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Article Summary: The Corps of Engineers began Missouri River stabilization work in 1877. The Engineers had to experiment, gradually developing tools to train the river.

Cataloging Information:

Names: Charles Russell Suter, Max Boehmer, Chester B Davis, Charles S Pease, Thomas H Handbury

Missouri River Place Names: Saratoga Bend, Indian Bend, Tarbox Point, St Mary's Bend, Carter Lake ("Cutoff Lake"), Steamboat Bend, Lake Manawa, Willow Island Chute, Florence Point

Keywords: Charles Russell Suter, Corps of Engineers, Max Boehmer, Union Pacific Bridge, willow mattress, mattress boat, brush dikes, wire screen dikes, revetment, cutoff, River and Harbor Act

Photographs / Images: schematic map of Corps of Engineers work on the Missouri River at Omaha and Council Bluffs, Major Charles R Suter, launching ways of a mattress boat, screen dikes erected to catch detritus, grader boat that carried willow poles to the mattress boat, "one-man stone" being laid over the newly-woven mattress, grader boat crew cutting away the bank, Captain Thomas H Handbury, snag boat named the *C R Suter* in recognition of the major's work on the Missouri

"A Thousand and One Little Delays": Training the Missouri River at Omaha, 1877-1883

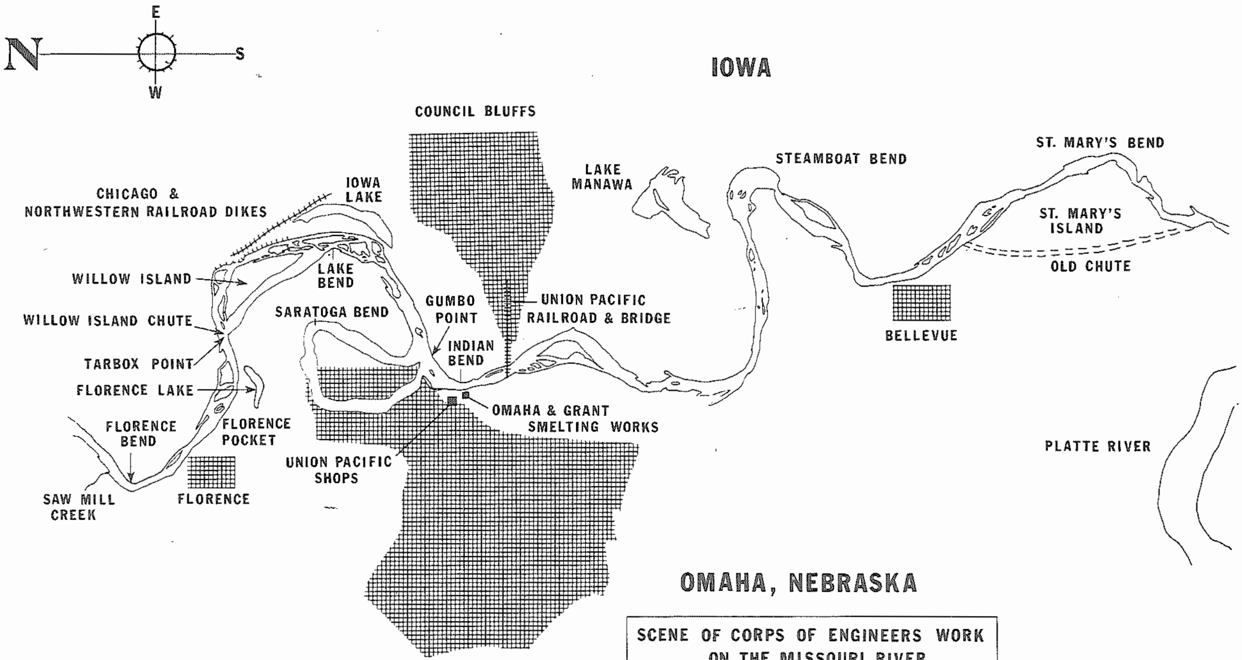
By Lawrence Carroll Allin

The reach of the Missouri River from Florence, Nebraska, to the mouth of the Platte was the scene of an unequal struggle between man and the river in 1877-1883. A meandering, eroding, silt-laden stream, the Missouri posed a constant danger to the communities and structures along its banks. At the almost-circular Saratoga Bend immediately upstream from Omaha and neighboring Council Bluffs, the river threatened to make a cutoff by eroding through the bend's narrow neck.

Although the Missouri frequently created such cutoffs, they were not always harmful. But if the river were to cut through the neck of Saratoga Bend, its full force would be unleashed directly against the Omaha shore, damaging waterfronts, steamboat landings, and lowlands. In greatest jeopardy were the maintenance shops of the Union Pacific Railroad, the Omaha and Grant Smelting Works, and the important Union Pacific Railroad Bridge.

On May 21, 1877, the impending Saratoga cutoff received attention when Major Charles Russell Suter of the U.S. Army Corps of Engineers sent one of his civilian assistant engineers to examine the river. The assistant, Max Boehmer, arrived in Omaha, made his survey, and reported his findings to Suter on June 22.[1]

A significant River and Harbor Act, passed by Congress on August 13, 1876, had authorized the first federal attempts to improve the Missouri River. Work was to be done at three sites by the Corps of Engineers as part of its traditional duty of maintaining the nation's navigable waterways. Initial work on the Missouri was planned at widely scattered locations: Dauphin's Rapids, above Carroll, Montana; Nebraska City, Nebraska; and St. Joseph, Missouri. The act authorized



SCENE OF CORPS OF ENGINEERS WORK
ON THE MISSOURI RIVER
AT OMAHA & COUNCIL BLUFFS

surveys of other locales where river improvement might be needed. Under this authorization Suter was able to send Boehmer to Omaha.[2]

By 1877 the effects of the Missouri River's behavior were well known. The April and June rises, caused by snowmelt and rainfall, could fill the river with water. Rushing through its flood plain, the Missouri increased in volume and accumulated sand and silt. Obstructions deflected the current and changed the direction of the river's flow. The stream gnawed into its banks, sometimes eroding fertile farm land at the rate of 2,000 feet per year. As the Missouri eroded one bank, it tended to drop silt on the opposite side and build new land. One engineer wrote of the river: "Its physics are characteristic and as yet imperfectly studied. It is a sand and silt bearer, and as such differs in character from the best type of sand bearer—the Lower Mississippi—[and] from the clear stream which flows in an immovable channel."[3]

The engineers knew little of the Missouri's hydrological intricacies and had not commenced work on any of the authorized projects when Boehmer submitted his report of June 22, 1877. Seventeen days later on July 8, 1877, the Missouri broke through the neck of Saratoga Bend with violent erosive action.[4] It formed "Cutoff Lake," now Carter Lake in Iowa, and directed its full force against the land in front of the Union Pacific shops, where it cut 1,200 feet into the bank. Railroad crews dumped rocks, sandbags, and brush along a 2,000-foot stretch of the bank to deflect the current. These strenuous efforts, aided by the river's fall, prevented further erosion.[5]

After formation of the cutoff, Suter instructed Boehmer to make a second survey of the Omaha reach of the river. Boehmer did so in November 1877 and reported to Suter that the spring rises of 1878 would cause more damage. Suter reported Boehmer's findings to his superiors.[6]

The change of course at Saratoga Bend threatened to drastically alter the river's channel. Through the erosion of new banks, the river would become filled with sediment that would be deposited elsewhere to form new deflecting obstacles. Such channel changes would make the always hazardous navigation of the Missouri even more difficult. The river would seriously impede navigation if it flowed obliquely around the piers of the Union Pacific Bridge.

