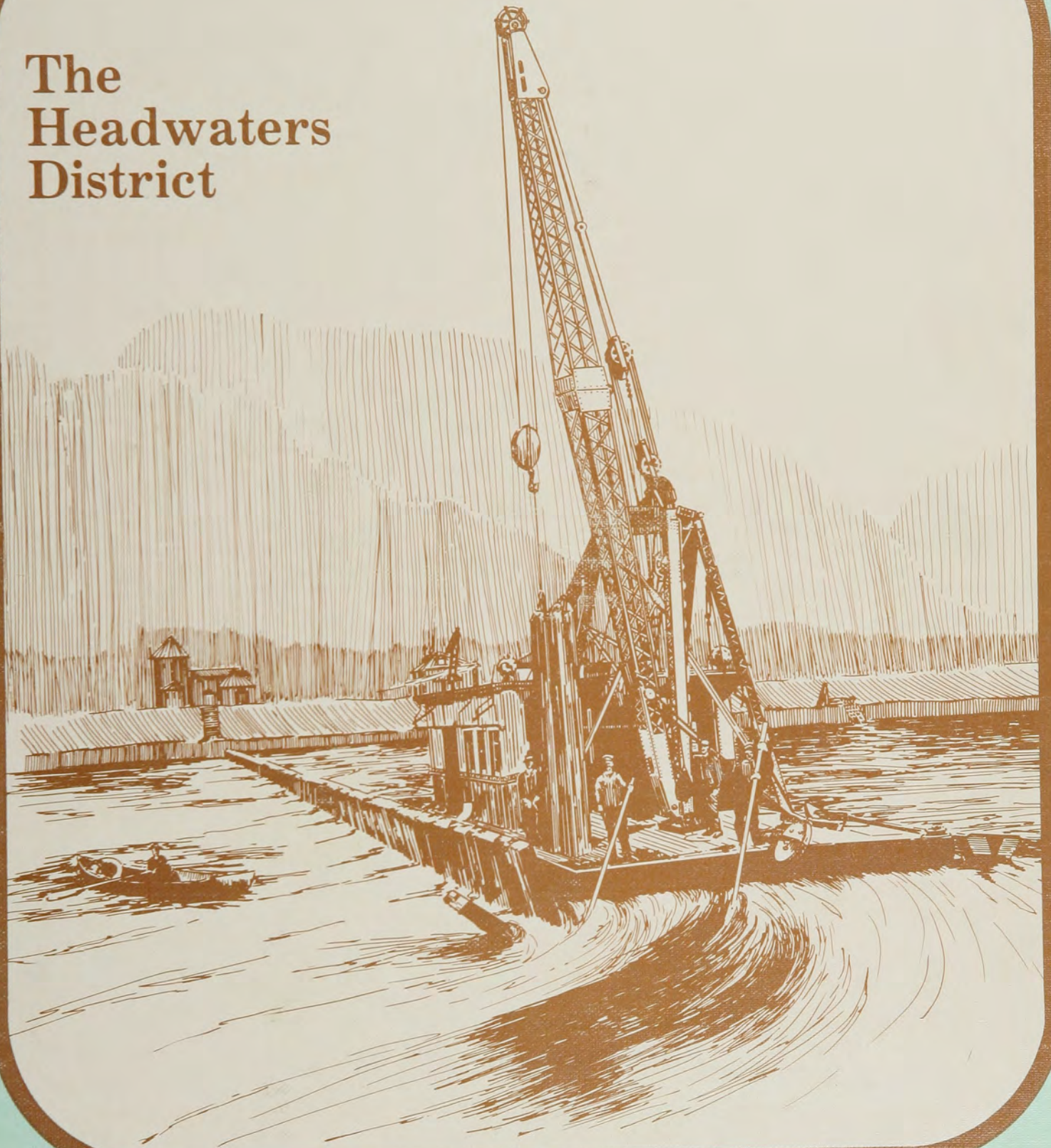
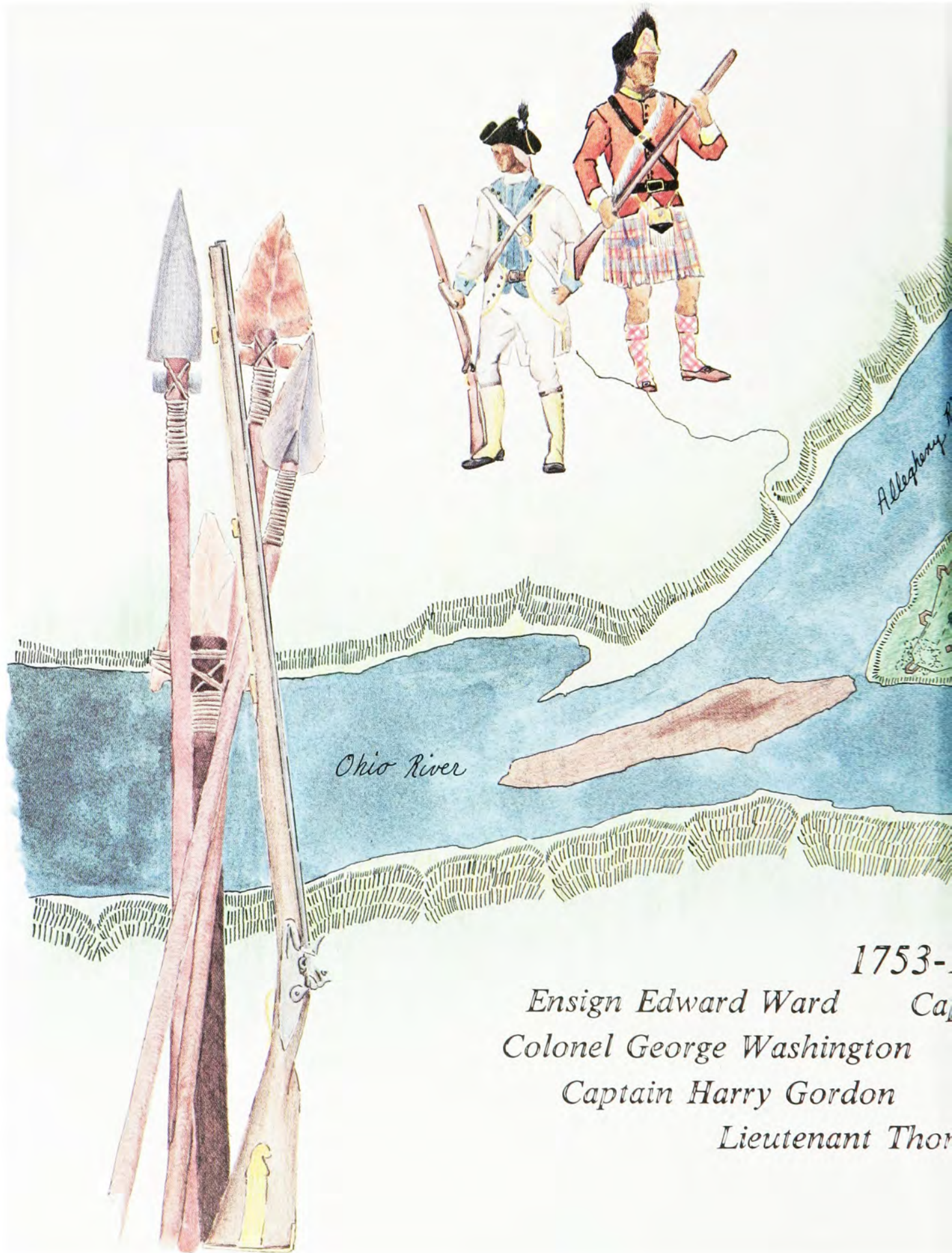


The Headwaters District



A HISTORY OF THE PITTSBURGH DISTRICT, U.S. ARMY CORPS OF ENGINEERS

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1753-

Ensign Edward Ward Cap
Colonel George Washington
Captain Harry Gordon
Lieutenant Thor



3761

Captain Francois Le Mercier
 General Edward Braddock
 General John Forbes
 Gas Hutchins



The Headwaters District

A HISTORY OF THE PITTSBURGH DISTRICT, U.S. ARMY CORPS OF ENGINEERS
By Dr. Leland R. Johnson

FORWARD

This is a history of the Engineers in the headwaters district, - military and civilian. By authority of Congress, the Army Engineers began the task of taming the waters of the Ohio River Basin in 1824. Many of their accomplishments were achieved by trial and error, since the problems that they were asked to solve had never been faced before. I think it appropriate to paraphrase a statement from an individual who, at one time, served the District with considerable distinction. His comment was used in a much narrower context, but I feel sure the reader can sense its applicability to much of the action in this history.

It is interesting and almost thrilling to read of these Engineers and see how they worked out their problems, because in earlier days there were no computers and many of their decisions were worked out on the basis of feeling. Now whether this is good engineering or not, I don't know, but it was the ART, and they practiced it exceedingly well...

The course of history never changes instantaneously. Nevertheless, sometimes there appears to be accelerated periods of transition. The decade of the 1970's may have been one of those periods for the Pittsburgh District. Modernization of navigation facilities on the Ohio River eliminated the last of the wicket dams. The flood control reservoir system was thoroughly tested by Tropical Storm Agnes. Flood plain management was becoming an increasingly important factor in consideration of flood damage prevention. And in a surge of development of recreation facilities, the District took on the task of environmental education directed to school children.

The third century of Engineer activity in the headwaters district must include involvement with the delicate balance between energy demands and environmental protection. Maintenance, repair and replacement of navigation and flood control structures will still be necessary, but attention of the headwaters Engineers may well be directed to additional fields of major importance. A prime concern will be water availability, whether it be for the usage of an increasingly urbanized population or for production of power, - hydroelectric, nuclear, or created by synthesis of fossil fuels. Based on the records of the past, the Engineers of the Pittsburgh District will meet the challenges of the future.

The author has paid tribute to the support provided by my predecessors. I should like to add my own word of appreciation, especially to Max Janairo, whose lot it was to get the project actually started.

JOSEPH A. YORE
Colonel, Corps of Engineers
District Engineer

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AUTHOR'S PREFACE

The Pittsburgh Engineer District is merely one of many Districts of the Corps of Engineers, United States Army, that direct water resource development and perform other assigned missions throughout the world; yet, it is proper for many reasons to refer to the installation at Pittsburgh as *the* "headwaters district." At Pittsburgh, British and French Army Engineers first met in combat, launching the French and Indian War; and from Pittsburgh, American frontier engineers staged their campaigns during the Revolution to secure the Ohio and Mississippi basins for the United States. Here, Army Engineers began their explorations of the American West, and here, the pioneers boarded their frail craft to begin their voyages to new homes on the frontiers. A reminder of those events is the fact that distances along the Ohio River are measured not in miles above the mouth of the stream, as on other rivers, but in miles below Pittsburgh.

The term "headwaters" refers to the sources and upper waters of a stream, and the Pittsburgh Engineer District is responsible for a region including the Allegheny, Monongahela, and Beaver rivers and their tributaries to their sources and the Upper Ohio River, which is formed by the confluence of its headwater streams at Pittsburgh. The Engineer District includes the westernmost parts of the states of New York, Pennsylvania, and Maryland and eastern sections of West Virginia and Ohio, an area of generally rugged terrain along the western slope of the Appalachians where streams tumble down mountainsides, flowing swiftly toward the Ohio at Pittsburgh and from thence on toward the west. Geographically, the Pittsburgh Engineer District is a "headwaters district."

The Pittsburgh Engineer District was the home of the pioneer marine engineers and waterways shippers. Here were built the first flatboats, keelboats, and steamboats; here the first barges and towboats were built. The District was the cradle of American inland river commerce.

It was natural therefore that the improvement of inland river navigation should begin at Pittsburgh. Here, the Army Engineers undertook their first experiments with waterways improvement engineering, clearing snags and constructing dams in 1824 to open river channels for reliable commerce. So many innovative waterways engineering methods were tried and tested in the Pittsburgh Engineer District that it became the empirical "experiment station" for the entire inland rivers system. Pittsburgh was the "headwaters district" for waterways navigation engineering.

It was at Pittsburgh that the great political and engineering controversies over flood control methods began and were fought out during the twentieth century. To find the origins of the modern multipurpose water resource development mission of the Corps of Engineers, one must look to the history of the Pittsburgh Engineer District.

In the history of the Pittsburgh Engineer District, one also finds many firsts in military construction engineering, - in the engineering of aerospace facilities ranging from biplane aerodromes to moon rockets, and in the multitude of other missions assigned to the Corps of Engineers during the past two centuries. In sum, the District has been the site of so many "firsts" that it clearly is *the* "headwaters district."

The purpose of the author has been to relate the turbulent story of the operations of Army Engineers within the headwaters district against the background of the history of the Corps of Engineers, with some attention to the correlation between Engineer activities and general regional economic and social development. The interests of the general reader, as well as those of the Engineers, have been taken as a basis for the selection of materials.

This study began during the administration of Pittsburgh District Engineer Edward G. West and continued during the administrations of District Engineers Norman G. Delbridge, Max R. Janairo, and Joseph A. Yore, and the author appreciates the support that each has given to the study. Mr. Jacques S. Minnotte, Chief Engineering Advisor in the District during this same period, has been most helpful in his meticulous review of the text. Special thanks are due to a number of individuals retired from service in the Pittsburgh District, who loaned personal papers, described certain incidents, or answered puzzling questions. Their names are listed on another page. It would not be feasible to similarly list the names of the many active employees who surrendered precious time to answer questions, but they also deserve the author's heartfelt gratitude.

Critics may complain that the author has been too sympathetic to the functioning and goals of the Army Engineers. He has observed the work of the Engineers for several years during routine operations and during crises that came after AGNES in 1972 and at Johnstown in 1977, and he admits that he admires their dedication and integrity. He is convinced that "The Corps Cares" slogan is not a mere public relations gimmick.

LELAND R. JOHNSON

ABOUT THE AUTHOR: Dr. Leland R. Johnson is truly the historian of the Army Engineers in the Ohio Valley. He has written histories, now in print, of the Nashville, Louisville and Huntington Engineer Districts, edited historical studies for the Ohio River Division, and composed articles on relevant subjects that have appeared in *The Military Engineer*. This history of the headwaters district completes the cycle - from Cairo back to Pittsburgh.

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Chapter 1

ENGINEERS AT THE HEADWATERS

At sunset on June 16, 1775, Colonel Richard Gridley strode up Breed's Hill to begin work. Moving quietly to avoid alerting sentries and drawing fire from British cannon in Boston, Gridley reconnoitered the hill, determining what approaches the British might use, locating the best defensive positions on the hillcrest, and staking out a fort where the Yankees would have a clear field of fire. As the Boston church bells tolled midnight, he called up the troops, who shuffled stealthily up the hill and slushed a thousand shovels into the dirt, quickly forming the rude fortification. When the first glimmers of the sun lightened the eastern sky and the stars snuffed out, Gridley, his back aching and hands sore from the shovel, paced the hill for a final inspection and was pleased. "The British are in for quite a surprise," he thought, as he walked back of the fort to exchange his shovel for a sword.

Like most engineers of the Continental Army, Colonel Gridley learned his trade in the British Army during the French and Indian wars. He directed the Anglo-American siege of French Louisbourg at the mouth of the St. Lawrence River in 1745 and shocked the world by capturing that "Gibraltar" of America; he built fortifications throughout New England and led the troops who dragged cannon up the cliffs to the Plains of Abraham to take Quebec in 1759. For his services against the French, he was awarded a 3,000 acre landgrant, a valuable seal and cod fishery, and a pension. Some thought Gridley, because of the honors and fortunes granted him, would rejoin the service of the King in 1775 to suppress the American rebels, but, like his wealthy friend George Washington, he risked all to join the Continentals. "I shall fight for Justice and my Country!" he declared.

At daybreak on June 17, British officers gazed with astonishment at the fortifications thrown up on Breed's Hill by Gridley and the Yankees and

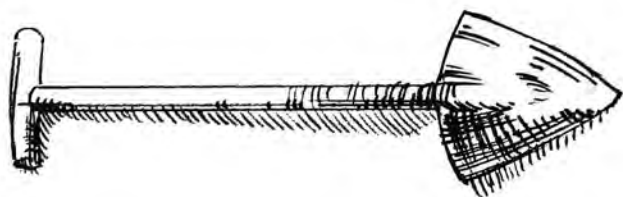


Colonel Gridley inspects the fortifications...

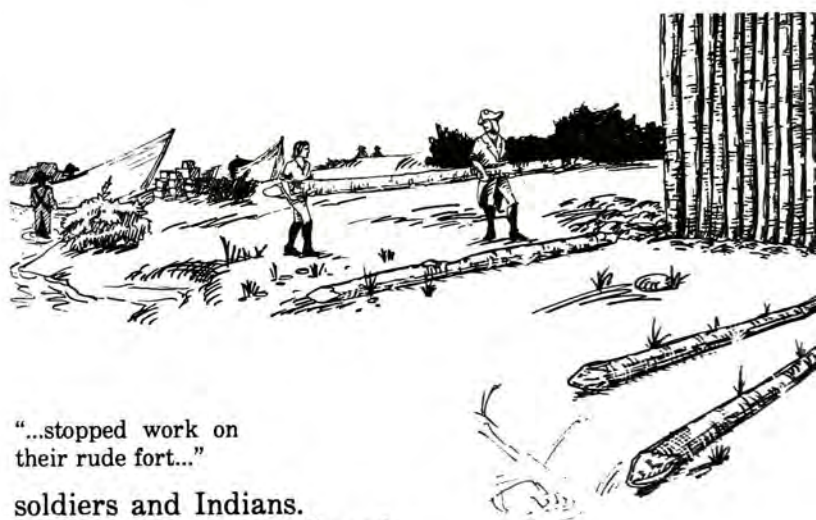
The Military Engineer

ordered an immediate assault to take the hill. Colonel Gridley served the guns that wreaked havoc on closely ranked British lines during the battle known to posterity as Bunker Hill until he was wounded. While recovering from his wound he learned that Congress, at the request of Washington who thought him one of the "greatest engineers of the age," had appointed him Chief Engineer of the Continental Army, the first of the vigorous and colorful officers who were to command the Corps of Engineers, United States Army.

The saga of the Army Engineers at work in the Allegheny, Monongahela, and upper Ohio River basins, the headwaters of the Ohio River and in a sense the headwaters of all American inland rivers, began before Colonel Gridley built the fortifications on Breed's Hill and became the first Chief Engineer of the Corps. Army Engineers, in fact, operated in the headwaters district long before the Revolution, some serving the British and others the French king.



French Engineers at the Headwaters Ensign Edward Ward and his men stopped work on their rude fort and watched in amazement as an immense French canoe and bateaux flotilla landed on the bank of the Allegheny and disgorged some 1400



"...stopped work on their rude fort..."

soldiers and Indians.

Ward could see the French

engineer directing the landing and placement of eighteen cannon to smash the Virginians' fort to splinters.

With two drummers under a flag, the Frenchman strode up the slope to meet with Ward. He explained that he was Captain Francois Le Mercier, engineer to Captain Pierre de Contrecoeur in the service of his majesty the King of France, in whose name it was demanded that the English surrender their fort, which was clearly a trespass on French lands, and return to British territory east of the Alleghenies or suffer the consequences. Ward, with forty men and no hope of reinforcement, made the wise choice, marched his men from the fort, and trudged back toward home. Captain Le Mercier immediately destroyed the English stockade and began construction of an elaborate fortification, to be named Fort Duquesne, on the point between the forks at the confluence of the Allegheny and Monongahela.

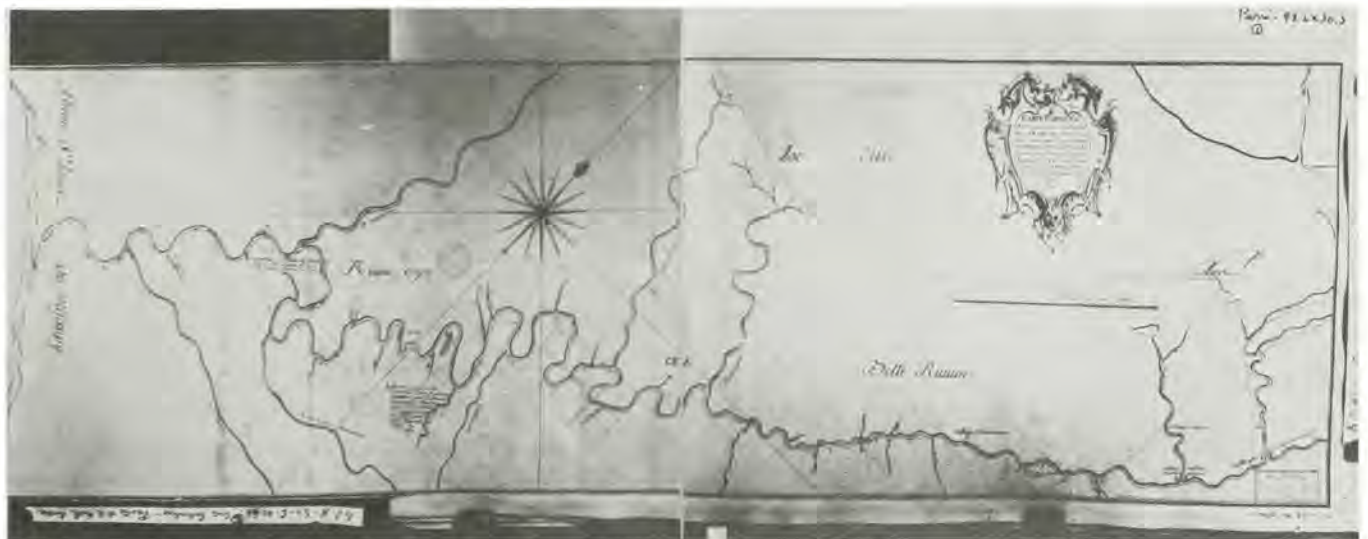
Captain Le Mercier, chief of Canadian engineers, had worked in 1753 on the forts building at Presque Isle, Le Boeuf, and Machault or Venango (at the present sites of Erie, Waterford, and Franklin, Pa., respectively), and had cleared *Rivière Le Boeuf*, later renamed French Creek, for navigation by canoes and bateaux transporting the French troops advancing into the headwaters district. In the spring of 1754, he left Montreal with 350 men and orders to build a fort near the mouth of the Monongahela and block the British advance via that river. He met Captain Contrecoeur on French Creek, and moved with the assault force in 300 canoes and 60 bateaux down the rainswollen Allegheny; his mission: to effect a landing at the Point, drive the impertinent British intruders from that strategic spot, and secure control of the headwaters district by construction of Fort Duquesne. Le Mercier accomplished his threefold task with precision, but the British were not to be so easily denied the riches of the Ohio River basin.

French engineers had been at work in the Mississippi and Ohio river basins, exploring and mapping the region and building fortifications,

throughout the 18th century. Sieur Le Blond de La Tour of the French Corps had dredged the lower Mississippi near New Orleans about 1720 and had also built the first levee for flood protection in America. Joseph Gaspard Chaussegros de Lery, engineer to Baron Longueuil's expedition of 1739 against the Chickasaws, drew the first reasonably accurate map of the headwaters district, outlining the courses of French and Conewango creeks and *La Belle Rivière*, the Allegheny and Ohio rivers. Captain Le Mercier, when he cleared snags from French Creek in 1753, became the first engineer to improve a stream for navigation in the Ohio River basin.

The Royal Engineers of France were foremost in Europe during the 18th century. The first chief of the French Corps, the Marquis de Vauban, was renowned for his expertise in fortification construction. Many forts in North America were designed on principles developed by Vauban and every modern military engineer recognizes his name. Even in an-

Map of Joseph Gaspard Chaussegros de Lery
Library of Congress



cient times, men who built engines of war were known as engineers, but Vauban was first to understand the value of an organized corps of men trained in military engineering. In 1690, he founded the "Corps de Genie."

Because of its leadership, the construction methods and technical vocabulary of the French Corps became the standard, and French influence upon the American Corps of Engineers was greater than that of the British. Benjamin Franklin sent many French engineers to America during the Revolution, and two, General Louis Du Portail and Colonel Stephen Rochefontaine, served as chief engineer to General George Washington. At the first American engineer schools, French instructors used French texts to train Americans who would be engineers. Officers of the Napoleonic army came to the United States after Waterloo, joined the American Corps of Engineers, and had a significant role in performing the first American civil works projects.

Though the first American military engineers won their laurels in service to the British king, the heritage of the Corps of Engineers has retained a distinctly French character. *Essayons*, meaning "Let us try," became the motto of the American Corps of Engineers, whose technical vocabulary also had French roots. So it happened, for instance, in 1945 that the American Navy, which has a British heritage, delivered *pontoons*, boats that support floating bridges, to the Rhine River, where the Army Corps of Engineers promptly placed them in a *ponton* bridge.

Anglo-American Engineers Advance to the Headwaters Six weeks after they seized the Forks of the Ohio from Ensign Ward, Captain Le Mercier and the French received the alarming news that Ensign Jumonville de Villiers and a detachment had been surprised and nearly wiped out by Colonel George Washington and a band of Virginians. They were already acquainted with young Washington; in 1753, he had delivered them a



INSIGNIA OF THE U.S. ARMY
CORPS OF ENGINEERS

The Castle: Distinctive Corps insignia;
symbolizes design and construction
of fortifications

Early Engineer Seal: Device used
on uniform buttons beginning
with War of 1812

Official Seal: Adopted in 1866
and made official in 1897



George Washington's map accompanying his journal - 1754

with ice floes while ferrying the Allegheny, and produced a detailed report and superb map of the headwaters district that was printed throughout the colonies. The exceptional abilities he demonstrated during the 1753 reconnaissance won him a militia command.

Captain Le Mercier learned that Virginians were building a storehouse at Redstone (Brownsville) on the Monongahela and that Washington was erecting a square log stockade with earth embankments and rifle pits at the Great Meadows southeast of Fort Duquesne. Le Mercier planned to move troops in canoes up the Monongahela to take the storehouse at Redstone, then

protest from the Virginia Governor against their advance into the French Creek valley.

Colonel Washington was the first Anglo-American engineer to explore the headwaters district. He had learned, as a county surveyor, to take and record compass readings to the nearest degree, represent traverses on plans and plats, identify and locate trees and topographic features, design polygons to include given acreage figures, prepare accurate maps, recruit and manage survey parties, and survive in the wilderness. He used many of these engineering skills in 1753 during his reconnaissance-intelligence mission across the Monongahela, upper Ohio, Beaver, and Allegheny basins. While delivering the Governor's protest to the French, he studied the navigability of the headwater rivers, located potential sites for fortifications, collected intelligence about French forts and troop strength, survived a rugged encounter

march overland to assault Washington at Fort Necessity. Captain Coulon de Villiers, brother of the officer slain by Washington's detachment, took command of the expedition and carried it out as Le Mercier had planned. Low on ammunition and provisions, hampered by poor troop morale, Colonel Washington surrendered Fort Necessity after a day's siege on July 4, 1754, and marched his men out of the fort on the long trail home; but he returned to the headwaters again in 1755 as aide to General Edward Braddock.

General Braddock, who brought a lengthy train of supply wagons along with his army on the march toward Fort Duquesne, ordered Captain Harry Gordon and the engineer troops to cut a twelve-foot wide roadway ahead of the army. Officers were not commissioned as engineers in the British army until 1757, but men such as Harry Gordon with special talents were assigned the necessary engineering

tasks. Gordon and other officers serving as engineers were badly overworked: they prepared campaign maps, laid out roads, planned bridges and river fords, selected fortification sites, designed and supervised fort construction, and were also responsible for procurement of construction materials, accounting, and inventory. Troops detailed to road construction ahead of the marching columns were known as Pioneers; skilled soldiers assigned to construction were known as Artificers.

On the morning of July 9, 1755, Captain Gordon was ahead of Braddock's main column supervising the Pioneers building fords across the Monongahela; that is, cutting slopes through the precipitous banks for easy crossing by the troops and wagons. He finished the job at noon and, while the army forded the river near the mouth of Turtle Creek, he moved ahead in the vanguard with troops commanded by Colonel Thomas Gage, who bore the first brunt of the savage French and Indian attack that nearly annihilated Braddock's command. In the hospital at Fort Cumberland, Maryland, after the retreat, Captain Gordon dictated his afteraction report and signed it with his left hand, because, he explained:

I am a Good Deal hurt in the Right Arm, having Receiv'd a Shot which went thro', & Shattered the Bone, half way Between the Elbow & the wrist; this I had Early, & altho' I felt a Good deal of pain, yet I was too Anxious to allow myself to Quit the field; at the last my horse having Receiv'd three shots, I had hardly time to Shift the Sadle on another without the Bridle, when the whole gave way. The passage that was made thro the Bank in the Morning, I found Choack'd up; I was oblig'd to tumble over the high Bank, which Luckily Being of Sand, part of it fell along with me, which kept my horse upon his feet, & I fortunately kept his Back. Before I got 40 yards in the River, I turn'd about on hearing the Indians Yell, & saw them Tomohocking Some of our women & wounded people,

others of them fir'd very Briskly on those that were then Crossing, at which time I Receiv'd another Shot thro' the Right Shoulder. But the horse I Rode Escaping, I got across the River, & Soon came up with the General, Coll. Burton, & the rest of the Officers & men that were along with them, & Continued along with them in the Utmost pain, my wounds not having Been Dress'd untill I came to Guests's [Gist's].

With General John Forbes, Colonel Washington and Captain Gordon again returned to the headwaters in November 1758 to capture Fort Duquesne. It was Washington's fourth trip west in five years. "I have the pleasure to inform you that Fort Duquesne, or rather the ground on which it stood, was possessed by his Majesty's troops on the 25th inst.," Washington informed the Governor of Virginia. "The enemy, after letting us get within a day's march of the place, burned the fort, and ran away by the light of it, going down the Ohio by water, to the number of five hundred men, according to our best information."

Captain Harry Gordon began construction in 1759 of Fort Pitt at the site of the ruins of Fort Duquesne, working the garrison from morning drum to evening gun to build an elaborate Vauban-style pentagon earthwork with brick revetments protected by a deep ditch from the Monongahela to the Allegheny. Gordon was ordered east in 1760, distinguished himself at the siege of Havana in 1762, and in 1764 became chief engineer of all British forces in America.

Among the engineers who continued the construction of Fort Pitt was Thomas Hutchins, who had been quartermaster in General Forbes' army. Hutchins reconnoitered the abandoned French forts in the French Creek valley, found that he enjoyed topographic engineering more than quartermaster duty, and left the army in 1760 to roam the wilderness trails across the northern Ohio River basin as assistant to Indian agent George Croghan.



Above: Fort Duquesne

Below: Fort Pitt

Dioramas on display in Fort Pitt Museum, Pittsburgh



He improved his engineering skills during his travels, collecting intelligence and preparing maps of great value to the British command. At the recommendation of Colonel Henry Bouquet, he was appointed engineer in 1762 in the 60th Royal American Regiment stationed at Fort Pitt.

Hutchins was serving as engineer at Fort Pitt when Indians, followers of Chief Pontiac, attacked it in 1763. He built blockhouses for the fort, one of which is still preserved, and he directed road and bridge construction for Colonel Bouquet during the punitive expedition of 1764 against the Indians in central Ohio.

Opening Navigation on the Ohio Just after noon on June 18, 1766, painted Indians slashed their paddles in and out of the blue Ohio, sun-browned boatmen strained at the oars of seventeen bateaux, and the largest British fleet ever to navigate the Ohio embarked to the sound of cannon salutes from Fort Pitt reverberating from the Allegheny hills and Monongahela bluffs. Engineers Harry Gordon and Thomas Hutchins arranged their survey instruments for convenience in their bateau. They had orders to map the Ohio and Mississippi rivers. Their co-commanders were George Croghan and George Morgan.

George Croghan had negotiated a peace with Chief Pontiac in 1765. He traveled with Hutchins and Gordon in 1766 to confer with other chieftains, distribute the customary presents to the tribes, and defend the expedition with his Indian allies. Croghan had served with Gordon in the Braddock expedition and was partner with Gordon in land speculations. He was also silent partner in the Philadelphia trading firm represented by George Morgan.

George Morgan, junior partner of Baynton, Wharton and Morgan, was supervisor of the western operations of the firm. The partners hoped to supply British garrisons on the Mississippi River and enter the Indian trade. Hutchins, former assis-

tant to Croghan and deputy engineer to Captain Gordon, was a close friend of George Morgan and later became his business partner.

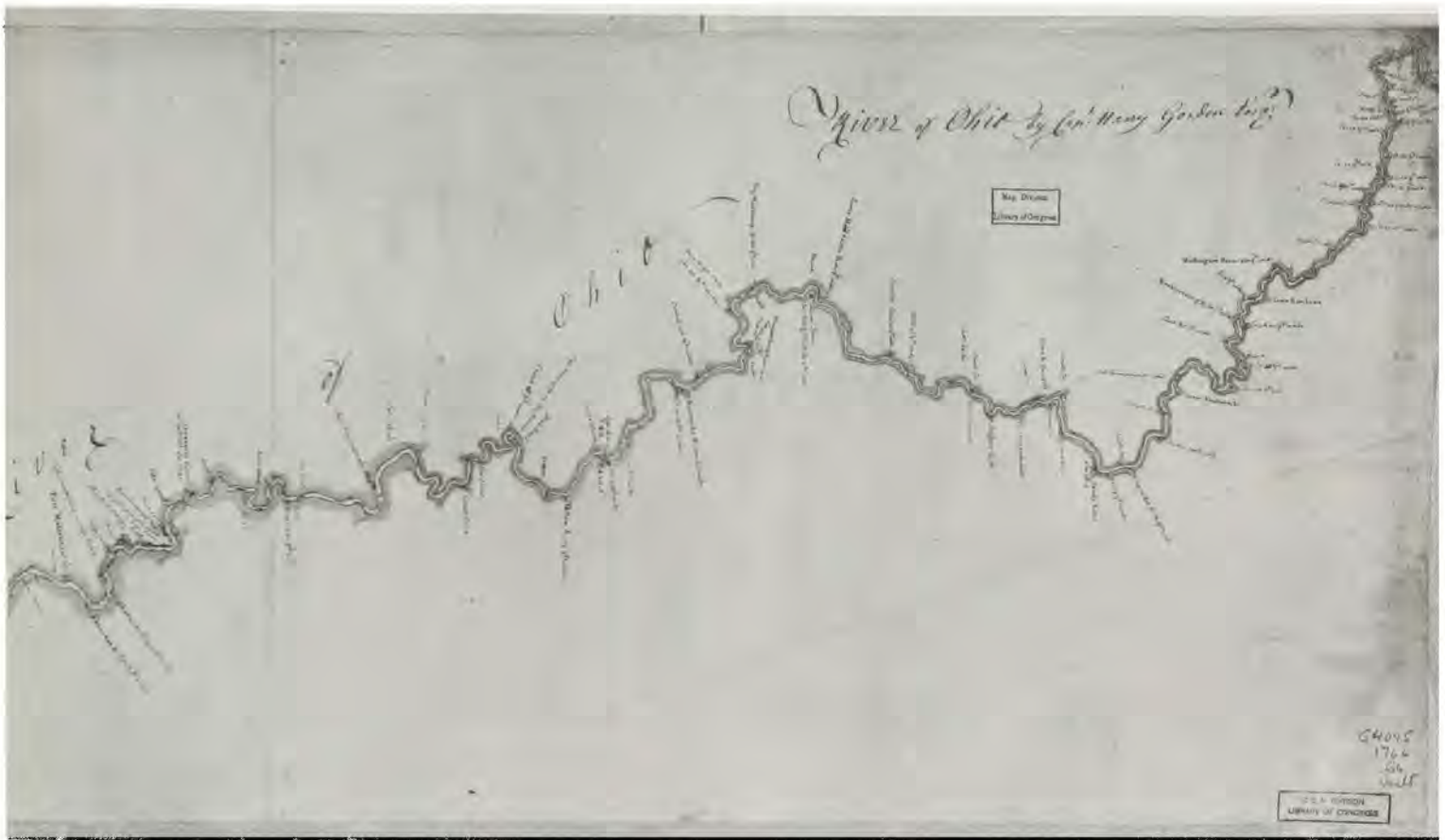
Those personal relationships suggested the multiple military and civil purposes of the 1766 expedition. Croghan was to negotiate with the tribes, defend the expedition with his warriors, and perhaps profit from the Indian trade. Morgan would develop and supervise a profitable trade via the Ohio River and also supply the army garrison. And the engineers would map the river and plan its use as a logistic line for troop supply and avenue for the Indian trade.

Because the British command had encountered obstacles to manning and supplying the forts taken from the French along the Mississippi, General Thomas Gage had ordered Gordon and Hutchins to



Colonel George Morgan

Carnegie Library of Pittsburgh



Captain Gordon's map of the Ohio River
Library of Congress

map the Ohio, noting its width, depth, velocity, channels, and surrounding topography. The engineers were also to locate camp sites for traders and troop units moving by water and to explore the Mississippi, obtaining intelligence about Spanish forts and troop strength. That is, the engineers were to gather precise information vital for policy planning and proper troop disposition.

During the voyage down the Ohio in the summer of 1766, Morgan often rode in the light, maneuverable bateau used by Hutchins to crisscross the river, gathering hydraulic and topographic data; he hoped thereby to obtain more information about river navigation for his firm. Croghan met with tribes along the river, while his Indian allies hunted along the banks to supply fresh meat for the boatmen. The fleet sometimes grounded on bars—one boatman drowned trying to free a stranded bateau—and sometimes was forced to bank by violent storms, but reached the mouth of the Ohio on August 7, having averaged about forty miles a day.

Thirteen bateaux carried cargo for George Morgan, who had established a yard for bateaux construction at Fort Pitt in 1765. Indian watercraft, canoes made of tree bark and dugouts or pirogues made of hollowed tree trunks, had been used by early French and British explorers and traders, but by 1765 the bateau, because of its greater cargo capacity and stability, had largely supplanted the native vessels. Bateaux, ribbed and planked flatbottom boats, wider amidship than at the bow and stern, were somewhat similar to the skiffs still used on inland rivers.

The French had rowed bateaux up and down the inland streams since the early 18th century. The first British bateaux on the inland streams were built at Fort Pitt in May 1760 by shipwright Jehu Eyre and sixteen carpenters sent west from Philadelphia by the army. Eyre later built ships for the Continental Navy and the boats in which Washington crossed the Delaware at Christmas, 1776.

In March 1766, George Morgan sent John Jennings and the first five company bateaux--the *Ohio Packet*, *Beaver*, *Dublin*, *Good Intent*, and *Otter*--down the Ohio to the Illinois country. Morgan took the second bateaux fleet downriver in June; and a third fleet, commanded by Mathew Clarkson, who later became mayor of Philadelphia, followed late in the year.

The bateaux fleet led by Morgan, Croghan, Hutchins, and Gordon arrived at the British posts on the Mississippi in August 1766. The engineers continued their survey to the mouth of the Illinois River, then descended the Mississippi, securing the intelligence required by their orders, to New Orleans and returned by sea to the Atlantic coast to make their report. General Gage copied the Hutchins-Gordon map of the Ohio and distributed it to the appropriate field commanders. It was the first detailed hydrographic survey of the river and remained the most accurate source of information about the stream until the American Army Engineers resurveyed it in 1821.



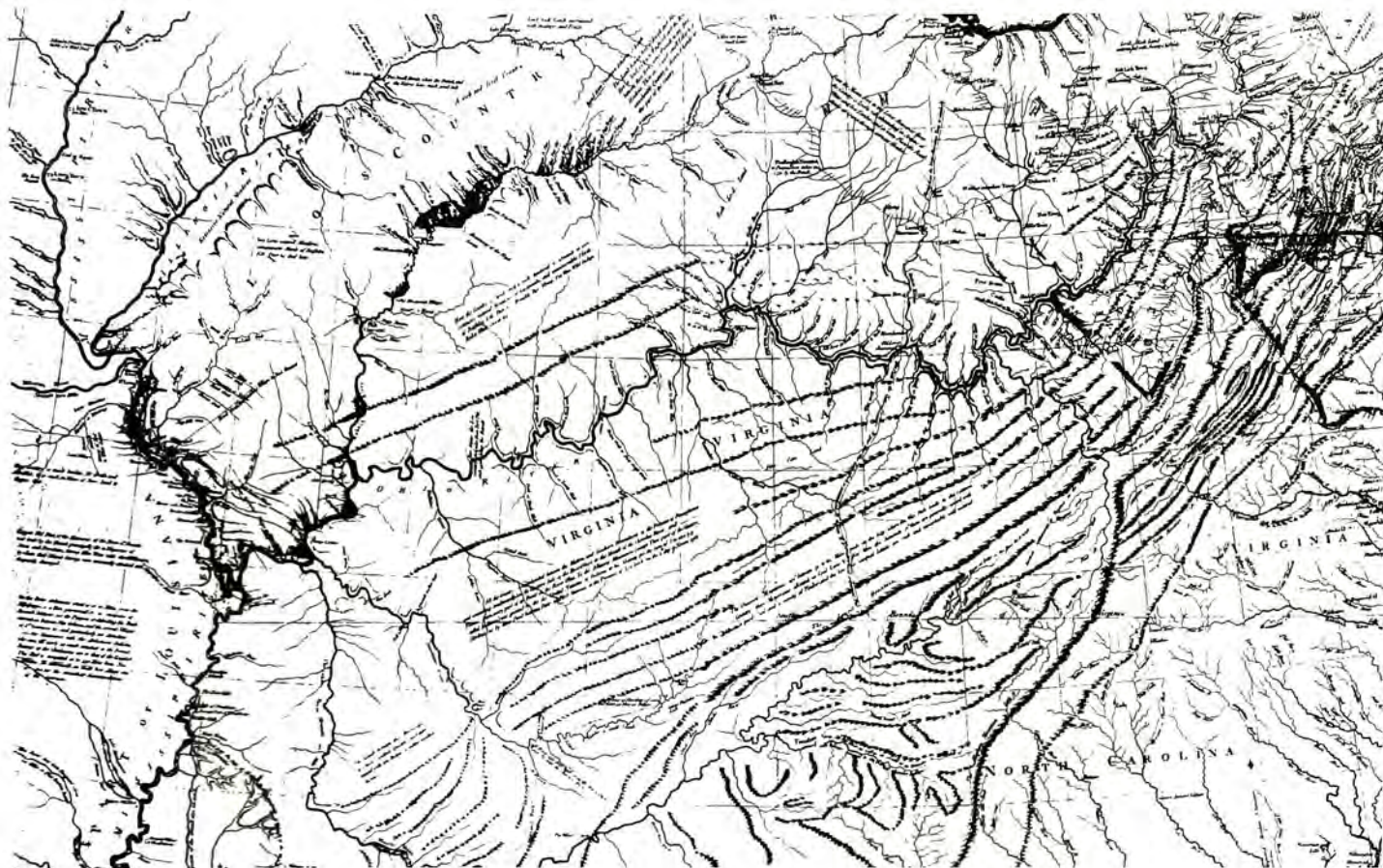
...on parade (a modern reenactment)

British troops often moved to the Mississippi River garrisons after 1766 via the Ohio. Lieutenant George Phyn, for instance, led the 21st Regiment of Foot down the Ohio in eleven bateaux in 1767, conveying a chest of silver for pay of the garrisons, 20,000 pounds of wine to make the troops' tour at the isolated posts more endurable, and a large supply of engineer stores for repair of the forts. Lieutenant Phyn chose the wrong season for the trip. He left Fort Pitt on September 29 and did not arrive at the mouth of the Ohio until November 21. "Never did any party undergo more fatigue than mine has done," Phyn complained, "through the lowness of the Ohio."

Thomas Hutchins returned to Fort Pitt in 1768 and guided five companies of his Royal American regiment down the Ohio to Fort Chartres. He informed his commanders that no army units should leave Fort Pitt after June 10 in any year, for the 981-mile trip down the Ohio could be covered in eleven



Royal American Regiment in action



Thomas Hutchins' map

days at high water but took months when low water stages bared the rocky bottom and the sandbars that obstructed the stream.

Hutchins lived with his friend George Morgan in Illinois and performed the normal duties of a frontier army engineer. In 1769 he built an immense armed bateau, mounting a cannon on its forecastle and capable of transporting 35 men with six-months' provisions. Named the *Gage*, this first warship on the inland rivers was designed for patrol of the lower Ohio and its tributaries. While on river patrol in 1771, Hutchins narrowly escaped an Indian attack. He later built fortifications at Pensacola, Florida, became a member of Benjamin Franklin's American Philosophical Society, and became captain in the British army.

Ohio River Bateaux Trade By 1767, George Morgan had 65 bateaux and 315 men in his navy plying the Ohio. He had four trading posts in the Illinois country and a two-story warehouse, said to have had the first shingle roof in Pittsburgh, at the corner of Ferry and Water streets in the village growing around Fort Pitt. Experience taught Morgan that navigating the Ohio in the summer and fall was arduous and hazardous, so he arranged for bateaux construction at Fort Pitt in the autumn, cargo loading in the winter, and departure downriver at the first moment after the ice broke.

Morgan found his trading profits were devoured by the boat crews, who were paid four pounds currency per month and all they could eat. To reduce personnel overhead, he designed a 46-foot long, 12-foot wide boat, with a 5-foot cargo hold, canvas sails, and 18-inch wide gang boards along its gunnels. He had the boat built at Fort Pitt in 1768 and named it the *Three Friends*, presumably for the three partners, Baynton, Wharton and Morgan. Morgan hoped the *Three Friends* with its large cargo capacity could supplant several bateaux and their crews. It was also designed to ascend the Ohio by sailing before prevailing winds or, when winds were unfavorable, by its crewmen, walking along the gangway and pushing on poles to force the boat upstream.

Morgan called his boat a "bark," meaning a small sailing ship with two or more masts. The *Three Friends* was either the first sailing ship or the first keelboat built on the Ohio River. It was too large for ease of handling in tortuous channels, however, and Captain Patrick Roberts wrecked the boat on the Falls of the Ohio (at present Louisville, Kentucky) in 1768 on its first trip out.

The Ohio River trade was also harrassed by Indians. In July 1767, two bateaux with cargoes worth 3,000 pounds currency were taken by Indians, who murdered the fourteen crewmen. Morgan demand-



ed that the British command build forts along the river supply route and patrol it in armed boats to chastise the Indians who "pillaged our Boats on the Ohio." No doubt one of the missions of the *Gage*, built by Thomas Hutchins in 1769, was to protect Morgan's bateaux fleet.

High overhead, losses to Indians, wrecks on the snags, shoals, and rapids of the Ohio, fierce competition from Spanish and French traders, and the loss of the army supply contract forced Morgan and his associates into bankruptcy in 1772, after eight years in the business. Morgan returned to Philadelphia, where he was elected, along with Hutchins, to the American Philosophical Society and became associated with Benjamin Franklin in a quest for landgrants in the Ohio River basin from the British crown.

Captain Thomas Hutchins was in London preparing his maps and topographic inventories for publication when Colonel Richard Gridley was fortifying Breed's Hill. While in the British capital, Hutchins continued his business correspondence with Samuel Wharton, member of the defunct Baynton, Wharton and Morgan firm and also part of Benjamin Franklin's intelligence organization. British counterintelligence learned of the correspondence, arrested Hutchins, and clapped him in irons on charges of treason; but they could not substantiate the charges and released him. He secretly fled Britain to France, and with a letter of recommendation from Franklin, sailed for America aboard the *Alliance* as secretary to John Paul Jones to become an engineer in the Continental Army.

We Must Quit this Country or Attack! Robert Benham carefully raised his rifle to avoid stirring the leaves of the fallen treetop in which he was concealed and frightening away the raccoon. Hidden in the treetop for two days after the British and Indians had ambushed Captain David Rogers and the Monongahela volunteers, Benham feared Indians might still lurk along the river but gnawing hunger forced him to risk discovery. He squeezed the trigger, cracking the wilderness silence and drop-

ping the 'coon. Food at last! Still, how was he to get to it, for each painful move reopened the wounds in his legs and blood flowed anew.

Rustling leaves warned Benham someone was approaching; he reloaded hastily, pouring powder from the horn, ramming the ball down the barrel, and aiming at the man emerging from the thicket. Just before he fired, he recognized the blood-spattered white man. "Over here, Brown," he called, and Basil Brown walked to him. Their macabre situation was grimly amusing: Benham, wounded in both legs, could not walk; Brown, wounded in both arms, could not use a rifle or feed himself. Benham kindled a fire, and Brown kicked the 'coon to the tree where Benham dressed and cooked the first meal they had eaten in two days. Nineteen days they hid on the bank of the Ohio. Brown walked the forest, driving game to Benham's rifle and kicking it to the treetop for cooking; Benham fed Brown by hand; and Brown waded into the river with a hat clenched in his teeth to get water for Benham. Together they survived and healed, finally attracting the attention of a passing boat which rescued them and eventually returning to their homes on the Monongahela with news of the grim sacrifice the people of the Monongahela had made for American victory on the frontier.

Basil Brown, of the family for whom Redstone was renamed Brownsville, and Robert Benham, who later founded the town of Newport, Kentucky, at the place where he and Brown had hidden in 1779, were volunteers in Captain David Rogers' expedition, the third of a three-phased American amphibious assault down the Ohio River against the British and their Indian allies in 1778 and 1779.

From the onset of Revolution, the tiny Engineer Corps of the Continental Army was not of sufficient size to meet the needs of Washington's army in the campaigns against British regulars along the Atlantic coast. West of the mountains, where the enemy usually were the Shawnee, Wyandot, Seneca, and Cherokee tribes led by British loyalists such as Simon Girty and Matthew Elliott, engineering

tasks, involving construction of log stockades and water craft and topographic reconnaissance, were generally performed by militia officers without professional training but with extensive exploration and Indian warfare experience. Continental regulars garrisoned Fort Pitt and built Fort McIntosh in 1778 at the mouth of the Beaver River. Virginia militia garrisons occupied Fort Fincastle at the present site of Wheeling, West Virginia, renaming it Fort Henry in honor of the Governor of Virginia, and Fort Randolph at the mouth of the Kanawha River. Other militia detachments built many small log stockade forts and blockhouses in the Ohio River basin.

But those forts could not stem the tide of Indian raiding parties. They set the frontier afire during the bloody year of three sevens, and George Rogers Clark told Governor Patrick Henry; "We must quit this country or attack!" His argument was so persuasive that the Governor issued secret orders for Clark to attack British posts on the Mississippi and Wabash river, with the ultimate goal being the



"...aiming at the man emerging from the thicket"

western headquarters of the British army at Detroit.

The American counterattack in the Ohio River basin in 1778 took place in three, perhaps four, roughly coordinated phases. First, in the spring of 1778, General Edward Hand led 500 regulars from Fort Pitt to chastise hostiles along the Mahoning River. Floods hampered the advance, however, the warriors escaped, and only a few women and children were captured. Of that "Squaw Campaign," General Hand sarcastically reported: "In performing these great exploits, I had but one man—a captain--wounded, and one drowned."

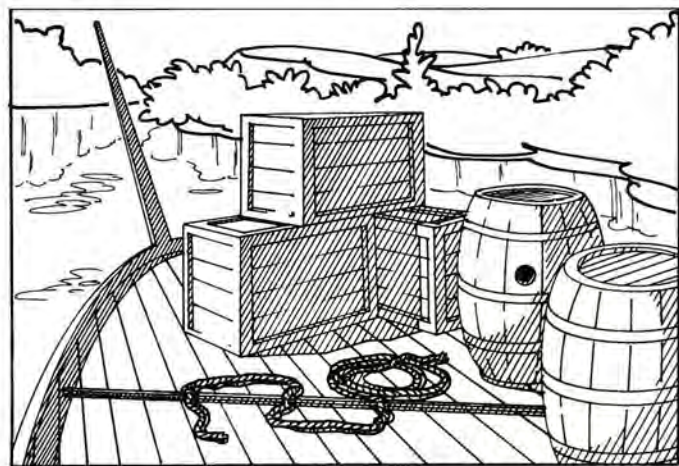
The three other phases of the counterattack of 1778 were by water, in boats built on the Monongahela and supplied at Fort Pitt by Colonel George Morgan.

Congress appointed George Morgan colonel of the Continental Army and sent him back to Fort Pitt in 1776 as commissary general. Morgan converted Fort Pitt into a massive supply depot and made the Monongahela valley the staging area for the American campaigns on western water. He built storehouses along the Forbes Road and at Redstone on the Monongahela and organized a boat department to build vessels to take the war into enemy territory. He arranged construction of thirty bateaux, each 40 feet long, 9 feet wide, with 32-inch gunwales, at the confluence of the Monongahela and Youghiogheny rivers for troop and supply transport, and in early 1778 built six large bateaux armed with small cannon to serve as gunboats.

Morgan still had business contacts in Illinois and Louisiana and in 1776 conceived the idea of obtaining gunpowder from his merchant friends at New Orleans. Carrying a letter from Morgan, Captain George Gibson, Lieutenant William Linn, and fifteen men disguised as traders left Fort Pitt in July 1776, floated down the Ohio and Mississippi and secretly obtained 4.5 tons of gunpowder at New Orleans. Since Spain was at peace with Britain in 1776, authorities at New Orleans arrested Gibson as

a cover, while Linn slipped back upriver and delivered the powder to Fort Henry on May 2, 1777.

Late in 1777, James Willing, scion of a Philadelphia merchant family who had traded at Natchez on the Mississippi before the Revolution, was commissioned captain in the Continental Navy and ordered to clear British loyalists from the Mississippi and secure munitions from the Spanish at New Orleans. Colonel Morgan supplied Willing with the armed gunboat *Rattletrap*, and Willing recruited a thirty-five man crew in the vicinity of Fort Pitt; among them was Lieutenant George Girty, brother to loyalist Simon Girty. The *Rattletrap* sailed from Fort Pitt on January 10, 1778, seized Natchez in February, raided loyalist plantations



"...munitions from the Spanish at New Orleans"

along the Mississippi, and captured the British brigs *Neptune* and *Despatch* and the 16-gun ship *Rebecca*. Willing inflicted damages amounting to more than a million dollars on the loyalists on the Mississippi and temporarily cleared the river as a supply route.

Colonel George Rogers Clark and 150 Virginia volunteers left Fort Pitt in May 1778 in bateaux supplied by Colonel Morgan and flatboats built by John Minor at the mouth of Dunkard Creek on the Monongahela. Clark established an advance base at the Falls of the Ohio (founding the city of Louisville),

then floated to old French Fort Massac near the mouth of the Ohio, from whence he made an epic march to surprise and capture British posts in the Illinois country.

The third phase of the attack via the Ohio was led by Captain David Rogers of Redstone with forty volunteers, Basil Brown and Robert Benham among them, who floated in two flatboats down the rivers to New Orleans to secure gunpowder for delivery to Clark in the Illinois country. Captain Rogers carried a letter from Governor Patrick Henry to the Spanish Governor, in which Henry explained the Americans were short of supplies because of the blockade of the British fleet. "The inland Navigation of Mississippi & Ohio, altho at present subject to many Inconveniences," Henry wrote, "has the great advantage that British Cruisers cannot infest it." Governor Henry was right, but Indians could and did infest the rivers.

Captain Rogers delivered Henry's message to New Orleans and powder to Clark, then began his return up the Ohio to the Monongahela. On October 4, 1779, Rogers saw Indians crossing the Ohio near the present site of Cincinnati and landed his boats to pursue them. The Indians were led by George Girty, together with his brother Simon and Matthew Elliott. George Girty had deserted the Willing expedition at New Orleans in May 1779, made his way to Detroit in August, and led the Indians to set an ambush for the Americans. Rogers and forty-two of his men were killed, five made prisoner, and only thirteen escaped.

In spite of Rogers' defeat, the American counterattack from their staging area in the headwaters district forestalled a British plan to seize the Kentucky and Monongahela settlements. About the same time, another American force was engaged in securing northwestern Pennsylvania and western New York State.

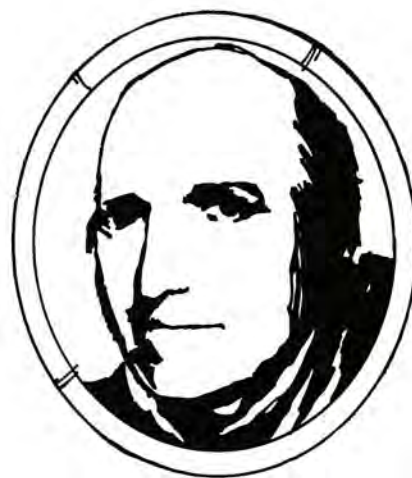
While Colonel Clark was at work in the Illinois country, General Daniel Brodhead moved against the Seneca citadel in the upper Allegheny River

basin. General Washington had learned during his reconnaissance of the Allegheny basin in 1753 that the Senecas and other tribes lived in well-organized villages, subsisting on rich corn harvest from fertile riverbottoms. He decided in 1779 to take the offensive and lay waste to Indian villages and supply sources in western New York and Pennsylvania, planning a three-pronged attack up the Mohawk, Susquehanna, and Allegheny valleys. He sent General Brodhead to command the expedition up the Allegheny.

General Brodhead loaded provisions and munitions into sixty boats and left Fort Pitt on August 11, 1779, ascending the Allegheny to the mouth of Mahoning Creek where he transferred the supplies to packhorses for the overland march, fording Clarion River at Tobys Falls, returning to the Allegheny at the mouth of Tionesta Creek, and continuing up the Allegheny into New York. Brodhead defeated forty warriors he found canoeing down the Allegheny and laid waste to the Seneca homeland in the vicinity of Kinzua and Olean without opposition, for Chief Cornplanter and the Seneca warriors had left home to meet the other American columns at the Battle of Newtown (Elmira, New York).

The Clark and Brodhead campaigns of 1778 and 1779 broke British-Indian power in the Ohio River basin. Sporadic Indian raids continued, but British hopes for victory on the frontier were blasted and the security of American settlements south of the Ohio and east of the Allegheny was greatly increased. To maintain this security, gunboats built by Colonel Morgan patrolled the upper Ohio, and in 1782 Colonel Clark built two gunboats and the *Miami*, a 73-foot galley armed with eight cannon, at the Falls of the Ohio to patrol the lower river. By 1782, the pioneers of the headwaters district felt so secure that they tried to begin a commerce with Spanish New Orleans via the inland streams.

Engineers of the Confederation The Corps of Engineers, like most of the Continental Army, was disbanded at the end of the Revolution. Engineer veterans returned to private surveying and business



Colonel George Rogers Clark

or accepted appointments from state governments, with one exception: Thomas Hutchins.

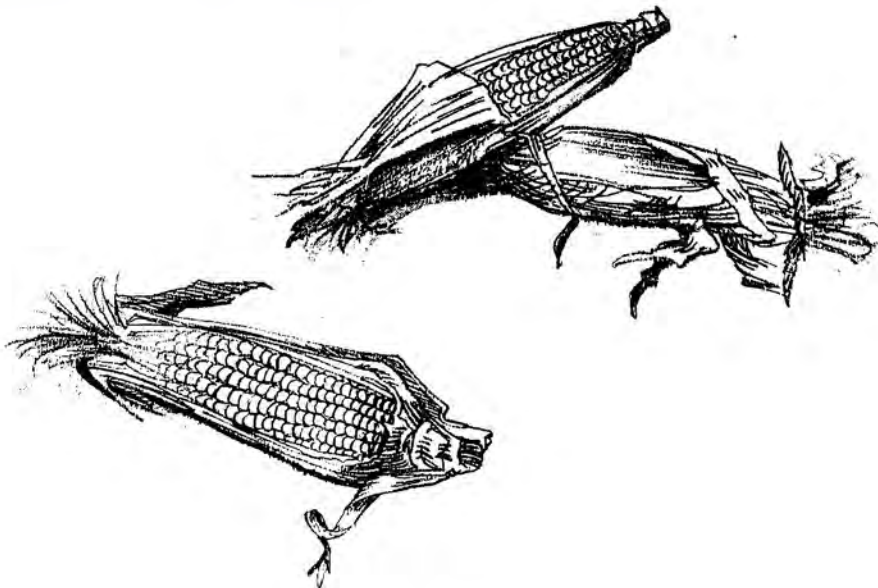
Congress appointed Hutchins "Geographer to the United States" in 1781, by which date he had become justly famed for his surveying and mapping abilities. George Rogers Clark had used Hutchins' map of the inland rivers as a guide during his expedition to Illinois; eastern newspapers printed Hutchins' reports for the benefit of readers who planned emigration to the west; and Thomas Jefferson was studying Hutchins' maps and personally corresponding with the engineer about economic resources, river navigation, and flood frequency in the Ohio River basin.

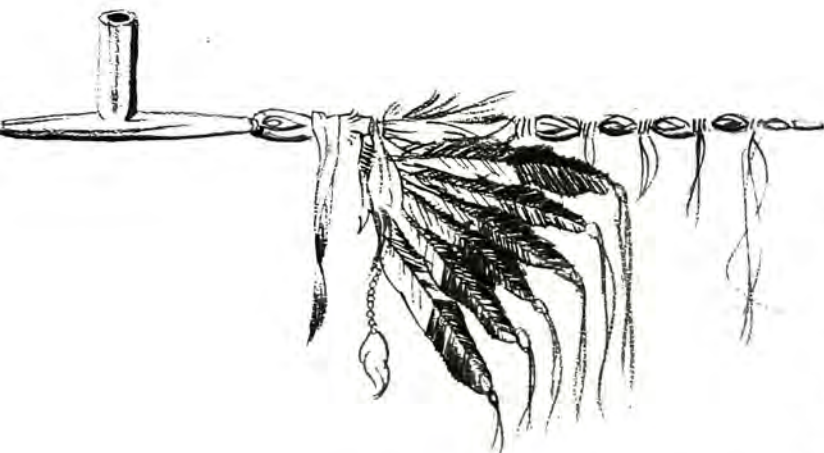
George Washington also studied Hutchins' maps in search of ways to join navigation on the Potomac or James rivers with navigation on the Monongahela and Kanawha rivers, thereby linking coastal cities to inland river commerce. The General had acquired more than 20,000 acres of land in various parcels along Chartiers Creek and the Monongahela, Ohio, and Kanawha rivers in southwestern Pennsylvania and western Virginia. In the autumn of 1784 he visited his western lands, met with Colonel John Canon of Canonsburg, Albert Gallatin of New Geneva, and Zackquill Morgan of Morgantown, and discussed business matters and



possible routes for road and canal systems linking the Potomac River with the Youghiogheny, Cheat, or Monongahela rivers. On his return to Mount Vernon, he dispatched a letter to Congress.

The Assemblies of Virginia and Maryland have now under consideration the extension of the inland navigation of the rivers Potomac and James, and opening a communication between them and the Western waters: they seem fully impressed with the political as well as the commercial advantages which would result from the accomplishment of these great objects; and I hope will embrace the present moment to put them in train for speedy execution. Would it not at the same time be worthy of the wisdom and attention of Congress, to have the western waters well explored, and the navigation of them fully ascertained, accurately laid down, and a complete and perfect map made of the country...?





Through personal exploration of the terrain and information obtained from Thomas Hutchins and others, George Washington had concluded that it might be feasible to connect the Potomac with the Youghiogeny River and the James with the Kanawha River by canals. Improvement of navigation on the rivers named and construction of a canal up the Beaver River valley to Lake Erie could open a complete national waterways system. But such projects would require cooperation among the states, for the federal government under the Articles of Confederation had no interest and certainly not the necessary financial resources for such massive projects.

Virginia and Maryland sent commissioners to Mount Vernon in 1785 to discuss the proposed canal from the Potomac to the Youghiogeny. The commissioners recognized that Pennsylvania should also be consulted and that some uniform commercial regulations should be devised. Thus, planning for waterway transportation improvements led to recognition of the need for closer cooperation among the states.

A second convention on the subject met at Annapolis in 1786, and a third met at Philadelphia in 1787, where it wrote the Constitution of the United States. Historians have sometimes argued that Washington's interest, indeed it has been called an obsession, in the construction of improved waterways to bind the nation together as a political and economic unit led directly to the writing of the Constitution.

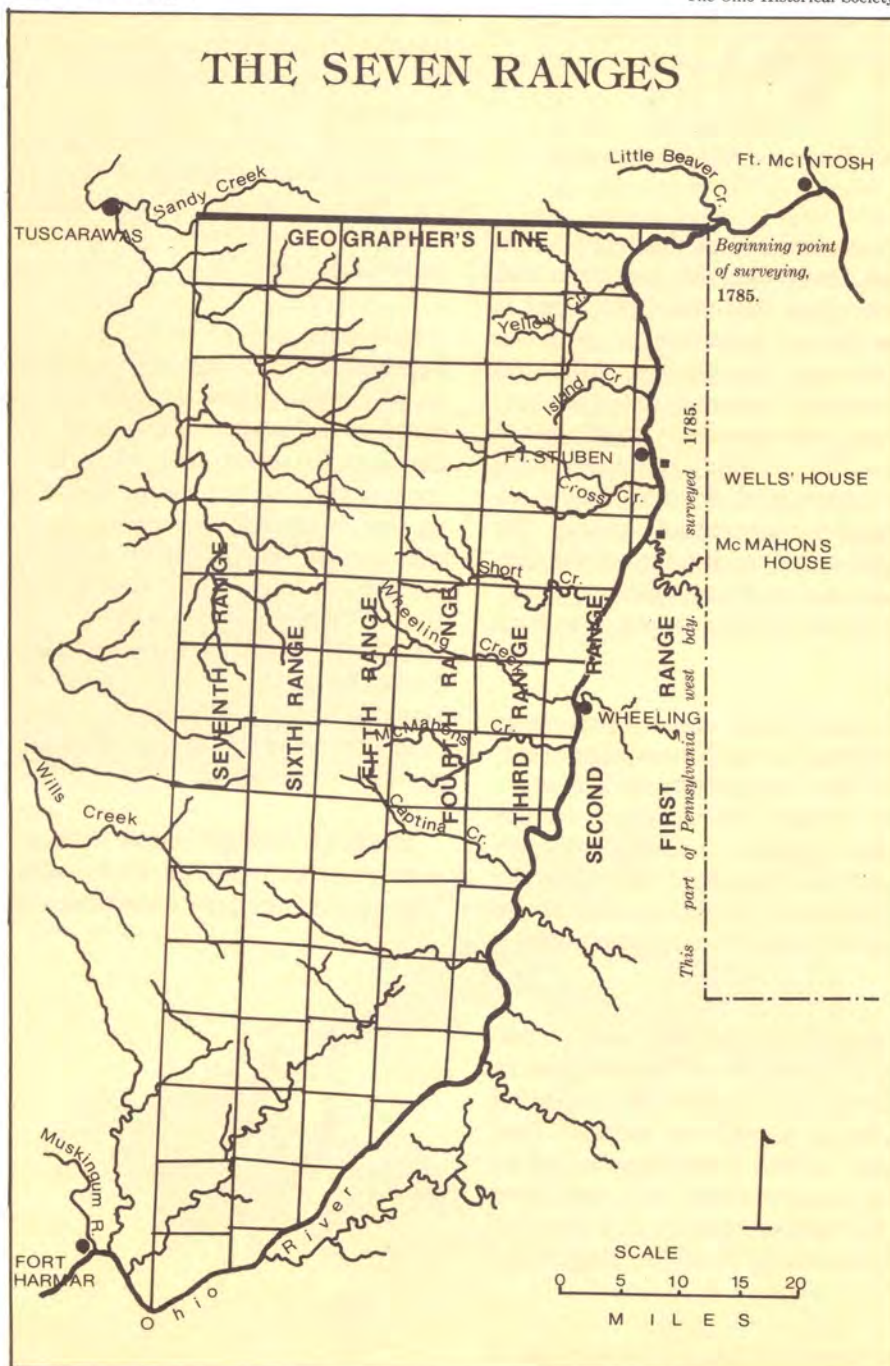
The Confederation Congress loaned the services of Geographer Hutchins to Pennsylvania in 1784. He

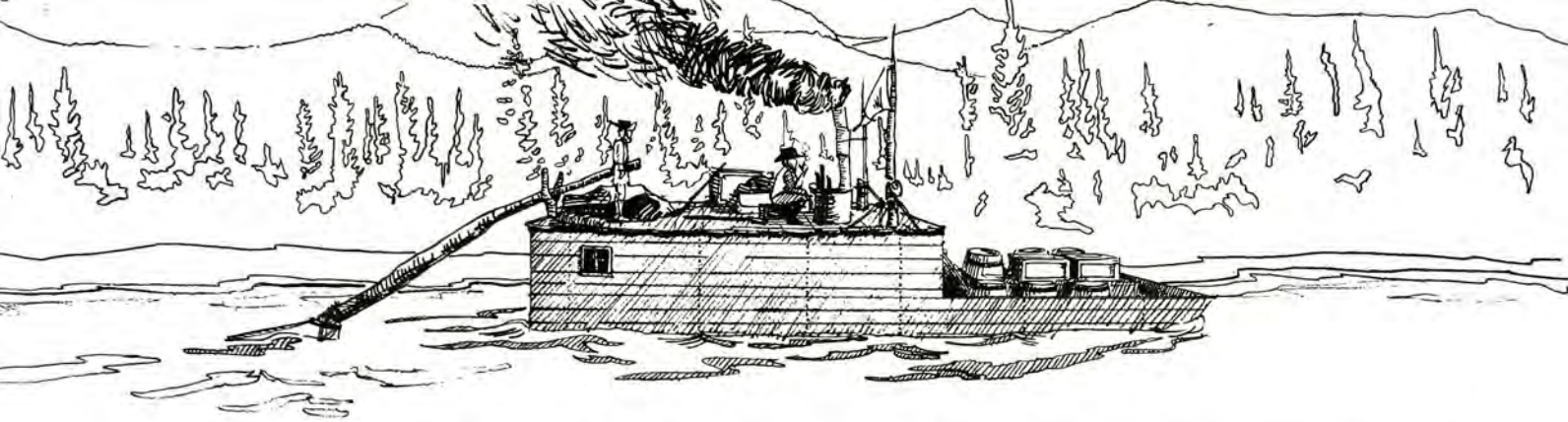
joined the survey party that continued the Mason-Dixon line, southern boundary of Pennsylvania, to the west. Thomas Jefferson, in the meantime, using Hutchins' map as guide, drew up plans for survey of the lands northwest of the Ohio. The Land Ordinance of 1785, as the legislation which established the unique American rectangular survey system became known, directed the Geographer to survey the Seven Ranges in southeast Ohio with the assistance of thirteen gentlemen surveyors, one from each state.

Hutchins arrived at Pittsburgh, old Fort Pitt, in September 1785 and organized his survey party, securing provisions and horses, employing chain carriers and rodmen, and seeking troop protection for the surveyors from General Josiah Harmar. Among the thirteen gentlemen surveyors who joined Hutchins at Pittsburgh were Absalom Martin, who founded Martin's Ferry, Ohio, Israel Ludlow, a founder of Cincinnati, and Ebenezer Sproat and Benjamin Tupper, founders of Marietta, Ohio, who later built ships for the Ohio River trade. General Rufus Putnam, second Chief Engineer of the Continental Army, was also appointed to the survey, but was surveying in Maine at the time and sent his nephew in his stead.

Hacking straight lines through the wilderness was rugged business and Indians still posed a threat; the surveyors found the scalped heads of two







men fastened to a tree as a warning of what might happen to all. Troop detachments from Fort McIntosh furnished some protection, and General Har-mar built Fort Steuben at the present site of Steubenville, Ohio, in 1786 as additional protection for surveyors, but they still were frequently forced to cross the Ohio to safety, usually to the fortified homes of William McMahon, Charles Wells, William Greathouse, and Ebenezer Zane near the present sites of Wellsburg and Wheeling, West Virginia. Scalpings and horsethieving in the vicinity of the surveyors continued, but they persevered and completed their survey of the Seven Ranges on July 10, 1787.

Thomas Hutchins did not find hacking lines through the forests without adequate troop protection to his liking; he yearned to resume his single-handed exploration of the West. Funding by the Confederation Congress was also insufficient, so he had to use his personal credit to finance the surveys and then threaten legal action to get reimbursement from the government. Twice he asked Congress to allow him to do what General Washington had suggested, prepare complete and accurate maps of the inland rivers; twice he was rejected. Concerned by the weaknesses of the Confederation government, he became convinced, he said in 1788, that "the political salvation of this country inevitably depends on the adoption of our new constitution." He was also worried by the failure of the Confederation government to secure free navigation for Ohio River basin commerce via the Mississippi. The British ceded free navigation on the Mississippi to the United States in the treaty ending the Revolution, but Spain was not party to that treaty and refused the right. Hutchins was certain that if Congress did not act the pioneers across the mountains would attack the Spanish at New Orleans to secure the right as their own, "be the consequence what it may."

Hutchins joined Colonel George Morgan and New Jersey veterans led by Colonel Israel Shreve in 1788 in planning a settlement at New Madrid on the Mississippi in Spanish territory, where they would be free to trade down the rivers to New Orleans.

Hutchins hoped to secure an engineer commission from the Spanish government to continue his exploration, navigation, and mapping of the inland rivers west of the Mississippi.

Early Engineers and the Waterways Rivers of the headwaters district and connecting portages served both Indians and early explorers as avenues through the wilderness into the Ohio River basin and the interior of America. Canoes, dugouts, and bateaux moved French and British troops to the frontier via the inland rivers; the first significant waterborne commerce on inland streams was largely in support of the frontier military garrison; and the earliest navigation by Americans on the inland rivers had military purposes. Military engineers were therefore interested in waterways navigation at an early date.

French engineers mapped the Ohio River basin, built a chain of fortifications from Lake Erie to the Monongahela, and first improved inland river navigation. Though the French lost the struggle for empire in America, their engineers and technology had such influence that the American Corps of Engineers remains proud of its French heritage.

Anglo-American engineers--George Washington, Harry Gordon, and Thomas Hutchins--made significant contributions to British success in the headwaters district before the Revolution. Their surveying and mapping activities, their continuing interest in waterways navigation for military transport and internal commerce, and their support for increased federal responsibility for interstate commerce were formative during the critical years between the end of the Revolution and the beginning of government under the Constitution.

