unit received the Croix de Guerre from the government of France.

2d Engineer Regiment Distinctive Unit Insignia

Dugout entrance, Argonne, France, 1918

Trench warfare, France

Vehicles of the 3rd Armored Division cross the Seine River on an engineer-built ponton bridge, August 1944

Combat Engineers in World War II

As Imperial Japanese forces expanded their conquest of China and Nazi Germany gained territory in Central Europe during the late 1930s, the U.S. Army Corps of Engineers numbered fewer than 800 officers and 6,000 enlisted men in active Regular Army service. During the years since the 1922 withdrawal of U.S. Army engineer troops from Coblenz, Germany, where they had occupied territory along the Rhine River, the U.S. Army had maintained on active duty only eight or nine combat engineer regiments, two engineer squadrons, and a single topographic battalion. Furthermore, it staffed even this short troop list at only some 70 percent of authorized strength. Engineer officers thus spent most of their time during the 1920s and 1930s administering the Corps' civil works program, whose budget in 1938 was nearly four hundred times greater than its military budget.

Engineer military mobilization began in earnest in mid-1940, after the German conquest of France. During late 1940 and early 1941, the U.S. Army inducted eighteen National Guard divisions, each containing an engineer combat regiment, and their men began to undergo intensive training. The U.S. Army quickly organized engineer aviation companies and battalions to build the airfields needed to defend the Western Hemisphere.

A source relatively untapped in previous wars, African-Americans joined the U.S. Army in unprecedented numbers during 1940 and 1941. Many were assigned to engineer units. Black Soldiers, who numbered 20 percent of Corps personnel by war's end, were assigned to

Engineers train in constructing an assault ponton bridge, Fort Belvoir, Va.

segregated units, usually in the construction field, but they were trained by white officers such as Major (later General) Andrew Goodpaster.

Initiated well before the attack at Pearl Harbor, engineer research and development projects directed by the Engineer Board at Fort Belvoir, Virginia, were to have a significant impact upon the war. Experiments conducted during 1940 and 1941 developed a light and inexpensive pierced-steel plank mat that the U.S. Army Air Forces would widely use to provide safe, stable landing fields for American planes. Spurred by the ideas of engineer Captain (later General) Bruce Clarke, Engineer Board studies perfected a new steel treadway bridge constructed on pneumatic floats that would carry heavy modern tanks across the rivers of Europe. By 1943, the Engineer Board produced a tank dozer capable of knocking over substantial barriers while conducting an armored assault.

Engineers lay pierced-steel plank to construct a runway rapidly in New Guinea, February 1944

When the Japanese bombed military bases in Hawaii and the Philippines on the morning of December 7, 1941, engineer units that had already been deployed to those islands were called upon to respond. The 34th Engineers, a combat regiment that had lost some equipment but incurred no casualties during the bombing in Hawaii, worked to maintain roads that were suffering from heavy military traffic. The skimpy, 1,500-man U.S. Army engineer garrison in the Philippines was almost evenly divided between Filipino and American personnel. After Japanese forces landed there on December 10, the engineers destroyed bridges from one end of Luzon to the other to slow the enemy's advance. The engineers later erected a series of defensive lines on the Bataan Peninsula and fought as infantry in these defenses before succumbing to superior Japanese forces in April and May 1942. In the southern Philippines, a number of U.S. Army engineers escaped to the mountains of Mindanao, where they worked with Filipino guerrillas and

The Pentagon under construction

remained active throughout the Japanese occupation.

On the home front in December 1941, the U.S. Army Corps of Engineers assumed the military construction role formerly held by the Quartermaster Corps, and accelerated construction of military bases, including all of the airfields for the U.S. Army Air Forces. An engineer officer headed the construction of the largest office building in the world, the War Department's headquarters, known as the Pentagon. The Corps established Engineer Replacement Training centers at Fort Belvoir, Virginia; Fort Leonard Wood, Missouri; and Camp Abbot, Oregon, to meet the high demand for combat engineers. Further, the Corps adopted enhanced security measures at sensitive facilities such as the Washington Aqueduct. The Corps also developed, built, and oversaw the implementation of significant logistical systems for war support, such as the movement of petroleum and related products along the nation's waterways. Of note, at the outset of the war, the U.S. Army Map Service was formed under the command of the Chief of Engineers. Among the Corps projects contributing to the war effort was the Bonneville Dam, which supplied the power that eventually generated 25 percent of the Nation's finished aluminum used for aircraft and in other armaments.

U.S. Army engineers first entered combat against German and

(above) Lacking Bailey bridging equipment, the 10th Engineer Combat Battalion "hung a bridge in the sky" using captured timbers to cross this gap in the road at Cape Calava, Sicily, August 1943.

(below) Two 5th Army engineer units building a ponton bridge across the Po River north of Bologna, Italy, April 1945.

Italian forces in North Africa, when American forces landed in November 1942. During the first five months of 1943, a few units of American engineers assisted U.S. Army movements in the broad deserts and fields of Tunisia, clearing enemy mines and building roads from scratch. Prior to the American attacks on Gafsa and Maknassy in the barren plains of southern Tunisia, the 1st Engineer Combat Battalion and a company of the 19th Engineer Combat Regiment built combat approach roads through a no-man's land between the combatants, where the engineers were vulnerable to surprise attacks.

After the Allied victory in North Africa, American and British forces landed first in Sicily and then in mainland Italy during the summer of 1943. Defended by well-equipped and determined German forces, Italy's mountainous terrain and rapidly flowing rivers challenged the road- and bridge-building skills of the Army engineers. The combat engineers particularly distinguished themselves in the fighting at and just south of the Rapido River in the Allied drive north from Naples.

The 48th and 235th Engineer Combat Battalions, assigned to an armored task force under Brigadier General Frank Allen that was ordered to capture Mount Porchia just south of the Rapido, not only removed obstacles and opened supply lines but also fought as infantry on the flanks of the task force's advance. After enemy fire had substantially reduced the armored infantry units leading this attack, the 48th was ordered to secure the top and sides of the mountain. It was in this effort that engineer Sergeant Joe Specker of Odessa, Missouri, having observed an enemy machine-gun nest and several well-placed snipers blocking his company's progress, advanced alone with a machine gun up the rocky slope. Although mortally wounded by intense enemy fire, Sergeant Specker nevertheless set up and fired his weapon so effectively that the enemy machine gun was silenced, and the snipers were forced to withdraw. With this assistance, the battalion was able to clear the summit of Mount Porchia. Sergeant Specker was honored by a posthumous award of the Medal of Honor.

Sgt. Joe Specker

More than a dozen U.S. Army engineer combat battalions landed on the beaches of Normandy during the Allies' assault landing on June 6, 1944. The engineers cleared the beach obstacles and minefields that the Germans had implanted there and absorbed substantial casualties on Omaha Beach, including the loss of two battalion commanders. Bulldozer drivers, often working in the face of heavy enemy fire, opened exits up narrow draws through the cliffs lining the beaches. Some of the engineers quickly engaged in combat with the Germans alongside assault infantry teams. In one such action, Lieutenant Robert Ross of the 37th Engineer Combat

American engineers lay out roads on a French beach, 1944

Battalion took charge of an infantry company that had lost its leaders and led it and his own engineer platoon up the slopes adjoining Omaha Beach, where they killed forty Germans and captured two machine-gun emplacements.

Engineers clear Saint Lo for traffic from Omaha Beachhead.

Crossing the Seine on a ponton bridge, August 1944

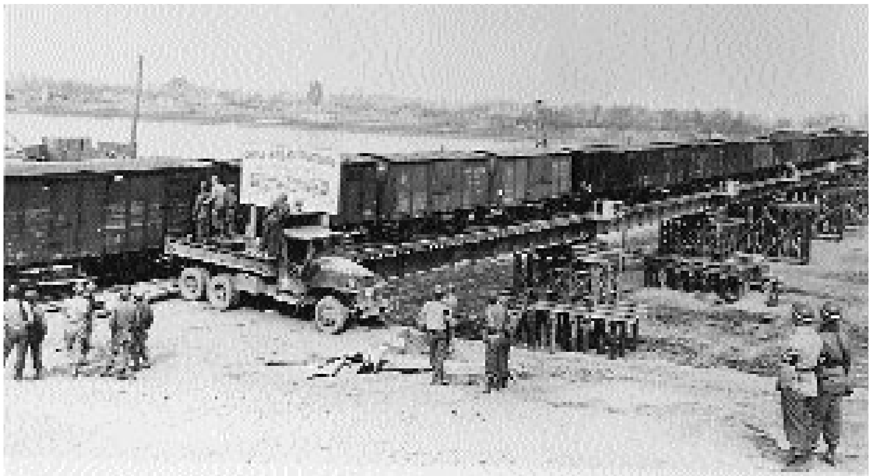
The U.S. Army engineers again provided critical support to the achievement and exploitation of the breakthrough that American forces created in late July 1944 in enemy defenses southwest of St. Lo, France. U.S. Army and divisional engineer troops repaired roads and cleared enemy minefields in and beyond St. Lo with exceptional speed, and they rapidly bridged the small rivers in the area to maintain the Americans' momentum. After the German line had been effectively pierced, armored division engineers constructed the treadway bridges needed by Patton's tanks in the Third Army's quick pursuit of the retreating Germans across northern France. Engineer general service regiments behind them rapidly reconstructed or replaced railroad bridges that had been destroyed by the retreating Germans. In Lorraine, the 130th Engineer General Service Regiment built, under heavy artillery fire, a 190-foot-long double-triple Bailey bridge that Third Army troops used to cross the Moselle at Thionville, France. This bridge had to reach ten feet beyond the specified maximum span of such a bridge, yet it successfully carried heavy American tanks.

The massive German offensive in the Ardennes Forest that began on December 16, 1944, exacted a heavy toll among the sparse American forces surprised in the area. A disproportionate number of those troops were engineers who had been operating sawmills or repairing forest roads, and of necessity, these engineer troops were called upon to fight as infantry. The 81st Engineer Combat Battalion, which had been engaged in road maintenance around Auw, Germany, quickly found itself caught in the center of the powerful enemy assault; within a week, the Germans had captured or killed a majority of its troops despite their determined combat, notably in the defense of St. Vith, Belgium.

Colonel H.W. Anderson's 1111th Engineer Combat Group was headquartered at Trois Ponts, Belgium, right in the path of Joachim Peiper's fast-moving German assault tanks. Despite their inferior numbers, Colonel Anderson's engineers put up a stout and effective resistance that crippled Peiper's force. A minefield was hastily laid by a squad of the 291st Engineer Combat Battalion before Stavelot delayed Peiper's entry into that town overnight. On the following day, December 18, engineers from that battalion helped deflect the German tank column away from the critical petroleum depot near Francorchamps, located on the road to Spa, where the First Army had its headquarters. A company of the 51st Engineer Combat Battalion then diverted the column again at Trois Ponts by blowing the bridges there and defending the village alone until airborne troops could reinforce it. Peiper's tanks eventually ran out of fuel well short of his Meuse River objective, and Peiper's men had to abandon them.

Assembling a treadway bridge in Belgium, 1945

Army engineers sanding a road, Luxembourg, 1945



Gouldin railroad bridge on the Rhine built by Army engineers in ten days, April 1945

To the south, elements of the 44th, 103rd, and 159th Engineer Combat Battalions delayed portions of the German Fifth and Seventh Armies at the villages of Wiltz, Hosingen, and Scheidgen in Luxembourg, before German forces overwhelmed American positions. Although ultimately unsuccessful, the defense undertaken by these engineer units delayed enemy forces long enough to permit American infantry, airborne, and armored units to come to the defense of critically located Bastogne.