Because of these threats to navigation, Congress appropriated $80,000 in 1878 to stabilize the channel at Omaha and Council Bluffs.[7] Boehmer appraised conditions at Omaha and devised a plan to control the river. Before Saratoga cutoff, the Missouri had flowed through an 18-mile reach from Florence to Omaha. The cutoff shortened that distance by four miles.

The Missouri flowed through the new cutoff directly from the east toward the shore at the Union Pacific shops. Then it turned due south through Indian Bend, which had a radius of only 1,200 feet. At a six-foot stage, the river emerged from the curve with a swift 5.08 mile-an-hour current, carrying 20,178 cubic feet of water per second.[8] However, the Missouri had the potential to flow faster and carry even more water. The spring rises in 1878 and the increased volume of water they would bring concerned both Boehmer and Suter. Boehmer made plans to meet the coming rises. He proposed to dig a 1,200-foot-long trench in front of the smelting works, fill it with rock, and permit the river to erode the shore to the trench. Another 800-foot, rock-filled trench would be placed above the bridge, directly in line with the smelting works trench. Boehmer hoped to turn the river with the first stone trench and make the current flow parallel to the second trench.[9]

Suter saw the problem differently. His first concern was keeping the river from flowing obliquely under the bridge, and he wanted to let Indian Bend move downstream. To do so would require holding the Nebraska shore in place above and below the Union Pacific Railroad revetment and strengthening the Iowa bank.[10]

Boehmer began to implement Suter's plan during the fall of 1878. He accomplished four things before cold weather forced him to suspend work on November 20. Boehmer ran revetment made of willow mattress 2,030 feet down the Nebraska shore from the Union Pacific's revetment to the smelting works. Then his crew wove over 1,000 feet of mattress to protect the bridge. The Iowa shore received 9,796 linear feet of mattress revetment, and 2,100 linear feet of brush dikes were placed in the river.[11]

The willow mattress revetment and brush dikes were standard tools used to control the river during this period. Willow mattresses were simply woven fabrics of willow brush, 40 to

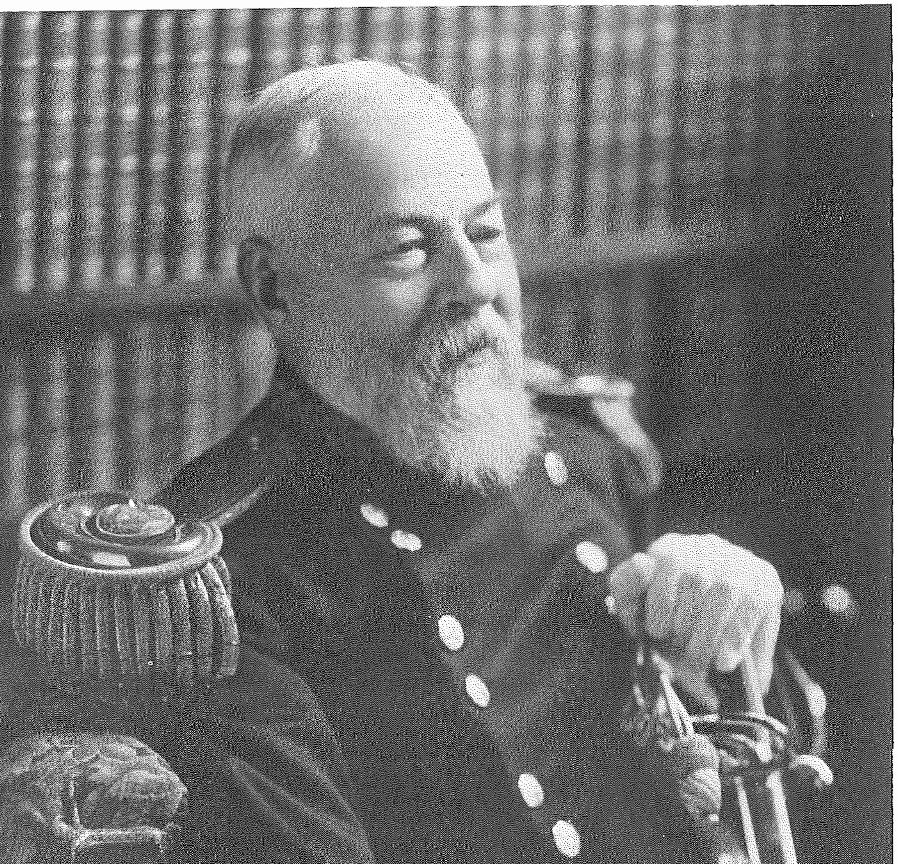
120 feet wide, 6 to 18 inches thick, stitched together with wire. They were placed on the river bank below and above the water line. When weighted with stone and/or earth, the mattresses became revetment to prevent the river from eroding its banks.

The brush or "weeds" were equally simple tools. The Engineers bound willow slash into a bundle about 20 feet long or used a willow tree attached to a line. One end of the line was tied to a rock anchor and the other end attached to a buoy. The brush or weed was placed in the river as part of a dike designed to momentarily slow the river and force it to drop silt to form solid accretion downstream from the dike. It was hoped that the accretion would force the river through the desired channel. From the fall of 1878 to the winter of 1883, the Engineers used willow mattresses and brush dikes to control the river and to help them achieve two aims: the creation of a safe, stable channel for the Missouri and the perfection of their river control tools.

Chester B. Davis was one of Suter's innovative assistants in this experimental work. When he arrived at Omaha on April 19 to begin the 1879 season, Davis found some of the revetment damaged and its underlying mattress destroyed. Believing the condition was not serious, he set out to restrain the river to a 4,500-foot radius through Indian Bend above the Union Pacific shops with a brush dike extending from the Iowa shore.[12]

Boehmer's brush dike of the year before had a rope core and 12-foot weeds. Davis used a different method to make and place his dike. He loaded a 1,200-foot line, his weeds, and their anchors and buoys aboard a barge; anchored one end of the line to the shore; and moved the barge into the river. The weeds were fastened to their anchors and buoys and tied, evenly spaced, along the line. As the barge moved across the river, the line was paid out, and the weeds were lowered into the river.[13]

At the beginning of the 1880 season, Davis inspected his imperfectly functioning dike. The weeds had only partially done their job. They had broken up an eddy which was eroding the shore and had built a deep accretion of silt in 50 feet of water. But the force of the river had separated the weeds and ruined Davis's even spacing. As a result the accretion was uneven and



Major Charles R. Suter. Courtesy of U.S. Military Academy Archives.

gully-slashed and could be quickly washed away by the next high water.[14]

During the April and June rises of 1879, the river had forced its channel against the Iowa shore, damaged Boehmer's revetment, and carried away 1,200 feet of it. Davis saw the change as the opportunity to develop the 4,500-foot radius in Indian Bend and devised a three-point plan to accomplish his aim during the 1880 season.