The early work of military engineers in the Allegheny, Monongahela, and Ohio River basins was, as it was to be throughout the history of the American West, of central importance to the settlement and early development of the headwaters district.

Chapter 2

THE GATEWAY TO THE WEST

Rufus Putnam peered through the blinding snowstorm, saw the trail ahead was covered by waist-deep drifts, and realized his half-frozen men and exhausted teams could move the wagons no farther. He knew the pioneer band he led must reach the Youghiogheny River in time to catch the floods in the spring of 1788, or they would never be able to navigate the rivers to new homes on the frontier, for he had learned from Thomas Hutchins and General Washington that the "Yough" went dry in the summertime.

General Putnam had served as Chief of the Continental Engineers. He remembered the forts he built around Boston in 1776 had been armed with cannon dragged on sleds across New England snows from Ticonderoga. He made his decision, strode back to camp, and ordered his men to break out their tools. Moving quickly in the cold, his frost-bitten men built four stout sleds, transferred supplies to the sleds from the wagons emblazoned with the slogan "FOR THE OHIO COUNTRY," hitched teams to the sleds, and moved out over the Appalachians, the General along with his hardest men breaking trail through the snowdrifts ahead of the sleds.

After trudging for two weeks through the frozen mountain wilderness, Putnam's pioneers arrived at the present site of West Newton on the Youghiogheny, where they hurriedly built a fleet of boats to bear them down the inland river. General Putnam had planned settlement and defense of the Ohio frontier by bands of Revolutionary veterans trained for combat and skilled at building fortifications and watercraft. General Washington heartily approved the idea and in 1787 Congress granted lands to Putnam and his associates of the



General Rufus Putnam

Howe's Historical Collections of Ohio, Vol. III

Ohio Company. Soldiers and sailors from Rhode Island, Connecticut, and Massachusetts assembled in late 1787, made a difficult winter trek to the Youghiogheny, and by the end of March 1788 had completed a fleet at West Newton.

Headed by General Putnam in the 45-foot, 50-ton galley *Mayflower*, the pioneers embarked on the Youghiogheny on the first of April 1788, timing their departure perfectly, catching a swift Youghiogheny flood and rushing down the rock-studded stream and the Monongahela and Ohio rivers to found Marietta, Ohio. President Washington relied on his second Chief Engineer to build fortifications to defend the frontier, to negotiate treaties with the Indians, to arrange safe delivery of the mails, and, in 1796, appointed him Surveyor-General of the United States. Putnam's contributions to the settlement, defense, and development of the Northwest Territory were so monumental that historians have honored him as the "Father of Ohio."



"Indians made pirogues..."

The Great Flatboat Emigration General Putnam and his veterans were a small part of the human tide that swept across the mountains and down the inland rivers after the Revolution; not since the medieval crusades had such a mass migration of peoples been seen. Pioneer hordes followed trails across the mountains to strike the Allegheny at Olean, the Conemaugh at Johnstown, the Youghiogheny at West Newton, the Monongahela at Brownsville, or the Ohio at Pittsburgh, Wellsburg, and Wheeling, and there they built or purchased watercraft to pursue their westward voyages. In 1788, 323 boats passed down the Ohio, carrying 5,885 people, 2,714 horses, 937 cattle, 245 sheep, 24 hogs, and 267 wagons. In that year, Thomas Hutchins remarked the spirit of emigration was incredible, and Colonel Israel Shreve, who personally led a party of New Jersey veterans west, commented: "It seems as if people were mad to get afloat on the Ohio."

Described as Noah's Arks, well-built hogsties, or oblong boxes, the flatboats that carried the emigrants down the rivers varied in size according to the needs and abilities of their builders. Flatboats commonly were classed as either Kentucky boats or New Orleans boats, the former being smaller, only partially roofed, and less well built, the latter stoutly built and completely roofed for long distance travel. Not being well designed for upstream navigation, flatboats were disassembled at their destination and the lumber used to build the pioneer cabins.

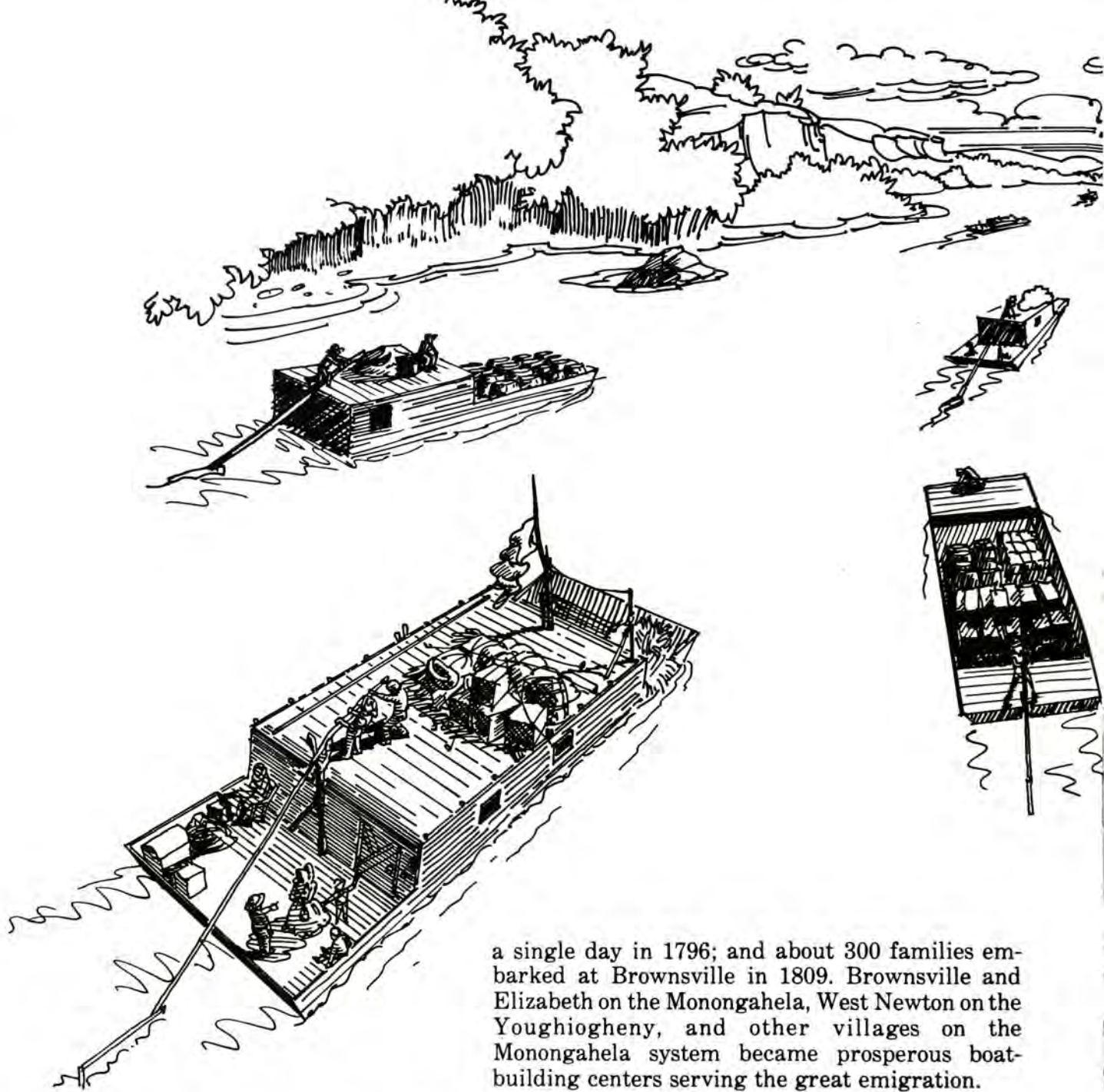
Thomas Ridout, who left Pittsburgh in March 1788 in a flatboat carrying twenty passengers, sixteen horses, and large cargo, said: "These boats are flat bottomed, with upright sides and stern, and the front turns up like a skate. They seldom use any sail, and are steered by means of a long oar from the stern, and two or three oars are occasionally used to conduct them, for the stream, which runs at the rate of about five miles an hour, carries the boat with great rapidity." Some distance down the Ohio, Ridout wrote, Indians "like so many furies, yelling and screaming horribly, brandishing their knives

and tomahawks," attacked and captured his flatboat, took him prisoner to Canada, where he eventually won his freedom and, being of philosophical bent, he settled and became Surveyor-General of Upper Canada.

No one knows the origin of the flatboat. They were afloat on inland rivers by the end of the Revolution, and, because of greater cargo capacity and ease of construction, soon supplanted the French bateaux for downstream navigation. Perhaps the flatboats evolved from the Indian pirogue or dugout canoe; at least, construction techniques were somewhat similar. Indians made pirogues, more durable than the wood-framed, bark-covered canoes, by shaping tree trunks with fire and axe, cutting and hollowing to form pirogues of up to fifty-foot lengths; for river ferriage, they placed two pirogues parallel and decked them together with planks to form two cargo holds and a wide deck. Large pirogues were built by splitting a dugout in half, pinning crossbeams between the two halves, planking over the bottom of the crossbeams and caulking the seams to form a



"...more durable than the wood-framed, bark-covered canoes"



a single day in 1796; and about 300 families embarked at Brownsville in 1809. Brownsville and Elizabeth on the Monongahela, West Newton on the Youghioghene, and other villages on the Monongahela system became prosperous boat-building centers serving the great emigration.

flat-bottomed boat capable of transporting thirty men and fifty tons. Until their use ended in the late 19th century, flatboats were built in similar fashion: a tree trunk was split, the two halves shaped into rigid timbers, each six inches wide and twenty-four inches high to serve as gunnels and side keels, cross timbers were fixed between the two gunnels, the bottom planked and caulked, and sides and roof then installed.

Flatboat construction in the headwaters district, the gateway to the west, became the first industry in the region, for watercraft supply scarcely met demand, especially on the Monongahela. More than 120 boats transporting 1800 pioneers passed down the Monongahela in 1787; two hundred left Brownsville in 1788; seventy passed Brownsville on

Johnstown at the head of the Conemaugh River was perhaps the earliest port of embarkation on the Allegheny River system; emigrants were descending the Conemaugh and Kiskiminetas rivers on the way to the Allegheny and Ohio long before the Indian threat ended in the area. At a later date, Olean, New York, became the principal port of departure for emigrants traveling the Allegheny. Major Adam Hoops, an engineer officer who served on Washington's staff during the Revolution, founded Olean in 1804 and built a sawmill on Olean Creek to supply lumber for boat construction. The scene at Olean in March 1815 was vividly described by emigrant Tilly Buttrick:

This place is called Olean Point, and was much altered in appearance since my former visit here; instead of a few log huts



Down the Ohio River on flatboats

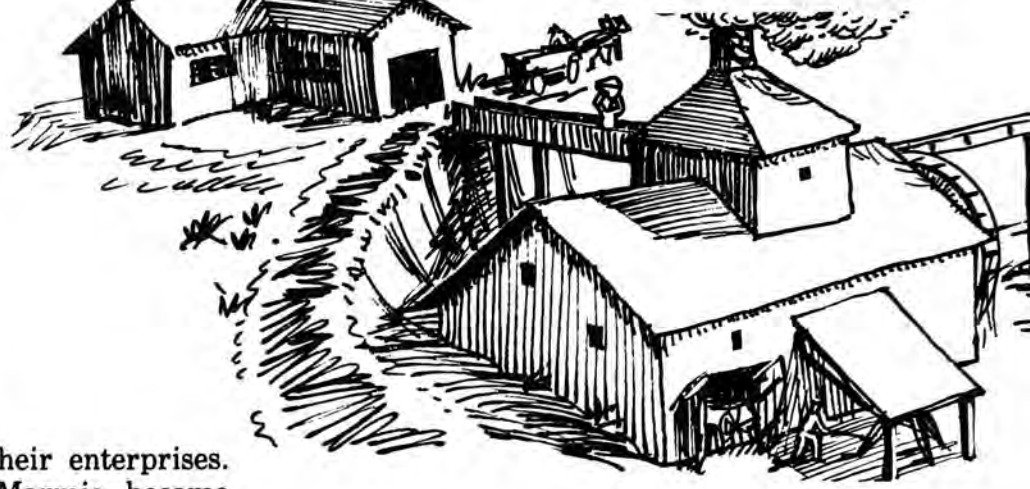
as before, there were forty or fifty shanties, or temporary log houses, built up, and completely filled with men, women and children, household furniture thrown up in piles; and a great number of horses, waggons, sleighs, &c., &c. These people were emigrants from the eastern States, principally [bound] down the Ohio river. Two gentlemen undertook to take a number of these people, and found it to be about twelve hundred, of all ages and sexes. They had a large number of flat-bottomed boats built for their conveyance; these were boarded up at the sides, and roofs over them, with chimneys suitable for cooking, and were secure from the weather. There were also many rafts of boards and shingles, timber and saw logs, which would find a ready market at different places on the Ohio river. There are many saw-mills on the stream above this place, where these articles are manufactured from the fine timber which grows in vast quantities in this vicinity. The river at this time had risen full bank, and I should suppose was navigable for vessels of fifty tons burden; but was frozen over.....I waited about ten days, which brought it nearly to the close of March. On Saturday night sat up late, heard some cracking of the ice, several of us observing that we should soon be on our way went to bed. Next morning at daylight found the river nearly clear, and at eight o'clock it was completely so. The place now presented a curious sight; the men conveying their goods on board the boats and rafts, the women scolding, and children crying, some clothed, and some half clothed, all in haste, filled with anxiety, as if a few minutes were lost the passage would be lost also. By ten o'clock the whole river for one mile appeared to be one solid body of boats and rafts. What, but just before, appeared a considerable village, now remained but a few solitary huts with their occupants.

Origins of the Flatboat Commerce Pioneers of the headwaters district were producing more than they could consume before the end of the Revolution. Grain from the fertile river bottoms could be converted into liquors and laboriously transported by packhorses and wagons across the mountains to Philadelphia or Baltimore, but frontier merchants wished more accessible and more economical transportation to markets. They naturally looked to the rivers, where, at the time of the Revolution, there were two markets: American troops down the Ohio needed provisions, and the Spanish at New Orleans, cut off from normal supply sources by the British naval blockade, needed food stuffs.

Barthélemi Tardiveau, French merchant from Nantes, was first to attempt to open markets for waterborne commerce from the headwaters district. He was one of the merchants who took advantage of the disruption of British-colonial trade during the Revolution to launch new commercial enterprises.

Tardiveau met Jonathan Williams, nephew of Benjamin Franklin and a supply agent for the Continental Navy, at Nantes. Williams and Franklin had business and real estate enterprises under way; Franklin was partner with George Morgan, George Croghan, the Philadelphia financier Robert Morris, and John Holker, wealthy Huguenot merchant and assistant to the French Secretary of Navy. At the recommendation of Williams and Franklin, Tardiveau emigrated to Philadelphia in 1777 to join John Holker, French consul and supply agent. With credit supplied by Holker and Robert Morris, Tardiveau, William Turnbull, and Peter Marmie moved to Pittsburgh about 1780 to purchase flour and provisions from Monongahela pioneers to supply the French navy operating off American coasts and George Rogers Clark and American forces on the frontier. They had supplied the Virginians with 70,000 pounds of flour by 1782, in payment for which, Virginia granted them lands in Kentucky.

When the Army supply market ended in 1782, the representatives of the Holker-Morris interests at



18th century iron furnace

Pittsburgh began to diversify their enterprises. William Turnbull and Peter Marmie became partners with Major Isaac Craig and Stephen Bayard. The firm opened a distillery, built a saw-mill on the Allegheny, retailed boats built at Elizabeth on the Monongahela, and tried to establish a saltworks on the Mahoning River near present Youngstown, Ohio. They purchased old Fort Pitt in 1785, dismantled parts of the structure, and put the bricks into an addition to the Bouquet-Hutchins blockhouse, in which Turnbull and Major Craig resided. In 1790, Turnbull and Marmie blew in the Alliance Iron Furnace on Jacobs Creek, a tributary of the Youghiogheny. This furnace, it has been claimed, became the first west of the Alleghenies and started the iron and steel industry, central to the headwaters district economy. The name "Alliance" doubtless was in honor of the Franco-American alliance of the Revolution.

While supplying Colonel Clark in Illinois, Barthelemi Tardiveau learned of the food shortage at New Orleans. In the spring of 1782, he loaded several flatboats with flour and left Pittsburgh in company with other boats captained by Monongahela farmers who wished to market their own produce. He carried letters of introduction from John Holker and Robert Morris to Oliver Pollock, the New Orleans merchant who had supplied munitions to the Gibson-Linn and George Rogers Clark expeditions.

The Monongahela flour fleet was attacked by Indians on the Ohio, who destroyed at least one boat. On the Mississippi near Natchez, where British loyalists still smarted from the blow given them by Captain Willing and the *Rattletrap* in 1778, a British-Indian force attacked Tardiveau's boats. Tardiveau resisted with a small cannon aboard his boat but finally surrendered. He was released to return to Pittsburgh but lost his boat and investment. Some Monongahela farmers, however, did slip by the Indian blockade to New Orleans. Captain Jacob Yoder of Brownsville got through, sold his cargo at profit, sailed to Havana, then to Baltimore, and walked home. William Kelso also reached New Orleans, but the Spanish ship on which he took

passage home was seized by the British, who made him prisoner.

The effort to open waterborne commerce with New Orleans in 1782 had not gone well, and at the end of the Revolution in 1783 Spanish New Orleans resumed importation of foodstuffs by sea and closed the Mississippi to American commerce, but Tardiveau's interest did not flag. He made the first "industrial survey" of the Ohio River basin in 1783, addressing questionnaires about agricultural surplus, natural resources, and marketing opportunities to frontier leaders. John May, for whom Maysville, Kentucky, was named, told Tardiveau the commerce of inland America would inevitably go by waterway instead of over the mountains to coastal cities, saying: "I am sensible that the navigation this way would be much longer than any other, but it is not the distance, but the having water carriage that makes the expence of transportation light." Attorney General Walker Daniel of Virginia advised Tardiveau that boats in the New Orleans trade should be sold along with the cargo, not returned up-river, and that warehouses ought to be built at New Orleans for receipt of the produce of the Monongahela and Kentucky farmers. Tardiveau published his report on Ohio River basin economics in 1787. In it, he concluded that economic prosperity for the region rested on wise use of its rivers for transportation. He urged his fellow Frenchmen to retake Louisiana from the Spanish and open the Mississippi to American commerce.

Tardiveau visited his bedfast friend Thomas Hutchins in his room at Pittsburgh throughout the spring of 1789. They discussed economic opportunities in the West, Hutchins' plans to continue his explorations, and Hutchins' venture with George Morgan and Israel Shreve in establishing a settlement at New Madrid (Mo.) on the Mississippi just below the mouth of the Ohio River. The Geographer had entered the final stages of consumption, his body was racked by disease, but Tardiveau wrote on



IN COMMEMORATION OF THE GRANT OF THIS LAND FOR THE PRESBYTERIAN CHURCH AND FOR TRINITY CHURCH BY THE HEIRS OF WILLIAM PENN IN 1787 AND IN HONOR OF THE OFFICERS OF THE COLONIAL AND REVOLUTIONARY ARMIES WHO AFTER ASSISTING IN THE ACHIEVEMENT OF AMERICAN INDEPENDENCE WERE ASSOCIATED WITH THE EARLY HISTORY OF PITTSBURGH MANY OF WHOM WERE BURIED IN THIS ENCLOSURE. ▲ THIS TABLET IS PLACED BY THE PITTSBURGH CHAPTER OF THE DAUGHTERS OF THE AMERICAN REVOLUTION 1915.

CAPTAIN WILLIAM ANDERSON
COMMODORE JOSHUA BARNEY
COLONEL STEPHEN BAYARD
CAPTAIN JOHN BRANDON
SURGEON FELIX BRUNOT
CAPTAIN EDWARD BUTLER
CAPTAIN PERCIVAL BUTLER
GENERAL RICHARD BUTLER
COLONEL THOMAS BUTLER
GENERAL WILLIAM BUTLER
CHAPLAIN H. H. BRACKENRIDGE
MAJOR ISAAC CRAIG
CAPTAIN SAMUEL DAWSON
CAPTAIN EBENEZER DENNY
GENERAL ALEXANDER FOWLER
COLONEL GEORGE OIBSON

COLONEL JOHN OIBSON
CAPTAIN JOHN OUTHRIE
CAPTAIN HENRY HETH
CAPTAIN MICHAEL HUNNALE
SERGEANT MAJOR JOHN HULL
CAPTAIN THOMAS HUTCHINS
CAPTAIN NATHANIEL IRISH
CAPTAIN JOHN IRWIN
COLONEL JAMES JOHNSTON
MAJOR ABRAHAM KIRKPATRICK
MAJOR JOEL LEWIS
COLONEL STEPHEN LOWREY
CAPTAIN GEORGE MCCULLY
COLONEL AENEAS MACKAY
COLONEL GEORGE MOROAN
SUPGEON JOHN MORGAN
COLONEL JAMES MORRISON

GENERAL JOHN NEVILLE
LT. COLONEL PRESLEY NEVILLE
Qm. GENERAL JAMES O'HARA
MAJOR JOHN ORMSBY
LIEUTENANT GABRIEL PETERSON
Ass't. Qm. SAMUEL SAMPLE
MAJOR JOHN SMALL
MAJOR THOMAS SMALLEMAN
CAPTAIN DEVEREUX SMITH
LIEUTENANT JACOB SPRINGER
CAPTAIN DAVID STEEL
CAPTAIN ADAMSON TANNEHILL
CAPTAIN GEORGE WALLACE
CAPTAIN EDWARD WARD
CAPTAIN JOHN WILKINS
Qm. GENERAL JOHN WILKINS Jr.

April 20, 1789, that "feeble as he is, he still expects that his health and his strength will return in the spring, and is planning a great number of trips in the West; but I am very much afraid that he will never leave Pittsburgh." Hutchins died nine days later.

One of the reasons Hutchins, Morgan, and Shreve had for founding the New Madrid colony in Spanish territory was that settlers there would be free to navigate the Mississippi without paying foreign import duties. Settlers at New Madrid could purchase Monongahela and Ohio valley produce and market it as their own, and therefore Spanish goods, at New Orleans. A similar ploy had worked for General James Wilkinson, staff officer to General Washington who had settled in Kentucky at the end of the Revolution and in 1787 boldly descended the rivers to New Orleans, took the oath of allegiance to Spain, sold his cargo for profit and won contracts for more produce. His dual allegiance received some critical comment, but in 1787 it won him access to the New Orleans market. Wilkinson purchased produce from farmers throughout the Ohio River



General James Wilkinson

Wilkinson, soldier and pioneer - James Wilkinson

basin, including Samuel Jackson and other merchants in the Monongahela valley, and shipped it to New Orleans in his name as a citizen of Spain.

Hutchins never made the move to New Madrid, and Morgan and Shreve, after founding the settle-



ment in early 1789, returned upriver to settle near Canonsburg, Pennsylvania, but some merchants did make the move to New Madrid. Dr. Richard Jones Waters moved there from Pittsburgh in 1790 and began importation of produce from the Monongahela that he retailed to the Spanish without paying import duties. In 1792 he had the 55-ton sloop *Ulela* built on the Monongahela, loaded it with flour, navigated it down the rivers on the spring flood of 1793, and sent it on to Philadelphia.

Barthelemy Tardiveau secured a land grant and flour supply contract from the Spanish in 1793 and attempted to settle royalist refugees from the French Revolution on the grant. His contract said that he would be free to bring in flour from the Ohio River basin free from all import duties. Tardiveau's supply boat was seized on the lower Ohio in 1794 by frontiersmen led by George Rogers Clark and financed by French minister Edmund Genet. Tardiveau was released and settled at New Madrid, but his colony of French royalists never thrived and his hope for commercial empire on the inland rivers never materialized.

Under the guise of Spanish citizenship, pioneers of the headwaters district continued to slip produce through the Spanish blockade, often pretending that the owner of the cargo wished to settle in Spanish Louisiana while the crew members returned to the States. By 1798, over a million dollars worth of commodities arrived at Spanish Natchez in Ohio River flatboats, and by 1802 the flatboat commerce had swollen to 45,906 tons valued at 4.5 million dollars; but control of American commerce

by a foreign power seemed an intolerable situation to the transmontane pioneers, who frequently threatened secession from the Union unless free navigation of the Mississippi for their waterborne commerce were to be secured.

Flatboats went west and south from all ports in the headwaters district, but the port with the greatest volume of flatboat commerce was not Pittsburgh, Brownsville, or Wheeling, but Charleston, Virginia, now known as Wellsburg, West Virginia, which in 1791 was the first town organized in the Panhandle. The town became a milling center and fleets of flatboats departed the port at every high water. In 1798, for example, twenty flour-laden flatboats commanded by William Hesselgesser arrived at Natchez from Charleston; others had wrecked on snags and shoals during the downriver voyage. Wellsburg millers built a four-story warehouse over Buffalo Creek to load flatboats with flour by a system of pulleys at a rate of five barrels a minute; it may have been the first "modern" river terminal in the headwaters district. Of the 23,591 barrels of flour arriving at New Orleans in 1805-07, 16,314 or 69% came from the port of Wellsburg.

The fundamental commercial institutions of the headwaters district were shaped by the flatboat commerce. Farmers paid for their land and the necessities they could not grow in installments of produce which the pioneer merchants collected and shipped downriver. Farmers, merchants, real estate speculators, millers, and bankers came to rely on an elaborate marketing system, composed of mills, warehouses, flatboats, and credit system in a

River commerce: flatboat and keelboats

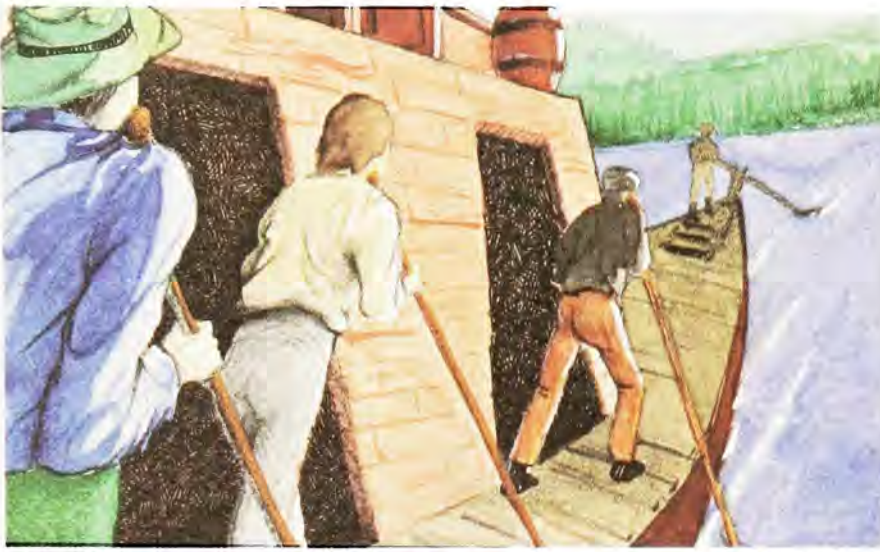
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triangular trade. Western merchants, with credit from Eastern mercantile houses, imported manufactured goods from Philadelphia and Baltimore and sold the goods on credit in exchange for agricultural produce. Flatboats carried the flour, meats, liquors, and frontier staples to New Orleans, where brokers purchased the cargoes and credited the merchants' accounts with Eastern capitalists, then exchanged the flatboat cargoes for sugar, indigo, and cotton for shipment by sea to the East coast. Flatboatmen sold the boats at New Orleans, took ship to Philadelphia or Baltimore, and walked home; as a result, upstream trade rarely amounted to as much as 10% of downstream trade prior to the advent of steamboats.

Origins of Keelboat Commerce The keelboat, called "la barge" in Louisiana, was, as the name im-

plied, built like a ship on a longitudinal timber keel that supplied rigidity and bore the brunt of collisions. The long, narrow keelboat hull was ribbed and planked over, the hold covered by a cabin, and the cabin surrounded by an eighteen-inch runway along each gunnel on which the crew walked when poling the boat upriver. Keelboats ranged from 40 to 80 feet in length, from 7 to 10 feet in width, and drew about 2 feet of water when loaded; there were, however, a few large "barges" with up to 120-foot length, 20-foot width, and 4-foot draft. In 1809, naturalist John James Audubon described them: "a keelboat was generally manned by ten hands, principally Canadian-French and a patroon or master. These boats seldom carried more than from twenty to thirty tons. The barges had frequently forty or fifty men with a patroon and carried fifty or sixty tons. Both of these kinds of vessels were



through modification of ship design to meet the special conditions of tortuous and shallow inland river channels.



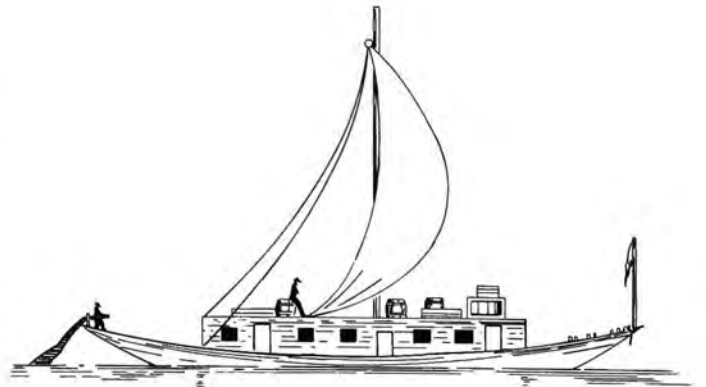
Keelboat man

provided with a mast, a square sail, and coils of cordage known by the name of cordelles."

The origins of the keelboat, like those of the flatboat, have been lost. The first boat of record to have the cleated runway common to keelboats was the *Three Friends*, built by George Morgan at Pittsburgh in 1768 and wrecked on the Falls of the Ohio on its first trip; Morgan, however, described the *Three Friends* as a "bark." The first keelboats did resemble small ships and the larger class of "barges" were in fact ships of a sort; perhaps this was logical since the first shipwrights in the headwaters district came from Atlantic coastal cities. The unique keelboat design probably evolved

Keelboats were rowed by four to twelve men on downstream trips and steered by the patroon standing on the cabin or a platform and moving a long tiller oar pivoted at the stern. Downstream trips could have been pleasurable, but upstream trips were sheer agony for the crew, which used any handy means of propulsion. Narrow channels restricted use of sails, and when the wind failed the keelboatmen faced downstream, lanced iron-tipped poles into the riverbottom, braced the poles against their shoulders, and walked the keelboat upstream beneath their feet until they reached the stern, or rather the stern reached them, then scrambled back over the cabin to again take their place in the line. Like a slowly turning carousel, the men moved down the runway from bow to stern, then back to the bow to begin anew, hour after hour, day after day at a rate of about six miles a day.

When the keelboats ran near the bank, where currents were less swift, the crews frequently "bushwhacked," or pulled the boat up with tree





General Anthony Wayne
Carnegie Library of Pittsburgh

branches instead of using poles. When sailing, rowing, and poling failed at rapids, the crew broke out a rope, tied it to the mast, and "cordelled" or "warped" the boat upstream. To "cordelle," the crew walked along the banks, scrambling through the brush and wading tributary creeks, pulling the rope to tow the boat. To "warp," one man in a skiff tied the rope to an upstream tree and the crew stood on the boat bow and pulled the rope, while the skiff secured a second rope to a tree farther upriver.

Flatboatmen usually were farmers, merchants, and farmhands temporarily afloat; keelboatmen were true rivermen, commonly called "alligators" because they were equally at home on land or water. Poling boats upriver, three months from New Orleans to Pittsburgh, was not the genteel life, and keelboatmen were proverbially profane, dissolute, and disputatious. The keelboatmen had their own dialect, their own pleasures, their own riots, and even their own hero, Mike Fink, a Pennsylvania scout during the Indian wars hired by David Bell to run keelboats out of Wheeling. Bell, owner of the Wheeling boatyard and a fleet of keelboats, took a keelboat to New Orleans in 1814 and "fit" the British at New Orleans, but his fearless and cunning employee Fink won eternal fame for his daring feats and vulgar wit.

Keelboats were in wide use in the headwaters district by 1786. Stephen Bayard and Joseph Chester at Elizabeth and Allenport on the Monongahela were building and selling keelboats in 1786, and John Blair and John McDonald were running regularly scheduled keelboats from Pittsburgh up the Monongahela. Captain John Bartlett operated keelboats out of Belle Vernon. One of his cargoes in 1791 consisted of 142 barrels of flour, 84 barrels of superfine flour, plus provisions for his crew: 5 quarts of whiskey, 1 tin cup, 16 pounds of bread, and 1 blanket. The business was not without hazard: John McDonald sank his keelboat at rapids on the Monongahela in 1789 and four passengers drowned.

Keelboats were hauling the necessities of life upstream on the Allegheny by 1800 and returning with

agricultural staples shipped by the pioneers. Amazing trips were made by keelboats on the Allegheny River system. In 1822, for instance, a 35-foot keelboat arrived at Pittsburgh from Oneida Lake, New York. It had navigated Oneida Lake, Oswego River, Lake Ontario, and Niagara River to the falls, portaged to Lake Erie, then portaged to Chautauqua Lake and floated down Conewango Creek and the Allegheny to Pittsburgh.

Keelboats greatly reduced transportation costs at Louisville, Cincinnati, and downriver ports, which began to receive manufactured goods from New Orleans instead of Philadelphia or Baltimore. But the long distance prevented extensive development of a major upstream trade from New Orleans to Pittsburgh. Keelboats of the headwaters district operated on the Monongahela, Allegheny, and the Ohio as far as Louisville, but seldom to New Orleans—except for very high value cargoes, overhead was prohibitive. Fifty keelboats of thirty tons each operated in the headwaters district in 1805; the number increased to 150 by 1817, when steamboat construction began its boom. Steamboats did not entirely wipe out keelboats, however, for a few keelboats operated on streams inaccessible to steamboats and at extreme low water on the larger rivers until the late nineteenth century.

The Army Moves West "I dread the low state of the Waters of the Ohio, much more than I do the prowess & Number of the Indians," exclaimed General Anthony Wayne in 1793; he was maddened by the difficulties of moving and supplying his army by river, and he was also disturbed by a shortage of trained military engineers. His sole officer with engineering experience, General Rufus Putnam, had been sent by President Washington ahead of the army to seek a negotiated peace with the hostile tribes.

After the Indians inflicted disastrous defeats on two American armies in 1790 and 1791, President Washington selected General "Mad" Anthony Wayne to chastise the tribes. Wayne collected his Legion at Fort Fayette in Pittsburgh in 1792 and



Andrew Ellicott:

Carnegie Library of Pittsburgh

began their training, crossing and recrossing the Allegheny in maneuvers so realistic that the soldiers sometimes injured each other. To separate his men from the temptations of the dens of iniquity in Pittsburgh, General Wayne moved his Legion downriver in 1792 and camped at what became Legionville, Pennsylvania, where he built a magazine, laboratory, and armory and trained his officers in the rudiments of engineering.

General Rufus Putnam recommended a two-front assault on the Indian homeland near present Toledo, Ohio: one column to descend the Ohio and ascend the Miami River, the other to ascend the Allegheny and French Creek and cross Lake Erie. General Wayne rejected the two-front concept, though it forced him to rely entirely on the Ohio River for supply.

On the last day of April 1793, General Wayne in the barge *Federal*, with twelve brightly painted oars each lettered with the boat's name, embarked from Legionville. His army followed in a massive fleet of flatboats, each precisely in the leader's wake. With the guidance of a copy of Hutchins' map of the Ohio, the Legion safely negotiated the island-strewn channels of the upper Ohio and camped at the mouth of the Miami River five days later.

Low water during the summer of 1793, lower according to General Wayne than ever before "in the Memory of the Oldest Inhabitants," broke the Ohio River supply line and brought the Legion to the verge of starvation. General Wayne profited from this experience, appointed the capable Pittsburgh merchants James O'Hara and Isaac Craig to head his quartermaster department, and arranged that all supplies needed by the Legion for the campaign of 1794 be sent down the Ohio on high water before the first of May. With his supplies secure, he marched north to defeat the allied Indian tribes at Fallen Timbers and force the British to withdraw from their posts on American territory.

Wayne's victory at Fallen Timbers in August 1794 was timely, for the people of western Pennsylvania, disgruntled by a tax on their famed

Monongahela Rye, began a revolution against the new federal government in the summer of 1794 and by late autumn President Washington had a second army at Pittsburgh to suppress the Whiskey Rebellion. This disruption at the Legion's source of supply could have been disastrous to the Fallen Timbers campaign had it occurred earlier in 1794, before the 104 flatboats and keelboats in the Legion's supply fleet had departed Pittsburgh for the frontier.

With General Wayne's urging, President Washington established a new Corps of Artillerists and Engineers in 1794 and employed French engineers to train the new Corps at West Point. French engineer Colonel Stephen Rochefontaine commanded the new Corps; the son of Thomas Hutchins became one of its officers. Several years elapsed, however, before the officers of the new Corps were sent to the frontier in the Ohio River Basin. Secretary of War James McHenry explained in 1798 that training engineers required several years:

The knowledge of certain arts and sciences is absolutely necessary to the artillerist and engineer; such are arithmetic, geometry, mechanics, hydraulics, and designing.

Without a knowledge of arithmetic, an officer cannot calculate the expense incurred, or to be incurred, on any work, or any subject whatever.

Without that of geometry, he cannot form a just plan or chart, regulate the design of a fortification, with its lines and angles, trace it upon the ground it is to occupy, nor estimate and measure the solidity and surface of its several parts.

Without that of mechanics, he will not be able to appreciate the proportion of the machines used in war, the dimensions of carriages for artillery, nor to augment or diminish the force of the several kinds of machines, when it may be necessary.

Without that of designing, he will not have it in his power, to give plans and

profiles of works, nor to exhibit the topography of the environs of a work, or any part of a country.

Without that of hydraulics, he will not be qualified to conduct water from one place to another, or to sustain and elevate it, when there may be a necessity in sieges, or other military operations, for so doing.

The Successor to the Geographer After the death of Thomas Hutchins in 1789, the duties of the Geographer of the United States were assigned to Major Andrew Ellicott, famed scientist and astronomer and Revolutionary veteran. Ellicott surveyed the western and northern boundaries of Pennsylvania during the 1780s, and, because Hutchins was listed as a deserter by the British and refused to enter Canada, Ellicott surveyed the boundary between the United States and Canada in the vicinity of Niagara Falls. As successor to Hutchins, Ellicott surveyed the federal District of Columbia in 1790 and laid out the new capital city.

Major Ellicott early learned the techniques of wilderness survival; he later supplied the benefits of his experience to Meriwether Lewis in planning the Lewis-Clark expedition to the Pacific. Once Ellicott's packhorses failed while he and his survey party were on a tributary of the Allegheny; in six days, he and his men with three axes, two tomahawks, and a chisel, built five dugouts, two of them fifty feet long, and continued on their survey by river. While on the Allegheny in 1794, Ellicott had met with Chief Cornplanter, the Seneca who kept his tribe at peace when others fought General Wayne at Fallen Timbers, and arranged safe passage for his survey party through Seneca lands to establish roads and lay out the towns of Franklin, Warren, Waterford, and Erie, Pennsylvania.

When the Spanish agreed in 1795 to 31° latitude as the boundary between the United States and Spanish Louisiana and Florida, President Washington sent Major Ellicott to survey the new boundary. Ellicott arrived at Pittsburgh in September 1796, organized his survey party, and set

out down the Ohio on October 23 in a flatboat and three keelboats supplied by quartermaster Isaac Craig. The voyage was the most miserable experience of Ellicott's life. The Ohio was so low that he and his men had to drag their boats over the shoals in weather so cold that their clothes froze stiff when they came out of the water. The boats had been ruined by the time Ellicott reached Cincinnati on November 25, and he learned that his were the first boats to reach Cincinnati from Pittsburgh since August. "We made it," Ellicott said, only because of the number of men in his party "whose quiet submission to unusual hardships does them great credit."

Yet Ellicott was impressed by the Ohio River and its people. "The Ohio is certainly one of the finest rivers within the United States," he asserted. "The people who reside on the Ohio and its waters, are brave, enterprising, and warlike," he continued. "It arises from their situation; being constantly in danger from the Indians, they are habituated to alarms, and acts of bravery become a duty they owe to themselves and to their friends. But this bravery, too frequently when not checked by education, and a correct mode of thinking, degenerates into ferocity."

The Major left Cincinnati at the end of November and reached Spanish Natchez at the end of the year, but, he informed President Washington, the Spanish refused to permit the survey and would not remove their troops from forts north of the proposed boundary. As a result, President Washington ordered General James Wilkinson to move the American Legion from its headquarters at Pittsburgh to the mouth of the Ohio to seize the Spanish posts, if they were not promptly evacuated. General Wilkinson was the officer who had opened the flatboat trade to New Orleans in 1787. He had commanded a wing of the Legion at Fallen Timbers, and had succeeded to command of the Legion at the death of General Wayne in 1796.

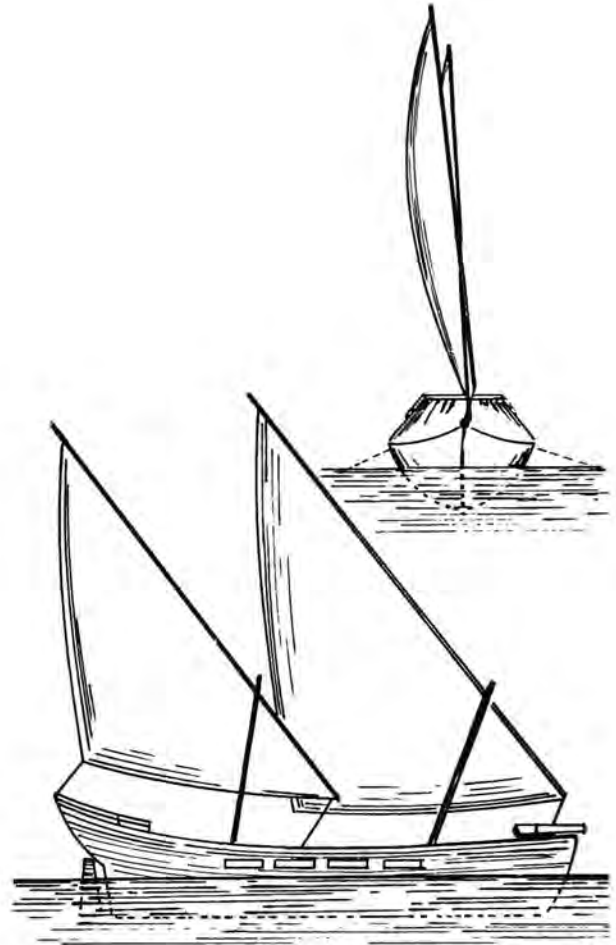
Warships at the Headwaters The sailing master touched the match to the firehole and the eighteen-pound cannon blasted a signal for the departure of the fleet. The crew scurried about the

deck, setting the sails and hoisting anchor. The lateen sails on the two masts of the galley flapped, then billowed, as the *President Adams* came round to the wind, then moved out of the Pittsburgh harbor followed by a line of flatboats transporting, with the exception of post garrisons, the entire United States Army.

General James Wilkinson, in his elaborate barge *Kitty* at the rear of the fleet, watched carefully to see that his orders were obeyed. The orders were that each boat in the fleet proceed in single line at one hundred yard intervals, maneuver at signals from the galley guns and from bugles sounding retreat or assembly, carry signal lanterns displayed prominently at the stern of each boat, and, when grounded, to give the distress signal only after the crew had jumped in the river to try to free their own boat. To encourage watchfulness, the General ordered that officers in command of boats that hit snags be immediately reduced in rank.

When the Army sailed on June 8, 1798, plans to take the Spanish posts on the Mississippi had been laid for a year. The Spanish had a ten-ship armada, 3 galleys, 3 gunboats, 3 galiots, and a bombardier, patrolling the Mississippi up to St. Louis, and General Wilkinson had concluded: "We dare not move out of the Ohio, until we have built a river navy of decided superiority." With the aid of shipwrights sent west by Joshua Humphreys, Chief of Navy Construction, Major Isaac Craig and the quartermasters at Pittsburgh began building two war galleys in late 1797.

Major Craig launched the two-masted, thirty-oared *President Adams*, 50.5 feet long, 14 feet abeam, carrying an 18 pounder on the forecastle and smaller cannon on the quarterdeck, into the Allegheny on May 19, 1798. It and the second galley would, said Craig, be superior to any Spanish ship on the Mississippi. Sailing Master John Brevoort and a crew of volunteer rivermen sailed the *Adams* at the head of the flatboat fleet to Fort Massac at the mouth of the Ohio in June 1798. General Wilkinson commented:



Sailing galley

The Galley President Adams in her passage produced a good Effect and was everywhere received with acclamations; the novelty of the scene was impressive and awoke new Interests. The Mississippi and its tributary streams will in a few years, be able to furnish ordinary shipping to the whole world at half price—the idea is stupendous, yet it is strictly correct.

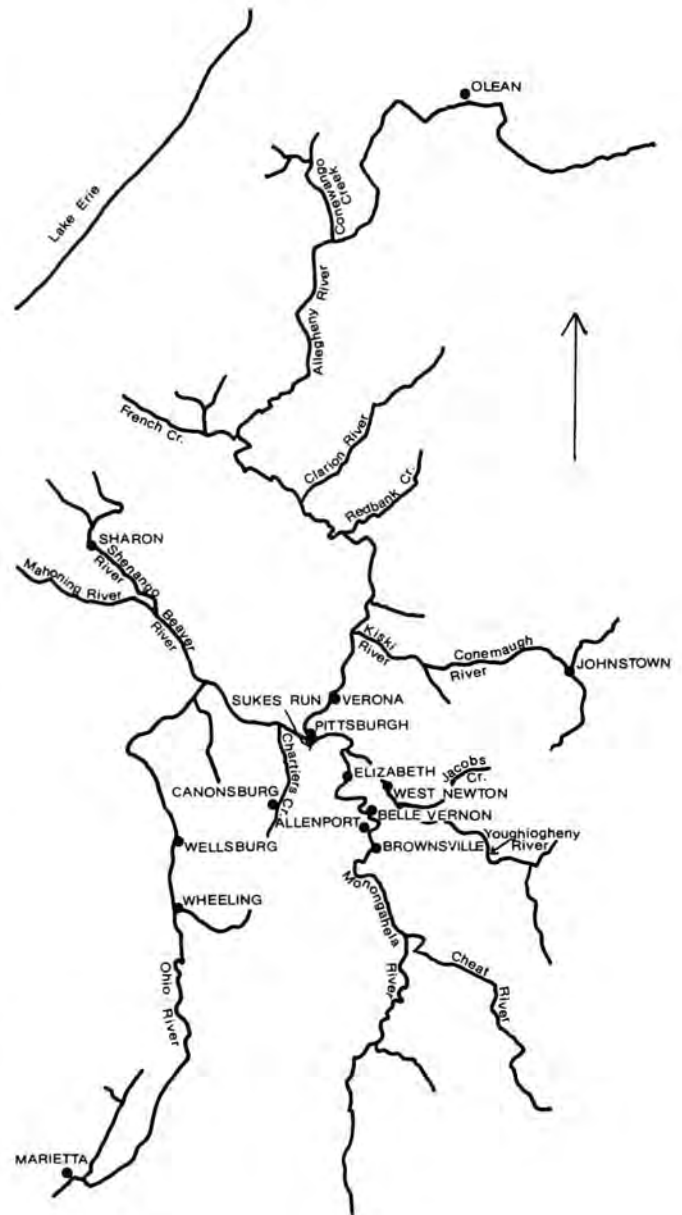
When the Spanish learned of the advance to the frontier of the American warships and army, they abandoned their posts above Natchez, withdrew their navy to New Orleans, and permitted Andrew

Ellicott to proceed with his boundary survey. The *President Adams* and the American fleet took Memphis and Natchez in the autumn of 1798, and the Corps of Artillerists and Engineers began construction of fortifications to protect against Spanish or Indian counterattack.

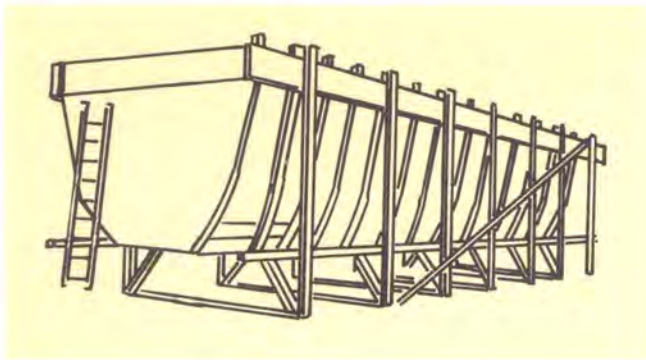
Major Craig completed the galley *Senator Ross*, named for Senator John Ross of Pittsburgh, two months after he launched the *Adams*; the *Ross* was larger than the *Adams* and had larger armament. The three rivers at Pittsburgh receded during 1798, however, to a point twelve inches below any stage ever known before, said Craig, and he was unable to launch the *Ross* before ice closed navigation for the winter. Craig finally was able to launch the *Ross* on March 25, 1799, and it joined the *Adams* on the Mississippi, convoying troops between the mouth of the Ohio and Natchez until 1803, when President Thomas Jefferson purchased Louisiana, and then sailing to New Orleans to assure quick evacuation of the city by the Spanish.

The Headwaters Shipbuilding Industry
Perhaps stimulated, as General Wilkinson speculated, by construction of the two galleys, a thriving shipbuilding industry had developed in the headwaters district by 1803.

The first sailing ship built in the Ohio River basin was probably the bark *Three Friends*, designed by George Morgan in 1768 and built at Fort Pitt. Thomas Hutchins had suggested in 1778 that ships, schooners, and sloops suitable for foreign trade could be built on the Ohio and its tributaries and sent to sea laden with lumber, iron products, and agricultural produce, saving at least 50% of the cost of transporting freight overland to Philadelphia and Baltimore. The *Mayflower*, built by Rufus Putnam and Yankee sailors on the Youghiogheny in 1788 was a sailing galley, but transported emigrants to Marietta and was not used for commerce. Dr. Richard Jones Waters had built the 55-ton schooner *Ulela* on the Monongahela in 1792, floated it to New Madrid, where he loaded it with flour, raised masts and sails, and continued the



Shipbuilding in the headwaters



Shaping the hull

voyage to Philadelphia. In the same year, the sloop *Western Experiment* under the command of Captain Charles Nicholson, sailed from the Monongahela to Philadelphia. Troubles with the Spanish on the Mississippi had interrupted shipbuilding in the headwaters district in 1794, but the business resumed after General Wilkinson took Memphis and Natchez in 1798 and the troubles with the Spanish were amicably settled.

Samuel Jackson, a business associate of General Wilkinson, built the 45-foot schooner *Redstone* at Joseph Chester's shipyard at Allenport on the Monongahela in March of 1801. In April, John Scott built the schooner *Monongahela Farmer* at Elizabeth for a farmers' association. Under command of John Walker, the *Monongahela Farmer* took a cargo of flour, whiskey, hides, hemp, and flax to New Orleans and entered the West Indian trade. The first commercial ship launched on the Allegheny was the 170-ton brig *Dean*, built in 1802, probably by Brintley Robbins for William Dean near Oakmont-Verona. It sailed in January 1803, took on a cargo of cotton shipped by General Andrew Jackson at the mouth of the Cumberland River, and delivered its cargo directly to Liverpool, England.

The major shipbuilders at Pittsburgh were Louis A. Tarascon and James O'Hara. O'Hara, Army Quartermaster General, funded construction of several ships at Pittsburgh by master mariner Eliphalet Bebee and placed them in foreign trade. Tarascon and his brother John, emigrants from Bordeaux, France, became partners with James Berthoud in 1802 and opened a store, warehouse, sail and rigging loft, anchormsmith shop, and a complete shipyard at the mouth of Suke's Run on the Monongahela. Tarascon ships were taken downstream by experienced rivermen, like John Brevoort, the galley sailing master, who took the 400-ton *Western Trader* to New Orleans in 1804, from whence it, like most Tarascon ships, entered the Atlantic trade between Bordeaux and Philadelphia.

Sailing ships were also built along the Ohio at Wellsburg, Wheeling, Marietta, Cincinnati, and Louisville. The 100-ton schooner *Mary Ann* and the 177-ton brig *Recovery* were launched at Wellsburg in 1804 and 1805 and taken to New Orleans for the foreign trade by Captains Peleg West of Nantucket, Massachusetts, and John A. Fry of Rhode Island. The schooner *Nancy* was launched in 1808 at the confluence of Wheeling Creek with the Ohio.

Ships were built in the headwaters district because they could sail directly to coastal or foreign markets, avoiding the cost of transshipment from flatboat to ship and eliminating the New Orleans middlemen, and because they could be built nearer plentiful timber sources at a cost less than ships built at coastal ports. Many ships built in the headwaters district were funded by shippers at coastal cities who sought to reduce construction costs. For the same reason, the Secretary of Navy contracted in 1803-08 for construction of at least a dozen gunboats at inland river ports; some were fitted out at Wellsburg on the Ohio.

The Navy gunboat construction program was interrupted by the Burr conspiracy in 1807, because some of the contractors were close associates of the Vice President and it was feared they might lend the warships to Aaron Burr for an attack upon Mexico or New Orleans.

The Vice President left Pittsburgh in April 1805 in a sixty- by fourteen-foot flatboat, equipped with dining room, kitchen, bedrooms, and even glass windows, built at a cost of \$133. "How it can be made for that sum," Burr, commenting on the economy of river boatbuilding, "passes my comprehension." On his return trip in 1806, Burr visited Colonel George Morgan and his sons at Morganza, the manor Morgan built on Chartiers Creek, and made the mistake of revealing his plans to the old patriot and his family. Burr told the Morgans that with 500 men he could seize Washington and New York and drive the federal government into the Potomac. Morgan's son retorted: "By God, sir, with that force you cannot take our little town of Canonsburg." Colonel Morgan

told Jefferson what he had heard from Burr and the President set the wheels in motion that caught up with the Burr expedition on the Mississippi in 1807. Construction of the Navy gunboats resumed and they sailed down the rivers to New Orleans, performing good service with the Navy against Lafitte's pirates and the British in 1814.

Many ships from the headwaters district wrecked or were damaged during the downriver voyage; to avoid these losses, the Tarascons relocated their shipyard below the Falls of the Ohio in 1806. Navigation hazards, in conjunction with the Embargo Act of 1807 and conflict with British and French corsairs on the high seas, brought depression to the headwaters shipbuilders in 1808, but sailing ships were built from time to time in the headwaters district until the Civil War, sometimes in unexpected places. The two-masted schooner *Locust Tree*, 56 feet long and 19 feet wide, for example, was built in 1851 at Sharon, Pennsylvania, on the Shenango River and floated to New Orleans, where it operated in the coastal trade until 1863.



Major (later Colonel) Jonathon Williams

Jonathan Williams and the Corps Major
Jonathan Williams and Lieutenant Alexander Macomb organized a press detail and sent it through the narrow streets of Pittsburgh to drag the recruits for the Second Regiment of Artillerists and Engineers from the taverns and alleys and carry them to the flatboats at the wharf. "I have never seen such beastly drunks," said Williams, "that poison is ruinous & I believe they would drink till they died if they had always the Power." Once he had the sloppy Engineer recruits in one boat, the horses and dragoons in another, and the Army band in third, he left Pittsburgh on July 2, 1801. To prevent the recruits locating a new supply of poison, Williams did not land the boats until he reached the Engineer training camp at the mouth of the Ohio.

Major Williams had been educated by his uncle, Benjamin Franklin, had served as naval supply agent at Nantes during the Revolution: he and his uncle had sent John Holker, Barthélemi Tardiveau, and Thomas Hutchins from France to America. Williams studied French military engineering, took a Harvard degree in 1787, joined his uncle in scientific experiments, and accepted a commission as Major of Engineers from President Jefferson in 1801. He planned new fortifications on the Niagara frontier in early 1801, then took his regiment down French Creek and the Allegheny to Pittsburgh.

Once the recruits sobered, Major Williams enjoyed his voyage down the Ohio. He made detailed notes about valley geology, resources, and river navigation, while Lieutenant Alexander Macomb made topographic sketches. "The French used to call this *la belle Riviere*," Williams wrote, "I believe it to be *la plus belle de l'universe*." He was most impressed by the productivity of the people; every family along the river seemed to have six children. "They may in less than a Century defy the power of the world. The Ohio in that time may represent what the Rhine is now." Williams arrived at the mouth of the Ohio in late July and put his regiment through rigorous field training, performed ordnance experiments, and designed field fortifications. In October, he poled a canoe back up the Ohio on his way

east to become commandant of West Point and first Chief of the modern Corps of Engineers.

The Corps of Artillerists and Engineers established in 1794 had not been satisfactory: the Engineers had not received adequate training. Secretary of War James McHenry recommended the Engineers be made a separate Corps and thoroughly trained at West Point. McHenry explained to Congress:

We must not conclude . . . that the services of the engineer is limited to constructing, connecting, consolidating, and keeping in repair fortifications. This is but a single branch of their profession, though, indeed, a most important one. Their utility extends to almost every department of war, and every description of general officers, besides embracing whatever respects public buildings, roads, bridges, canals, and all such works of a civil nature. I consider it, therefore, of vast consequence to the United States, that it should form in its own bosom, and out of its own native materials, men qualified to place the country in a proper posture of defence.

Probably persuaded by the argument that skilled engineers could contribute both to national defense by military construction and to national welfare through civil works, President Thomas Jefferson, on March 16, 1802, separated the Corps of Engineers from the Artillery Corps and established an academy for engineer training at West Point. As both Superintendent of West Point and Chief Engineer of the Corps, Jonathan Williams appointed Major Andrew Ellicott professor of mathematics at the academy. Before Williams retired in 1812, he trained every man who served prior to the Civil War as Chief Engineer of the Army. Among them was Lieutenant Alexander Macomb, who had assisted Williams during the voyage down the Ohio. Macomb defeated a British army at the Battle of Plattsburg in 1814, became Chief Engineer of the Army in 1821, launched the Engineer project to improve inland river navigation in 1824, and designed the Essayons button still worn by Engineer officers.

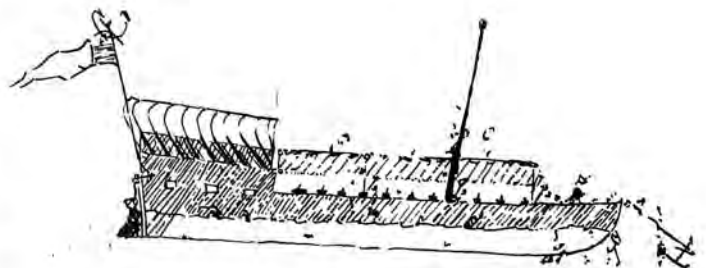
Lewis and Clark Expedition "At this stage of water, oxen make the best sailors on the Ohio River." Captain Meriwether Lewis wrote in disgust to President Thomas Jefferson. He explained he had planned to leave Pittsburgh on an early summer rise on the way to the Pacific, but had been thwarted by a drunken contractor who did not finish the boats until the end of August 1803, while Lewis had stood daily at the Point and watched the receding water trickling down the boulder-strewn channel.

Jefferson selected Lewis, who had great experience with river navigation, fort construction, and wilderness travel as an officer in General Wayne's Legion, to head up the Corps of Discovery on its trip up the Missouri and on to the Pacific. Lewis chose William Clark, brother of George Rogers Clark, who had served in the Legion with Lewis, as expedition co-commander. Jefferson tried to get these two infantry officers, who had learned engineering with the Army in the field, commissions in the new Corps of Engineers, but War Department regulations prevented it.

The 55-foot keelboat finally splashed into the river at Pittsburgh on August 31, and Captain Lewis and his crew tossed their supplies aboard and were off within four hours. Three miles downstream, Lewis's boats rammed the shoals at McKee's Rocks; Lewis and his men jumped into the water and pried their boats free, only to strand on a second ripple and

"The 55-foot keelboat finally splashed into the river..."

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Meriwether Lewis

spend their first night just four miles from Pittsburgh. The Captain was pleased to see a soupy fog over the river next morning; perhaps the heavy dew would raise the river a bit, he hoped. That morning he hit Horsetail Ripple at the head of Neville Island, where he unloaded his boats and lifted them over the rocks, then promptly stranded solidly on rocks at the toe of the island. The boats could not be budged, so Lewis hired a team of oxen to tow them to deeper water.

On September 2, the Corps of Discovery grounded on Logstown Ripple near Ambridge, Pennsylvania, and Lewis hired another team. The Corps struck Beaver Shoals on September 3, sank one boat, stranding the rest; Lewis fumed at the high rates charged by teamsters, but paid, for he had no choice. He told Jefferson that he and his men could cut a channel through sand and gravel bars with their paddles, but if the bottom were rock, the only recourse was to unload and pry the boats downriver with pushpoles, or hire teams to drag them free, springing the hulls in the process.

At Steubenville, the river appeared deeper, so Lewis hoisted a sail and made good speed, only to ram a shoal and break the mast-spars. "Now having no assistance but by manual exertion and my men worn down by perpetual lifting," Lewis lamented, "I was obliged again to have recourse to my usual resort and sent out in search of horses and oxen." Lewis rested his men at Wheeling on September 8, camped near Bellaire on September 9, and inspected the mounds at Moundsville on September



William Clark

10th. He reached the mouth of the Ohio on November 14; seventy-six exasperating, agonizing days to navigate the 981-mile course of the Ohio, but superb training for the hardships the Corps of Discovery was to endure on its exploration to the Pacific.

The Gateway to the West During the late 18th and early 19th centuries, the Allegheny, Monongahela, and upper Ohio river, the headwaters district, was truly the gateway to the west. The great pioneer emigration, the flatboat and keelboat commerce, the inland river shipbuilding industry, all had origins in the headwaters district. By 1824, when the Corps of Engineers began improving navigation on the inland rivers, flatboat and keelboat traffic from the headwaters district to New Orleans was carrying an enormous tonnage. The connecting rivers from the Monongahela to New Orleans had become by 1824 what they were still a century and a half later: carriers of the greatest waterborne commerce on the inland rivers of the United States.

The role of the Army and its engineers in developing traffic on the inland rivers was not insignificant. Rivers were the principal logistical lines for American forces operating on the Ohio River basin frontier. From Hutchins and Putnam to Lewis and Clark, the Army Engineers built a backlog of information about, and experience with, river navigation that would be useful to the engineers assigned in 1824 to the improvement of inland streams from the headwaters district to the mouth of the Mississippi.

Chapter 3

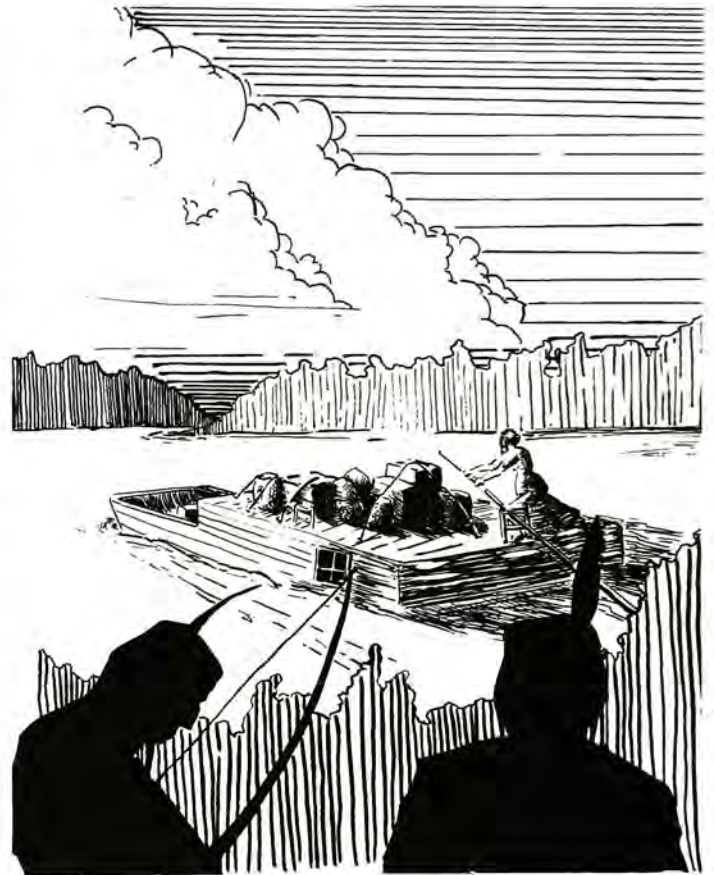
REDUCING THE RISKS

OF NAVIGATION

Mother Ann Sharp sat on the riverbank near the flatboat, puffing her pipe, listening to the distant roar of the Falls of the Kiskiminetas, and watching the children romping through the bright-green foliage of late May. She and her husband Andrew expected another child in a month, and she hoped when Andrew returned with the canoe he would agree to camp for the night. That day they had floated out of Conemaugh River and descended the Kiskiminetas, dashing between the threatening rocks at the Falls of the Kiski.

Captain Andrew Sharp had moved to Western Pennsylvania at the end of the Revolution and in 1794 had decided to follow the frontier to Kentucky. The Sharps joined the families of other veterans at Blacklick Creek, where they built a flatboat and embarked on a flood, running the shoals and rapids on Blacklick Creek, Conemaugh River, and the Kiskiminetas. While crossing the Falls of the Kiski on May 30 they lost a canoe that broke free and went spinning downstream. The Captain landed the flatboat and jogged across the river bends to catch the canoe.

As the sun set, Mother Sharp heard her husband crashing through the brush and shouting: "Indians are coming!" She and the women hastily shoved the children into the flatboat and climbed in after. Captain Sharp raced to the boat and slashed the rope at the bow with his axe as the Indians fired. The first volley smashed Mother Sharp's pipe from her mouth and wounded her husband in the left shoulder; the second hit the Captain in the right shoulder as he cut the stern rope, but he clambered over the gunnel into the boat and Mrs. Sharp handed him a rifle. She loaded while he, despite his wounds, fired with good effect. Warriors pursued the drifting boat downriver, firing from behind trees. Captain Sharp blazed away in return till he fainted from loss of blood. By dark, two men lay dead in the



Ambush on the Kiski

boat, Captain Sharp and another were badly wounded, and the boat, with no able men aboard, careened wildly down the flooded Kiskiminetas, narrowly missing snags and rock studded banks.

Mother Sharp hushed the children, telling them the Indians would hear and return, made her bleeding husband as comfortable as possible, and crawled to the stern, over the bodies and around the women and children huddled in the boat bottom. She stood cautiously, grasped the tiller oar and, by forcing the oar back and forth with all her strength,

found that she could control the course of the boat. During the silence of that long night, punctuated only by sounds of rushing water, whimpering children, and groans of the wounded, she held the boat in the channel as it floated out of the Kiski and down the Allegheny. Through the mists of daybreak she spied white men on the bank and called for help. The men paddled a canoe to the flatboat to help Mother Sharp land nine miles above Pittsburgh.

Captain Sharp died of his wounds on July 8 and was buried with the honors due a veteran of the Revolution. But only his children followed the casket to the cemetery, for Mother Sharp had just been delivered of child.

Richly laden and slowly moving flatboats were easy prey. General Wayne's victory at Fallen Timbers in 1794 curtailed Indian attacks on river traffic, however, and the ambush on the Kiski in 1794 was the last Indian attack on flatboats in the headwaters district. Boatmen, nevertheless, still ran a gauntlet during each voyage: renegades at Cave in Rock and boatwreckers near Fort Massac on

the lower Ohio, sharpsters at Natchez and New Orleans on the Mississippi, and robbers on the trails leading back to the headwaters district.

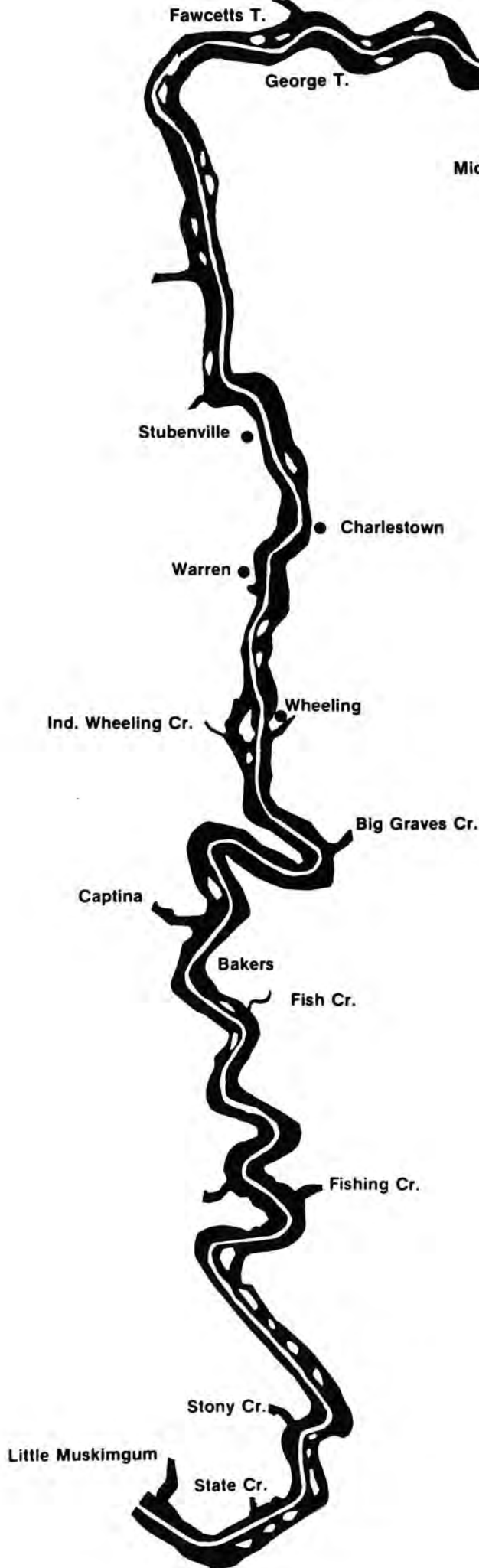
But human hazards were infinitesimal when compared to the natural obstructions to navigation. Rivermen braved Allegheny River ice, Monongahela low water, and snags, boulders, shoals, ripples, shallow bars, and great flow fluctuations on nearly all inland streams. Ice on the Allegheny stopped traffic for weeks in most winters and destroyed many watercraft on both the Allegheny and Ohio. When the Allegheny ice broke in 1793, for instance, it swept away and sank a fleet of flour-laden flatboats at Wellsburg on the Ohio, causing losses estimated at 437 pounds in Pennsylvania currency. The Monongahela low water problems were perhaps best described by John May, a Boston merchant on his way in 1789 with a boat load of merchandise to join Rufus Putnam at Marietta.

Captain May had a flatboat that drew only 12.5 inches of water, but shallow conditions stopped him on



Kiskiminetas-Conemaugh Valley - 1790

Portion of Map by
John Adlum and John Wallis
(See end of chapter)



From Zadok Cramer's
Navigator, the first
 navigation charts
 Carnegie Library of Pittsburgh

the Monongahela for weeks. "Oh that my goods were back in Boston," he lamented, "or anywhere rather than on this dismal Monongahela river! I cannot help recording, this is the severest trial of my life. If I am ever happy enough to get out of this, I put these thoughts down that the lessons of the past may not be forgotten. Here week after week, with little or nothing to do, no money stirring, & with no sort of amusement to divert the mind from gloomy fancies."

Captain May finally got out of the Monongahela, but found the Ohio little better. He gave up the voyage at Wheeling, rented a building from the Zanes, and opened one of the first stores in Wheeling.

The Ohio River above Wheeling had such a steep slope and was so littered with obstructions that it became notorious as a flatboat graveyard. Timothy Flint, who took a flatboat from Pittsburgh in 1815, described what happened when he hit Deadman Island Ripple (at present site of Dashields Locks and Dam):

The boat began to exchange its gentle and imperceptible advance for a furious progress. Soon after, it gave a violent bounce against a rock on one side, which threatened to capsize it. On recovering her level, she immediately bounced on the opposite side, and that in its turn was keeled up. Instead of running to the oar, we ran to look in the Navigator. The owner was pale. The children shrieked. The hardware came tumbling upon us from the shelves, and Mrs. Flint was almost buried amidst locks, latches, knives, and pieces of domestic cotton Sometimes we were jostling on the rocks in the ripples. Sometimes we were driven furiously along the chutes, and sometimes we stuck fast on the sand-bars.

Flint eventually abandoned the flatboat in favor of a more maneuverable skiff to descend the Ohio.

Deadman Island Ripple, Horsetail Ripple, the Trap, Beaver Shoals, White Woman Rapids, each obstruction on the upper Ohio was known by name to rivermen. Emigrants relied on Zadok Cramer's *Navigator*, first printed in Pittsburgh in 1802, which furnished the first navigation charts available to those who risked their all on the inland rivers.

Collisions with snags and rocks heavily damaged the inland river flatboat fleets. Flatboat losses have been estimated as high as 25%, and marine insurance rates for flatboats were near 10%. The carriers must have estimated that one boat in ten would be totally lost. With rivers badly obstructed and commercial losses heavy, it was not surprising that state and local governments became interested in improving river navigation long before the federal government began work in 1824.

Rivermen commonly removed minor obstructions to navigation. Captain Meriwether Lewis, during his 1803 trip down the Ohio, dredged channels through gravel bars with canoe paddles and spades, and he told President Jefferson that with hard work he could clear a fifty-yard channel in an hour. Captain George Rowley, who later served as snagboat captain for the Pittsburgh Engineer District, often boasted that he had backed all the way up the Ohio to Pittsburgh, meaning he had poled keelboats up the river, and mentioned that he always carried flashboards and stakes aboard his keelboats. When his boat grounded, he drove stakes into the river bottom and placed boards on the upstream side of the stakes to divert the river flow under the boat hull, thereby gaining a little more depth and washing sand from around the hull.