Placing explosive charges to demolish concrete tank barriers on the Siegfried Line, October 1944

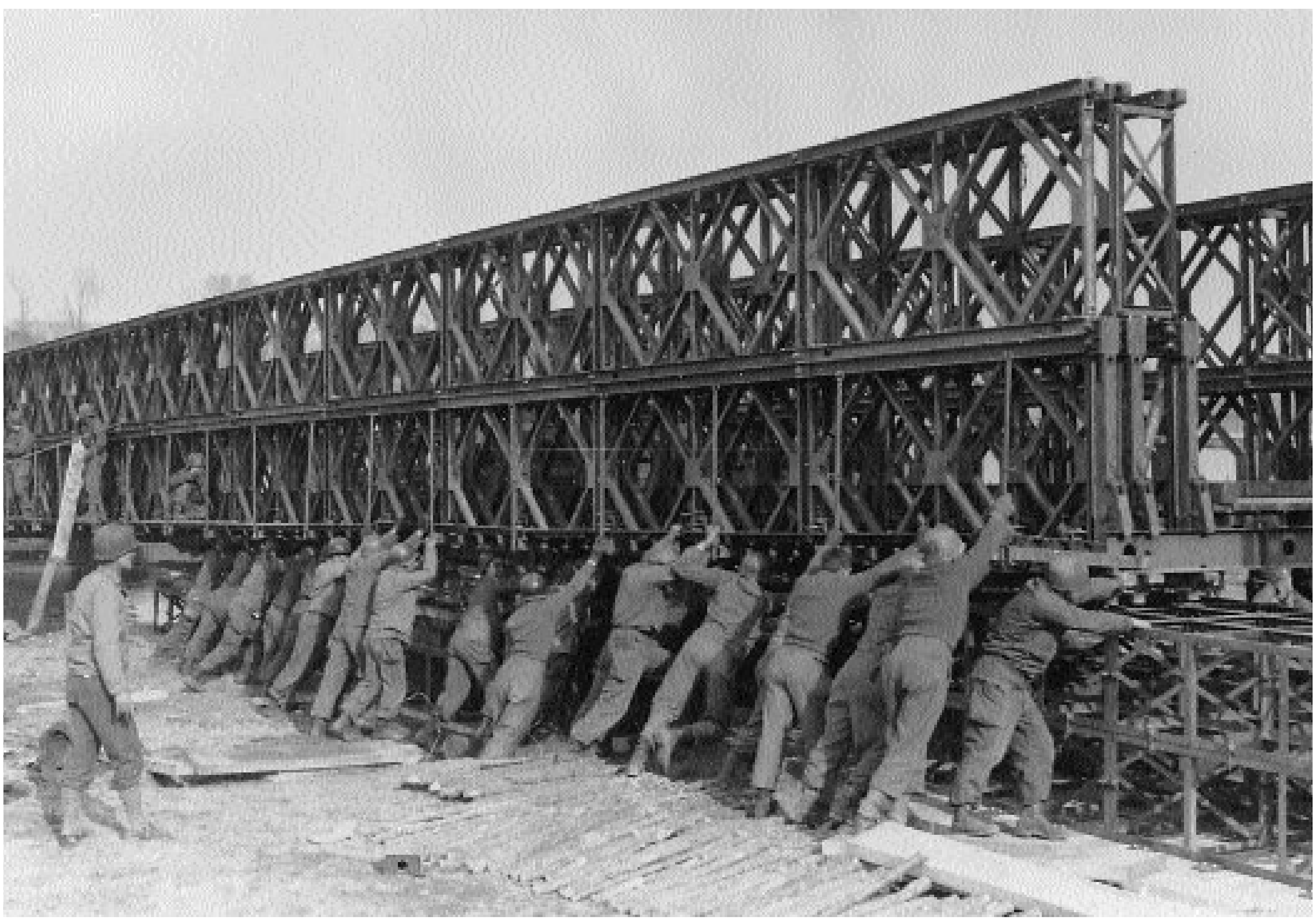
Engineer troops also fought before Bastogne, some using antitank weapons with which they had no experience. Private Bernard Michin of the 158th Engineer Combat Battalion waited until an enemy tank came within ten yards of him before having sufficient assurance of his target to fire a bazooka at it. The resulting explosion temporarily blinded him. He rolled into a ditch and, hearing enemy machine-gun fire, lobbed a hand grenade toward its source. The firing stopped abruptly. Private Michin was awarded a Distinguished Service Cross.

In January 1945, American forces pushed a badly weakened German army out of the Ardennes and advanced to the river barriers of the Roer and Rhine. Relying on U.S. Army engineer bridging skills, the Americans crossed the Roer on February 23, 1945, before flood waters released by the breaking of upstream dams had subsided, thus surprising the Germans and permitting a rapid American advance.

Engineers also played a critical role in the unexpected capture of the Ludendorff Railroad Bridge across the Rhine at Remagen on March 7, 1945. As elements of the armored combat command, under career engineer officer Brigadier General William M. Hoge, Jr., approached the bridge that afternoon, the Germans set off a charge of dynamite in an unsuccessful attempt to destroy the span. Risking a new explosion, Lieutenant Hugh Mott, Sergeant Eugene Dorland, and Sergeant John Reynolds, all members of Company B, 9th Armored Engineer Battalion, ran onto the bridge in the company of assault infantrymen. The engineers first located four thirty-pound packages of explosives tied to I-beams under the decking, cut them free, and sent them splashing into the Rhine. After the infantry had cleared the far-shore bridge towers, Sergeant Dorland found the master switch for some five hundred pounds of intended bridge demolition explosives, and he quickly shot out the heavy wires leading from it. Under continuing heavy enemy fire, Lieutenant Mott then directed the repair of the bridge's planking, and seven hours later, he reported that tanks could cross.

While nine U.S. Army divisions crossed the Rhine at Remagen, most

Engineers assembling a Bailey bridge to put across the Rhine River at Wesel, March 1945



Roosevelt Bridge over the Rhine

U.S. forces crossed that broad river in assaults in late March 1945 that were supported by the combat bridge-building endeavors of the U.S. Army Corps of Engineers. Engineer boatmen piloted Navy landing craft to carry assault units across the swift-flowing Rhine. Behind them, other engineers began installing numerous heavy ponton and treadway bridges that would securely tie the assaulting troops to their sources of supply. Third Army engineers built a 1,896-foot-long treadway bridge across the Rhine at Mainz under combat conditions. Further south, Seventh Army engineers completed, in less than ten hours, a 1,047-foot ponton bridge across the Rhine at Worms.

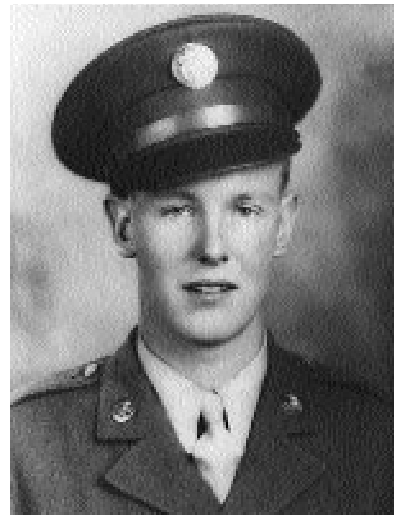
Heavy enemy fire delayed completion of some bridges and exacted casualties. Captain Harold Love, commander of an engineer treadway bridge company, was killed when the treadway section he was ferrying to a partially completed bridge at Milchplatz was struck by a German shell. Nevertheless, the U.S. Army engineer efforts achieved remarkable results. After crossing the Rhine, the Western Allies pushed rapidly across Germany toward their rendezvous with the Russians at the Elbe River. When the Soviet Red Army arrived in Magdeburg in May, it found that Ninth Army engineers had already, on April 13, 1945, built a treadway bridge across the Elbe at Barby fifteen miles south of that eastern German city.

In the fighting against Japanese forces in the Pacific, U.S. Army engineers distinguished themselves

An engineer soldier of the 96th Engineer Battalion, an African-American unit, operating a bulldozer to construct a reservoir near Port Moresby, New Guinea, February 1943.

notably during the amphibious landings that they supported. The engineer boat and shore regiments of the 2d, 3rd, and 4th Engineer Special Brigades directed a series of landings on the north coast of New Guinea and on nearby New Britain, Los Negros, Biak, and Morotai Islands as U.S. and Australian forces advanced by sea in a step-by-step fashion toward their October 1944 return to Leyte Island in the Philippines. The engineer boatmen, who brought ashore a task force of the 41st Infantry Division at Nassau Bay, New Guinea, on June 30, 1943, found themselves engaged in hand-to-hand combat with a much larger Japanese force assaulting the beaches just one day after the landing. Demonstrating their skill with knife and bayonet, the engineers held their portion of the beach perimeter.

After the Allies captured the Japanese base at Finschhafen three months later, U.S. Army shore engineers operating the beach depot two miles north of that New Guinea town were surprised by a Japanese landing attempt before dawn on October 17, 1943. Here, engineer gunner Junior Van Noy, a nineteen-year-old private from Idaho, refused to heed calls to withdraw from his shoreside machine-gun position, despite heavy enemy attacks on it with grenades, flame throwers, and rifle fire. Van Noy managed to expend his entire stock of ammunition on the fast-approaching Japanese before succumbing to enemy fire. He alone is thought to have killed at least half of the thirty-nine enemy



Pvt. Junior Van Noy

Engineer aviation battalions used heavy equipment such as bulldozers and carryalls to construct airfields for heavy bombers, Kiriwina Island, July 1943.

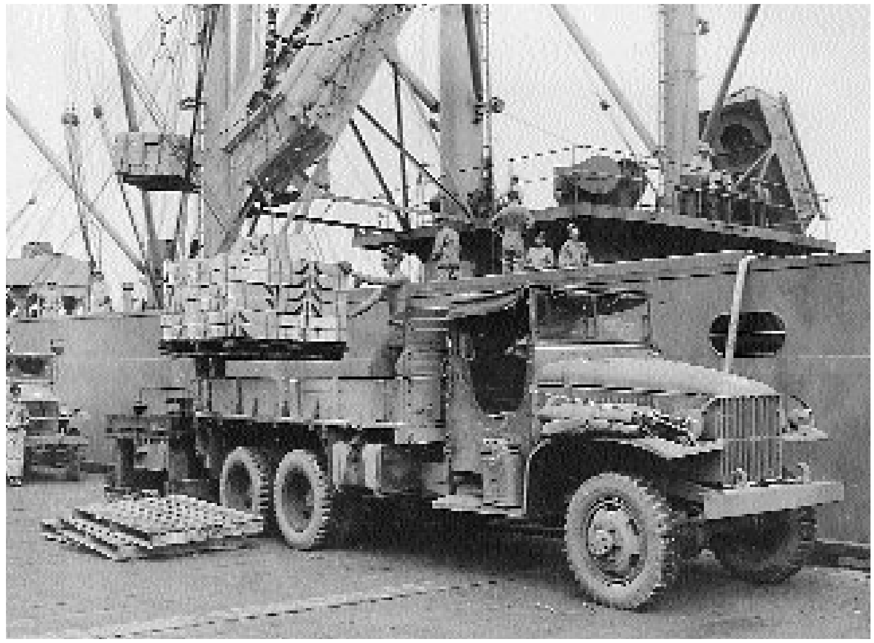
troops who had disembarked. Private Van Noy was honored with a posthumous award of the Medal of Honor.

Engineer combat forces also participated in maneuver warfare on land against the Japanese. On May 29–30, 1943, the Japanese, who had been surrounded by U.S. Army forces on Attu Island in the Aleutians, attempted to break through the portion of the American lines held by an engineer combat company, but the Japanese were decisively repulsed. The unit killed fifty-three of the enemy while suffering only one officer killed and one enlisted man wounded in the battle. In the Philippines, the 302d Engineer Combat Battalion, responsible for road maintenance across rice paddies and swamps near Ormoc on Leyte, built or reinforced fifty-two bridges for tank traffic in mid-December 1944, generally working under small-arms and mortar fire, and contributed men and armored bulldozers to flush enemy troops out of their foxholes in the bamboo thicket. In northern Luzon and on Mindanao in the Philippines in early 1945, divisional engineer battalions completed essential road- and bridge-building projects in difficult mountainous terrain that sometimes rose higher than four thousand feet above sea level. The 106th Engineer Combat Battalion on Mindanao constructed

Laying pierced-steel plank on an airstrip at Nadzab, New Guinea, February 1944.

a 425-foot infantry support bridge across the Pulangi River; encountering a gorge 120 feet across and 35 feet deep, they blasted out its sides to quickly create a crude rock bridge. Much of the engineer construction work on Luzon and Mindanao was interrupted by enemy fire. Engineer officers also played principal roles in planning for the invasion of Japan.

During World War II, the U.S. Army Corps of Engineers contributed essential military services wherever the Army was deployed throughout the world.



Unloading cargo in New Guinea

Engineers of the 856th Engineer Aviation Battalion, an African-American unit, grading an airfield on Kiriwina Island, east of New Guinea, October 1943.