First he would hold the river in an easy curve at Florence to prevent the stream from damaging the Chicago and North Western Railroad's dikes on the Iowa shore. Then Davis would help the river make a gradual curve toward the smelting works. Finally he planned to extend the Iowa revetment downstream.[15]

Davis began work on the Iowa revetment, which ran upstream from Council Bluffs. He hired a crew of 30 men and wove 2,200 feet of willow mattress on the ground atop the river bank to replace the revetment which had been carried away. Davis believed that the river would erode the soil from under the willows and let them gradually fall into place to protect the shore. The work was more difficult and expensive than anticipated and not as successful as Davis had hoped, because the river did not neatly erode the soil from beneath the mattress.[16]

The willows to make the 120-foot-wide mattress were hauled seven miles to the work site. The rock to weight the mattress was hauled 8.5 miles over poor roads. Davis's crew wove about 100 linear feet of mattress a day at a cost of $1.90 per running foot.

During the April 1880 freshet the river rose three feet in 36 hours. A north wind forced the drift of the river against the mattress, almost cutting it in two, and carried away a 300-foot section. Then the river fell as rapidly as it had risen. The mattress began to tear. Davis and his crew repaired the damage and added a 30-to 40-foot section. On May 21 the river tore the mattress almost in two and flooded its inshore edge by eroding the bank underneath it. The upper Iowa revetment was ruined.[17] Davis, who had done much other innovative work on the river and had spent most of his appropriation, was compelled to let matters take care of themselves.

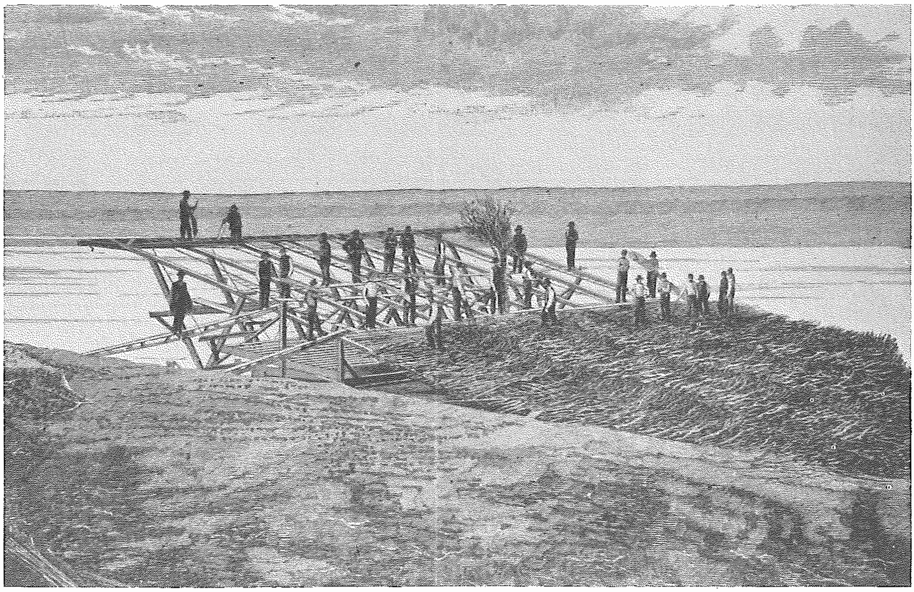
Davis had also run a weed dike into the river from the head of the upper Iowa revetment. He used no new or innovative methods to build the dike. His sketchy account of the work mentioned only that it was composed of materials on hand and that he saved some of the buoys not stolen by vandals or carried away by ice.[18]

Davis's downstream extension of the Iowa revetment was a combination of ingenious solutions to three essential problems: (1) He wanted to devise a method for grading the riverbank to an angle which would allow the mattress to remain in position and resist the forces of the river. (2) Weaving the willows on the ground had been less than efficient, and Davis sought a better platform for weaving the mattresses. (3) Finally he wanted a light yet strong mattress.[19] In developing the techniques to achieve these goals, Davis was on his own. The Corps of Engineers had not accumulated a body of information about the subject of river stabilization, and most engineers lacked experience in this area. Davis was forced to do the best he could under the circumstances.

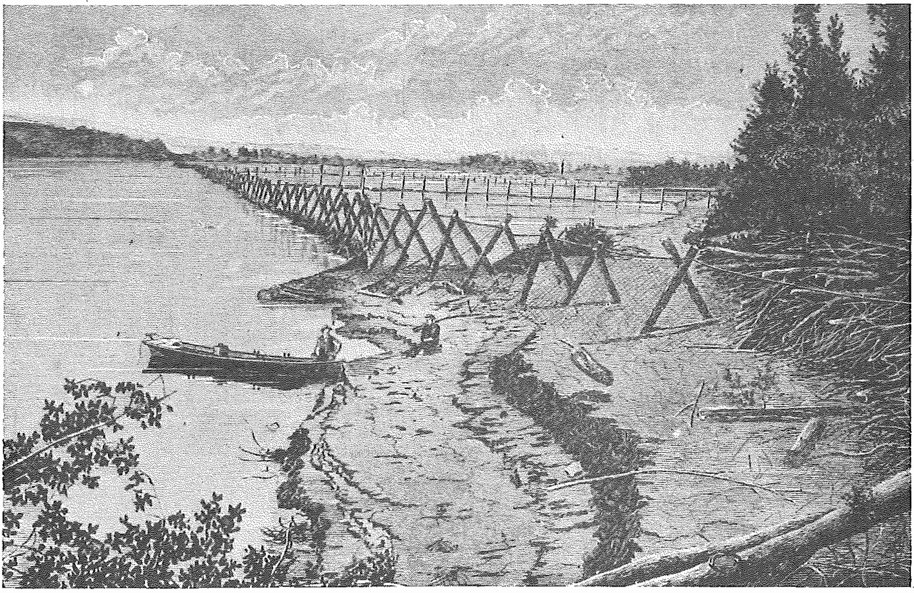
Davis built a new work boat to grade the bank. He secured a 12- by 45-foot flatboat and mounted a horizontal tubular boiler and mining pump aboard the vessel. A 2.5-inch rubber hose and several nozzles were attached to the pump and mounted on a swivel on the flatboat. Davis then tried to cut the bank to grade by water jets directed from the boat, but the experiment failed.