The need for improved navigation in the headwaters district was so great that in 1794, when Captain Sharp and his family were ambushed on the Kiskiminetas River, that stream had already been improved for navigation by rivermen and Pennsylvania was planning a project for the stream.

The Kiskiminetas River was the first stream west of the Alleghenies to be declared legally navigable. The Pennsylvania Council on March 9, 1771, designated it a navigable public highway and forbade obstructions that might prevent navigation by "his Majesty's liege subjects," Pennsylvania still being a colony at the time. Colonel Charles Campbell, owner of a milldam on Blacklick Creek, the first mill in the Kiskiminetas-Conemaugh basin, wished to ship the product of his mill to market in flatboats, and about 1790 he and others interested in navigating the Kiskiminetas system joined to clear the boulders from the channels, especially from the Falls of the Kiski near the present site of Apollo, Pennsylvania. Campbell and his associates contracted with Pennsylvania to continue work in 1794 on the Kiski and Conemaugh. In the same year, Pennsylvania began work on the Monongahela, Youghiogeny, Allegheny, and French and Conewango creeks.

Governor Thomas Mifflin launched Pennsylvania's river projects in 1790 with the aim of securing the trade of the West for the Commonwealth, which, the Governor said, was "a natural avenue from the shores of the Atlantic to the vast regions of the Western Territory." His river improvement program was one of the opening shots of the economic war waged by Philadelphia, Baltimore, New York, Richmond, and their respective states for access to western commerce through construction of improved waterways, roads, canals, and railroads to the headwaters district and the Great Lakes.

Governor Mifflin appointed Timothy Matlack, Samuel Maclay, and John Adlum in 1790 to locate river routes and connecting portages from Philadelphia to the Susquehanna, from tributaries of the Susquehanna to tributaries of the Allegheny, and on to Lake Erie via French and Conewango creeks. Adlum had assisted Andrew Ellicott in boundary surveys and in platting the towns of Erie, Waterford, Franklin, and Warren; Matlack and

MacLay were Revolutionary veterans who served in the Pennsylvania legislature and in Congress.

The surveyors ascended the Susquehanna, its West Branch, and Sinnemahoning Creek to Driftwood, crossed the divide and examined the Allegheny, Clarion, Kiskiminetas-Conemaugh rivers and French and Conewango creeks. They met Chief Cornplanter and the Seneca council on the Allegheny and found the Indians eager for the opening of the waterways for trade. They also made the mistake of examining the Clarion and its East Branch and the Conemaugh and Little Conemaugh rivers in August, at extreme low water; their boatmen fainted from the labor of dragging their canoes for great distances over the shoals.

In their report to the Governor, the surveyors recommended that all the streams examined be cleared of snags, boulders, and bars. In their opinion, the best route examined was up the Susquehanna system to Driftwood on the Sinnemahoning, a short portage to Portage Creek in present McKean County, down that creek and the Allegheny to Warren, up Conewango Creek to Lake Chautauqua, and from there a second portage to Lake Erie. Lake Chautauqua, they thought, should be dammed at its lower end to raise the lake level and assist navigation on Conewango Creek by releasing lake water through the dam. The Pennsylvania assembly had allotted 600 pounds currency for the survey. Costs were actually just over 1,411 pounds, a 135% cost overrun and not a good omen, but the assembly was well pleased with the report and acted upon it.

To plan improvement of the Youghiogheny and Monongahela as southern trade routes, Governor Mifflin selected John Badollet, schoolmate of Albert Gallatin at Geneva, Switzerland. Badollet emigrated to America to join Gallatin on the Monongahela in 1786, and became his partner in founding New Geneva and in building a glass and gun factory there. He later became judge and militia captain in Greene County, surveyed roads in Ohio and Indiana, and opened the federal land office at Vincennes, Indiana.

Badollet canoed from the mouth of Indian Creek down the Youghiogheny and examined the Monongahela to the southern boundary of Pennsylvania. He found both streams much obstructed by fish dams, built by Indians and pioneers to trap fish at low water, and he recommended that the state strictly enforce the act of April 13, 1782, in which the two rivers had been declared navigable public highways. He reported navigation on the Monongahela was hampered by caving banks, which constantly fell into the river and formed bars that obstructed boat traffic. Bank instability was even a threat to parts of Pittsburgh. Rocks, he declared, were the greatest menace to Youghiogheny commerce. Boatmen on the stream



John Badollet - navigation planner Indiana Historical Society Library

had removed some of the largest boulders, but many yet remained. Badollet recommended a channel clearance project for both streams, with minimum fifty-foot width on the Monongahela, minimum forty-foot width on the Youghiogheny, and both with minimum depth of twelve inches at low water. Flatboats and watercraft drawing a foot or less could slide over the rocks and bars and down the channel at low water. Boats drawing more than a foot could wait for a rain.

In legislation enacted on April 13, 1791, and April 10, 1792, the Pennsylvania assembly funded improvement of rivers in the headwaters district as part of a program designed to open an east-west waterways system with connecting portage roads. The Susquehanna River system was to be improved to Driftwood Fork of Sinnemahoning Creek, the Allegheny from Warren to Portage Creek, the Kiskiminetas-Conemaugh and Little Conemaugh from Portage in Cambria County downstream, all of French Creek, the Youghiogheny to the mouth of Indian Creek near Ohiopyle Falls, and the "Mon" to the Virginia line. On April 14, 1792, the Governor asked contractors to bid for improvement of the streams named "by blowing rocks, erecting sluices and wing walls, clearing shoals, &c." To insure proper contract performance, the Governor appointed agents of information, equivalent to modern resident engineers, to prepare detailed onsite plans and inspect the work. John Badollet was made agent for the Youghiogheny and Monongahela, William Findley and William Smith for the Conemaugh and Kiskiminetas.

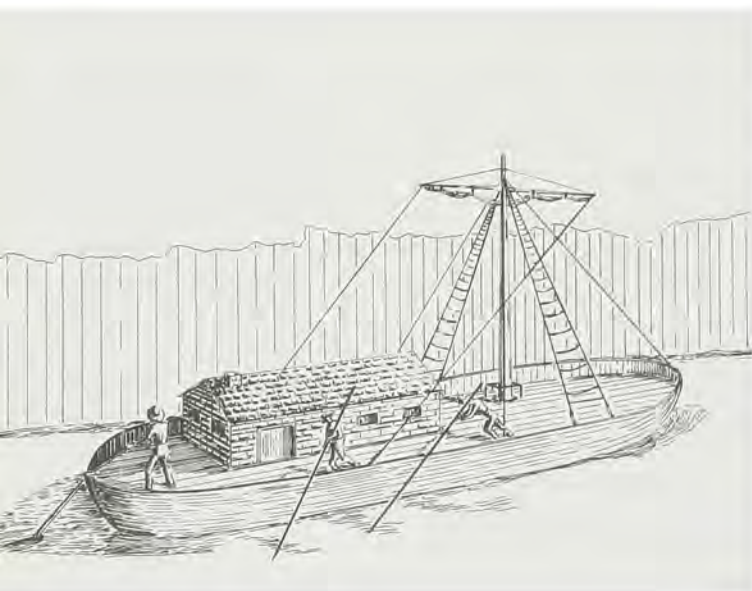
Findley and Smith obtained a copy of the Adlum report of 1790 and prepared detailed plans for the Kiskiminetas-Conemaugh project in late 1792. They thought it possible to build locks and dams on the Little Conemaugh River and the Poplar Run branch of the Juniata, a reservoir at the summit for water supply, and a canal connecting the two streams to completely eliminate the portage, but funds were too limited and a road was built from Frankstown on the Juniata to the Little Conemaugh.

Strict enforcement of navigation laws on the Kiski and Conemaugh rivers was imperative, Smith and Findley asserted, for "the navigation has been shamefully obstructed by persons clandestinely and sometimes openly replacing their fish-dams where they have been regulated or thrown down."

They laid plans for the improvement of the Kiskiminetas and Conemaugh rivers under four contracts, blasting away obstructive rocks and building longitudinal side walls to form a 25-foot wide and 14-inch deep channel at low water for flatboat traffic, with clear sluices and towing paths at rapids for ascending boats, at an estimated cost of 3,050 pounds currency.

Colonel Charles Campbell, David Todd, John Dennison, James Brady, and other men interested in undertaking the contract work complained in 1793 that the Findley-Smith cost estimates were way low, but the problem was resolved through negotiation and the contracts let in early 1794, just before Captain and Mother Sharp set out down the river. Some contractors performed well; others not. Captain James Brady took the contract to clear the Conemaugh from the site of Johnstown to the mouth of Richards Run on April 22, 1794. He finished the job as agreed by September 1, 1796. Charles Campbell and John Dennison in 1794 took the contract for the three sections from the mouth of Richards Run on the Conemaugh to the mouth of the Kiskiminetas and went speedily to work, blasting channels through shoals and dumping the stone in low walls to divert low water flow into the main channel. State inspectors reported, however, that some channels were cut in the wrong direction, some of the riprap walls poorly located, and that the contractors had not performed well. The contractors were required to remedy project defects and did not receive final payment for their work until December 9, 1805, about nine years after the originally scheduled completion date.

No comparison of costs with benefits of the Kiskiminetas-Conemaugh project was ever



Keelboats

attempted, but canoe and flatboat traffic plied the waterway in a steady stream. In the spring of 1818, for example, 59 flatboats carrying up to 40 tons each of dry goods from Philadelphia and bar iron and salt produced in the Kiski-Conemaugh basin passed the mouth of Loyalhanna Creek on the way to Pittsburgh and west. Major tributary streams, such as Blacklick Creek, were also placed under the protection of state navigation laws. State commissioners George Mulholland, Peter Wallace, Andrew Boggs, John Hill, and Jacob Drum expended \$5,000 in state funds to repair the Kiski-Conemaugh project in 1822, and traffic on the waterway continued until Pennsylvania completed a canal through the basin.

We Have Met the Enemy and They Are Ours
All Americans remember Commodore Perry's message of victory on Lake Erie on September 10, 1813, but few are aware of the contributions of French Creek boatmen to that victory. When the Commodore began construction of a fleet to meet the British flotilla on Lake Erie he needed ship rigging, naval hardware, and munitions, and he made contracts with the experienced shipbuilders and iron manufacturers of Pittsburgh and the Monongahela. The job of delivering these naval stores to Erie was given to keelboatman Marcus Hulings of French Creek.

Marcus Hulings and his five husky sons had pushed keelboats up the Allegheny in 1790 to settle at Franklin, where they opened an inn, kept a ferry, built a milldam on French Creek, and organized a keelboat line to supply Allegheny basin pioneers with the necessities of life. He and his sons began the business of rafting timber from French Creek forests to Ohio River ports, skimmed oil from French Creek for use as liniment, and later entered the petroleum business in Tennessee.

Hulings and his boys loaded rope, cannon, and shells aboard his keelboats at Pittsburgh in the summer of 1813 and set out up the Allegheny and French Creek to Waterford, from whence only a short overland haul to Erie would be necessary.

Thrusting the long wooden poles firmly into the creek bottom, the Hulings boys staunchly planted their feet on the keelboat runways, braced their shoulders to the poles, grunted under the strain, and slowly walked the keelboats under their feet toward the head of French Creek. When their utmost efforts could not stem the currents at rapids, they lashed hawsers to their boats, jumped to the bank, seized the ropes and scrambled through the brush, hauling the boats and the precious naval stores upriver. At the longest rapids, they double-tripped, leaving part of the cargo at the foot of the rapids, towing the boats up, unloading, then returning to bring up the rest of the cargo. In spite of bodies scratched and bruised, clothes torn by brambles, muscles burning from fatigue, Marcus Hulings and his sturdy sons beat their way up French Creek, delivering the naval stores and ordnance to Commodore Perry in time for him to finish and arm his ships. When Perry's resounding message was received in September 1813, there was great rejoicing at Pittsburgh ropewalks and foundries and in the homes of Marcus Hulings and his boys, for the enemy, in part, belonged to them.

Marcus Hulings might not have been able to get his keelboats up French Creek in the low-water season of 1813, had the creek not been improved for navigation. Captain Le Mercier of the French Engineers first cleared snags from the stream in 1753. The British put bateaux transporting troops, munitions, and supplies into operation on French Creek in 1759, but lost many boats on the snags and rapids. Colonel Henry Bouquet said one of his large bateaux struck "in a Rapide, and being carried down with Great Impetuosity by the Current fell against a Tree hanging on the River; splitt & oversett, one man was killed by the Tree, another drowned." Bouquet sent a hundred men in 1761 to again clear snags and trees from French Creek.

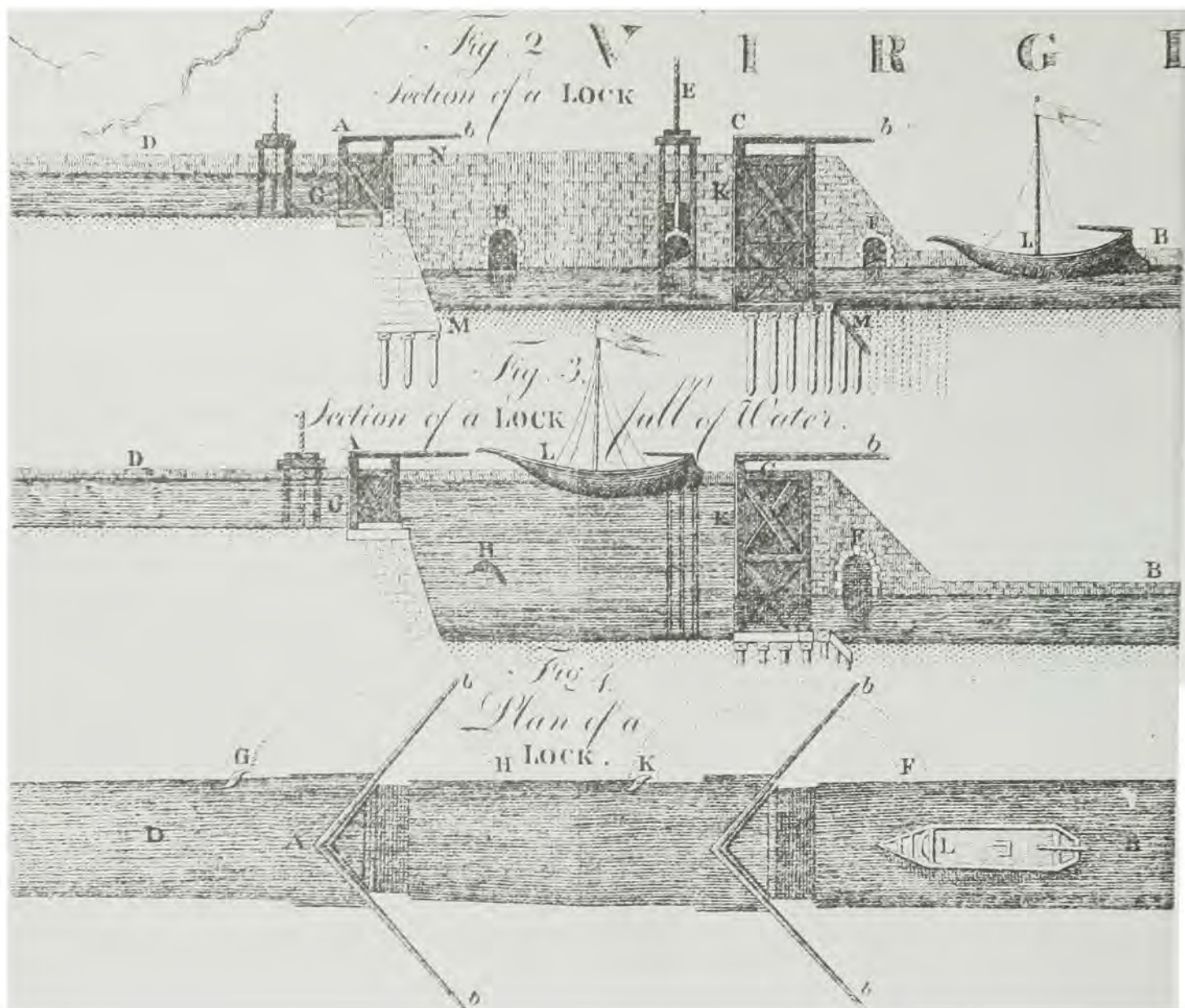
The American pioneers who moved into the French Creek basin after the Revolution sent hundreds of flatboats freighted with whiskey, beans, furs, paper, salt, and lumber down French Creek to faraway markets. Samuel B. McGaw of Meadville,

for instance, arrived at New Orleans from French Creek in 1806 with four flatboats and a hundred tons of flour, lumber, and butter. On board one boat was Daniel Horn, the "Walker," who walked back to French Creek from New Orleans each year. Most French Creek boatmen sailed to Philadelphia and took the short walk over the Alleghenies.

Quartermaster General James O'Hara began supplying salt to the frontier armies in 1796 from Syracuse, New York, by shipping it across the Great Lakes and the portages to French Creek, then down the creek and the river system to the garrisons. On November 23, 1809, more than 14,000 barrels of salt were stacked at Waterford on the banks of French Creek awaiting a rise. Salt shipments by that route continued until the British disrupted the transportation line during the War of 1812.

French Creek was so valuable for transportation that the channel was improved for navigation on several occasions. William Smith supervised the expenditure of 800 pounds currency for Pennsylvania in 1794 to clear French Creek and improve the road from Waterford to Erie. Funds amounting to \$500 from land sales in Erie County were spent in 1807 for the improvement of French Creek. Pennsylvania appropriated \$2,000 in 1810 and \$800 in 1817 to continue the project. Contractors Richard Patch, a flatboat captain, and John Martin, with shovels, axes, and horsedrawn scrapers, worked over the stream to Waterford, and the channel served well. The huge flatboats built along the stream were commonly used by Monongahela miners to ship coal to New Orleans, and to rivermen a "French Creek" came to mean a sturdy wooden barge.

The Mon and Yough Project After John Badollet made his report on Monongahela and Youghiogheny navigation, the Governor appointed him agent of information on April 10, 1792, and asked that he distribute circulars asking for bids from contractors. Bids were received from James Lang, Samuel Jackson, Neal Gillespie, and several men involved in the Whiskey Rebellion, and were delivered to the Governor by Albert Gallatin. The



Design of navigation locks - John Adlum's map

Dr. Leland R. Johnson

Governor accepted the bid from Samuel Jackson on December 7, 1792. For 1200 pounds currency, Jackson proposed to remove dangerous rocks, build low stone dams, and clear a 50-foot wide channel from the juncture of West Fork and Tygart rivers to the mouth of the Monongahela. Jackson guaranteed the channel would pass downstream at low water flatboats 40 feet long, 12 feet wide, and with 6-inch draft. In accepting the bid, the Governor noted the Monongahela was "not navigated by boatmen who live by the business, but very generally by the farmer, and in boats not calculated to return."

At the time Jackson undertook the contract, he was associated with General James Wilkinson in the flatboat trade down the inland rivers to New Orleans and had flour mills and boatyards in operation in the Monongahela basin; he later built iron

works that supplied ordnance to Commodore Perry and General Andrew Jackson during the War of 1812. Under the inspection of Badollet, Jackson blasted rock, built riprap dams to confine low-water flow to the channel, and completed the project as agreed in 1798.

Isaac Meason, co-founder of Connellsville, and John Gibson of Fayette County accepted the contract on January 31, 1793, for improving Youghiogheny River navigation from the mouth of Indian Creek above Connellsville to its confluence with the Monongahela at McKeesport. Improvement of the "Yough" was badly needed, for many flatboats sank with loss of life while trying to descend the swift, boulder-strewn stream. In 1788, for example, a flatboat stove on rocks at Youghiogheny Falls and both families aboard drowned.

XY (Fig. 1.) are the two flood gates, each of which consists of two leaves, resting upon one another, so as to form an obtuse angle, in order the better to resist the pressure of the water, the first (X) prevents the water of the Superior Canal from falling into the Lock; and the second (Y) dams up & sustains the water in the Lock, these flood gates ought to be very strong, and to turn freely upon hinges, in order to make them open and shut with ease, each leaf is furnished with a long Lever A b, A b; C b, C b. they should be made very tight & close, that as little water as possible may be lost.

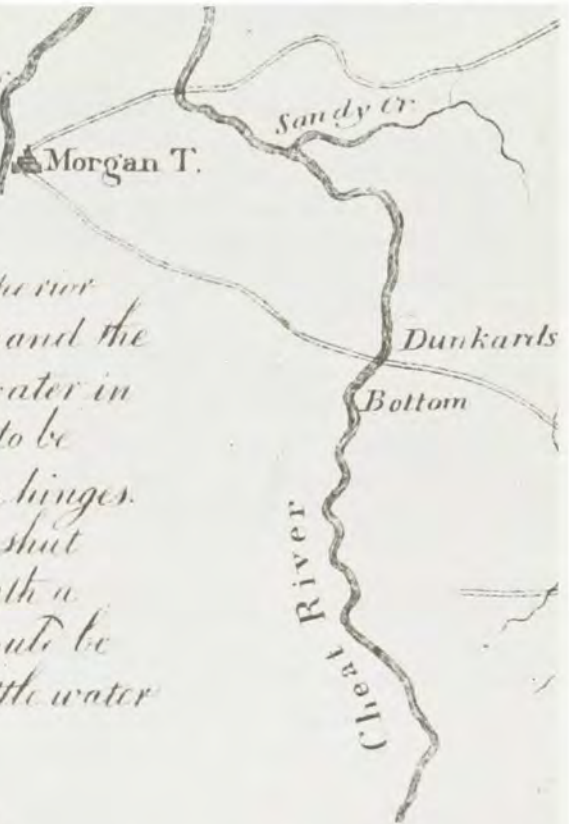


Fig. 1.

Perspective VIEW of part of a CANAL with LOCKS.



Meason and Gibson removed the dangerous rocks listed by Badollet in his report, destroyed fish-dams, blasted a channel and placed the spoil in riprap dams. The project was a credit to the contractors, the state inspector reported in 1797, when he approved final payment to the contractors.

Pennsylvania kept the Youghiogheny project in repair; \$2,950.03 was expended for the purpose in 1821. Flatboat traffic on the stream thrived, and Joshua Gilpin wrote in 1809:

The Youghiogheny is navigable from about 3 miles above the town [Connellsville] to the Ohio & of course gives an immense outlet for all the produce of this country—the union therefore of wood, coal, iron & perhaps a variety of other minerals with water carriage to a market down the Mississippi seems to destine it to be a great manufacturing district—there are already 7 furnaces & as many forges & slitting mills in this country all of them upon or at the foot of the mountains. . . the iron made in the furnaces is chiefly converted into castings and bar iron, nail rods, sheet iron &c. & sent down the Ohio in Arks, for the supply of the western country which is the chief market.

Pennsylvania invested funds in the improvement of its rivers until about 1825, when it embarked on a vast canal construction program. Almost every stream capable of floating a canoe at high water in the Allegheny, Monongahela, and Beaver River basins in Pennsylvania was improved for navigation or declared a legal public highway to prevent construction of dams that would close traffic on the streams. Other states also acted to improve and protect streams for navigation. New York made the upper Allegheny River and its tributaries legal public highways and acted to prevent their obstruction; Ohio protected its streams; and in the upper Monongahela basin Virginia protected its rivers and authorized the first slackwater navigation project built west of the Alleghenies.



General John G. Jackson

Clarksburg, West Virginia, Public Library

Slackwater on West Fork Virginia chartered a company led by Congressman George Jackson of Clarksburg to clear the Monongahela and its West Fork for flatboat navigation on December 5, 1793, and required that all persons building milldams on those streams install slopes for the passage of watercraft; in 1800, Virginia declared the Monongahela, West Fork, Tygart River, and several tributaries navigable public highways. Flatboats transporting agricultural produce and manufactured iron products regularly sailed from Clarksburg, Fairmont, and Morgantown to Pittsburgh and New Orleans. The flatboat *Hopewell*, Simeon Woodrow, master, for example, arrived at New Orleans from Morgantown in 1806 with a cargo of 250 barrels of flour and 2 barrels of whiskey. Traffic was so heavy on West Fork that in 1807 Virginia required millowners to maintain lamps at the head of chutes through their dams for the guidance of flatboat captains.

George Jackson and his two sons, Edward and John G. Jackson, who represented Harrison and Lewis counties in the Virginia legislature and in Congress, built flour mills and iron forges in the vicinity of Clarksburg; Edward Jackson owned a milldam on West Fork five miles below the mouth of Stonecoal Creek; and John G. Jackson had a milldam at his iron furnace and foundry on Elk



Building a raft

Creek at Clarksburg. Both shipped the products of their mills by river, and in 1817 John G. Jackson, general of Virginia militia and civil engineer, organized the Monongalia Navigation Company to build dams with locks and chutes on West Fork to supply slackwater for flatboat navigation.

Virginia chartered the Monongalia Navigation Company and agreed that when General Jackson and his associates had raised three-fifths of the capital needed to build the project the Commonwealth would subscribe the remainder, provided the chutes through the dams be at least 60 feet wide and the slopes below at least 65 feet long, with not over a 4 degree slope angle.

State governments commonly required owners of milldams on navigable streams to install chutes or locks for navigation during the 19th century. Navigation locks, a Renaissance invention sometimes credited to Leonardo da Vinci, were first built in America in 1790, but their construction costs were high and mill owners usually built navigation chutes and slopes. Chutes were openings in milldams about two feet lower than the remainder of the dam crest. They were closed with boards at low water to conserve water for the mills located at one abutment of the dam. When flatboats wished passage, the millowners removed the boards and the boats dashed through the chute. To prevent the boats dropping from the chute to the river bottom, slopes, generally of rock-filled timber construction, were installed below the dams, sloping from the chute to the riverbed at, in the case of the West Fork dams, no more than a 4° angle.

In July 1818, General Jackson and the Monongalia Navigation Company, which had offices in the Webster building in Clarksburg, informed the Virginia Board of Public Works that \$90,000 in company stock had been subscribed. The Board sent its chief engineer, Major Thomas Moore, to investigate the project, survey the West Fork and upper Monongahela in detail, and report his findings. Moore began his survey on June 6, 1820, at the juncture of Stone Coal Creek with West Fork near

Weston. He found five milldams were in operation on the stream between Weston and Clarksburg; the only improvements necessary on that section were removal of rocks and installation of slopes below the dams. Just below Clarksburg, the Major found the navigation company had begun construction of its first dam, 300 feet long and 9 feet high, but neither lock nor slope was under construction. He learned the contractor had agreed to build the dam with a lock and slope for navigation and an adjacent sawmill for \$2,600. The contractor did not complain of his bargain, said Major Moore, "but I am of the opinion, that if he executes the lock in a proper manner, he will find it a hard one."

The Virginia engineer reported many people in the West Fork valley opposed the project:

The objections they urge against it are these; that the fording places on the river will be destroyed; that it will require a much greater freshet to pass the dams with large flat bottom boats and rafts than is necessary in the natural bed of the river, and consequently, that the opportunities of getting their boats and lumber to market will be less frequent, even if the slopes to the dams should always be kept in repair; but they contend, that where there are so many, it may be expected that one or more will frequently be in an impassable condition. They also suppose that it may have a tendency to overflow the lands, and render the country sickly. The latter two, however, are unfounded, because in the first 45 miles, about 21 miles is already covered by the reflux water of 6 dams, without having produced in any important degree, either of these effects.

The principal problem with the project, said Moore, was water supply; the drought flow of West Fork was next to nothing. The flatboats navigating West Fork seldom exceeded a 15-foot width, so to conserve water Moore recommended width of the navigation chutes be reduced to 25 feet and that sidewalls be built down the slopes to confine

available water. He recommended installation of navigation slopes in the five milldams between Weston and Clarksburg, construction of seven dams with average nine-foot lift and slopes and locks in each to furnish slackwater from Clarksburg to the mouth of West Fork, and clearance of the Monongahela channel from Fairmont to the Pennsylvania line. He estimated the cost of the dams would be \$3,000 each and total project costs to be \$32,800, and he recommended that Virginia purchase company stock to aid the project.

Contractor Thomas Chapman completed the first company dam near the mouth of Jacks Run in 1821; he built the navigation slope, but thought the 16-foot wide lock to be "unnecessarily large." Its construction was deferred pending restudy. Company president John G. Jackson planned the six additional dams and slopes needed to canalize West Fork to its mouth and also developed plans to meet the water supply problem by diverting the flow of Buckhannon River to Stonecoal Creek and West Fork through a 5-mile long, 50-foot deep canal cut through the divide. Jackson then accepted the contract for building the six lower dams, while continuing to serve as president of the company. The arrangement was a serious mistake; because of it, Virginia withdrew its support from the project in 1822 after contributing only a few hundred dollars.

Colonel Benjamin Wilson and Edwin S. Duncan, representing the navigators and millowners who opposed the project, took their case to the Virginia Board of Public Works. Wilson said in thirty years he had rafted more than 200,000 board feet of lumber from his West Fork mills to Pittsburgh and had never lost as much as fifty feet of lumber. The Monongalia project, he protested, is merely a visionary scheme, and he claimed the navigation slope at the dam finished in 1821 had already been twice destroyed by floods.

Wilson's son-in-law Duncan raised serious issues. Is it not strange, he asked, that the principal stockholder and company president is also the contractor? Who will inspect his work to insure it is properly done and not a fraud perpetuated on other

stockholders, including state government? And, he asked, where is the \$90,000 in stock subscriptions the company claimed to have had? The company had given, said Duncan, stock for offers to furnish construction materials and labor and for mortgages on worthless wilderness lands. The Board of Public Works accepted the allegations without investigation and stopped all state subscriptions to the Monongalia Navigation Company.

General John Jackson, brother-in-law to President James Madison, first United States Judge for Western Virginia, and also a noted duelist, vehemently answered, asserting the Wilson and Duncan had made serious misstatements of fact, if they had not deliberately lied, to even old scores with him. The decision of the Board was final, however, and state support was not renewed.

General Jackson mortgaged his saltworks, iron mines, foundries, tanneries, and woolen and flour mills, and, almost singlehanded, continued construction of the West Fork slackwater system, building five more dams with lift averaging nine feet and with navigation chutes on the stream below Clarksburg. Twelve-foot wide, stone-filled, timber crib dams were built near Yellow Rockford, the mouth of Coon's Run, the mouth of Bingamon Creek, Shinstown, and Maulsby's Ford, at a cost of \$21,350, to which Virginia had contributed \$412.80. Construction of locks for upward bound traffic and the proposed canal from Buckhannon River was never undertaken.

Jackson had the dams and chutes nearly finished in May 1824, when a near record flood swept down West Fork and heavily damaged the structures. In his efforts to repair the dams, Jackson overworked himself, suffered from exposure to the elements, and died on the job in March 1825; he had lost most of his estate and finally his life on the West Fork project. His wife Mary, daughter of Governor Return J. Meigs of Ohio, offered to continue repairs to the project after the death of her husband, but the other stockholders, discouraged by the end of state support, flood damages to the dams, and the fact that



Roads to the west

West Fork had insufficient flow to fill the pools behind the dams in summer, decided to abandon the project. In 1829 Edwin Duncan brought suit for removal of Jackson's dams as nuisances to navigation, but that proved unnecessary, for West Fork floodwaters did the job efficiently without cost.

Intercity Rivalry and the Ohio River Project
Tempers flared in the rival cities of Pittsburgh and Wheeling on the upper Ohio River during the hot, dry summers of 1818 and 1819. Wheeling had won its contest against Wellsburg, Moundsville, and Steubenville to become the Ohio River terminus of the National Road from Cumberland in the Potomac valley, and when the National Road opened into Wheeling in 1817 the city prepared to challenge Pittsburgh for the title "Emporium of the West."

The roads cut by Army Engineers through the forests for Generals Braddock and Forbes and improved navigation on the Allegheny, Monongahela, and headwaters tributaries had given Pittsburgh an early lead in the competition for control of westward emigration and Ohio River commerce. Wheeling countered in 1817 with advertisements describing the advantages of traveling the National Road to Wheeling and taking the Ohio River there. A Wheeling newspaper editor claimed that nine-tenths of the boats lost on the Ohio were wrecked above Wheeling and that the channel was at least six inches deeper below Wheeling than above. "We are

convinced," Wheeling merchants said, "that Steamboats cannot be profitably employed above this place during the summer months." Wheeling, they said, was the head of low-water navigation on the Ohio.

The opening of the National Road did erode Pittsburgh's economic position, and business losses were multiplied in 1818 and 1819 by extended droughts. "Our rivers are so low as to render navigation very difficult," lamented Neville Craig, editor of the *Pittsburgh Gazette*, in 1818, "and at this moment there is probably near a million worth of merchandize lying along our shores. The western merchants are lounging through our streets or moping in our taverns in restless anxiety." Before rains ended the drought of 1818 more than three million dollars worth of commodities had accumulated at Pittsburgh. For twenty years we neglected the improvement of Ohio River navigation, Craig continued, "it now becomes a task that can no longer be dispensed with!"

Neville Craig, William Wilkins, and Pittsburgh civic leaders organized a town meeting in August 1818 to discuss improvement of the Ohio, but public support for the project ended when rains fell and the rivers rose. Craig continued his newspaper campaign, however, and public interest reawakened when a second drought began in April 1819. A boat drawing only fourteen inches of water took thirty-

five days to float from Pittsburgh to Cincinnati in September 1819. The owner said he grounded at least fifty times on ripples where the river was only ten inches deep and "worked as hard as ever I did in my life" getting his boat over the bars. By the end of 1819, scores of boats were grounded on bars or laid up along the Ohio and its tributaries, for the usual fall rise did not occur in 1819 and navigation did not resume until February 1820. A severe economic recession resulted in the headwaters district.

Neville Craig and William Wilkins organized more town meetings at Pittsburgh during the 1819 drought emergency, and in August Wilkins was made chairman of a committee to plan clearance of the Ohio channel to Wheeling. After Wilkins reported urgent need for removal of boulders from the channel, especially three dangerous rocks at Montour Island, Horsetail Ripple, and Lowry's Ripple, Craig wrote in his newspaper: "If a party of fifty or sixty would assemble on any given day, and go down, the removal of these rocks would only afford a pleasant picnic. Fellow citizens what say you?" In October, with funds donated by the people of Pittsburgh, Wilkins and his assistants went to work at Pittsburgh, dragging rocks from the channel and blasting channels through rocky ripples. The Wilkins party cleared the hazardous obstructions from the river as far as Wheeling by mid-October, when the donated funds were exhausted.

A joint committee appointed by Ohio valley states to survey the Ohio and plan its improvement met at Pittsburgh on August 1, 1819, and Wilkins supplied the commission with boats and survey instruments. The Ohio general assembly on January 27, 1817, had invited all states bordering the Ohio to appoint representatives to a commission charged with devising plans for improvement of Ohio River tion. While not favorably received at first, the dry weather recession of 1818 brought action; Samuel Blackburn of Virginia, John Adair of Kentucky, and Walter Lowrie of Pennsylvania were appointed commissioners, and they selected Magnus Murray as surveyor. Murray had studied law in the office of William Wilkins; he also was a chemist, surveyor,



"Wilkins supplied...survey instruments"



Magnus M. Murray

Carnegie Library of Pittsburgh

iron manufacturer, and civic leader, and he became fourth mayor of Pittsburgh and a founder of the University of Pittsburgh.

The commissioners floated down the Ohio in the autumn of 1819 and observed Murray while he carefully surveyed and mapped the 102 major obstructions between Pittsburgh and the Falls of the Ohio at Louisville. In November, the commission submitted its report and maps to the state governments. The Ohio was full of boulders and snags and obstructed by rock ledges and sand and gravel bars, and it would be necessary, the commission reported, to develop proper equipment for removal of boulders and snags and to perform experiments with methods of deepening the channel at bars and rapids.

Estimating project costs was next to impossible, the commission said, because there were no standards in the United States for ascertaining the costs of blasting rock or dredging bars in a rapid stream. The commissioners did not think comparison of project benefits with costs was necessary, however, for during their trip downriver they had seen more than thirty boats representing millions in invested capital "worse than dead, ruinously expensive to their owners, lying in all directions, chiefly high and dry, some half in and half out of water, all sustaining incalculable injury from an exposure of six or eight months, waiting the returning flood." The commission recommended that each of the four participating states appropriate \$10,000 for the Ohio River project. But of the four states, only Pennsylvania did more than appeal to Congress for federal assistance.

Governor William Findlay, when submitting the report of the commission to the Pennsylvania legislature, declared "there is no object of internal improvement to which an appropriation of the amount suggested by the commissioners could be more beneficially applied." William Wilkins, who had been elected by Allegheny County to the Pennsylvania House in late 1819, pressed for state funding to continue his work on the Ohio; he and his Allegheny County colleagues presented petition after petition in support of appropriation for the Ohio. Wilkins was an Allegheny County attorney, first president of the Bank of Pittsburgh, and member of the Pittsburgh city council. He won election to the Pennsylvania House in 1819 chiefly because of his leadership of the Ohio River project, and throughout his subsequent career as congressman, senator, and secretary of war he supported improved navigation on the Ohio and its tributaries. Wilkinsburg and Wilkins Avenue in Pittsburgh honor him, and the Homewood district in Pittsburgh grew on the site of his estate, long the social center of the city.

Wilkins' campaign on behalf of the Ohio River project succeeded on March 26, 1821, when the legislature provided \$15,000 for improvement of the

river from Pittsburgh to Wheeling. The act appointed William Courtney and James Adams of Pittsburgh and Thomas Foster of Beaver County, all recommended by Wilkins, as Ohio River commissioners charged with "permanent" improvement by removing fishdams, rocks, and timber, and deepening the channel by confining river flow to narrower channels. On August 8, 1821, the three men began work, personally supervising 100 laborers under foreman Asa B. Shepherd. They cleared boulders and snags from twenty-one ripples, placing rock spoil in low riprap dams behind islands to divert low-water flow to the main channel and dredging channels through bars with teams of oxen pulling plows and scrapers. The commissioners paid laborers fifty cents a day, plus all the food and whiskey they could consume. Work ended at the Pennsylvania-Ohio line when the river rose on October 1; it resumed in the summer of 1822 and continued during each low water season until 1825 when funds were exhausted. The aim of the project was to open a low-water channel to Wheeling sufficient for navigation by 25-ton keelboats. In October 1824, the editor of the *Pittsburgh Gazette* commented:

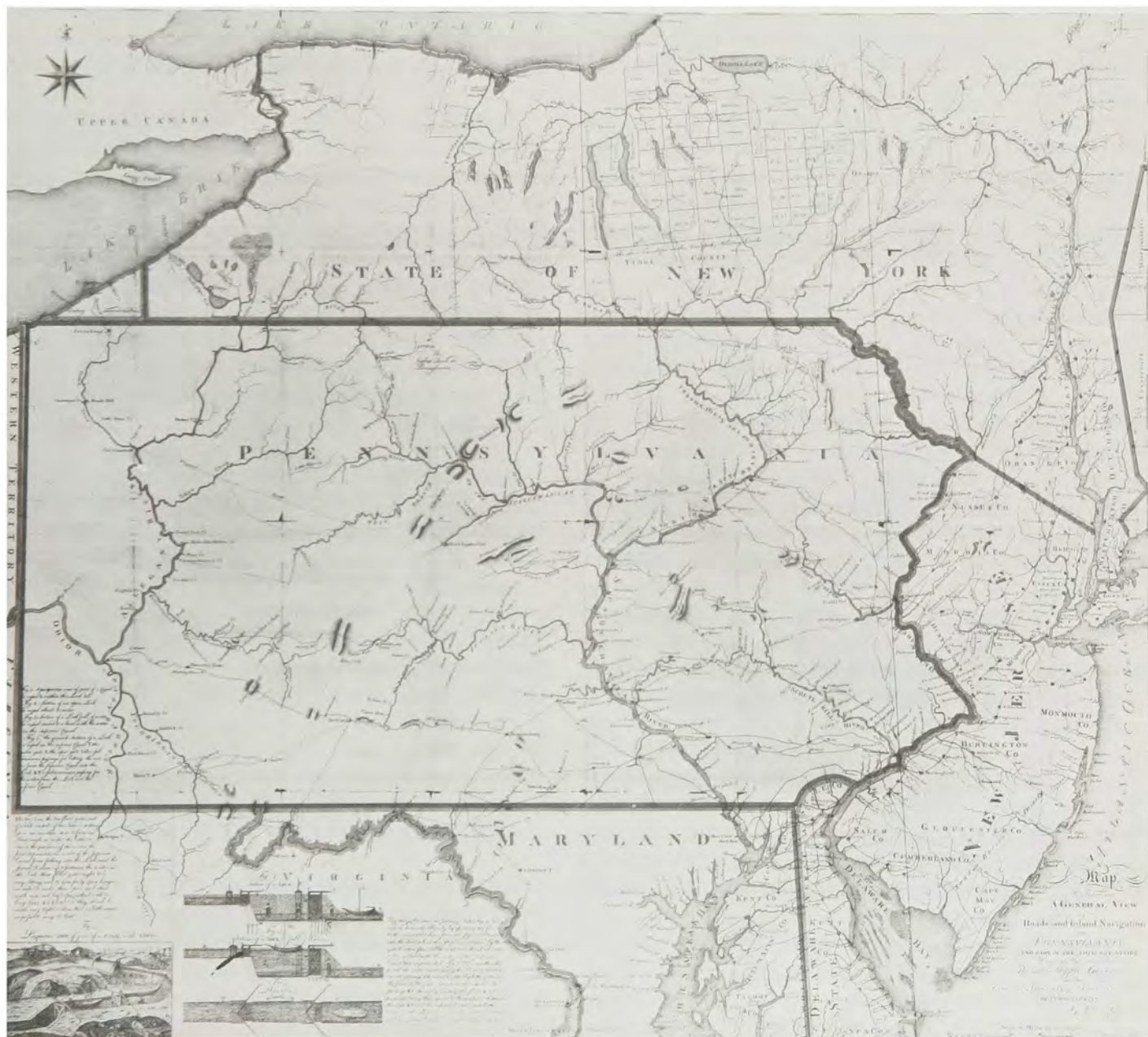
It may be worthy of remark, that notwithstanding the immense trade carried on in Keel Boats, during the late season of low water, not a single accident or detention has occurred from obstructions in the Ohio, between this city and Wheeling. This is no doubt principally owing to the judicious labors of the Pennsylvania Commissioners appointed to clear out the channel of the river.

Summary: Early River Projects The urgent need of the pioneers for easier, more economical transportation than overland trails and roads generated early interest in waterway improvements in the headwaters district. Rivermen commonly made such improvements as they could, then appealed to state government for assistance. To protect flatboat and canoe navigation, state governments declared most streams in the headwaters district navigable public highways, re-

quired that their navigation be not obstructed, and compelled owners of milldams to install slopes to pass river traffic. Pennsylvania, interested in using waterways as routes for western trade, made extensive improvements on streams in the headwaters district, beginning even before Indian resistance had ended, and Virginia approved the first attempt to canalize a stream west of the Alleghenies.

On a small scale, local and state projects undertaken before 1825 met many of the same problems encountered by the Army Engineers at a later date. Declaring streams to be legally navigable was easy; enforcing the laws was more difficult. Removal of boulders and snags and dredging deeper channels required the development of machinery and tools to do the job; permanent improvements required the design and construction of dams; and these tasks made skilled men with some knowledge of engineering indispensable and necessitated substantial capital investment. The early projects had two goals: to gain access to markets for commodities too bulky for economic transportation by packhorse or wagon and to lengthen the navigation season and mitigate the effects of low-water recessions. Flatboat records indicate the early projects achieved the first goal, but had only limited success in accomplishing the second. Permanent river improvement was beyond the technological and financial resources of 19th century local and state governments.





Chapter 4

STEAMBOATS AND THE WESTERN ENGINEERS

"I well remember the alarm created by its sudden appearance," Robert Buchanan of East Liverpool recalled. "Few had heard of the boat and none expected it," he added. "With its lever beam moving up and down, it looked like a floating sawmill, for the cabin was below, and no upper works on the deck. With our townspeople, it was a source of marvelous relation to the surrounding neighbors for years afterward." He had vivid memories of the *New Orleans* and its 1811 voyage because it was the first steamboat successfully operated on the inland rivers. It was not the first steamboat, however, nor was it the first steamboat built on the inland rivers.

Rowing and poling boats against river currents generated both considerable sweat and intense interest in the development of alternate means of propulsion. At Fort Pitt in 1761, William Ramsey hinged two bateaux together and installed paddlewheels on each side, powering them with two pedals bicycle-fashion. He could pedal the boat as fast as two men could row, but his invention never caught on. Ingenious ferrymen devised horse-powered ferryflats: two boats placed parallel, decked over, and powered by horses or oxen on the deck turning a shaft geared to paddlewheels. One inventor patented such a boat in 1795 and took it down the Ohio and Mississippi rivers to New Orleans. Army engineers also experimented with ferryflats, moving supplies up the inland streams, but soon learned that horses and oxen gave out long before soldiers with oars and poles were exhausted.

Early Army Engineers who were interested in improved waterway transportation lent their assistance to inventors of steam and mechanical boats. Thomas Hutchins sought federal support for the boat propulsion devices invented by John Fitch, but, though Fitch demonstrated his boat to the Constitutional Convention of 1787, he never acquired government or business backing and eventually

died penniless in Kentucky. George Washington backed inventor James Rumsey, who had assisted George Morgan in the Ohio River trade before the Revolution, and Rumsey won a grant of 30,000 acres of land along the Ohio River from Congress, on condition that he navigate his boat six successive days upstream on the Ohio. Rumsey never made it.

Captain James McKeever, who had sailed several Tarascon ships from Pittsburgh to Philadelphia, purchased a steam engine from inventor Oliver Evans in 1803 and built an 80-foot steamboat hull on the lower Mississippi. When the river fell, however, leaving the hull high and dry with no prospect of a rise for months, McKeever rented his steam engine to a sawmill, where it angered hand sawyers by cutting 3,000 board feet of lumber daily. McKeever lost his \$15,000 investment and eternal fame when the disgruntled sawyers burned the mill containing the engine to the ground.

Instead of Fitch or Rumsey, McKeever or Evans, credit for invention of the steamboat has generally been awarded to Robert Fulton, who first operated a steamboat on the Hudson River in 1807 and who designed the *New Orleans* built at Pittsburgh in 1811. Fulton sent Nicholas Roosevelt, distant ancestor of the Presidents of the same name, to Pittsburgh in 1809 to study the commercial potential of inland river steamboating. Roosevelt flat-boated to New Orleans and made favorable report to Fulton, who secured a grant of monopolistic privileges from Louisiana and dispatched Roosevelt back to Pittsburgh in 1810 to build a steamboat at the Tarascon shipyard on the Monongahela.

A sudden Monongahela flood nearly washed away the Tarascon shipyard in 1811, but Roosevelt saved the *New Orleans* from destruction, and, after a trial run on the Monongahela, sailed it on October 29, 1811, on the way to its namesake city. Curious crowds gathered at communities along the Ohio to see the boat pass, and a few spectators were alarmed by the smoking vessel. One farmer, when he saw the boat approaching, ran for his rifle, shouting: "The British are coming!" General William H. Harrison



The *New Orleans* (replica)

Captain Fred Way

was then engaging the Indians at Tippecanoe on the Wabash, and rumors of war with the British were circulating.

When the *New Orleans* reached the mouth of the Ohio it was shaken by the New Madrid earthquake, so named because it ruined the town founded by Morgan, Hutchins, and Shreve. Pilot Andrew Jack, for whom Jack's Run at Bellevue, Pennsylvania, was named, had serious steering problems; channels had changed and were still changing, banks were caving, islands disintegrating and forming. Captain Jack lashed the *New Orleans* to a tree on an island one night; next morning he found the rope went straight down into the river, for the island had sunk. Captain Jack got The *New Orleans* to the city of its name safely, however, and the Fulton company made \$20,000 profit, 50% of their investment, on the boat during its first year of operation, which was fortunate because it hit a snag in 1814 and sank, a total loss.

Fulton and his associates planned operating steamboats in relays from New Orleans to Natchez, Natchez to Louisville, and Louisville to Pittsburgh, and built four steamboats, the *Vesuvius*, *Aetna*, *Buffalo*, and a second *New Orleans*, for the trade. The company's efforts to monopolize river steamboating were frustrated, however, by independent rivermen who built their own boats and made free navigation an issue in the courts.

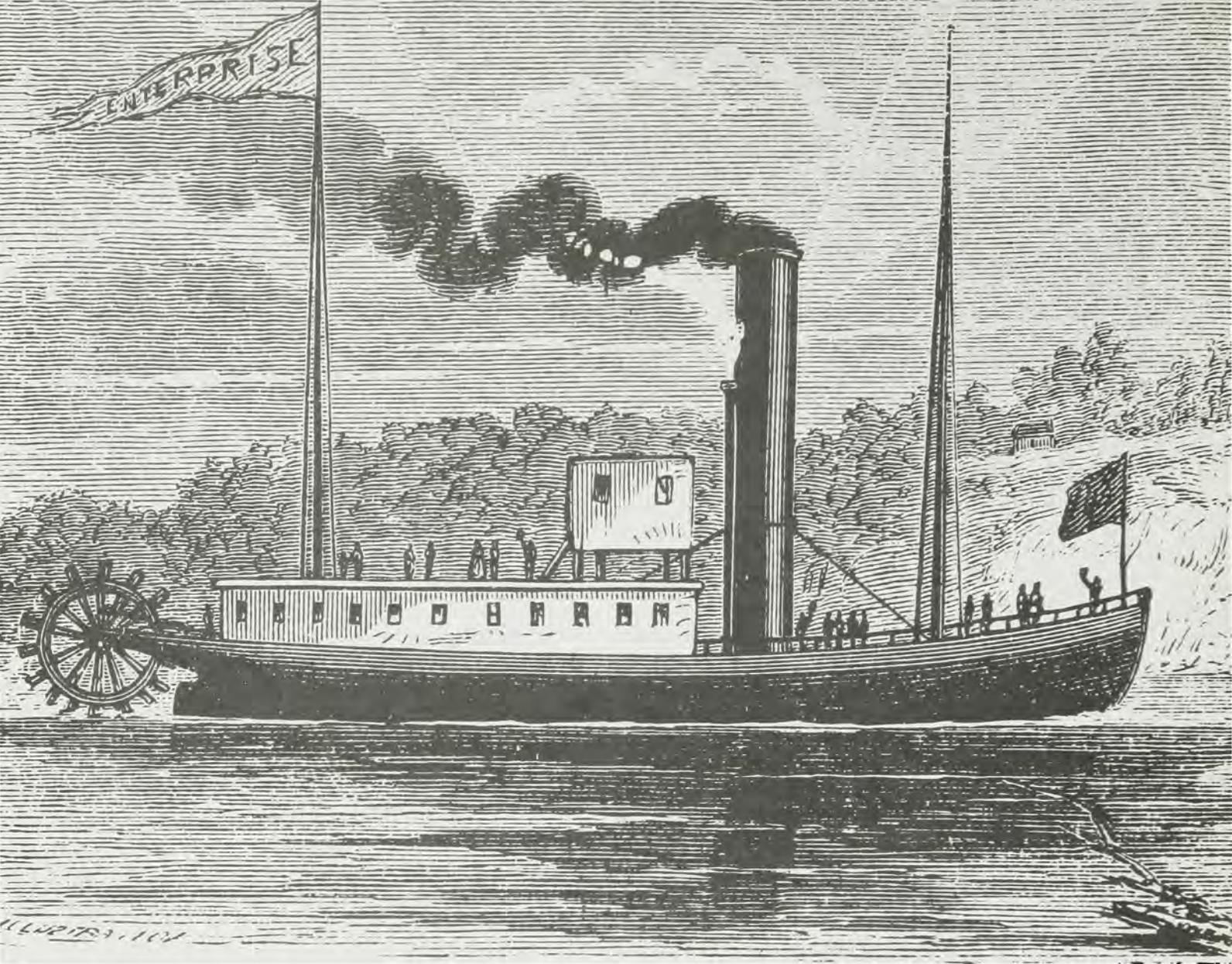
Shreve's *Enterprise* Ice floes bobbing down the Allegheny crashed regularly against the steamboat *Enterprise*, lashed snugly to the bank at Allegheny Arsenal, and ground down the side of the boat, chewing at the wood. Captain Henry Shreve, commanding the *Enterprise*, was eager to get underway before being frozen in for the winter. He leaned against the rail and anxiously watched the soldiers carrying box after heavy box, containing

7,000 stand of rifles and ammunition, from the Arsenal down the bank, up the stageplank aboard the *Enterprise* for stowage, and then rolling cannon up the planks and onto the deck.

When the gunnels of the *Enterprise* were nearly awash, the troops began loading the keelboats moored next to the steamer, and Colonel Abram Woolley, commandant of Allegheny Arsenal, and Major William Foster of the Quartermaster Department boarded to give Captain Shreve the manifest and final orders. Major Foster, better known to posterity as the father of balladeer Stephen Collins Foster, had sold the land at Lawrenceville (now part of Pittsburgh) to the government in 1813 as the site of Allegheny Arsenal, first federal ordnance depot in the Ohio River basin. In 1814, Foster risked his personal credit to purchase arms for General Andrew Jackson, then facing a British invasion at New Orleans.

"We have word," Colonel Woolley told Captain Shreve, "that the British have landed near New Orleans. General Jackson badly needs these arms." Shreve nodded his massive head and replied: "I will get there in time or sink my boat in the attempt." The officers shook hands, wished the river captain good speed, and returned to the Arsenal, while Shreve barked out orders for pulling the gangplanks, casting off lines, and backing into the current. He set off under full steam during that darkening December afternoon, deftly handling the wheel to dodge the running ice, snags, and boulders in the channel. He spent his Christmas in 1814 guiding the sturdy steamer through a snowstorm down intricate river channels.

While it was his first trip to New Orleans at the helm of a steamboat, Shreve knew the river channels as well as the wrinkles of his palm. Son of Colonel Israel Shreve, the partner of Morgan and



The *Enterprise*

Dr. Leland R. Johnson

Hutchins, Henry Shreve had learned river piloting as a youth. He commanded a keelboat at age 22; in 1810 he opened the upper Mississippi lead commerce, shipping lead from Galena, Illinois, to New Orleans; and in 1811 he built a 95-ton keelboat at Brownsville for regular trade to and from New Orleans. He, Israel Gregg, and Daniel French built the little *Enterprise*, known to New Orleans creoles as "le petite Steam Boat," in 1814 at Brownsville, and Captain Gregg tested it that summer on a run to Louisville and back.

Robert Fulton and his partners learned of the fast little *Enterprise* and placed ads in the Pittsburgh papers warning they would use "every legal means to prevent the violation of their patent rights" and stating that Daniel French's steam engine and placement of the paddlewheel at the stern instead of at the sides still infringed their patent. Shreve realized he would meet the Fulton interests at New Orleans, where they had influence with authorities

and a monopoly on steam navigation, but speedy delivery of arms to General Jackson was imperative.

Shreve brought the *Enterprise* to port a few days before the Battle of New Orleans and was welcomed by General Jackson, who sent him back upstream to tow down the ammunition-laden keelboats that followed. When Shreve returned with the keelboats, Jackson challenged him: "Captain Shreve, I understand you are a man who will always do what you undertake. Can you pass the British batteries on the bank of the river nine miles below, and with your steamer bear supplies to Fort St. Philip?" Shreve accepted the challenge, covered the exposed side of the *Enterprise* with cotton bales, and passed the British cannon under cover of fog and darkness to resupply the fort. On January 8, 1815, Shreve joined the hunters of Kentucky and Lafitte's pirates in the American line outside New Orleans, serving one of the cannon that broke the British assault.



Henry Shreve

Up the Heights of Fame and

Fortune, by Frederick B. Read, 1873

After defeat of the British, a new battle began: Shreve was arrested and the *Enterprise* impounded for violating the legal prerogatives of the Fulton company. Shreve made the necessary bond and turned his steamer toward home, arriving at Brownsville 51 days later. "Le petite Steam Boat" was first to ascend the Mississippi, Ohio, and Monongahela from New Orleans, first to tow other boats, first to go to the mouth of the Mississippi, first to navigate Red River, first to be used in combat, and first to challenge the Fulton steam navigation monopoly.

Shreve meant always to be first and had an uncanny knack for finding the action. He, Gregg, and French built a second steamer, the *Dispatch*, at Brownsville in 1815, and Captain Gregg took it to New Orleans, where the Fulton company prevented it from taking on a cargo. Shreve, meanwhile, built the *Washington* on Wheeling Creek, using seasoned timbers from old Fort Henry for the hull. It was the first double-decked steamer, first to have its cylinders connected by pitman to the paddlewheels, and first to have its boilers on the deck, arrangements that became standard for inland river steamboats.

Flying a flag embroidered by ladies of Wheeling with the legend OUR FRIENDS SHALL NOT TAKE FROM US WHAT WE HAVE WRESTED FROM OUR ENEMIES and on the reverse with DON'T GIVE UP THE SHIP, Shreve sailed the *Washington* from Wheeling in June 1816 to again challenge the Fulton monopoly. At Marietta, a cylinder head on the *Washington* exploded, blowing Captain Shreve overboard and mercifully scalding fortunate passengers to death. The unfortunate were skinned alive by the steam and died slowly in agony or were maimed for life. Shreve swam to the bank and escaped the first steamboat explosion on the inland rivers without serious injury.

Shreve continued his voyage after repairs, but had lost high water and stranded the *Washington* near Maysville, Kentucky, where it lay the entire summer before a rise freed it. At New Orleans, he

again met legal action by the Fulton interests, who offered him a substantial share in their company if he would deliberately lose his case; Shreve peremptorily refused the offer. During his return trip, he raced the *Washington* against the *Constitution* on the lower Mississippi and won the race because the *Constitution* exploded, killing eleven passengers and a gambler who was buried separately. On the Ohio, he was challenged to a race by the captain of the *General Pike*; the *Pike* also exploded with loss of life. Shreve had nearly lost his life in the first steamboat explosion on the inland rivers and had won the first two steamboat races at a terrible price. He became leader of a campaign for steamboat safety legislation and improved river navigation, and was selected in 1826 to direct river projects for the Corps of Engineers.

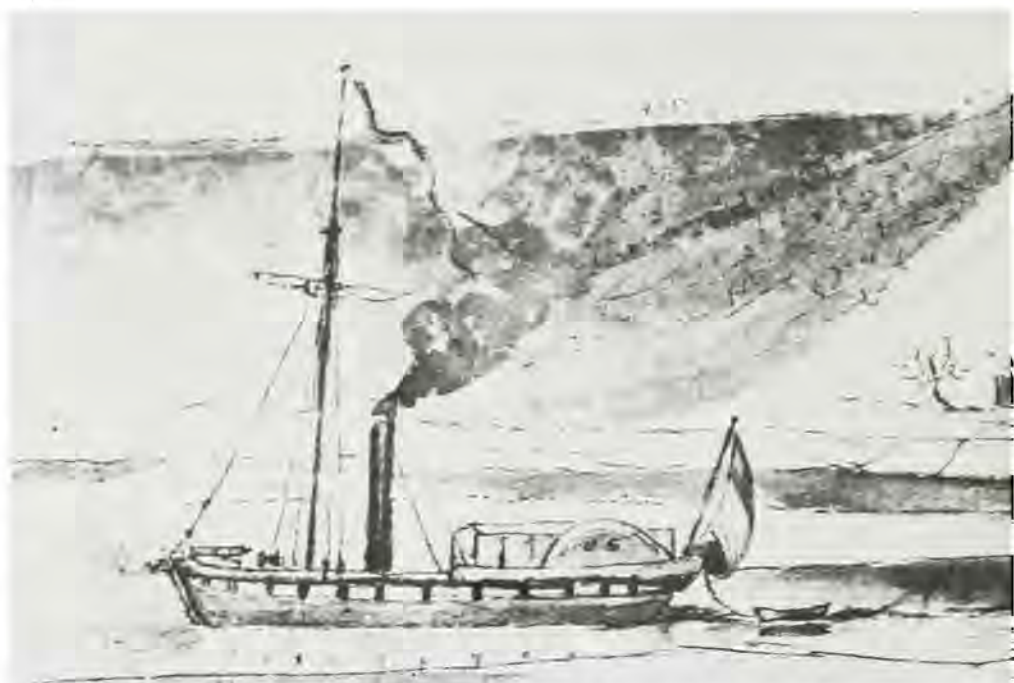
For his feats and especially for his scornful opposition to the Fulton monopoly, Captain Shreve became quite a hero to the people of the Ohio River basin, who vehemently resented restrictions on free navigation and steamboat development. Legislatures of states bordering the rivers asked their congressmen to seek federal investigation of the Fulton monopoly, and Ohio enacted a retaliatory law forbidding Fulton boats from landing in the state. By 1819 the Fulton company had ended its efforts to maintain its monopoly on inland river steam navigation, and in 1824 the Supreme Court ruled that such monopolies could not be granted because interstate commerce was under federal rather than state jurisdiction.

The Western Engineer As the boom echoing from the Allegheny hills subsided, artillerymen at the Arsenal scurried about the fieldpiece, wheeling it back into position, swabbing out the bore, and ramming home another powder bag to fire the second of twenty-two salutes, one for each state in the Union. Major Stephen H. Long touched the match to the cannon on the forecastle of the *Western Engineer* and stood away from the recoil of the salute in answer to those from the Arsenal. Crowds along the banks cheered wildly as the weird *Western Engineer* got under way, water dashing from under its hidden

sternwheel, a serpent at its bow belching steam from its mouth, flags snapping in the breeze, and cannon on its decks blasting salutes as it steamed the two miles from the Arsenal to the Pittsburgh Point.

Major Long anchored his steamboat away from the bank at the Point to prevent boarding by enthusiastic spectators, but ordered rockets launched to arch gracefully into the sky above the Monongahela bluffs for entertainment of the crowd and to announce to all Pittsburgh that the Engineers had arrived. A newspaper reporter, much impressed by the unusual craft, wrote a vivid description:

The bow of this vessel exhibits the form of a huge serpent, black and scaly, rising out of the water from under the boat, his head as high as the deck, darting forward, his mouth open, vomiting smoke, and apparently carrying the boat on his back. From under the boat at its stern issues a stream of foaming water, dashing violently along. All the machinery is hid. Three small brass field-pieces mounted on wheel carriages stand on the deck.....Neither wind nor human hands are seen to help her and to the eye of ignorance the illusion is complete, that a monster of the deep carries her on his back smoking with fatigue, and lashing the waves with violent exertion. Her equipment is at once calculated to awe and to attract the savage. Objects pleasing and terrifying are at once before him—white men and an Indian shaking hands, the calumet of peace, the sword through the apparent monster with a painted vessel on his back, the sides gaping with port-holes and bristling with guns—taken altogether and without intelligence of her composition or design, it would require a daring savage to approach and accost her.



U.S. Western Engineer

Titian R. Peale: American Philosophical Society, Philadelphia

Major Long of the Corps of Engineers built the *Western Engineer* at Allegheny Arsenal and took it on its maiden voyage down the Allegheny to the Point on the evening of May 3, 1819. He had orders to spearhead an Army expedition up the Missouri River, explore the rivers and the West to the Rockies, and collect all information of value to the Army and to westward bound pioneers.

Major Long had explored the upper Mississippi River basin in 1816 and in 1818 had won approval for scientific exploration in advance of the Army moving up the Missouri and for construction of an experimental steamboat designed for shallow snag-strewn inland rivers to transport his scientific task group. He built his steamboat in the autumn of 1818, in the process inventing the cam-cutoff for more economical use of steam, placing the paddlewheel in housing at the stern to prevent damage by snags, and engineering a craft, 75 feet long and 13 feet wide, that drew merely 19 inches of water. Its shallow draft and cam-cutoff were significant marine engineering innovations, but its serpentine disguise and heavy armament engrossed public attention.

With the foremost scientists of the day, a small crew, and soldiers to serve the cannon, Major Long



Stephen H. Long, Colonel, Corps of Engineers

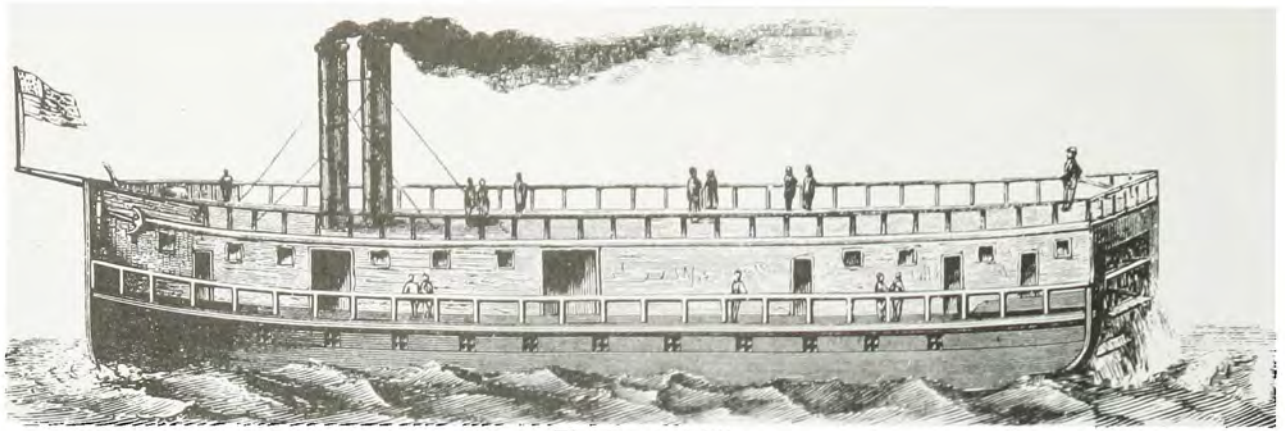
left Pittsburgh on May 5 in company with keelboats bearing the Sixth U.S. Infantry, stopping at Steubenville the first night out and saluting the ports of Wellsburg and Wheeling with cannon as he passed. As had Meriwether Lewis in 1803, Major Long used the trip down the Ohio to train members of his expedition, drilling his boatcrew and artillerymen, tinkering with the engine to obtain maximum power, and pausing along the river to investigate area geology, botany, zoology, and archaeology. He also prepared a report on the navigation and obstructions of the Ohio River, a report that was to bring him back to the river in 1824.

The *Western Engineer* missed being the first steamboat to navigate the Missouri by a few days, but, because of its shallow draft, ascended that muddy stream much farther than the first steamer, reaching the site of Council Bluffs, Iowa, from whence Major Long marched his exploration party across the Great Plains to the Rockies. On his return trip, he hoped to ascend the Ohio to Pittsburgh aboard the *Western Engineer* but found that even with a 19-inch draft it could get no farther upstream than the mouth of the Cumberland River because a depth of merely 15 inches was available over some bars.

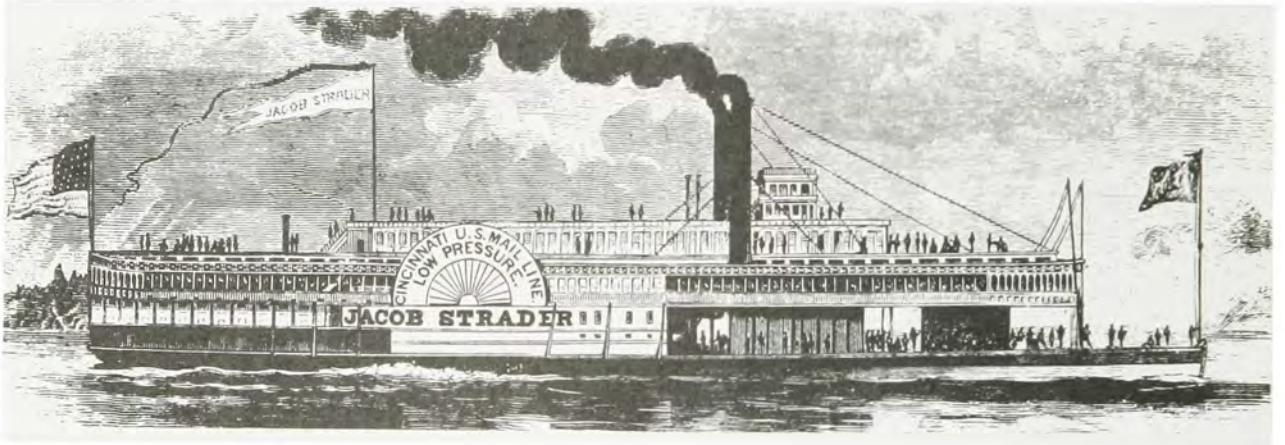
The Steamboat Boom "The improvement of our barges and steamboats insure within two years the total supply by the Mississippi and Ohio Rivers of many articles which are now wagoned from Baltimore and Philadelphia and our exports will be then commensurate with our imports," announced the editors of the *Brownsville Telegraph* in 1815. "Our flour, pork, tobacco, and whiskey will return in calicoes, hardware, coffee, cotton, sugar, bartered for at New Orleans. There was never such a prospect for improvement and trade at one time on any portion of the globe as that which is now exhibited to western America."

With the defeat of the Fulton monopoly, steamboat construction became the major industry in the headwaters district, and by the end of 1819 seventy-five steamboats employing 2,500 hands were plying the inland rivers. Nearly six thousand steamers, aggregating more than a million tons, were built on the inland rivers between 1820 and 1880, an average of a hundred boats measuring 18,000 tons annually, and the headwaters district produced at least 32% of all steamboats ever built. And the business of building the floating gingerbread palaces stimulated secondary industries: machine shops, boiler works, foundries, and sawmills worked to capacity to supply materials to the boatyards. By 1850, steamboat tonnage on inland rivers surpassed the steamboat and steamship tonnage, foreign and domestic, of the rest of the world.

Timothy Flint descended the inland rivers in a flatboat in 1816 and ascended ten years later in a steamboat. "I found the Ohio, ten years before, with log-houses, and wooden benches," he said. "There were now brick houses, ornamented court-yards, trellis-wrought summer-houses, fruit-gardens, and within, carpets, side-boards, and sofas." By cutting travel time 50% or more and reducing transportation costs by as much as 80%, steamboats had a major role in the transformation of the Ohio River basin in a decade from a frontier dependent upon subsistence farming and flatboat marketing to a mature agricultural-commercial-industrial region bound to the national economic structure by a

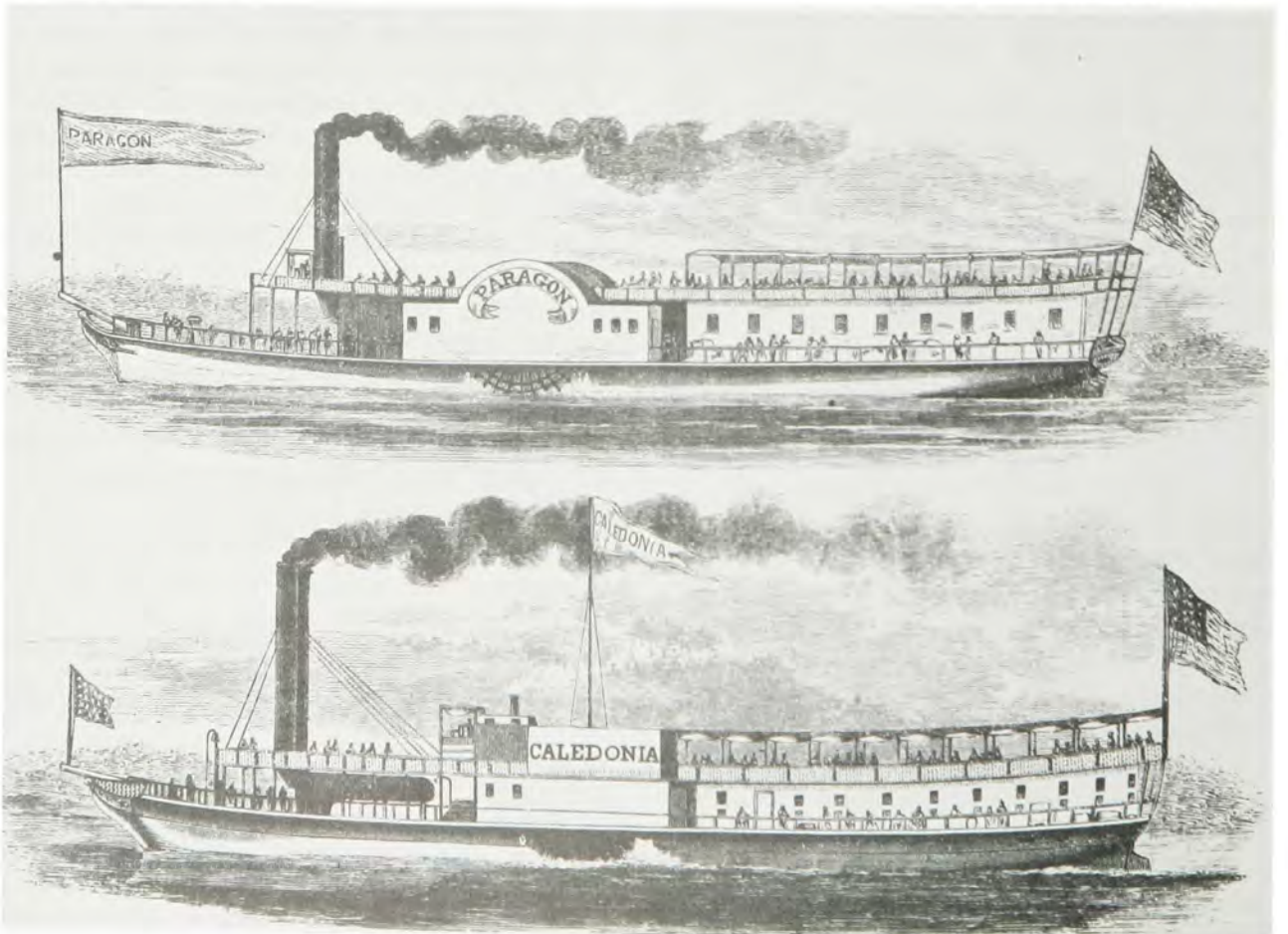


The General Pike



Early Steamers on the Ohio
1818, 1819, 1823

Up the Heights of Fame and
Fortune, by Frederick B. Read, 1873



steamboat chain. Surely the steamboat was the chief technological development of the early 19th century.