Engineers searching for Japanese mines

Building a Bailey bridge, the Philippines, 1945

Exploiting Enemy Mistakes: Army Engineers, Meter Beams, and the Advance into Germany

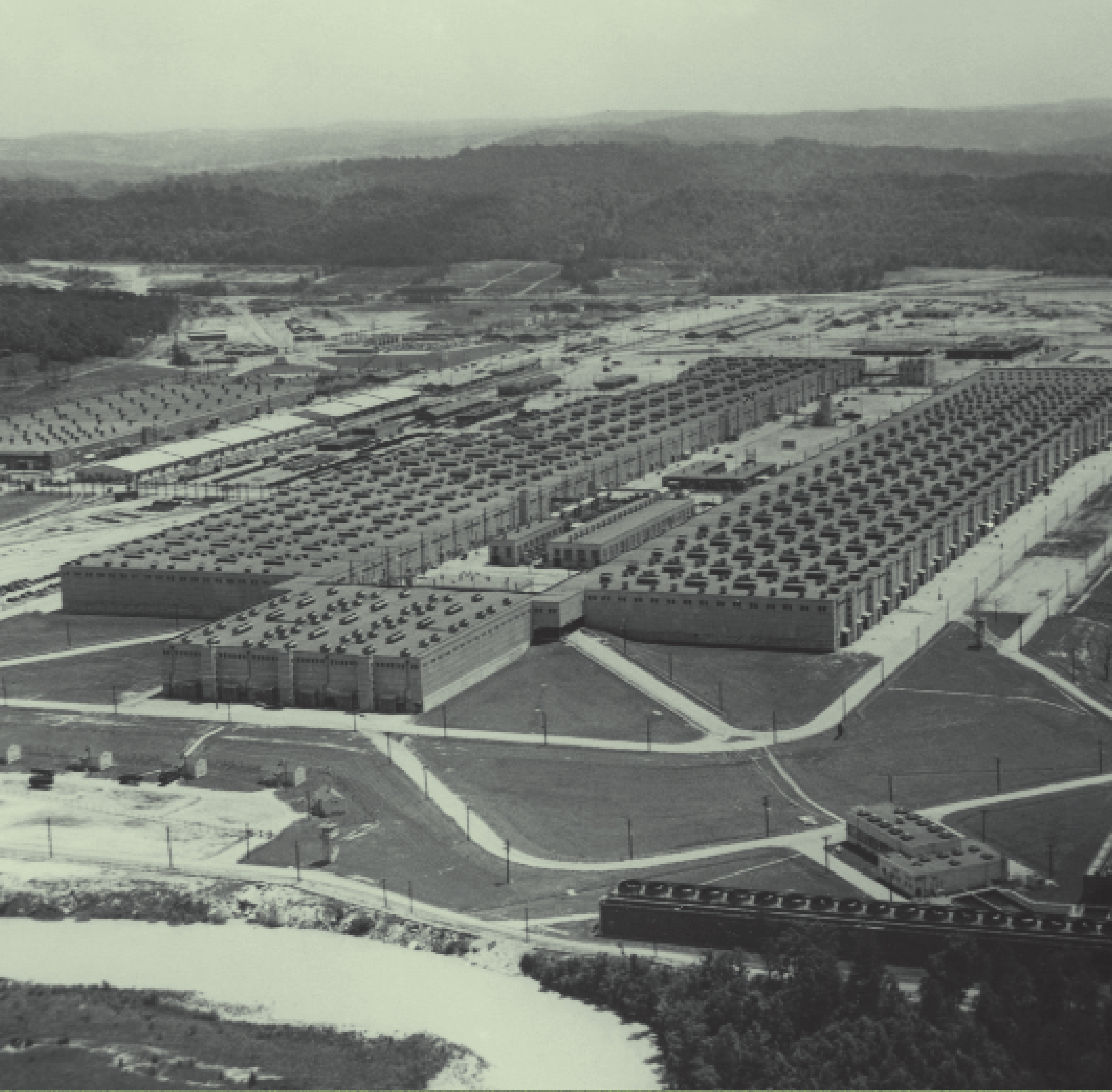
When the Germans withdrew from northern France in the summer and autumn of 1944, they left Cherbourg Harbor a shambles. A massive reconstruction job faced engineers with the American forces who occupied the city. The difficulty of obtaining adequate construction materials from the United States only exacerbated the problem. The situation demanded prompt and ingenious improvisation, and the Advance Section (ADSEC) engineers of the Communications Zone were up to the task.

The enemy had made a big mistake at Cherbourg, and the engineers turned it to their advantage. Colonel Emerson C. Itschner, ADSEC engineer, recalled the situation: The Germans were kind enough to leave us a lot of very heavy steel beams, one meter in depth and up to seventy-five feet long. We had enough of these to bridge from the piles that we drove back to the seawall.

Exploitation of the mistake did not stop with the reopening of the Port of Cherbourg. The ADSEC engineers noted that all of the beams bore the name of a single steel mill, Hadir, in Differdange, Luxembourg. Right then, Colonel Itschner decided they would head for Differdange. As soon as the town fell, the ADSEC men were there. They were not disappointed: the Hadir plant was intact, and the citizens were eager to reopen it.

After a little repair and cannibalization, Hadir began once again to produce meter beams. In a short time, these beams were put to many important uses, including the construction of massive railroad bridges across the Rhine. Thus did engineer alertness and ingenuity solve a major supply problem.

Railroad bridge over the Rhine built by Army engineers, April 1945



Completed gaseous diffusion plant at Oak Ridge, Tenn., part of the massive construction program managed by the Manhattan Engineer District

The Manhattan Project

The Manhattan Project was the United States' effort to develop an atomic weapon during World War II. In three short years, the project brought atomic weaponry from scientific hypothesis to reality. The U.S. Army Corps of Engineers played a major role in the development of the largest single government program undertaken to that date.

Following the discovery of nuclear fission in Germany in 1930, physicists the world over began experimenting to determine if neutrons were released during fission, and if so, how they might be utilized to create a chain reaction. If controlled in a reactor, such a chain reaction would be a great power source. If uncontrolled, it could produce an explosion far greater than any from chemical explosives.

The initial effort to hasten the progress of atomic research in the United States came from the scientific community. A small group of European scientists had settled in the United States after fleeing from Nazism in the late 1930s, and they were well aware of the atomic research being done in Germany. Fearing that Germany would produce an atomic bomb first, they prevailed upon the renowned physicist Albert Einstein to persuade President Franklin Roosevelt to increase funding for atomic research and development.

After America's entry into the war in December 1941, researchers from the Allied nations joined the effort. The Allies drew up formal agreements on atomic cooperation, and established a scientific military intelligence unit to follow German progress in atomic research.

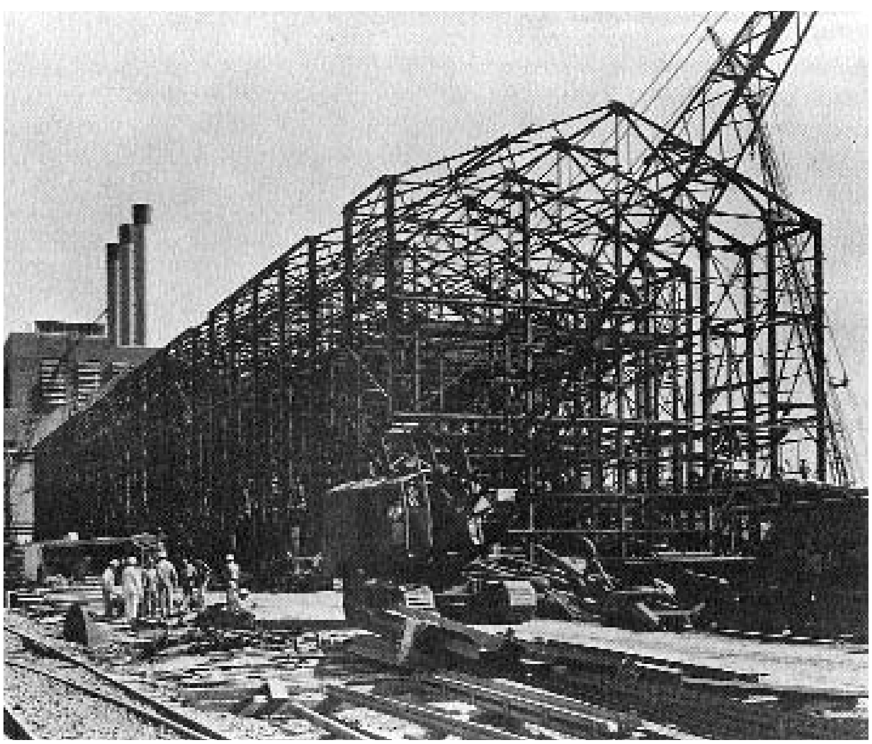
By spring 1942, Allied research had progressed to the point that an atomic weapon actually seemed possible. The National Defense Research Committee, then coordinating atomic research and headed by Vannevar Bush, began to formulate plans for the construction of production facilities. The U.S. Army Corps of Engineers, designated by the committee to oversee the program, provided the technical expertise required for this mammoth construction project.

On June 18, 1942, Major General W. D. Styer, chief of staff for

Army Services of Supply, directed Colonel James C. Marshall of the U.S. Army Corps of Engineers to form a new engineer district. The district was to carry out the Corps' new responsibility for construction for the project. The new district's offices were initially located in Manhattan at the headquarters of the Corps' New York District. The name "Manhattan" stuck. It seemed to be a name that would arouse the least suspicion for the district, the project, and its super-secret mission.

By September, Brigadier General Leslie R. Groves, formerly deputy chief of the Construction Division in the U.S. Army Corps of Engineers, had been named by Secretary of War Henry L. Stimson to direct the entire project. Under Brigadier General Groves's command, the Manhattan Engineer District began a construction effort that would include production sites across the United States and a workforce of 125,000. Major construction projects included the electromagnetic, gaseous diffusion, and liquid thermal diffusion plants at the Clinton Engineer Works in Oak Ridge, Tennessee; the plutonium production plant at Hanford, Washington; the weapons design and production facilities at Los Alamos, New Mexico; and the numerous facilities such as housing, shopping centers, and hospitals to support the large workforce at these remote and undeveloped locations. Scientific direction remained with the National Defense Research Committee within the Office of Scientific Research and Development, headed by Vannevar Bush.

S-50 thermal diffusion plant under construction at Oak Ridge
National Archives



As research continued in autumn 1942, Groves and Marshall began to select sites for the atomic material production plants. The sites all had to be isolated so they could be sealed off for tight security. They all needed great quantities of both water and electricity. An additional site also had to be found where scientists could finally assemble and test the weapons.

On the recommendation of Groves and Marshall, the government purchased 83,000 acres of land near Clinton, Tennessee, for the Clinton

Oak Ridge, Tenn., shopping center (foreground) and district headquarters (background)

Engineer Works (later called Oak Ridge). Here the U.S. Army Corps of Engineers built uranium separation plants to separate the fissionable isotope uranium-235 from the more prevalent isotope in uranium ore, uranium-238. Army engineers also constructed residential communities to house employees.

In December 1942, when famed scientist Enrico Fermi produced a controlled chain reaction at the University of Chicago, he discovered a new material suitable for fission. He found that during the chain reaction, uranium-238 could capture neutrons and be transformed into plutonium, a new element as unstable as uranium-235. Twelve days after Fermi's successful experiment, Groves initiated discussions involving

Plant under construction at Oak Ridge, Tenn., April 22, 1944

First reactor pile area at Hanford Engineer Works

leading scientists and industry and Corps representatives to build a plutonium plant site. The government soon purchased almost a half million acres of land around Hanford, Washington, near Bonneville Dam, for the construction of five plutonium reactors and employee housing.

In addition to building huge industrial plants and providing the most basic community needs of water, roads, sanitation, housing, and power, the U.S. Army Corps of Engineers also managed the construction of scientific equipment, newly designed and as yet untried. The initial budget outlay for the atomic energy project in June 1942 was only $85 million. Project requirements had been underestimated. For example, at Oak Ridge the cost of the land alone was $4 million. By the end of 1946, construction costs at Oak Ridge totaled $304 million. Research at this site eventually totaled $20 million, engineering $6 million, and operations $204 million. Power for operations cost $10 million. Instead of requiring a workforce of 2,500 people, as originally estimated, Oak Ridge eventually had 24,000 employees on the payroll.

As work continued at Oak Ridge and Hanford, General Groves appointed J. Robert Oppenheimer to take charge of the newly created weapons laboratory in an isolated desert area around Los Alamos, New

Maj. Gen. Leslie R. Groves considers potential targets.

Mexico. Here scientists assembled the actual weapons. The first explosion of an atomic bomb occurred at the Trinity Site in the predawn hours of July 16, 1945. The atomic bomb was a reality, and those meant for actual use were already in transit to the Pacific.