The simple expedient of placing the swivel on the bank was then tried. A four-man crew controlled the swivel, traversing the hose and nozzle so that the water jet graded the bank smoothly and at the desired angle. The results were mixed. The grading was normally done by pick and shovel at a cost of 6.75 cents per cubic yard. The four-man crew moved 500-600 cubic yards of bank per day with the water jet at a cost of 3.5 cents per cubic yard. But the boiler was inefficient, the hose continually burst, and an effective nozzle could not be found. The water jet worked well in loose soil but had difficulty cutting through clay or clay mixed with willow roots. These difficulties were eventually overcome, and Davis's methods of hydraulic grading became widely used in river work.[20]

After grading the bank Davis had to protect it with mattress revetment. Both the mattress and his methods of launching it were unique. Normally mattresses were woven of willow



This etching shows the launching ways of a mattress boat. Supple willow poles were placed on the ways and woven into large fabrics. . . . (Below) Screen dikes were erected to catch detritus, which would slow the river's currents and build bank accretions.



poles. This involved making three or four thin bundles of poles and weaving them into a long, seamless covering for the bank. Davis wove his mattresses on a mattress boat equipped with weaving and launching ways—lengths of timber inclined to a 15-degree angle on which the mattress slid into the water after it was woven.[21]

The mattress boat became generic to river work. Many variants of such craft were built for the Missouri, because each assistant engineer was allowed to use his own initiative to meet the problems of his assigned locale as best he could. Davis elected to build a double-hulled mattress boat to complement his hydraulic grader.

The boat's two hulls were 60 feet long and three feet deep. The upstream hull was 15 feet 9 inches wide, while the downstream hull was 12 feet wide. The hulls were joined by great beams, and they were 50 feet long from the apron of the upstream hull to the downstream gunnel of the stern hull. Unlike a catamaran, whose twin hulls run fore and aft, the hulls of Davis's mattress boat ran at right angles to their direction of travel. The upstream hull was the wider of the two, as it supported the weight of the mattress and withstood the strain of its launching.

The mattress-weaving ways were simply 55-foot lengths of six-by-six-inch clear pine inclined on sturdy supporting posts at a 15-degree angle. Below the ways were two floored platforms on which the weavers worked. Running diagonally across the ways were thin walkways for brush passers. There were eight of the 55-foot ways on Davis's boat.

First light willows were laid at right angles to the ways. Then four to six inches of small willows were laid on the small brush parallel to the ways. A third layer of longer willows was laid at right angles to the launching ways. The mass was then stitched together with heavy wire. Double-pointed, 14-inch shuttles were used as needles to make the stitches. The 8-inch-thick mattress was woven in 40- to 60-foot-wide sections from the bow or upstream hull toward the stern or downstream hull. When the ways were full of mattress, the boat was slowly pulled downstream. The mattress slid down the ways, over the curved apron, and into the water. When only a few feet of willow remained on the ways, the weaving began again.[22] Rock was then placed on the mattress to weight and sink it.

The entire vessel was made of stout timbers. It was a convenient platform for the labor-intensive process of mattress weaving, which Davis began on November 1, 1879. He used his boat to lay on the Iowa shore 2,650 feet of revetment, which ran downstream from Boehmer's work of 1878.[23]

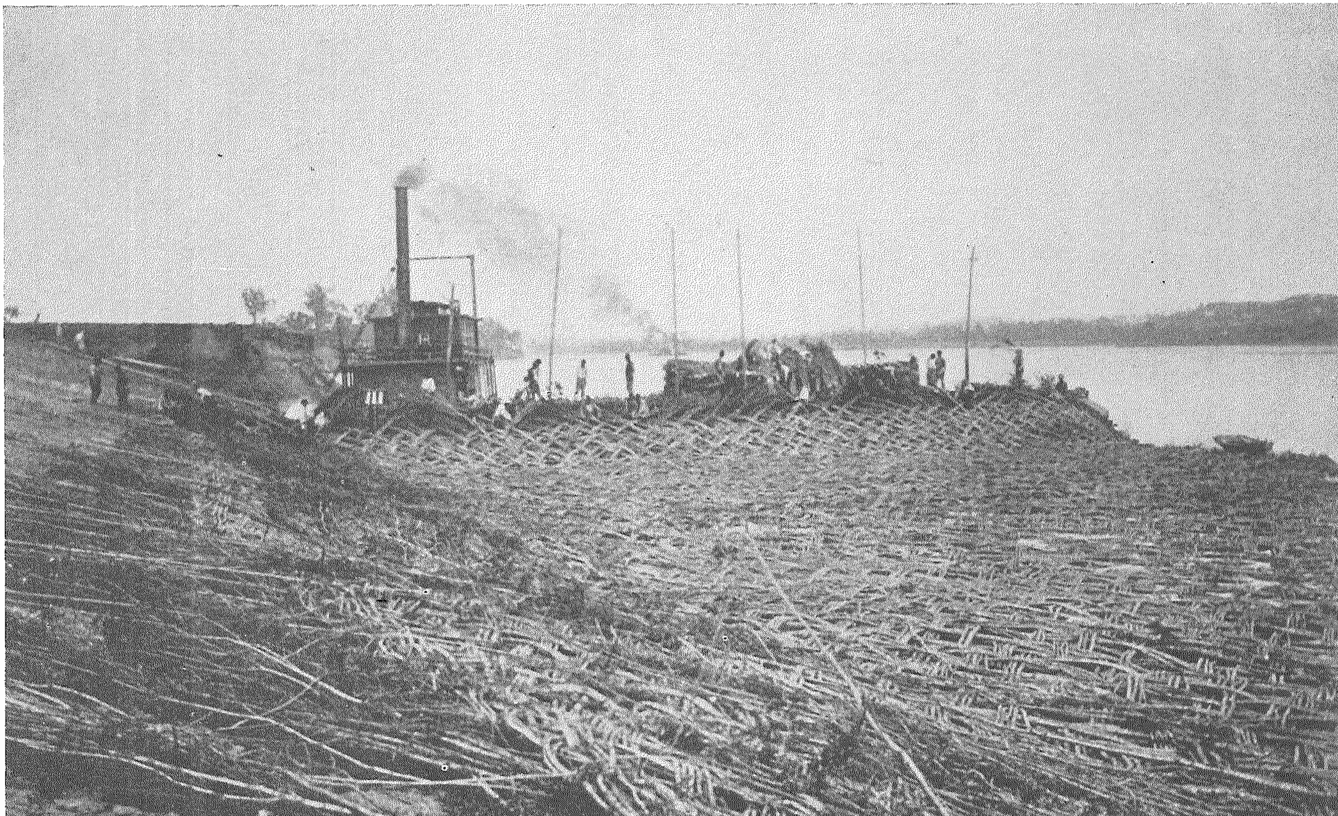
Early during the 1880 working season, Davis built experimental wire screen dikes at Tarbox Point, upstream from the Iowa revetment and downstream from Florence Bend. The wire screen dikes manufactured and placed by Davis and his crew were also unique. They were 30 feet wide and 800 feet in length, woven of coarse wire mesh, anchored with rock, and supported by buoys.