Origins of Inland River Projects "Nothing exhibits in so significant a manner the extent to which steam navigation is identified with the active genius of the people of the West, as the daily motion of the floating ark, known as the *steamboat of the West*," said Captain William Tell Poussin of the Corps of Engineers. Poussin was aide to Colonel Joseph Totten, Chief Engineer of the Army, and General Simon Bernard, former chief engineer to Napoleon, who in 1821 resumed the survey of the Ohio begun in 1819 by Magnus Murray and the joint state commission. Bernard and Poussin were French engineers who fled France at the recommendation of Lafayette after Waterloo to join the American Corps of Engineers. Poussin thought river steamboats somehow embodied the aggressive American spirit. "This is especially the case," he said, "when two steamboats coming in opposite directions are seen to pass each other. A stranger cannot witness this scene without a feeling of apprehension. But the cool and tranquil American, confiding in the skill of the helmsman, contemplates with interest and a species of vanity these two smoking points, which are scarcely in sight before they are far away in contrary directions. They indicate his genius and his power!"

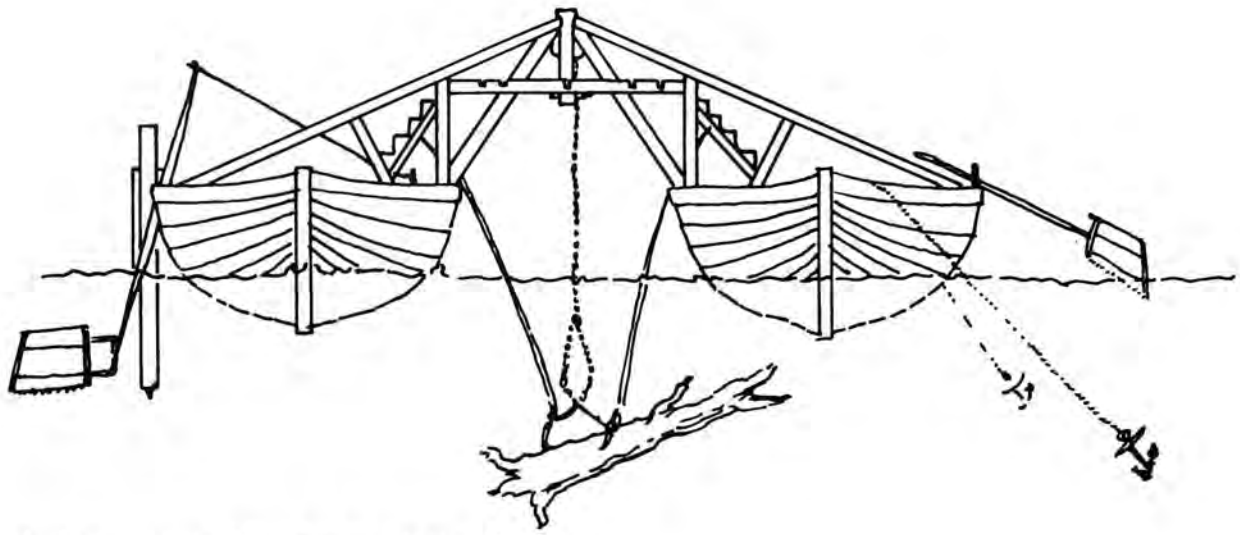
The Bernard-Totten survey of the Ohio and Mississippi in 1821 culminated several decades of increasing support for federal waterway projects. "No country is more capable of improvements in this way than our own," President Washington commented, and "none which will be more benefited by them." But the constitutionality of federal civil works was questioned, and the only navigation improvements made during the Washington and Adams administrations were minor harbor works and the installation of seacoast beacons and buoys. In 1806, President Jefferson approved federal construction of the National Road to the Ohio, and in 1807 Senator Thomas Worthington of Ohio introduced a resolution calling on the Secretary of

Treasury to plan nationwide transportation projects.

Secretary Albert Gallatin, of New Geneva on the Monongahela, in 1808 recommended a \$20 million federal investment in a canal and road system from Maine to Georgia and across the Appalachians to the Ohio River basin. He thought canals and roads should be built to link the Potomac with the Cheat River, the Juniata with the Allegheny, the James with the Kanawha, and the Savannah with the Tennessee. Gallatin was a financial wizard who not only balanced the federal budget, but also paid the national debt, leaving a surplus that he proposed to invest in civil works. Foreign conflict, the Embargo Act of 1808, and the War of 1812 intervened, however, eroding the budget surplus and distracting public attention from domestic needs.

The high cost of supplying armies on the frontiers and the difficulty of concentrating troops to meet British attacks on Washington, New Orleans, and other points during the War of 1812 focused public attention during postwar years on the defense values of improved transportation. General Simon Bernard, Colonel Joseph Totten, and Captain Jesse D. Elliott, a Navy engineer, assisted by Captain Poussin, began national defense planning in 1816 and reported it should rest on four pillars: a strong navy, a standing army and organized militia, a strategic chain of coastal and frontier forts, and improved transportation. Poussin commented: "While every improvement in the channels of communication has, as we have just shown, a direct relation to the national defense, it especially tends to develop the agricultural industry of the country...and to consolidate the internal peace of the citizens. Moreover, such improvements are fruitful sources of revenue."

After review of the Gallatin plan of 1808 and the report of the engineer board, Secretary of War John C. Calhoun in 1819 proposed extensive federal aid to transportation, recommending, among other projects, construction of canals linking the Potomac with the Monongahela River and the Ohio with Lake Erie and of waterway improvements on the Ohio



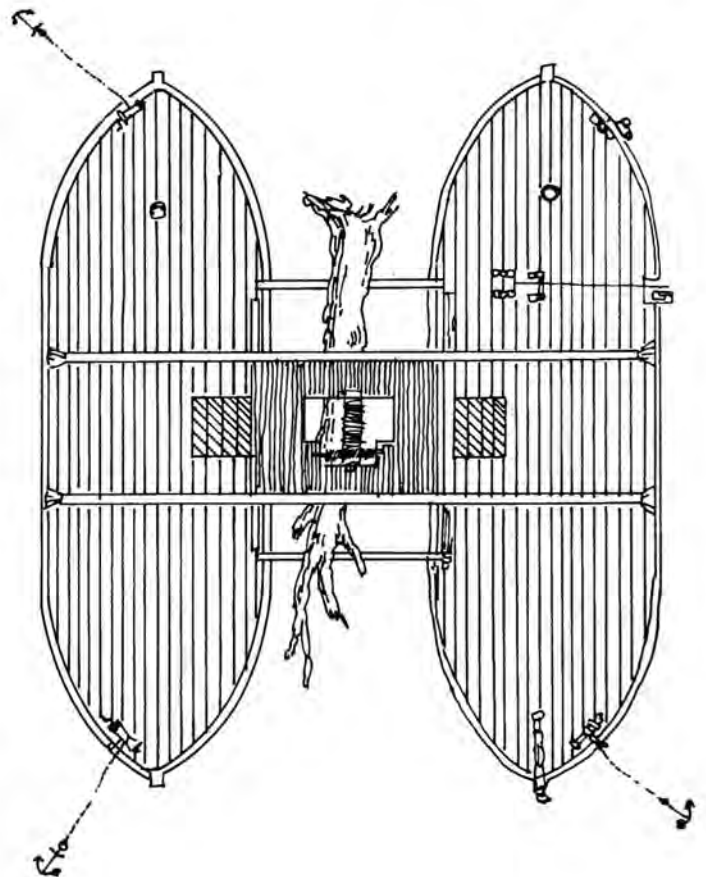
and Mississippi rivers. "It is in a state of war," Calhoun declared, "when a nation is compelled to put all of its resources in men, money, skill, and devotion to country into requisition, that its Government realizes in its security the beneficial effects from a people made prosperous and happy by a wise direction of its resources in peace."

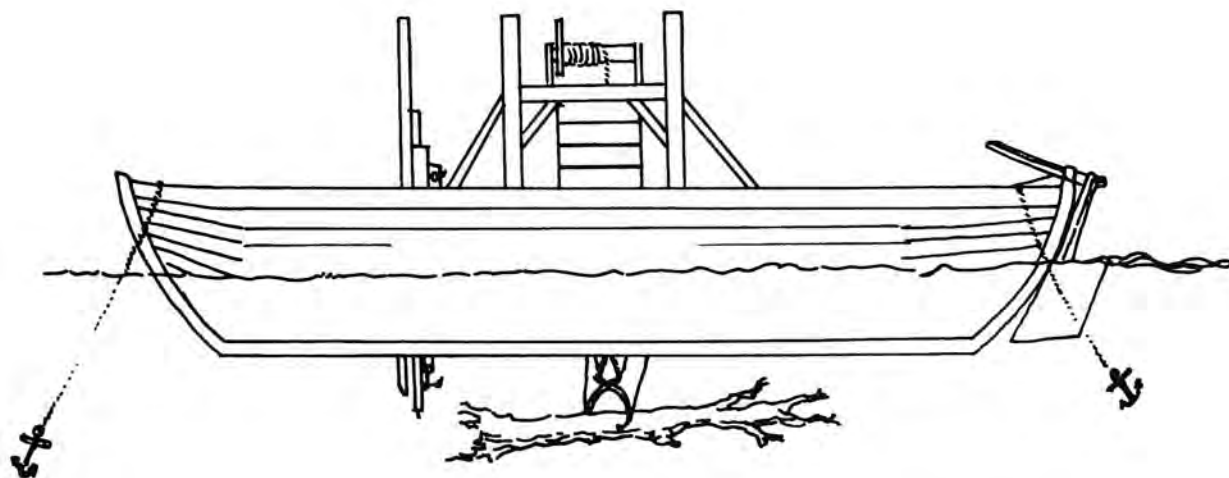
Members of Congress from states bordering inland streams supported the Calhoun plan for internal improvements or civil works and won a preliminary victory on April 14, 1820, through enactment of an appropriation for continuing the survey of the Ohio begun in 1819 by the states. Bernard, Totten, and Poussin completed the survey in 1821 and 1822. They found river channels so obstructed that steamboats dared not run at night and shippers suffered heavy losses, and to reduce navigation risks they recommended development of machines to remove snags and hydraulic experiments with wing dams as a means of deepening channels.

Proponents of federal civil works pushed the General Surveys Act through Congress on April 30, 1824. It assigned the Army Engineers to surveys and planning studies for transportation projects that might benefit national defense and commerce. General Bernard and Colonel Totten, assisted by Engineer officers and outstanding civil engineers such as John Sullivan, Dr. William Howard, and James Shriver, began the national survey program in 1824 by dispatching survey crews to Uniontown and Meadville, Pennsylvania, to locate the routes of the most important canal projects in the nation: canals between the Potomac and the Youghiogheny and between the Ohio River and Lake Erie.

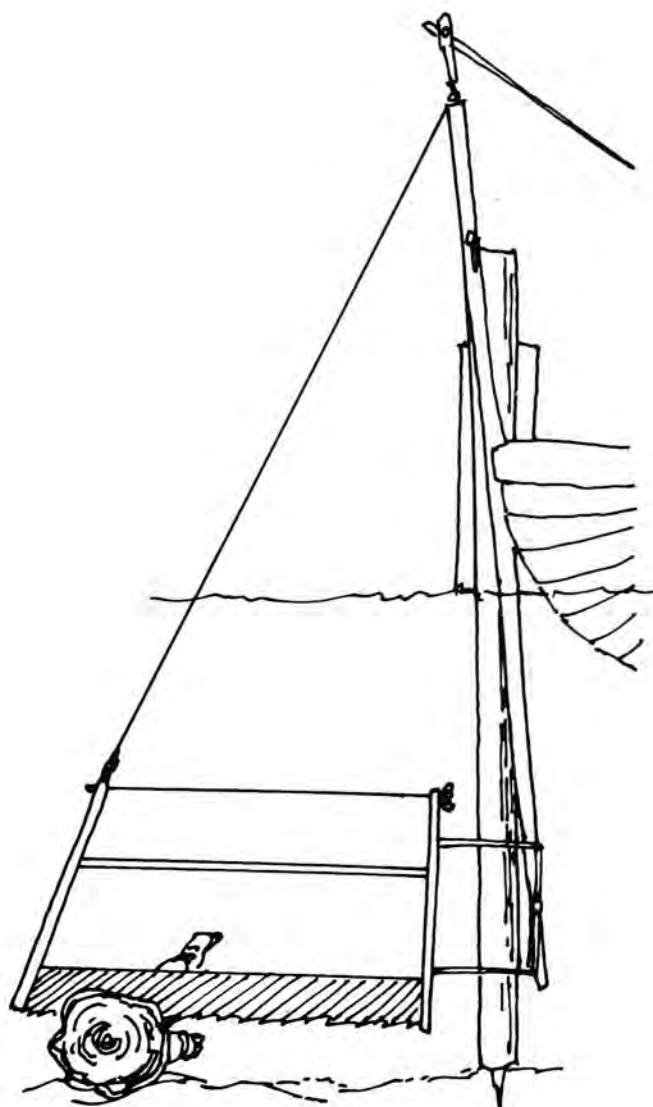
After enacting the General Surveys Act, Congress turned its attention to improvement of the trunkline of inland river commerce from Brownsville to New Orleans. Debates centered around three issues: whether the government had constitutional authori-

Experiments in snag removal





ty to improve waterways, what rivers should be improved, and how should the work be done. Congressman Alexander Smyth of Virginia suggested the issue of constitutionality be avoided by ordering the Navy to again build gunboats in the headwaters district and directing the gunboat crews to clear the rivers while on the way to New Orleans. Henry Clay contended clearance of inland streams bordering several states and the "common commercial highway of all," was clearly within federal powers; the issue, he argued, was not constitutionality but expediency, and his view prevailed. Clay and his friends reminded Congress that people of the Ohio River basin had on several occasions prior to 1803 considered separation from the Union to secure free navigation, that in 1794 western Pennsylvania had actually revolted against the central government, and warned that river projects would be undertaken by a regional compact of the states, if not by Congress, and such a confederacy, devoted to its special interest, might threaten national unity.



The original waterway bill called for removal of snags and construction of dams at bars to provide a minimum three-foot navigation depth from Brownsville to New Orleans. Henry Clay amended the bill to assign the project to the Army Engineers and leave specific engineering details to them. Andrew Stewart of Uniontown fought hard for work on the Monongahela below Brownsville, but lost, apparently because the river flowed within a single state below Brownsville and because he had opposition from within his delegation, notably from James Buchanan (U.S. President, 1857-61).

As enacted on May 24, 1824, the bill deleted improvement of the Monongahela and added work on the Mississippi from the mouth of the Ohio to St. Louis as part of the approved project. Henry Clay commented the \$75,000 appropriation would be inadequate, but he felt sure more appropriations would be made. The bill, he said, set the precedent for treatment of the inland rivers "as our SEAS—as

our Atlantic ocean and Mexican gulf, and as such are considered as entitled to special care and attention."

The Wing Dam Experiment Major Long stood at the stern watching his men turn the windlass to pull the 500-pound ram to the top of the tower, then release it to plummet guillotine-fashion to the top of the pile, impacting with the sound of cannonshot. The Major had several piledrivers mounted on flatboats at work on the dam, and the constant concussion of the falling weights driving the piles ever deeper into the riverbed resembled a barrage from an artillery battery. The men turning the windlasses perspired freely in the summerheat and had stripped to their waists. Carpenters wading in the river to spike crossttimbers between the double row of piling were cooler, but had trouble keeping on their feet in the swift current rushing over the bar. The Ohio had been inching upwards for several days, and Major Long was rushing the end of the

dam to a point where it might withstand winter floods and ice; tomorrow they would stop work and return upstream to harbor at Steubenville.

Stephen Long had arrived at Pittsburgh in the summer of 1824 with orders to build the first federal dam on the Ohio and perform the Corps' first experiments with fluvial hydraulics. He built flatboats, 37 feet long and 14 feet wide, to quarter his workmen and serve as platforms for piledrivers, and he employed Asa B. Shepherd, who had worked for the Pennsylvania commission that cleared the Ohio to Wheeling, as foreman; Shepherd thus became the first civilian employee of the Corps of Engineers on an inland river project. After the Major finished his preparations at Pittsburgh, he floated down the Ohio and put the piledrivers into operation, forming a wing dam at a compacted sand and gravel bar that had only fifteen inches of water over it during dry spells. His workmen cut trees to serve as piles, placed them at points indicated by the Major, and drove them into the riverbed in a row. Carpenters followed the piledrivers, spiking timber stringers between the piles to form a box-like framework that was filled with brush and stone. When high water interrupted work, Long harbored the first Engineer fleet on the inland rivers at Steubenville, then returned to the damsite in the summer of 1825 to finish the job.

The Major tried dams of differing lengths, widths, and heights until he had a 402-yard long structure that seemed to answer the purpose. The wing dam, unlike slackwater dams, did not close the channel. It extended from one bank toward the channel at about a 45° angle downstream with the purpose of concentrating river flow to erode the obstructive bar. (Wing dams were later renamed spur dikes to prevent confusion with slackwater dams.)

Long left Asa Shepherd to observe the effects of the first dam on the Ohio, and in 1826 Shepherd reported it had eroded the bar, establishing a four-foot channel without creating current velocities that



Early pile driver

Carnegie Library of Pittsburgh

might hamper upstream navigation. Sand and gravel accumulated around the Long wing dam, making it nearly impervious, and it served navigation until 1872 when it was repaired and extended. Modified versions of the wing dam type structure devised by Major Long were still built by Army Engineers on a few inland rivers a century and a half later.

The Contest of 1824 "The Amazing Quantity of Goods, of all Descriptions, and Lives lost on these Rivers, is Frightful in the Extreme to the Human Heart," declared one inventor who entered the contest of 1824. "Could I cast in a Mite," he continued, "to Prevent this Wonderful Devastation, it would be a lasting Source of Consolation, and to the People of the United States an Unknown Saving." He had entered a contest begun in 1824 by General Alexander Macomb, Chief Engineer of the Army, who had orders to "promptly" remove all snags from the Ohio and Mississippi rivers. General Macomb offered a \$1,000 prize for the best snagging device.

"Snag," in the parlance of rivermen, was a timber obstruction to navigation. Snags were commonly classed as planters or sawyers. A riverman explained: "A *Planter* is a tree rooted fast to the bottom of the river, & rotted off level with the water; a heavy boat striking one of them may be staved and sunk. *Sawyers* are trees less firmly rooted; they rise and fall with the water; if they point up the stream, they are dangerous, but not so much when they point down." An estimated 50,000 water-soaked snags, some more than a hundred feet long and weighing many tons, were deeply embedded in the Ohio and Mississippi, indeed in nearly all inland rivers. They could be sawed or chopped off at low water, but stumps were more dangerous than the original snags because pilots could not see them. General Macomb wanted a powerful mechanism to extract snags entire.

An avalanche of contest entries fell on General Macomb during the summer of 1824, coming from engineers, rivermen, mechanics, and well-meaning



General Alexander Macomb

crackpots. Scores of ingenious, promising, worthless, and weird snagging devices were submitted. One contestant proposed an "Impulse Boat," a flatboat loaded with stone and attached by long chain to a snag, which, when running with the current, would jerk snags from the bottom when it reached the end of the chain. Another suggested floating wooden dams propelled by the current with enough force to pull plows down the riverbed, excavating channels and cutting snags; such devices, the inventor suggested, could be regularly released at Pittsburgh and collected when they arrived at New Orleans. Devices for boring holes in snags, inserting gunpowder canisters, and blasting snags to splinters were common, as were subaqueous sawing machines. One unusual entry recommended that men in diving suits patrol the riverbottom from Pittsburgh to the Gulf and sever snags free with crosscut saws.

Most entries were inspired by twin-hull ferryflats propelled by horses walking in circles on deck and turning a capstan geared to paddlewheels. These entries proposed anchoring a ferryflat below a snag, attaching a chain from the capstan to the snag, then whipping the horses. Charles DeHass, engineer of Washington, Pennsylvania, asserted that horses would be "preferable to steam for they may be instantly checked if necessary."



Wing dams

General Macomb awarded the prize in early 1825 to John W. Bruce, flatboat and steamboat captain from Kentucky, for a twin-hull ferryflat with windlass and lever mounted on timbers between the hulls that Bruce called a "machine-boat." The machine-boat was positioned above a snag, and an iron claw, hanging from the short end of a lever, was hooked to the snag. Four stout men turned a windlass attached by rope to the long end of the lever, pulling it down and obtaining sufficient leverage to break snags from their mooring and raise them for sawing into disposable chunks. The machine-boat may not have been the most effective snagging device submitted, but Bruce had been awarded a contract for clearing the Ohio and Mississippi rivers of snags and had made his bid contingent on use of his own equipment.

The Contract of 1824 John Bruce had served in the Kentucky legislature and was an ardent campaigner for presidential candidate Henry Clay, author of the 1824 waterway act; Clay told the Secretary of War he was confident Bruce could successfully clear the rivers of snags. General Macomb received about a dozen bids for the snag-removal project, and most resembled the \$175 per river mile bid of C. S. Reno of Pittsburgh; Bruce, however, made a lump sum bid about \$140,000 less than the bid of his nearest competitor, Samuel McKee. The Secretary of War was astonished by the low bid, but since Bruce was highly recommended by many congressmen for his integrity and appeared to have a workable snagging machine, he instructed General Macomb to award the contract to Bruce. The contract provided that for \$60,000 Bruce would remove all snags impeding navigation on the Ohio-Mississippi waterway in accordance with the 1824 act, would complete the job by January 1, 1827, and submit to inspection by an Engineer officer.

As project inspector, General Macomb selected Major Samuel Babcock, a distinguished veteran of the War of 1812. Babcock arrived in Pittsburgh in November 1824 and found Bruce building machine-boats and collecting workmen. Since Bruce would

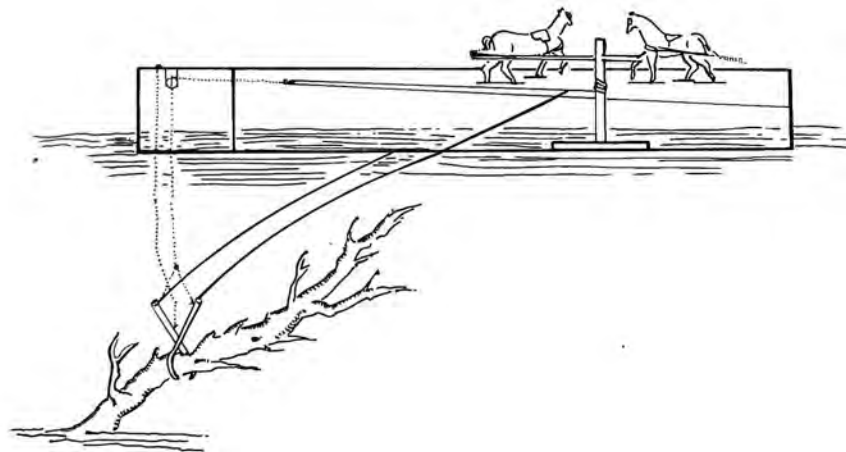
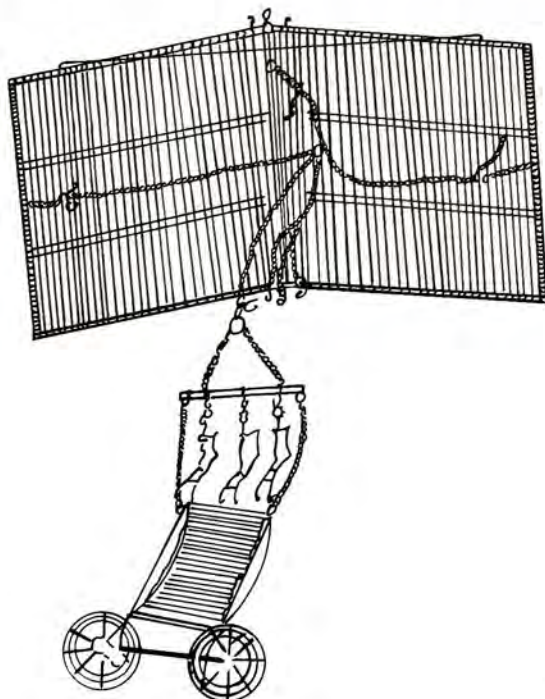
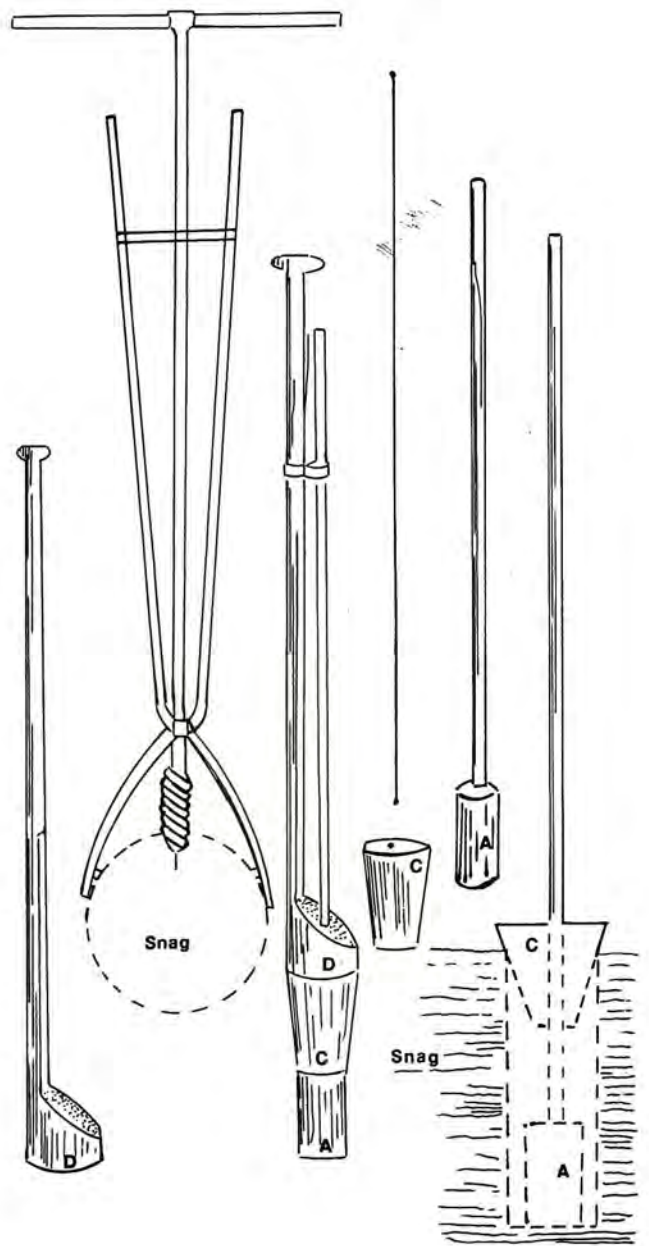
not begin work until low water in June 1825, Babcock requested leave until that date, but General Macomb ordered him to stay on the job, explaining: "Western people look with great anxiety towards the accomplishment of the contract, and the Department feels great solicitude that nothing shall be wanted on its part towards carrying into effect the magnificent designs of Congress in this instance."

Bruce assembled a floating plant of eight skiffs and four machine-boats, employed thirty-two men to operate the machine-boats and others to use hand tools, and left the Pittsburgh Point on June 30, 1825, with eighteen months contract time remaining. Major Babcock drifted along behind the workboats in a bateau to inspect the snagging as it progressed downstream. Because Pennsylvania had cleared the upper river section in 1824, Bruce reached Wheeling in eleven days and was paid \$1,000 for the work, which he used to begin construction of machine-boats at St. Louis. Work temporarily stopped at Maysville, Kentucky, in September, when Bruce's workmen celebrated, overindulged, and were arrested, but amicable settlement was arranged and work resumed.

Major Babcock became concerned because Bruce was clearing only the low-water channel and requested instructions from the Chief Engineer. General Macomb replied: "It appears to me impossible to make the 1st Article of that contract, which embraces the points in question, more clear by any attempt at explanation which would be merely a repetition of the language in which that article is couched. I must again refer you to the contract which admits of but one interpretation." The contract, nevertheless, was subject to two interpretations: the government's and the contractor's. One phrase required removal of all snags that impeded navigation; another required the work be done in accordance with provisions of the Act of 1824. Bruce doubtless presented Babcock with copies of the Act of 1824 and the advertisement for contract bids, both of which called for snag removal from the channel at the lowest stage of water, for Babcock accepted the contractor's interpretation.

By November 1825, rivermen were describing the work of Bruce and Babcock with their most pungent adjectives. In letters to Congress and the Chief Engineer, they asserted only the low-water channel was being cleared and that not very well, and they urged removal of Babcock, "one who knows nothing of the rivers Ohio and Mississippi, who has never navigated them, who knows not on which side the channel is." They pointed out that more snags impeded navigation at high water than at low, that they commonly used different channels at high water, and that they opposed the Bruce contract because contractors "consult their own interest, rather than the public good, which, in the present instance, they do not hesitate to say has been the case."

Senator William H. Harrison and the Ohio congressional delegation formally protested to the Chief Engineer, and General Macomb launched an investigation, ordering Captain William H. Chase to catch the express stage to Pittsburgh and proceed down the Ohio. The contract called for clearing the entire river and made no allusion to the channel of the river, General Macomb told Captain Chase, and



Contest of 1824
Some of the losing entries

Twin-hulled snagboat
The winning entry
looked like this

The Military Engineer, July-August 1973



he added: "I can hardly believe Major Babcock or Mr. Bruce could have construed the contract in the manner imputed to them; and particularly the latter, who was present when it was formed, and who, in the course of frequent discussions respecting it, became thoroughly informed of the intention of the Government." Chase arrived at Pittsburgh on November 26, 1825, purchased a skiff and hastily embarked, examining the Ohio as far as Louisville. He reported the river "exhibited the greatest neglect on the part of the contractor, Mr. Bruce, in the execution of his contract." General Macomb immediately suspended the Bruce contract, issued orders for the arrest of Major Babcock, and directed Stephen Long, then at Steubenville, to take over as project inspector.

A general court-martial at Cincinnati in June 1826 tried Major Babcock for disobedience of orders, neglect of duty, and falsifying official reports. Rivermen testified for the prosecution, as did Captain Chase and the pilot of Babcock's bateau. Notable witnesses for the defense were John Bruce and Samuel McKee. The court found Major Babcock guilty on all charges and sentenced him to dismissal from the service, but recommended clemency because of the project's novel character and the Major's distinguished service record. President John Quincy Adams, after review of the evidence, concluded that Babcock had not been qualified for the project, had performed his duties to the best of his abilities, and had erred chiefly in accepting Bruce's interpretation of the contract. He therefore remitted the sentence and ordered the Major retained in the service.

Because Major Long was needed for important canal and road surveys, General Macomb appointed Samuel McKee as snagging project inspector. McKee was a former Warhawk congressman from Kentucky and had been Bruce's chief competitor for the contract. Bruce resumed work in the summer of 1826, but progress slowed because McKee required clearance of the Ohio from bank to bank before approving payments. Bruce was again delayed in October by the death of McKee and during General

Macomb's search for a replacement whose appointment would satisfy rivermen. At the recommendation of Stephen Long and others, on December 10, 1826, General Macomb appointed Henry M. Shreve, the famed steamboat captain, as Superintendent of Western River Improvements.

The Chief Engineer told Captain Shreve the Bruce contract could be terminated and the penalty for nonfulfillment exacted on January 1, 1827, but he would not do it until Shreve completed an inspection. At the time, Bruce with eight machine-boats had reached the mouth of Green River on the Ohio, had five machine-boats under construction at St. Louis, and had 129 employees who were paid \$12.50 a month plus board. Shreve reported in early 1827 that Bruce had neither the means nor the ability to complete the job satisfactorily, and the Chief Engineer forfeited the contract on April 9, 1827, directing Captain Shreve to employ workers and personally supervise continued snag removal.

John Bruce had been paid \$18,563.93 for work completed and had received the \$1,000 prize of the contest of 1824. He hired attorneys and asked Congress to reimburse his losses, basing his case not on the wording of the contract but on the failure of the Corps to furnish adequate supervision. Congress awarded Bruce \$6,240.63 in 1834, but rejected claims for additional compensation. The Bruce case continued in the courts for forty years, until the United States Court of Claims in 1865 decided: "There is not, apart from the contract and the act of Congress upon which it is founded, one scintilla of legal evidence in this record that can in any way support this claim."

A House committee that investigated the contract of 1824 debacle concluded:

The undertaking was new. Persons possessing the requisite practical knowledge of the navigation and the obstructions to the same, of those rivers, could not be, or were not employed at the commencement of the work. The difficulty of removing obstructions which were

THE CONTRACT OF 1824

[Doc. No. 14.] [Doc. No. 14.]

Articles of Agreement between Major General Alexander Macomb and John Bruce, October 12, 1824.

Articles of Agreement, made and concluded the 12th day of October, in the year of our Lord one thousand eight hundred and twenty-four, by and between Alexander Macomb, Major General and Chief Engineer in the Army of the United States, on behalf of the Department of War, of the first part, and John Bruce, of Vanceburg, Lewis County, Kentucky, of the second part, to wit:

Article the first. It is hereby agreed, by and between the parties aforesaid, that the said party of the second part for, and in consideration of the sum of sixty thousand dollars, to be paid him by the said party of the first part, in the manner hereinafter stated, hath covenanted and agreed, and by these presents doth covenant and agree, to improve the navigation of that portion of the River Mississippi, extending from the mouth of the River Missouri to New Orleans; and of the whole extent of the River Ohio, from Pittsburg to its junction with the Mississippi river; according to the provisions of the act of Congress of the twenty-fourth of May, one thousand eight hundred and twenty-four, by removing all trees, limbs, and roots of trees, and logs, commonly called planters, sawyers, and snags, that may be found in those rivers, respectively, which impede the navigation of the same, by extracting them from their positions, or cutting them off at the bottom of the river, or at least ten feet below extreme low water mark; and disposing of them in such manner upon the shore, or otherwise, as will effectually prevent their becoming afterwards injurious to their navigation.

Article the second. It is further agreed, by and between the parties aforesaid, that the said party of the second part, shall complete the abovementioned improvement of the navigation of the Rivers Mississippi and Ohio, on or before the first day of January, in the year of our Lord one thousand eight hundred and twenty-seven. The whole to be done under the inspection, and to the satisfaction of an officer of the Corps of Engineers, or some other person, to be appointed by the Department of War to inspect the same.

Article the third. It is further agreed, by and between the parties aforesaid, that no advance of money shall be made by the party of the first part, on account of work to be performed under this agreement; but, that the sum stipulated to be paid, shall be paid, in proportion as the work advances; and, on the inspection and certificate of the officer of the Corps of Engineers, or person designated for that purpose, setting forth the extent of work done, and that it is completed in conformity to the stipulations of the first article of this Agreement, and, also, certifying the value of the same, in his opinion, compared with the entire amount which the party of the second part is to receive on the completion of the work: Provided always, that the said party of the second part, shall have no right to claim the inspection and certificate, aforesaid, to entitle him to receive payment for a less value than one thousand dollars, to be estimated, as above, by the officer or person designated to inspect the work in its progress.

fastened in the bed of the river, 20, 30, and 40 feet below the surface of the water, was not easily to be overcome. The agency of some machinery, not before in use, for the improvement of our water courses, was deemed indispensable. Much of the time, and a great portion of the money was expended in the necessary experiments and preparation to commence the work.

The Lessons of 1824 While the contest and contract of 1824 were unproductive of the goals set by the first appropriation for inland rivers, Congress and the Corps of Engineers learned lessons that had nationwide application. The tools and machinery necessary to improve waterways could only be developed by men with intimate knowledge of the special problems of river navigation and extensive on-the-job experience. There were no "prompt"

Article the fourth. It is lastly agreed, by and between the parties aforesaid, that the said party of the second part shall furnish, as security for his faithful performance of this Agreement, a penal bond for the sum of sixty thousand dollars, to be approved by the Secretary of War.

In testimony whereof, we have hereunto, interchangeably, set our hands and seals, at the dates hereinafter specified by the witnesses thereto.

ALEXANDER MACOMB, Maj. Gen. [Seal.]

JOHN BRUCE, [Seal.]

Copy of bond given by John Bruce and others to the United States.

Know all men by these presents, that we, John Bruce, of Lewis County, in the state of Kentucky, Henry Halbert, William Jameson, Burton Palmer, James Palmer, John Boyle, Robert Boyle, Henry Terrell, are held and firmly bound unto the United States of America, in the just and lawful sum of sixty thousand dollars, for the payment whereof, well and truly to be made, we bind ourselves and each...of our heirs, administrators, executors, and assigns, jointly and severally, firmly, by these presents: Sealed with our seals, and dated this 12th day of October, in the year of our Lord one thousand eight hundred and twenty-four.

Whereas, on the 12th day of October, 1824, an agreement was made and concluded, by Major General Alexander Macomb, on the part of the War Department of the United States, and John Bruce aforesaid, for the improvement of the navigation of the Mississippi and Ohio Rivers, as by reference to said agreement will more fully and at large appear: now the condition of this obligation is such, that, if the said John Bruce shall well and faithfully execute his part of the said contract, or cause the same thus to be executed, then this obligation to be void; otherwise, to remain in full force and virtue in law.

John W. Dyal, witness
to the signature of
John Bruce & Henry Halbert.

JOHN BRUCE,
HENRY HALBERT,

WM. JAMESON.

James Morris, witness
to the signature of
Burton Palmer.

BURTON PALMER.

Laura Boyle, witness
to the signature of
James Palmer & John Boyle.
Alexander Boyle, Jun.

JAMES PALMER,
JOHN BOYLE,
ROBERT BOYLE.

witness to the signature of
Henry Terrell.

HENRY TERRELL.

methods to establish safe and reliable channels; new snags and bars were formed by every flood and river projects would perforce be continuing efforts. Work on rivers was so variable that the Engineers would have to develop firm contract specifications and standard evaluation procedures before performing such work by contract could be successful.

These lessons were reflected in the "Rivers and Harbors" Act of March 3, 1827, first of a series of annual appropriations, that directed removal of obstructions of every description that endangered navigation at any river stage and that required a "practical agent" with long experience on inland rivers be placed in charge of the project. Under the capable direction of that "practical agent," Captain Henry M. Shreve, the snagging project on the Ohio and Mississippi rivers resumed in 1827 and was expanded to include several tributary streams.

Chapter 5

THE THIRTY INCH PROJECT

Peals of laughter greeted the ungainly vessel as it wallowed down the Ohio like two fat ducks on a pond. Rivermen, after their anger about the Bruce contract debacle had subsided, had been amused by Captain Henry Shreve's efforts to jerk huge trees from the river with the ridiculous machine-boats. Even when a machine-boat managed to pull a snag, the current swept it and the snag away downstream, with Shreve behind in a steamboat in hot pursuit. The weird double-hulled craft that Shreve called a snagboat resembled two roughly built steamers joined like siamese twins. With the ludicrous name *Heliopolis*, it was certainly a laughable sight,

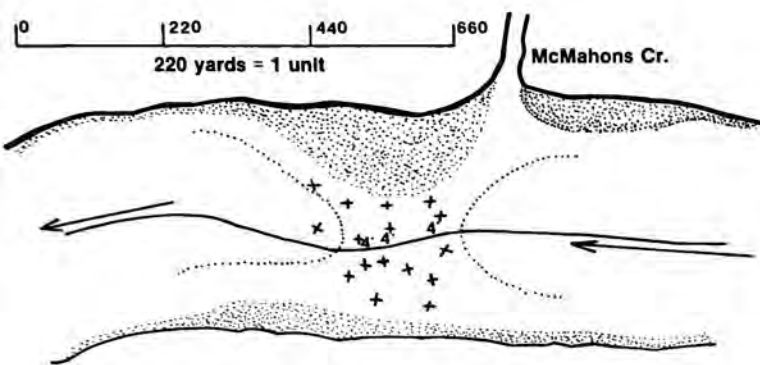
Captain Henry Shreve and his snagboat

doubtless another government boondoggle. Still, Shreve was a man to respect.

After chopping and sawing and pulling his way down the Ohio and Mississippi to the mouth of White River, Shreve had abandoned the machine-boats; they would never work and, besides, it was costing about fourteen dollars for each snag removed. Shreve recalled that steamboats hitting snags at full speed sometimes knocked them over and out of the way, if the boat hull were not punctured; perhaps a steamboat specially built for the purpose could do the job. While his workmen hacked away at snags, he spent time in his boat cabin, drawing up plans, building models, and tinkering until he had what seemed a workable snagging machine.

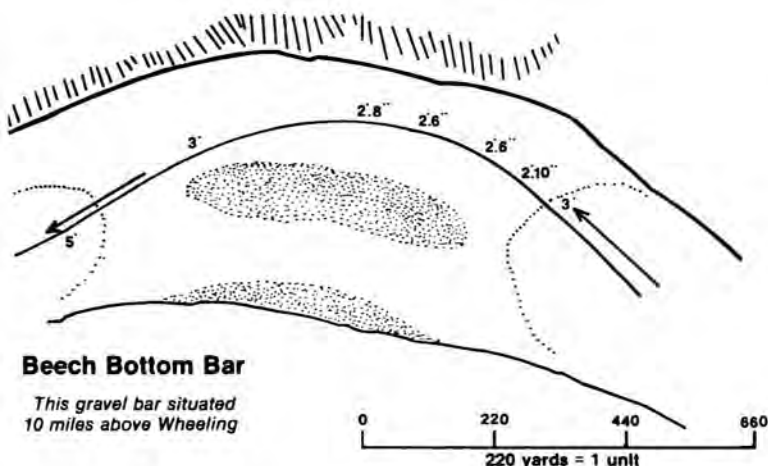
Copyright 1970, the R.W. Norton
Art Gallery, Shreveport, Louisiana





MacMahons Creek

4 miles below Wheeling



Beech Bottom Bar

This gravel bar situated 10 miles above Wheeling

Sections of Lt. George Dutton's 1835 map of the Ohio
(Prepared from material furnished by National Archives)

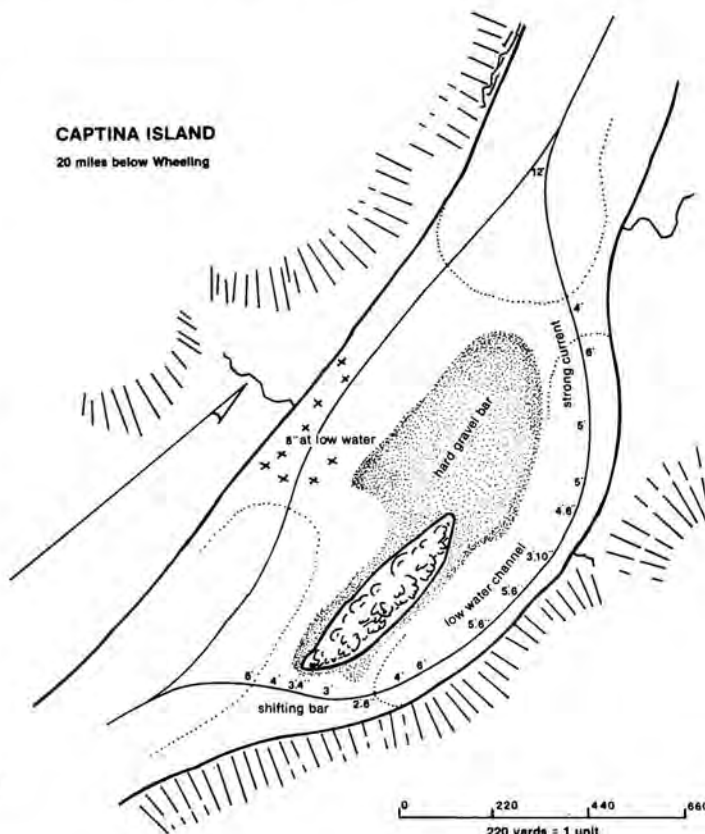
couragement, and saw the weird vessel gain speed and bear down on a monster snag. Shreve deftly aimed his boat to strike the snag with the beam between the two hulls, then rammed at top speed. The crash of impact boomed across the river, the *Heliopolis* shuddered perceptibly, the snag waved for a second and toppled with splintering crunch into the water. Kibitzers on nearby boats and the crew of the *Heliopolis* cheered, while Shreve backed off and men on the bows put down chains from the windlass to catch the snag and raise it for sawing into harmless chunks.

After eleven hours work, the *Heliopolis* had cleared several miles of river and Shreve dispatched the triumphant message to the Chief Engineer that his snagboat had exceeded the "most sanguine expectations." An inspecting Engineer officer confirmed the report, commenting that "no machine can surpass it in its adaptation to the work in the execution of which it is now engaged." One riverman declared the boat extracted snags as fast as a debt-

Shreve sent his plans to the Office of the Chief Engineer (OCE) in 1828 and requested funds to build an experimental prototype. With memories of the Bruce disaster fresh in mind, the Chief Engineer was reluctant to invest money in another untried experiment that might heap more coals on the Corps; yet, the clamor for action in Washington was terrific. He gave Shreve approval for building the prototype, but warned that both Congress and the people of the Ohio and Mississippi valleys demanded quick results.

Shreve's snagboat was actually two steamboats with hulls 100 feet long and 12 feet wide, spaced 10 feet apart and joined by heavy timbers. Between the two hulls at the waterline near the bow was a timber bulkhead covered with sheet iron that Shreve called the "snag-beam." The prototype *Heliopolis*, named after the home of ancient Greek engineers, cost \$26,424.71 and was launched at the Falls of the Ohio on April 28, 1829. Shreve planned to run it at full steam with the current and smash head on into snags. Either it worked, or the government lost \$26,000 and he lost his job.

Rivermen anchored their boats near the test site to watch the fun; most expected failure. They saw clouds of smoke fogging from the chimneys of the twinboat, as Shreve, a notorious man to swear, gave the men stoking the furnaces vigorous verbal en-



CAPTINA ISLAND

20 miles below Wheeling

ridden dentist pulled teeth, and so it and its successors became "Uncle Sam's Toothpullers" to rivermen.

The *Heliopolis* so impressed rivermen and engineers that the Chief Engineer approved construction of a second "toothpuller," the *Archimedes* completed in 1830. With these, Shreve roamed the inland rivers knocking snags from channels. Because the snagboats had too much draft for convenient operation on the upper Ohio, Shreve employed William Courtney, one of the Pennsylvania commissioners who had cleared the Ohio to Wheeling in 1824, to recruit workers at Pittsburgh and remove snags from the Ohio missed by John Bruce or newly deposited. By 1832 Shreve had the Ohio and Mississippi fairly clear of snags, and in that year he heard of no boats of any kind that sank as a result of hitting these obstacles. Snags had caused about three-fifths of all sinkings before 1824, and perhaps the best index to the value of Shreve's work was that marine insurance rates for vessels plying the inland rivers dropped as much as 75% between 1827 and 1834.

Shreve had indomitable energy, but his experience as river captain had ill-prepared him for the paper work and strict accounting required at Corps of Engineers projects. He was, in addition, constantly traveling between work parties and snagboats scattered from Pittsburgh to New Orleans. "If I was so situated as to be at one point with all my work under my eye & all my papers in an office, I could then comply with all the rules and regulations of the Engineer Department," Shreve complained, "but the work under my charge, is of an entirely different character, attended with more casualties and more complicated in its operations than perhaps any other work under the direction of the Department. I cannot carry on works on the Mississippi, Red, Arkansas, and the Ohio and do justice to all," he said, "and I therefore ask to be relieved from the Ohio, which differs so materially from that of the other rivers that it requires much more of my time than can be spared from the other rivers."

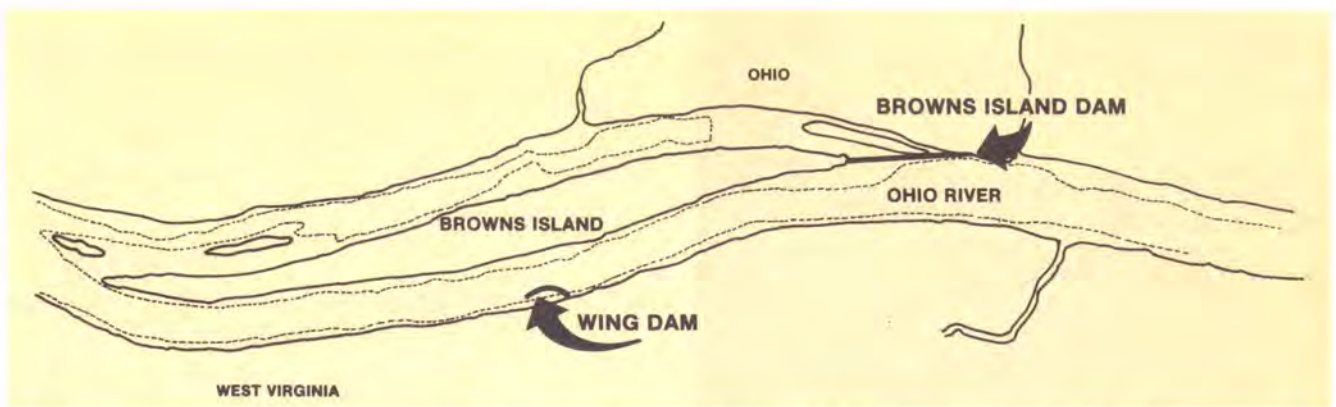
The Thirty Inch Project Lieutenant George Dutton of the Corps, with copies of the 1819 Ohio River survey supplied by Pennsylvania engineers, boarded a skiff at Pittsburgh in September 1835 and embarked down the Ohio to update the maps and plan a separate project for the Ohio from Pittsburgh to Louisville. He found the channel again littered with snags and rocks washed in by each flood, gravel bars with barely fifteen inches of water over them, and the condition of the upper Ohio not much different from what it had been in 1819.

On March 3, 1835, Congress appropriated \$50,000 for work on the upper Ohio River and separated its improvement from the remainder of the inland rivers. At the request of Captain Shreve, the Chief Engineer placed Lieutenant Dutton in charge of the upper Ohio.

After his return to Pittsburgh, Dutton informed the Chief that only a slackwater lock and dam system would provide satisfactory depths on the Ohio, because its low-water flow was inadequate, but rivermen opposed locks and dams because they might delay traffic at high water stages. Since funds for the project were insufficient to complete a single lock and dam, much less canalize the stream from Pittsburgh to Louisville, Dutton proposed to clear the channel of rocks and snags, build wing dams to create scouring currents at bars, and build dams to close channels back of islands.

The Chief approved Dutton's plans and by the summer of 1836 Dutton had four machine-boats and crews at work on the river. The project had just gotten underway when Dutton was reassigned to construction of the National Road (now Highway 40) across Ohio from Wheeling through Zanesville, Columbus, and Springfield into Indiana; direction of the Ohio River project was assigned to Lieutenant John Sanders.

John Sanders, graduate of West Point in 1834, was short, stout, gregarious, and good humored despite the intense pain he suffered as victim of a disease later recognized as diabetes. His contem-



poraries thought him a mathematical genius, and he was indeed a remarkably original engineer: he invented a steam-powered piledriver and developed formulas for calculating bearings and resistance of piles; he invented a mechanical cement mixer and conducted some of the earliest studies of the strengths and properties of cements.

Sanders opened the Office of Ohio River Improvements in Pittsburgh in 1836, and he personally enjoyed life in the bustling little city to its fullest. He spent his leisure hours at the magnificent Homewood estate, then the city's social center, and demonstrated his intelligence by marrying the beautiful daughter of its owner, Congressman William Wilkins, the man who had supervised the first improvement of Ohio River navigation in 1819.

Charles A. Fuller and Allan Campbell headed the engineering and surveying section of the new Pittsburgh office. Campbell had learned his trade on the Erie Canal; he later built the first railroad in South America and served as chief of construction on the Union Pacific Railroad and as director of public works for New York City. Fuller, a classmate of Sanders at West Point, had resigned from the Army to become a civil engineer. He worked for the Corps on inland river projects until his death, except for four years as an Engineer officer in the Confederate Army. Sanders hired steamboat captains James McKinney and Benjamin Crooks to direct snagging operations and Henry McCarty, a Pittsburgh mechanic and inventor, to supervise dam construction.

Sanders contracted with Samuel Walker and C. & I. Boyle of Elizabeth, Pennsylvania, for the floating plant needed by the Pittsburgh office. The twin-hull machine-boats, built for \$650 each, were two flat-boats, each 70 feet long and 10 feet wide with 40-inch gunnels, spaced 9 feet apart and joined by 12-inch timbers on which the machinery, wheels with 16-foot diameters and cast iron axles, was mounted. Workers were quartered in keelboats, 80 feet long and 15 feet wide, with blacksmith shops in their sterns. Sanders placed the fleet under command of

James McKinney, chartered the steamboat *Ploughman* (sometimes *Plowman*) to tow the boats up and down the Ohio, and made Steubenville the headquarters for the fleet.

Working up and down river from Steubenville, the machine-boats and their crews removed rocks and wrecks from the channel, pulled snags and sawed them up, and blasted stumps and roots to bits. At high water, the workers cleared trees from banks and islands with hand tools.

Lieutenant Sanders realized the machine-boats could not handle the largest boulders and snags, so in 1836 he built a steam snagboat for the job, naming it the *Henry M. Shreve* after its inventor. The *Shreve* was smaller than the first toothpullers and, instead of twin hulls, had a single hull with a double bow. Sanders appointed John K. Dillingham, former captain of the *Archimedes*, to command of the *Shreve*, which began operation on August 1, 1837. During its first month, the *Shreve* cleared the upper Ohio of 2 wrecked boats, 4 driftpiles, 7 treetops, and 415 snags, many a hundred feet long with six-foot butt diameters, at a cost of \$9.44 per obstruction.

"The articles of traffic and commerce transported on the Ohio river," Lieutenant Sanders reported in 1836, "consist of produce, lumber and coal, merchandise and manufactures. The three first articles, which are undoubtedly the greatest in tonnage, if not also in value, are wafted to market by the current in flatboats and rafts, and, therefore, are seldom shipped at low water when the current is too sluggish to carry them down. The merchandise and manufactures are generally freighted in steamboats, unless the water is too low; then in keel-boats. The steamboat is the only vessel which plies backwards and forwards between the several ports and carries passengers." Sanders recommended the Corps attempt to establish a channel 200 feet wide with minimum depth of thirty inches, to permit low-water navigation by 100-ton steamboats. A reliable thirty-inch channel, he thought, would result in reduction of river freight rates to 2/3 cent per ton mile and passenger fares to 1/6 cent per mile.



Ohio River at the mouth of Beaver River about 1840
Carnegie Library of Pittsburgh

Sanders planned to increase the low-water depth of the Ohio to thirty inches by building low stone riprap dams closing secondary channels behind islands and wing dams narrowing the channel to constrict flow and erode obstructive bars. He selected Brown's Island, seven miles upstream from Steubenville and the shoalest point on the upper Ohio, as the site of the first Engineer dam built above Louisville. He designed a dam to close the chute on the Ohio side of the island and divert flow to the Virginia side, which was the chute used by steamboats at low water. He also planned a wing dam on the Virginia side to narrow the chute to a width of 385 feet and to increase flow across the gravel bar.

Henry McCarty opened a stone quarry near Brown's Island in 1836 and soon learned that people in the vicinity opposed the project. They did not want the Ohio chute dammed because they loaded flatboats with flour at mills on Island Creek and floated them out of the creek and down the Ohio side of Brown's Island. They shipped 24,000 barrels of flour by that route in 1835 and they complained that damming the Ohio chute would ruin their business. They asked that the dam be relocated to the Virginia side of the island and they offered to supply labor, horses, plows, and scrapers to dredge the Ohio chute without charge to the government. Sanders explained to the flatboatmen that the dam would divert only low-water flow and would not interfere with high-water flatboat traffic, and he continued the project as first planned.

McCarty and forty laborers quarried stone, loaded it in scows, floated it to the site where Sanders had staked out the outlines of the dams, and pushed the stone into the river. When completed on September 24, 1838, the dam across the Ohio chute was 2,178 feet long, 11 feet high, with a base seven times its height. The wing dam running out from the Virginia bank and downstream in an arc was 2,246 feet long, 4 feet high on a 20-foot base, and contained 78,111 cubic feet of stone.

The dams increased low-water depths in the Virginia chute about twelve inches and were appreciated by steamboat captains who had often stranded in the chute before its improvement. Island Creek flatboatmen did not approve, however, and Sanders had to bring suit to prevent their breaching the dam across the Ohio chute. The dam across the Ohio chute was repaired in 1884 and a timbercrib superstructure was added. In 1907 it was again rebuilt with more stone, piling, and a concrete crown. The Brown's Island dam on the back channel is still in place.

Through construction of the Brown's Island dams, Sanders gained sufficient cost data and construction experience to permit preparation of firm contract specifications, and he arranged the building of more dams under contract. He asked in 1838 for funds to build dams at the head of Brunot Island, Neville Island, White's Ripple, Woolery's Trap, Deadman's Island, Raccoon Bar, Black's Island, Captina Island, Horsetail Ripple, and Beaver Shoals. Funds supplied were insufficient to begin all the projects, but were enough for a small start; in 1838 he began construction of dams at Woolery's Trap, 10 miles below Pittsburgh near Coraopolis, and at Captina Island, 108 miles below Pittsburgh near Powhatan Point.

Construction of riprap dams was supplemented by limited channel excavation, usually by blasting rocks and rock ledges out of the channel. The biggest job of this variety was at Beaver Shoals, just below the mouth of Beaver River, where Sanders blasted a 150-foot wide channel to a three-foot depth through a solid rock ledge. Workmen waded into the stream at low-water stages to drill holes in the rock. To drill the holes, some men held metal star drills upright and turned them between each blow from the power tools--sledgehammers. After holes were at the proper depth, the men inserted tin tubes containing powder charges and fuse, tamped clay around the charge, lit the fuse, and ran for cover from the shower of rock fragments. After the blast, they wad-



Sketch of McCarty dredge - across the channel

ed back into the river and shoveled the broken rock into small scows for removal. Sanders reported he excavated 250 cubic yards of rock at Beaver Shoals with 666 blasts, consuming 17 kegs of powder and 1600 feet of fuse.

The Survey of 1838 Lieutenant Sanders learned the survey of the Ohio made in 1819 by Magnus Murray was not sufficiently detailed for rational selection of damsites and channel excavation and that he needed high-detail maps showing channel depths, foundation conditions, stream gradient, and other data. He began his survey in 1838, a year of record low water in the headwaters district, when every tributary of the Monongahela except the Youghiogheny below Brownsville went dry at its mouth. Sanders descended the Ohio in a rowboat to Cincinnati in September and found no more than twelve-inches of water over many bars, and he reported to the Chief Engineer.

The inconvenience and loss arising from an interrupted navigation of the river has been felt throughout the Union. Large quantities of merchandise destined west, were detained for want of river transportation at Pittsburgh, Wheeling, and Portsmouth, and the produce of the country at the points where grown. Travellers had to resort to an expensive land transportation, or await the rising of the river. To give an idea of the length of the suspension of navigation, I will mention that steamboats stopped taking freight about the 20th of July, and the lightest draught stopped running on the 26th of August. On the 22d of October a few light-draught boats commenced running; on the 8th November steamboats recommenced freighting; so that steamboat navigation from this port was entirely suspended for fifty-seven days, and for three and a half months steamboats carried little or no freight.

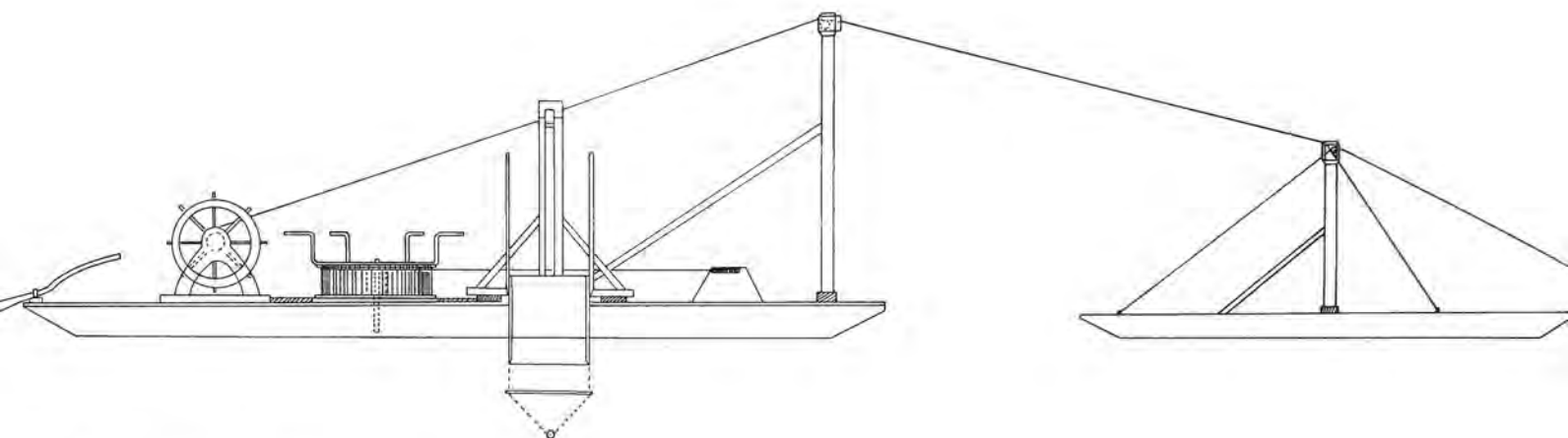
Sanders and Charles A. Fuller began at Pittsburgh and waded downstream, measuring depths and channel dimensions and noting founda-

tion conditions, while survey parties ran levels along the banks to determine elevations and amount of stream slope. They mapped the upper 234 miles of the Ohio on a scale of 1000 feet to 1 inch, from Pittsburgh to Letart Falls, and their maps were so accurate that the Corps did not find resurvey necessary until 1895.

Sanders asked for an appropriation in 1839 of \$312,000 to place all structures needed to secure a thirty-inch channel from Pittsburgh to Louisville under contract at once. "The magnitude and importance of the Ohio, as a national and commercial thoroughfare," said Sanders, "seems to justify the hope that adequate means will be furnished to perfect its navigation." But his request was fruitless, for in 1839 Congress and the Van Buren administration suspended funding for the thirty-inch project and all other waterway improvements.

Projects Suspended in 1839 "We are not aware of the causes which have induced the discontinuance of this valuable service," rivermen complained, "but we know that the consequences have been disastrous." Between 1836 and 1840, 41 steamers were built at Wheeling and 170, aggregating 24,016 tons, at Pittsburgh. From the first of 1838 to mid-1840, 3,650 steamboats and 62 keelboats landed at Pittsburgh; in the same period, 4,175 steamers and 11 keelboats landed at Wheeling. River traffic was burgeoning. But from 1839 to 1842, 136 steamers went to the bottom of the rivers, causing losses estimated at a million dollars a year.

General Andrew Jackson, President from 1829 to 1837, had marketed the produce of his Tennessee plantation by river since 1795, and he approved waterway projects. As an Army officer, he also understood the work of the Corps of Engineers. "In improving the navigation of our rivers, bays, and harbors, constructing roads, and, above all, erecting those important fortifications which are to constitute the frontier defence of this country, this corps forms an essential reliance," said Jackson. "Intelligent and skillful," he continued, "these branches of service have been confided to them, and



Sketch of McCarty dredge - side view

the fidelity of execution everywhere displayed is a manifestation of their worth and value to the country."

President Martin Van Buren, however, thought waterway projects unconstitutional and imprudent. When a national economic depression began in 1837, Van Buren curtailed federal expenditures and stopped waterway projects. Captain Shreve "mothballed" his snagboat fleet at St. Louis, and Lieutenant Sanders moored the *Henry M. Shreve* and other floating plant at the warehouse of Captain James McKinney at Steubenville, where it was sold at great loss in 1840. Sanders had finished only the dams at Brown's Island, the Trap, and Captina Island when he was reassigned to New York harbor defenses in 1839; the other half-finished dams were abandoned and left to destruction.

Though rivermen complained loudly, no improvement of inland river navigation was approved from 1839 to 1842. Van Buren paid the price for national depression in 1849, and President John Tyler, who became President at the death of William H. Harrison in 1842, favored improvement of the Ohio and Mississippi. "The great importance of these subjects to the prosperity of the extensive region referred to, and the security of the whole country in

time of war," Tyler said, "cannot escape observation." Congress enacted and Tyler signed a River and Harbor bill in 1842, and, after a three year hiatus, the Army Engineers resumed their work.

The Second Beginning, 1842 "This is embarrassing," wrote snagboat superintendent John W. Russell. "Captain Shreve, the former superintendent, has secured a court injunction against me." Captain Russell, known to rivermen as "Roaring Jack," was not easily embarrassed. A physical giant hardened by years of keelboating, he had once whipped pirate Jean Lafitte in a New Orleans brawl and had won a reputation as the bravest steamboat captain on the rivers. When one of his passengers was relieved of his wallet at Natchez, Russell ran a cable from his boat around a notorious pleasure house and towed the rickety frame building into the Mississippi, threatening to tow in the entire town. His passenger's wallet was promptly returned.

"Roaring Jack" was also an ardent Whig, and when the Whig administration of Harrison and Tyler fired Henry Shreve, a Democrat, in 1841, it chose Russell for the job. Russell was the perfect man, one newspaper editor said, to supervise the snagboats because he could "knock down six of the best men in his employment at any time."



"Roaring Jack" Russell
Sketch from portrait - Kentucky
Historical Society

Shreve was disgruntled by his dismissal, and he embarrassed Russell in 1842 by securing an injunction against use of the "toothpullers," which he had patented in 1838. Shreve dropped court action, however, when Congress agreed to study his claim, and Captain Russell put the *Heliopolis* and *Archimedes* back on patrol in 1843; he also began building more snagboats, the *Hercules*, *Samson*, *Sevier*, *Gopher*, and *Dragon*. Shreve refused \$40,000 compensation for use of his snagboat design, contending his invention had saved waterborne commerce millions. In 1881, thirty years after Shreve died, Congress awarded his estate \$50,000.

To improve administration of river projects and perhaps also to reduce some of the political controversy in connection with the work, the Chief Engineer sent Colonel Stephen H. Long to Cincinnati in 1842 to open the Office of Western River Improvements in charge of all inland river projects. Colonel Long was to serve in a capacity similar to that of the modern 'Division Engineer,' supervising and coordinating the work of subordinate, or "District Engineers." He also sent Captain George W. Hughes to Pittsburgh to examine the upper Ohio and ascertain the condition of the thirty-inch project after three years of neglect.

With a copy of the Sanders-Fuller survey in hand, Captain Hughes, steamboat pilot Nelson Crooks, and two oarsmen left Pittsburgh in a skiff on October 12, 1842. They found the channel again filled with snags and drift, the unfinished dams washed out, and the completed dams breached by vandals.

In his report, Captain Hughes commented that river navigation improvement was considered "the most difficult problem of solution in the whole science of civil engineering," and that the complexities of the problem in England had resulted in the construction of canals instead of river improvements, with rivers used merely as feeders for canals. French engineers, however, had devised methods of building locks and dams in rapid streams to form "une rivière canalizée."

Hughes thought canalization would best serve the needs of Ohio River navigation, but agreed with John Sanders that the costs of canalization would exceed available resources. He thought a minimum thirty-inch depth could be secured through an open-channel project at a cost of about \$2 million, but warned that the job would require "intimate knowledge of the *habitudes* of the river." Colonel Long at Cincinnati concurred. Long said that open-channel work was the "only feasible and economical means of improvement that can be applied in this river with a fair prospect of beneficial results."

At the request of rivermen, and perhaps also because he was married to a Pittsburgh belle, the daughter of the Secretary of War, Captain John Sanders was sent to reopen the Pittsburgh office in April 1843. He reemployed Charles A. Fuller, recovered the tools and machinery stored at Steubenville, and built five crane boats, so called because instead of the wheel and axle used on the Bruce machine boats they had stiff-leg timber derricks on their bows to raise snags and rocks. He assigned each of the five boats and their crews to a specific hundred-mile section of river and made it their responsibility to keep that section clear of snags, wrecks, and boulders.

Sanders entered into 27 contracts for completion of old dams and construction of new. The contracts simply called for quarrying of stone and delivery in scows to damsites for placement as directed by an inspector appointed by Sanders. He estimated the costs of placing stone in the dams at 50¢ a ton, but bidding was highly competitive and he let the contracts at an average of 36¢ a ton. The contractors, however, later took legal action to recoup some of their losses; some took their complaints to Congress and occasionally won additional compensation through act of Congress.

Dredging channels through compacted sand and gravel bars was a major engineering problem. Horse and oxen teams pulling plows and scrapers could do the job, but only at lowest water stages. The Engineers had ladder dredges of the endless bucket-

chain type in use in 1843 at coastal harbors, but those had too great a draft for use on the upper Ohio except at flood time. Henry McCarty invented a dredge for the Ohio by mounting a steam engine on a boat anchored upstream of the bar to be channeled; the steam engine turned a drum winding a cable attached to a small boat holding a scraper, and pulled the scraper over the bar. At a cost of \$1,500, Sanders built a McCarty scraper, the first crude dredge used by the Engineers on inland rivers, and put it to work at Brunot's Island on August 1, 1843. He reported it produced "most beneficial results," excavating in a single day fifty cubic yards of compacted gravel at a cost of 25¢ per cubic yard! And it even transported the spoil a hundred feet. The McCarty scraper worked so well that Sanders built four more for the upper Ohio project.

The Hazards of Snagging "This is the most eccentric and obnoxious branch of the public service," Colonel Long complained to the Chief Engineer, "and more resembles a military campaign than work. My men are dying from disease and are being killed and maimed for life as if they were engaging an enemy." He explained that in 1844 alone he lost Isaac Graham who lost his footing, fell overboard, and drowned; Nathan Griswold, dragged off a snagboat by a chain; Michael Fry, nearly beheaded by a rope from a capstan; George Crawford, crushed by a falling snag; and Jack, a black man, who fell out of a yawl while running rapids. They were the dead. Those who lost eyes, legs, and hands continued on the job as watchmen. Engineer employees had no pensions nor disability retirement in 1844.

At the request of Colonel Long, the Chief Engineer asked that any captain or crewman of the Engineer Fleet, "employed on duties as exposed, as hazardous, and often as fatal, as the vicissitudes of a campaign, should like the wounded and disabled soldiers, receive a pension proportioned to the injury he has received." Forty years passed, however, before Congress acted on that and similar requests.

Congressional neglect accentuated the headaches Colonel Long suffered as chief of the Office of

Western River Improvements. "The service in which I am engaged," he once wrote in a moment of despair, "is the most irksome and disagreeable I have had to perform. Were it extended, its loathsomeness would be increased in due proportion."

First of all, Colonel Long was badly overworked. He was responsible for projects on 1,600 miles of the Mississippi, 600 miles of the Arkansas, 600 miles of the Missouri, the Red River to the head of the Great Raft, and all 981 miles of the Ohio, plus minor projects. Nor were relations between the quick-tempered Colonel and his subordinates, especially the gregarious Captain Sanders at Pittsburgh and the rambunctious "Roaring Jack" Russell at Louisville, always harmonious. He quarrelled with Sanders and Russell, about whether supervision meant joint planning and accounting, or merely inspection, an issue that the Chief Engineer merely confused by ruling that supervision entailed both inspection and joint planning.

His principal headache was the snagging project. During each winter, Long recruited new crews, repaired and supplied the snagboats, and planned the next season's campaign, usually sending the light-draft single hull snagboats *Gopher* and *Dragon* to the upper Ohio, Missouri, and Mississippi and the heavy twin-hull boats to the lower river sections. All had to be ready for action when spring floods ended, for the Colonel was not likely to see the boats again until late autumn, when they limped into port looking as if they had been shelled by an enemy, with many of their crewmen missing, sick, maimed, or dead.

At first, crewmen often deserted the dangerous and lonely work. Long put a stop to that by withholding pay until the boats returned to port. He hired the bravest, soberest, and most experienced rivermen he could find as snagboat officers, but still found it necessary to issue strict regulations for shipboard conduct. After a drunken captain sank a snagboat, the Colonel absolutely forbade ardent spirits aboard ship, and frequent accidents forced him to issue orders that hanging wrenches on safety

valves would cease. To promote shipboard discipline, the Colonel instituted severe penalties for infractions of snagboat rules, revealing his ascerbic view of human nature in his orders:

The propriety of substituting rewards instead of penalties, for the purpose of promoting correct discipline...is questionable & would probably tend to the subversion of order and good fellowship on board; for however worthless and inefficient any individual may prove to be, he is generally unwilling to admit, that his services are not equally as valuable & praiseworthy as those of the most industrious...; which the awarding of a compensation to one, greater than that allowed to another, would be likely to engender dissatisfaction, animosities & strife on board.