The engineering problems encountered in the project were numerous. Groves and his staff fought constantly for needed raw materials. The engineers had to translate the scientists' theories into precise specifications. New materials had to be formulated for building the reactors and the separation equipment. Contractors were held to extremely exacting specifications for everything they supplied. The Corps' engineering role required the coordination of construction with research and new discoveries. It required building huge industrial facilities along with the housing, community, and recreational facilities needed to provide a livable environment for the employees. It required the transportation of goods to these isolated areas, the management of huge amounts of money, and the coordination of input from hundreds of contractors. Further complicating the development process was the need for secrecy—only a select few knew that the ultimate goal of the Manhattan Project was to produce an atomic bomb.

The project also required the maintenance of a delicate relationship

Administrative and residential areas at the Hanford Engineer Works

Completed chemical separation plants and steam-electric facility at Hanford, Wash.

between the military and the scientific communities. Workers and scientists had relocated to physically isolated areas and, because of the secrecy of their work, had to limit their contact with the outside world. Even in wartime, when the work had a special urgency and sacrifices were made for the war effort, morale was a great concern. The scientists especially were uncomfortable under military supervision and security restrictions. Very few of the thousands of employees on the project knew what they were actually working on because of the strict security; however, the employees did share anxiety over the unknown dangers inherent in the materials they dealt with.

No one dreamed at the beginning how massive the project would become. The four-year-long research and development project was completed at a cost of $2 billion. Very few who worked on the project understood at the time the tremendous impact the project would have on the world. In the end, the Manhattan Project produced the weapons that leveled Hiroshima and Nagasaki, ending World War II and marking the onset of the Atomic Age.

Women Played Key Roles in the Manhattan Project

While significant numbers of civilian women served at all of the project sites for the development of the atomic bomb, many of the women serving in the Manhattan Engineer District were Soldiers and officers of the U.S. Army. During World War II, more than 150,000 American women served in the Women s Army Corps, or WAC, and many assigned to the U.S. Army Corps of Engineers participated in the Manhattan Project. As early as 1943, women Soldiers were brought into the Manhattan Project for clerical, technical, and administrative work.

The need for additional personnel led to the establishment of a Manhattan District Women s Army Corps Detachment on June 3, 1943. After February 1, 1945, the entire military complement of the Manhattan District was designated by the Chief of Engineers as the 9812th Technical Services Unit—Civil Engineers. By the end of the war in 1945, approximately 425 women were in this unit, which earned the Meritorious Service Unit Award.

Jobs performed by women assigned to the Manhattan Engineer District included stenographer, telephone operator, laboratory technician, clerk, cryptographer, classified information handler, metallurgist, electronics technician, photographer, spectroscopist, nurse, and scientist. A large number of notable women, both WAC and civilian, worked in the Manhattan Project. The first commanding officer of the WAC detachment was Lieutenant Frances W. House. She was succeeded by Lieutenant Arlene G. Scheidenhelm in March 1944. Master Sergeant Elizabeth Wilson ran the cyclotron at Los Alamos. Electronics technician Jane Heydorn helped to develop bomb-testing equipment. Lieutenant Catherine Piccolo wrote official press releases explaining why the bombs were utilized. Physicist Chien Shiung Wu played a key role in developing the gaseous diffusion uranium separation process. Leona Woods monitored the first nuclear chain reaction. The head of a vital research team, Maria Goeppert Mayer, later received the Nobel Prize in physics. Elizabeth Riddle Graves developed a neutron reflector to surround the atom core at Los Alamos.

In commending the WACs for their contributions to the Manhattan Project, on August 9, 1945, then-Major General Groves wrote, I wish to express to you, the military personnel of the Manhattan Project, my official and personal appreciation for the industry, ability and attention to duty under most trying conditions which you have displayed since the inception of the project. Without you, this project could not have achieved success. Your devotion to duty and particularly your conscientious efforts to maintain the vital security of the project have been of the highest order. You have every right to be proud of the vital role which you have played in this development which has culminated in the use in combat against Japan of the greatest weapon man has ever forged. Our achievement could not have been realized but for your individual effort. The saving in American lives will be your reward.

Women's Army Corps Detachment at Oak Ridge, Tenn.

Soldiers of the 2d Engineer Combat Battalion sweep a road for anti-tank mines, March 1953
National Archives

Army Engineers in Korea

Following World War II, the Korean Peninsula was occupied by the victorious Allies. By the time the occupation ended, two Korean governments had arisen—the Soviet-sponsored Democratic People's Republic of Korea in the north and the Western-supported Republic of Korea in the south. On June 25, 1950, the North Korean government launched an attack across the 38th parallel in a plan to unite the peninsula under communist rule.

Surprised by the North Korean attack, U.S. Army troops in Korea and the Republic of Korea's forces could at first do no more than delay the advance of the larger and better equipped North Korean forces. U.S. Army engineers played a major role in this delaying action, mining roads and destroying key bridges. The rugged terrain of the Korean Peninsula and the numerical superiority of enemy forces made engineer construction and combat vital to the U.S. Army during the Korean War.

In the early fighting, engineers were frequently required to do tasks not traditionally theirs. For example, on July 20, 1950, members of Company C, 3rd Engineer Combat Battalion, made the first verifiable combat use of the newly developed 3.5-inch rocket launcher, using it to destroy a tank that was threatening their division commander near Taejon. Attempting to withdraw from Taejon that evening, U.S. forces were stopped for a time by enemy roadblocks. Engineer Sergeant George Libby placed wounded men on an artillery tractor and used his body to shield the driver as it crashed through two enemy roadblocks before

Engineers mine a bridge to impede the North Korean advance, July 1950
U.S. Army Engineer School

Sgt. George Libby

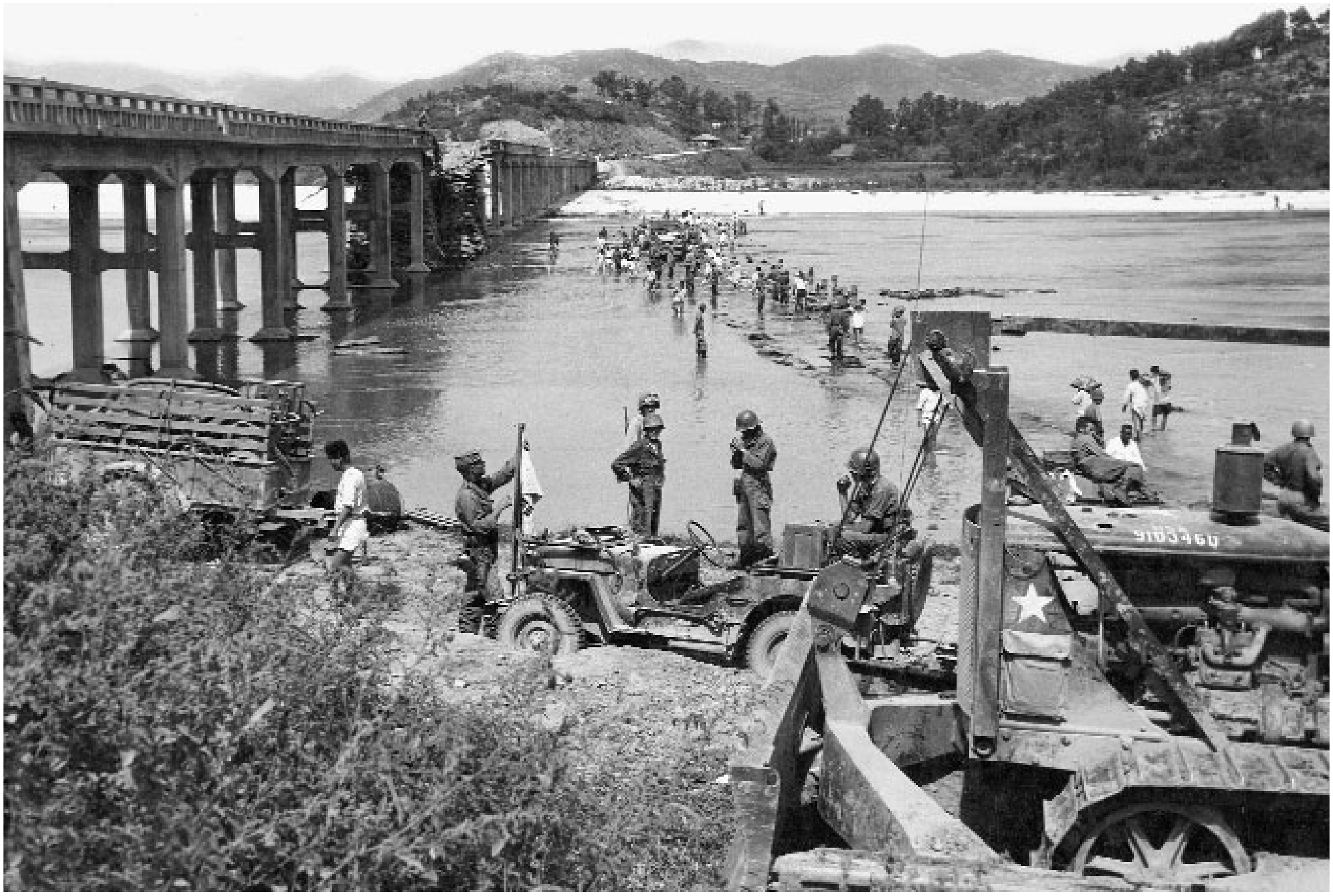
reaching American lines to the south. Sergeant Libby, who died of his wounds, was posthumously awarded the Medal of Honor.

By early August 1950, U.S. and South Korean forces had withdrawn to the southeastern port city of Pusan. The outnumbered allied forces maintained a long defensive perimeter around Pusan as General Douglas MacArthur prepared to land a large body of U.S. troops behind enemy lines at Inch'on. Engineers were frequently committed to fight as infantry on the Pusan perimeter. Private Melvin Brown of the 8th Engineer Combat Battalion was awarded the Medal of Honor for bravely holding his position on a wall of the ancient fortress of Kasan during an enemy assault. After he had expended his ammunition, Private Brown used his entrenching tool to repel the armed attackers as they reached the top of the wall.

MacArthur's behind-the-lines assault at Inch'on, which began on September 15, 1950, caught the enemy by surprise. Subsequently, U.S. forces took the offensive throughout Korea. The bridge-building and road and rail repairs undertaken by the U.S. Army engineers allowed U.S. and allied forces to push north rapidly in pursuit of the disintegrating North Korean

Soldiers of the 14th Engineer Battalion place barbed wire along the banks of the Naktong River, 10 August 1950.

U.S. Army Engineer School



Engineers of the 2d Infantry Division construct a bypass to enable heavy equipment to cross the Hwang-gang River, 25 September 1950

U.S. Army Engineer School

Army. Handicapped at first by tremendous shortages of supplies, the engineers had to make innovative use of available materials for these construction efforts.

When Chinese units began their powerful counteroffensive in November 1950, the U.S. Army engineers had to destroy many of the same bridges they had recently built as U.S. forces again retreated south of Seoul. But lateral roads built by the engineers behind the new defensive lines proved critical when the Chinese broke through a portion of that line. These roads enabled the

Men of the 65th Combat Engineer Battalion reinforce a muddy road on the north bank of the Han River, March 1951

U.S. Army Engineer School

A cable car built by the 3d Engineers carries men and supplies up the steep hillsides
National Archives

Soldiers of the 77th Engineer Combat Company lay a single-apron barbed wire fence
National Archives

Americans to transport the 3rd Infantry Division 100 miles in a single day to plug the hole that the Chinese had created.