Davis experimented with the wire mesh, weaving part of it in a diamond shape with diameters of 16 and 24 inches. The wire was unwound from spools, brought over the top of a 24-inch drum, joined beneath pegs on the drum, and twisted so that each diagonal was formed of a single wire. Four men worked at the drum while a fifth kept wire on the spools. The crew could weave 180 feet of mesh a day.

The remainder of the wire screen dike was composed of hexagonal mesh made on an 8- by 30-foot horizontal frame. The wires were run 10 inches apart through a sliding guide. Two of the wires were brought together and twisted with an iron pin to form a 10- by 24-inch hexagonal mesh. Seven men and two boys wove 400 feet of mesh a day. Both meshes were rolled into tubular masses for ease of handling.

The rolled wire mesh was placed on a barge. Davis then determined the line he wanted the dike to follow. Upstream from the line of his dike, he anchored a line of barrel buoys. The barge was then winched into the river with its gunnels at right angles to the barrel buoys. Eighty-pound rock anchors were wired to the screen mesh on the deck of the barge. Wooden box buoys, 12 by 12 by 24 inches, were tied to the top of the screen. As the anchors and buoys were attached, the wire screen was slowly unrolled over the barge's stern.[24]

The experiment was not a success. Erosion had tumbled into the river many young willows, which clogged the meshes. Within 12 hours the screen dike caught enough willows and silt to build an accretion eight feet high. But the force of the current pushed the dike into the accretion, and it then lost its effectiveness. Davis responded by building a second wire



The grader boat in the background has probably brought willow poles to the mattress boat. This photo indicates the size and scale of material and equipment needed to train the Missouri.

screen dike above the first. He extended the second dike 400 feet into the river before he exhausted his funds. It produced the same effect as the first. Davis concluded that the meshes should be larger in size so that they would not stop all the debris the river carried. The screen dike would thus stand longer to build deep accretions.[25]

Captain Thomas H. Handbury, Suter's assistant, examined the Missouri between Omaha and Plattsmouth during January of 1880 and found a complex situation. The Saratoga-Carter Lake cutoff threatened to change the river 20 miles above and below its location. It shortened the river's course, steepened its gradient, increased its current, strengthened erosive forces, and impeded navigation. A new railroad bridge being built at Plattsmouth was in jeopardy. And Handbury noted that a cutoff had occurred at St. Mary's Bend. The town of St. Marys found itself on an island, effectively transferred from Nebraska to Iowa jurisdiction when the river—the boundry between the two states—made its cutoff. The citizens of St. Marys had abandoned the town. Handbury also noted that the river threatened to make a cutoff at Council Bluffs's lower landing.[26]

On August 20, 1880, Davis was relieved by Assistant Engineer Charles S. Pease. Pease encountered problems with the upper revetment on the Nebraska side. Over 1,000 feet of Boehmer's revetment needed repair. Pease placed earthfill over the damaged mats, reworked the bank's grade, and laid new mattress on the trouble spot.

Pease found an ample stand of willow for the work three miles upstream opposite Camp Richardson. Willows of .75-inch diameter were best. They were flexible and tough though they took more time to weave. Larger diameter willows were strong but not tough, and their stalks would not bend into the mat as well as the smaller material.

The smaller willows were cut with corn knives and hauled to the river in wagons. The wagons could not take the willows to the work site because of the Carter Lake mud flats. To get the willows to the job site, Pease built a portable raft of joists and scantlings. Twenty-four cords of willows standing six feet high were placed in the skeleton raft. Fully loaded, only 15 inches of the raft and willows were above the waterline. Two men in the skiff worked the raft to a 15- by 60-foot mattress boat at the repair site. When the raft was unloaded, it was dismantled, placed on a wagon, and hauled back to the willow stand.[27]

Pease had to resort to the makeshift raft, because his paddlewheel work boat *Doris* had sunk in the Missouri during a fierce storm in the spring of 1880. Pease tried to raise the *Doris* during low water that fall. She was firmly embedded in silt with only a small arch of her starboard paddlebox above the mud, and considerable effort was required to raise the 15-ton iron-hulled steam tug. The bank was graded so that she could be hauled out of the water. Then a cofferdam of poles and brush was built around the *Doris* and filled with water. The water and silt in the cofferdam were pumped into a long trench leading to the Missouri's low water channel. This permitted Pease's crews to work on a relatively dry boat. Machinery and the boiler were taken off the *Doris* and stored for the winter while the many holes in her bow were patched. During the spring of 1881 the *Doris* was sent to the Western Iron Boat Building Company at Carondelet, Missouri, where she arrived on July 1.[28]

Mid-March of 1881 held an unpleasant surprise for Pease and the other Engineers working on the Missouri River. The hard winter turned mild. From March 10 to 16 the shallow Missouri rose. From March 24 to 27 the river grew more swollen. Between April 1 and 9 the river rose from 16 to 22 feet, due to snow melt. The engorged stream began a cutoff at Steamboat Bend below Council Bluffs and formed Lake Manawa. On April 15 Pease began building screen dikes. Without a network of upstream gauging stations, he had no way of knowing that even more upstream runoff was to come, but he saw its effects when the Omaha gauge reached 23 feet 9.75 inches on April 24. The Omaha lowlands and the Missouri River Valley were flooded. On April 26 the Steamboat Bend cutoff went through. The next day great cakes of ice, broken loose from upstream ice dams, began flowing past Omaha. Gradually the water subsided. When the Missouri returned to somewhat normal conditions, the Engineers' work had been badly damaged.[29]

After the flood of 1881 Pease was faced with the problems of the instability of the three great bends and the river's southward turn at the Chicago and North Western Railroad dikes. Upstream from the dikes the river had carved a chute or secondary channel—Willow Island Chute—through the land on the Nebraska shore. Willow Island was created between Nebraska and Iowa in the bend.

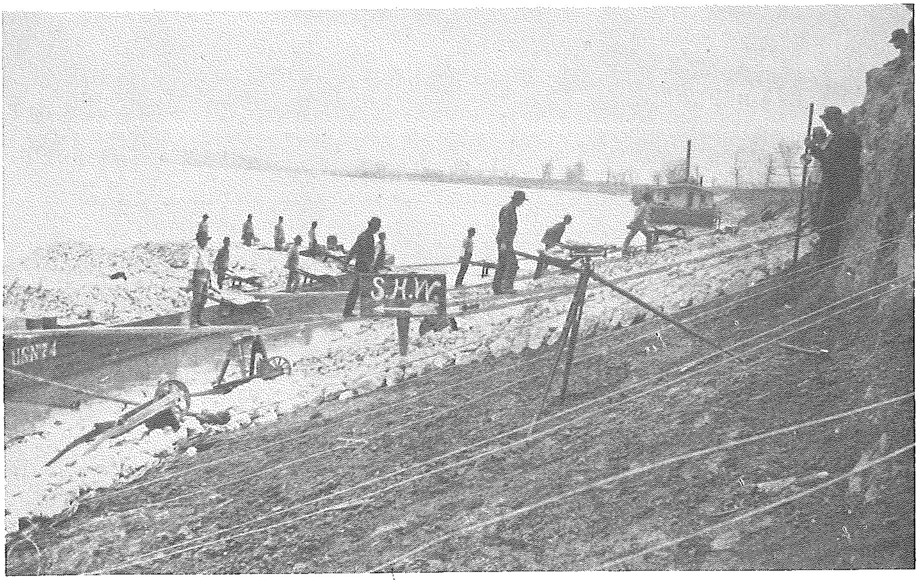
If the main channel of the river flowed through the chute, the full force of the river would be directed toward the Council Bluffs shore. The chute had been narrowed to 150 feet by falling silt during the flood of 1881, and a large sandbar had formed across it. Pease decided to place a screen dike across the chute and a brush fence across the bar to the Nebraska shore.