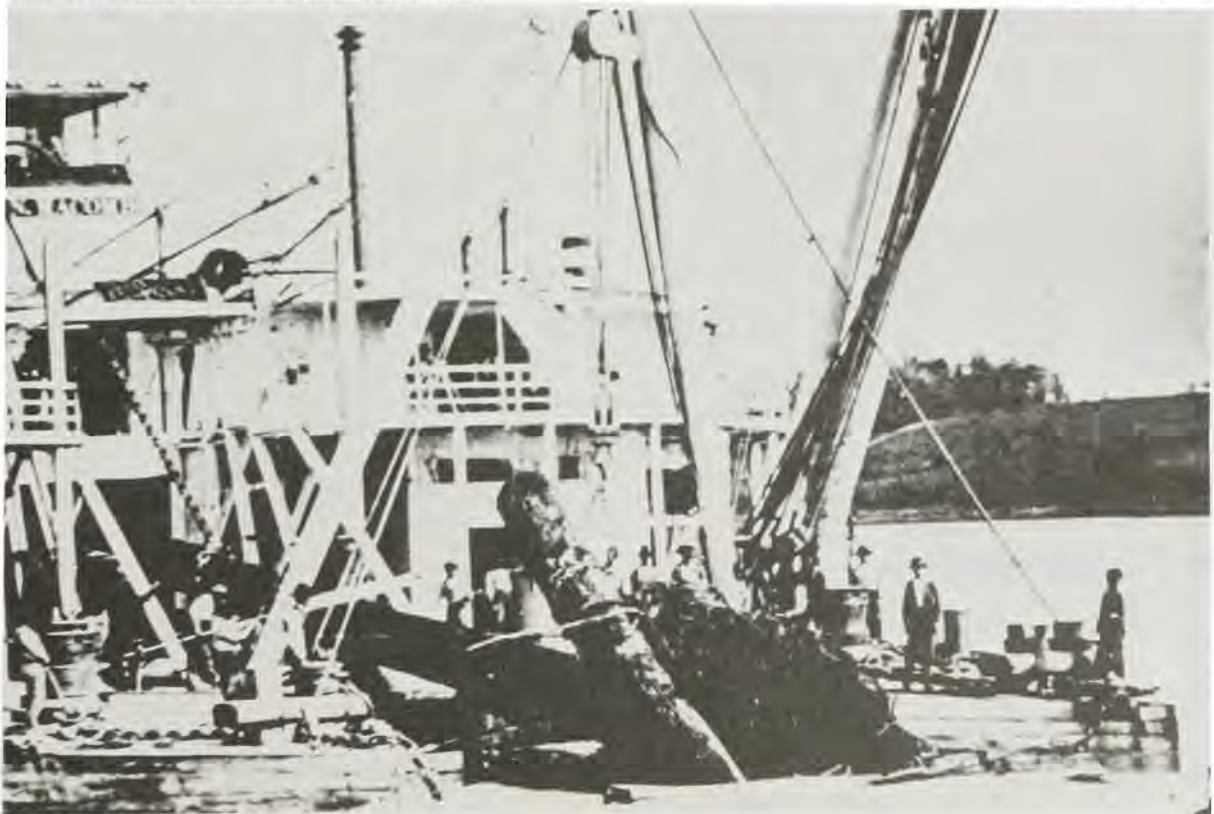
Mexican War and the Waterways Colonel Long's problems were abruptly resolved in 1845, Snagboat John N. Macomb (Post Civil War)

when the Democratic administration of James K. Polk terminated the river work. On the issue of federal waterway projects, the presidential candidates in 1844 had been clear: Henry Clay favored; Polk opposed. Clay carried Pittsburgh in that election, but Polk's campaign managers complained it was because the rivermen supporting Clay had hired all the Democrats they could find as boat crews and sent them downriver before election day.

Chief Engineer John J. Abert made himself very unpopular with the Polk administration by continually calling attention to the connection between waterway projects and national defense. Abert declared:

It is a country that is to be benefited, not a county--a nation that has to be aided, not a town. And all these [projects], by increased facilities of intercourse, by concentrating population, by encouraging agriculture and manufactures, add to national

Carnegie Library of Pittsburgh



resources, civil and military; give wealth, give arms and implements of war, and means of making them; increase national unity, national strength, and add to all elements of national defence.

While at Pittsburgh, Captain John Sanders had developed concepts similar to those of the Chief Engineer; and in 1840 he published his *Memoir upon the Military Resources of the Valley of the Ohio* in which he proposed formation of military and naval depots in the valley and construction of ironclad steamboats and steamships as a freshwater flotilla capable of descending the inland rivers to defend the Gulf frontier and operate on the high seas. Monongahela coal, he said, could be bunkered at New Orleans and other Gulf ports; foundries of Pittsburgh, Wheeling, and Cincinnati could supply armament, ordnance, and munitions; and inland river shipyards could produce upwards of a hundred steam vessels a year.

Captain Sanders closed his Pittsburgh office in 1845 and transferred the Pittsburgh floating plant and Engineer property to Colonel Long who warehoused machinery that might be used if work resumed in a few years and sold the residue along with most of the snagboats at public auction. Sanders left for Texas and was with General Zachary Taylor at the outbreak of war with Mexico. Under orders from Taylor, Sanders implemented part of his plan for use of Ohio valley resources, returning to Pittsburgh to purchase fourteen steamboats and rushing them to the Rio Grande, where they supplied General Taylor's army and initiated steam navigation on that stream. Sanders commanded the combat engineers at the Battle of Monterey, where he cut a path, literally through adobe walls and roofs, for Taylor's army into the city. Sanders was breveted Major for his gallantry in the action at Monterey.

Congressman William W. Irwin of Pittsburgh, inspired by Sanders' mobilization plans for the Ohio valley, had, before the Mexican War, pushed a bill through Congress establishing a navy yard at



U.S.S. Michigan

Western Pennsylvania Historical Society

Memphis and funding construction of ironclad steamships at Pittsburgh for service on the Great Lakes and the Gulf. The first iron vessel of the American navy, the *Michigan*, was built at Pittsburgh in 1841 and transported to Erie, where it was reassembled and launched for revenue service; it served the Navy on the Great Lakes until 1927. Other iron warships were built at Pittsburgh and launched during the Mexican War. The *George M. Bibb*, for example, went to New Orleans in 1845 and saw action on the coast of Mexico in 1847.

Colonel Long contributed to the war effort through loan of Engineer snagboats to the Quartermaster Department to clear snags from Texas rivers and by construction of a steam ladder dredge and six huge steamships, carrying both steam power and full sail, for service in the Gulf of Mexico.

Captain Sanders' prewar mobilization plans for the mustering of Ohio valley military resources were almost completely effected during the Mexican War. Troops and immense arms shipments departed Fort Pitt Foundry, Allegheny Arsenal, and other mills and towns along the Ohio regularly by river. The Ohio-Mississippi waterway became a major logistic line to the armies in Mexico.

The Third Try, 1852 "I entertain no doubt of the authority of Congress to make appropriations for leading objects in that class of public works comprising what are usually called works of internal improvement," declared President Millard Fillmore. He and his predecessor Zachary Taylor, the Whig administration elected in 1848, plainly approved river projects. They could not obtain the cooperation of Congress, however, and by 1850 rivermen had become upset by that lack of cooperation.

Navigation obstructions, the rivermen lamented, caused annual losses greater than all money spent for national defense. The inland rivers, they argued, carried more passengers and freight than did the American merchant marine. Yet, as a result of congressional neglect, navigation on the inland streams was little better in 1850 than "when the first 'broadhorn' floated down the Ohio and Mississippi and deposited her cargo of flour and whiskey, after a two months' voyage, in the *Spanish port* of New Orleans."

In 1852, Congress debated at length the merits of river improvements. One congressman pointed out that 951 river steamers had been lost since 1811: 166 by fire, 209 by explosion, and 576 by snagging. Another declared: "Whatever diminishes the risks and the cost of navigation and the cost of insurance goes to benefit the producer as well as the consumer; and just as we open safe channels to navigation from the interior of the country, we, to a certain extent, benefit every agriculturalist in the country." Proponents of river projects won their fight on the floor of Congress in 1852 and enacted the first major river and harbor bill since 1844.

The old team of Colonel Long, Charles A. Fuller, and "Roaring Jack" Russell resumed work in 1852, building a steam ladder dredge, the *Gopher*, and five new snagboats for the inland rivers. The dredge *Gopher* and the snagboat *Terror*, commanded by Captain John K. Dillingham, former captain of the *Henry M. Shreve*, were assigned to the Ohio River and began clearing the stream in 1853. Major John Sanders was performing engineering experiments at Fort Delaware in 1853 and was not returned to the Ohio; diabetes claimed his life in 1858.

Charles A. Fuller went to Pittsburgh in 1853, recovered the Engineer equipment left there in 1845 by Major Sanders, and reconnoitered the river, inspecting the dams and channel excavation work. He reported the dams had benefited low-water navigation but had been breached by vandals. "A remarkable resemblance was observed," he commented, "in several instances between the rocks at certain landings, in saw-mill ways, &c., to those

remaining in the neighboring dams." Fuller contracted with local quarrymen to place new stone in the breached dams to restore their effectiveness.

Fuller asked for \$90,000 to continue work on the thirty-inch open-channel project by building thirty-two new dams. His proposal was not well received, however, by the Board of Western Rivers and Lake Harbors, a distant predecessor of the Board of Engineers for Rivers and Harbors (BERH). In its review of the thirty-inch project, the Board commented:

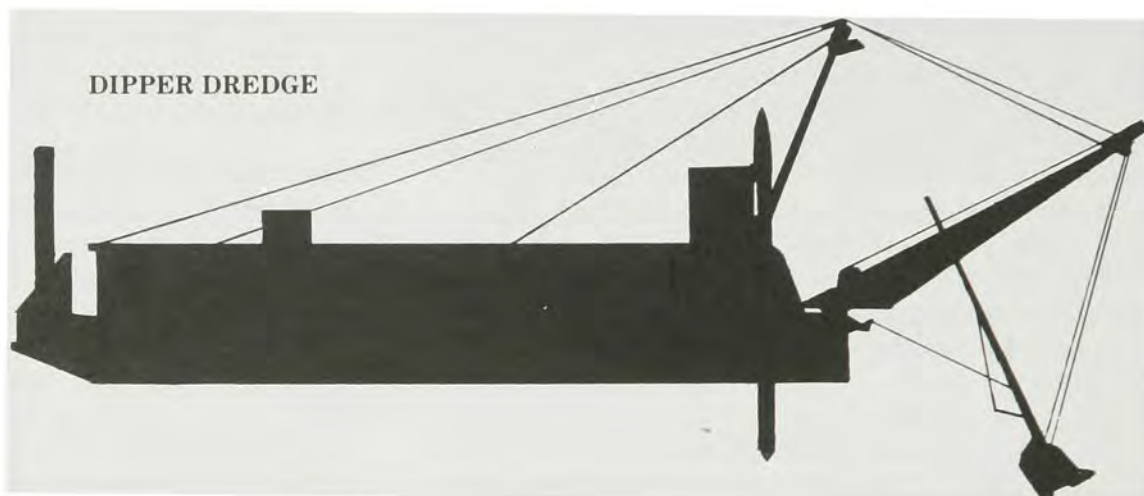
The method of improving these localities by the erection of jettys, wing dams, &c., of stone or other materials, is very questionable.....The Board is therefore of the opinion, that in almost every case where channels are to be found across shifting sand bars, the surest and most economical method of improvement consists in the use of properly constructed steam dredges, to be employed on the subsidence of every considerable freshet, and prior to the occurrence of ordinary low water.

Not a bad idea, thought Fuller, but he had a single dredge for the entire Ohio River and it had such deep draft that it could not ascend the stream above Louisville. The question of the merits of wing dams versus those of dredging was never settled, for in 1853 Democrat Franklin Pierce, who thought waterway projects unconstitutional, became President.

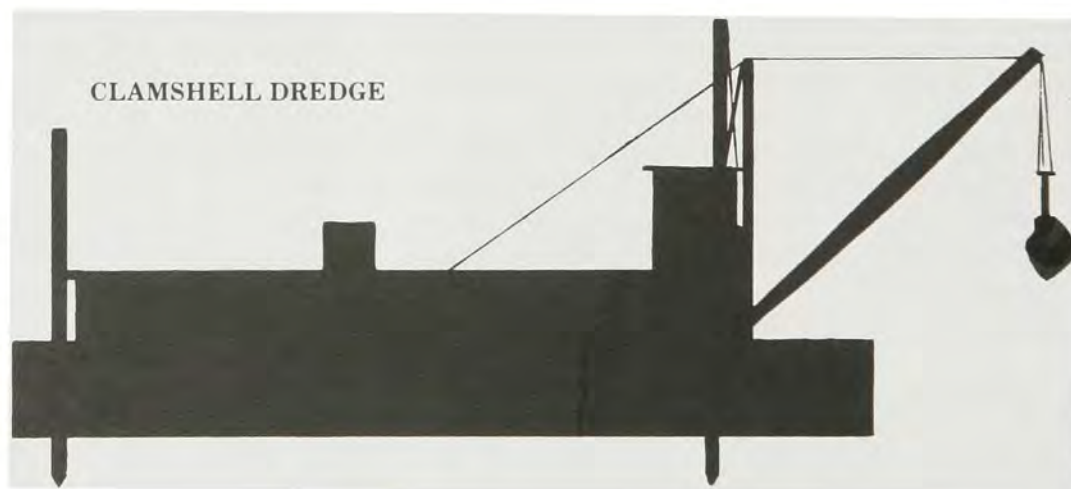
President Pierce selected Jefferson Davis, later President of the Confederacy, as Secretary of War and axed every waterway appropriation bill that crossed his desk. Congress enacted a few bills over his vetoes, but those provided mere pittances for minor projects and none at all for general improvement of the inland rivers.

At the first opportunity, President Pierce fired "Roaring Jack" Russell, a Whig appointee. Colonel Long kept Russell on the payroll for a time to settle accounts, but when Secretary Davis learned of it he

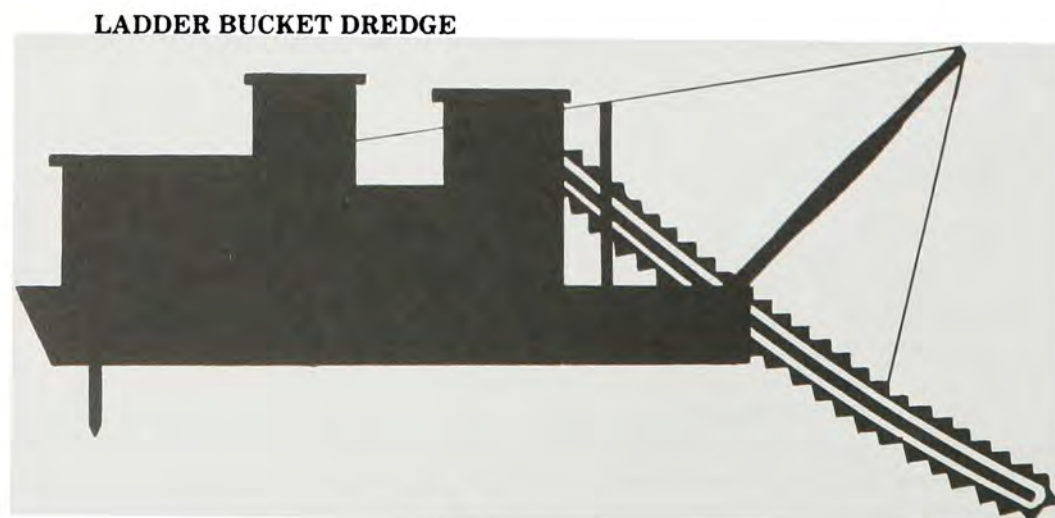
A dipper dredge uses a power shovel to rip hard material such as rock and highly compacted soil. It has proven extremely successful in excavating glacial till formations consisting essentially of boulders and clay.



A clamshell dredge uses a bucket suspended from a boom by cables and is primarily for excavating loose alluvial soil. Its method of operation lends itself to working in confined areas.



A ladder bucket dredge uses a series of buckets on a continuous chain and has general application in mining sand and gravel. In modern times this type of dredge is seldom used on waterway projects.



accused the Colonel of trying to protect Russell and summarily relieved Long as chief of inland river projects, replacing him with Colonel Joseph E. Johnston (who became a Confederate General in 1861).

After two years, the quarrel over Russell was forgotten and Davis reassigned Colonel Long to the Office of Western River Improvements. Long reported that 124 people had lost their lives in 85 steamboat accidents in 1854 and urged appropriation of \$621,000 to resume river projects. Funds were not furnished, however, and Colonel Long was forced to sell the snagboat fleet at a huge loss for the third time. Most of the boats were purchased by James B. Eads for conversion into "submarine boats" used to salvage boats wrecked on the rivers.

When he closed the Office of Western River Improvements in 1856, Colonel Long was age 72. Officers in those days were retired only by severe physical disabilities or death. The Colonel had never enjoyed river work, but he had invested half his life in it and had the audacity to publicly lecture Congress on the shortcomings of its waterway policies. Three times, he said, we have built a fleet and placed work under contract; three times we have sold the fleet at great loss and annulled the contracts, thereby wasting nearly half of all funds provided. Only regular and continuous funding, he argued, will make and keep the inland waterways safe for navigation.

For the benefit of his successors, if any, Colonel Long published some advice gleaned from hard experience:

The selection and appointment of local agents, snag-boat captains, &c., demand the utmost circumspection and caution on the part of the appointing power. None but men of experience, ability and integrity, recommended by disinterested, competent and impartial judges, should be deemed worthy of such appointments. The agent in charge of surveys, delineations, constructions, &c., should be well versed in engineering. Every agent charged with the

disbursement of funds should be a practical accountant. Every captain of a snagboat should be well-versed in the management of watercraft.....

The laborers employed should be in all cases robust, healthy, strong, active, and industrious, and in addition to these qualifications should possess quiet and peaceable tempers, kind dispositions, and be temperate and orderly in all respects.

A careful observance of the rules and regulations prescribed for the government of the western river service should be exacted from all concerned.

The End of an Era The Pennsylvania railroad built into Pittsburgh on November 29, 1852, the Baltimore and Ohio line reached Wheeling by way of Fairmont and Grafton on January 1, 1853, and railroad mania began in earnest in the Ohio River basin. Increasing interest in railroads, declining interest in waterways, low-water interruptions to navigation for months each year in the late 1850s, and a national business depression beginning in 1857, combined to depress river business and rivermen during the years just before the Civil War. Though waterborne tonnage was increasing, passenger traffic and high value freight moved to railroads as quickly as they were built and marine engineers built larger steamers to replace several smaller vessels. It appeared that traffic on inland rivers was dwindling. Because the new and larger boats stranded more often on bars, it seemed the navigability of inland streams was deteriorating.

Both Army Engineers and rivermen were discouraged by the wreck of the waterways improvement program on the rocks of political factionalism and party principles and especially by irregular and inadequate federal funding. Congress had appropriated more money prior to 1861 for construction of seacoast lighthouses to warn ships of dangers than for removal of obstructions from inland streams. During the late 1850s, James B. Eads and his salvage company, using the Engineer snagboat fleet to retrieve wrecked boats from inland river channels, made a fortune.



"...the venerable Seneca chieftain..."

Chapter 6

ALLEGHENY, MONONGAHELA, AND YOUGHIOGHENY

The boisterous whitemen crowding into his cabin and disturbing his rest displeased the venerable Seneca chieftain, but his son explained the whites had ascended the Allegheny to Kinzua in a "fire canoe" and were anxious for the old warrior to see it. Chief Cornplanter pushed aside the buckskin covers, rose from his pineboard bed, and magnanimously left the rude comfort of his cabin to appease the whites, who seemed to think he would be amused by their new contraption.

After nearly a century of war and uneasy peace with the whites, Cornplanter preferred to be left undisturbed in his magnificent isolation. Born of a Dutch trader and the sister of Goyasuta, Chief of the Senecas, Cornplanter had reluctantly joined the British in war against George Washington and the Americans, had won great victories, even capturing his white father, and had suffered bitter defeats, once swimming the Allegheny to escape the vengeance of Captain Samuel Brady. George Washington had sent troops up the Allegheny in 1779 to lay waste the Seneca villages, and after that disaster Cornplanter had made peace with the

Americans, kept that peace during postwar conflicts, and established a model community for his people. But the perfidy of the whites alienated him and he burned the uniform, destroyed the medals, and broke the sword presented him by President Washington. In 1830 the aged chief cared little about the schemes of whitemen. Still....a "fire canoe"?

His tribe followed him to the riverbank to see the thunder-rumbling, smoke-puffing boat with two wheels at its stern. His son translated the clamor of the whites, who said they left Fort Pitt on May 14, 1830, six days before, in the *Allegheny*, first true sternwheel steamer on the inland rivers, with engines that pushed them up boulder-strewn rapids without human help. Cornplanter did not believe,



The *Allegheny*
(Simulation; the boat pictured is a model)

Captain Fred Way

but boarded the "fire canoe" and rode upriver six miles, watching the wheels thrashing the river till he was convinced. "White men," he thought, as he boarded his canoe to return home, "will do anything to avoid using their muscles."

First steamboats on the Allegheny River had been the *Harriet*, a Monongahela boat tested against the Allegheny in 1816, the *Car of Commerce* built at Freeport in 1818, and the *Western Engineer* built by Colonel Long at Allegheny Arsenal in 1819, but regular steamboating on the river did not begin until 1827 when the *Albion* ascended to Kittanning and 1828 when Benjamin Crooks, later a snagboat captain for John Sanders, took the *William D. Duncan* to Franklin. Navigation against Allegheny currents



Map of upper Allegheny River prepared from 1828 survey by Lt. Col. James Kearney.

at the rapids presented such difficulties that David Dick of Meadville hired Thomas Blanchard, a Springfield Army Arsenal mechanic who had invented a special sternwheel steamboat, to build a boat to conquer the Allegheny. Blanchard built the *Allegheny*, 90 feet long, 18 feet wide, with 12-inch draft, and mounted twin paddlewheels twelve feet aft of the stern for increased power and mobility. This special boat was the first to ascend the Allegheny to Olean, where it landed "amidst the loud and constant rejoicing of the hospitable citizens of the village."

Allegheny Rafting "The Olean boys have scattered themselves in squads through the city," the *Pittsburgh Dispatch* reported in April 1856, "and knocked up rows at every point where four or five of them got together. On Prospect Street and Cherry Alley they mustered quite strong." Each spring the Allegheny raftsmen reached Pittsburgh on the first rise after the ice broke, sometimes a hundred rafts together filling the river from Herr's Island to the Point and often breaking their rafts into jumbles on the bridge piers. After a winter in the forests, the redjacketed raftsmen with coonskin caps and their Seneca companions were prone to carouse, searching the alleys of Pittsburgh for grogshops and snake-eye. Steamboat captains regretted the advent of the rafting season, for they had to haul the exhausted and ill-tempered raftsmen back to their upriver homes.

Logs and lumber comprised by far the greatest tonnage shipped via the Allegheny River in the 19th century. Cornplanter and the Senecas, Marcus Hulings of French Creek, and Daniel Jackson, Michael McKinney, and Daniel McQuay of Warren County began the Allegheny River rafting business before 1800. A hundred million board feet of forest products floated the Allegheny in 1838. Traffic

grew to two-thirds of a billion board feet in 1857, when more than 400 saw mills marketed their product down the Allegheny River.

Small rafts from the upper river jumped the milldams and shot the rapids into Warren each spring, where twelve of the small rafts were coupled into "Pittsburgh fleets." Raft fleets not sold at Pittsburgh were joined in threes, covering better than an acre of water and containing 1.2 million board feet of timber, to continue their voyage to Cincinnati or Louisville. Charles Chase of Warren, as one instance, made two, sometimes three, rafting trips annually to Cincinnati or Louisville.

Though flatboats carrying salt, pig iron, farm produce, and even ice cut from French Creek went to southern markets each year from the Allegheny, forest products constituted the chief cargo of Allegheny River flatboats. The most notable trade of this variety consisted of pails, tubs, furniture, window sash, and wooden wares manufactured in the Lake Chautauqua and Jamestown area and loaded in flatboats that floated the Chadakoin River and Cassadaga and Conewango creeks, jumping milldams at high water and passing through crude locks at low, to reach markets at Pittsburgh and below. Commodore Nathan Brown, between 1843 and 1885, floated out 156 flatboats with aggregate cargo value of a half million dollars by this route and peddled his wares, known as "Yankee notions," from Pittsburgh to Paducah.

The Allegheny Surveys "The connexion of the waters of the Ohio River with those of Lake Erie is considered as an object of great national importance," reported the House Committee on Roads and Canals. As a result of that report, General Simon Bernard and Colonel Joseph Totten led Army Engineers survey parties during the summer of



1824 to the Beaver and Allegheny River valleys to examine potential routes for a canal from the Ohio River to Lake Erie.

Colonel Joseph Totten personally examined the Allegheny and reported it obstructed by forty-four falls or ripples below the mouth of French Creek. He thought cutting a canal and towpath through the precipitous bluffs bordering the Allegheny would be very costly and such a canal would be subject to repeated flood damages. He therefore suggested that improving the river navigation might be preferable to the construction of a parallel canal.

Pennsylvania sent two engineers to study building a canal alongside the Allegheny to connect the Pennsylvania Canal, which was to strike the Allegheny at Freeport, with the French Creek Canal, planned to link Franklin with Conneaut Lake and the Erie Extension Canal. James Geddes, Dean of Erie Canal engineers, examined the Allegheny in 1826 and concurred with Colonel Totten: a canal cut through bluffs along the river would cost nearly two million dollars and would be

devastated by floods. Edward F. Gay reported in 1828 that locks and dams for slackwater navigation could be built at half the cost of a canal parallel to the Allegheny.

Edward Gay proposed construction of eighteen dams with locks to furnish slackwater navigation on the Allegheny from the mouth of the Kiskiminetas River to that of French Creek. He recommended the locks be 120 feet long and 26 feet wide to pass 60-ton steamboats towing two canalboats in a single lockage. He pointed out that Allegheny raftsmen would violently oppose dams that might impede their trade, but thought it best to leave settlement of their objections to the "wisdom of the legislature." He also warned that building dams on the Allegheny would be hazardous and expensive, so only the most "prudent and energetic" contractors should be selected for the job.

On December 9, 1828, after steamboats had ascended to Kittanning and Franklin, Congress directed the Corps of Engineers to make its second survey of the Allegheny below French Creek and the task was assigned to Colonel James Kearney. Kearney began his survey in 1829 and prepared detailed maps and profiles showing stream width and depth, obstructions and islands, stream gradient, foundation conditions, and normal flood elevations. He was one of the first engineers to recognize the value and economy of building dams of rock and other materials available near the construction sites. "Of this method of construction," he said, "we have examples exhibiting great power of resistance, and which, although displaying little of the elegance of finished masonry, yet, where water is abundant, fulfilling all the useful purposes for which they designed." He recommended dams of stone and gravel with a base width twelve times their height, which should be no more than five feet in order that rafters might cross in safety at high water. Such dams, together with masonry locks of a size sufficient to pass 85-ton steamboats, could canalize the Allegheny to the mouth of French Creek at a cost of a half million dollars, about a quarter the cost of a canal for that distance.



General Simon Bernard

The Pennsylvania canals
Historic Pennsylvania Leaflet No. 1



The Pennsylvania and French Creek Canals Spurred by the threat that the Erie Canal might deliver western commerce to New York, Pennsylvania launched a vast civil works program in 1826, with its first efforts concentrated on building a combined rail and canal system linking Philadelphia with Pittsburgh. Rails were laid from Philadelphia to Columbia, a canal built from Columbia up the Susquehanna and Juniata rivers to Hollidaysburg, a railroad put down to portage boats across the mountains to Johnstown, and a canal built down the Conemaugh and Kiskiminetas rivers to Freeport. From Freeport, the canal followed the west bank of the Allegheny to Pittsburgh, where it recrossed the river by aqueduct and passed through a tunnel under Grant's Hill to a basin on the Monongahela River. The principal engineers on the western division of the canal from Johnstown to Pittsburgh were Abner Lacock, Sylvester Welch, and Alonzo Livermore, who supervised the work of 125 contractors and thousands of workmen building 64 locks, 16 aqueducts, 10 river dams, 2 tunnels, 64 culverts, 152 bridges, and the canal itself, 40 feet wide and 4 feet deep.

The Pittsburgh to Johnstown and Hollidaysburg to Columbia canal sections were open to traffic by 1830, but the problem of moving the canalboats over the mountains remained. Stephen H. Long of the Corps of Engineers participated in early railroad project planning during periods when his river work was interrupted. In the process, he devised systems of inclined planes for moving freight over steep grades, patented improved bridge structures, and designed steam locomotives. The Chief Engineer of the Corps sent Long to assist Moncure Robinson, Sylvester Welch, and W. Milnor Roberts in planning the rail portage section of the Pennsylvania Canal. These engineers devised and built a railway and ten inclined planes on which canalboats on railcars were pulled over the mountains between Hollidaysburg and Johnstown by horses, with extra power supplied at the inclined planes by stationary steam engines and cables.

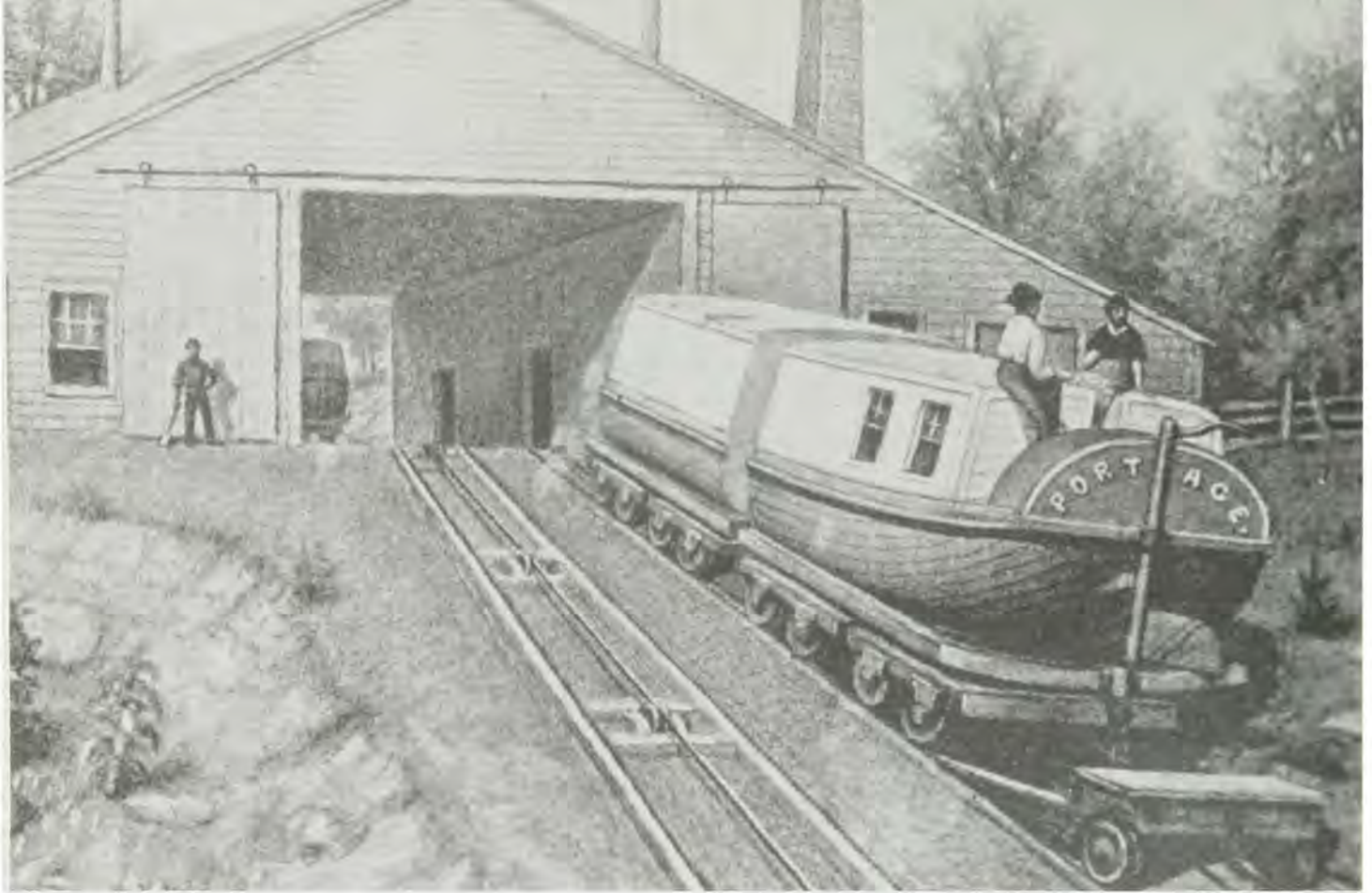
First canalboat across the portage railroad was the *Hit or Miss* that crossed in October 1834. It was

followed by many others, and as traffic mushroomed, so did the population of Johnstown, Blairsville, and other communities along the canal line. At one time, the western canal section was navigated by 121 canalboats with 900 crewmen moving thousands of tons of commodities.

Engineers trained on the Pennsylvania Canal scattered to other projects in the Ohio River basin and throughout the nation. Sylvester Welch, Abner Lacock, and Alonzo Livermore designed and built slackwater navigation projects on rivers in Kentucky. Livermore had two towns named for him: one on the Pennsylvania canal line and a second in Kentucky on Green River. W. Milnor Roberts became chief engineer on the Monongahela slackwater project and in 1866 established the Engineer office in Pittsburgh that became the Pittsburgh Engineer District.

Pennsylvania began construction of the French Creek Canal in 1827 and opened it to traffic in 1834. French Creek was dammed in eleven places to furnish slackwater from Franklin to Meadville; the 120 feet of slope was overcome by 16 masonry lift-locks, each 122.5 feet long and 21.5 feet wide. A feeder canal was built from Meadville to Conneaut Lake to divert flow from French Creek to the lake for supply of the Erie Extension Canal, which linked the Ohio River with Lake Erie via the Beaver and Shenango River valleys. Major commerce never developed on the French Creek Canal, but the slackwater was useful to the flatboat and keelboat traffic on the stream, and in 1853 Captain David Edgar ran the 9-ton steamboat *Major Adrain*, transporting fifty passengers, in regular excursions between Pittsburgh and Meadville.

The Hughes Survey of the Allegheny, 1837 "If the Allegheny River is improved from Olean to Pittsburgh, a water communication is opened for a distance of more than 12,000 miles, extending into the heart of one of the most fertile regions of the globe, on which Europe might comfor-



"Portage"

Carnegie Library of Pittsburgh

tably rest all her nations," commented Major George Hughes of the Corps in his report on the Allegheny. Though he had learned that keelboats sometimes ascended the Allegheny to Coudersport, Major Hughes began his survey on July 11, 1837, at the mouth of Potato Creek in McKean County. He examined the river to Franklin, where he arrived September 15, 1837, at the point where Colonel Kearney had begun in 1828.

During the survey, Hughes saw the *New Castle*, 115 feet long and loaded with 80 passengers and 60 tons of freight, that ascended the Allegheny in 1837 to Olean, second and last steamer to make the trip. Captain Joshua Leech also steamed the *New Castle* in 1838 up the Kiskiminetas River to his family home at Leechburg, the only steamer of record to make that trip. Hughes also learned that construction of the Genesee Valley Canal from Rochester to Olean had begun in 1837. That 104-mile long canal, linking the Erie Canal with the Allegheny River, took twenty years to complete. Because of railroad competition, the canal never realized the expectations of its promoters; yet, its construction stimulated greater public support for the improvement of Allegheny River navigation.

Major Hughes recommended in 1837 that the river above Olean be cleared of snags and that millowners be required to burn mill refuse instead

of dumping it into the river, where it collected and obstructed traffic. "The general plan of improvement," Hughes said of the river below Olean, "is to concentrate the water into a single channel, by low dams, uniting the islands together when there are several of them, and with the main land; the partial removal of the bars, which are generally formed of gravel and pebbles, thus producing a plane of descent nearly parallel to that which the river assumes in time of high water; the removal of snags, driftwood, sunken boats, and loose rocks." Project costs would be insignificant, he said, when "compared with the vast importance of the great interests which it is calculated to subserve."

The Hughes report was well received by proponents of improvements to the Allegheny, who used it as ammunition in their campaign to secure state or federal funding for the project. One widely reprinted letter came from an Allegheny raftsmen, who took a 350-foot raft from above Olean downriver in 1841 and wrote:

When Congress does its duty by improving the navigation of one of the most beautiful rivers in the country, and the road and canal are completed, both this [Port Allegany] and Olean must become important points. That the river may be made navigable, the report of a survey by Congress [Major Hughes] clearly shows;

and even the eye, without the aid of any instrument, can plainly see that such is the case. Indeed, had not those nuisances called dams obstructed the channel, boats might have traded several weeks from Pittsburgh to Olean, the last spring. They have ascended over the dams in high water, and carried freight to Olean. You of New York should move in this matter, since it is the only means of securing a large share of Western commerce.

The Pennsylvania legislature urged its congressmen in 1845 to support federal improvement of the Allegheny to Olean, and in 1846 resolved that waterway improvements were clearly the duty of Congress, which should give special attention to those rivers leading from Olean to New Orleans, "the great interior highway of the nation, indispensable to its defense, and essential to its commerce." But the question of constitutionality and divisive political factionalism that disrupted the Army Engineer project for the Ohio River also prevented federal improvement of streams tributary to the Ohio, and the Allegheny River, without improved navigation, never developed a waterborne commerce as extensive as that on the Monongahela, where slackwater navigation was available by 1844.

Monongahela Navigation Surveys The Monongahela River was the cradle of the inland river steamboat. The first river steamers were built at Pittsburgh and Brownsville, and others were soon sliding down the ways and splashing into the Monongahela at Elizabeth, McKeesport, Monongahela, Webster, Belle Vernon, Fayette City, California, and other ports along the river of falling banks. Monongahela boatyards were launching fifty new steamers a year by 1846; and from 1811 to 1888 they turned out more than 3,000 steamers, aggregating a million tons and valued at fifty million dollars.

Steamboat traffic on the Monongahela itself, however, grew slowly because of the difficulties of navigating the unimproved stream. The little *Enterprise*, commanded by Captains Israel Gregg

and Henry Shreve, in 1814 and 1815 first ascended the Monongahela to Brownsville; the *Reindeer* in 1826 was first to ascend to Morgantown; and the *Plowman* first reached West Newton on the Youghiogheny in 1835; but not until February 1850 did the steamboat *Globe* cross the milldams and obstructions on the upper river to reach Fairmont at the head of the Monongahela, and that to collect a thousand dollar prize offered for the feat. First Pittsburgh to Brownsville packet was the *America*, that began its run in 1825, but steamboating on the Monongahela did not thrive until after slackwater opened to Brownsville in 1844.

The Pennsylvania legislature on March 28, 1814, just after the first steamboats were built on the Monongahela, directed the Governor to appoint a commission to survey the river; and he appointed Henry F. Pearson, John Crawford, and Israel Gregg. Gregg, a river pilot who took the flatboat *Blackbird* with a cargo of flour from Brownsville to New Orleans in 1805, was co-captain with Henry Shreve aboard the steamboats *Enterprise* and *Dispatch*. The commissioners surveyed the Monongahela during the summers of 1814 and 1815 and reported: "There is no way of making said river navigable at all seasons but by erecting dams and locks." To build the necessary locks and dams, Pennsylvania chartered the Monongahela Navigation Company on March 14, 1817, and set aside state funds to purchase stock in the company. The company planned to supply slackwater through construction of sixteen low dams, averaging about four feet high, and adjacent locks, but did not begin construction before its charter expired.

A week after the first Monongahela Navigation Company charter expired, the Pennsylvania General Assembly on April 2, 1822, transferred \$10,000 of the funds appropriated for company stock to a commission charged with creating a "slope or inclined navigation" from the Virginia state line to the mouth of the Monongahela. The purpose of the project was to divert traffic from the National Road and Wheeling to the Monongahela and Pittsburgh. Commissioners Solomon Kripps, Joseph Eneix, and William Leckey employed

laborers, cleared the Monongahela of snags and boulders and dredged its bars with teams of horses pulling plows, completing their work in 1825. Apparently the project was beneficial, for in 1825 the steamboat *America* began regular runs from Pittsburgh to the National Road at Brownsville, and in 1826 the *Reindeer* was able to get upstream to Morgantown.

Pennsylvania engineer Edward F. Gay resurveyed the Monongahela in 1828 to determine whether either a parallel canal or slackwater navigation was feasible. When he saw the "slippery" character of the banks of the Monongahela, he rejected a canal and recommended a four-foot slackwater project with eight dams and ten locks to overcome a slope of about 75 feet between the state line and Pittsburgh. Gay proposed construction of timber-crib dams, filled with loose stone and capped with planking, and of stone masonry locks with chambers 120 feet long and 26 feet wide. The entire project, he estimated, could be built for slightly more than \$300,000.

Congressman Andrew Stewart of Uniontown had fought desperately in 1824 for inclusion of the

Monongahela below Brownsville in the first federal inland river navigation project but had failed. He and Congressman Philip Doddridge of Wellsburg, (West) Virginia, continued the efforts to secure federal improvement of Monongahela navigation. In 1830, Doddridge sponsored a resolution asking federal improvement of navigation on the Monongahela and its West Fork as far upstream as Clarksburg. That resolution failed, but on July 3, 1832, Congress approved an Engineer survey of the Monongahela below Brownsville.

The Monongahela survey was assigned to Dr. William Howard of Baltimore, a U.S. Civil Engineer and an assistant to General Simon Bernard and Colonel Joseph Totten on canal surveys. Dr. Howard began the survey in late 1832, and, after interruptions resulting from high water and a cholera epidemic, completed the study in the summer of 1833. He learned that Monongahela boatyards had launched sixteen new steamboats in 1832 and that many flatboats carried the products of Monongahela coal mines and glass factories to Ohio and Mississippi ports. The open-channel "sluice" project completed by the Pennsylvania commissioners in 1825 had so increased current

Map of Monongahela River prepared from 1833 survey by Dr. William Howard





velocities at ripples, however, that ascending keelboats and steamboats had to be towed by oxen and horse teams.

Dr. Howard recommended construction of a slackwater lock and dam project suitable for year-round navigation by 100-ton steamboats to Brownsville. Because Monongahela flatboatmen opposed anything that might interfere with open-channel navigation at high water, he proposed building eight dams between Pittsburgh and Brownsville, all with a lift of 4.5 feet except No. 1 near Pittsburgh that would have a 6-foot lift but with an open sluice in its center to be closed by planks during periods of low flow. Low dams could be jumped at high water by flatboats, and as another concession to flatboatmen Dr. Howard suggested the dams be built in an arch with the apex pointing upstream to reduce the hydraulic jump or wave below the center of the dam and allow flatboats to go over without plunging their bows underwater. He proposed stonemasonry locks, with chambers 160 feet long and 40 feet wide, and he estimated total project costs at \$258,720.

With the Howard survey in hand, Congressman Stewart redoubled his efforts to secure federal funding for the Monongahela project, or, as he preferred to put it, extending the Ohio and Mississippi project upstream to the National Road at Brownsville, cutting off 57 miles of land carriage to Wheeling. His efforts were furthered by conventions meeting at Greensboro and Brownsville in 1833 and 1835, which asserted in petitions to Congress that the Monongahela was worthy of federal attention because its coal propelled the machinery and fired the boilers at communities throughout the Ohio and Mississippi valleys and because its improvement would permit "speedy transportation of troops, ammunition, and arms."

Proponents of the Monongahela improvement, despairing of federal assistance, turned to state government and on March 31, 1836, secured a charter for a new Monongahela Navigation Company to build locks and dams to the state line and as much farther as Virginia would permit. About \$80,000 of company stock was subscribed by individuals, \$5,000 by the Bank of Brownsville, \$50,000 by the Bank of the United States, and \$125,000 by the Commonwealth of Pennsylvania, permitting organization of the company in early 1837 and employment of W. Milnor Roberts as chief engineer.

Monongahela Slackwater "The first time I saw Old Slackwater," W. Milnor Roberts recalled, "he was standing in a river in water to his neck. I asked if he were not a bit wet, and he replied that while other contractors might go under no river would get the best of him." Colonel Roberts had become acquainted with General James K. Moorhead, "Old Slackwater," on the Pennsylvania canal project where Moorhead was a contractor and Roberts an engineer. After completion of the Pennsylvania Canal main line in 1834, Roberts had transferred to the Erie Extension Canal building up the Beaver and Shenango valleys to Lake Erie and Moorhead had continued his contracting, building several dams including one for Captain Sanders on the Ohio River project. Moorhead became a director of the Monongahela Navigation Company that employed Roberts as chief engineer in 1837.

Roberts surveyed the Monongahela during the record drought of 1838, gaging river flow at Brownsville at 4500 cubic feet per minute (75cfs), and that was one of the reasons he recommended construction of dams 8 feet high instead of 4.5 feet as planned by Dr. Howard. Higher dams, Roberts argued, would increase water storage and reduce



Probably based on detailed survey by W. Milner Roberts in 1838

interruption to navigation resulting from low water to perhaps thirty days a year. The higher dams would also reduce construction costs by a quarter of a million dollars, because 10 instead of 17 dams would furnish slackwater to the Virginia line, saving an additional \$5,000 a year in maintenance cost, furnishing deeper pools for navigation, and eliminating about 3.5 hours lockage time between Pittsburgh and the state line. He recommended that lock dimensions be 190 feet by 50 feet in the chambers, the same as the Louisville and Portland Canal locks, then the largest in the world, which had been completed in 1831 by a private company at the Falls of the Ohio (Louisville, Ky.).

Because people of the Monongahela valley feared the eight-foot high dams would increase flood heights and damages, Roberts conferred with Sylvester Welch, who was building slackwater projects on the Green and Kentucky rivers, and with Pennsylvania engineer Edward Gay. Welch and Gay declared that eight-foot dams were completely drowned out at flood time and had negligible effects of flood flows.

Robert's proposals, nevertheless, were greeted by howls of protest from Monongahela flatboatmen and coal shippers who objected to the destruction of free navigation on the river, argued that consumers

must inevitably pay the tolls "merely to aid a chartered monopoly," and declared the dams would destroy valuable bottom lands and create stagnant pools that would become sources of epidemic disease.

"No work in the country has ever encountered greater obstacles than this," said one company of-



General James K. Moorhead

Carnegie Library of Pittsburgh

First cast iron bridge in the United States over Dunlap Creek at Brownsville, Pennsylvania, built in 1836; officer in charge, Captain Richard Delafield, Corps of Engineers



ficial. "Instead of being, as it ought to have been, fostered by our citizens, and hailed by the inhabitants of the Monongahela valley, as a blessing to themselves, it met with nothing but the most chilling regards from the one, and with either the most violent prejudice or the most determined hostility from the other." The company won approval from the Pennsylvania legislature for the eight-foot dams in 1839, but to appease flatboatmen the legislature directed that the company not collect tolls from traffic originating above Millsboro until Dam No. 5 was completed.

The company let the contracts for locks and dams 1 and 2 in late 1838; James Moorhead took the contract for No. 1 nearest Pittsburgh, and Corey and Adams took No. 2, located just above the mouth of Turtle Creek. The contractors purchased lumber for the timber cribs of the dams from Allegheny raftsmen, purchased random stone for dam fill and cut stone for masonry from quarries along the Youghiogheny, and began construction. The company let contracts for construction of locks and dams 3 and 4 in late 1840 and employed George W. Cass as assistant to Milnor Roberts to supervise the work at Nos. 3 and 4. Cass was a former Engineer officer who had built the first cast iron bridge in the United States across Dunlap Creek on the National Road near Brownsville; he later founded Adams Express Company and served as president of the Pittsburgh and Brownsville Packet Company.

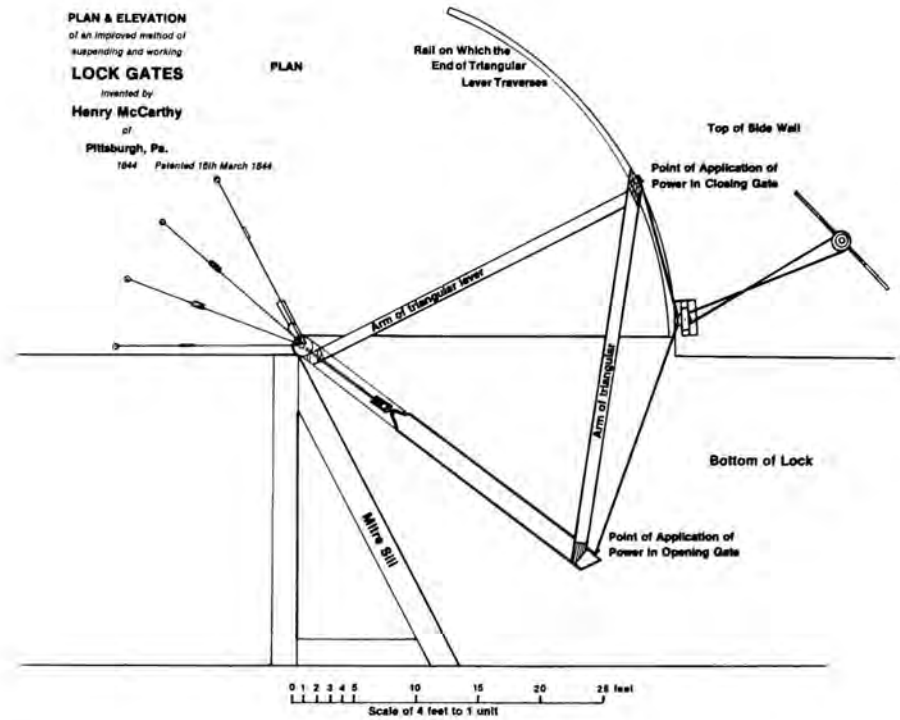
Locks 1 and 2 opened to navigation on October 18, 1841, and in their first eight weeks locked 38 steamboats, 155 keelboats, and 354 flatboats downstream and 34 steamboats and 355 other craft upstream. But headaches were just beginning for the company: rivermen willfully damaged the structures and used "violent means to effect a passage through the locks without paying the established tolls;"

owners of milldams on the Youghiogheny, flooded by Dam No. 2, sued for damages; and worse yet, a national economic depression eroded company capital and nearly put it out of business.

Crisis on the Monongahela General Moorhead, with set jaw, waded back into the Monongahela in the spring of 1844. He was in up to his neck because he stood to lose more than \$130,000 if he could not repair Dam 1 and complete locks and dams 3 and 4. And soon! By 1844 the Monongahela project had become a mortification to its friends, a nuisance to navigation, and General Moorhead was determined to end that embarrassing situation and open the project into Brownsville by the end of the year.

Company directors in 1841 noticed that individuals, squeezed by hard times, were defaulting their stock pledges; then in 1842 the Bank of the United States defaulted its \$50,000 dollar pledge and Pennsylvania purchased its stock in the company with state bonds, worth only 50% of par value. Without capital funds, the company had been forced to pay creditors from tolls, end repairs and maintenance at Dams 1 and 2, and stop construction at Locks 3 and 4 where cofferdams were already in place. The final blow had come in July 1843, when the river washed a hundred-foot wide, forty-foot deep hole through Dam 1 and its foundation, ending revenue from tolls.

It appeared the Monongahela Navigation Company and its property would fall under the hammer of the sheriff at public auction in the autumn of 1843, and, at the same time, Pennsylvania was so hard-pressed financially that the sale of all state corporation stock was ordered. Old Slackwater and his friends went to Harrisburg, purchased company stock owned by the state at a few cents on the dollar, and General Moorhead then contracted to save the



Henry McCarty's lockgate

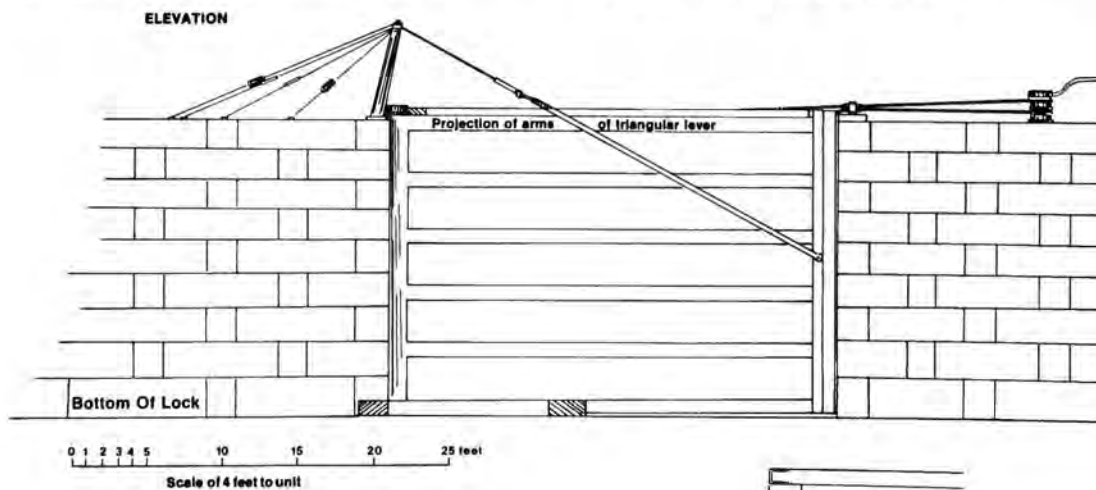
Redrawn from original plans National Archives

company by repairing Dam 1 and building Nos. 3 and 4, taking instead of cash payment a ten-year mortgage on company property to be retired with toll revenues, if any were to be had. He risked his personal fortune on the gamble that he could finish the project and that it would be financially successful, reimburse his expenditures for construction and return his near worthless company stock to par value.

When the company ran out of funds in 1841, Milnor Roberts left for Canada to work on the Welland Canal. General Moorhead selected Sylvanus Lothrop as his new chief engineer. Lothrop had been a contractor on the Pennsylvania Canal for locks and dams and for the aqueducts over the Conemaugh at Lockport and over the Allegheny at Pittsburgh. He had become engineer for the Ninth and Sixteenth Street bridges at Pittsburgh and for slackwater projects on the Wabash River in Indiana and the Duck River in Tennessee.

Lothrop directed the emergency repairs to Dam 1, which were accomplished by floating timber-crib frameworks into position across the breach in the dam and quickly filling the frameworks with stone. Old Slackwater, in the meantime, placed log cribs around the sites of locks 3 and 4, filled the cribs with stone and clay to serve as cofferdams holding out the river, and began pumping water from the interior of the coffer.

During the construction of Nos. 1 and 2, coffer had been "dewatered" with screw pumps, which were wooden cylinders with wooden screws turning eleven times in the length of the cylinders and powered by horses walking in circles. General Moorhead was racing to finish the project before high water in late 1844, however, so he cut the horses free and attached steam engines to the wooden pumps and moved 2,100 gallons per minute out of the nine-foot deep lockpits.





Old bear trap at Lock 1
(1909 photograph)

Since solid rock foundation was seldom available, General Moorhead built the lockwalls on a grillage of timbers laid on gravel, just as railroad ties are laid on rock ballast. The General moved cut stone for the masonry in scows from the Youghiogheny to the lock sites, swung the massive blocks from the scows to their place in the lock walls with timber A-frame derricks, and laid them symmetrically in hydraulic cement. Each lock wall was about 252 feet long, 25 feet high, and 10 to 12 feet thick, containing 5,300 perches (roughly 4,900 cubic yards) of stone.

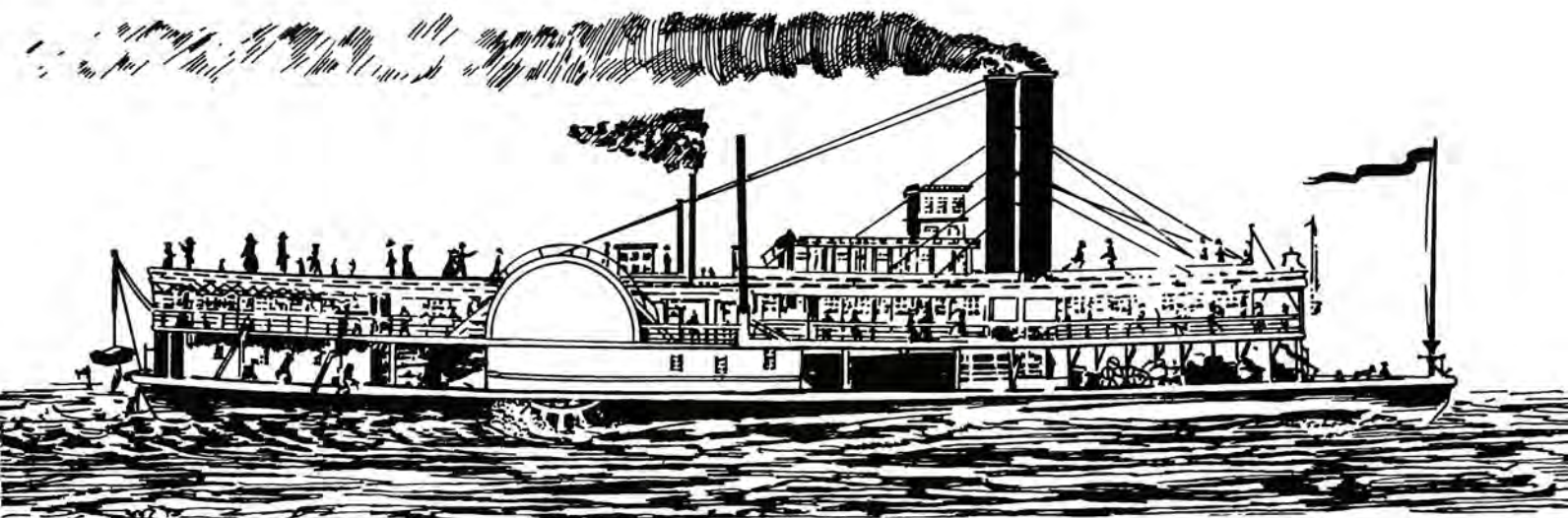
Milnor Roberts originally planned installation of beartrap gates in the middle of the lock chambers, with the idea of using these easily raised and lowered gates to flush debris and silt from the lock and its approaches, but Moorhead and Lothrop abandoned the idea because of construction fund shortages. The General rested the lockgates on rollers running on a rail track laid on a segment of a circle on the floor of the lock. He soon learned, however, that the system did not work well and purchased the method patented by Henry McCarty, assistant to John Sanders at the Pittsburgh Engineer office, for suspending the lockgates from posts on the lock walls, allowing them to swing open and closed like common house doors.

While the locks were under construction, General Moorhead had men at work building timber cribs for the dams. Logs, squaring at least a foot, were laid in alternate courses, much as log cabins were built, with long iron bolts through the corners to clamp the logs securely in place. The completed cribs were moved into place along the line of the dam, filled

with rock and sunk in place without much concern about foundation conditions. The tops of the cribs were planked over with oak timbers, wooden sheet piles were driven vertically along the upstream face of the dam into the bed of the river to deter undermining, gravel dumped in upstream of the dam to further stabilize the structure, and the job was done. It was a cheap but effective system; none of the dams failed from undermining, though their crests were cut down and breached by heavy ice and floods.

Success on the Monongahela "Our aim is to make known to our fellow citizens throughout the Union who may have occasion to travel Eastward or Westward between the seaboard and the Mississippi Valley," wrote Charles A. Fuller of the Corps of Engineers and Lieutenant John Rodgers of the Navy, "that a new avenue has just been opened which presents great advantage on the score of economy, comfort and speed." Fuller and Rodgers had joined Old Slackwater and a host of dignitaries aboard the steamboat *Consul* on its triumphant trip to Brownsville on November 13, 1844, in celebration of completion of the Monongahela slackwater project. "Trade and travel for Baltimore will now take a new course, and instead of making Wheeling a place of transshipment," proclaimed the *Pittsburgh Post*, "those who have heretofore taken that town in their route, or sent their goods through it, will find it to their advantage to come directly to this city."

Doubtless General Moorhead, aboard the *Consul*, watched with immense satisfaction the placement of the last stone in Lock 4 that day, for it finished his job of opening 60 miles of five-foot slackwater to Brownsville, and he had done the job a month ahead



Pittsburgh and West Newton Daily Packet

of contract schedule. In September 1844, when he saw he would get the river open to the National Road on time, along with engineer George Cass and river pilot Adam Jacobs, he organized the Pittsburgh and Brownsville Packet Company and purchased the steamboat *Consul*, later adding the packets *Josephine* and *Louis McLane*. The *Consul* picked up passengers arriving via the National Road at Brownsville on its first trip up and delivered them to Pittsburgh. The Monongahela slackwater did divert trade from Wheeling to Pittsburgh; in 1847 the packet company transported 45,825 through and 39,777 way passengers. But it was coal rather than passenger traffic that made the Monongahela the most successful slackwater project of the 19th century.

Coal shipment down the Monongahela to Pittsburgh began in the 1780's, and in 1793 Quartermaster Isaac Craig began shipping coal down the Ohio to supply the blacksmiths and armorers of General Wayne's army. David Bradford, leader of the Whiskey Rebellion, escaped down the Ohio in 1794 in a coalboat. Zachariah Reno made the first commercial coal shipment down the Ohio, sending two flatboats in 1814 with 5,000 bushels of coal to foundries at Louisville. By 1830, Monongahela coal was boated to New Orleans for use by sugar refineries.

Coal from hillside mines along the Monongahela was run out wooden inclines in wheelbarrows and mule carts and dropped through hoppers into large flatboats known as coalboats, or sometimes as French Creeks because they had been built on that

stream. Coalboat size varied at first but became standardized at a maximum 175 feet in length, width of 24 feet, and 10-foot high gunnels, with a capacity of 25,000 bushels or 1,000 tons (25 bushels roughly equalled 1 ton). Two such coalboats, lashed together, completely filled lock chambers on the Monongahela.

Crews for each pair of coalboats numbered fifteen, three men to handle each of the four oars, two pilots, and one cook, all living in a shanty in the center of the boats. They lived rough and dangerous lives during their downriver trips. In 1854, for instance, 120 coalboats sank in a storm on the Ohio and at least 17 crewmen drowned.

Though they strenuously opposed payment of the tolls, coal shippers found the Monongahela slackwater beneficial because it permitted loading the boats during any season of the year and regular supply to the plants and foundries at Pittsburgh. Coal shipments bound for Cincinnati, Louisville, and New Orleans were harbored in the pool of Lock and Dam 1 at Pittsburgh, where they were able to catch the first ten-foot rise on the Ohio to proceed to market. In their first full year of operation, 1845, the Monongahela locks passed through 4.6 million bushels of coal; the total rose to 22.2 million bushels in 1855, 37.9 million bushels in 1860, and to 65.8 million bushels in 1874, after the barge towing system had fully developed.

Tolls collected from the coalboats enabled the Monongahela Navigation Company to repay General Moorhead the construction costs by 1853,

and in that year the company began paying dividends to its stockholders, but headstrong coalboat captains caused operations problems. Except for preference given passenger packets, the rule was first come, first served, at the locks, and the result was races to the locks, immense jams at the lock approaches with no captain willing to give an inch, verbal pyrotechnics and brawls over the tops of the coalboats and on the lock walls, and assaults on lockmasters. In 1854 the Pennsylvania legislature established a \$25 fine for violation of locking regulations, but most pilots were willing to pay the fine to get down to the Ohio River in time to catch a flood. Company officials said the fine ought to be \$500 and imprisonment to at least "restrain the reckless and desperate and protect the more moderate."

Youghiogeny Slackwater Construction of the Monongahela project generated interest in building a companion project on the Youghiogeny. The pool of Dam 2 on the Monongahela furnished slackwater on the lower seven miles of the "Yough," the little steamboat *Ploughman* (or *Plowman*) had navigated the Youghiogeny to West Newton in 1835, and coal and coke shipped down the river from West Newton, Connellsville, and above was of such high quality that even coal from the Monongahela was marketed at New Orleans as "Youghiogeny Coal."

Youghiogeny river captains and mill and mine owners organized the Youghiogeny Navigation Company to construct a project extending slackwater up to West Newton, 18.5 miles from the mouth of the stream, and secured a state charter on April 18, 1843. Financial problems prevented any construction, however, until 1848, when General William Larimer, like James Moorhead on the Monongahela, came to the rescue by funding construction in return for a mortgage on company assets and tolls.

Construction of tow timber-crib dams and masonry locks began in 1848 under direction of

engineer James E. Day and General Larimer, the "Columbus of West Newton." Lock 1 at Boston and Lock 2 at Buena Vista, 5.5 and 12 miles above the mouth of the Youghiogeny, had 180 feet by 50 feet chamber dimensions and lifts of 13 and 15 feet, respectively. They opened to navigation on October 31, 1850, supplying four feet of slackwater up to West Newton.

Thousands of spectators gathered at the West Newton wharf, military companies paraded, bands played, and cannon salutes rent the air, as the steam packets *Atlantic*, *Shipper*, and *Youghiogeny* packed with celebrating passengers, landed at the wharf on November 5, 1850, to formally open Youghiogeny slackwater. After speeches by dignitaries, including the "Columbus" himself, the crowd adjourned to a huge warehouse for dinner.

The project began with great promise. Travelers via the Cumberland and West Newton Plank Road boarded steamboats such as the *Genesee* and *Shriver* at West Newton to continue their westward trips by water, and Youghiogeny coal and coke moved through the locks to market. West Newton even became a steamboat construction center: the 75-ton *Justice* and the 59-ton *Aquilla* were built there in 1851 and 1854. But the tolls collected were insufficient to repair frequent damages to the locks and dams by swift Youghiogeny ice and floods.

The navigation company was insolvent by 1858, and General Larimer lost \$14,000 dollars invested in the work, and went west to make a new fortune in railroad construction and found the city of Denver, Colorado. The company and its property were offered for sale in 1861, there being some hope the Monongahela Navigation Company would purchase and maintain it, but there were no buyers, for in 1861 the Pittsburgh and Connellsville Railroad was completed, robbing the Youghiogeny of all except its coalboat traffic. An ice gorge in January 1865 cut down the crests of the navigation dams; coal shippers led by William N. Robbins repaired the dams and acquired the navigation company, not for

cash but in exchange for funds expended for repairs. Coal shippers operated the project for two years until an ice gorge and flood on the night of February 17, 1867, broke the dams beyond repair. The locks and dams on the Youghiogheny were never rebuilt, though support for such a project continued for a century after the original project was destroyed.

Slackwater to Virginia? "The trade of the Monongahela Valley is rapidly increasing, the banks of the river are fast becoming lined with manufacturing villages, the coal business is just beginning to be developed," reported directors of the Monongahela Navigation Company in 1847, "and from the great extent of the Ohio and Mississippi Valleys, which must receive their main supply from thence, may expect its continued and rapid increase." The burgeoning coal traffic and boat jams at the locks forced the company to build second and larger locks adjacent to the first locks at dams 1 and 2 less than ten years after the first locks had been completed. Chief Engineer Sylvanus Lothrop designed and directed construction of the second locks, finishing the lock at dam 1 in 1851 and the lock at dam 2 in 1853. He built the new locks with chambers 250 feet long and 56 feet wide, dimensions sufficient to pass two of the largest coalboats simultaneously; at completion, the new locks were the largest in the world.

People along the Upper Monongahela, realizing that slackwater navigation could result in the opening of new coal mines and in greater real estate values, clamored for extension of the project upstream. In 1854, the Pennsylvania legislature required the company to begin construction of Locks and Dams 5 and 6, extending slackwater 28 miles above Brownsville to Geneva. Lothrop and his assistant Charles Stewart designed Nos. 5 and 6, let contracts in 1854, and opened the two new locks to navigation in November 1856.

Citizens of Monongalia, Marion, and Harrison counties, Virginia, were as eager as Pennsylvanians for slackwater navigation, but General Moorhead's

company held no charter from Virginia and did not have the capital needed to finish the project to the state line, and certainly not into Virginia. Virginians, largely from Morgantown and Fairmont, secured a charter on March 10, 1847, for a Monongahela Navigation Company with power to build locks and dams to extend slackwater up the Monongahela and even to Clarksburg on West Fork, where the ruins of General John G. Jackson's slackwater project could still be seen. The Virginia legislature offered to subscribe more than half the funds needed for construction, if individuals would subscribe the remainder, and therein lay the catch: the funds could not be raised.

By offering a prize of \$1,000, the people of Fairmont got the steamboat *Globe* up to their town at high water in February 1850, proving the upper river was navigable for steamers, even in an unimproved condition. Delegations from Morgantown and Fairmont met with General Moorhead and the Pennsylvania directors in 1853, and arranged for the Pennsylvania company to open books for stock subscription at ports on the upper river, but there simply was no money for investment there. On March 8, 1860, Virginia appropriated \$48,000, its share of the \$80,000 needed to begin construction, and books were opened at Morgantown and Fairmont in 1861 to collect private subscriptions, but this business was obliterated by marching armies that ended the authority of the Virginia government in the upper Monongahela valley and temporarily interrupted public interest in river improvement projects.

Capital Investment and Project Success Why did some 19th century waterway projects succeed while others failed, miserably? Chiefly because waterway projects required immense capital investments for construction and sufficient traffic afterwards to justify maintenance and operations costs. The necessary capital could come from three sources: federal government, state government, and private corporations. Sufficient traffic could come from transport of large volumes of bulky commodities.



Coal fleets at Pittsburgh

The Federal Government invested funds intermittently in the improvement of Ohio River navigation between 1824 and 1852, but politics prevented regular funding needed for proper project maintenance and benefits of the work were largely lost. The same politics prevented federal investment in improvement of Ohio River tributaries. Only the Cumberland and Tennessee rivers were improved with federal funds before 1861 and those were minor channel clearance projects whose benefits also were lost when funds for maintenance were not provided.

When people of the Allegheny and Monongahela basins failed in efforts to obtain federal capital for waterway improvements, they turned to state governments. State governments in the headwaters district, however, had invested most of their available capital in elaborate canal projects that brought them to the verge of fiscal disaster, projects that were wiped out by railroad competition.

Private capital resources were sufficient only for three waterway projects, on the Monongahela, its West Fork, and the Youghiogheny, in the headwaters district. And of the three, only the Monongahela project was successful, thanks to General James Moorhead who invested his money in construction of the locks and dams when the navigation company was near bankruptcy and to swelling coal commerce with resulting toll revenues that made the project profitable for investors and permitted proper maintenance and some expansion of the system. Without similar heavy traffic and toll revenues, maintenance costs of the West Fork and

Youghiogheny slackwater projects overwhelmed the resources of private capital and destroyed the projects.

A similar comparison might be made between the Monongahela project and slackwater projects built by the states of Ohio and Kentucky on the Muskingum, Kentucky, and Green rivers during the same era. The states underwrote construction costs, but without a heavy traffic in bulky commodities, like the Monongahela coal commerce, toll revenues were insufficient, maintenance was neglected, and when the locks and dams were completely worn out the states abandoned the projects.

Coal saved the Monongahela Navigation Company and made it the most successful slackwater project built in the 19th century; indeed, for years in the 20th century tonnage on the Monongahela exceeded that on the Ohio and Mississippi rivers and was even greater than that passing through the Panama Canal. Thomas P. Roberts, son of the engineer who designed the Monongahela slackwater and himself chief engineer for the project, declared with great pride:

Perhaps not in the history of the country has so small an investment of capital brought about, directly and indirectly, such a growth of population and wealth as resulted from the capital expended in the construction of the locks and dams on the Monongahela, and which has made Pittsburgh a household word, from the Allegheny mountains to the Gulf of Mexico.

Charles Ellet
Carnegie Library of Pittsburgh



Chapter 7

THE WATERWAYS AND WAR

As the ram fleet rounded the riverbend, Colonel Charles Ellet saw the Union gunboats lined across the Mississippi moving downstream toward the Confederate fleet protecting Memphis. Ellet ordered his engineer to put on all steam: eighty, ninety, one hundred pounds pressure; the *Queen of the West* and the rams that followed spurred ahead, passing through the line of slowly moving Union ironclads and aiming for cannon flashing from Confederate boats visible through the wall of smoke hanging over the river. The *Queen of the West* plunged into the smoke, lost from sight. Captain Alfred Ellet aboard the ram *Monarch* peered anxiously into the haze and finally saw the *Queen* and his brother Charles standing tall on its deck, waving his hat to direct the *Monarch* to the attack. "Follow me," Colonel Ellet shouted, "Now is our chance!" The *Queen* and the *Monarch* sliced swiftly down the Mississippi, and Confederate rams moved to meet them head on, prow to prow. A thousand feet, five hundred feet, four hundred feet. Collision would send both Union and Confederate rams to the bottom with all hands.

After the Confederate ram *Merrimac* devastated the Union fleet at Hampton Roads on March 8, 1862, near panic had prevailed in Washington. John Ericsson's *Monitor* was available to meet the *Merrimac*, but Confederates had powerful steam rams under construction at Memphis that could wipe out the Union river squadron. Secretary of War Edwin Stanton called Congressman James "Old Slackwater" Moorhead and engineer Charles Ellet to his office to discuss the emergency.

Use of powerful steamboats as rams to crush the hulls of enemy vessels was not a new idea. Ramming had been a common naval tactic since ancient times, and in 1829, after watching his *Heliopolis* smash snags from the rivers, Captain Henry Shreve had told President Andrew Jackson that the Navy should build snagboats for use as rams in combat. Colonel Charles Ellet in 1854 told the Czar that the

Russians might break the British siege of Sevastopol with a fleet of steam rams; and in 1855 he recommended the American Navy build rams. Neither the Czar, nor the Navy had acted on the plan, but in 1862 Stanton remembered and sent Ellet and Moorhead to Pittsburgh with *carte blanche*.

Ellet and Moorhead purchased the powerful coal towboats *Mingo*, *Lioness*, and *Samson* and the smaller *Dick Fulton* and *T. D. Horner* at Pittsburgh, installed timber bulkheads anchored with iron rods from stem to stern in the hull of each, and acquired the sidewheelers *Monarch*, *Queen of the West*, *Switzerland*, and *Lancaster* for conversion at Cincinnati and New Albany. Ellet completed the job in six weeks, recruited crews for what amounted to a suicide mission, and set out down the Ohio. The ram fleet was unarmed, but Ellet picked up his brother Alfred Ellet, captain of the 59th Illinois, and his regiment at Cairo to serve as marines.