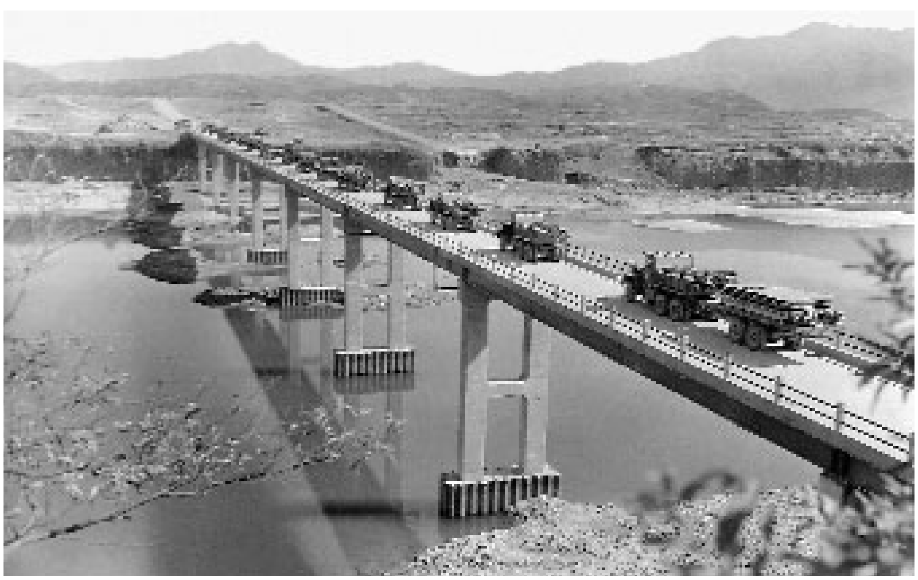
As U.S. forces returned to the offensive in mountainous central Korea in early 1951, engineer units blasted cliffsides to construct new roads and built aerial tramways to carry supplies to the troops. When the advancing 23rd Regimental Combat Team and a French battalion were surrounded at Chipyong-ni on February 13, 1951, by an attacking force apparently composed of three Chinese divisions, the engineer company supporting the combat team fought as infantry. They withstood the attack until an American armored relief column could reach the town two days later.

In early October 1951, the 2d Engineer Combat Battalion converted a rough track leading north to Mundung-ni into a road usable by armor, enabling an American tank battalion to surprise a Chinese column attempting to relieve hard-pressed Chinese troops on Heartbreak Ridge near the 38th parallel. A U.S. Army engineer construction battalion also supported the 1st Marine Division in its combat in mountainous central Korea during much of 1951.

The engineers confronted a critical challenge after the summer floods of July 1952 washed out two

Soldiers of the 185th Engineer Combat Battalion stand watch over a floating bridge damaged by flood waters on the Soyang River, May 1951.

National Archives



Built by the 84th Engineer Construction Battalion, the Libby Bridge provided a vital high-level crossing of the Imjin River, July 1953.

National Archives

of the five high-level bridges across the Imjin River, located a mere four miles behind the battle lines of three U.S. Army divisions. After installing two temporary floating bridges, engineer troops built at the less critical site an innovative low-level bridge sturdy enough to survive if overtopped by flood waters. In the center of the I Corps line, within range of enemy artillery, the 84th Engineer Construction Battalion erected a modern, commercial-type highway bridge utilizing sheet-pile cofferdams and reinforced concrete piers. Dedicated to engineer Medal of Honor recipient Sergeant George Libby, that bridge remains in use and retains its tactical significance decades after its construction.

The U.S. Army engineers in Korea compiled a remarkable record of combat and wartime construction that complemented and often multiplied the combat effectiveness of the highly motorized and mobile American units engaged there. U.S. Army engineers often were the unsung heroes of the Korean War, for they helped create the environment that allowed the United States and its allies to fight and win.

On their way to a second tour of duty in Korea, soldiers of the 8th Engineer Combat Battalion wait to disembark from their troop transport.
National Archives

In Their Own Words: The U.S. Army Engineer Experience in Korea

The Korean Peninsula was an inhospitable place in which to wage a war, not only due to topography and climate but also because the U.S. Army faced a well-supplied enemy fighting an ideological crusade. In overcoming the elements as well as a tenacious enemy, U.S. Army engineers again proved invaluable in combat support roles. Personal accounts by some of the participants shed light on the challenges they faced.

Engineers were deeply involved with operations in Korea before the outbreak of hostilities. After reading intelligence reports, Lieutenant Colonel Edward Rowny, a planner in General Douglas MacArthur s Far East Command (FECOM) headquarters, warned intelligence officials that the United States needed to be mindful of the possibility of an attack in Korea. After the North Koreans invaded, and U.S. and South Korean forces with-drew south, Rowny and others in FECOM helped draft a plan for an amphibious invasion to relieve the pressure on the Pusan perimeter. The staff officers recommended invading near or slightly behind the front line. MacArthur took a much more aggres-sive approach, directing his staff to study an invasion at the port of Inch'on, 100 kilometers up the coast opposite Seoul. One should land as close as possible to the objective, and the objective is the capital the General said. You re all timid, MacArthur lec-tured his staff, you should think boldly and decisively. When another planner cited the danger posed by Inch'on s thirty-one-foot tide, MacArthur brushed those fears aside. And as for the tides, he said, don t take counsel of your fears. Physical obstacles can be overcome by good planning, strong nerves and will power. Rowny would need all those attributes, for General MacArthur appointed the young officer

Lt. Col. Edward Rowny is awarded the Legion of Merit by Maj. Gen. Edward Almond, commander, X Corps, December 1950.

National Archives

Snow and bitter cold made operations in Korea difficult. Here, soldiers of the 2d Engineer Combat Battalion survey a new supply route.

National Archives

to be the engineer for the Inch on landing and he went ashore in the first wave of the assault.

During the first winter of the Korean War, Lieutenant Maurice D. Roush was a platoon leader with the 13th Engineer Combat Battalion. He described the lack of personal equipment to face the harsh seasonal conditions following his amphibious debarkation along the eastern coast of Korea: About the time we landed we were given trigger-finger mittens and some hats with earflaps. That was the extent of winter gear. We still had our blanket sleeping bags. We didn t have good parkas or good footgear. We got into one of the worst winter situations I ve ever seen. I ve never been so cold and I come from Wyoming! Up in North Korea on the plateau, up near the Yalu River, it s extremely cold.

For most of 1952, Lieutenant Colonel Harry D. Hoskins, Jr., commanded the 10th Engineer Combat Battalion in support of the 3d Infantry Division near the 38th parallel. He later recounted the defensive measures Army engineers used: We made a series of firetraps to be used in the event the North Koreans got into the Ch orwon Valley. That was a wide area, so we needed to have a lot of people or a lot of mines or something to stop them. You have to have a series of interlocking firetraps to stop that kind of an attack. At that time the North Koreans didn t have tanks. They were just waves, and waves, and waves of manpower. You had to have mines, especially antipersonnel mines, to stop the manpower and any heavy vehicles. Then all kinds of napalm were needed, so you could drop it in quickly. You couldn t be waiting around because once there was a breakthrough they d pour in there in a hell of a hurry.

Republic of Korea Army Engineer Training School

National Archives

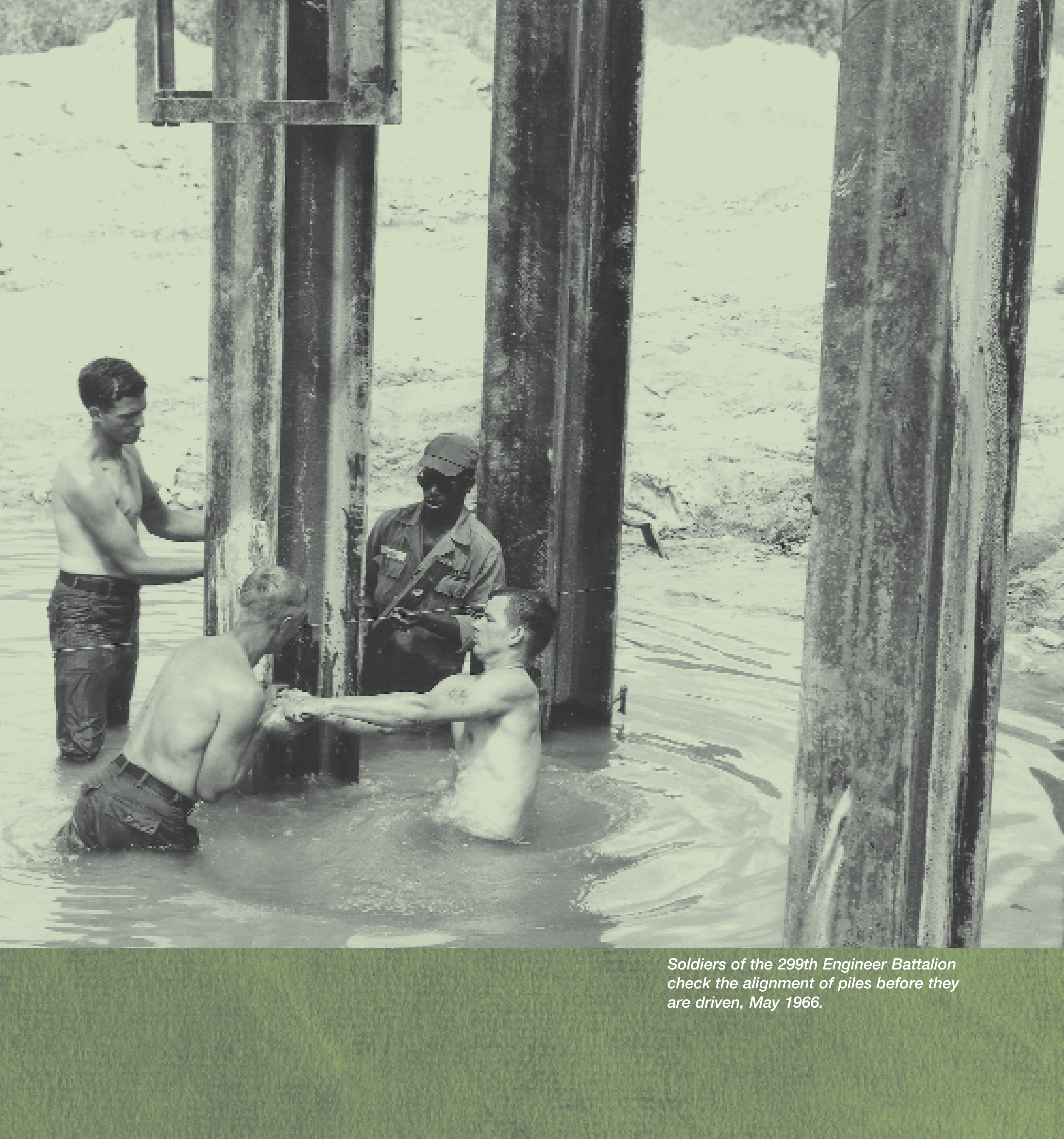
Colonel Pashal N. Strong, Jr., was an engineer officer with the Eighth Army. Commenting on the performance of reserve engineer officers, he noted, From my own experience, the best regimental commanders for heavy construction work were contractors who had been doing that in the reserves. I found them better for that than the West Point graduates, because the West Point graduates hadn t had the practical experience in heavy construction that the contrac-

An engineer uses a bulldozer to repair a road damaged by retreating enemy troops.
National Archives

tors had. West Pointers also were a bit too worried about the spit-and-polish, sometimes at the expense of their construction activities.

Personnel shortages forced the U.S. Army to use Korean soldiers to fill out many of its under strength units. The Korean soldiers were introduced into the U.S. units through the Korean Augmentation to the United States Army (KATUSA) program, and the Korean soldiers quickly proved their value. Although the KATUSAs had to be brought up to speed, once trained they proved invaluable to the U.S. Army engineers. As Lieutenant Colonel Evan S. Pickett later commented, When we first received them, the KATUSA troops were untrained and inadequate for engineer work. They had no coordination for running bulldozers and graders or running our hydraulic equipment. They were good at hand labor, but they were very poor with mechanical equipment. But, as time went on, we found that they learned to operate the mechanical equipment fairly quickly. In the end they were well qualified and seemed to contribute a lot to our mission.

Lieutenant Joseph K. Bratton served with the 13th Engineers, 7th Division. Lieutenant Bratton, who later became Chief of Engineers, summed up the importance of his experience in Korea this way: The overwhelming positive lesson I learned was the great value of direct engineer support to the infantry regiments. If the regiment knew how to use the engineers, and if the engineers were not too bashful in explaining their capabilities to the tactical unit commanders, they gained a great deal from the engineers support. I was thrilled to see how well our companies worked with the regiments. That was happening when I arrived and it built up while the 7th Division stayed in Korea. That was a tremendous lesson that I think not only engineers learned, but everybody learned.



Soldiers of the 299th Engineer Battalion check the alignment of piles before they are driven, May 1966.

U.S. Army Engineers in the Vietnam Conflict

The U.S. Army again called upon its engineers for combat support in Asia to assist the Republic of Vietnam in its struggle against a communist insurgency. Beginning in the early 1960s, the American commitment of ground forces to Vietnam eventually numbered more than 535,000 and lasted for a decade. In South Vietnam, insurgent forces often relied heavily upon a strategy of concealment when in combat against American troops. U.S. Army operations in Vietnam thus did not occur along a well-defined front line, but could break out wherever the Americans encountered Viet Cong guerrillas or North Vietnamese troops. The elusiveness of the enemy led U.S. Army engineers to alter the way they pursued their task of enhancing the combat effectiveness of friendly forces.