When the river dropped from 18 to eight feet in depth, Pease began his work. His Willow Island screen dike was unusual. It was hung from a heavy wire supported by tripods of cottonwood poles. The crew of a small scow hung the 8- by 12-inch hexagonal screen mesh from the wire and anchored it with bailed rock. Willows, rootlets, and grass collected in the dike, and accretions built up. The river continued to fall, and the water passing through the chute measured only two feet in depth. Unfortunately such low water did not help build the desired accretion.

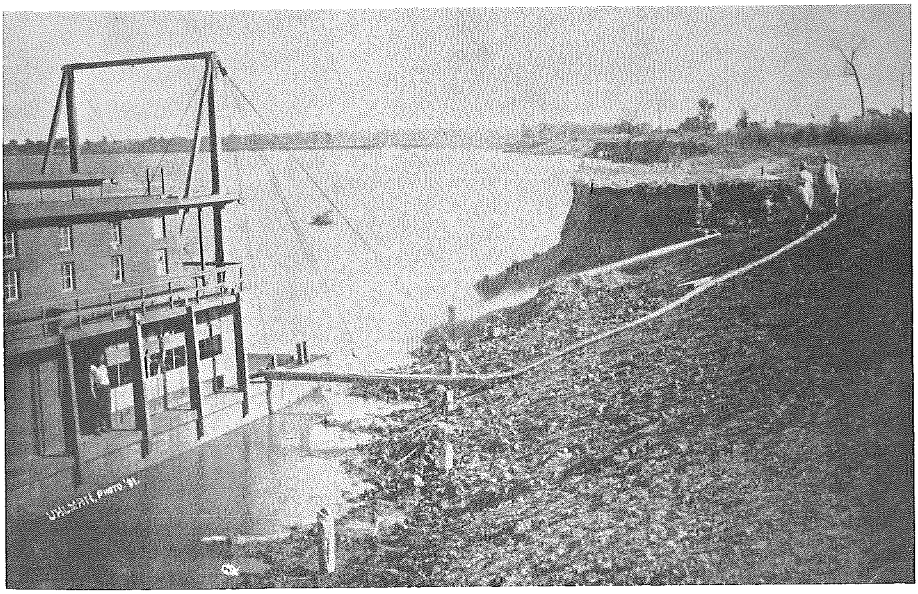
Pease's sand fence was a continuation of the screen dike. The fence was made on frames measuring 4 by 12 feet. The top timbers of the fence were wired together. Then three wires were strung along its 1,100-foot length. Willows were woven into the wires to produce a barrier which resembled a snow fence. The fence had a double purpose: During the summer it was to stop and hold wind-blown sand, and in fall it was to stop silt.[30]

Below Florence a pocket or curved indentation had formed. Pease wanted to keep the river flowing through the pocket, because the indentation lengthened the river's course and slowed its current. Pease placed another tripod-mounted screen dike on the Iowa shore to help keep the river in the pocket. Like other Assistant Engineers on the Missouri, Pease used locally available material to make his dike. He found stout willow poles at Florence Point, a mile above the work. Rock shingle on the bank opposite Florence Point was used as ballast for the tripods.

To make the tripods three 4-inch by 16-foot willow poles were laid on the deck of the 15- by 60-foot barge to form a



A hardy crew lays "one-man stone" over the newly woven mattress on a graded bank. The stone weighted down the mattress and resisted the erosive force of the river's currents. . . . (Below) A grader boat crew is cutting away the bank ahead of a completed stretch of mattress. The piles serve as anchoring points.



triangle. Then Pease secured three 25-foot willow poles to the triangle and formed a right-angle pyramid 23 feet high. The great triangle or tripod was braced internally with more poles. Three 100-pound bags of sand were fixed to each leg of the tripod, which was then raised overboard with a derrick and placed in the water 30 feet from its neighboring pyramids.

When five pyramids were placed in the water, number eight wire was run across their apexes. This formed a 150-foot section of the dike. Pease placed four of these sections in the river to make his 600-foot-long dike.

It the meantime the screen-weaving machine was set up on shore, and hexagonal screen was wound. The rolled bundles of screen were put aboard a scow. The crew of the scow hung the screen from the number eight wires and anchored it with wire bails of shingle. Floating logs or heavy debris could tear out one of the 150-foot screens without destroying the entire dike. Like the other training structures, Pease's tripod-mounted screens filled with rootlets, grass, and willows and built accretions.[31]

Pease had to assess and record the impact of the Engineers' work on the river by surveying and mapping it. He made his first survey during the fall of 1880 when the river was low and drafted a 400-foot-to-the-inch map. From February 24 to March 6, 1881, Pease surveyed from the Union Pacific bridge to Bellevue. The map of this survey showed shore lines, locations of sandbars, and general topography of the area. Because the river was frozen, Pease could not make soundings and show the river's depths and slopes on his second map. The latter map was submitted to Suter on July 20, 1881, after the great flood had changed the river.[32]

The April cutoff at Steamboat Bend invalidated parts of Pease's map. Prior to the cutoff the bend was an almost ideal stretch of river—it was narrow, had a gentle slope, and was scoured out by the current. The Steamboat Bend cutoff, the third such occurrence in three years, shortened the river five miles and created the "most unsettled regime imaginable," according to Pease. The damage was done by surface scour—the river simply washed away the topsoil on the neck of the bend and then cut into succeeding layers of earth.[33]

However, good effects were also produced by the 1881 meandering of the river. The head of the bar across from

Omaha was washed away. This increased the curvature of the bend below Gumbo Point and dispersed the impact of the current on the Omaha shore. The erosion of the bar also set the river flowing toward the Union Pacific bridge at a 70-degree angle, which lessened the danger to the bridge and to navigation.[34]