Colonel Ellet took his ram fleet to Memphis on June 6 and met the Confederate river flotilla. In his afteraction report, Ellet told Stanton:

I directed my attack upon two rebel rams which were about the middle of the river, very close together, and supported by a third, a little in their rear and a little nearer to the Memphis shore. These two rams held their way so steadily, pointing their stems directly upon the stem of the Queen, that it was impossible for me to direct the pilots, between whom I had taken my stand, upon which to direct our shock; but as the distance between us and the enemy, short at first, became dangerously small, the two rebel boats, apparently quailing before the approaching collision,



Charles Rivers Ellet
Carnegie Library of Pittsburgh

began first to back water and then to turn, thus presenting their broadsides to my attack. It was impossible to choose between these boats which to attack, for there was still a third ram within supporting distance to which I would be exposed if I struck the second, while the second would be sure to reach me if I selected the first. My speed was high, time was short, and the forward vessel presented rather the fairer mark. I selected her. The pilots.....brought the prepared bow of the Queen of the West against the broadside of the rebel ram just forward of the wheelhouse. The crash was terrific; everything loose about the Queen, some tables, pantryware, and a half-eaten breakfast, were overthrown and broken by the shock. The hull of the rebel steamer was crushed in, her chimneys surged over as if they were going to fall over on the bow of the Queen. Many of her crew, I have been told, leaped overboard, yet the rebel wreck, in consequence of the continued motion of the Queen, still clung to her bow.

A Confederate ram hit the *Queen* thirty seconds later. Ellet ran from the pilothouse to the deck at the impact to assess damages. He was felled by a Confederate sharpshooter. Alfred Ellet drove the ram *Monarch* hard into the ram that hit the *Queen* and sank the Confederate. Union rams and gunboats following the Ellets into action sank more Confederate boats and pursued the residue toward Vicksburg, and Colonel Ellet sent his son, Cadet Charles Rivers Ellet, into Memphis to raise the flag over the city.

Ellet and the Reservoir Scheme Ellet and Stanton had been adversaries in the years before the

war. Stanton once deliberately rammed a steamboat into the Wheeling Bridge, first bridge over the Ohio, completed by Ellet in 1849.

Lieutenant John Sanders began planning for the Wheeling bridge in 1838 when the river was frozen over and he could cross and recross on the ice. Construction of the National Road was then the responsibility of the Army Engineers, and Congress had requested study of a bridge at Wheeling to carry the road over the river. Sanders reported the bottom of the bridge roadway should be very high and there should be no piers in the channel to obstruct river commerce. Sanders had studied European bridges and the first suspension bridge in the United States, built by James Findlay across Jacob's Creek in 1796 on the National Road near Uniontown. He recommended the bridge over the Ohio at Wheeling be a suspension bridge supported by wire cables to obtain essential clearances for navigation.

The Wheeling & Belmont Bridge Company hired Charles Ellet, noted canal, railroad, and bridge engineer, to supervise design and construction, and by 1849 Ellet had completed the stone bridge towers and suspended a record 1,010-foot roadspan between them. But Pittsburgh rivermen employed Edwin Stanton of Steubenville as attorney to seek injunction against the Wheeling Bridge as an obstruction to navigation. Stanton dramatized the case by chartering the steamer *Hibernia*, running it full speed under the bridge, and watching with glee as the bridge span ripped away the smokestacks. Stanton took the case to the Supreme Court in 1851 and won an order for removal of the bridge, but Congress saved the bridge by declaring it part of a federal mail route.

The bridge was long a source of acrimony. Pittsburgh boats were pelted with rocks at Wheeling wharf. In line with the custom of naming boat cabins after states--staterooms--Pittsburghers labeled the toilets on their boats the Wheeling. In fact, rivermen still refer to those facilities as Wheelings. When the suspension bridge span fell in a windstorm in 1854, Pittsburgh river captains

lowered steamboat smokestacks in derision at the site and sought injunction against its reconstruction, but they failed and Ellet rebuilt it.

While at work on the bridge in 1847-49, Ellet studied historic flood and flow records, established a discharge measurement section, recorded surface velocities with loaded floats, and developed a stage-discharge curve for the Ohio, contributing a great deal to the development of the science of hydrology. He had engineered canals and reservoirs as canal feeders, and that experience plus data on the flow of the Ohio clicked in his mind. He concluded a five-foot depth for navigation could be maintained on the Ohio through regulated releases from reservoirs built on tributaries, and in 1849 he published a paper advocating such a project.

He proposed construction of high multipurpose masonry dams on headwater tributaries of the Ohio, a 58-foot high dam on the Allegheny above Franklin among them, to retain flood water for release during droughts, thereby reducing flood crest heights and flood damages and maintaining navigable depths on the lower Allegheny and Monongahela and on the Ohio.

Reservoir releases, he also claimed, could power water mills and abate stream pollution. "These things will be effected, not by main force, but by skill," he declared. "The rain gauge will indicate the approaching danger from the summits of the distant mountains; the telegraph will announce the fact at the flood-gates, and the whole may thus be controlled by the provisions of science. In fact, the desired effect can be produced by a few dams in the mountain gorges, and the constant attention of some twenty men."

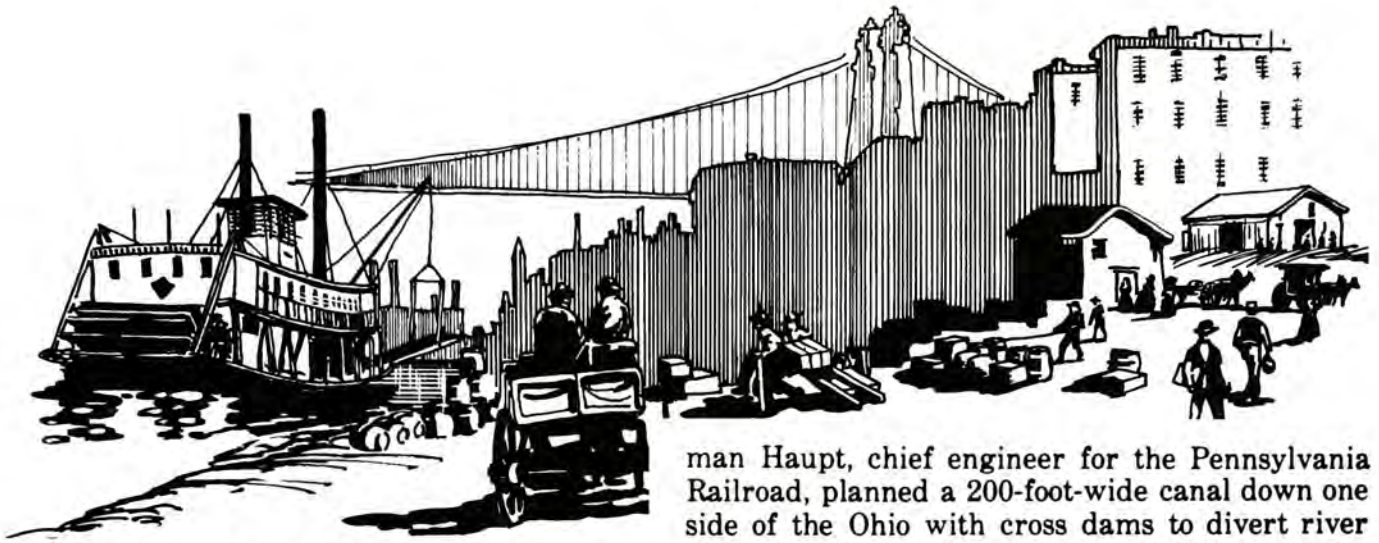
The multipurpose reservoir concept became his obsession; he even named his son Charles *Rivers* Ellet. He took the idea to Congress in 1850 and found support from Senator Henry Clay. "The conviction is strong upon me that this project will ultimately prevail," Clay said. "I think we adopt what nature

points out to us by constructing reservoirs to supply a deficiency of water in the channel at certain seasons of the year."

Congress asked appointment of a board of engineers in 1850 to study flood problems on the lower Mississippi, and Colonel Ellet, Colonel Stephen H. Long, and Captain Andrew A. Humphreys were appointed. Humphreys and Long wished detailed information about river regimen before making recommendations, and they continued their surveys and studies until 1861, when their classic *Physics and Hydraulics of the Mississippi River*, known also as the Humphreys-Abbot report, was published. Ellet, however, published his independent report, *The Mississippi and Ohio Rivers*, in 1852. In it, he recommended improvement of the Mississippi River levee system and construction of reservoirs for flood control and multiple purposes on all tributaries and subtributaries from the Appalachians to the Rockies.

Congress was at the verge in 1857 of approving surveys of reservoir sites in the Allegheny and Monongahela basins when William Milnor Roberts, the Monongahela slackwater engineer, published a devastating critique of Ellet's reservoir scheme. Roberts contended engineering and construction of a reservoir system would be more complex than Ellet imagined, that coordination of operations would present problems, and that Ellet had not fully considered the costs of relocating towns, railroads, and other property from reservoir sites.

In 1828, Pennsylvania engineer Edward F. Gay had planned a slackwater project for the Ohio from its head to the mouth of Beaver River, with four dams and locks. Roberts asked why reservoirs, an expensive experiment, were even considered for bettering Ohio River navigation when the Monongahela slackwater project had operated with success for years, as had similar projects on other tributary streams. Before Congress invested in reservoir studies, Roberts suggested it fund full investigation of all feasible engineering methods.



Wharf scene - Wheeling

"Experience, everywhere," he said, "teaches the danger of merely legislative decisions of such questions."

A third plan for the Ohio developed in 1855, largely as the result of a campaign by Pittsburgh and Kittingh newspaperman Josiah Copley. Copley informed his readers:

The year 1854 was one of unexampled drought. Never before was the necessity of the contemplated improvement more keenly or painfully felt. Your warehouses groaned under the weight of accumulated stocks, while the industry of the city languished for want of its indispensable stimulus, money. Men of enterprise found it extremely difficult to bear up under the constantly increasing weight of their responsibilities, while the poor were reduced to utter poverty....The hearts of all sickened with hope deferred, while looking and longing day after day, and week after week, for water. These calamities . . . inspired an earnest and widespread desire for an improvement of this great river, upon which we find we are so dependent, so as to render it a permanent and reliable avenue of commerce.

Copley declared government public works were not only unprofitable but also "demoralizing and dangerous." He suggested formation of a corporation similar to the Monongahela and Youghiogheny navigation companies to undertake work on the Ohio.

William Wilkins of Homewood, Edwin Stanton, James "Old Slackwater" Moorhead, William Larimer, and John Edgar Thompson and Herman Haupt, the latter two engineers of the Pennsylvania Railroad, formed the Ohio River Improvement Company in 1855 under Pennsylvania charter. Her-

man Haupt, chief engineer for the Pennsylvania Railroad, planned a 200-foot-wide canal down one side of the Ohio with cross dams to divert river water into the canal and automatic sluice gates instead of navigation locks to overcome stream gradient. The company took Haupt's plans to Congress in 1856 and sought a grant of public lands, similar to grants made to railroads then building, to fund construction of Haupt's Ohio River canal. Congress refused to act until the company acquired approval of all states bordering the river. "The Ohio is a national highway," a House committee declared, "and no single State can claim jurisdiction over it, or pretend to the right to disturb the flow of its waters, to regulate the transportation or tax the commerce that floats on its surface."

The ruckus among engineers over what method would best improve the Ohio temporarily died at the approach of Civil War. William Milnor Roberts went to Brazil to direct a massive railroad project; Herman Haupt became a Union Army General and director of military railways; and Charles Ellet took his ram fleet to Memphis.

The pistol wound Ellet received at the Battle of Memphis festered and he died aboard ship a few days after the battle. His body was returned to Philadelphia to lie in state under the Liberty Bell in Independence Hall and was buried with honors due a national hero. His wife died of exhaustion and grief two weeks later. His son, Charles Rivers Ellet, became commander of the ram fleet and died in the service in 1863 at age twenty.

Charles Ellet was perhaps the most original engineer of his era. His mercurial personality, however, frequently resulted in hasty and inadequate planning; his bridge at Wheeling, for instance, fell into the river and had to be rebuilt. But his multipurpose reservoir scheme, the crowning achievement of his career on which he thought his future fame would rest, eventually became what he had hoped. Every multipurpose reservoir in the nation today bears mute testimony to the innovative thinking of Charles Ellet.



New Madrid, 1862

Battles and Leaders of the Civil War

Divisive War at the Headwaters At the time Ellet was building his ram fleet at Pittsburgh, James M. Morgan, a midshipman aboard a Confederate gunboat on the Mississippi River, received orders from Commodore George Hollins to burn a deserted riverbank town that had been evacuated at the advance of a Union army. Midshipman Morgan went to the Commodore to protest the order. "If New Madrid must be destroyed, don't send me to do it," he said. "My grandfather, Colonel George Morgan, founded the town." Commodore Hollins considered the midshipman's protest a few moments, then responded that it seemed appropriate for a descendant of the town's founder to destroy it. Morgan did his duty with regret. "I had undone the work of my ancestor," he said, "and I was not particularly proud of the job."

James Morgan's parents had moved from Chartiers Creek to New Orleans, and Morgan had resigned from Annapolis in 1861 to join the Confederate navy. George Washington Morgan, another grandson of Colonel George Morgan, had moved from Chartiers Creek to Ohio. He became a Union General and distinguished himself at Cumberland Gap and in other campaigns.

The dilemma met by the Morgans at the outset of the Civil War was not atypical. Stephen H. Long and Charles Fuller of the Corps of Engineers were dredging the mouths of the Mississippi River in 1861. Colonel Long rescued federal funds from New Orleans banks and went north to become Chief of Topographical Engineers for the Union. Fuller resigned to become colonel of Confederate Army engineers.

Colonel Long prepared plans for the Union inland river squadron for service during, he said, the "unhappy civil war with which our once peaceful country is now afflicted." He warned that Union gunboats should have the minimum draft because of government neglect of waterways during the prewar years. He was the last Chief of Topographical Engineers. They were merged with the Corps of Engineers in 1863, and General

Richard Delafield became the first Chief of Engineers.

Like the Morgan family, the Army Engineers were divided by the war. Of the 93 officers in the Corps in 1861, fifteen resigned to join the Confederacy. Confederate generals Robert E. Lee, Joseph E. Johnston, and P. G. T. Beauregard had been Army Engineers before the war, as had Union generals George Meade, George McClellan, William Rosecrans, John Pope, and James McPherson. Those who did not accept field commands built fortifications, roads, and bridges throughout the nation for either the Union or Confederate armies.

The first incident of the war in the headwaters district occurred at Pittsburgh in December 1860, when Secretary of War John Floyd, a Southerner, ordered a hundred cannon shipped from Allegheny Arsenal to New Orleans aboard the steamer *Silver Wave*. Pittsburgh newspapers opposed the move and a mob stopped the cannon rolling from the Arsenal to the Monongahela wharf. General James K. Moorhead spoke to the irate crowd at Allegheny Court House on December 27 and perhaps averted riot by urging that public peace be preserved until he heard from Attorney General Edwin Stanton. Stanton arranged cancellation of the cannon shipment, and perhaps wisely: the *Silver Wave* was seized by Confederate sympathizers on the Arkansas River and its cargo confiscated.

The people of western Virginia owned few slaves, were developing a mining and industrial economy, and were linked more closely by waterways to Ohio and Pennsylvania than to eastern Virginia, and both pro-union and pro-secession forces trained on the streets of several cities; at Clarksburg they used the city hall park on alternate nights. But Wheeling was strongly pro-union, perhaps as a result of the fact that it was a major industrial center sandwiched between two free states; and the people of Wheeling led the movement for formation of the separate state of West Virginia.



Monitor *Umpqua*

Western Pennsylvania Historical Society

Monitor *Manayunk*

Western Pennsylvania Historical Society



As it had during the Revolution, War of 1812, and Mexican War, the headwaters district became again a major military depot and staging area for the army in 1861. Pittsburgh, Wheeling, and other industrial centers became arsenals for the Union army and navy, producing cannon, armor, small arms, and ammunition and sending them in a steady flow by river and rail to the combat theaters. Fort Pitt Foundry (Knapp, Rudd & Company) alone produced 15% of all ordnance supplied the Union armies, including the largest cannon in the world. The cannon were tested at a proving ground at Tarentum. Munitions plants in the headwaters district produced more than 10% of all shells used by the Union; and the region achieved similar records in production of uniforms, wagons, harnesses, gun carriages, and other war materiel.

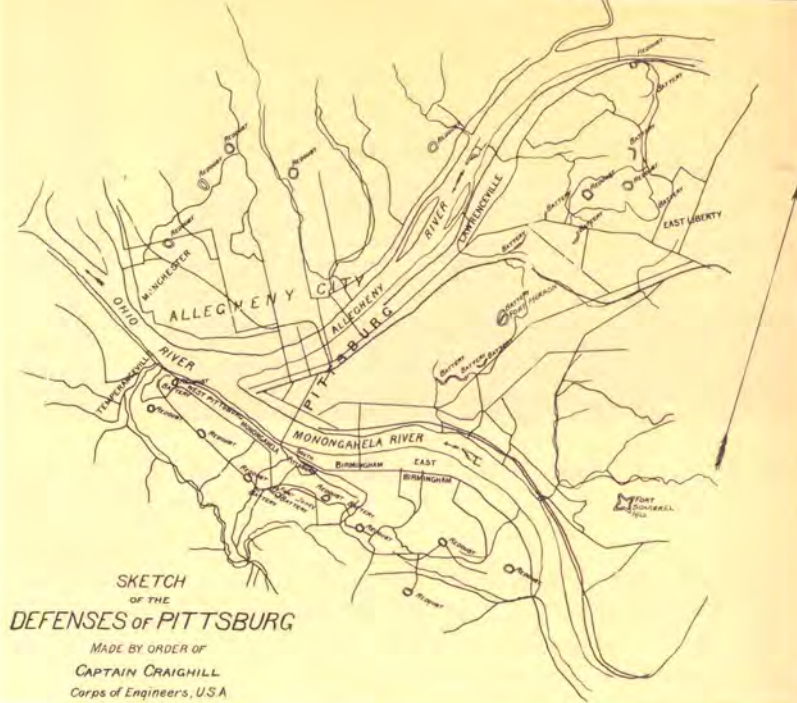
After hostilities began in April 1861, Judge William Wilkins of Homewood, who had initiated the Ohio River project in 1819, became chairman of the Pittsburgh Defense Committee and arranged quartering and equipping of volunteers at fairgrounds, renamed Camp Wilkins, on Penn Avenue. Soldiers assembled there from throughout the headwaters district; Allegheny raftsmen, for example, met at Warren, built skiffs, and floated the river to Camp Wilkins for training. At Wheeling, General William Rosecrans established his headquarters in the McClure House and a prisoner of war camp on Wheeling Island.

Shipping and shipyards of the headwaters were mobilized by William J. Kountz, superintendent of river transportation for General George McClellan, Captain John Rodgers of the Navy, and Colonel Charles Ellet. Kountz, a steamboat captain from Wellsville, purchased a steamboat fleet for service as Union transports and cooperated with Captain Rodgers in conversion of the steamers into "tinclad" gunboats. Ellet converted five Monongahela towboats into rams in 1862 for his assault on Memphis. The Navy also contracted with Mason and Snowden and Hartup and Tomlinson at Pittsburgh for construction of ironclads with revolving turrets of the monitor class. Towards the end of the war, Mason and Snowden launched the huge monitors *Manayunk* and *Umpqua* and Hartup and Tomlinson the smaller *Marietta* and *Sandusky*.

Former Engineer officers Robert E. Lee and George McClellan commanded the forces that fought the "first land battle" of the war on June 13, 1861, at Philippi on Tygart River. Lee sent Colonel George Porterfield into the upper Monongahela basin, and McClellan sent Colonel Benjamin F. Kelley and the First West Virginians from Wheeling to meet them. The sole Union casualty at the Philippi skirmish was Colonel Kelley. One of the wounded Confederates was James E. Hanger, who lost a leg. Hanger devised his own artificial leg and founded a factory for manufacture of artificial limbs that became the largest in the world.



General William P. Craighill



Carnegie Library of Pittsburgh

With Engineer officers Orlando Poe, William E. Merrill, and H. W. Benham reconnoitering mountain passes, trails, and enemy camps in advance of the Union forces, Generals George McClellan and William Rosecrans dealt General Lee and the Confederates severe checks at Rich Mountain, Cheat Mountain, and Carricks Ford on Shavers Fork of Cheat, driving Confederates from the Monongahela basin and clearing the way for formation of the mountaineer state of West Virginia in 1863. But Confederate raiders penetrated into the region on many occasions throughout the war.

In April-May 1863, Generals John D. Imboden and William E. Jones rode across the Monongahela basin at the head of columns of thousands of grayclad troopers in a daring raid to break the Baltimore and Ohio Railroad, which was carrying munitions and supplies from the Ohio River basin to the Union Army of the Potomac. They crossed the

Monongahela basin at a trot, taking Rowlesburg, Morgantown, Fairmont, Grafton, Philippi, Buckhannon, and Weston, performing their mission, then leaving as fast as they had come, before Union forces could concentrate to meet them.

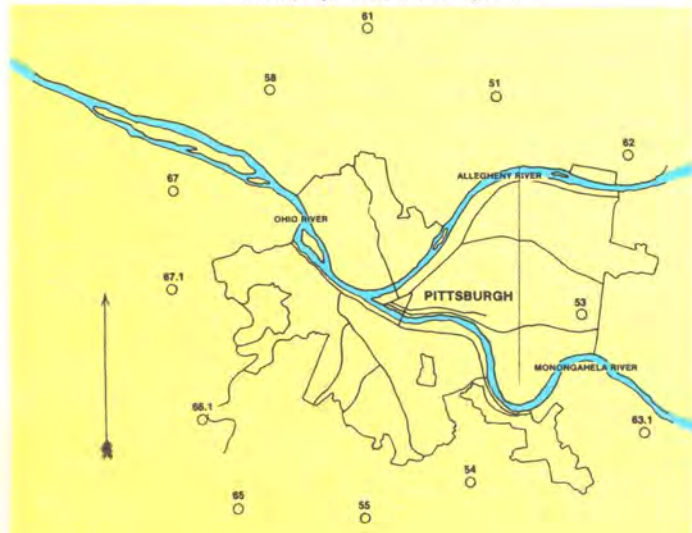
The Jones-Imboden raid at Morgantown, scarcely 75 miles from Pittsburgh, demonstrated that the headwaters district was not immune to attack, and the fright had not subsided before a new threat appeared. The Union Army of the Potomac lost contact with the Army of Northern Virginia and Confederate cavalry in Maryland, and the Confederates were marching north, perhaps even toward Pittsburgh.

Secretary of War Edwin Stanton approved mobilization of the Pittsburgh home guard in May 1863 and placed an artillery battery at its disposal. In early June, General James Moorhead, then candidate for governor, met with Stanton to urge more steps for protection of Pittsburgh from rebel raiders rumored moving toward the city; and on June 10 Stanton ordered General John G. Barnard, Colonel Cyrus B. Comstock, and Captain William P. Craighill to Pittsburgh to "assist the municipal authorities and the people in preparing for their own defense." "They are capable," the orders read, "and, it is presumed, ready to defend their town against any efforts the rebels may make to capture or destroy it. You will assist and animate them in the performance of this patriotic duty should the occasion arise."

General Barnard and Colonel Comstock were engineers and aides to General U. S. Grant; Captain Craighill was a fortification expert. A Virginian,

90mm Antiaircraft sites 1952-53

History repeats itself; see Chapter 14



1863 Defense site - Fort Herron
(Photograph in 1890)
Carnegie Library of Pittsburgh



Craighill had refused commission in the Confederate army and also rejected Union field command where it might be necessary to fire on his friends. During the war he served as chief engineer to General George Morgan, fortified Cumberland Gap, Pittsburgh, and other points, and built blockhouses for defense of railroads.

The Engineers planned Pittsburgh's defenses, laying out a line of trenches connecting 31 redoubts and artillery emplacements on a line atop Coal Hill from West End to Beck's Run, from Gazzam's Hill above Soho to the Allegheny opposite Sharpsburg, and, on the north side, from Uniondale Cemetery to Troy Hill. General W. T. H. Brooks, commanding the Department of the Monongahela, met with Pittsburgh civic leaders on June 14 and demanded they get on with the project, and on June 15 business ceased as 10,000 miners, mill and plant workers began digging trenches, rifle pits, and building redoubts and batteries. News that General Lee had entered Pennsylvania accelerated the shovels. Artillery from Allegheny Arsenal rolled into the forts, 5,000 militia marched into the trenches, and the city was ready to receive an enemy by July 4, when the Confederate army was turned back at Gettysburg.

Army Engineers designed and built fortifications not only at Pittsburgh, but also at Cincinnati, Louisville, Nashville, Paducah, and scores of other sites in the Ohio basin during the war, and most, like those at Pittsburgh, were never needed. Union authorities never knew, however, where intrepid Confederate units might strike, and even temporary capitulation of major cities and industrial centers to fast-moving Confederate cavalry would have been a terrific blow to public morale and a dangerous in-

terruption to war production. The threat was not illusion or panic. John Hunt Morgan and his Confederate cavalry proved that during their ride through Indiana and Ohio to East Liverpool in July 1863. In fact, the Union armies were at their best where engineering was paramount: the Union armies never quit a siege once begun, nor lost a major fortified city to Confederate siege.

River Work Resumes, 1865 Inland rivers were the backbone of Union supply service in the West during the Civil War. Union quartermasters chartered 640 steamboats for supply transport, of which 143, valued at near \$4 million, were sunk by obstructions or Confederate artillery. Lewis B. Parsons, chief of Union river transport, wrote an eloquent tribute at the close of the war to the western rivermen:

Much credit is also due to the boatmen of the west,...who have so often and patiently



1863 Defense site - Fort Jones
(At top of Castle Shannon Incline;
photograph in 1890)
Carnegie Library of Pittsburgh

submitted to the seizure of their transports and effectively assisted in securing the success of our armies during the last four years. It has often fallen to my lot to witness the cool bravery and acts of daring of this class of men in the passage of batteries or the sudden and unexpected attack of bands of guerrillas while navigating our western rivers; and Generals Grant and Sherman, with many others, will bear witness that none have shown greater firmness and resolution in danger or more reckless daring and disregard of personal safety...It was by the services of such men that the government was enabled so rapidly to concentrate re-enforcements at Donelson and Shiloh; that with seven days notice it was enabled to embark forty thousand men under Sherman in mid-winter for movement against Vicksburg, and subsequently precipitate the same force upon and capture the post of Arkansas. It was their courage that piloted our transports past the batteries of Island No. 10, Vicksburg, and numberless other places along our western waters; and all who have seen the unblanched cheek and steady arm by which the pilot at the wheel or the captain on the hurricane roof have discharged their duties in hours of danger cannot fail to acknowledge that they justly deserve a page in the history of the events of this war.

TIDIOUTE

Built at Tidioute, Pa. on the Allegheny River, 1865. 63.13 tons. Came out new at Pittsburgh Oct. 1865, Capt. Amos Dingley of Warren County, Pa. She had lake engines, brought from Erie, Pa. and ran on 8" of water. Sold to the U.S. after a period of use on the Allegheny. Her name was changed by the U.S. to MAJOR SANDERS, honoring Major John Sanders, U.S. Topographical Engineer in charge of the Ohio River 1837-1844.

Running on the Allegheny in June 1866, to Oil City.

Enroute up the Ohio River with a party of U.S. Engineers on an inspection tour, July 1869. Captain Fred Way

One of the first acts of the new government of West Virginia in 1863 was to ask Congress for renewed work on the rivers, claiming the course of the war clearly demonstrated the national defense values of improved waterways. In the case of *Gilman vs. Philadelphia* in 1865, the Supreme Court ruled that the Constitution gave the federal government power to keep the rivers open and free from any obstructions, and to punish those who obstructed them. That favorable court decision, the eclipse of the states' rights element of the Democratic party, and the rise of the Republican party that was firmly committed to federal civil works projects produced a climate favorable to renewed work on the rivers.

Congress in 1865 directed Chief of Engineers Richard Delafield to review prewar projects and make report. The Chief found inland rivers, after a decade of neglect and war, had become filled with snags and wrecked boats. None of the snagboats and equipment used by Colonel Long and Captain Sanders survived, but data they gleaned from experiments and experience were available. General Delafield recommended immediate resumption of snagging and clearing projects, and Congress appropriated \$55,000 in 1866 to fund the work.

General Delafield ordered Colonel John N. Macomb to Cincinnati on August 22, 1866, to reopen the Office of Western River Improvements that Colonel Long had closed in 1856. Macomb had been



the first Army Engineer to build installations for an Army Air Corps; as chief engineer to General McClellan, he had directed construction of launching pads for the Balloon Corps of the Army of the Potomac. Macomb purchased the steamboat *Commodore* and converted it to the wrecking boat *J. G. Totten*, complete with submarine armor, diving bells, derricks, and explosive torpedoes, and sent it to blow wrecks of bosts sunk during the war from the channels. He hired E. M. Shield, builder of rams for Colonel Ellet in 1862, as chief of design for a new fleet of snagboats. In rapid order, the snagboats *S. H. Long*, *J. J. Abert*, *R. E. DeRussy*, *S. Thayer*, and the dredge *Octavia* were launched and sent to patrol the lower Ohio, Mississippi, Missouri, and Arkansas rivers.

Major Henry Clay Long, son of Stephen Long, inspected the new doublehull snagboats and pronounced them superior to the "toothpullers" built by his father, John Sanders, Henry Shreve, and "Roaring Jack" Russell before the war. The old boats had a single pair of steam engines; the new boats had six pair and could raise snags and saw them without disconnecting the main engines from the paddlewheels. By 1870, Macomb's new snaggers had fairly cleared major inland streams of snags and wrecks accumulated from 1856 to 1866.

The Roberts Clear the Ohio "The mosquitoes nearly killed me last night, and at daylight the flies set to work to cut me off," complained Thomas P. Roberts. "It was a fearful night," he said, with ill humor. Nor was he pleased with the food aboard the *Major Sanders*, and breakfast had been especially bad. He had fired both cooks the previous week, one on account of the "length of her tongue" and the other because her morals were not "A No. 1." That had been a mistake, for one did not learn in engineering school how to scramble an egg. He was, nevertheless, well pleased with the little steamer *Tidioute*, the new survey boat he had renamed *Major Sanders* in honor of the former Pittsburgh District Engineer. It drew only fourteen inches of water and saved the government money, while disappointing the greedy teamsters who

waited with oxen and towlines at Ohio River shoals to pick up an easy ten bucks from stranded steamers. But he would have to move the pilothouse; it was located over the boiler and "sweat just rolled off a fellow."

Roberts anchored the *Major Sanders* at Logstown Bar on June 25, 1867, broke out survey chains and instruments, and put new recruits overboard to the top of Major Sanders' old riprap dam to take measurements. "Men for this riverwork ought to be over six feet tall and have strong toenails," Roberts thought, for they had to hang on in four feet of water atop the rock while the river thundered over the dam. He took secret pleasure in baptizing new recruits for the survey party on such dams. He picked them up in a skiff after they were swept downriver, and permanently employed those who returned to the dam after the experience.

Thomas had come to the Ohio with his father in 1866. The Corps of Engineers had been decimated by war, not enough officers were left for civil works, and Secretary of War Stanton and "Old Slackwater" Moorhead had selected William Milnor Roberts to renew the Ohio River project, finish the river survey begun in 1838 by John Sanders and plan the "radical" improvement of the river.



Captain George W. Rowley

Milnor Roberts received his appointment on August 3, 1866, opened a temporary office at Third and Market streets in Pittsburgh, then moved on October 1 to the U. S. Customs House at the corner of Smithfield and Fifth Street. He hired his son Thomas as assistant and George W. Rowley as chief pilot.

Captain George W. Rowley knew the Ohio better than any other man. He had emigrated to Kentucky in a flatboat as a child, had run flatboats and keelboats in the Pittsburgh to New Orleans trade, had piloted the steamers *Buckeye State*, *Crystal Palace*, *Thomas Swann*, *Alvin Adams*, and others, had captained river gunboats for the Union, and had become known as the "best packet pilot on the Ohio." His job was to get the engineers up and down river at low water, the best stage for surveying. "In seasons of real drought," he told Roberts, "there isn't much difference as to depths on the shoals. If you hear a pilot talking about such and such rapids having a foot or so better water than other neighboring rapids, put him down as a raftsmen. He knows nothing about genuine low water, when the Ohio drops like going down steps with risers the same, but with different treads."

Milnor Roberts chartered the *Greenback* from former Navy Captain John Rodgers in September 1866 and went down the Ohio with Rowley piloting, while Thomas Roberts updated the old Sanders maps, and he located obstructions needing immediate attention and collected commercial statistics. Roberts found the riprap dams built by his old friend Sanders had become so compacted that it took a crowbar to loosen them, but many needed repairs.

Roberts learned that 301 steamboats with 77,769 registered tonnage had been launched at Pittsburgh during the war. The city had 11 boatyards employing 500 men, 24 machine shops producing steamboat engines, 12 plants manufacturing steamboat boilers, and 10 forges making chains, anchors, and boat ironwork. When he learned the annual value of Pittsburgh manufactures was \$80 million, he com-



■ Milnor Roberts

Courtesy MG Milnor Roberts

mented there was no limit "to the future manufacturing and commercial greatness of this favored point. Nature had done all that any city could ask; enterprise has already effected very much, and future enterprise will effect much more."

He was impressed by the revolution that had occurred in the coal shipping business since he had designed the Monongahela slackwater project. When he planned the locks for the Monongahela in 1838, they had been large enough for the "French Creeks" that carried the coal to New Orleans. He learned that in 1866 about 7,000 men worked in the Monongahela mines, producing 2.5 million tons annually, of which two-thirds went downriver, mostly in the 1,500 barges pushed by 98 steam towboats. Barge tows were also transporting oil from the Allegheny and manufactured iron from Pittsburgh, Steubenville, and Wheeling. "It is reasonable to



Thomas P. Roberts

Courtesy MG Milnor Roberts

believe," Roberts predicted, "that after a while a large proportion of the steamers engaged in freighting will be towboats, running in connection with barges. Some single steamers will of course still be useful in carrying on the local passenger and freight business between the numerous commercial points along the river. . . . but the bulk of the freighting will probably be ultimately carried on by means of barges towed by steamers."

Roberts doubtless knew that Henry Shreve had towed keelboats with the *Enterprise* in 1814 and that other river captains had done the same, but early tows were actually towed, lashed alongside or aft of the steamers. In 1845, however, Daniel Bushnell had *pushed* three coalboats from Pittsburgh to Cincinnati with the little 28-ton *Walter Forward*. Bushnell put the *Black Diamond* into the towing business in 1851, and in the same year Captain

Hugh Smith began pushing coal tows with the *Lake Erie* from his Dilles Bottom mines near Moundsville. In 1854, Captain Charles H. Cockran steered the *Crescent City* pushing the first tow of 64,000 bushels of Monongahela coal to New Orleans, launching a trade to which there seemed to be no bottom. Except for an interruption in the early years of the Civil War, Louisiana sugar refineries and ocean steamers at New Orleans purchased all the Monongahela coal they could get.

It was an amazing sight when the markers showed the Ohio had risen to a seven-foot stage at Glasshouse Ripple next to Brunot Island. The coal tows, like huge floating islands, left Pittsburgh one behind the other. Through narrow channels, round sharp bends, between bridge piers, where a misturn of the wheel, a failure of judgment, a miscalculation meant wreck and disaster, the pilot guided the tow, now backing, now flanking, now pushing, now floating. Like the tail wagging the dog, the steamboats at the rear of massive coal islands turned them round bends, squeezed between piers, flanked past the points, and checked in narrow channels. Wrecks were frequent, disasters common, for the Ohio was full of obstructions. Milnor Roberts knew it was his job to do something to help those lonely pilots at the wheel of each tow.

Milnor and Thomas Roberts, Captain Rowley, and Chief Clerk John Vandergrift (who indeed was the only clerk) moved into the Customs House at Pittsburgh in October to spend the winter planning resumption of the Sanders survey of the Ohio and their snag-fishing and rock-hunting work. A great deal of their time, however, was consumed by accounting and paperwork. They shipped their vouchers to Washington, which returned them for correction and, after the corrections had been made, issued new directives requiring preparation of new vouchers. "We are drowning in red tape," Thomas Roberts complained. "Uncle Sam has sent no funds as yet so we whistle our credit. It has been rather a losing business so far. The devil himself can't tell how much will be refunded."



Milnor Roberts employed engineers Alonzo Livermore, the Pennsylvania canal engineer who also canalized the Green River in Kentucky, and Sigismund Low, the railroad construction engineer who founded the Pittsburgh *Volksblatt* newspaper, to continue the Ohio River survey. Thomas Roberts purchased flatboats, equipped them, and employed surveymen; he and Captain Rowley aboard the *Major Sanders* towed the survey parties in flatboats from Pittsburgh in June 1867, and delivered them to the point where Captain Sanders had ended the survey in 1844. Though delayed by floods and by fevers that sometimes incapacitated the entire force, Low and Livermore finished the survey to the mouth of the river by November 7, 1868, and produced 118 maps on a scale of 1.3 inches to the mile, which were so accurate that they served the Corps until 1898.

The Ohio was obstructed by snags at 90 places, by drift piles at 66 places, and by 46 wrecked steamboats and 83 sunken barges in 1866. Milnor Roberts contracted with Captain John Rodgers and his steamboat *Greenback* for \$88.50 a day to restore a clear channel on the upper Ohio; with Captain T. W. Spencer and the *Zebra* to clear the stream between Cincinnati and Evansville; and with Captain James Routh and the *Petrolia* for work below Evansville. The contractors and their small steamers had trouble pulling snags that were up to 120 feet long and 5 feet through the butt. Captain Routh and the *Petrolia* once broke chains, wore out saws, and consumed four days removing a single monster pecan. By 1869, Roberts had concluded the Ohio River snagging project needed a Shreve "toothpuller."

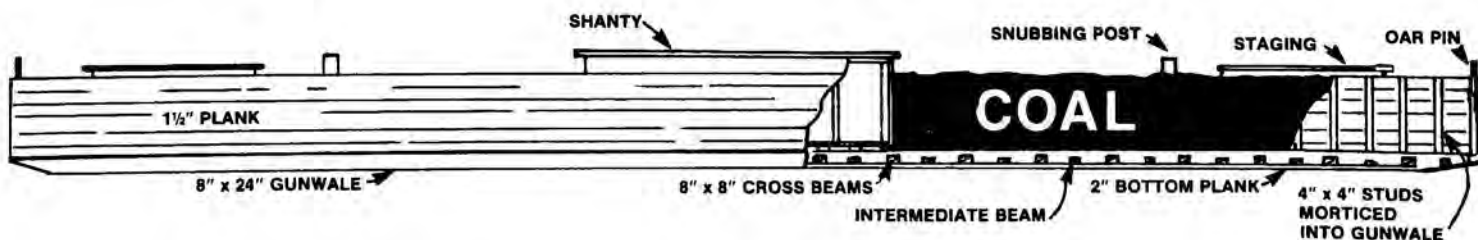
In the days before the towboat, coalboats proceeded downriver in fleets during the spring high water.



Coal tows

Because funding was meager, Roberts concentrated on rebuilding the Sanders dams and adding a few new wing dams on the upper river, where coal tows had the greatest difficulty. An increase of six inches channel depth allowed each boat and barge to carry 70 tons more freight, and Roberts explained: "An improvement of one foot in depth along the Ohio navigation is a matter of very great importance, involving material benefit to the commerce of the country, far beyond the sums expended in accomplishing it." He contracted with Swan & Fenton, Routh & Lane, C. M. Cole, J. J. Power and Charles Cable for repair of the Sanders dams at White's Ripple, Logstown Bar, Twin Islands, Captina Island, Fish Creek Island, and Petticoat Bar, and he planned construction of more low riprap dams at Wheeling Island, and other points. He did not employ project inspectors at each worksite; instead, Captain Rowley and Thomas Roberts traveled from site to site continuously in the *Major Sanders* to assure proper stone placement and to measure the amount of rock quarried by the contractors and dropped into place.

As had John Sanders at Browns Island in 1837, Milnor Roberts encountered opposition to several dams. He planned at Wheeling Island, as example, a dam to close the Ohio (right) chute, diverting low-water flow down the West Virginia chute. When he let the construction contract on October 10, 1868, the people of Bridgeport, located on the Ohio bank opposite Wheeling, protested that while a covered bridge from their town to the island closed steamboat navigation through the Ohio chute, a coal tippie



and keg factory located above the bridge shipped their products by river. They asked that the West Virginia chute be dredged and construction of the dam across the Ohio chute be stopped.

Roberts described the incident as a conflict between public and private interest and said it was a "delicate task to decide to what extent either or both should be compromised." A dam at the head of the Ohio chute was preferable from an engineering standpoint, but Roberts compromised by building the dam below the covered bridge, placing a wing dam at the head of Wheeling Island, and dredging the West Virginia chute to a limited extent.

Roberts' efforts greatly improved the upper river channel in three working seasons. The Pennsylvania General Assembly, in an 1870 petition to Congress asking further funding for the work begun by Roberts, declared: "The small expenditure made on this river during the past three years has resulted in great benefit to the navigation. A few inches added to the depth of water on the shoaliest bars extended the number of days that a trade amounting to \$2,000,000 per day can be conducted, while the removal of snags and wrecks has saved many losses to the community at large, as well as to those engaged in the river trade, and to insurance companies."

Merrill Revises the Open-Channel Project "There certainly is an urgent need of larger appropriations than those of the last two years—\$50,000 each year," urged Colonel William E. Merrill in 1871. "For a river one thousand miles long, with a commerce estimated at over \$500,000,000, the sums lately appropriated are insignificant." Merrill explained that, while Roberts had done much good with limited funds, necessary administrative and office overhead took too large a percentage of each small appropriation.

The outspoken Colonel who succeeded Roberts at Pittsburgh in 1870 seemed to relish lecturing Congress on the shortcomings of its waterways policies; he did so throughout the two decades he served as District Engineer. Tops in the Class of 1859 at West

Point, William Merrill, because of his strict personal standards, almost brutal honesty, and fondness for foreign languages, was known to his friends as "Padre." He once resigned as Louisville (Ky.) District Engineer because a politician controlled appointments and interfered with project performance. During the Civil War, while performing frontline reconnaissance for the Union Army, he was wounded and captured by Confederates. After his exchange, he built fortifications throughout the South and demonstrated remarkable engineering talent through development of improved ponton bridges, better railroad defense systems, and faster map-production facilities. He began his study of international waterways engineering in the postwar years and was assigned to Pittsburgh on June 17, 1870.

Milnor Roberts left the Corps of Engineers in 1870 to help build the Eads Bridge over the Mississippi at St. Louis; he and Thomas rode muleback across the Rockies in 1872 to locate the route of the



Colonel William Merrill



Snagboat *E. A. Woodruff*

Captain Fred Way

Northern Pacific Railroad. Milnor became president of the American Society of Civil Engineers in 1878, then returned to Brazil as chief of public works. Thomas returned to Pittsburgh to work for Colonel Merrill on the Allegheny River and later for General Moorhead as chief engineer of the Monongahela Navigation Company.

"Padre" Merrill began reorganization of the Ohio River project in 1871. Because he was responsible for improvement of the entire Ohio River and for all its tributaries except Cumberland, Tennessee, and Wabash rivers, he relocated the District office from Pittsburgh to Cincinnati on June 1, 1871, to reduce travel costs. (Colonel John Macomb in 1870 moved the Office of Western River Improvements from Cincinnati to St. Louis.) He also launched campaigns to secure sufficient allotment from river and harbor appropriations to permit construction of improved dam structures and an Engineer snagging and dredging fleet for the Ohio River project and to obtain federal funding for marking river channels.

With support from the interstate Ohio River Commission, chaired by General Moorhead, Merrill won

increased funding for the Ohio River and began construction of an Engineer floating plant. The snagboat *E. A. Woodruff*, completed in 1876, was single hull with Shreve snag-beam between double bows. Equipped with steam saws, derricks, grapples, and blasting appliances, with Captain George Rowley and later William H. Christian at the wheel, the *Woodruff* patrolled the Ohio from end to end each year, often tailing the Monongahela coal fleet downstream to remove wrecks as fast as they occurred. Merrill had designed the *Woodruff* with an iron hull because he thought its higher construction costs would be amortized by long service and also as a test project for the edification of marine design engineers. The iron hull paid off. the *Woodruff* served the Corps and Ohio River navigation until 1926, and its hull was used as a wharfbat until 1940.

Milnor Roberts and "Padre" Merrill had contracted with Benjamin L. Woods and others of Pittsburgh for dredging, but prices ranged up to a dollar per cubic yard of excavation. They learned that emergency contracts for dredging troublesome shoals could not always be arranged and that



U.S. dredge *Oswego*
Captain Fred Way

private dredges often had insufficient power for the work. In one instance, a dredging contractor, who could not lift boulders out of the river with his machinery, simply dredged out holes and rolled the boulders into them.

Merrill built the dipper dredges *Ohio* and *Oswego* in 1872 and 1874 and placed E. J. Carpenter in command of the two. Ready for action at a moment's notice, the two dredges worked for less than 25¢ per cubic yard in 1874, slashing dredging costs 75%, and reimbursed their construction costs within two years. Merrill put them on iron hulls in 1882, and the *Oswego*, renamed the *Northern No. 2*, was still dredging for a private firm as late as 1970.

Because of meager funding, Roberts had confined dam construction to the upper Ohio; Colonel Merrill extended construction to the lower Ohio and devised an improved dam structure. Shreve, Sanders, and Roberts had built dams of rubble stone piled on the riverbottom, with the largest stones atop the structures and a few wooden piles to provide stability. In 1876, Merrill commenced a cribwork dike atop the old stone dam at White's Ripple, eleven miles below Pittsburgh. The new cribwork dam was five feet higher than the old dam and consisted of two parallel timber walls spaced twelve feet apart, rigidly drift bolted, bound together with timber

crossties, and filled and paved with stone. The 3,000-foot experimental cribwork dam at White's Ripple functioned for more than a half century, and nearly all stone dikes built on the Ohio and Allegheny rivers after 1877 followed the design of the Merrill cribwork dam.

"Besides appropriating money to improve the river channel," Merrill said in his 1870 report to Congress, "I think that Congress ought to provide for lighting and buoing it." Congress had provided for lighthouses and buoys along the seacoasts since 1789, but river traffic had been forced to rely on pilot recognition of bluffs, lone trees, farmhouses, and topographic features to locate channels; night time navigation was exceedingly hazardous. Colonel Merrill recommended establishment of lighthouse districts for the Ohio and other inland streams with authority to install white marker towers with lanterns on the banks and to place channel buoys.

Rivermen lent their support to Merrill's proposals, and in 1874 Congress established inland river lighthouse districts, which placed 150 marker lights and buoys on the Ohio in 1875. Corps officers commonly served as directors of lighthouse districts; those at Pittsburgh served in the 14th Lighthouse District, which by 1920 had 503 signal lights and daymarks on the Ohio and 173 on its tributaries. The Coast Guard took charge of the channel marking system at the outset of the Second World War.

Benefits of the channel markers, channel clearance by the Engineer floating plant, and the cribwork dams were substantial. Yet, as soon as the Engineers cleared an adequate channel at one point, the rivermen found other locations to complain about to their congressmen. Funding was never sufficient to improve all shoals simultaneously, nor would open-channel methods have ever created sufficient channel depths for year-round navigation. "Padre" Merrill agreed with Milnor Roberts: nothing save the permanent and "radical" improvement of the Ohio River would suffice.



Merrill cribwork dam on the Ohio

Chapter 8

THE UNMENTIONABLE RIVERS

"There are appropriations in this bill for rivers in Pennsylvania the very names of which the Speaker of this House is ignorant of, the names of which I do not find on the map of the United States--of rivers I never heard of," complained Congressman John Ellis of Louisiana during his eloquent attack upon the 1878 public works bill. "The bill provides only a pittance for work on New Orleans harbor," he continued, "but provides funds for an unmentionable river in Pennsylvania. Is this statesmanship? Is this looking after the great interests of the whole country?"

From across the aisle, another congressman shouted: "May I ask the gentleman from Louisiana to name the unmentionable river?"

"I will spell it," said Ellis, "K-i-s-k-i-m-i-n-e-t-a-s."

General Harry White

Carnegie Library of Pittsburgh



Peals of laughter interrupted the debate. After the uproar had subsided. Harry White of Indiana County, who sponsored the surveys of the Allegheny and its unmentionable tributaries, rose to respond. "The gentleman says he cannot pronounce these names. It is the Kis-ki-min-e-tas River he stumbles at."

Laughter again shook the hall, but General White continued: "The honorable gentleman's education has been sadly neglected if he cannot pronounce that name. It is a musical Indian name, has a local association, and signifies, if I rightly remember, 'sprightly stream.' It is one of the tributaries of the Allegheny River. Twenty-seven miles above Pittsburgh the Kiskiminetas, so difficult for the gentleman from Louisiana to pronounce, empties into the Allegheny, being one of its main tributaries. The Kiskiminetas is formed by the junction of the Conemaugh and Loyalhanna at Saltsburg, a town of considerable size some twenty-three miles above its mouth, and the Conemaugh, being called for a tribe of Indians of that name, has its sources in the Allegheny Mountains."

"Is there a steamboat on those rivers?" shouted a listener.

"There has been," replied General White. "I can bring evidence of a steamboat in former years when there was slackwater and canal navigation along these streams going up the Allegheny from Pittsburgh to the Kiskiminetas, thence up to Johnstown near the head of the Conemaugh."

"A sternwheel, was it not?" queried another congressman, and the House again broke up with laughter.

"It was not a steamer of the heaviest draught," admitted White, "but, sir, we want the examination by the Government to see how far artificial appliances can improve these streams for navigation and thus add to the wealth of the country."

Representative Hendrick Wright of Wilkes-

Barre asked, "Where is the stream that is called Conemaugh, Kiskiminetas, or some such name?"

"Why, the gentleman from Pennsylvania," answered General White, "aspires to be the chief executive of that State, and if he does not know the location of these streams he is ignorant of the geography of his State and ought not to seek such a high position."

"I do not fish in such shallow waters for the nomination of governor," Wright retorted, and laughter made the chandeliers dance.

"Whither are we drifting?" asked General White. "The gentleman is an old Democratic politician in Pennsylvania. He was famous when I was a child, but does not know enough of geography to be our governor, I fear." He then recited the history of navigation on the Kiskiminetas and of the Pennsylvania Canal for the edification of his colleague and the House.

Wright ignored General White's lecture and asked, "Are they navigable streams?"

"They can be a portion of the year," White replied, "and it is practicable, in my opinion, that they can be made navigable the greater portion, if not the whole of the year. I want the survey to show this to the country for my part of the State. Come out and see our coal-fields, our coke-ovens, our fire-brick works, our lumber-yards, our mills, our agricultural wealth, our furnaces and rolling mills run by natural gas welling up from the bowels of the earth; our oil wells, making wealth to the State and the country. Come, travel a little and learn what your state needs."

"That is the way they slipped in so easily," interjected Ellis of Louisiana, "being so well oiled."

Newspapers round the nation played the debate for all it was worth, using the survey of the Kiskiminetas as a prime example of grease oozing from the pork barrel. The *Philadelphia Ledger*

suggested that Hendrick Wright look out the car window next time he crossed Pennsylvania by rail to see the Kiskiminetas in all its glory. The *Pittsburgh Gazette* commented: "The idea of improving the roaring Kiskiminetas and babbling Conemaugh does not seem to be received by the press of the country with the seriousness that is absolutely required. At all events, if they are not navigable, that is exactly what it is intended to make them." Editors of the *Chicago Tribune* were outraged by the appropriation for the "unpronounceable creeks," the Kiskiminetas and Conemaugh; they reported:

In the spring freshets the mountains furnish them with a temporary supply of water. At other seasons the farmers use them as highways. No bridges are needed, as an ordinarily athletic person can jump over either of the three creeks or all together. They do not rise to the dignity of trout streams, as trout require running water several inches deep and water the year round. An ordinary catfish could not dive in them, because he would not have room to turn around. If they were ever navigated, it must have been by those steamers of which Mr. Lincoln used to tell, that could sail where it was a little damp.

Jealousy and envy were the principal reasons for the "pork barrel" appellations in the opinion of Captain Frederick A. Mahan, deputy to Colonel Merrill at Davis Island. "So long as the press of one city regards the work in its neighborhood as all-important, and denounces all work done elsewhere as robbery, as a political job, as unnecessary to the commercial interest and development of the country, just so long will Congress be hesitating in the matter of appropriations," Mahan said. "Then, too," he admitted, "it must be acknowledged that much is included in the appropriations which would better be left out. Members of Congress are but human after all, and so long as the services of any one of them are judged by the amounts of money obtained for his district, just so long must unworthy measures clog the completion of those which are good."

Congress appropriated in 1882 for sixteen rivers that had never been surveyed by the Engineers and for eighteen on which the Corps had reported unfavorably. The Chief of Engineers was once forced to report he could not complete an authorized stream survey because, after "diligent search and inquiry," he had been unable to find it. "Pork barrel" surveys and projects were few, however, in the headwaters district in comparison to other areas.

Though ridiculed in Congress and by newspapers, the 1878 survey of the roaring Kiskiminetas and babbling Conemaugh had genuine value. Farm organizations, that thought themselves victimized by high rail rates and railroad monopolies, lobbied in the 1870's for canals and waterways to handle farm produce shipments, primarily of grain for export markets, in the hope that low cost waterways transportation would allow American grain to be competitive in world markets. The 1878 survey of the two streams was a response to that public demand.

Colonel Merrill appointed James Worrall, former assistant to William Milnor Roberts on the Pennsylvania Canal, to study restoration of the slackwater project on the Kiskiminetas and reconstruction of the Pennsylvania Canal. Worrall planned rebuilding the canal from Pittsburgh to Havre de Grace for 280-ton boats, replacing the Allegheny Portage Railroad with a 5.5 mile tunnel, at an estimated cost of \$40 million. In his review of the Worrall report, Colonel Merrill declared the restoration feasible but too costly. Worrall estimated the cost of slackwater navigation on the Kiskiminetas and Conemaugh to the Johnstown industrial district at \$3.6 million, and Merrill thought that work might become desirable after slackwater had been provided on the Allegheny.

Merrill also sent Worrall to examine Redbank Creek and Clarion River as alternate canal routes and sent other engineers to look at Tionesta Creek and Youghiogheny River. The report on each was that they carried floated forest product commerce that could be benefited by channel clearance work,

but, though state government and private corporations did improve the streams for navigation, Congress never approved the projects. Not a single tributary of the Allegheny, not even the "roaring Kiskiminetas," was improved for navigation by the Corps of Engineers, but the Corps did work on two tributaries of the Monongahela.

Buckhannon River Project Improvement of Buckhannon River navigation was apparently the brainchild of D. T. Farnsworth, governor of West Virginia from Buckhannon. Farnsworth told Colonel Merrill in 1882 that the Buckhannon and Western Railroad was building into Buckhannon and people wanted boulders cleared from the stream so they could float their logs to the railhead for market. "Unless our river can be some improved, and that in a reasonable time, that this lumber can be safely gotten out," Farnsworth declared, "it will be burned up and destroyed by the fast-increasing settlers."

Colonel Merrill learned that lumberjacks had floated logs since 1852 from Elkins, Buckhannon, and Philippi down Buckhannon and Tygart rivers to the B. & O. Railroad at Grafton. He saw logs lodged in jams 20 feet high against boulders in the

Unimproved stream





Buckhannon River

streams, and he calculated that a few thousand dollars worth of dynamite would blast open a channel. After Congress appropriated \$1,500 for the Buckhannon River in 1885, Merrill sent a few workmen to begin at the town of Buckhannon and blast their way about 25 miles upriver to the juncture of the right and left forks. The men waded up the channel at low water, breaking apart the log jams and blasting boulders out of the way to create a 30-foot wide channel with a minimum depth of two feet during logging season rises.

About 900,000 feet of logs, eight times the previous annual record, floated the Buckhannon River to market in 1885, and in 1886 the total jumped to 8 million feet. Two coal mines on the river above Buckhannon began flatboating coal down to the town. Timber and coal with aggregate value of \$150,000 gained access to market via the Buckhannon River before a railroad was built on the riverbank in 1890. The Engineers then stopped work on the Buckhannon River and recommended that no further appropriations be made.

Cheat River Project "Look out for yourselves, men!" shouted the pilot. "I've lost all demand of'er. She's a-goin' to Hell." The pilot, Steve Warman, was a mechanic at Prideville iron works on the Cheat River who had built himself a tiny sternwheel steamboat on the Cheat. He launched it on a natural river pool and set out downstream when a flood came, only to ram into Rudes Island, where tree branches swept him and his crew off the boat into the river. Steve did not hold a Cheat River pilot's license; nor, for that matter, did anyone else.

Steamboating on the Cheat, a tributary that joins the Monongahela at Point Marion, Pennsylvania, was never a major factor in Cheat valley economic development, but steamboats did navigate the stream on occasion. The 70-ton sidewheeler *Reliance* was built on the Cheat River in 1833; the *Izaak Walton* ascended the Cheat seven miles in 1841; and in 1879 Captain E. D. Abrams got the little *Juno* five miles up the Cheat.

Emigrants had sometimes flatboated west via the Cheat River, and by 1809 Samuel Jackson, owner of Cheat Neck iron works ten miles above Point Marion, was shipping manufactured iron downriver: some went to Commodore Perry on Lake Erie in 1813 and some to General Andrew Jackson at New Orleans in 1814. Boats and nail kegs built at Quarry Run floated down to the Jackson iron works where the kegs were filled with nails for shipment to Pittsburgh at the next high water. Cheat River flatboating was so important that in 1834 Joseph Eniex, Isaac Crow, and James McCartney spent \$500 appropriated by Pennsylvania to clear the stream of snags and boulders.

By 1888, development of forest resources along Shavers, Glade, Laurel, and Dry Forks, four more or less parallel streams in Randolph and Tucker counties that join at Parsons to form the Cheat River, was underway, chiefly by firms that had booms near the mouth of the Cheat to catch logs dropped into the river and its tributaries at upstream points. Logs from the four forks, however, jammed in the 30-mile stretch of the Cheat below Rowlesburg where it broke through Laurel Hill;



Log rafts
Carnegie Library
of Pittsburgh

and because access into the gorge was limited the logs lay in the stream until they rotted. Lumbermen cleared away some obstructions on their own, then asked Congress to send the Corps of Engineers to clear a 50-foot channel.

Colonel Merrill said he could clear a logging channel through the Laurel Hill gorge for about \$13,000 and said the benefits would be "a thousand fold." "I have strong personal feelings in the matter," he said, "on account of the great difficulty I experienced in getting suitable timber for the lock-gates at locks 8 and 9 on the Monongahela River, while I knew that millions of feet of exactly the timber needed were growing on the Cheat River that could have been rafted directly to the locks in question had the river been reasonably clear of obstructions."

When Congress appropriated the \$13,000 in 1890, Merrill sent Philip Golay to Rowlesburg. Golay built a flatboat to carry tools, camping gear, and dynamite, hired 22 men, and began blasting his way down the gorge. By the end of the first season, Golay had used 4,600 pounds of dynamite to excavate 5,626 cubic yards of rock from Laurel Hill gorge and had placed the rock fragments in low dams to close back channels. By January 1892, he had spent the appropriation to remove a total of 10,058 cubic yards of rock and had established a fairly clear channel for running logs on six-foot rises. The Corps did no further work for benefit of Cheat River navigation, but lumbermen spent more than \$6,000 of their own funds to keep the channel clear and log traffic on the stream continued until the best timber was exhausted in the early 20th century.

When a power company first planned Lake Lynn Dam near the mouth of the Cheat River in 1910, the Corps of Engineers required installation of a chute through the dam to pass floated logs. There was even some interest in navigation locks at the dam to permit coal barging from points on Lake Lynn to Pittsburgh. But by 1926, when West Penn Power Company completed Lake Lynn Dam, Cheat River commercial navigation was at an end.

The "Pork Barrel" Projects Opponents of waterways projects relegated even work on the Ohio, Monongahela, and Allegheny rivers to "pork barrel" status, but assuming that "pork barrel" projects were those on streams with limited capacity for navigation whose benefits went chiefly to local interests, the Corps of Engineers spent only about \$20,000 on clearly "pork barrel" projects in the headwaters district. The Engineers opened channels for floated logs on the Buckhannon and Cheat rivers at minimum cost, and thousands of logs dashed down the channels to market. The logging industry on Cheat and Buckhannon rivers was, after all, just as important to area economic development as coal barge traffic on the Monongahela. Logging provided perhaps the greatest source of cash income for mountaineers during the 19th century, and the product went into sewing machines, furniture, and fine homes throughout the nation.

In fact, projects like those on the Cheat and Buckhannon rivers reaped quick and substantial benefits. Colonel Merrill said:

In my judgment, the small sums heretofore expended on the rafting rivers of this section of the country have produced relatively larger returns than the vastly greater sums expended on rivers that are navigable by steamboats; and I am decidedly in favor of the continuance of this policy within reasonable limits..... The beds of the streams are more or less choked by huge boulders and it is practically impossible to drive timber, even when there is an abundant supply of water. In my judgment, the removal of these boulders and the general clearing up of the beds of the streams, so as to permit the free passage of logs whenever there is a supply of water, is a public benefit that fully justifies the very small outlay required to attain it. To assist in bringing this timber to market is to increase the national wealth, as otherwise a large part of this particular product will mature and decay without benefit to anyone.

Economic historian Edward L. Pross, after analysis of pork barrel projects, concluded that if the deficiencies of waterways funding policies had been as negligible as those of the Engineers, river and harbor bills would never have earned the sobriquet "pork barrel." Pross agreed with the editors of *American Engineer* journal, who wrote in 1885:

It is very natural for those who see the results of our river and harbor expenditures to charge those results to the United States Engineer Corps. That body has ample sins of omission and commission. In fairness to the Engineer Corps, it must be said that it is working under a system of appropriations so abominable that we may well wonder at any results.

The Allegheny Oil Boom "Pond freshet!" the men shouted, as they pulled boards from the splash dams to start a wave down Oil Creek in December 1862. A thousand crewmen cut 200 boats laden with 20,000 barrels of oil loose from the banks of Oil Creek to race downstream on the flood crest created by opening the splash dams.

The boats dashed downstream in twos and threes with crewmen sparring off bars and rocks and pushing to get out of the creek before the artificial wave subsided. The lead boats scraped on a bar, then

Oil boom on the headwaters district

Drake Well Museum



grounded, sending crewmen sliding toward the bow and headlong into the greasy barrel-filled cargo holds. The men on boats following lanced their setting poles firmly into the creek bottom, trying to avoid collision with the lead boats, but to no avail. They crashed into the stranded boats, oars and poles splintered, crewmen fell overboard, and smaller boats were run down by larger boats that followed. When the wave subsided, 56 wrecks were counted, 10,000 barrels of oil worth \$100,000 had been lost, and Oil Creek was a greasy mess.

Chief Cornplanter and the Senecas had used the oil skimmed from creeks in the Allegheny basin for ceremonial purposes; Thomas Hutchins had inscribed "Petroleum" across his 1778 map of the Allegheny near the future site of Oil City; and Marcus Hulings and other pioneers had collected the oily substance, "Seneca Oil," for sale as liniment. Samuel M. Keir founded the first oil refinery at Pittsburgh about 1850, using a one barrel still, but oil for lighting during the early 19th century was extracted chiefly from whales or cannel coal—"coal oil"—mined on Coal River in West Virginia and at other points. By 1857, people had learned that Seneca Oil was an economical illuminant, and in 1858 Colonel Edwin L. Drake organized the Seneca Oil Company. He brought in the first oil well at Titusville on Oil Creek in August 1859, launching the rush for quick fortunes on Oil Creek and an unsurpassed boom in Allegheny River commerce.

The oilmen first wagoned the product of Oil Creek to the Allegheny for shipment to Pittsburgh refineries, of which there were 7 in 1860 and 58 in 1866, but when roads became impassable the oilmen turned to the creek for transport. Loggers throughout the Allegheny basin built splash dams of boards that could be removed to release a wave, or "pond freshet," to wash logs to deeper water for rafting to their destination. Oilmen organized Oil Creek Navigation Company, slapped a 2¢ toll on each barrel shipped to defray project costs, built splash dams along the creek and cleared away the most dangerous rocks. They hauled flatboats up the creek, loaded them with oil, and sent them to market



on the twice weekly freshets, but with indifferent results. In May 1864, for example, boats jammed six deep against McClintock bridge near the mouth of the creek and boatmen lost 15,000 barrels of oil.

Between 1860 and 1867, the heyday of the oil boom, about 2,000 flatboats, guiphers, keelboats, bulkboats, and steamboats were used in the Allegheny oil trade, hauling empty barrels, drilling equipment, and passengers upstream and oil down to Pittsburgh refineries. "Guiphers," unique to the Allegheny River, were very large flatboats towed upriver by five horses when steamboats could not run. The largest was the *Elephant*, owned by Captain Daniel Fry, that hauled 3,000 oil barrels up to the oilfield in 1864. Bulkboats were special craft, forerunners of petroleum tank barges.

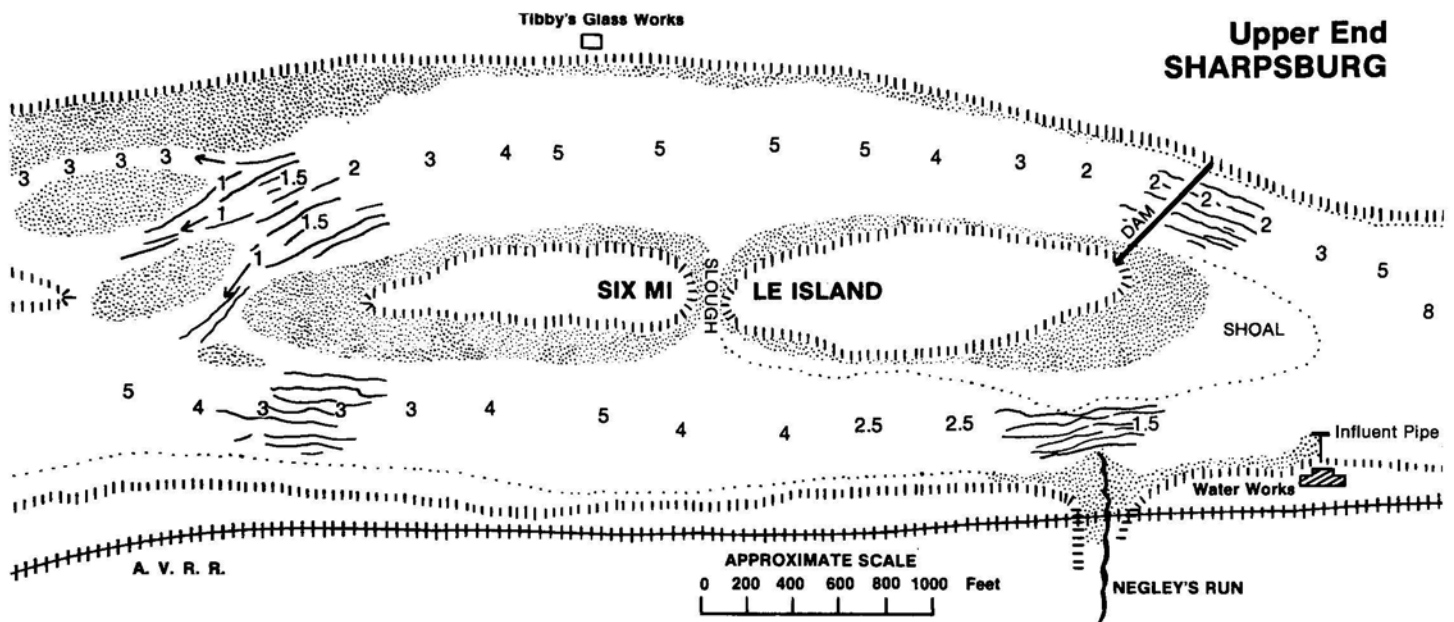
Richard Glyde in 1862 invented the bulkboat, a simple oblong wooden box into which oil was directly pumped to save barrels. Captains J. J. Vandergrift and Daniel Bushnell, the men who had launched the Monongahela coal towing business about 1850, in 1861 became the first men to use petroleum tows. They built twelve of Glyde's bulkboats, each 80 feet long and 14 feet wide with 400 barrel capacity, and towed them back and forth between Pittsburgh and Oil Creek: the first petroleum tank barge tows on the inland rivers. They made \$70,000 their first season and profits remained high. Vandergrift became a director of

Standard Oil Company and built the Conestoga Building, named after his steamboat, in Pittsburgh.

In 1865, the *Ida Rees* took a 2,700 barrel shipment to St. Louis and the *Oil Valley* took a petroleum tow to New Orleans, the first petroleum tows to reach those cities, and the Allegheny oil trade peaked: 441,570 barrels of oil arrived at Pittsburgh in 1865 by river; 380,200 pounds of pig iron, 3.5 million feet of lumber, and 903,000 shingles also landed that year at Pittsburgh's Allegheny wharf.

The Allegheny Valley Railroad began to divert traffic from the river in 1866 and when it reached Oil City in January 1868 steam packet service on the river stopped, but petroleum barging continued. When the Chesapeake and Ohio Railroad reached Huntington on the Ohio River in 1873, the Standard Oil Company, which thought rates charged by railroads from Pittsburgh exorbitant, arranged petroleum shipment down the Allegheny and Ohio to Huntington for rail shipment east to Richmond. The trade was handled by the *Ella Layman*, *C. W. Hornbrook*, and *James Jackson*, generally towing three barges with 7,500 barrels of oil on each trip. Twenty-four petroleum tows, transporting 263,000 barrels of oil, went to Huntington in 1877.

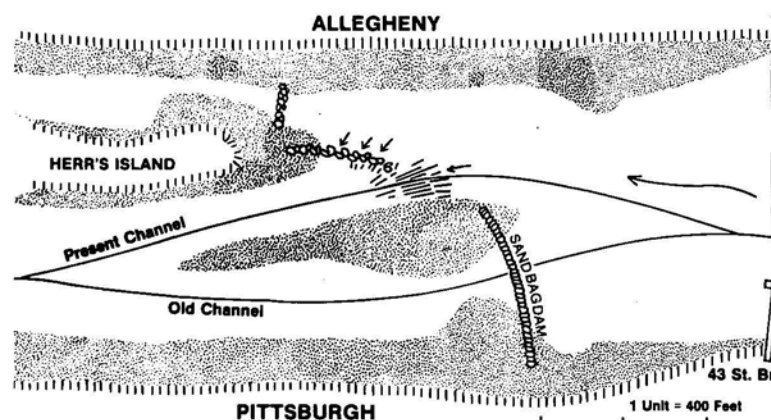
The Allegheny Project "Steamboat commerce on the Allegheny has almost been extinguished by railroad competition, by natural obstructions in the



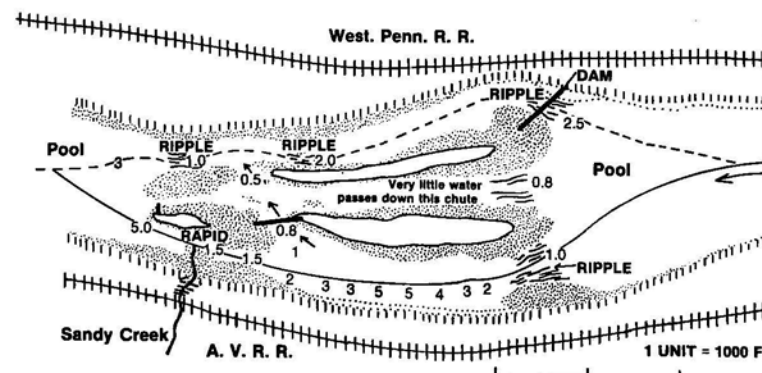
river, and by obstructions that man has put there in the shape of low bridges, with narrow spans badly located. There is hardly any river that shows more clearly the utter inadequacy of state laws to protect river commerce from wanton injury," complained Colonel Merrill. "Rock obstructions are larger and more numerous," he said, "in the Allegheny River than in any other that is now or has ever been under my official charge."

General Harry White of Indiana County had won an appropriation for the Allegheny in 1878, same year he obtained a survey of the roaring Kiskiminetas. Like Merrill, he had spent time at Libby Prison in Richmond during the Civil War. He ran for governor of Pennsylvania in 1872 and lost. General White took intense personal interest in the Allegheny project, even joining Thomas P. Roberts at times during the 1879 survey of the Allegheny. Roberts, assigned to the survey by Merrill, flat-boated from Olean to Oil City in 1879, locating and mapping 190 ripples, or shoals, on the stream. He completed the survey to the mouth of the river in 1880, updating the maps drawn in 1830 by Colonel James Kearney. Roberts reported the river was obstructed by 32 low bridges below Olean that would have to be raised before regular steamboat navigation could resume. For the immediate benefit of rafters, flatboatmen, and occasional steam packets and petroleum tows, he recommended

Six Mile Island



Herr's Island (Garrison Ripple)



Nine Mile Island



Packet boat *Nellie Hudson*

Captain Fred Way



Allegheny River improvement - Redbank dike

clearing the channel and building wing dams, and Colonel Merrill approved the plans.

Roberts and General White met oilmen and rivermen in Pittsburgh, who wished the project to begin with improvements at Garrison Ripple, a shoal that obstructed traffic to and from Allegheny Arsenal. The editor of the *Pittsburgh Chronicle-Telegraph* commented: "No spot in the entire United States has contributed so much to the fitting out of its armies and navies as the locality interested in the complete opening up of the Allegheny river for its first ten miles. This is a strong statement, but one that can be verified any time it may be questioned. Jackson, at New Orleans, and Com. Perry, at Put-in-Bay, fought their victories with supplies derived from this city. More than 2,500 cannons and mortars have been cast in the neighborhood."

Roberts asked Merrill where work should begin, and Merrill responded: "If General White recommends the improvement of Garrison Ripple, undertake it. I am willing to give you *carte blanche*

as to the points selected as it is impossible for me to more than glance at the Allegheny. I reported to the Department that I had too much to do & hope to get relief at some time in the future." Put the \$10,000 appropriation, Merrill directed, "where it will do the most good."