American forces frequently employed search-and-destroy missions to attack areas of enemy strength. The 1st Engineer Battalion supported Operation Rolling Stone in Binh Duong Province near Saigon by building a road into the Iron Triangle and War Zone D, two staging areas frequently used by the Viet Cong. Men of this battalion engaged in a half-hour-long firefight with the enemy on February 26, 1966. The following summer, a fifty-two-bulldozer battalion task force cleared 2,700 acres of jungle, destroyed six miles of enemy

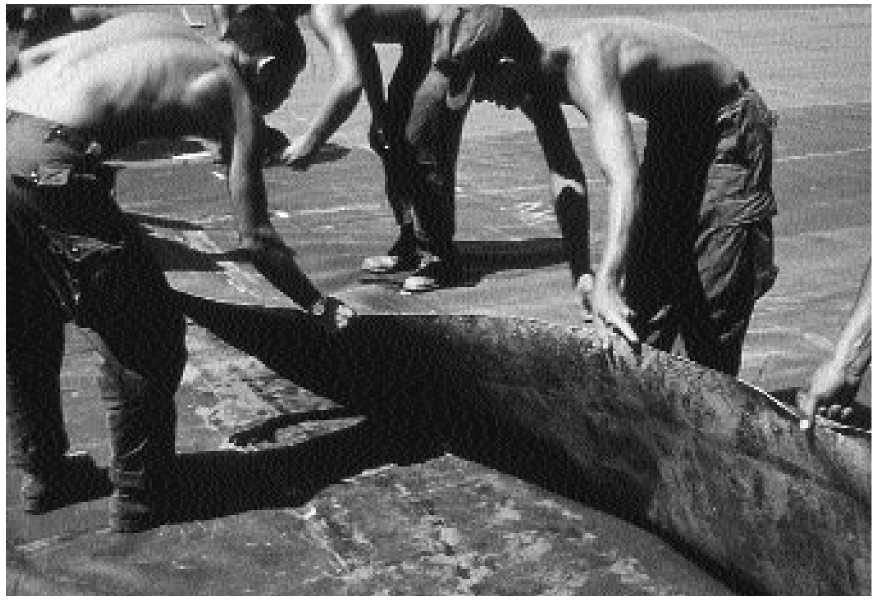
Land clearing at Ben Cat, South Vietnam

Soldiers of the 1st Engineer Battalion sweep for mines near the village of Thien Thanh.

tunnels, and demolished eleven factories and villages in the Iron Triangle.

The widespread use of helicopter transport in Vietnam enabled U.S. forces to respond quickly to attacks anywhere in the country. After South Vietnamese forces relieved a besieged Special Forces camp at Plei Me in the Central Highlands in October 1965, an engineer company of the airmobile 1st Cavalry Division lengthened and improved an earthen airfield at a nearby tea plantation, using equipment brought in by helicopter. The division then pursued the attacking North Vietnamese regiments west from Plei Me through the jungles of the highlands. For forward supply and reinforcements in this campaign, the division relied upon helicopter landing zones that divisional engineers quickly cleared from the jungle using chain saws and demolitions. By the time the North Vietnamese forces reached the safety of Cambodia, they had lost 1,800 men. During the next ten months, the 8th Engineer Battalion built seven airfields for the division in the Central Highlands, including one at a site eight miles from the Cambodian border to which all construction equipment, supplies, and personnel had to be transported by helicopter. Moving the equipment by air was possible because U.S. Army engineer planners had modified procurement orders for large earthmoving equipment to obtain machinery that could be disassembled for airlift and then quickly reassembled.

Various technological innovations aided the U.S. Army engineers in Vietnam. To combat the thick mud that could quickly disable the tactical airfields in the monsoon season, the engineers employed the new T-17 membrane, a neoprene-coated fabric used to cover the airfields and provide them with an impermeable "raincoat." Another problem was the additional wear on helicopter rotors caused by the abrasive dust stirred up by flight operations. The swirling man-made dust storms also significantly reduced helicopter pilots' vision, further complicating flight operations. At the end of 1965, U.S. Army Chief of Staff General Harold K. Johnson directed Lieutenant General William F. Cassidy, the Chief of Engineers, to find a solution. Cassidy relied upon the expertise of the Corps' research laboratories, which had been using peneprime, a dust palliative with an asphalt base, as a penetrant in civil works projects. Personnel from the Waterways Experiment Station led an assessment team to Vietnam to determine the appropriateness of this agent for battlefield use. Subsequently, U.S. Army engineers sprayed peneprime onto heliport sites during the dry season to prevent dust clouds from interfering with helicopter operations.



Spreading T-17 membrane on a runway

Land clearing was a very effective weapon against the Viet Cong insurgency. Guerrilla forces used the thick forests along the nation's major transportation routes to conceal themselves before laying mines or staging ambushes. Consequently, the engineers had to clear all vegetation

Installing T-17 membrane at Bao Loc

Department of Defense

60th Land Clearing Company's Rome plow

A heavily armed Rome plow operator clearing jungle

up to 100 yards on either side of major roadways. Finding bulldozers and flammable napalm unequal to the task, in 1967 the engineers introduced the Rome plow, a military tractor equipped with a protective cab and a special tree-cutting blade that was sharpened daily. The Rome plow was used to cut trees at or near ground level; it also had a stinger to split longer trees. Lieutenant General Julian Ewell, commander of the 9th Infantry Division in Vietnam, called the Rome plow "the most effective device" in his arsenal. A land-clearing engineer company equipped with thirty Rome plows could clear 180 to 200 acres of medium-density jungle each day.

Supporting the U.S. military effort in Vietnam required a massive construction effort. During the war, U.S. Army engineers, supported by a large contractor workforce, built thousands of facilities including warehouses, piers, troop cantonment areas, maintenance facilities, roads, and bridges. At its peak, Army engineer troop strength in Vietnam approached 40,000 soldiers, augmented by tens of thousands of contractors. The presence of so many construction contractors was a notable innovation and marked the first time civilians assumed a major construction role in an active theater of operations.

When American troops and equipment began to pour into

Vietnam in the mid-1960s, the country had only two ports capable of docking oceangoing vessels. With 90 percent of U.S. supplies destined for Vietnam arriving by ship, the lack of sufficient port facilities soon created a massive backlog of ships waiting to unload. To ease the congestion, the United States began improving South Vietnam's ports. To improve access, a fleet of dredges, including two from the Corps of Engineers, set to work clearing waterways and deepening channels. To expedite the construction of deep-water berthing facilities, Army engineers installed floating piers. Fabricated by the DeLong Corporation in the United States, the first pier and all of its support equipment were towed to Vietnam and installed by the 497th Port Construction Company. The pier consisted of a ninety by three-hundred-foot-long barge supported by eighteen tubular steel caissons to anchor it to the bottom. Once caissons were in place the engineers used pneumatic jacks attached to the caisson collars to lift the barge up on its legs to the right height. Engineers installed the first DeLong pier at Cam Ranh Bay in December 1965, and it quickly doubled the capacity of the port. Soon after, the DeLong piers were installed at many of South Vietnam's major ports.

The enemy's Tet Offensive early in 1968 closed for more than a month several critical roads, particularly in the northern part of the Republic of Vietnam. The U.S. Army's 35th Engineer Battalion, which had concentrated on road-building during its previous service in Vietnam, reopened coastal Route 1 north of Da Nang in late February 1968 while assigned to the

The port of Cam Ranh Bay showing newly constructed piers.

DeLong pier floated into position with caissons ready to be driven down, Cam Ranh Bay, December 1965.

Soldiers of the 1st Engineer Battalion driving pile for the construction of a new bridge near Di An

III Marine Amphibious Force. By this time, the engineers had built a sufficient number of airfields, heliports, and troop cantonments to permit them to continue to concentrate on road construction. The 27th Engineer Battalion built a new, all-weather highway from Hue west to the A Shau Valley, an enemy stronghold.

In fact, U.S. Army engineers constructed much of South Vietnam's highway system. Overall, engineer troops constructed roughly 900 miles of modern, paved highways connecting the major population centers of the Republic of Vietnam. Engineer officers also monitored the construction by private American contractors of an additional 550 miles of Vietnamese highways. Brigadier General Carroll Dunn, Director of Construction, Military Assistance Command, Vietnam, described the road construction effort as "the single most effective and important development program undertaken by the American effort in Vietnam." The engineers also safeguarded the roads. Units in the Mekong Delta developed a clay-lime coagulation process that they used there to build durable roads from locally available materials. The engineers protected their bridges by installing extensive lighting systems and antiswimmer and antimine devices using concertina wire and booms.

Army engineers also undertook certain responsibilities for installation security, and these sometimes involved heroic individual actions. When an enemy team infiltrated the base of the 173d Engineer Company at Camp Radcliff at An Khe in the Central Highlands on March 20, 1969, engineer Corporal Terry Kawamura threw himself on an explosive charge that had been hurled into his quarters, absorbing its blast and thereby protecting other members of his unit endangered in the attack. Corporal Kawamura was posthumously awarded the Medal of Honor.

A half dozen U.S. Army engineer battalions participated in the Cambodian incursion in May and June of 1970. Engineers built thirty-five miles of new roads, twenty-three fixed bridges, and twenty-five fire-support bases during the attack on North Vietnamese supply points and staging areas within Cambodia. During this period, the senior U.S. Army engineer officer in Vietnam, Major General John Dillard, and two other high-ranking engineers were killed when their helicopter was shot down southwest of Pleiku. The U.S. Army Corps of Engineers showed the same bravery and dedication as the combat troops during service in Southeast Asia.

Engineers pour concrete for a new bridge approach.

U.S. Army Engineers Helped Clear Viet Cong Tunnels

To counter the immense technological advantage held by U.S. and allied forces during the Vietnam conflict, the Viet Cong developed an extensive network of underground tunnel complexes. From these tunnels, which were concentrated mostly around Cu Chi but spread as far as the outskirts of Saigon, the enemy could ambush American forces and then safely vanish underground. The tunnels became so highly developed that they eventually contained armories, hospitals, mess halls, manufacturing centers, and storage facilities. Some complexes ranged up to fifty kilometers long. Extensive booby-trapping made it next to impossible for American troops to extricate the enemy from their underground safe havens, which allowed them to withstand intense aerial bombardment.

U.S. Army engineers developed a number of methods for destroying the tunnels or making them unusable. The least effective was by mechanical means, as bulldozers and plows could displace only the shallowest tunnels. Moreover, it was difficult to deploy bulldozers and plows in densely vegetated and remote areas. Flooding also proved substantially ineffective because the Viet Cong had dug additional wells deep inside the tunnel complexes to prevent them from becoming saturated. An even less desirable but most immediately available method was for volunteers from special engineer tunnel demolition teams (who became known as tunnel rats) to enter the tunnels headfirst to clear them out the hard way.

Conventional explosives also were used to clear the tunnels. Block explosives placed at critical points with a force of two pounds per foot could bring down a section, and shaped charges facing upward could destroy certain tunnel segments. Another method was to deposit cratering charges in five-foot-deep holes along the outside trace of a known tunnel. Because of their explosive characteristics, Bangalore torpedoes were the most successful conventional means of effecting complete destruction, but each section had to be carried into the tunnels and emplaced by hand.

An engineer tunnel demolition team
Department of Defense

Other methods employed were innovative. One was to run tubing along the length of a tunnel and then fill it with liquid explosive either by gravity fill or a pumping system, although the highly flammable nature of these liquid explosives often countered their effective use. Another means of denying use of the tunnels was through the introduction of tear gas dispersed by the Mitey-Mite blower. Although these chemical agents could persist on the walls of the tunnels and render them uninhabitable for months, the dense jungle and attendant climatic conditions often swallowed up chemical dispersants.

In the most effective method, engineers used acetylene for destruction of tunnels with less than seven feet of overburden. Three cubic meters of acetylene pumped into an area could destroy forty cubic meters of tunnel volume. When acetylene was used in conjunction with conventional explosives, the effect could collapse fifteen feet of overburden. In the end, however, enemy operations from the tunnels were never completely eradicated.