During the fall of 1881 Pease repaired the Omaha revetment. He cut willows at Cutoff Lake (Carter Lake) and Iowa Lake. The willows from Cutoff Lake were hauled to the job site on wagons; those from Iowa Lake came downriver on a sailing barge. The rock to weight the mattress came from Green's Quarry, a short wagon haul from the work site. The eight-inch-thick mattress was woven aboard one of the 60-foot scows and launched in ten-foot increments. The mattress was 60 feet wide, covered the old mattress, and ran ten feet beyond it. In all Pease repaired 730 linear feet of mattress on the Nebraska shore.[35]

During the summer of 1881 Pease used an expedient to halt erosion of the sandbar at Willow Island Chute. Some of the bank was graded, and posts were sunk 1,150 feet along the bar. The wire-making machine was mounted in the bows of one of the 60-foot scows, and the barge drawn close to the shore. Forty-foot-wide screen of number 12 wire with 18-inch meshes was woven and paid out across the barge's bows. The bottom of the screen was anchored and the air edge, as Pease called it, was fixed to the posts. The screen filled with fibrous material, slowed the river's silt, and built up an accretion. Pease reported that the work was inexpensive though temporary, and he judged it to be reliable for a year.[36]

During July of 1882 Pease built the same type of tripod screen dikes he had used in 1880. He placed 300 linear feet of the tripod dike at Florence and 400 linear feet at Willow Island Chute. Falling water and the light character of the work produced few results.[37]

Spring of 1882 brought warm weather and falling water. Pease spent April 15 to June 15 placing pile screen dikes at Florence. He wanted to ease the river closer to the Nebraska bank by building accretions from the Iowa bank. He attempted to define the proposed shore line with 3,700 linear feet of tripod screen dike running down from Saw Mill Point, located just above Florence at the confluence of Saw Mill Creek and the Missouri.

Pease's ultimate aim was to obtain a better alignment of the river along the Omaha waterfront and under the Union Pacific bridge. In addition to the tripod dikes, Pease built screen spur dikes into the river to build accretions. Next he began another pole screen dike running downriver to further delineate the desired shoreline.

Pease used both of his 60-foot barges on the work. He also used Davis's hydraulic bank grader as a pile sinker by mounting a derrick on it and then attaching its hose and nozzle to a pile. He lowered the pile into the river and let the water jet "dig" the holes for his piles.

However, Job would have had difficulty enduring the 1882 working season.[38] The river rose three feet in one night. A large raft of piles broke loose from its moorings and tore out most of the spur dikes. From June 10 to 23 the river rose 7.5 feet. A heavy drift of debris carried off most of the wire netting on the remaining pile dikes.[39] Pease had also placed dikes on the line of the proposed Iowa shore of the river's new alignment. The river scoured out 1,200 feet of that work. The loss was of

Captain Thomas H. Handbury. Courtesy of U.S. Military Academy Archives.

no particular concern, according to Pease, as the river was flowing where he wanted it to flow.[40]

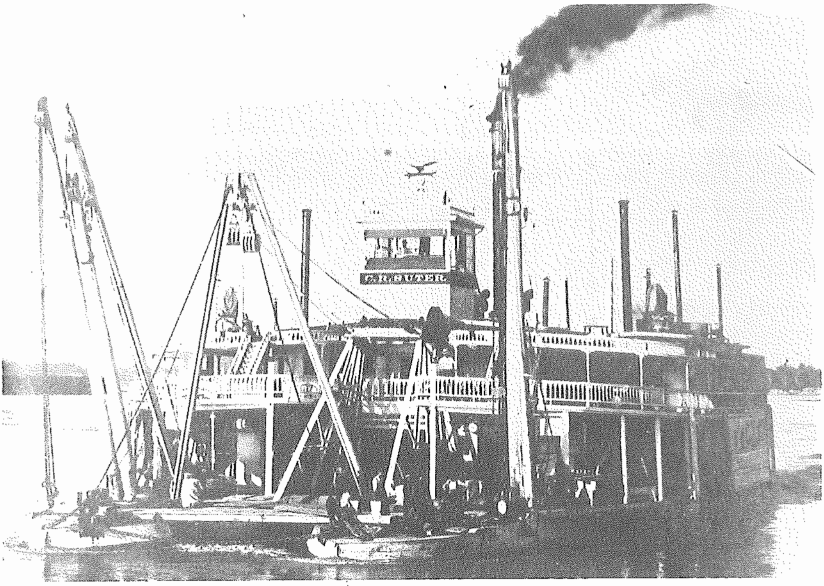
Pease built 7,218 linear feet of screen dike during the 1882 working season. He also explained some of the facets of his pile-sinking work in his report to Suter that year. Pease used cottonwood piles rather than Norway pine [sic] piles, as the cottonwood was half the price of the pine [sic]. The cottonwood piles arrived at the work sites in rafts of 10 to 100 piles 18 to 32 feet long, six inches in diameter at the tip, and eight inches in diameter at the butt. His crew sank 32 piles to an average depth of 14 feet during its best ten-hour workday. Pease explained that his crew was inexperienced, the work experimental, and the hydraulic pile sinker less than efficient. He also recommended that a picked crew be hired and paid by the year so that the work could be done more efficiently.[41]

In his report to Suter about the 1882 work, Pease mentioned the effective service of his assistants, Wynkoop Kierstad Jr. and A. J. Grove. Pease also summed up the difficulty of the work: "The time wasted in putting in a thousand feet of dike is appalling, and is simply the aggregate of a thousand and one little delays, insignificant in themselves but formidable in the grand total."[42]

The River and Harbor Bill for 1883 failed to be passed by Congress. During July and August of that year Pease's crew consisted of himself and a watchman to tend the idle work boats. Then Suter made $9,563.35 available to Pease from the balance of prior appropriations. Pease spent the money repairing 2,500 feet of the Omaha revetment and extended the revetment down the Omaha shore to the Union Pacific bridge.[43]

Pease again used a sailing barge to bring 20 cords of willow from upstream stands. He wove the willows into a continuous mattress ten inches thick and 75 feet wide on the 15- by 60-foot scow. His crew was able to weave 110 feet of mattress a day. Three 3/8-inch wires were woven into the mattress to give it longitudinal strength. The mattress was weighted with stone brought in by the Burlington and Missouri River Railroad. One thousand pounds of rock were laid on each linear foot of mattress. The bank above the government work was covered with crushed rock.

The work began on September 30, 1883, and extended into December. At that time the work was ended and the working



Charles Suter's pioneering work on the Missouri with the U.S. Army Corps of Engineers is reflected in the name of this snag boat, the C. R. Suter, *photographed in 1906 at Kansas City.*

fleet transferred to the Corps of Engineers project at St. Louis.

The years 1877 to 1883 constituted a period of experimentation in training the Missouri River. Although Suter's three assistants met the Missouri with intelligence and innovation, their knowledge, methods, and means were insufficient to constrain the river. Perhaps the greatest benefit of their work was an increased understanding of the Missouri River.