During the 1879 working season, Roberts sent a craneboat and crew down the Allegheny. It removed 503 boulders, 109 snags, and 1 wrecked boat. He employed other crews to build a stone-filled timber-crib dam closing the right hand channel at Six Mile Island, a riprap dam closing the left channel at Nicholsons Island, and a temporary sandbag wing dam to deepen the channel at Garrison Ripple. Near the end of the season, Roberts found himself in a pickle. General White met the craneboat and crew at Freeport and, as congressman who sponsored the project, took it upon himself to hire more labor to remove the stone piers of the old canal aqueduct, a job that was needed, but Roberts was not advised of it until the craneboat reached Pittsburgh. He had to stop dam construction to save enough money for pay of the extra workers hired by General White. Roberts thereupon resigned from the Allegheny River project, and General Moorhead hired him as chief engineer of the Monongahela Navigation Company.

Colonel Merrill transferred Israel V. Hoag from the Ohio to the Allegheny project and replaced Hoag with John W. Arras in 1887. Arras, a native of Coraopolis, had begun his service with the Corps in 1877 at \$1.70 a day; he had a hand in building 34 dams in the Pittsburgh District before his retirement in 1932.

Each summer, Hoag and Arras dispatched crews up the Allegheny to clear the channel. Work parties



Coalboat bottoms on the Allegheny River
Captain Fred Way

on the lower river used craneboats and decked flats; those on the upper river used dragsleds pulled by horses. After drilling holes in boulders with steel drills and sledgehammers, they inserted dynamite in the holes and reduced the boulders to portable fragments, which were loaded on the flatboats or the dragsleds and moved out of the channel. By 1898, the Engineers had removed 1,400 snags and more than 150,000 tons of rock from the river below Olean. Similar work continued well into the 20th century.

The sandbag wing dam and channel dredging kept the river open at Garrison Ripple near the Arsenal while John Arras and Colonel Merrill were planning a lock and dam for the site. Arras completed dams across back channels at Six Mile Island, Nicholsons Island, Pithole, Tionesta, Hickory, and Cornplanter, spur dikes at Cowanshannock and Red Bank, and a log chute in Corydon mill dam. The Cowanshannock dike was riprap stone; the remainder were timber cribwork filled and paved with stone. By 1898, Arras had established a 150-foot wide channel with minimum depth of a foot at low water from Pittsburgh to the New York state line on the Allegheny at a cost of about \$197,000.

After the clearance project had begun, the Hudson brothers put the *Nellie Hudson* on the Allegheny, restoring steam packet service, and operated it and the *Florence Belle* on the river until

1898. Packet service then ended, but the steamers made occasional runs up the Allegheny until the *Florence Belle* was sunk by ice at Creighton in 1910 and the *Nellie Hudson No. 3* went down at Ford City in 1913.

The open channel project also benefited raft and coalboat traffic. Lyman and Louis Cook, who piloted coalboat bottoms for T. D. Collins from Tionesta Creek to Pittsburgh, said it took them ten days to make the trip in 1887 because they could not run at night and made frequent stops to clear a channel through ripples, but by 1899 they were able to make the run without stops and reach Pittsburgh in less than five days. Coalboat bottoms, that were converted into coal barges at Pittsburgh, floated down the Allegheny from Tionesta, Clarion, Redbank, and West Hickory in droves until the 1920s, when steel barges began to replace the wooden coalboats.

Captain Frederick Way of Sewickley reviewed the record of the open channel project in his 1942 saga of the Allegheny River, and he concluded:

A person cannot go over the history of the performance of this group of the United States Army service without gaining an admiration for the methods and policies of this Engineer Department. Ever since Colonel T. P. Roberts started wading around the Allegheny River water with a surveying instrument, every task that has been handed those engineers has been performed diligently and successfully. There is only one trouble with them; they are hard to get started on a job. Once they get started, it is doubly hard to get them stopped.

On to Morgantown "Since 1850, steamboats have reached Fairmont only ten times," Colonel Merrill reported in 1872. "*The Globe, Eclipse, Lindsey, and Thomas P. Ray* made the trip at unusual high water, and in 1871 the *West Virginia*, specially built with 12-inch draft, managed the trip from Morgantown to Fairmont five times." He reported that Morgantown received most of its supplies by wagon over bad roads from rail heads at Uniontown and Fairmont, or by flatboats towed by horses sixteen miles upriver from the head of slackwater at New Geneva. He thought extension of slackwater up to Morgantown badly needed, and he recommended federal construction of locks and dams 8 and 9 which, with construction of No. 7 by the Monongahela Navigation Company, would do the job.

Colonel Merrill learned that commerce on the lower Monongahela had burgeoned after the Civil War and people of Morgantown and Fairmont were eager for regular packet service to their cities and for the mining and industrial development that slackwater navigation might permit. James Rees had organized the People's Line of packets in 1865, put the *Chieftain* and *Elector* into runs on the

Monongahela, and, after a few years of cutthroat competition, merged his firm with the older Pittsburgh and Brownsville Packet Company. Monongahela coal shipment had grown from 4.6 million bushels in 1845 to 37 million bushels in 1860, paused when war closed the New Orleans market, then resumed its upward spiral, reaching 57 million bushels in 1870.

With the aid of lobbyists from the Morgantown Board of Trade, Congressman James McGrew of Kingwood obtained a small appropriation in 1872 for planning slackwater extension to Morgantown. Colonel Merrill located the sites of locks and dams 8 and 9 at the mouth of Dunkard Creek and at Hoards Rocks, designed locks that were 200 feet long in the chamber, ten feet longer than the navigation company locks at Nos. 5 and 6, and, at the recommendation of "Old Slackwater" Moorhead, designed a stonemasonry arch dam instead of a timbercrib structure. Stonemasonry construction was selected because the 15.5-foot lift at Dam No. 9 would be nearly double that of the downstream timbercrib dams and because a masonry dam would be tighter and hold more water during droughts. The chief engineering innovations at No. 9 were the use of



Packet boat *Adam Jacobs*

Sketched from photo belonging to Captain Fred Way



Lock and Dam 9, Monongahela River



culverts through the lockwalls for emptying and filling the chamber, instead of valves in wooden lockgates; and first use in the United States of Stoney valves, a combined slide and roller valve invented by English engineer F. G. M. Stoney that allowed one man to open and close the valves in the emptying and filling culverts.

Contractors Smith and Hawkins won the contract for construction of No. 9 in 1873 and began work under supervision of resident engineers S. Petitdidier and J. E. Bell, but they worked slowly, frittering away the prime working seasons, so Colonel Merrill terminated their contract in 1876 and employed hired labor to finish the job. He thought contractor delays at No. 9 had cost the government about \$20,000 and vowed never to let another contract for the Monongahela project. He finished No. 9 in late 1879 and during the drought of that year found that the masonry dam held a full pool while the company timbercrib dams stood four feet out of water, but No. 9 would be of little value to navigation until locks and dams 7 and 8 below it were finished.

In 1881, Merrill began construction of Lock 8 and General Moorhead began No. 7. Moorhead and engineer James H. Harlow completed No. 7, four miles below No. 8, in 1883, but Merrill had to stop building No. 8 for lack of funds. Merrill protested

the funding failure as a breach of faith on the part of the United States, asked General Moorhead to "put in his oar" with Congress to obtain another appropriation, and complained that the funding freeze would greatly increase costs. "When work drags over many seasons," he said, "the expense of general administration is much increased, floods damage unfinished parts, cofferdams and plant must be repaired or renewed from time to time, and innumerable petty expenses add greatly to the ultimate expenditure."

After more funds were provided, construction of No. 8 resumed in 1887 under direction of resident engineer Philip J. Schopp, who saved the project from complete disaster during the record July 1888 flood by lashing derricks, tramways, and construction equipment to trees so they could be recovered after the water subsided. On November 8, 1889, Colonel Merrill rode the packet *Adam Jacobs* up to Morgantown to celebrate completion of No. 8; the *Jacobs* and the *James G. Blaine* were the first to make the run to Morgantown on slackwater, and they began daily service between Pittsburgh and Morgantown, carrying 17,000 passengers and 24,000 tons of freight in 1891.

"Padre" Merrill, responsible for projects throughout the Ohio River basin, hoped opening

slackwater into Morgantown would reduce his workload, but he soon learned that operations required as much attention as construction. Floods and runaway boats caused structural damages that had to be repaired each year; he had to build flatboats equipped with derricks to clear the pools of snags; and dredging channels and lock approaches was necessary on a nearly annual basis. Politics also consumed his time.

Congressman William L. Wilson of Morgantown complained that B. F. Hoard, first lockmaster in Pittsburgh District, at Lock 9 delayed river traffic because he finished his meals while boats waited. Rumor was that Hoard once told a boat captain he would lock him through, but not until he had finished milking his cow. Colonel Merrill told the congressman that politics had nothing to do with Hoard's job, that he had hired Hoard because he lived near the lock and because his father had donated the land on which the lock was built. "I object," Merrill said, "to removing men who have done their duty, for political reasons; but nothing would induce me to retain a man who has failed in that respect." Yet, Merrill investigated the case and exonerated the lockmaster when he learned the charges of negligence came from a man who wanted Hoard's job and went to the congressman to get it.

Political and public support was also increasing for extension of slackwater on to Fairmont. Congress ordered a survey between Morgantown and Fairmont in 1875 and Thomas P. Roberts made the study for Merrill. Roberts found that river traffic above Morgantown consisted chiefly of rafts and flatboat shipments of lime and brick, but people were distressed by high rail rates charged for the 70,000 tons of coal shipped annually from Fairmont and wanted slackwater to reduce transportation costs. Roberts thought construction of six locks and dams, numbered 10 to 15, would extend slackwater to Fairmont and encourage the development of the resources of Marion, Monongalia, Harrison, Tucker, Taylor, Preston, Barbour, Randolph, and Upshur Counties. Colonel Merrill thought the project had merit, but Congress, which even had dif-

ficulty finding funds to complete Lock 8, did not appropriate funds to carry the slackwater on to Fairmont until about twenty years after the 1875 survey.

Pittsburgh District Reopens William Merrill had moved his office from Pittsburgh to Cincinnati in 1871 to obtain a more central location, for his work was scattered from Pittsburgh to Cairo on the Ohio and on many tributary streams. By 1888, the increasing number and complexity of projects under Merrill's supervision made the burden of paperwork alone overwhelming, and Merrill was forced constantly to travel from dredge to snagboat to construction site to field office and back to Cincinnati. He died aboard a train in 1891 while traveling to inspect work on the lower Ohio.

For the relief of Colonel Merrill and the many officers working under similar conditions, the Corps began administrative decentralization in 1888, creating new Engineer Districts and establishing Engineer Divisions. Prior to 1888, the Engineer officers had reported directly to the Office of the Chief of Engineers (OCE). The Chief divided the nation into five Engineer Divisions in 1888, and thereafter the District officers reported through the Division officers.

Engineer Districts in the Ohio River basin were first placed in the Southwest Division under Colonel Cyrus B. Comstock, and later moved to the Northwest Division under Colonel Henry M. Robert, author of *Robert's Rules of Order*. In 1901, Divisions were reorganized with boundaries generally following watershed lines, and the Ohio River basin, including the Pittsburgh District, fell to the Central Division with offices at Cincinnati. The Central Division became the Ohio River Division (ORD) in 1933.

The Second Cincinnati District was established to relieve Colonel Merrill of responsibility for some tributary streams in 1888, and Colonel Merrill's office, still responsible for the entire Ohio River, became the First Cincinnati District. Decentralization continued with assignment of Captain Richard

L. Hoxie on November 10, 1893, to open an Engineer District office at Pittsburgh.

Captain Hoxie found John W. Arras directing the Allegheny River project from an Engineer suboffice, a single room fairly plastered with maps off the main lobby of the Hotel Boyer in Pittsburgh. Hoxie moved the District office in February 1894 to four rooms on the fourth floor of the Federal Building at the southeast corner of Fourth and Smithfield to make space for the draftsmen and clerical force assigned to the Pittsburgh District. Captain Hoxie and his executive staff occupied one room, the engineers and draftsmen another, the clerks a third, and records files and maps the fourth. The blueprinting, or "reproductions branch," was located in a large closet.

Captain Hoxie's command in 1893 included three active projects: channel clearance on the Cheat

River, an open-channel project on the Allegheny River, and construction of locks and dams on the Monongahela. The Ohio River was not added to the District until 1902. The Cheat River boulderblasting project was closing down, but John Arras was planning the first lock and dam on the Allegheny at Herrs Island and Captain Hoxie began planning for construction of locks and dams on the Monongahela to extend slackwater on to Fairmont.

The case of the United States versus the Monongahela Navigation Company, the largest condemnation suit in American history before 1900, was dragging through the courts at the time Captain Hoxie opened the Pittsburgh District. In fact, the House Rivers and Harbors Committee was inspecting the Monongahela by boat on the day Hoxie arrived at Pittsburgh. Captain Hoxie was in for an exciting tour of duty in the new Pittsburgh Engineer District.



Captain Richard L. Hoxie



Chapter 9

THE RADICAL PROJECTS

Raw October wind cutting through his uniform and chilling his old warwound made "Padre" Merrill squirm in his chair, but he suffered stoically while the interminable speeches continued. Captain Charles W. Batchelor had spoken first, followed by a line of others, and now Daniel Agnew, standing on the bow of the *Geneva*, was delivering a spreadeagle attack on railroads. "Rivers," Agnew shouted to the people crowded around Davis Island Lock, "take no taint of dictation from boards of directors, no corruptions from combinations, no discrimination, no favoritism, no rebates or drawbacks. How grand is this freedom from watered stock, bloated bonds, oligarchal control, arbitrary regulation, and insolent officialism!"

DAVIS ISLAND LOCK AND DAM

Colonel Merrill lost interest in the speech. He had waited fifteen years for this day, but though clouds parted, rains ended, and the sun brightened the dedication day pageant, October 7, 1885, had been a miserable day for him. At 11:00 that morning, when the 39 flag-bedecked packets and towboats with whistle cords tied down had set off from the Monongahela wharf, with fifty thousand people lining the river bluffs to watch, Merrill had heard the booming salutes from artillery on the bank suddenly stop and shrieks come from the crowd. A cannon had fired prematurely while a gunner was ramming a powderbag down the barrel; the ramrod severed the gunner's hands at the wrists and its splinters spiked into the crowd of spectators. Most people crowded aboard the steamboats were unaware of the accident, however, and the celebration of completion of



The dedication
Dr. Leland R. Johnson

Davis Island Lock and Dam, No. 1 on the Ohio River, continued.

The mayor, the city council, local congressmen, and every civic and business organization in Pittsburgh were aboard the steamboat flotilla, except the Pittsburgh Coal Exchange whose opposition to the project had not ended. Merrill traveled aboard the flagship *Geneva* with Captain Batchelor and the Chamber of Commerce. He stood at the rail and watched closely as the boat crossed Glasshouse Ripple, the riverman's nemesis at Brunot Island that had ripped the bottom from a thousand boats. The *Geneva* and the steamers that followed, some drawing more than five feet of water, passed across the ripple without scraping, and Merrill was then certain the obstruction was gone forever.



Above: Normal operation
Below: Flood stage

Louisville District

The fleet finished its five-mile trip at noon, moored above Davis Island Dam, which had been raised a few days before, and William Martin, resident engineer at the dam, boarded the *Geneva* and took Merrill off to the side, alone.

"Colonel, we won't be able to lock you through," Martin said in a near whisper.

The Colonel's face flushed red. "What!" he exploded, and then lowered his voice when people turned to stare. "Why don't you have the lock in order?"

"The pump broke, Colonel, and we couldn't get enough water into the storage tanks to operate the valves. We can open the upper gate and let you into the chamber, but that's it. You couldn't get far below the lock anyway. The river is too low."

"How long will repairs take?" Merrill asked.

"One, maybe two days," Martin replied.

Merrill grimaced, raised his hands in a gesture of despair, and told Martin: "Let's get on with it."

Martin gave the signal, the upper gate creaked and groaned as the chains tightened and rolled back into its recess. The *Geneva* followed by five boats steamed into the lock chamber, and the speeches began.

"Water, glorious water! Free as air, pure as the snowflake, refreshing as the dew dancing in the sunlight, and plentiful as the flow of Heaven." With that, Daniel Agnew finished his peroration. The applause snapped "Padre" Merrill back from his memories. He stood and walked to the bow of the *Geneva*, determined to make it short.

"Let us hope," Merrill said, "that this celebration is but the forerunner of many similar ones until our beautiful river becomes the permanent home of a

The recommended improvements

Dr. Leland R. Johnson



steady and beneficial commerce and the ancient slur that it is dry all summer fades into oblivion." He thanked the politicians, the Ohio River Commission, and the Pittsburgh ironmasters for their support of the project, especially Harry Oliver, who had "snatched victory from the jaws of defeat." Merrill's son—it was his twelfth birthday—stepped to the flagstaff and briskly hoisted the banner to the top; and as the red, white, and blue snapped in the crisp October wind Colonel Merrill closed the ceremonies, saying: "In the name of the United States, I now declare the Davis Island Lock and Dam to be open to navigation. *Esto perpetua.*"

The lock, however, was not opened until the following day, after William Martin made the repairs. That afternoon, the Pittsburgh *Evening Penny Press* reported with apparent glee: "An insignificant little market boat was the first of the river craft to pass through Davis Island dam. The honor intended for the Chamber of Commerce was captured by a boatload of cabbages." Perhaps the coincidence was appropriate, for major benefits of the Davis Island and Ohio River canalization project went not to elaborate passenger packets but instead to tows of bulky commodities and to the very interests that so opposed the project that they did not participate in the dedication ceremony. Opposition to locks and dams on the Ohio in 1885 was still so strong that Colonel Merrill decided not to "press the matter until the pioneer dam has fully demonstrated its usefulness."

Slackwater for the Ohio When Colonel Merrill arrived in Pittsburgh in 1870, he found a report left by William Milnor Roberts recommending "radical" improvement of the Ohio by construction of 66 locks and dams to supply six-foot slackwater from Pittsburgh to Cairo. Rivermen jeered at Roberts' plans, but Merrill continued the investigation, looking also at alternate plans.

First, there was the plan presented by Professor Benjamin S. Roberts of Yale, who had defended Clarksburg against the Jones-Imboden raid during the Civil War. Professor Roberts suggested diversion of water from Lake Erie to the Ohio through the

Mahoning and Beaver rivers, or perhaps by pumping Erie water into Lake Chautauqua and sending it down the Allegheny to increase Ohio River flow during droughts. Merrill rejected that idea when he learned the upper Ohio River was above the elevation of Lake Erie and when he calculated it would require 300 pumps at an initial cost of \$625 million to move significant quantities of Erie water into Lake Chautauqua.

Second was Charles Ellet's reservoir scheme, which had not died with its author. William Milnor Roberts again rejected the Ellet concept in 1870 and Colonel Merrill agreed. Loss of farmlands, mines, industries, railroads, and highways in the valleys where reservoirs would be constructed was considered objectionable to begin with, and costs of relocation and land acquisition would be great, in fact prohibitive in the 1870's when Congress had difficulty funding single locks and dams. And, though reservoir releases could benefit navigation on the Ohio, the dams would block navigation on tributary streams, where traffic was still important economically in the 1870's. Engineering was also a problem. "How can one build a dam a hundred feet high," asked Merrill, "when we have difficulty building fifty-foot dams that are watertight?"

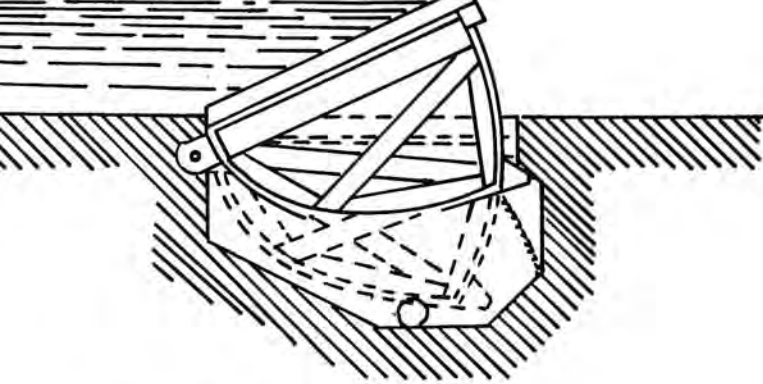
Third plan presented was that of General Herman Haupt, who obtained support in the postwar years for his idea from the Pittsburgh Chamber of Commerce. General Haupt, with his prestige increased by his service as director of Union military railroads, vigorously pressed his idea upon Colonel Merrill. He still advocated building a canal downstream alongside the river with low cross dams to divert waterflow into the canal; he added an automatic sluice patented by Alonzo Livermore that would be installed in the dams to drop at high water and allow coal tows to pass through without lockage. Merrill disapproved of the idea because of its high cost and because a canal would be damaged by floods.

Colonel Merrill concluded that alternate plans would not serve so well as locks and dams. Slackwater navigation was an effective solution,

proven on the Monongahela and many other streams, that would cause minimum flowage damages, establish riverport harbors, and, most important, cost least. Merrill recommended in 1872 that construction of a slackwater system for the Ohio River commence with the first lock and dam below Pittsburgh and proceed in general downstream order.

The slackwater plan met distinct hostility from coal shippers and towboatmen. Dams would obstruct open-channel navigation and require breaking tows for lockage; rivermen feared the system would require them to break their tows fifty or more times for lockage on the downriver trip. If Colonel Merrill were allowed to proceed, they contended, it would "utterly ruin and annihilate the entire towing system." Rivermen organized torchlight protest marches in Pittsburgh, and, despite the successful operation of locks and dams on the Monongahela, spread rumors that sewerage and garbage dropped into the river at Pittsburgh would convert "stagnant" slackwater pools into cesspools, sources of epidemic disease. With the sole exception of Captain John A. Wood, all members of the Pittsburgh Coal Exchange and the Steamboatmen's Association preferred continuance of the open-channel project and argued that locks and dams would be "unwise meddling."

Merrill found support from General James K. Moorhead, the Ohio River Commission, and iron prince Henry W. Oliver. Though accused by rivermen of seeking to dam the river to keep coal at Pittsburgh for his mills at depressed prices, "Harry" Oliver wanted slackwater because water supply for his Ohio River plant was inadequate in summer months. He worked through business and civic organizations to get the project underway. General Moorhead became chairman in 1872 of the Ohio River Commission, consisting of delegates appointed by governors of Ohio basin states, and began annual treks to Washington to urge approval for Ohio River slackwater. "Whilst millions are appropriated annually for seacoast and lake harbors, piers, lighthouses, &c., we sometimes get a pitiful fifty thousand dollars for the Ohio River," General



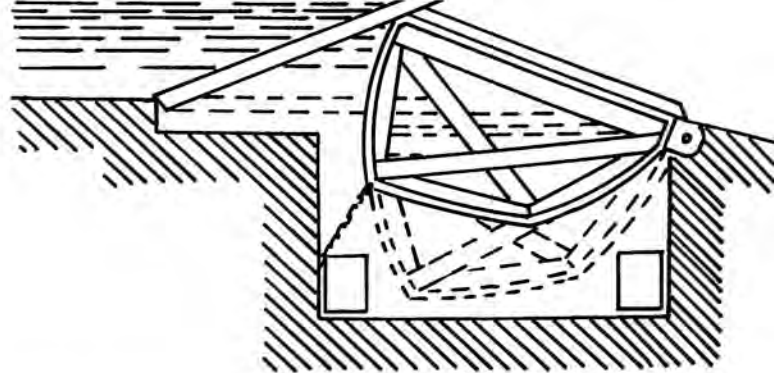
Brunot's gate

Moorhead complained. "Congress has just voted four millions of dollars, very properly, for public buildings lost in the Chicago fire;" he reasoned, "why not with equal propriety vote a few million for good navigation on the Ohio and benefit ten states of the Union?"

Farmers in the 1870's were worried by high rail rates charged for grain and farm produce shipments. Colonel Merrill shared their concern and thought the issue had wide social significance. "Money expended in transportation is money wasted," he said, "inasmuch as it adds nothing to the intrinsic value of the thing transported." He thought waterways transport could reduce the price of wheat, and he argued: "Cheap bread is a guarantee against such starving mobs as began the French Revolution, and in these days when the poor are said to be growing poorer, it is a matter that deserves most serious attention. A nation can well afford to expend large sums in assisting the masses to earn their daily bread without excessive labor."

Merrill testified before the Senate Committee on Transportation Routes to the Seaboard, the "Windom Committee," formed to develop plans for reducing transportation costs for grain and other commodities, and presented the case for slackwater on the Ohio effectively. In 1874 the Windom Committee recommended construction of a six-foot slackwater project from Pittsburgh to Cairo, along with study of canal routes from the Ohio basin to the seacoast, as a means of reducing the price of bread.

Planning Davis Island Dam To placate hostile rivermen, Colonel Merrill turned to the idea of movable dams that would be raised to hold water during droughts and be lowered at high water to pass coal fleets without lockage. He sent his deputy, Lieutenant Frederick A. Mahan, to Europe for on-site studies, while he personally translated literature about British, French, Russian, and German waterways engineering, eventually publishing his translation in paperback as *The Improvement of Non-Tidal Rivers. Memoirs of S. Janicki, L. Jacquet, A. Pasqueau*. He also began experiments and model



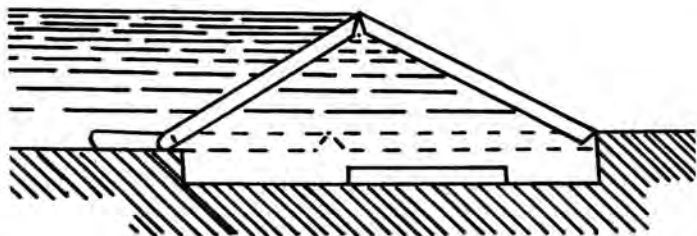
Brunot's gate with upstream apron

studies of movable dams and chutes proposed by Americans.

River captain John A. Wood submitted plans for gates raised or lowered with a chain and axle system located in a masonry foundation beneath the gates. S. M. Petitdidier, assistant engineer on the Monongahela, sent plans for wooden gates moved up and down by counterweights in masonry piers. Philip J. Schopp, superintendent of the Louisville and Portland Canal, suggested triangular caissons operated by hydraulic pressure. Model studies showed those plans unsuitable because of their complexity, friction, or operational power requirements, but Merrill became interested in plans submitted by John DuBois and Felix R. Brunot.

John DuBois, a rugged lumberjack who made millions driving logs down the Susquehanna and Allegheny rivers and their tributaries, had patented a beartrap gate in 1862 for use as a splash dam to flush logs and rafts downstream. Invented by Josiah White on the Lehigh River in 1818, the beartrap gate, so named because it somewhat resembled the deadfalls used by pioneers to trap wild animals, consisted of two wooden platforms or leaves hinged between piers in an opening or chute in a dam. The two leaves could be raised to an upright inverted "V" position forming a dam by allowing water from the upper pool to flow through culverts into the space beneath the leaves. Closing the culverts stopped flow under the leaves and allowed them to collapse against their foundation. Colonel Merrill inspected the modified beartraps John DuBois had in operation on Sandy Lick Creek near Dubois, Pennsylvania, and on the West Branch of the Susquehanna. He thought the Dubois beartrap had potential, but noted the wooden leaves had a tendency to warp on rising.

Merrill also became interested in the hollow metal caissons invented in 1867 by Felix R. Brunot, for whose father the first island in the Ohio below Pittsburgh was named. Brunot had assisted Milnor Roberts in planning the Monongahela slackwater project and had become president of the Allegheny

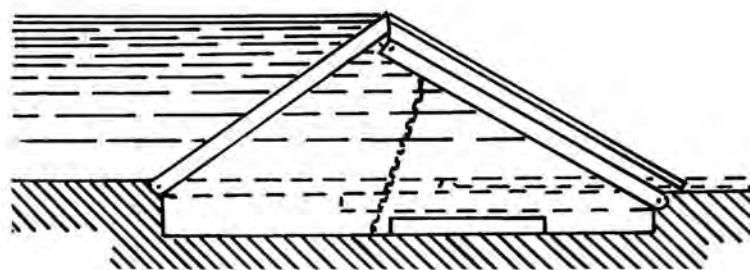


Bear trap with DuBois' apron

Valley Railroad and director of the Monongahela Navigation Company. The mainspring of Pittsburgh humanitarian organizations for years, Brunot had chartered steamers in 1862 to deliver surgeons and medical supplies to the Shiloh battlefield, where he was captured along with the field hospital and sent to the same Confederate prison that held "Padre" Merrill. The Brunot caissons were to be installed atop masonry foundations and be raised or lowered by admitting or expelling water into and from the caissons.

"Old Slackwater" Moorhead had long wanted a chute closed by movable gates in Dam 1 on the Monongahela to pass coal fleets and relieve congestion at the locks. Since Merrill wished a full scale test of movable dam devices before building them on the Ohio, General Moorhead suggested the test be made at Dam 1 with the company and the government splitting costs. The Chief of Engineers rejected the idea because funds appropriated for the Ohio could not be spent on the Monongahela, and General Moorhead proceeded on his own, cutting a chute for a 120-foot wide and 9-foot high DuBois beartrap in Dam 1 and contracting with John DuBois for installation of the wooden leaves. DuBois completed the gates in 1884, but they warped, one end rising five feet in advance of the other, and DuBois was never able to make them work properly. Not a single boat ever passed through the chute and in 1886 the company sealed the gap in Dam 1 and ended the experiment.

During his study of international engineering, Merrill learned that French engineers saw beartraps in operation on the Lehigh River in 1818, built similar structures on French rivers, developed more sophisticated movable dams, and had 124 movable dams operating in 1874 on the Seine, Marne, Meuse, and Yonne rivers. He, Colonel William P. Craighill, and their assistants went to Europe for onsite inspection and decided the movable wicket dams invented in 1852 by Chief Jacques Chanoine of the French Corps of Engineers could be modified to serve the needs of Ohio and Kanawha river navigation, because such dams were



DuBois modification

already serving coal tow traffic on the Seine River near Paris.

Chanoine wickets, timbers bolted together that somewhat resembled huge wooden ironing boards, laid flat against masonry foundations at high water and left an open channel for navigation; they could be raised on end at low water to form a dam. When rivers fell, French engineers raised a metal service bridge on the foundation upstream of the wooden wickets, ran a hand winch out on the service bridge, and with cable and grapple from the winch caught handles on the wickets and raised them out of the water, allowing an iron prop on the backside of each wicket to catch in a groove in the foundation to hold the wickets upright. They raised and set each wicket into place until the entire river was dammed and a slackwater pool formed. They lowered the wickets when a rise came by moving long iron tripping bars back and forth on the foundation to dislodge the props and allow the wickets to fall.

Colonels Merrill and Craighill in 1874 recommended construction of chanoine wicket dams on the Ohio and Kanawha rivers to assist steamboat and coal tow traffic. Merrill specifically asked Congress to provide for six-foot slackwater from Pittsburgh to Wheeling through construction of thirteen chanoine wicket dams, each with a lock 630 feet long and 78 feet wide. German engineers had built swinging mitering lock gates to close locks as wide as 76 feet; Merrill thought he could design mitering gates for chambers 78 feet wide, which would permit lockage of barges three abreast, or a total of 9 barges and towboat without breaking tow. But coalmen still denounced the project as a "damnable move," because even the widest mitering lockgates in the world would not permit lockage of the normal Ohio River coal tow, usually four barges abreast (100 feet wide) without breaking tow.

Merrill went back to the drafting board to design lockgates capable of closing 110-foot wide lock chambers, capable of passing four barges abreast with a few feet to spare. He found no way to design swinging mitering lock gates of wood and iron for a

Detail of wicket



110-foot wide chamber that would not sag in the middle or break loose from their anchorages on the lockwalls. As substitute, he designed 117-foot long rolling lockgates, simply a wooden Howe truss laid on its side and mounted on iron wheels and axles. Housed in a recess in the riverbank when the lock was open, the Merrill rolling gates ran out on tracks like a railroad car across the chamber to a niche in the lock riverwall to close the lock. He also reduced lock chamber length to 600 feet, which with a 110-foot width could handle ten barges and a towboat without double lockage.

Because opposition from coalmen did not abate, because wicket dams had never been built in a river the size of the Ohio, and because 110-foot wide locks and rolling lockgates were engineering firsts, Colonel Merrill recommended the Ohio River canalization project begin with construction of a single lock and dam at Horsetail Ripple next to Davis Island about five miles below Pittsburgh. It would form a deepwater harbor for Pittsburgh where coaltows could be made up for their down-river trip. If the experiment were not a success, if rivermen were not pleased with the structure, he could blast it out of the river and restore the channel to its natural condition.

Congress funded Merrill's experiment at Davis Island in March 1875, but the "Padre" met another obstacle in the Pennsylvania legislature, which had to cede jurisdiction over project lands and the right



Chanoine dam under construction

of eminent domain before construction could start. General James Moorhead arranged submission of the necessary legislation to the Pennsylvania General Assembly, and the bill passed both houses but was vetoed by Governor J. F. Hartranft because he questioned the legality of certain provisions. A new version of the bill passed the House in the spring of 1875, but was mysteriously mislaid in the Senate. Coal shippers of Pittsburgh used their influence in the legislature to defeat the bill on its third trial in late 1875.

"The course of the coal-dealers of Pittsburgh is unjustifiable and contrary to public policy," Colonel Merrill angrily declared. "They condemn the whole project in advance," he complained, "and refuse to consent to the construction of even one dam, notwithstanding the fact that, in case of failure, the dam could be removed without either injury or delay to navigation." Ironmaster Harry Oliver and the Pittsburgh Chamber of Commerce came to the rescue of the bill at its fourth appearance in the legislature; it passed and Governor Hartranft signed it on March 17, 1877.

During the wait for approval from Pennsylvania, Merrill refined and improved the Davis Island design, notably by substituting hurters for tripping bars. Iron tripping bars, used by the French to dislodge wicket props and drop the wickets out of the way of boat traffic, were frequently clogged by drift and debris. French engineer Alfred Pasqueau in 1877 designed a cast iron double-step hurter for La Mulatière dam on Saône River near Lyons that eliminated need for tripping bars and service bridges. Laid in the masonry foundation behind and below the wickets, Pasqueau hurters had two grooves to carry wicket props. When men in a maneuverboat pulled a wicket up, the trailing prop followed to a notch against which it rested to support

the wicket. Maneuverboat crews dropped wickets by pulling them upstream until the prop reached the end of the groove, where it shunted sideways into a second unobstructed groove and slid down it as the wicket fell. Pasqueau sued the government for compensation for use of his invention, and in 1900, after twenty years of litigation, received a small sum, which doubtless had been consumed by attorney fees. The Corps of Engineers switched to an improved hurter, designed about 1890 by Addison Scott on the Kanawha River, for the Ohio River dams.

Construction at Davis Island Colonel Merrill sent Lieutenant Frederick A. Mahan to open a sub-office at Bellevue near the site of Davis Island Lock and Dam, and Mahan hired laborers and began clearing brush from the riverbank on August 19, 1878. The dredges *Ohio* and *Oswego* excavated the lockpit, sandstone for the lock masonry was brought in by river from Stoop's Ferry and by rail from Baden, and Louisville natural cement was imported for the masonry because the cost of Portland cement was thought prohibitive.

James H. Harlow and William Martin served as resident engineers at Davis Island; project or office engineers were Merrill's deputies: Lieutenants Frederick Mahan, William M. Black, Lansing H. Beach, and George W. Goethals. Harlow, a founder of the Engineers' Society of Western Pennsylvania, left the Corps in 1881 to become chief engineer on the Monongahela. Martin directed the Davis Island project and construction of Merrill Dam (No. 6) until 1905. Lieutenant Mahan became an international expert on waterways engineering and in 1911 a principal consulting engineer for the National Waterways Commission; Lieutenants Black and Beach became Chief of Engineers for the Corps; and Lieutenant Goethals built the Panama Canal.

Davis Island Lock and Dam was George W. Goethals' first civil works assignment. Goethals, a stickler for military protocol, just after his graduation from West Point was presented to the disheveled William Tecumseh Sherman, commander of the Army, who was cordial until Goethals told

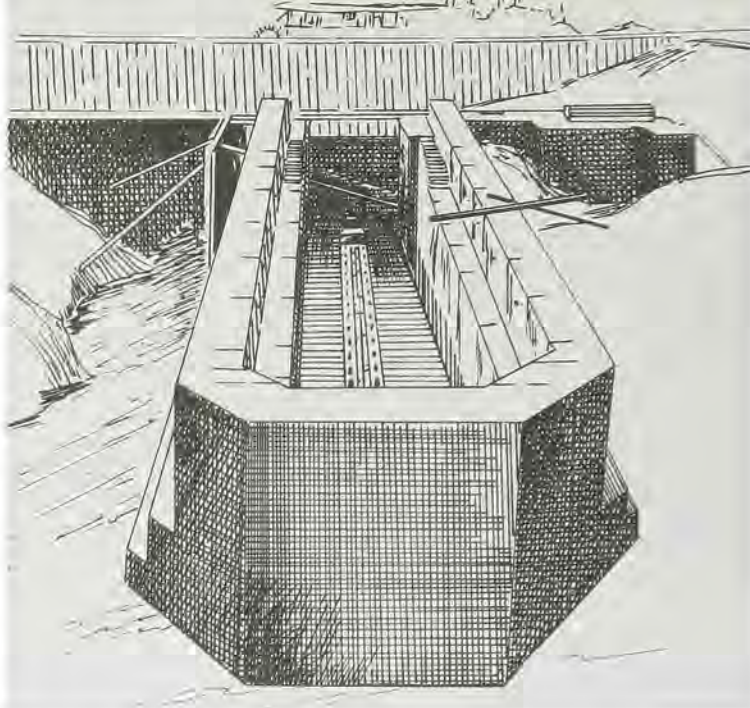


Method of raising the dam (The service bridge was later wrecked by drift and runaway barges)
Pittsburgh History and Landmarks Foundation



William Martin

Sketch of recess for rolling lock gate



him he was joining the Engineers. "Oh; hell!" barked Sherman with apparent disgust. "However, in spite of that," Sherman remarked, "I hope you may do some good for your country some day." When Goethals marched in full uniform complete with epaulets into Colonel Merrill's office in 1884, Merrill told him to get the uniform off if he wanted to learn river engineering; otherwise, he could stay in the office and do paperwork. Goethals donned overalls, went to work as a survey rodman, and graduated to masonry foreman and project engineer before leaving Merrill's tutelage to continue his civil works career, capped by his work at Panama.

Because the Davis Island project was experimental, Merrill maintained complete records in minute detail and devoted personal attention to all construction features. In 1882, for example, while designing the chain and power system for rolling the heavy lockgates back and forth across the lock chamber, he wrote to Commodore George Dewey of the Navy:

My dear Dewey:

Please answer the following naval conundrum.

How many turns ought a $\frac{5}{8}$ " chain to take around an 18" cast-iron drum so that it won't slip when pulling a weight of 2 tons?

I want to use such a chain and drum at the Davis Island dam & want to know how many extra turns I must provide for. I suppose that your experience in weighing anchor will enable you to answer at once, but out here we don't use anchors.

Merrill and his aids commonly experimented with new construction procedures to reduce costs and expedite progress: "value engineering" at its finest. Cutstone masonry at first was lifted from scows and railcars into place in the lockwalls by men cranking drums to operate cables on stiffleg derricks. In 1881, Lieutenant Mahan attached steam engines to the drums and lifted 150 six-ton stones in ten hours, speeding work because men could lift only 60 stones in ten hours. That method also achieved a reduction in force.

The timber pile and wooden framework cofferdams around the work sites were first filled with loam dug by men with shovels on Davis Island, moved in wheelbarrows and scows to the cofferdams, and again shoveled into the cofferdams. Workmen were paid only 12½¢ per hour, but filling the cofferdams by hand was costly. Mahan and Martin installed a pump and 900 feet of pipeline from Davis Island to the cofferdams, had horses pulling plows and scrapers drag island soil into a vat agitated by streams of water, and pumped liquid mud puddling from the vat into the cofferdams. Delivered in that fashion at a rate of 25 cubic yards an hour and at a cost of \$1.05 per cubic yard, the mud penetrated into every crack in the cofferdams and hardened as it dried.

Excavation of the foundation within the cofferdams was also performed by hand at first, with shovels, wheelbarrows, and stiffleg derricks. The engineers accelerated work and reduced costs in 1882 by installing a "running dump," which was an endless rail track round which cars constantly moved and were filled with spoil and emptied in turn.

Construction of Lock and Dam No. 1 at Davis Island was completed at a cost of \$940,832.31 on October 7, 1885, after seven years and nineteen days of work. Locks and dams built later on the Ohio were often completed in three years, but funding for No. 1 was irregular, floods severely damaged construction equipment in 1883 and 1884, and Colonel Merrill worked deliberately because the project was an experiment upon which the future of the Ohio River canalization project depended.



Typical rolling lock gate - Ohio River

The people aboard the *Geneva* and the other steamboats who dedicated Davis Island Lock and Dam on October 7, 1885, saw a 1,223-foot dam, not including a timbercrib structure built to close a channel behind Davis Island, composed of a 559-foot long navigable pass, through which boats passed at high water, and three weir sections used to regulate pool levels, and three masonry piers separating the four dam sections. They saw a total of 305 chanoine wickets with water spraying through between them that somewhat resembled a picket fence across the channel. Because the dam foundation was underwater, the most impressive structure was the massive masonry lock. Its 600-foot long and 110-foot wide chamber was the largest in the world, and wider even than the locks built in 1914 at the Panama Canal. Construction had been successful, but operations would determine whether it would be the first, or the last, lock and dam on the Ohio.

Freeing the Monongahela It was 1897. Rivermen thronged around the office of William Speakman, superintendent of Lock 1 on the Monongahela, waiting impatiently for word to arrive. They had begun their vigil on July 2 and had littered the lock grounds with cigar butts, tobacco splatters, and accumulated scraps during their five day wait. Sixteen million bushels of coal up the Monongahela was loaded and ready. Lockmasters Charles Wood at No. 2, George Connell at No. 3, Abram McGowan at No. 4, Abraham Milliken at No. 5, Thomas Speakman at No. 6, and George Lutes at No. 7 were standing by their phones and waiting, too, for almost no boats were moving.

Word of the end to the fifteen-year legal tangle had arrived at Pittsburgh on July 2, and newspapers had reported the Monongahela would be freed on July 3. The comptroller of the Treasury, however, wanted careful review of the papers before issuing warrant No. 38 for \$3,601,615.46 to the Monongahela Navigation Company. At noon on July 7, 1897, the Monongahela was still not free, and rivermen were disgusted.

From the beginning in 1841, rivermen had resented payment of tolls to the Monongahela Navigation Company, and about 1883 Captain John F. Dravo of the Pittsburgh Coal Exchange had launched a public and political campaign to secure federal purchase and operation of the slackwater project. He received encouragement from members of Congress, especially Representatives Thomas Bayne and John Dalzell and the influential Senator Matthew Quay, who in 1886 arranged appointment of an engineer board of investigation. Members of that board were taken aback when the Monongahela Navigation Company told them it would not sell the project and wished to be left "in undisturbed enjoyment" of its property.

Colonel Merrill asked the company in 1888 if it would sell Lock and Dam 7, next below the locks Merrill was building on the upper river, but the company would not even negotiate and Merrill, through the Justice Department, initiated a condemnation suit against the company to secure Lock 7 for public use. In November 1890, the Circuit Court awarded the company \$209,000 for No. 7, but the company appealed to the Supreme Court, which decided in 1892 that the company had a right to compensation for loss of its franchise to collect tolls in addition to the tangible value of its property and remanded the case for a new trial.

John Dravo and his colleagues continued their agitation for government purchase and freeing of the Monongahela, arguing that company tolls hampered development of West Virginia coalfields and undermined the value of government Locks 8 and 9. They also thought it unfair that they should pay tolls while the government was building locks



"Emancipation Day"

and dams on the Kanawha River to furnish regular and free navigation for Kanawha coal shippers. Merrill, William P. Craighill, and Addison Scott had begun canalization of the Kanawha in 1875, and, with the full support of Kanawha coal shippers, had built the project in short order, completing all ten locks and dams by 1899. Free from the burden of tolls and located nearer downriver markets, Kanawha coal undersold Monongahela coal. Rivermen and coal shippers of Pittsburgh began to regret their opposition to slackwater on the Ohio and to increase their clamor for a free Monongahela.

The Pittsburgh Coal Exchange entertained the House Committee on Rivers and Harbors aboard the steamer *C. W. Batchelor* on November 9, 1893. Accompanied by John W. Arras and William Martin of the Pittsburgh District and Maxwell Moorhead and Thomas P. Roberts of the Monongahela Navigation Company, the House committee inspected Lock 1 on the Monongahela and Davis Island Dam. During the trip, John Dravo and the Coal Exchange won a commitment from the committee for federal acquisition of the Monongahela slackwater.

The House committee directed the Engineers to report the value of the navigation company property and franchise. After Pittsburgh District Engineer Richard Hoxie estimated the value of the company works and rights at just over \$3.6 million, Congress directed that condemnation of the Monongahela Navigation Company proceed. In 1897, the Circuit Court awarded the company \$3,761,615.46 for its property, the largest condemnation award made to that date.

The Corps of Engineers finished its share of the paperwork for the transfer by the end of June 1897 and tried to arrange for freeing the river by the Fourth of July. On July 3, District Engineer Charles F. Powell informed the Monongahela lockmasters the United States would soon take possession and sent Chief Clerk Gulentz to each lock to explain government records keeping and navigation regulations.



Captain Fred Way

After rivermen protested the transfer delay, Congressman John Dalzell went to the comptroller's office in Washington to expedite the business and walked with the papers to see them handed to the Secretary of War, who put his assistant G. D. Meiklejohn with the papers on the first train to Pittsburgh. Meiklejohn met Monongahela company president J. J. Donnell at the Duquesne Club for breakfast on July 7, then joined Major Powell at the District office, and the three walked to the Bank of Pittsburgh to complete the transfer.

At 3:13 p.m., Superintendent William Speakman at Lock 1 answered his phone. Every ear in the lock office strained to hear. "Yes, this is Speakman," he said. A moment's pause. "Very well, Major, goodbye," he said, and put the receiver back on the wall. Without a word to the men in the office, he strode to the window, and he shouted: "Hoist the flag!"

Lockman C. W. Keibler ran up the banner and at that signal pandemonium broke loose. Boats that had been waiting with full steam raced for Lock 1 for the first free lockage and the *Courier* won. First free coal tow was pushed through Lock 1 by the *Charles Jutte*, and it was followed by some 16 million bushels of coal that had been sold at reduced prices contingent upon freeing of the river. "It was a long battle, but we have victory at last," commented Captain John Dravo. "She's free," said another grizzled riverman, with tears on his face. "Thank God, I lived to see it."

On July 16, the official "Emancipation Day," a hundred thousand people watched 32 packets and towboats under command of "admiral" John Dravo steam from Monongahela Lock 1 to Davis Island Lock, where the crowd was treated to orations to the effect that Western Pennsylvania might have lost the fight against the whiskey tax in 1794, but had won its fight against river tolls in 1897. The real jubilee occurred, however, on Sunday, July 11, when the Monongahela locks first opened to Sunday traffic.



Bear traps at Herr's Island lock and dam

The navigation company had held Sunday traffic to a minimum, locking only regular packets and, during river rises, coal tows. Sunday excursions had been thereby limited to the Allegheny and Ohio, but on July 11 excursion boats packed with people celebrating the free Monongahela demanded lockage and the District Engineer had no authority to refuse them. The celebration was rather overenthusiastic, even riotous, and during the week following the Chief of Engineers was bombarded by protests. One read, for example: "We felt that the Sunday steamboat excursion, one of the most demoralizing and prolific sources of crime in our midst, would be cut off. Our hearts are saddened, our hopes blighted, hearing that this floodgate of crime and degradation should be thrown open wider than before."

District Engineer Powell received a telegram from the Chief of Engineers directing that the Monongahela locks remain open to all traffic on Sundays, but deploring the desecrations of the Sabbath that occurred on July 11 and ordering that they be stopped. Major Powell issued an order to the Monongahela lockmasters: "Referring to Sunday excursions, you will give me information of any disorder, indecent exposure of person, selling of liquor, or similar conduct on such excursion boats when at the locks." There was no further trouble from the excursion boats, at least not in sight of the locks.

Just after freeing of the river in July, the Hudson Brothers moved their *Florence Belle* and *Nellie Hudson No. 3* from the Allegheny to the Pittsburgh to Morgantown run in competition with the packets *Adam Jacobs* and *James G. Blaine* operated by the Pittsburgh, Brownsville and Geneva Packet Company; by the end of 1897, nine passenger packets were plying the river of falling banks. Only about a million bushels of coal annually had come down the Monongahela from above Dam 5 prior to 1897; freeing the river stimulated the upstream coal industry and shipments assumed major proportions.

Locks 1 to 4 were each passing about 40,000 craft in 20,000 lockages annually by 1901, and Thomas P.



John W. Arras

Dr. Leland R. Johnson

Roberts, retained by the Pittsburgh District as principal engineer for the Monongahela, complained the lockmen had to perform heavy labor in 12-hour shifts, nights and days and Sundays, and were subjected to much abuse from rivermen angered by delays at the locks. Boat captains often told lockmen what should be their destination and sometimes assaulted them. Roberts requested a change to 8-hour shifts at Locks 1 to 4 and requested protection for the lockmen. The District Engineer concurred with the two recommendations and also began planning new and larger locks and raising of dams to increase channel depth to at least eight feet. Improving the Monongahela slackwater was undertaken as the 20th century began.

Herrs Island Lock and Dam "Such a work, in connection with the Davis Island Dam, would complete the harbor of Pittsburgh," said Colonel Merrill, "and would receive throughout its limits the cheap transfer of coal, coke, ore, petroleum, limestone, pit and manufactured iron, and other bulky articles to the great advantage of the manufacturer, and, ultimately, of the consumer." Thomas Roberts had placed a temporary sandbag wing dam at Garrison Ripple in 1878 to permit boat access to Allegheny Arsenal at low water. Colonel Merrill in 1880 indorsed construction of a lock and dam at Herrs Island to submerge Garrison Ripple, a wide shoal where the Allegheny fell two feet in a quarter mile. Congress approved the plan in 1885.

Construction at Herrs Island was delayed because Pennsylvania did not cede jurisdiction over the site

until 1887 and because riparian owners and the City of Pittsburgh opposed the project. Owners of land adjacent to the locksite opposed because the lock would block their access to river transportation, and Pittsburgh opposed because it feared a fixed dam might increase flood crest heights and cause ice gorges. To allay those fears, Colonel Merrill and project engineer John W. Arras substituted a movable dam for a fixed dam and located the lock fifty-five feet away from the river bank to allow continued access to river terminals. Those changes satisfied adversaries, and on July 12, 1893, Arras began building workshops on Twenty-Second Street in Pittsburgh and the cofferdam for the lock.

Arras planned a concrete instead of a cutstone masonry lock because he had observed deterioration of the sandstone used at the Monongahela locks; he also proposed use of beartraps instead of chanoine wickets because those at Davis Island Dam were constantly fouled by drift. Division Engineer Orlando M. Poe disapproved the Arras plans, saying Arras should stick with cutstone masonry and wickets. The Corps had built only one other concrete lock at that time, a tiny lock on the Rough River in Kentucky, and had experienced operational problems with the beartrap sluices built at Davis

Island Dam and on the Kentucky River in 1888. A review board approved the Arras plan for a concrete lock, but directed that the dam be chanoine wickets throughout.

When Arras completed the cofferdam around the Herrs Island locksite in 1893, he found it impossible to pump dry. Years of private dredging at the site had removed sand and small stones, leaving boulders with spaces between and a permeable bottom. Arras decided to place the foundation underwater without a dry cofferdam. He dredged the lockpit and drove in the piles to hold the concrete forms. High water stopped work in late 1894, filled the excavation with new material, and winter ice destroyed the piles. He began anew in 1895, redredging the site and driving new piles. In July, he sent divers down to attach hemlock lumber stringers and plank forms to the piles; workmen above the water lowered each stringer and plank to the divers who spiked them securely to the piles.

Floods and other troubles constantly interrupted the work at Herrs Island: six times in 1896; five times by floods and once by a tornado that destroyed the steam powerplant. The delays so angered rivermen that they accused District Engineer Richard Hoxie of neglect of duty and threatened charges against him. Divers finally had the forms spiked in place on August 28, 1896, and concrete placement began from 1.5 cubic yard mixers mounted on piles under which scows were loaded to carry concrete to the forms.

Concrete was placed underwater with six iron tubs handled by derricks and placed in the lockwalls by shoveling directly from scows to the forms. Poured dry as brown sugar and rammed in six-inch layers by men pounding with cast iron tools, the concrete was placed with little time for curing, allowing completion of the lockwalls in 63 working days. Concrete quality and placement were primitive at the second concrete river lock built in the United States, but proved satisfactory: closing and pumping Herrs Island Lock for repairs was not necessary until 1930.

Allegheny River Lock No. 1 (Herr's Island)





Though an engineer review board had disapproved use of beartrap sluices at Herrs Island Dam in 1894, Arras and John McCulloch had continued studies of improved beartrap designs. Engineers had used wood, because of its buoyant qualities, in beartrap leaves since 1818; Arras and McCulloch designed the first steel beartrap leaves and devised a system of introducing compressed air into the lower leaf for added buoyancy. They won approval from the Chief of Engineers in 1898 for installation of steel beartraps at Herrs Island.

First test of the steel beartraps came in the spring of 1903. Arras opened Herrs Island Lock on December 2, 1902, and when the Allegheny subsided in April 1903 began raising the dam to hold a seven-foot pool for navigation. The chanoine wickets of the 500-foot navigable pass came up without trouble, but the beartrap leaves would not budge an inch. Three days he tried; three agonizing days he failed. It seemed he might become the laughing stock of Pittsburgh and of his profession. He lowered the wickets, cleaned the culverts to the beartraps, installed new air valves and a propeller pump to force water under the leaves. Nothing

happened. April passed. May. No results. As a last resort, he fastened boards beneath the upper leaves to reduce leakage between the leaves. On June 2, they popped up under water head with a sound perhaps equalled in volume by the sigh of relief from John Arras.

Crowded steamboats gathered at Herrs Island Lock on July 28, 1903, to celebrate completion of Allegheny Lock and Dam 1 and hear a dedicatory speech by John L. Vance, first president of the Ohio Valley Improvement Association (OVIA). Larger packets, however, could not get to the lock because of the Union Bridge, and rivermen improved the occasion by publicizing the need for raising low bridges over the Allegheny. "Here I is; can't go. Low bridge. Gee whiz!" read a sign carried on the steamer *Mayflower*. Though Arras and the Pittsburgh District had Locks and Dams 2 and 3 underway by 1903, rivermen, led by Captain William B. Rodgers, complained slackwater on the Allegheny would have little value until obstructive bridges were raised or removed. They launched a political and legal battle that disrupted progress on the canalization of the Allegheny for a quarter century.

Chapter 10

A GOLIATH AT THE FORKS

"It was a godsend that the Davis Island Dam had been up the twenty-two days previous to the flood," one thankful riverman declared, "for otherwise not a boat or barge would have been saved from destruction, as the first boat adrift would have started others and they in their turn the entire fleet." The record flood of July 1888 sank at least a hundred boats on the Monongahela, but not a single boat moored in the Davis Island pool. "I have been told by two prominent coal operators," said Colonel Merrill, "that in this one experience the dam saved more than its original cost."

The July 1888 flood demonstrated graphically to rivermen and coalmen the value of the Davis Island Dam. Operation of the dam in the years after its completion in 1885 demonstrated to the people of Pittsburgh that it did not increase flood damages, that it abated effects of pollution, and that it improved municipal and industrial water supply. Smelting a ton of steel took 70 tons of water, refining a barrel of oil took 18 barrels of water, and producing one barrel of beer took 7 barrels of water; water supply was vital to riverside industry and to Pittsburgh pubs. "In my judgment," said Colonel Merrill, "the time has now come for continuing the radical improvement of the Ohio River on the plans that are in successful operation at Davis Island."

An engineer review board concurred with Colonel Merrill in 1888, finding that Davis Island Lock and Dam had benefited both navigation and industry and that opposition from rivermen had decreased. It recommended construction of more dams on the Ohio below Davis Island, but Congress did not fund the project for several years. Experiments continued, meanwhile, with operations at the Davis Island dam.

The biggest mistake in the design of Davis Island Dam had been the failure to protect against scour. Merrill had thought there would be little undermining scour at the downstream edge of the



movable dam, but the mad rush of water through the openings when the dam was raised or lowered caused erosion worse than at some fixed dams. In fact, the dam was saved from destruction by sinking barges loaded with stone into the holes gouged by the river below the dam. About 40,000 tons of riprap stone stabilized with piles were eventually placed below the first dam, and all dams subsequently built on the Ohio below Davis Island were so protected.

Merrill had substituted Pasqueau hurters and maneuverboats for service bridges to operate the wickets of the navigable pass, but had retained service bridges above the three weir sections. Service bridges were metal trestles located upstream of the weir wickets. They supported a small rail track along which the damtenders rolled a dolly carrying a winch to maneuver the wickets. That operation was hazardous and the service bridges were wrecked by drift and runaway barges in 1887 and 1888. Those problems resulted in increased reliance upon a beartrap weir installed at Davis Island Dam in 1889 to maintain pool levels instead of maneuvering the wicket weirs.

Merrill and Martin began construction of a 52-foot wide beartrap "drift-chute" with wooden leaves to close a 9.3-foot high chute adjacent to Weir 2 of Davis Island Dam in 1888. Removal of a pier made Weir 1 part of the navigable pass. Rivermen highly approved removal of the pier and widening the pass,

Davis Island lock and dam, July 1891
Note remains of service bridge in foreground.



U.S. Army Engineer District, Louisville

for several tows had wrecked while flanking through the pass and the steamer *J. N. Bunton* had rammed the pier and sunk with loss of four lives.

"The drift-gap consists of two parallel walls of masonry, between which is a bear-trap gate, closing a clear opening of 52 feet," Colonel Merrill explained. "This gate is handled by opening or closing valves, which control culverts built in the masonry walls and connecting with the spaces under the gates. With this device it is practicable to fill the bay above the beartrap with drift, and flush it through by closing one valve and opening another. The advantage of this apparatus over any other is due to the fact that it can be lowered and raised by one man without special exertion and regardless of the head of water."

The "Johnstown" flood of May 31, 1889, destroyed the cofferdam and construction equipment, but William Martin finished the beartrap by the end of the year. Beartrap operations also presented problems. As an instance, on July 16, 1890, hay from a burning stable thrown into the river at Pittsburgh drifted down and clogged the beartrap culverts. The beartrap leaves sank to their foundations, and when the hay was cleared from the culverts the beartrap leaves popped up, breaking their safety chains and locking in upright position. The Engineers learned, nevertheless, that beartraps could pass drift and sudden rises better than chanoine wicket weirs.

They installed large beartraps, usually two, in the dams below Davis Island, but substituted steel for the wooden leaves.

The original Merrill rolling lockgates, built of pine with Howe trusses, supported by cast iron wheels shrunk onto axles, and moved by chains and drums in and out of their recesses in landward lockwalls on an 11.5-foot gage rail track, often broke the wheels, axles, and chains. Since the gate recesses had only a foot clearance on each side of the gates, the gates had to be raised with derricks to allow men access to repair the undercarriage or to excavate silt that was sometimes seven feet deep. A steel caisson gate with Pratt truss, sturdier throughout, replaced the wooden gate in 1896, and covers for the recesses were devised to reduce silt accumulation, but the problems were never entirely eliminated. Use of Merrill rolling lockgates at the locks where originally installed continued, nevertheless, until replacement structures were completed.

Merrill left William Martin in charge of operations experiments at Davis Island in 1885 and hired James W. Riggs as first lockmaster, who was succeeded in 1889 by his son U. Kidd Riggs. Merrill expected to operate the lock and dam with four permanent employees assisted by temporary help when the dam was maneuvered or repaired, but soon learned that operation complexity and hazards precluded much use of temporary labor.

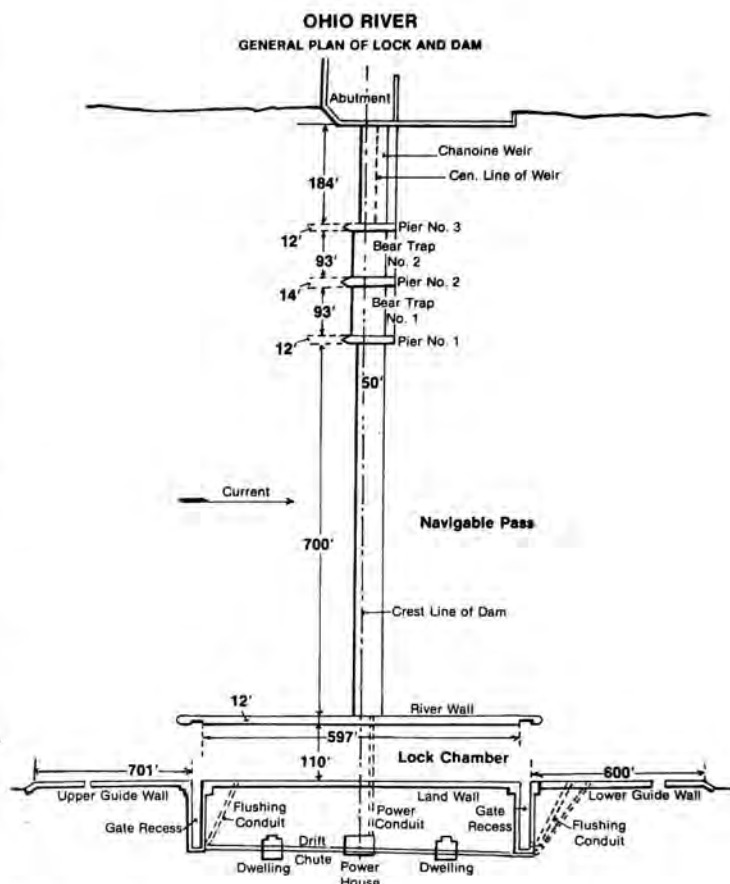
A man in a skiff and three men below the dam were repairing a wicket in 1887 when its support broke. The falling wicket barely missed the men working below, and the fellow in the skiff saved himself by jumping onto an adjacent wicket as his skiff went over the dam. Near disaster occurred on a Sunday in 1888 when telegraph offices were closed and Martin received no warning that an ice gorge was coming out of the Allegheny. At its approach, the damtenders ran out on the service bridges to lower the weir wickets, but the ice mass lodged on the service bridges, forcing the workers to the bank for safety and crushing the maneuverboat. Martin got the dam down by chartering two steamboats,

lashing barges between them, and butting the wickets from the downstream side until they fell and released the ice gorge. Inexperienced temporary labor was no help in such situations and Colonel Merrill increased the permanent staff to eight men, who worked twelve hour shifts. He also had telephones installed to furnish warning about upstream river conditions.

First maneuverboat was a small scow from which the damtenders raised and lowered the wickets of the navigable pass with hand-powered winches and cables, but the labor exhausted the men and in 1887 Martin built a flatboat equipped with steam engine and derrick for the job. The flatboat was replaced in 1895 with a steel-hull boat. The old maneuverboat became a "needleflat," used to carry square timbers placed in the spaces between the wickets to reduce flow from the pool at extreme low water.

Service at Davis Island Lock and Dam, located at the head of the Ohio where slope was steep and river flow swift, where traffic was heaviest, and where floods and ice gorges could come suddenly from either the Allegheny or the Monongahela, was rigorous and risky. Damtender Harry Weibush was killed in 1899 when a boiler powering the lock machinery exploded (seventeen days after it had passed safety inspection). The fast launch *Wenonah*, stationed at Davis Island under Inspector S. H. Fowler to serve the lock force and to blow wrecked boats out of the channel with dynamite, got its prop tangled in a line while trying to assist the towboat *Emily Jung* in 1911 and was run down by the *James Moren*. Lockmaster Riggs saved his life by jumping from the *Wenonah* to the *Moren* at impact, but engineer James W. Dickey was sucked under the *Moren* and drowned.

Despite troubles and risks, basic operations methods used at all fifty of the locks and movable dams built on the Ohio by 1929 were worked out, and the experience acquired at No. 1 resulted in improved design at the downstream dams. By the time Davis Island Lock and Dam was replaced in 1922, nearly every part of the structure save lockwalls and



Dr. Leland R. Johnson

dam foundation at one time or another had been renewed or modified for improved operation and to prolong the life of the structure. Perhaps not "esto perpetua," as Merrill had hoped, but long enough to reimburse its costs several times and to have major impact on waterway engineering and design.

Bridge Rebellion on the Allegheny "Goliath"
Sibert made a serious mistake in 1902: he spoke to the Engineers' Society of Western Pennsylvania. He told the members that John Arras had nearly finished Herrs Island Lock and Dam (No. 1), had No. 2 at Six-Mile Island and No. 3 at Springdale under construction, and had authorization to extend slackwater to Monterey, 80.5 miles above the mouth of the Allegheny, but low bridges had destroyed steam packet service on the river and hampered other commerce.



Captain William B. Rodgers
Carnegie Library of Pittsburgh

"We see on the Allegheny River the only steel boat-building establishment in Pittsburgh, launching the hulls of its boats and floating them under the Union bridge, and then building the upper part in the unobstructed river below," Sibert said. "We see manufacturing plants on the Allegheny hauling their products by wagon to the Monongahela or Ohio River for shipment to the lower Mississippi River points, paying half as much for this hauling as it costs to transport the same material 2,000 miles to its market." The bridges would have to be raised to clear the way for commerce and also to prevent flood damages. He warned that eventually a flood and ice gorge would carry away the bridge superstructures, which would lodge on bridge piers below, form ice gorges, and cause appalling destruction in nearby communities.

Thomas Roberts, William Martin, and James Harlow of the Pittsburgh Engineer District had been charter members of the Engineers' Society, District personnel commonly participated in Society functions, and Sibert was a member. But Sibert's address to the Society on "Full Use of the Rivers at Pittsburgh" brought calls for his removal from the post of District Engineer. It was said he had prejudged the Union Bridge case and prejudiced himself.

Major William L. Sibert, a large fellow with the nickname "Goliath" because he had roomed with diminutive David Galliard at West Point, learned river engineering under the tutelage of Colonel Merrill and became Pittsburgh District Engineer in 1901. On arrival at Pittsburgh, he landed in the Allegheny bridge controversy, begun in 1899 when Congress gave the Engineers blanket supervision over navigation obstructions, including low bridges.

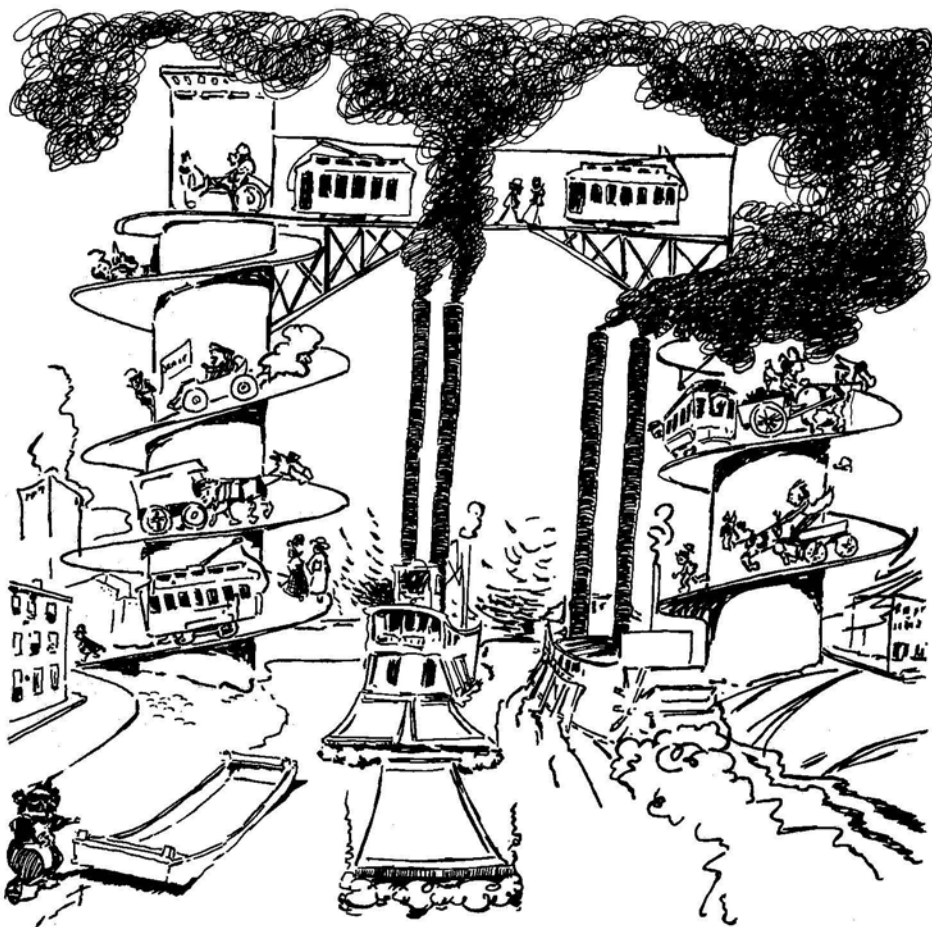
The Army Engineers had built many bridges: ponton bridges, trestle bridges, military road bridges, aqueduct bridges, and bridges on the National Road. Captain John Sanders in 1838 had prepared the original plans for a suspension bridge over the Ohio at Wheeling. From time to time, Congress gave the Corps jurisdiction over specific

streams and individual bridges, and made the authority general in the River and Harbor Act of 1899, directing the Corps to prevent obstruction of all navigable streams.

The Allegheny bridge problem had a long history, perhaps beginning in 1849 when rivermen of Wheeling tried to turn the tables on Pittsburghers by demanding raising of the bridges over the Allegheny as a nuisance to navigation and a violation of the Northwest Ordinance of 1787. Upset by Pittsburgh's demand that the Wheeling bridge be raised, people of Wheeling signed a petition advising Congress that: "aqueducts and three bridges have been erected across the Allegheny supported by innumerable piers, so constructed that boats and rafts cannot be navigated amongst them without danger to life and property, and these bridges and aqueducts are so low that steamboats cannot pass under them in any stage of the river while at high flood. The water reaches the woodwork of these structures, which completely shuts off every description of navigation, even descending rafts and keels."

All appeals for raising the Allegheny bridges were ignored, however, until the Allegheny River Boatmen's Association, founded in 1897 and later renamed the Allegheny River Improvement Association, took the case to the Corps of Engineers in 1900. Chief ringleader of the campaign to raise the bridges was Captain William B. Rodgers, owner of a dredging firm and unofficial successor to John Dravo as head of the Pittsburgh rivermen's lobby. Rodgers had been pilot of the *Little Bill* that was caught in a crossfire between striking workers and Pinkerton detectives at the Homestead steel mill in 1892. Captain Dravo's chief goal had been freeing of the Monongahela. Captain Rodgers had two related goals: raising the Allegheny bridges and slackwater navigation from Oil City to Cairo.

Captain Rodgers and his colleagues presented their charges against the Allegheny bridges at hearings before Major Sibert in 1902 and 1903, and railroads, private companies, and local



Cartoon ridiculing Colonel Sibert
Post Gazette - November 30, 1902

governments owning the bridges offered acrimonious opposition. Crowds attending were so large that Sibert adjourned the hearings to court rooms, where they took on the trappings of a trial.

"Perhaps never before in the history of the Engineer Corps was one of its members ever beset by abler and more persistent attorneys on the contending sides," declared Thomas Roberts. "The lawyers," Roberts said, "threw up such clouds of argument that the poor germs of truth were totally hidden from view."

Sibert's duties at the hearings more resembled those of judge than engineer. When an attorney learned from Roberts what Sibert was paid, he said: "Well, that's pretty damn tough. The Major has mistaken his calling. In a year's time he ought to be able as a consulting attorney to earn five times that pay. Where did he get his ideas of law, anyhow?" Sibert had never studied law, but had served under Chief of Engineers Henry M. Robert, author of *Robert's Rules of Order*, and he did his utmost to prevent legal machinations from obscuring the facts. The facts were that packets could not pass under the bridges an average of 52 days each year and small towboats were obstructed 17.7 days a year. Sibert recommended in 1904 that the government require raising the bridges.

Attorneys for the Union Bridge company, owners of the bridge nearest the mouth of the Allegheny, filed an opposition brief declaring that Sibert had prejudiced himself in his address to the Engineers' Society of Western Pennsylvania in 1902, that proceedings at the "mock" trial had been barbarous, that Sibert had even allowed testimony from "the ignorant class of people that generally composes the body of rivermen in the United States." For some time afterwards, attorneys who promenaded along the Pittsburgh wharves risked their lives.

The attorneys and bridge owners approached local congressmen to demand Sibert's removal from Pittsburgh. Captain Rodgers told the congressmen they would answer at the next election if Sibert were transferred. The Major asked the Chief of Engineers to bring libel suit against the attorneys, but the Chief refused, telling Sibert the charges from the attorneys would "injure those who prepared them more than those against whom they are directed." Sibert remained at Pittsburgh until 1907, when General Goethals called him to Panama.

The Allegheny bridge ruckus continued throughout the first quarter of the 20th century. Secretary of War Elihu Root in 1904 decided the bridges were not "unreasonable" obstructions, but his successor William Howard Taft disagreed and

appointed an investigating board which in 1911 recommended the bridges be raised, only to be overruled by a new Secretary of War.

John Arras and the Pittsburgh District completed Locks and Dams 2 and 3, extending slackwater to Natrona, by 1908, but work stopped there pending settlement of the bridge question. Congress in 1912 made construction of Locks and Dams 4-8 to extend slackwater on to Rimerton contingent upon raising the bridges. Chief of Engineers William M. Black, a former assistant to Colonel Merrill, inspected the Allegheny bridges in 1916. Black thought opposition to raising the bridges as ill-advised as the opposition he had encountered in 1881 to the Davis Island project; he ordered District Engineer Francis Shunk to submit a new report on the subject to Secretary of War Newton Baker.