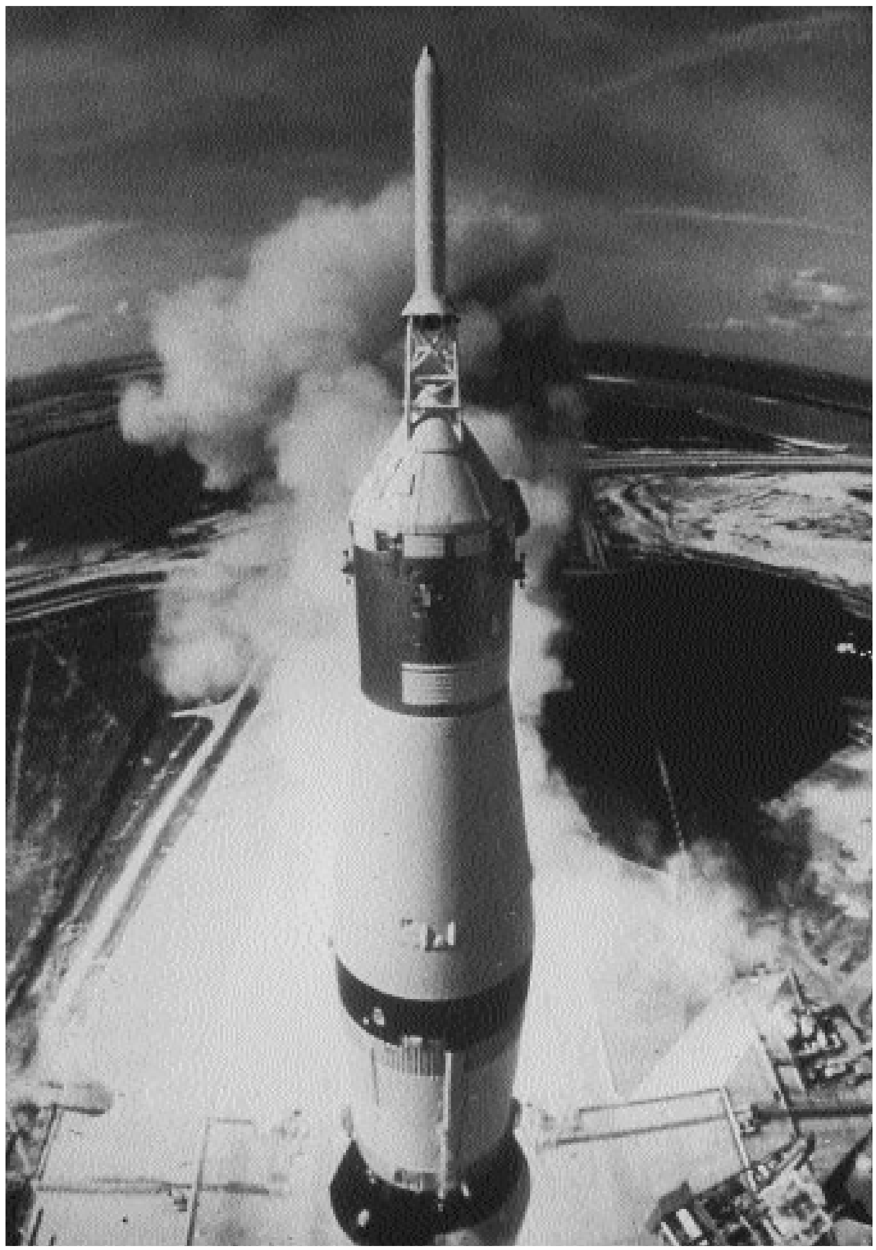
Engineers setting charges to collapse underground enemy bunkers

A Saturn V test vehicle emerges from the Vehicle Assembly Building. The launch control center is in the foreground.

The Corps and the Space Program

Given its past experience in missile site construction on the Intercontinental Ballistic Missile (ICBM) program, the U.S. Army Corps of Engineers was the logical choice of Congress and the National Aeronautics and Space Administration (NASA) to oversee NASA's accelerated construction program in the early 1960s. Not only was the Corps well versed in missile facility construction, using the Corps also eliminated the need for NASA to establish its own construction organization.

Although the Corps had been providing NASA with design and construction services since the spring of 1960, the scope of the Corps' support changed dramatically in May 1961 when President John F. Kennedy declared a national goal of landing a man on the Moon and returning him safely to Earth within the decade. The president's speech was the genesis of the Apollo Program, and the following September the civilian space agency turned to the Corps to build the facilities that would become the hub of the Nation's space program—the sprawling Mississippi Test Facility, later



Carrying an Apollo spacecraft, a Saturn V launch vehicle takes off from Kennedy Space Center.

A specially configured barge carries a Saturn booster near the Mississippi test facility.

renamed the John C. Stennis Space Center; the Manned Spacecraft Center in Houston, now the Lyndon B. Johnson Space Center; and the 84,000-acre facility on the east coast of Florida that would later be named the John F. Kennedy Space Center.

In response to the president's mandate, NASA and the Corps embarked on a massive construction program along the Gulf of Mexico and the Atlantic Ocean, an area that quickly came to be called the "NASA crescent." The launch vehicles destined to carry the NASA astronauts into space were orders of magnitude larger than NASA had ever built, and consequently transporting them by water was the only feasible alternative. As a result, early in the site construction process planners decided that it was imperative that all of the new facilities have easy access to navigable waterways to transport the boosters for testing and launch. Indeed, proximity to water was a factor in the selection of Houston as the site for the manned spacecraft center. On September 25, 1961, only three days after NASA requested the Corps' assistance, the Fort Worth District began arranging preliminary topographic and utility surveys of the site of the manned spacecraft center.

Fort Worth District's experience with incremental funding stood NASA in good stead in the construction of the center. This method of funding was based on the congressional tradition of appropriating construction funds on a year-to-year basis. That meant the district contracted for each segment of the center as a separate unit. One virtue of this procedure was that it allowed significant changes in construction plans without delaying the project. For instance, on July 17, 1962, NASA announced that the future Mission Control Center would also be located at the Houston center. This decision forced the Corps to insert an entirely new building into its master plan.

The incremental funding system also permitted major modifications of facilities already under construction. This was important because speed was essential if NASA's goals were to be met, and the engineers and NASA had to construct buildings at the same time NASA was designing the laboratories and machines they would contain. Troubles with the Space Environment Simulation Chamber showed the value of the arrangement. The failure of the chamber during its first vacuum test required not only its redesign, but also numerous changes in the one-third-completed building. Incremental funding enabled contract modifications to be made without major delays. In November 1966, after spending some $75 million on the 1,600-acre project, Fort Worth District completed its work on what came to be called the Johnson Manned Spacecraft Center.

Mobile District's involvement in NASA's rocket testing program began with the transfer of the Army Ballistic Missile Agency's Development Operations Division at the George C. Marshall Space Flight Center at Redstone Arsenal in Huntsville, Alabama, to NASA in 1959. NASA then established the Michoud Assembly Facility near New Orleans as a support facility for the Huntsville projects. Michoud was the assembly plant for the large Saturn booster rockets. In autumn 1961, NASA established its test facility for the rockets assembled at Michoud on a 217-square-mile tract at the Mississippi Test Center, later known as the National Space Technology Laboratories, accessible from Michoud by both land and water. Mobile District spent more than $200 million constructing space program

The Manned Spacecraft Center, Houston, Texas, under construction, December 1966.

Constructed at the George C. Marshall Space Flight Center in Huntsville, Ala., the Saturn V test stand was designed to withstand 7.5 million pounds of thrust.

A Corps official poses with drawings and specifications from the mammoth project at Launch Complex 39.

facilities up to the completion of the test center in April 1966. The center's initial mission was to test the Apollo-Saturn V second stage booster and to test flight models of both the first and second stage boosters, with thrusts of 7.5 million and 1 million pounds, respectively. The site became NASA's principal test facility.

Initially, design and construction work at Kennedy Space Center was handled by the Jacksonville District, but to meet the demands of the Apollo construction program in May 1963, the Corps of Engineers established the new Canaveral District to handle the construction effort.

Perhaps no other structure better symbolizes the Corps of Engineers' contribution to the United States space program than Launch Complex 39 at the Kennedy Space Center. Built to assemble and launch the giant Saturn V rockets that would carry the Apollo astronauts to the moon, facility construction began in 1963. Major components of the launch complex included the Vehicle Assembly Building (VAB), a 525-foot-tall building where the rockets were assembled; the adjacent launch control center that included four

The Vehicle Assembly Building at the Kennedy Space Center. Components for the Saturn V launch vehicle arrived by barge in the basin (foreground).

Launch Complex 39, Pad A, with the crawlerway connecting the pad to the Vehicle Assembly Building in the distance.

command centers; and a three-mile-long crawlerway built to transport the Saturn V rockets to the launch pad. The launch complex contained two launch pads, 39A and 39B, and each covered a quarter square mile. But the launch complex was only part of the project; supporting the NASA program was a large contractor work force, and to house them the Corps constructed an industrial area on nearby Merritt Island that encompassed fifty buildings, thirty-eight miles of roads, and at its peak 14,000 employees worked there.

Ultimately, the Kennedy Space Center cost $900 million to build, and in the decades since its completion has served as America's gateway to space. In the words of NASA Administrator James Webb, "The road to the moon is paved with bricks, steel and concrete here on earth."

Other Corps offices completed additional construction for NASA. For example, the New England Division selected the site for and supervised the construction of the Electronics Research Center in Cambridge, Massachusetts, in the late 1960s. That facility is now the Volpe National Transportation Systems Center. In supervising more than $1 billion of NASA construction, elements of the U.S. Army Corps of Engineers in all parts of the country made major contributions to the national space effort.

Lunar Maps for NASA

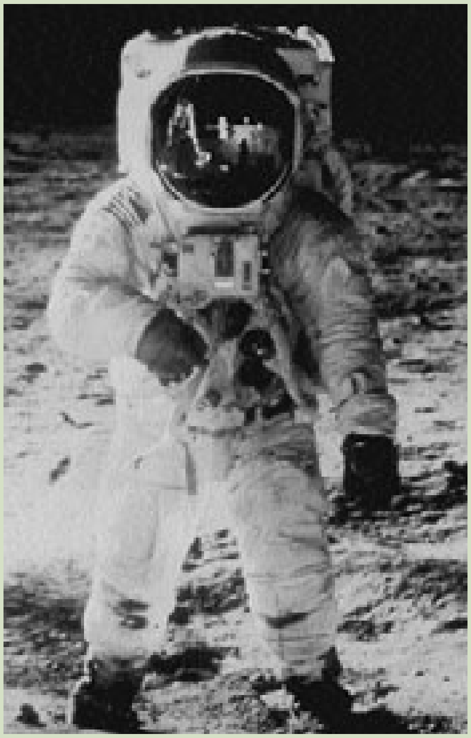
As the U.S. Government looked toward manned spaceflight and an eventual trip to the moon, it became clear that astronauts would need concise maps of that terrain. In 1958, the Army Map Service of the U.S. Army Corps of Engineers began to assess the feasibility of producing an accurate map of the moon based upon telescopic photographs. These Corps topographers concluded that reconnaissance-type photomaps at the scale of 1:5,000,000 were feasible; however, such maps would show only the most general of terrain features.

There were considerable technical challenges to this topographical effort. The moon was a quarter million miles from the Earth. Virtually all photomaps of the moon were taken from an altitude of six miles above the Earth. Because all photomaps were nearly identical, there was no way to utilize stereoscopic techniques to form three-dimensional images that could determine elevations for terrain features. Furthermore, there were no established fixed reference points on the moon by which explorers could determine the elevation, latitude, and longitude of their location.

To overcome initial failed attempts, topographers developed new or improved techniques and equipment. An important innovation was the use of closed-circuit television to enable mapmakers to observe lunar features under different conditions of light and shadow. This process made it possible to determine accurately the height and depth of various terrain features.

The resultant lunar map represented the visible surface of the moon at the feasible scale and showed five thousand geographical features. These terrain features were shown with 1,000-meter contours, and in some cases with 500-meter contours. The Corps managed to map certain small areas in greater detail; for instance, proposed NASA landing sites were mapped at a scale of 1:250,000, with color tinting added for realism.

The Army Map Service also produced rubber or plastic three-dimensional models of parts of the moon s surface. These models were photographed and the films made from them, when projected on large screens, effectively portrayed the varying altitudes that astronauts would face. The models were used in simulated landings practiced at NASA experimental stations.



First moonwalk

National Aeronautics and Space Administration

The topographic engineers also found solutions to other problems plaguing the space program. They developed a material that could withstand the extreme conditions of space travel and exposure on the moon. Special plastic and rubber compounds allowed the development of foldable maps that could withstand temperatures ranging from —250 to 214 degrees Fahrenheit. Additionally, photographic equipment was installed in high-orbiting satellites, providing better images to create improved maps.