Almost 100 years passed before the Engineers completed river stabilization work at Omaha. During that century the Engineers added to the knowledge they had gained during the years 1877 to 1883 and developed new tools which finally helped them train the Missouri River. It was not until 1981 that Colonel Vito D. Stipo, the Omaha District Engineer, ceased to spend money for the improvement of the Missouri River.[44] Thereafter the Engineers' fund would be expended to maintain the effective works then in place.

NOTES

1. Major Charles R. Suter, *A Report from Major Suter Upon the Survey of the Missouri River at Omaha,* Senate Executive Document 17, 45th Congress, 2nd Session, pp. 2-3.

2. River and Harbor, "Forty-fourth Congress," *New York Times,* July 24, August 4, 1876.

3. Lyman E. Cooley to Major Charles R. Suter, August 6, 1879, in Appendix 09 of the *Annual Report of the Chief of Engineers for 1879.* Hereafter these reports will be cited as *Annual Report* and the year.

4. Title obscured, article in *The Omaha Daily Herald,* July 10, 1877.

5. Major Charles R. Suter, *Surveys of the Missouri River at Omaha, Atchison, Plattsmouth and Brownville,* Senate Executive Document 30.

6. Report of Assistant Engineer Max Boehmer to Suter, December 7, 1877, Appendix M, *Annual Report of 1878.* All of Suter's civilian assistants carried the title of Assistant Engineer. They will be styled A. E. on their first introduction.

7. George C. Hayden, *The Missouri River and Its Improvement* (Kansas City: 1931) and Raymond L. Huber, *Stabilization of the Missouri River* (Omaha: n.d.), typescripts in the historical file of the Omaha District of the Corps of Engineers. They were written to explain the Missouri River and its improvements to individuals without an engineering background.

8. Boehmer, report of December 7, 1877; Chief of Engineers, Brigadier General A. A. Humphreys, to Secretary of War George Washington McGrary, July 31, 1878, *Annual Report of 1878,* p. vii.

9. Suter to Humphreys, July 31, 1878, Appendix M, *Annual Report of 1878.*

10. Suter to Chief of Engineers, Brigadier General H. G. Wright, September 24, 1879, Appendix O, *Annual Report of 1879* and *Missouri River Between Omaha Nebraska and the Mouth of the Platte River,* House Document 46, 62nd Congress, 1st Session, p. 6.

11. Leland R. Johnson, "An Army Engineer on the Missouri in 1867," *Nebraska History,* 53 (Summer 1972), pp. 253-255; *Missouri River Between Omaha Nebraska and the Mouth of the Platte River,* p. 5; Suter to Wright, September 24, 1879.

12. Captain Thomas B. Handbury to Suter, January 28, 1880, Appendix Q, *Annual Report of 1880; Missouri River Between Omaha Nebraska and the Mouth of the Platte River,* p. 5.

13. Report of Chester B. Davis, A. E., to Suter, July 19, 1880, Appendix Q, *Annual Report of 1880;* S. Waters Fox, A. E., to Board of Engineers for Rivers and Harbors in *Missouri River Between Omaha Nebraska and the Mouth of the Platte River,* pp. 7-8.

14. Davis to Suter, July 19, 1880; Suter to Wright, September 10, 1880.

15. Wright to Secretary of War Alexander Ramsey, October 16, 1880, *Annual Report of 1880,* pp. 165-166; Davis to Suter, July 19, 1880.

16. Davis to Suter, July 19, 1880; Suter to Wright, September 10, 1880.

17. Ibid.

18. Davis to Suter, July 19, 1880; Handbury to Suter, January 28, 1880; *Missouri River Between Omaha Nebraska and the Mouth of the Platte River,* Appendix A, p. 9.

19. Davis to Suter, July 19, 1880; *Missouri River*, p. 17.
20. Davis to Suter, July 19, 1880; *Missouri River Between Omaha Nebraska and the Mouth of the Platte River*, Appendix A, p. 12.
21. Davis to Suter, July 19, 1880; Handbury to Suter, January 28, 1880.
22. Davis to Suter, July 19, 1880. See Cooley to Suter, August 6, 1879, and C. F. Potter, A. E., to Suter, July 9, 1881, Appendix S, *Annual Report of 1881.*
23. Davis to Suter, July 19, 1880; Suter to Wright, September 10, 1880.
24. Davis to Suter, July 19, 1880; Handbury to Suter, January 28, 1880; *Missouri River Between Omaha Nebraska and the Mouth of the Platte River*, Appendix A, p. 12.
25. Davis to Suter, July 19, 1880; *Missouri River Between Omaha Nebraska and the Mouth of the Platte River*, Appendix 12, p. 12.
26. "Rising and Falling," *Omaha Daily Bee*, April 26, 1881; Handbury to Suter, January 28, 1880; Wright to Ramsey, October 16, 1880; *Missouri River Between Omaha Nebraska and the Mouth of the Platte River*, Appendix A, p. 12.
27. Charles S. Pease, A. E., to Suter, July 14, 1881, Appendix S, *Annual Report of 1881; Missouri River*, p. 9.
28. Pease to Suter, July 14, 1881.
29. "Missouri's Majesty," "Higher Than Ever," and "Missouri's Might," *Omaha Daily Bee*, April 21, 22, 23, 1881; Pease to Suter, July 14, 1881.
30. Pease to Suter, July 14, 1881; Suter to Wright, September 28, 1881; *Missouri River Between Omaha Nebraska and the Mouth of the Platte River*, Appendix A, p. 10.
31. Pease to Suter, July 14, 1881.
32. Pease to Suter, July 1, 1882, Appendix S, *Annual Report for 1882.*
33. Pease to Suter, July 1, 1882; Wright to Secretary of War Robert Todd Lincoln, October 19, 1882, *Annual Report of 1882*, pp. 224-225.
34. Pease to Suter, July 1, 1882; Wright to Lincoln, October 19, 1882.
35. Pease to Suter, July 1, 1882; Suter to Wright, September 30, 1882; Wright to Lincoln, October 19, 1882; Suter to Board of Engineers for Rivers and Harbors in *Missouri River Between Omaha Nebraska and the Mouth of the Platte River*, p. 7.
36. Pease to Suter, July 1, 1882; *Missouri River Between Omaha Nebraska and the Mouth of the Platte River*, Appendix A, p. 9.
37. Pease to Suter, July 1, 1882; *Missouri River Between Omaha Nebraska and the Mouth of the Platte River*, Appendix A, p. 10.
38. Pease to Suter, July 1, 1882.
39. Ibid.; *Missouri River*, p. 19.
40. Pease to Suter, July 1, 1882.
41. Ibid.
42. Pease to Suter, January 1, 1884, *Annual Report of 1884;* Suter to Chief of Engineers, Brigadier General John Newton, August 14, 1884, *Annual Report of 1884;* Wright to Lincoln, August 13, 1883, *Annual Report of 1883*, p. vii.
43. Pease to Suter, January 1, 1884.
44. Colonel Vito D. Stipo, "Annual Report of the Omaha District Engineer," *The Annual Report of the Chief of Engineers for 1981* (Washington, D.C.: 1982), pp. 21-23.