Combat and Reconstruction: From the Gulf War to the Global War on Terrorism

When Iraqi forces invaded Kuwait in August 1990, the United States began to assemble a military and political coalition that would ultimately drive the Iraqis out. The liberation of Kuwait was the centerpiece of Operation Desert Storm, but the coalition's accomplishments on the battlefield were predicated on a large and often overlooked logistics effort that made the offensive possible. The Corps of Engineers was a vital part of that effort, deploying 160 people to Saudi Arabia to manage the construction of nearly $300 million of base camps, sanitation facilities, roads, bridges, warehouses, and maintenance facilities. In addition, Corps real estate specialists leased hundreds of Saudi facilities, ranging from housing complexes to warehouses to maintenance facilities, to accommodate the rapidly expanding Army, Navy, and Air Force presence in the country. In addition, scientists and engineers from the Corps' research laboratories developed new technologies for analyzing terrain, detecting mines, locating water, and controlling dust that helped coalition forces operate in the harsh desert environment.

After coalition forces drove the Iraqis out of Kuwait in March 1991,

An abandoned Iraqi tank with burning oil wells in the distance, March 1991

Cpt. Chris Beck of the Afghan Area Office discusses the construction of the Afghan National Army facilities at Pol-e-Charki, August 2003.

the Corps of Engineers played a leading role in rebuilding the war-weary nation. Working closely with the Kuwaiti government, the Corps of Engineers established the Kuwait Emergency Recovery Office to provide project management, engineering services, and contracting support for the reconstruction effort. Over the course of the next year, the Corps helped to repair hundreds of schools and government buildings, numerous hospitals, 3,000 miles of 300-kilovolt power lines, ninety electrical substations, water and sanitation systems, the international airport and two military airfields, 150 miles of national highways, eight bridges, and two deep-water shipping ports. The Corps also supervised the construction of Camp Doha, a base for 5,000 U.S. troops that were subsequently stationed in Kuwait.

As a part of its reconstruction efforts the Corps also engaged in the largest oil-fire-fighting campaign in history. When Iraqi soldiers withdrew from Kuwait they set fire to more than 600 oil wells. The result was devastating, an environmental catastrophe that darkened the skies over Kuwait with billowing clouds of smoke, leaving huge pools of oil on the desert surface. Capping the wells and bringing the fires under control was an intensive effort, but the last of the wells was sealed off in November 1991.

For a decade after the Gulf War, the United States maintained an uneasy relationship with the nations of Southwest Asia, attempting to unsuccessfully broker some type of lasting peace in the region. The continuing unrest in the region touched the United States on September 11, 2001, when terrorists launched devastating attacks on New York City and Washington, D.C. When the Taliban regime in Afghanistan refused to expel the al Qaeda elements that planned the attacks of September 11th, the United States took military action. The United States and its Afghan allies began offensive operations in October, and by early December 2001 forced the Taliban government out of power. In the months that followed the United

States and its coalition allies helped the Afghans form a new government and a new Afghan National Army. In October 2002 the Corps of Engineers established the Afghan Area Office (AAO) in Kabul to build barracks and facilities for the fledgling Afghan army. The office also provided construction management for a variety of U.S. Agency for International Development projects in Afghanistan including the construction of roads, bridges, schools, and medical clinics. The AAO also provided engineering support for U.S and coalition forces in Afghanistan and throughout central Asia. In recognition of the office's expanded workload, in the spring of 2004 the Corps of Engineers established the Afghan Engineer District in Kabul.

When the Global War on Terrorism expanded to Iraq, the Corps of Engineers participated in pre-war planning prior to the invasion of that country in March 2003. Shortly before the war, Corps planners helped prepare a database of Iraq's transportation, oil, and electrical infrastructure and after the air war began they helped prepare target lists and advised coalition forces on targeting decisions. At the outset of the war, Corps of Engineers personnel, operating in close coordination with ground forces, helped capture and secure Iraq's southern and northern oil fields. In the southern oil fields the Corps of Engineers' Task Force Restore Iraqi Oil (TF RIO) and its contractors were instrumental in extinguishing the oil well

Barracks take shape at the Afghan army's Central Corps headquarters at Pol-e-Charki. Building the army facilities was the first major construction program in Afghanistan in decades, August 2003.

Protected by a heat shield and streams of water, firefighters approach a burning oil well, April 2003.

fires set by the retreating Iraqis. Combat engineers such as the 249th Engineer Battalion participated in the capture of hydroelectric facilities at the Haditha Dam and later helped the dam's Iraqi staff resume electricity production.

Sgt. First Class Paul Ray Smith

An Army engineer also became the first recipient of the Medal of Honor in Iraq. Sergeant First Class Paul Ray Smith served with the 11th Engineer Battalion, 3rd Infantry Division. On the evening of April 4, 2003, his unit was attacked by Republican Guard troops near the Baghdad airport. To hold off the company-sized enemy force, Smith climbed aboard a damaged armored personnel carrier and repulsed the enemy attack using the vehicle's .50 caliber machine gun. Sergeant First Class Smith was mortally wounded during the engagement. For single-handedly saving the lives of his men and by killing at least half of the opposing enemy force, Smith was posthumously awarded the Nation's highest award for valor.

Soon after U.S. forces toppled the regime of Saddam Hussein, the Corps

Engineers inspect the construction at logistics support area (LSA) Anaconda, July 2005

of Engineers began to address two vital concerns—helping the Iraqis resume the production of oil and jump starting the nation's battered electrical infrastructure. To revamp the Iraqi oil infrastructure, Task Force Restore Iraqi Oil (TF RIO) began to repair worn or damaged facilities including oil pipelines, pumping stations, gas-oil separation plants, and refineries. Immediately after the war, when Iraq was neither pumping nor refining oil for domestic consumption, TF RIO also was in charge of importing hundreds of millions of gallons of benzene and diesel fuel, and hundreds of thousands of tons of liquid petroleum gas to sustain the country.

In the fall of 2003 the Corps of Engineers established Task Force Restore Iraqi Electricity (TF RIE) to bolster electrical production and enhance the distribution of power throughout the country. Working closely with their Iraqi counterparts, RIE engineers helped refurbish Iraqi power plants, build new generating capacity, rebuild hundreds of miles of electrical transmission lines, construct new electrical substations, and install automated control systems to monitor the flow of power across the nation's electrical grid.

But the rehabilitation of the Iraqi oil and electrical infrastructure was only part of a much larger effort by the American-led coalition to help rebuild Iraq and create a safe, stable, and secure nation. Toward that end, through the Iraq Relief and Reconstruction Fund, the U.S.

Engineers inspect the construction of a border fort near Kirkuk, May 2005.

government allocated approximately $11 billion for 3,000 reconstruction projects that included the construction or rehabilitation of Iraq's transportation facilities, water and sewage treatment plants, hospitals and local health clinics, schools, fire and police stations, and border forts. To provide construction management for the huge undertaking, as well as provide military construction and maintenance services for the U.S. military, in January 2004 the Corps of Engineers established the Gulf Region Division (GRD). Headquartered in Baghdad, the division encompassed three engineer districts located in the southern, central, and northern parts of the country. GRD was staffed with approximately 500 civilians and 200 military personnel. All of the civilians were volunteers, and operations in Iraq marked the first time the Corps of Engineers sent such a large contingent of civilians into a combat zone.

In addition to reconstruction, the Gulf Region Division also was responsible for conducting a wide range of military construction projects in support of coalition forces operating in Iraq. Other Corps of Engineers missions in that country included collecting 600,000 tons of Iraqi ordnance from arms caches scattered around the country, destroying the unusable munitions, and storing the rest in secure depots for use by the new Iraqi army. The Corps also deployed archeologists to Iraq to help with the somber task of exhuming the bodies of thousands of Iraqis murdered by the former regime.

A key component of the Corps of Engineers' operations in Iraq was the administrative and technical support provided by Corps employees based in the United States and Europe. Another important element of GRD's success was the ever increasing role played by its Iraqi employees. The division employed several hundred Iraqis who served in a wide variety of professional and support functions.

Indeed, training the Iraqis to enhance their technical and managerial skills has been an important part of GRD's overall mission. Training host nation personnel has been an important element of the Corps' overseas programs since the Second World War.

Since 1990 the Corps of Engineers has participated in combat operations in the Gulf War and again in Iraq in 2003; in both cases those operations proved to be only a prelude to the massive reconstruction activities that followed. Through its reconstruction activities, the Corps of Engineers has played a vital role in helping Kuwait, Afghanistan, and Iraq begin the difficult and uncertain process of emerging from the turmoil of war.

The Reconstruction of Kuwait

On February 28, 1991, a cease-fire ended military operations in the Gulf War. After a 100-hour-long ground offensive, coalition forces had achieved their objective: Iraqi forces had been forced out of Kuwait and the small Gulf nation was liberated. But the end of combat operations yielded a host of new challenges. When Iraqi forces withdrew from Kuwait they left much of the country in ruins. Consequently, at the end of the war, the U.S. Army Corps of Engineers mission rapidly transitioned from one of supporting military operations to helping the people of Kuwait rebuild their battered country.

The Corps role in the reconstruction of Kuwait actually began long before coalition forces took the offensive. Anticipating the destruction that could accompany the liberation of their country, in October 1990 the Kuwaiti government requested the Department of Defense s help in rebuilding their country after the cessation of hostilities. As a result of those overtures, on November 20, 1990, the Army Staff directed the Corps of Engineers to serve as the lead agent in assisting the Kuwaiti government to rebuild its public works and municipal utilities.

In January 1991, Chief of Engineers Lieutenant General Henry Hatch directed Colonel Ralph Locurcio, the commander of the Corps Savannah District, to establish an area office in Kuwait to oversee the reconstruction effort. That organization, which later became the Kuwait Emergency Recovery Office (KERO), was organized much like a Corps district, with separate offices for project management, emergency operations, engineering services, and contracting and support. In planning KERO operations Colonel Locurcio drew heavily on the Corps long experience in restoring power and water supplies after natural disasters. The recovery office was staffed largely with civilian volunteers from the Corps of Engineers, many of whom had previous emergency operations experience.

The KERO advance team traveled to Saudi Arabia at the end of January and quickly procured sufficient food, water, equipment, and vehicles to sustain the office for thirty days. On March 4th, just days after the ceasefire took effect, the first KERO personnel arrived in Kuwait City. They found the city in shambles. There was no electricity, the municipal water and sanitation systems had been destroyed by the retreating Iraqis, and thousands of

Abandoned Iraqi vehicles litter the highway heading north out of Kuwait City burned out Iraqi tanks and abandoned vehicles littered the streets.

KERO was initially attached to Task Force Freedom, the Army s coordinating activity for the reconstruction of Kuwait. Within hours of arriving in Kuwait City, KERO engineers, assisted by Kuwaiti volunteers, began fanning across the city to conduct damage assessments. The KERO damage assessment groups inspected ports, the Kuwait airport, the wastewater treatment system, power production and distribution facilities, public buildings, and defense installations. During its first forty-five days of the operation, KERO teams conducted more than 1,000 assessments that served as the foundation for later reconstruction efforts, many of which were managed by the Corps of Engineers. KERO expanded along with its workload, and by the end of March had a staff of 14 military officers, 112 Corps civilians, more than sixty Kuwaiti volunteers, and nearly 1,000 contractors.

KERO was a key member of a U.S. Army effort that quickly restored Kuwait s primary power systems within thirty days, replenished the nation s water supplies, and reopened the badly damaged airport within forty-five days. KERO s largest single mission was the restoration of Kuwait s public buildings. Working together, KERO and its contractors restored more than 1,000 public buildings including 145 schools, the Kuwait Airport, and the National Assembly building. By December 1991, a scant nine months after the end of the war, KERO had restored power to 99 percent of the country, returned three desalinization plants to operation, reconstructed two sewage treatment facilities, and completed an assessment of the entire sanitary system. The rehabilitation of the Kuwait transportation system also included repairs to more than 150 miles of road, and the removal of 3,700 bunkers, barriers, and abandoned or destroyed vehicles.

The contribution of the U.S. Army Corps of Engineers to the reconstruction of Kuwait is a source of pride to the entire U.S. mission, wrote Ambassador Edward Gnehm in a letter to Colonel Charles Cox. The achievements of your engineers have won high praise from both the government of Kuwait and its people. On another level, the working relationships forged between the Kuwaiti government and the Corps of Engineers during the reconstruction served both countries well when the United States traveled back to Southwest Asia in early 2003 to begin combat operations against Iraq.