On January 14, 1917, Secretary Baker made a secret visit to Pittsburgh and joined John Arras aboard the surveyboat *Kittanning* on a trip up the Allegheny. Arras took along the snagboat *General Theodore Schwan*, which had clearance requirements similar to those of packets, to graphically illustrate the bridge problem, though he did not emulate Edwin Stanton at Wheeling by ramming the boat into the bridge spans. Baker ordered, on March 23, 1917, that the bridges be raised, saying: "I have a confident feeling that the future of the city of Pittsburgh is of tremendous importance to the Nation, that by the order which I am now making I am freeing a great natural highway to contribute to the further expansion and growth of the city, and freeing the Allegheny River from obstructions which have until now prevented it being used, as it ought to be used, as a valuable part of the harbor of the city and a valuable artery of trade."

Enforcing Baker's order was deferred during the First World War, but in October 1920 General Lansing H. Beach, another assistant to Merrill who had succeeded William Black as Chief of Engineers, traveled to Pittsburgh to get the job underway. He met the Allegheny County commissioners and the Pittsburgh city council, who owned the bridges.

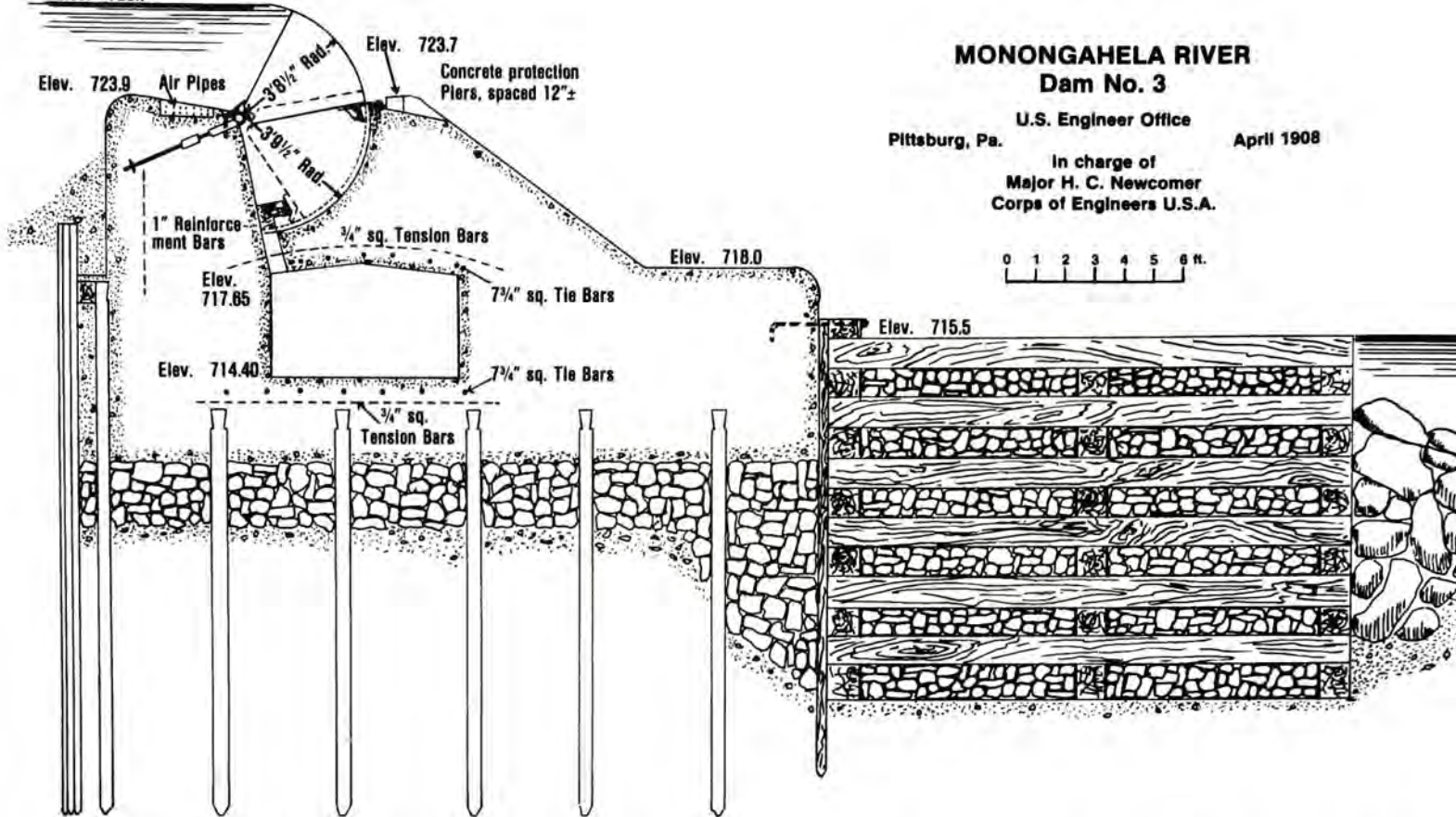
They told him they expected the November election to change the national administration and put in office a new Secretary of War who would rescind Baker's order. "Don't count on it," snapped the General. "I will be Chief of Engineers for several years and I intend to see those bridges raised!"

The new Secretary did not rescind the order, and General Beach returned to Pittsburgh in January 1922. He found that local authorities had not begun to raise the bridges and had not made plans for so doing. He came back in April. Still no progress. Instead, he heard vague threats of a new Whiskey Rebellion, or rather a "Bridge Rebellion." With patience exhausted, General Beach returned to Pittsburgh a fourth time on January 25, 1923, and delivered his ultimatum at the Duquesne Club:

The War Department has been long suffering—very patient—but this is at an end. It has become tired of asking the County Commissioners: "What have you done?" Now we will tell them what to do.

The plans for the Seventh and Ninth street bridges must be in the hands of my department by March 1. If they have complied, they will be instructed on or before April 1 what further the department will require. If they fail to comply with this order, legal proceedings will be immediately begun to enforce them. This will mean a fine of \$20,000 per month, which Allegheny County can shoulder until they have been carried out.

One determined soldier accomplished in 1923 what it had taken an army to do in 1794. Allegheny County surrendered, and when the General returned for inspection in July the work was underway. By 1929, the bridges had been moved, rebuilt, or modified to clear an adequate channel for navigation, and the Pittsburgh District had resumed construction of the Allegheny slackwater project. Had Allegheny County wished it done, the Corps of Engineers could perhaps have removed the bridges without cost, simply by dropping the paperwork generated by the thirty-year controversy into the Allegheny above the bridges at flood time.



Monongahela Reconstruction "A serious and remarkable disaster has occurred," reported Major Charles Powell. "On December 13, 1899, a passing freight train jarred the landwall of Lock 2 at Port Perry on the Monongahela loose from its backing and it fell on a towboat and tow in the chamber. Immediate repairs are necessary; in fact, all the locks and dams we acquired from the navigation company need repairs or rebuilding."

Thomas Roberts had Lock 2 pumped out for repairs when "Goliath" Sibert, successor to Powell as District Engineer, made inspection. Sibert looked at No. 2, built in 1841 with a second lock added in 1853, saw that collapse of the entire structure was imminent, and shook his head: repairs were a waste of time and money. As he and Roberts traveled upriver to inspect the other structures, Roberts explained how, over the years, he had propped lockwalls with stonefilled cribs to prevent their toppling over, how he had dropped tons of stone into lock chambers to hold buckled floors down while they were pinned with anchor bolts, and how he placed 30-inch timber flashboards atop the crests of the leaky dams to hold pools for navigation during droughts.

Recognizing complete failure of the Monongahela system was possible, even probable, Sibert went immediately to Washington to outline the situation for the Chief and to congressional committees. He explained that blockage of Monongahela navigation would mean unheated homes and plants without

power from Pittsburgh to New Orleans, plant shut-downs and unemployment, and, in short, economic disaster. His argument was fortified when Lock 3 caught fire and burned for two months; fill behind the lock guidewall, dredged from the river, had included coal waste from riverside mines and wrecked coalboats.

Sibert proposed extensive remodeling of locks and dams 1 and 4 and construction of new locks and dams replacing Nos. 2, 3, and 5. All were to have double locks, each 56 feet wide and 360 feet long to accommodate a towboat and three barges in a single lockage. The dams were to have movable crests to supply deeper pools at low water. Congress approved emergency replacement of No. 2 in 1902 and approved the entire reconstruction project the following year.

Principal Engineer Roberts, assistants John B. Dimmick, H. W. Brecht, and William D. Fairchild, and Captains A. E. Waldron, F. C. Boggs, and Lewis M. Adams supervised reconstruction of the lower Monongahela structures and finished the job by 1912. They rebuilt No. 6 with a new double lock in 1915 and also undertook improvements at Nos. 7, 8 and 9.

Chief innovation on the reconstruction project was use of adjustable crests atop the fixed dams to obtain an extra three-foot pool depth. Roberts had installed flashboards on Monongahela dams each summer after 1893 by inserting iron pins into bored

holes in the tops of the dams and securing two courses of planks to the pins. A party of a dozen men could place flashboards on the 962-foot long Dam 1, with a foot of water flowing over its crest, in a day. Drift often smashed the boards, but replacement was cheap. When the lower river dams were rebuilt from 1904 to 1912, Chittenden drum weirs at Dams 2 and 3 and Betwa wickets at Dams 1 and 5 were substituted for flashboards.

General Hiram M. Chittenden, who surveyed Lake Erie to Ohio River canal routes in 1896, directed preservation of Yellowstone National Park, revived the Charles Ellet reservoir scheme, and, in spare time, wrote monumental histories of the American West, also invented the drum weir. As an experiment, Chittenden drum weirs were placed on the back channel dam at Davis Island in 1904 and on Dams 2 and 3 on the Monongahela in 1906 and 1908. The hollow metal drums, placed in cavities in the top of the fixed dams and raised by piping compressed air into them to make them buoyant, could be easily lowered to pass drift, ice, and flood water. The problem was getting them back into position to hold additional summer pool: they leaked air and filled with water and mud, drift blocked their valves, and acid wastes from Monongahela mines corroded them in short order. Roberts still had to place flashboards so his crews could work on the drums to get them up, and annual repair costs were ten times the costs of flashboards. "If many dams are provided with the drums," warned Roberts, "the repairmen will have but little time for other work."

District Engineer Henry C. Newcomer launched a worldwide search for a substitute for the Chittenden drum weirs and found it at Betwa Dam at Paricha, India, where the Royal Engineers had 300 steel shutters or wickets, each 12 feet wide and 6 feet high, on the crest of the 3,600-foot long Betwa Dam. Major Newcomer realized Monongahela ice and drift might interfere with Betwa wickets, which were designed to trip automatically when water reached a certain height, but they could be built for a third the cost of drum weirs so he directed they be placed on Dams 1 and 5 as an experiment.

"It is absolutely impossible to make them trip automatically at the desired height," Colonel H. W. Stickle admitted to the Chief of Engineers in 1918, after several years of experimentation. Betwa wickets would not serve on the Monongahela: boat waves tripped the wickets at inopportune moments; drift lodged on wicket bases and prevented tripping at the proper time. Besides, riverside industry wanted fixed crests to stabilize water supply, so Stickle recommended an end to experiments with movable crests and embedding the drums and wickets in three feet of concrete. It was done.

On to Fairmont "Inflation has been a real problem in this District," "Goliath" Sibert wrote in 1901 while explaining his worries about the project to build six locks and dams between Morgantown and Fairmont. Because prices had increased by more than 30% between 1897 and 1901, the first contractor for the six locks and dams had lost money and abandoned his contract after only 10% of the work was finished. He was concerned that the new contractors might also fail, and even if they were successful there was still the low railroad bridge that would prevent boats from steaming up to Fairmont. Sibert had problems, but he would receive little sympathy from West Virginians who had sought the project for more than a half century and who would be angered by any further delays.

Ever since General John G. Jackson had begun construction of a slackwater project in 1817 on West Fork of the Monongahela, people of the upper Monongahela basin had sought improved navigation. After private and state efforts had failed, they had appealed to Congress and had won a survey of the upper Monongahela in 1875. That year, Thomas Roberts made the survey and reported favorably on construction of six locks and dams, Nos. 10 through 15, to extend slackwater to Fairmont and permit development of coal and other area resources, but Congress did not fund the project until 1892 and then provided funds sufficient only for Lock and Dam 10. Congressman Alston G. Dayton of Philippi and other West Virginians persevered in their campaign on behalf of the project until Congress made sufficient funds available in 1898 for construction of



Monongahela boat jam

all six concrete dams with locks, each 177 feet long and 56 feet wide in the chamber.

Engineers Philip Golay, I. N. Lucas, J. A. McCulloch, and J. L. Callard at a District suboffice at Morgantown supervised the work of contractor C. I. McDonald, who won the contract for construction of all six structures and began work in 1898 at Nos. 10 and 11. Inflation eroded the contractor's capital, however, and by the autumn of 1899 he was in hot water on the Monongahela.

District Engineer Charles Powell learned McDonald was working his men 33 hours at a stretch until they were nearly sleepwalking. "You are working your men until they are incompetent," he warned the contractor. "A sand and gravel mixture was actually placed in the lockwall because sleepy men at the mixer wholly omitted cement," said Powell. "You must work your men in shifts." McDonald threw in the towel after finishing only parts of Nos. 10 and 11.

Under strict surveillance of Major Sibert and his inspectors, the new contractors, Baker and Judson at Nos. 10 and 11 and T. A. Gillespie at Nos. 12 to 15, went to work vigorously in 1901 to finish the job before inflation finished them. They had the six

locks and dams ready for traffic by the end of 1903, but Major Sibert could not open the river into Fairmont until a railroad bridge 1.5 miles below Fairmont, which had only 27.5 feet clearance over the channel, was removed.

At a hearing in early 1904, railroad attorneys asserted that raising the bridge was unnecessary because river commerce at Fairmont amounted to only 152 tons in 1903 and would never amount to a hill of coal. Major Sibert told the Chief of Engineers that when the company built the bridge in 1884 it had agreed to raise it when the slackwater project was built, that commerce on the upper Monongahela below the bridge in 1903 had included 92,831 tons of freight and 18,682 passengers. He produced a photograph of the steamer *Isaac Mason* and ten barges loading 4,000 tons of lumber just below the bridge because it could not get above. He asked the Chief to bring charges of perjury against the company attorneys and to require the raising of the bridge. Legal action ceased, however, when the company agreed to do what it had promised in 1884.

The tiny steamboat *Gazette* got under the bridge on March 18, 1904, and was first to reach Fairmont on slackwater. The steamers *Wabash*, *Pastime*, *J.O. Watson* and the towboat *John F. Klein* entered the

Fairmont trade, and, after the bridge had been removed, the large sidewheel packet *Columbia* reached Fairmont on May 3, 1907, and inaugurated regular packet service. The Parkers Run Coal Company, located in the pool of Dam 15, began coal delivery by river to McKeesport Tinplate Company.

Monongahela Boat Jam Sunday morning, July 20, 1902. Pilot Frank Ganoe backed the *Elizabeth* from Morgantown wharf and left for Pittsburgh. Frank Williams moved the *I. C. Woodward* away from the wharf at the same time. The *Elizabeth* belonged to the Monongahela River Packet Company, the *Woodward* to the rival Pittsburgh, Brownsville and Morgantown Packet Company, and the pilots of the competing boats were determined to be the first to Lock 9 at Hoards Rocks, for the first boat through the lock would win most of the freight and passengers waiting at river-side above Pittsburgh. Nearly side by side, they raced down the ten-mile pool of Dam 9 and put on full steam as they hove in sight of the lock.

Lockmaster Benjamin Hoard heard their whistles and strode out on the lockwall to welcome them. He watched with amazement as the two boats, smoke boiling from the stacks and paddlewheels churning the water, bore down on the lock. Frantically, he tried to wave them off. Neither pilot slowed, neither gave an inch, and the two sidewheelers simultaneously crunched into the lock entrance.

When swearing subsided, the lockmaster asked both pilots to back the boats off. Neither would budge. He threatened them with every regulation in the book, and the answer was still no. Both were first at the lock. Finally he returned to the lockhouse and called the company superintendents and at last arranged orders for Williams to back the *Woodward* out of the lock entrance and let Ganoe take the *Elizabeth* through first. Damage was not serious, acrimony faded, and the two pilots later became friends and business partners.

Actual jamming of a lock was rare, but quarrels over precedence were common. There was the time

Abram F. McGowan at Lock 4 became puzzled about a beer boat that had a passenger license. Passengers packets were locked before towboats. McGowan told the District Engineer, however, that the beer boat steamed up and down the Monongahela, landing at any place to deliver kegs of beer, but took no passengers because the captain thought them a bother. The District Engineer surmised that the beer boat had obtained a passenger license merely to avoid lockage delays, and he ruled it should not have precedence over towboats. Beer delivery on the Monongahela slowed.

Experienced employees of the Monongahela Navigation Company remained on the job after the river was freed in 1897, and they served the Pittsburgh District well. Somehow, the name of the last navigation company employee to retire from the service seemed appropriate: Joseph Allfree began his service as a waterboy for the navigation company in 1892, spent many years as assistant lockmaster at Lock 4, and retired from the Pittsburgh District in 1940.

Experienced, capable, and dedicated lockmen were vital on the Monongahela, where for many years traffic was heavier than on any other stream in America and where difficult and hazardous situations often occurred. In 1909, for instance, the pilot of the *Stella Moren* lost control of his tow in the upper approach to Lock 2 at Braddock and the tow began to swing downstream, pivoting across the upper end of the lock guard wall. Lockmen tossed lines to the steamer and one jumped onto the boat, offering to cut it loose from the tow to save it. The pilot would not permit it, the mooring ropes snapped, and both boat and barges went broadside over the dam and wrecked.

In addition to employees, the Pittsburgh District inherited from the navigation company the repair steamer *Slackwater*, a few derrick and pump boats, and a repair shop near Charleroi at Lock 4. The Lock 4 repair station was comprised of a machine shop and forge that turned out metal parts for boats and locks, a saw and planing mill that produced lumber



for lockgates, boats, and flashboards, and a boatyard for the building and repairing of floating plant. In 1905, alone, the boatyard built 7 lock-service flats, 6 stone scows, 2 concrete mixer flats, a piledriver boat, a derrickboat, and 3 new lockgates.

The Engineers constantly sought methods to mechanize lock operations and speed traffic. Monongahela lockgates had first been opened and closed by chains winding on handpowered capstans. In 1876, Superintendent George W. Lutes at Lock 3 installed a waterwheel in the current passing over the dam and applied its power to lockgate operation and to the haulage of tows in and out of the chamber through a system of drums, shafting, clutches, and gearing patented by lockman Tom Pollard. The system opened a lockgate in thirty seconds, an eighth of the time the job took by hand, saving labor and speeding lockage. It was also installed at Locks 1, 2, and 4. The system allowed lockmen at No. 1 to handle 58 boats and barges transporting 63,118 tons of coal in twenty-four hours on December 17, 1881, and do it despite a four hour suspension of lockage while boat pilots argued about precedence.

After 1897, Pittsburgh District installed small steam plants at some locks to power the operating system, and about 1920 William D. Fairchild, successor to Thomas Roberts as Monongahela Principal Engineer, placed a water turbine in Dam 5 to generate electric power for operations; turbines were also installed at Dams 7 and 8 in 1924. Though steam packet service was drawing to a close on the Monongahela by 1920, growth of coal commerce continued and mechanized lock operations were sorely needed.

The elaborate passenger packet *Columbia*, with 75 staterooms, burned in 1910; the *Valley Gem*, last packet in the Fairmont trade, was cut down by ice in 1918; and the *Leroy*, last packet on the run to Morgantown, left the Monongahela in 1921. Passenger packet service ended in the early 20th century and inland river commerce in general dwindled toward its lowest ebb about 1920; but Monongahela coal shipments continued to increase, climbing to 21.8 million tons in 1924 and winning the sobriquet "Little Giant" for the Monongahela because its tonnage was greater than that of any other inland stream and larger than tonnage handled through the Panama Canal. Monongahela traffic moved at an estimated annual savings of \$14 million, though the federal government had invested a total of less than \$11 million in the Monongahela project prior to 1924.

On to Cairo Because it was a growing industrial center and because West Virginia had no District Engineer office, Major William H. Bixby recommended Wheeling in 1900 as the location of a new District office to have responsibility for construction of Ohio River locks and dams. Bixby explained: "Major Powell at the Pittsburgh office is already overloaded with work; Captain Hodges at the Second Cincinnati office has already about all that one officer can properly attend to; and I, at the other Cincinnati office, have my time so occupied with the general work of the Ohio River, surveys, snagging, dikes, low dams, channel dredging, special dredging, ice piers, harbor lines, special permits, etc., that I cannot give to the movable dam construction the personal attention that it ought to have."



Slackwater crew

Opposite Page:
Repair steamer *Slackwater* put to work -
Dam 11, Monongahela River

Persuaded by Major Bixby's argument, the Chief of Engineers sent Captain William E. Craighill, son of the officer who directed the fortification of Pittsburgh in 1863, to Wheeling on November 16, 1901, to open a District office at 500 South Broadway. But Pittsburgh rivermen were not at all pleased with supervision of the Ohio River dams by an Engineer officer and staff at rival Wheeling.

Captain Craighill agreed with the rivermen about Davis Island Dam; it was properly part of Pittsburgh harbor, and on January 20, 1902, he transferred it to Major Sibert at the Pittsburgh District. The Davis Island transfer did not satisfy Pittsburgh rivermen, however, and they took their complaint to Senator Matthew S. Quay of Beaver, Pennsylvania. Senator Quay accused Captain Craighill of firing Pennsylvanians from the Ohio River project, replacing them with West Virginians, and asked the Chief of Engineers to investigate. "These men are my neighbors," Quay told the Chief, "and I had part in getting legislation for Davis Island Dam through the Pennsylvania legislature and procured legislation for dams 2-6. I take a personal interest in this project."

The Chief told the Senator the charges were groundless, that Craighill had laid off fourteen men at Davis Island Dam because William Martin at the Davis Island office was no longer directing construction of the locks and dams below No. 1. The explanation satisfied neither Quay, nor the Pittsburgh Coal Exchange and Chamber of Commerce, and in September 1902 they asked President Theodore Roosevelt to transfer the Ohio River slackwater project back to the Pittsburgh District. The President told the Secretary of War he wanted Senator Quay's request honored "if it is a possible thing."

The Chief of Engineers opposed the transfer, explaining that the Ohio River locks and dams had been supervised by the Cincinnati District, never the Pittsburgh District, and it was therefore impossible to transfer anything *back* to Pittsburgh. Pittsburgh interests, seconded by Senator Quay and Senator Boies Penrose, continued their political

pressures, however, and President Roosevelt, who apparently never fully understood the situation, issued an order on February 25, 1903: "The President directs that the Pennsylvania dams on the Ohio River be put under the control of the new Pittsburgh office."

Captain Craighill at Wheeling protested that if Engineer Districts were to be organized along state boundaries then the upper Monongahela project logically belonged to his District, but to no avail. Ohio River Locks and Dams 2 to 7, those located upstream of the Pennsylvania state line, were transferred on February 29, 1903, from the Wheeling to the Pittsburgh District, from Captain Craighill to Major Sibert.

Thus, "Goliath" Sibert, already involved in reconstruction of the old navigation company project on the lower Monongahela, construction of six new locks and dams on the upper Monongahela, and the bitter Allegheny River bridge dispute, had the locks and dams on the upper Ohio more or less thrust upon him. And he did not like what he saw on the Ohio, where locks and dams for six-foot slackwater were being built for the benefit of barge tows that normally drew more than eight feet of water.

The Nine-Foot Project "Have you ever been down the Ohio?" Sibert asked young Lieutenant George R. Spalding when he reported in 1903 to the Pittsburgh office.

"No, sir," Spalding replied.

"Ever been assigned to dam construction? Know anything about dams?"

"No, sir."

"Goliath" Sibert picked the lieutenant's records from the desk, leaned back in his swivel chair, thumbed through the papers a few moments, noted Spalding had just returned from combat engineering in the Philippines, and was satisfied. "Spalding," he said, "you have a good record and I'm



Dam 5, Ohio River, constructed 1898-1907

going to put you in charge of construction of Dam 3 on the Ohio. You will have some fine assistants who know their business and will handle the details, but I don't want you to finish the dam."

Spalding's eyes widened with surprise. "Don't finish the dam?" he asked.

"That's right," Sibert replied. "You finish the lock and the dam foundation, but not the wickets. I think Congress will soon approve nine-foot instead of six-foot pools and it would make us look silly to build dams for six-foot navigation, then turn right around and tear them out to install wickets for nine-foot slackwater."

Sibert explained that Congress had approved construction of Merrill Dam, Lock and Dam 6 below the mouth of the Beaver, in 1890 and construction of Nos. 2-5 in 1896, but funding had been meager and none of the dams below Davis Island were finished. He recalled that when he arrived in Pittsburgh Thomas Roberts and Captain William Rodgers told him that rivermen wanted nine-foot instead of six-foot pools for navigation on the Ohio because it would allow loading barges to an 8.5-foot draft instead of 5.5 feet and would improve the speed and maneuverability of tows, saving millions of dollars every year. He reminded Spalding that Congress had approved a nine-foot depth for the lower Mississippi and had approved construction of the Panama Canal, that the Pittsburgh to New Orleans water route was, as it had been always, the artery most heavily used by inland river commerce. "If a similar nine-foot depth were made in the Ohio, from Pittsburgh to Cairo," Sibert reasoned, "by the time the Isthmian Canal is completed, Pittsburgh will be in a position to place her products at tidewater at a cost that would enable her products to compete favorably in the world's markets."

When Lieutenant Spalding fully understood the situation and his duties, he left Sibert's office and headed down the Ohio to build, but not to finish, Lock and Dam 3.

At the time Sibert interviewed young Spalding, he and Captain Craighill of Wheeling District and Colonel G. J. Lydecker of Central Division were studying changing the six-foot to a nine-foot project. Congress had authorized the study in 1902, thanks to the work of Captain William Rodgers and Senator Matthew Quay. The three officers thought it clear that the Ohio River above Lock 6 was destined to be lined on both banks by industrial plants that would ship iron, steel, and other products downriver to the tidewater and international markets. They calculated that savings on shipments from Pittsburgh to New Orleans would be 32.5¢ greater per ton on a nine-foot than on a six-foot project, and they estimated that, with a nine-foot depth available on the Ohio and Mississippi and the Panama Canal completed, Ohio River tonnage would climb to 10 million tons a year, transported at an annual savings of more than \$3 million. "The greater the draft," the Engineers concluded, "the cheaper the transportation by water."

On the basis of the Sibert report, Congress in 1905 approved increasing the depths of the pools behind Locks and Dams 1 to 6 to nine feet, through use of longer wickets and a few structural modifications. Major Sibert then gave Lieutenant Spalding and his other assistants on the Ohio River project the green light. They finished Locks and Dams 2 through 6 in short order; but Congress still had qualms about approving nine-foot slackwater for the entire Ohio River. It might take as many as 54 locks and dams and would be extremely costly.

"I have never participated in anything like it," said Senator Joseph Ransdell of his trip with other members of Congress down the Ohio by steamboat in May 1905. "All the great cities on the river entertained us royally, and the smaller cities, too. As our palatial steamer landed, bands of music met us with beautiful airs, thousands of children waving flags and singing patriotic songs met us and every whistle and every bell in the community sought to bid us welcome. On every flag we saw were these words: NINE FEET FROM PITTSBURGH TO CAIRO."



The very birds in the valley sang Nine feet from Pittsburgh to Cairo. The winds whistled it, the waters of the river gurgled it."

"By the time we reached Cincinnati," Ransdell recalled, "we had become firmly convinced of the merits of the project, but the trouble was how to do it. Every Rivers and Harbors bill that I had ever heard about was accompanied by a universal cry of pork barrel and was looked upon as utterly unworthy of consideration and when one was passed, the friends of waterways were almost obliged to hang their heads in shame that they were participating; digging down in the treasury and stealing a lot of money. Vicious legislation—that was the idea."

At Cincinnati in 1905, Ransdell and his friends organized the National Rivers and Harbors Congress, with nationwide membership to support worthwhile waterway projects, and in Congress that year they won appointment of the Lockwood Board, chaired by Daniel W. Lockwood, a former assistant to "Padre" Merrill, to study the Pittsburgh to Cairo project. The Lockwood Board reported in 1906 that nine-foot slackwater would cost \$13 million more than six-foot slackwater to build, but transportation savings would be substantially greater. The trouble with the report was that Ohio River commerce in 1906 seemed stagnant at 9 million tons and estimated savings would only be realized if commerce increased.

The Board of Engineers for Rivers and Harbors (BERH), established in 1902 to eliminate pork barrel projects from consideration, thought the Lockwood Board's prediction that slackwater would stimulate increased waterways tonnage a viable concept and stamped its approval on the nine-foot project, but the Chief of Engineers did not concur.

He sent the Lockwood report on to Congress with the note that it was based on "conjectural future commerce rather than upon the commerce now existing or plainly in sight," and saying that he preferred to leave the decision on the matter to the wisdom of Congress.

Railroad officials described the proposed nine-foot project on the Ohio as foolish and preposterous. Railroads, they argued, will force packets from the rivers, eventually undersell coal transport by river, and end the barge towing business. John H. Peyton, transportation economist for the Louisville and Nashville Railroad, called the predictions of the Lockwood Board "astonishing," and declared that the locks and dams on the Ohio would, in the end, become mere "monuments to the folly of men."

"It seems to me," said President William Howard Taft in 1910, "that in the development of our inland waterways it would be wise to begin with this particular project and carry it through as rapidly as may be." With support from the Taft administration, Congress approved nine-foot slackwater from Pittsburgh to Cairo through construction of up to 54 locks and dams in 1910, and it promised to supply funds sufficient to finish the job by 1922.

Many people still doubted the job could be done, or that it would pay to do it. Even editors of the *Engineering News*, an influential trade journal, questioned the value of the project. "Unless the rivers can be made to carry a *very large volume of traffic*," they wrote, "the investment necessary to build dams and locks all along them is bound to be a losing one." The Ohio River was clearly thought a test case. If Major Sibert and the Lockwood Board were wrong, if the project were not successfully built and operated, if major waterborne commerce did not develop, the future of all waterway projects would be in jeopardy.



Pittsburgh - the Monongahela Waterfront in 1900

Painting by John Stobart

Courtesy of Bird in Hand Gallery, Swickley

Troubled by wrecks and losses on unimproved sections of the Ohio and on the Mississippi, meeting competition in the New Orleans market from Alabama coal and Oklahoma oil, the Monongahela Combine restricted coal shipments after 1916 to plants on the lower Monongahela and upper Ohio rivers. Heavy tonnage still moved on the Monongahela, but traffic on the Ohio hit bottom in 1917 when only 4,598,875 tons moved on the stream. "The Ohio," Thomas Roberts lamented, "has become very largely a playground for the owners of small locally owned boats engaged in short-distance transportation."

Chapter 11

SLACKWATER TO CAIRO AND OIL CITY?

"Pittsburgh is the seat of inland waterways transportation, more than equalling the present tonnage of the entire Mississippi and its tributaries below the city," wrote Thomas P. Roberts toward the end of his career. "Here were made," he said, "experiments with beartraps, chanoine wickets, rolling lockgates, and other devices leading to further improvements elsewhere on the river. Pittsburgh has been the school of experience."

As a child, Roberts had observed the development of the Monongahela slackwater; as a young man, he had participated in the 1866-67 survey of the Ohio and the 1878 survey of the Allegheny; as an elder expert, he had become chief assistant to the Pittsburgh District Engineer. He had seen the steamboat packet business at its peak and the beginning and flourishing of the barge-towing system during the 19th century, but by 1920 he had become worried that the slackwater projects to Cairo on the Ohio and to Oil City on the Allegheny might never be finished, for the packet trade was languishing and commerce on the Ohio had been halved in 1916 when the Monongahela River Consolidated Coal & Coke Company, the "Combine," suddenly ended long distance coal towing.

"In time, there must come on the Ohio," Roberts predicted, "steel barge lines towed in fleets for long-distance transportation, that is, freight towed in fleets separate from the miscellaneous light traffic possible for fast passenger boats." Frederick B. Duis, principal engineer at the Wheeling District, agreed. Noting that in 1917 continuous slackwater was open only about 200 miles to Dam 20, he predicted that commerce would revive when slackwater reached Cairo. William Hall, who had built the first monolithic concrete locks and fortifications in America and who was construction engineer on 16 locks and dams in the Wheeling District, compared the Ohio slackwater to a railroad between Pittsburgh and Chicago that had been completed only to Fort Wayne: it would not pay until finished.

Critics of waterway projects pointed to the apparent demise of Ohio River commerce in 1917 as an object lesson demonstrating the foolishness of federal waterway investments. Frank H. Alfred, president of the Pere Marquette Railroad, declared:

In the light of present experience, one is forced to the conclusion that the construction of these works was an economic waste. The Ohio is the one river in the United States on which there seemed to be a fair prospect of developing a large and important traffic. These great expectations have not been realized, and the writer feels it

must be admitted that the experiment is a failure.

The Steel Argosy Marine engineers in the headwaters district, from the building of flatboats and keelboats to the fabrication of steamboats, iron-hull vessels, and tank barges, had always been pioneers in design. That tradition continued in September 19, 1892, when W. H. Brown and Sons launched the first steel barge on the inland rivers at Brown's Station on the Monongahela. It was 125 feet long and drew 7.5 feet. John Arras, the Allegheny engineer, told builders of wooden barges not to worry, for the first steel barge had cost fully \$3,000 to build, was just as liable to sink after collision as wooden barges, and after sinking would become a dangerous navigation obstruction. "It is highly improbable," Arras predicted, "that they will come into general use."

Arras lived to see his prophecy prove false. The first steel barge built lasted 35 years and others were built. By 1910, American Bridge Company was building steel barges for Monongahela coal fleets, for American Steel and Wire, and for United States Steel. When Wheeling Steel built 40 barges in 1920, the age of the standard welded steel barge, that revolutionized inland river commerce, was fully underway.

Construction progress on the Ohio Dam 5, September 1905 - river mile 23.9, placed in operation November 1907



Just as Harry Oliver and the Pittsburgh ironmasters had rescued the Davis Island project from political destruction during the 1870's, so Pittsburgh and Wheeling steelmen saved the nine-foot slackwater project on the Ohio during the 1920's. When railroad congestion, railcar shortages, and nationalization of the railways disrupted normal deliveries during the First World War, the steel industry at the headwaters began to look toward the rivers. The interest of big steel in waterways transportation continued in the postwar years when the corporations at the headwaters lost their competitive edge in rail rates known as "Pittsburgh Plus."

The idea of marketing finished steel products by barge has been attributed to B. F. Jones, Jr., of Jones and Laughlin Steel Company. He could see tows of coal and raw materials moving on the Monongahela from his Ross Street office windows. At any rate, Jones and Laughlin Steel in October 1921 loaded barges with finished steel products and hired Charles T. Campbell and his towboat *Transporter* to push them to downriver markets. The first drive-in gasoline station in America had opened at Pittsburgh in 1913, and to serve that new business Campbell had moved the first gasoline tows on the inland rivers, pushing wooden barges containing cylindrical tanks full of gasoline from Sistersville, West Virginia, to the Atlantic Refining Company on the Allegheny at Pittsburgh.

Publicized by Jones and Laughlin as the "Steel Argosy," the voyage of Campbell's *Transporter* with its steel tow down the Ohio in late 1921 was an eye-opener. The steel tow reached St. Louis in fourteen days, as compared with nine days by rail, and the shippers saved about \$1500. Campbell's tows, carrying the products of Jones and Laughlin, Aluminum Company of America, American Bridge Company, National Tube Company, and Pittsburgh Steel, known as the "Million Dollar" tows, soon were running regularly to St. Louis and Memphis. Savings of up to \$3 a ton was incentive enough; McClintic-Marshall, Crucible, Carnegie, Wheeling, and Inland steel corporations began barging their



products south. They saved altogether about \$250,000 through use of the rivers in 1922.

With the end of long distance coal towing from Pittsburgh in 1916, costs of the Ohio River slackwater project, when calculated on the basis of ton-mileage, had jumped dramatically. Congress, which in 1910 promised sufficient funding to open slackwater to Cairo by 1922, had neglected the project, in part because of the World War emergency and in part because of dwindling interest in what seemed a losing proposition. With construction about half finished, the Engineers had been unable to begin work on new locks and dams on the Ohio in 1921 because of funding shortages. At that crisis, steel executives of the headwaters district threw their full support behind the project, cooperating with waterways groups, lobbying with congressmen, and even buying full page ads in newspapers and journals on behalf of slackwater to Cairo. In a speech to industrial leaders in 1922, Arthur E. Crockett of Jones and Laughlin Steel chided Congress for not canalizing the Ohio by 1922 as promised and asserted that the events of the World War had conclusively demonstrated the value of the project. "During this period, as never before, there was emphasis placed on the fact that we could have had better industrial functioning if these rivers had been fully canalized," Crockett commented. "Many a day some of you men here in this room," he continued, "no doubt were obliged to spend weary hours striving to move the products of your mines and mills, but the inadequacy of the railroads at that time was such that the free movement of much-needed materials was blocked, with the result that there were necessary delays that could have been very damaging to our cause."

The headwaters steel industry made completion of Ohio River slackwater an issue in the midterm elections of 1922, and that year a "waterways bloc" in Congress appropriated \$42 million for river and harbor projects, sidestepping charges of "pork barrel" by directing the Corps to allot the funds to meritorious projects. With those funds in hand, the Engineers laid plans to open slackwater to Cairo by 1929. Like Jason, the "Steel Argosy" had won the fleece.

Experiments at the Head of the Ohio Engineers are prone to disagree, even to argue, about proper structural design and construction methods. The Engineers on the Ohio River were no exception. As a result, though each lock and movable dam on the Ohio seemed alike to the novice, each differed in some respects from the others. This characteristic was especially typical of the Pittsburgh and Wheeling Districts, where design and construction experiments were first made.

An effort to achieve standardization began in 1907 with formation of the Ohio River Board and the Ohio River Design Force stationed at the Wheeling District. The Ohio River Board, with the Division Engineer as chairman and District Engineers as members, met regularly at Wheeling to seek standardization, but conditions at the site of each lock and dam differed materially. Each District Engineer and his staff also had their own ideas about proper design and construction methods, and the meetings often ended with quarrels. When a District Engineer presented his ideas, he was criticized, even ridiculed, by his colleagues.

The Ohio River Design Force, headed by J. A. McDonough, C. I. "Pete" Grimm, C. A. Peterson, and C.

Lock and Dam 5, Ohio River - completed structure

N. Connor, was transferred from Wheeling to Division headquarters at Cincinnati in 1915 and became part of the Division staff. During the First World War, while Engineer officers were in France and the Ohio River districts were commanded by civilians (John Arras at Pittsburgh, Robert R. Jones at First Cincinnati, Benjamin Thomas at Second Cincinnati, and William McAlpine at Louisville), the Division Engineer ended the troublesome meetings of the Ohio River Board. Thereafter, each District prepared its own plans for submission directly to the Division office, which undertook whatever coordination that was necessary.

When the nine-foot slackwater project got underway in 1910, work was divided among four Engineer Districts: Pittsburgh had the upper section to Steubenville, Dams 1-10; Wheeling had the section from Steubenville to Huntington, Dams 11-

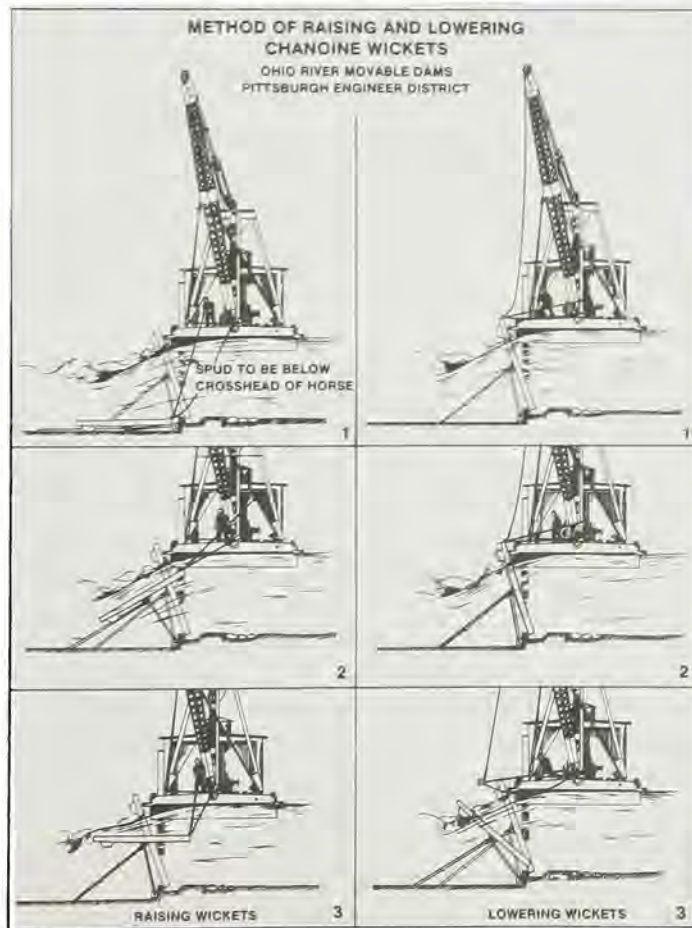


28; Cincinnati had the section from Huntington to Madison, Dams 29-40; and Louisville had the lower section, Dams 41 to 54 (Dams 40, 42, and 54 were eliminated through higher dams and location changes). When the District office at Wheeling was moved to Huntington in 1922, the Pittsburgh District boundary was moved downriver to include Lock and Dam 11.

Construction methods differed at each lock and dam, but perhaps those used at Lock and Dam 9 were typical. National Contract Company began work in 1910, first building 135-foot wooden towers on each bank to support cables used to deliver timber, stone, cement, and other materials from rail sidings and barges to different parts of the work. Under supervision of Karl H. Shriver and other Corps inspectors, the contractors built the lock, navigable pass, weirs, abutment, and guidewalls inside six cofferdams, beginning with the lock, in three working seasons.

The "Ohio River box-type" cofferdams used at No. 9 differed little from cofferdams used by Roman engineers twenty centuries earlier. Timber framing, held together with iron rods and wooden spacers, about 20 feet wide and 16 feet high, was built and sheathed on the sides with planks aboard barges and allowed to settle to the river bottom as the barges moved forward. After dredges filled the boxes with material from the riverbed, the boxes were decked over and banked on both sides with dredged fill.

The interior of the cofferdams was "unwatered" by pumps mounted on boats; excavation inside the coffer was finished; and rows of round wooden bearing piles were driven to bedrock by a derrickboat with swinging leads. Cement and aggregate moved to concrete mixers placed on the cofferdams in small carts pulled by men and mules along a railtrack laid atop the cofferdam; derricks swung the buckets of concrete to the wooden forms spiked to the top of the piles for the lock foundation; concrete for the dam foundation was moved by the highlines from the towers.



A-Frame construction - Dam 6, Ohio River



The lockwalls at Davis Island and Merrill Dam, Nos. 1 and 6, first two completed, were cutstone masonry, and lockwalls at the next four, Nos. 2-5, were natural cement faced with timbers. Lockwalls below No. 6 were of Portland cement, generally 5 feet wide at the top, 15 feet wide at the bottom, and with two recesses for lockgates in the landwalls.

Dams generally extended from the middle of the lockwall across the river, allowing space above and below the dam for valves to empty and fill the locks, but dams 8, 11, and 13 were located near the lower end of the lockwall in the hope of reducing scour. The experiment failed. Scour was not much lessened and the arrangement caused turbulence in the lower lock approach because emptying valves were located in the lower lockgates.

The Pittsburgh and Wheeling Districts also experimented with various movable dam weirs as substitutes for chanoine and beartrap weirs, which were used to pass rises and maintain pool levels. A-frame trestle wickets, invented by Benjamin Thomas of the Cincinnati District, were installed in a weir section next the bank at Dam 6. Located below a gravel bar, the A-frames were covered with gravel while collapsed against the foundation and it was necessary to build a cofferdam and clear away the gravel with picks and shovels before the trestles could be raised. They were never again lowered. Thinking the experiment had been a failure, John

Arras replaced the A-frame trestles with a fixed concrete weir in 1923. A-frames were never again tried on the Ohio, but the Nashville District installed them in 1933 on the crests of Cumberland River dams and made them work.

Automatic wickets, invented in 1908 by Guy B. Bebout of the Wheeling District, were placed in the navigable passes of Dams 13 and 18 in 1914-15. Bebout wickets resembled chanoine wickets but with support and hinge assembly designed for automatic collapse when water of upper pools reached a certain stage. Boat waves and drift sometimes tripped them, always it seemed on Sundays or holidays, and a maneuverboat and crew had to go out to raise them. That disadvantage resulted in sparing use of bebout wickets.

A reverse Parker beartrap with three leaves, invented by a Wisconsin lumberman, was installed at Dam 13 in 1909. The seventh time the beartrap was raised, its third, or middle "idler" leaf failed, and repairs were expensive. It was replaced in 1923 with a two-leaf beartrap and thenceforward only the old two-leaf beartrap, based on a rational design formula devised by General Hiram M. Chittenden, was used on the Ohio. The beartraps at Dam 13 never did work properly, however, and it took special air compressors to force them upright.

By October 31, 1915, the Pittsburgh District had finished construction of the ten Ohio River locks and dams on its river section. The Wheeling District had nearly completed the work on its section of the Ohio when that office was moved to Huntington in 1922. Cost estimates made in 1910 assumed the cost of an Ohio River lock and dam to be \$1.2 million where the river was 1200 feet wide, adding \$400 for each additional foot of width. Actual costs on the upper Ohio averaged close to that estimate, but dams built on the lower river after 1920 cost more. The Pittsburgh and the Wheeling Districts had done their jobs well, but before the downstream districts opened slackwater on to Cairo the locks and dams built on the upper river for a six-foot project before 1908 had reached the end of their usefulness.



Movable dam



Fixed dam

First Fixed Dam on the Ohio "How do you explain your high operations costs?" asked General Beach. Lansing Beach, Central Division Engineer, like his mentor William Merrill, was a blunt, sometimes caustic fellow. When he visited Colonel Francis Shunk at Pittsburgh in 1915, he was upset because operation-maintenance costs at Ohio River dams in the Pittsburgh District averaged \$15,000 annually, while the Wheeling District held those costs down to \$12,000.

"This is a headwaters district, with steeper slope and swifter runoff than in downstream districts," Colonel Shunk replied. "You know the river falls nearly 35 feet in its first 19 miles. It rises so fast we must begin lowering wickets at an eight-foot stage, or we can't get them down; and often we can't raise them before the river falls to seven feet. And

because ice gorges come from either the Allegheny or Monongahela, we must maneuver the dams more frequently in winter than downstream districts. All these increase operation costs. Repair costs are rising because we have the oldest dams on the Ohio and have six dams built for six-foot slackwater that are holding nine feet."

General Beach was unimpressed; he had heard it all before. "How do you propose to bring your costs in line with those in other districts?" he asked.

"A fixed dam to replace Nos. 1 and 2 would reduce our operations costs at least \$5,000 a year. Our repair costs at 1 and 2 are steadily climbing. Davis Island is thirty years old. We have repaired it 123 times; the sandstone walls are gouged and worn; its design is obsolete."

General Beach smiled, for he had had a hand in designing Davis Island, and asked, "What about No. 2?"

"The natural cement in the lockwalls is crumbling and the sill of the navigable pass is 1.5 feet above the low-water plane. The dam is at the head of Merriman's Run, where the fall is nine feet in two miles. The river bottom has changed since we built the dam, and when tows go through the pass the turbulence raises wickets, which punch holes in the barges and ruin the wickets."

Colonel Shunk called John Arras to the office, and the two spread maps and blueprints along the conference table. After they had explained their plans for a fixed concrete dam with double locks at Emsworth, 1.5 miles below Davis Island, General Beach commented, "You know the pilots' association and coal shippers will oppose it, don't you?"

"Don't they always," the Colonel replied with a grin creasing his face. "Conditions have changed here, General. Coal tows now go down to Dam 6 at the mouth of the Beaver, sometimes all the way to the end of slackwater, to wait for a rise, and they no longer need movable dams above the mouth of the

Below: Emsworth Dam, Ohio River - installing lower lock gates, outer lock

Beaver. We will have the support of industry located along the river; they want fixed dams like on the Monongahela for constant water supply and regular coal delivery. The Jones and Laughlin plant at Aliquippa has to stock 160,000 tons of coal reserve each winter because they can't get coal at times when the dams are down."

"The people of Pittsburgh," Beach interjected, "oppose a fixed dam that would increase their flooding problems."

"General, if that were so I would not recommend a fixed dam, but it is not. My deputy, Captain Harold Fiske, and Thomas Roberts calculated the effect of a 21-foot high dam at Emsworth and found it would have negligible influence on flood stages at Pittsburgh. Our only problem will be proving it to the public."

"All right," Beach said, "if our choices are either rebuilding dams 1 and 2 or building the fixed dam, let's get our ducks in a row. Send your recommendation to me and I'll forward it to the Chief with approval."

Colonel Shunk set up a public hearing on the Emsworth project at Pittsburgh on January 29, 1915, and arranged the return of Colonel William Sibert from Panama to testify at the hearing on behalf of the fixed dam. Sibert had proposed fixed dams for the upper Ohio in 1902, but opposition had been violent at the time. Shunk also asked the City of Pittsburgh and consulting engineer organizations for independent studies of the effect of a fixed dam at Emsworth on flood crests. The city, through its flood commission, had distinguished civil engineer Morris Knowles undertake the study, and he concurred with Roberts and Fiske: the effect of Emsworth Dam on extreme floods would be minor.

Shunk's advance work and the Knowles report allayed but did not stamp out opposition. As Shunk had predicted, the river pilots association vehemently opposed: it was happy with the old movable dams and it warned that fixed dams would



block river navigation and increase flood damages at Pittsburgh.

While the Chief of Engineers was considering the objections from rivermen, the reason for their opposition ended in 1916 when the Monongahela Combine stopped long distance coal shipments. When Congress approved Emsworth Locks and Dam on August 8, 1917, the immense coal tows that had run from Pittsburgh to New Orleans since 1854 no longer wended their way between bridge piers and through the passes of the movable dams. Ohio River commerce had reached its nadir, and need for movable dams on the upper river no longer existed.

Because a fixed dam at Emsworth, unlike movable wicket dams, could not pass traffic through a navigable pass when the lock was closed, the District planned two locks, one with standard 110 by 600 feet Ohio River dimensions and the other with standard 56 by 360 feet Monongahela dimensions, each with a 13-foot lift. Double locks allowed lock repair without closing navigation, permitted lockage of two tows simultaneously, and could conserve water during droughts through use of the smaller lock. Lockgates were the swinging mitering type, all steel. The novel feature of the 21-foot high concrete dam was the long downstream slope and apron designed to shoot water downriver away from the dam to prevent scour; that feature was not very successful.

Under supervision of John Arras and William Fairchild, Dravo Contracting Company began construction of the Emsworth project in 1919, using Ohio River box-type cofferdams, whirler cranes for excavation and materials handling, and the first floating concrete mixing plant on the inland rivers.

Completed at a cost of nearly \$3 million, Emsworth Locks opened to navigation on September 1, 1921, before Dams 1 and 2 were removed. Davis Island Lock ceased operations on August 3, 1922, Lock 2 closed later that month, and the stone from the two structures was removed to serve as riprap on the downstream side of

Dashields Dam, Ohio River - right bank abutment construction



Emsworth Dam. The pioneer Davis Island Lock and Dam, after 37 years of operation, thus became part of the experimental Emsworth project, the first fixed dam and first double locks on the Ohio. General Beach directed that plans for additional fixed dams be held up until rivermen and Pittsburghers became convinced that the fixed dam at Emsworth was no threat to their business or property.

The Story at Deadman's Island A salesman strode into Thomas Roberts' office at Pittsburgh in 1905, dropped his case on the floor, plopped into a chair next to Roberts' desk, and delivered a high-pressure spiel about the interlocking steel sheetpiles for cofferdams he was selling. He propped books in the middle of the desk to serve as make-believe bridge piers and rapidly surrounded them with models of the interlocking piles.

Roberts interrupted the sales pitch with a question, "What happens if a pile strikes a tree trunk 20 feet down in the gravel?"

The unabashed salesman chuckled and replied, "Why, you pound away until you cut right through it!"

"What if you hit a boulder?"

"That's easy. Now here's your ink stand; it's the boulder. When I come to it I start a curve and go



Major Edmund L. Daley

right around it and get on the line on the other side, see, just as slick as a wink."

"But suppose," Roberts countered, "it's a nest of big boulders."

"Well," the salesman drawled, scratching his head, "you keep on curving around and you'll get through all right."

Roberts glared at the huckster. "That's just it," he said. "You salesmen and all the books and the so-called authorities know all about cofferdams, except the trifling point of getting them securely in place at the desired depth so we can pump them out and get on with our work. We can get more advice that we can use up to the time we begin work, but when boulders, tree trunks and quicksands are encountered and big springs come boiling through fissures in the rock into the cofferdams, where are you salesmen? *You* are hundreds of miles away, setting up your models on someone's office table."

Taken aback by the tirade, the salesman glanced furtively at the door, but Roberts had not finished.

"No two jobs are alike on these three rivers," Roberts continued, "and each job seems meaner than the last. When we get a leaky cofferdam, we get help from men on the job. A dredge runner once found a leak for me by dropping a weighted gumball on a cord outside the dam and feeling nibbles on his line like a fisherman; one of my blacksmiths once stopped a leak by dumping ashes around the coffer to plug it; and my pumpmen have stopped leaks by inserting pipes into crevices and running grout mixed with chopped rope down the pipes. But I never got help from you experts. We will use wooden box cofferdams, we have used them a hundred years, and we will not use your expensive gadgets!"

Realizing the interview had ended, the salesman swept his models from the desk into his case and stalked out of the office. Thomas Roberts leaned back in his swivel chair until the door slammed, then returned to his work.

Until Thomas Roberts retired in 1923, interlocking steel sheetpiles were not used in cofferdams built by the Pittsburgh District, but in 1911 the Corps first used such cofferdams to raise the battleship *Maine* from the floor of Havana harbor. About 1919, Districts downstream from Pittsburgh used steel sheetpile cofferdams at Ohio River dams 23, 25, and 34 because they could be built to greater height and with less banking than wooden box cofferdams. But higher costs of the steel cofferdams and the difficulty of pulling the steel piles after the job was finished seemed to outweigh their advantages. The Contracting Division of Dravo Corporation, however, insisted in 1926 on use of steel sheetpile cofferdams in construction of Dashiels Locks and Dam, planned by the Pittsburgh District to submerge one of the three major falls on the Ohio.

"This continual menace to navigation must be obliterated," Major Edmund L. Daley wrote in 1925 when he recommended construction of the Dashiels project. Below Emsworth Dam, in the pool of movable dam No. 3, were Merriman's Ripple, White's Ripple, and the Trap, a near continuous rapids ending at Deadman's Island that had been ranked with Letart Falls and Louisville Falls as the most dangerous obstructions on the river. When the wickets of Dam 3 were up, the falls were submerged, but when down a high velocity current made navigation difficult. In 1926, the Chief of Engineers approved Dashiels Locks and Dam, named after pioneer David A. Shields of Shields Station near the project site, at Deadman's Island, 13.3 miles below Pittsburgh, to replace Dam 3 and permanently submerge the ripples above.

The Pittsburgh District permitted Dravo Contracting to use cellular steel cofferdams while building the 1585-foot long concrete dam. The cellular cofferdams consisted of 40-foot diameter cells, made of a hundred steel sheetpiles driven to rock with the interior filled and capped. The Dashiels experiment worked: cellular cofferdams proved exceptionally watertight, extended the number of working days, and allowed easy access to



Failure of cofferdam at Dashields Island Dam, June 1929
(See page 173)

the work through use of whirler cranes mounted on the cells.

More evidence of the value of cellular steel cofferdams was furnished on June 5, 1929, when an Ohio River wooden box cofferdam at the lower end of the 110-foot Dashields lock chamber failed. A man at work on the pumps on the lock floor heard a crashing noise, looked up to see water breaking through the cofferdam, and "instantly" scaled a ladder out of the hole to rouse men on the boats tied next to the dam. Captain Silas Sayre and his crew barely escaped when the pumpboat, derrickboat, coalflat, and survey steamer *Kittanning* were drawn into the breached cofferdam and sunk. John Arras, E. H. Beechley, Charles Wellons, R. C. McCullough, and Jack H. Dodds investigated the failure and found the rupture of the dam had been instantaneous, probably due to a defective rod or oak stringer inside the box coffer. It was an expensive lesson that in combination with the success of the steel sheetpile cells at Dashields resulted in increased use of cellular cofferdams at other projects.

Another innovation at Dashields was placement of steel armoring on the lockwalls. Steel barges, used extensively after 1920, gouged furrows and broke the vertical corners of lockwalls, requiring lock closure for expensive repairs. Charles Wellons and the District engineering staff conducted experiments with lockwall armoring. Some steel plate types were crushed by barges and railroad rails embedded in the concrete walls were soon broken loose, so those systems of protection were rejected in favor of cast steel armor, which was first installed at Allegheny Lock 6 and at Dashields Locks. Armoring lockwalls became standard practice on all inland waterways.

When the Ohio River dedication pageant, celebrating completion of nine-foot slackwater from Pittsburgh to Cairo, passed down the Ohio in October 1929, Dashields Locks were not completed, but District Engineer Jarvis J. Bain arranged installation of improvised machinery to operate the lockgates and valves and locked the pageant

through without difficulty. The second fixed dam with double locks was thus in operation in Pittsburgh District by the time the last movable dam was completed near Cairo.

Cairo at Last The media called it "Pittsburgh's Greatest Celebration." Perhaps it was. It began the rainy evening of October 17, 1929, when 1400 people packed into the grand ballroom of the William Penn Hotel for a dinner and orations honoring completion of the Engineer nine-foot slackwater project, Pittsburgh to Cairo. At the speakers' table were Mayor Charles Kline, Governor John Fisher, five members of the President's cabinet, six railroad presidents, one riverman, and one engineer. Most politicians and railroad men had an opportunity to express their quasi-approval of the nine-foot project at length. The riverman, Alexander Dann of the Coal Exchange, introduced the toastmaster; but the crowd had no opportunity to hear the engineer. That was regrettable. General Lytle Brown, Chief of Engineers, might have described his nasty encounter with Ohio River mosquitoes and shoal waters during his 1909 survey to locate lock and dam sites for the nine-foot project, or perhaps regaled the crowd with an account of his experiences in Cuba in 1898, when he built roads and river crossings under Spanish fire and joined the Rough Riders in the charge up San Juan hills.

Toastmaster James Francis Burke, the golden-tongued orator who had spoken at the "Free Monongahela" jubilee in 1897, broke the ice in the ballroom by proposing that those present form an "American Council of Transportation" to coordinate railway, waterway, highway, and airway systems. Every subsequent speaker seconded the proposal, but it came to naught. Doubtless the highlight of the evening was the address by Secretary of Treasury Andrew W. Mellon, who pointed out that the early development of Pittsburgh came because of its strategic location at the headwaters of the Ohio, the logical shipping port for east-west traffic. "We shall be among the first to feel the effects of the revival in water transportation that is bound to come," he said. "It will open a new chapter in the history of this city

whose development, since the very beginning, has been intimately connected with water transportation."

Next morning, survivors of the festivities boarded bunting-draped packets and towboats at the Monongahela wharf, while spectators by the thousands gathered on the river bluffs and bridges to watch the beginning of the dedication parade. The Engineer launches *Monongahela* and *Youghiogheny* and steamer *Swan* checked the river ahead of the dedication fleet. The stately packets *Cincinnati*, *Greater Pittsburgh*, and *Queen City* left the wharf first, followed by a line of towboats and the little *Betsy Ann*, towing a bargeload of spectators, at the rear of what was to be the last of Pittsburgh's historic steamboat pageants. Pilots of the flagship *Cincinnati* were Captains James Rowley and Jesse P. Hughes. Hughes had piloted the *Greenwood*, first boat through Merrill Dam (Lock 6) in 1904. Rowley had piloted a boat to Davis Island Lock in the 1885 pageant and was a nephew of Captain George W. Rowley.

The Pittsburgh pageant ended at Emsworth Locks, but the packets continued toward Cairo, passing Dashields Locks thanks to the improvised lock operation system. Circulating among the political and civic dignitaries aboard the packets were James Milnor Roberts, son and grandson of Thomas and William Milnor Roberts, the engineers who had renewed the Ohio River project in 1866; John W. Arras, principal engineer at Pittsburgh District since 1887, whose design innovations had had major impact on the nine-foot project; and General William "Goliath" Sibert, who had launched the nine-foot project while Pittsburgh District Engineer.

Welcomed by music, whistles, crowds, and cannon salutes at each port city, the packets proceeded at a leisurely pace to Cincinnati, where President Herbert Hoover, an engineer with a real understanding of the significance of the occasion, dedicated a monument to the men who had built the nine-foot project. President Hoover expressed his

regret that Colonel William Merrill and Captain William B. Rodgers had not survived to see their work completed. "In some generations to come," he said, "they will perhaps look back at our triumph in building a channel nine feet in depth in the same way that we look at the triumph of our forefathers when, having cleared snags and bars, they announced that a boat drawing two feet of water could pass safely from Pittsburgh to New Orleans. Yet for their times and means they, too, accomplished a great task. It is the river that is permanent; it is one of God's gifts to man, and with each succeeding generation we will advance in our appreciation and our use of it."

Except for a grim reminder of the Davis Island pageant, when a soldier firing a salute to the President was killed by a cannon that fired prematurely, the parade continued without incident and with royal welcomes at each port to Lock 53, last on the river nearest Cairo. During the trip, General Sibert renewed his acquaintance with Colonel George R. Spalding, the officer he had once ordered not to finish a dam until a nine-foot depth was approved. In the quarter century that had elapsed, "Goliath" Sibert had helped Goethals build the Panama Canal and had become first chief of Army Chemical Warfare Service; Spalding had served with the A. E. F. in France and had become the Louisville District Engineer, charged with rushing the nine-foot slackwater to completion by 1929.

At Lock 53, on October 29, 1929, General Sibert, the man who had initiated the nine-foot project, finished it by cutting a satin ribbon across the lock to open it to navigation, and the packets locked through; steaming the last few miles to Cairo by golden sunset. At ten that night, while a band played "Til We Meet Again," the packets *Cincinnati* and *Greater Pittsburgh* rang their bells, backed away from Cairo wharf, and began their return toward Pittsburgh. A more appropriate selection for the band would have been "Taps," for October 25 was Black Tuesday, day of the stockmarket crash that sounded the death knell for the historic steamboat packet business.



Marine celebration, Pittsburgh to Cairo
at Monongahela Wharf, October 18, 1929

Up to Olean Staccato throbs of a high power motor drew the Senecas to the banks of the Allegheny, where they saw the graceful motorlaunch *Monongahela* skimming upriver through Kinzua gorge between towering hills rising like walls on both sides of the stream. The Indians smiled when they heard the crunch of contact with rock, the racing motor, and then silence. They watched with amusement as the 24-foot launch drifted back downstream while the whites worked frantically in its stern. Only one prop blade had been damaged, however, and the whites soon had the prop back in the river and the motor restarted. The launch again moved upstream, at reduced speed, towards Olean.

Seated next to steersman E. H. Beechley was raftsman Louis Cook, who had piloted some 1500 wooden barges and rafts down the Allegheny before 1924. Cook peered through binoculars at the river ahead of the *Monongahela*, trying to see the channel. Pittsburgh District Engineer Jarvis J. Bain sat behind the pilot studying maps made by Thomas Roberts in 1878, but he could not be sure of the channel because islands had moved, old chutes were blocked.

The *Monongahela* scraped hull time and again on the rocks in Kinzua gorge. When all else failed, Colonel Bain seized a pike and felt for the bottom. When the Colonel yelled "rock," Beechley moved the

boat from side to side until the Colonel felt a channel. By crisscrossing the river, they reached Corydon on the afternoon of April 9, 1929, and there Captain George Barton, who once rafted from Salamanca to Pittsburgh, replaced Cook beside the helmsman. The voyage continued north into New York. Once, Barton lost the channel, the launch piled onto a bar, swung broadside to the rushing current, and began to roll over. Colonel Bain and the occupants jumped to the high side of the boat to stabilize it; Beechley eased the boat back off the bar, swung the bow into the current, and renewed his hunt for a channel.

Clouds were spitting snow, darkness coming on, when the *Monongahela* pulled into the bank at Salamanca. Without a pilot familiar with the river above Salamanca, Colonel Bain reluctantly ended the trip, eighteen miles short of his goal, the head of Allegheny River steamboat navigation at Olean. But he would be back; Bain was a stubborn man.

The peripatetic Colonel Bain was a constant headache to Pittsburgh District river rats, especially Captains William H. Shannon, Silas Sayre, and E. H. Beechley, who commanded the *Swan*, *Kittanning*, and *Monongahela*. He had the habit of calling the Boatyard at Lock 4 on the *Monongahela* at any time night or day and ordering a boat to meet him, often forcing the crews to load in a hurry and run all night to get to a point the Colonel could reach in an hour by auto. Colonel Bain wished to see every



Lieutenant Colonel Jarvis J. Bain

navigable river in his charge, preferably from the deck of a boat, and he became obsessed with the idea of ascending the Allegheny to Olean in a powered boat, a feat not accomplished since the steamer *New Castle* got up on a flood in 1837.

There was some purpose to the Colonel's madness, however, for in the late 1920's new public interest had developed in support of extending Allegheny River slackwater to Oil City, perhaps even to Olean, and linking the upper Allegheny to Lake Erie by canal via French Creek or to the New York Barge Canal by canal from Olean. And an association that had organized at Apollo, Pennsylvania, in 1926, put a small excursion boat into operation on the Kiskiminetas, and urged canalization of the "roaring Kiskiminetas" and the "babbling Conemaugh" to Johnstown. All were formidable projects.

While Jarvis Bain was District Engineer, Allegheny Locks and Dams 4 and 5 opened to navigation in 1927 and Nos. 6, 7, and 8 opened in 1928, 1930, and 1931 respectively, finishing the project approved in 1912 and supplying slackwater to Rimerton at Mile 61. It was apparent by 1928 that the Ohio River project would soon be finished; funds annually committed to completion of that job could then be diverted to projects on tributary streams, and Allegheny rivermen were anxious that slackwater to Oil City be funded.

No steamboat had gotten up to Oil City since the *Nellie Hudson No. 3* made the trip in 1897, so in March 1928 Colonel Bain ordered the survey steamer *Kittanning* upriver to inspect the old open-channel dikes and dams above the head of slackwater and determine whether the channel

could still be navigated. Captain Silas Sayre at the wheel was assisted by pilots John S. Faddis and Donald T. Wright, the latter an Oil City boy who had become editor of the *Waterways Journal*. Colonel Bain, John Arras, and Harry E. Anderson of the District office were aboard to inspect the old dikes.

The *Kittanning* slipped under the Emlenton bridge with a few inches to spare, bucked its way through Patterson Falls and other ripples, and steamed into Franklin with flags flying. Thousands of people waited at the Franklin wharf and followed along the bank as the *Kittanning* went on to Oil City. The Oil City radio station supplied its listeners with a blow by blow account of the progress of the steamer as it thrashed its way up to the petroleum capital. At dark, on March 31, the *Kittanning* reached its goal, where Colonel Bain, John Arras, and Donald Wright explained plans for slackwater to Oil City to the excited crowds.

The *Kittanning* argosy generated such public enthusiasm for the Allegheny project that Colonel Bain decided to duplicate the feat of the steamers *Allegheny* and *New Castle* and ascend the river to Olean. He selected the power launch *Monongahela* for the effort, but failed the first time at Salamanca in April 1929. On April 12, 1931, he tried again, shipping the *Monongahela* to Warren by truck to catch high water and launching at eleven in the morning. Beechley and Cook had learned the channel in 1929, so the boat made better speed through Kinzua gorge.

Snow covered the hills, the wind was cold, but the sun was still bright when the *Monongahela* pulled into Corydon to refuel and pick up raft pilot George



Survey Steamer *Kittanning*, March 1928

Barton. Captain Barton had died a few hours before they arrived. That sobering news dampened the spirits of the navigators, but they were cheered at the Seneca reservation where the Indians gave them a boisterous welcome and, in their honor, performed a war dance. Above Salamanca, where the uncharted river was obstructed by old milldams, wooden piles, and low ferry wires, progress slowed; nevertheless, the *Monongahela*, drawing thirty inches, pulled up at Olean at 6:15 that evening without having touched bottom during the entire voyage. Jarvis Bain stepped proudly ashore from the first powered boat to ascend the Allegheny to Olean, 260 miles above Pittsburgh, in a century. The Colonel had navigated every inch of river in Pittsburgh District that, to his knowledge, had ever been thrashed by a paddlewheel.

Both an intrepid riverman and an efficient administrator, Colonel Bain made the Allegheny project move again. Because the three lowermost locks and dams on the river, completed before 1909, did not provide nine feet for navigation, nor the standard 56- by 360-foot chambers for lockage, Bain recommended removal of Herrs Island Lock and Dam (No. 1), dredging a nine-foot channel to Lock 2, and replacement of Locks and Dams 2 and 3, which ice and floods had damaged, with new and standard structures. He thought extension of slackwater to Oil City uneconomical, but did approve raising Dam

8 and building No. 9 to open barge navigation to East Brady, where Vanport limestone, used as flux at iron furnaces, could be mined and shipped by river.

Chief of Engineers Lytle Brown approved Bain's plans for the Allegheny and Congress authorized the work. The Pittsburgh District, working chiefly with depression relief funds, opened nine-foot slackwater to East Brady, Mile 72, by 1938. There the project stopped, never to reach Oil City. Allegheny commerce reached 5.7 million tons in some years, but averaged around 4 million tons during the thirty years after Lock and Dam 9 was completed. Heavy traffic on the upper slackwater section, that might have justified further extension of the project, never materialized.

Rivermen grumbled about it all, but to no avail. Captain Fred Way, who launched his 18-foot yawl *Lady Grace* at Olean in May 1938 and was first "through" Lock 9, complained that the Engineers had said: "Now, boys, show us some traffic or else she goes no further." He said the Engineers were "almost stupid" to expect the development of commercial navigation on a half-finished highway like the Allegheny slackwater. "How will the river accomplish this?" he asked. "The answer to the riddle remains unsolved," he wrote in 1942. It is still unsolved.



Chapter 12

YE DELUGE OR INUNDATION

"Many Houses drove away & ye New Banks of ye fort Broke down very low. Many Goods wet & Damaged, ye Water getting into ye Magazines has I believe Wet all ye Ammunition & our powder also," wrote Quaker trader James Kenney while the January 1762 flood was receding from Fort Pitt. His cellar was full of water, everything in the village around the fort was mud covered, but Kenney was thankful because he had hauled his trading goods to safety in a canoe and no one had been drowned by "ye Deluge or Inundation."

Thomas P. Roberts smiled at the Quaker's quaint account of the 1762 flood: it seemed familiar, very much like what he had seen in Pittsburgh during March of 1907. He scribbled the description on a notecard, added it to his thick collection of information about historic floods in the Pittsburgh Engineer District, and glanced through his file on the 1762 flood. He had a 1762 flood report by Colonel Henry Bouquet, who said the flood got into the fort through drains and sally ports and even boiled out of the ground, washing away earthen revetments and floating the barracks down the Ohio. Seneca Indian refugees, crowding into the village after the flood to ask succor from agents George Croghan and Thomas Hutchins, told Bouquet that great floods seldom occurred at Fort Pitt.

Roberts smiled again. The Senecas spoke with forked tongues. Surely they remembered the ice flood of 1754 when George Washington nearly drowned trying to cross the Allegheny and the flood

of 1757 that nearly reached the rafters of cabins in the village around French Fort Duquesne.

At the bottom of the card stack, Roberts found the April 1762 report on flood damages at Fort Pitt made by Colonel William Eyre, chief engineer to General Jeffrey Amherst. Eyre found the earthen escarpments of the fort washed out and tumbled down; he recommended they be revetted with brick before another inundation carried them completely away. He said buildings inside the fort had been flooded to a four-foot depth; he recommended "flood-proofing" by raising the first floor of the buildings at least five feet off the parade ground. Because protective measures would be costly and might be undone by a higher flood, Colonel Eyre suggested that Fort Pitt be abandoned and the garrison moved across the Monongahela to the top of Coal Hill.

Roberts picked up his pencil and made some quick calculations to compare flood crest elevations. The 1762 flood was four feet deep on the parade ground inside Fort Pitt. That would be.....39 feet on the Point gage, 14 feet above the 25-foot flood stage. Why, that was a half foot higher than the "Fifty-Million Dollar" flood that ravaged Pittsburgh on the Ides of March in 1907! The figures confirmed what "Padre" Merrill had once told him. "Bear in mind," the Colonel said, "that even the great flood of 1884 was equaled by floods that occurred before the white man's axe had felled a single tree in the Ohio Valley; it is not the axe of the woodman that is to be feared, but the plow of the farmer."

Because information about river flow and floods was vital to proper bridge design and waterway project planning, Thomas Roberts, like most engineers and like his father before him, had collected data about flood elevations and river flows throughout his career. His intensive study of historic floods, however, began in early 1908 after his friend Hiram Chittenden had written to ask if he thought the cutting of forests was causing greater river flows at flood time and lesser flows during droughts.

As Chief Engineer of the Lake Erie and Ohio River Canal Company, Roberts had become ac-



General Hiram Chittenden (as a captain)

Dr. Jesse Remington

tion during droughts. That removal of forest cover increased water runoff rates, thereby increasing flooding problems and reducing low water flows, was a popular concept, publicized during the 19th century by such journals as the *Southern Lumberman*. In 1884, editors of the *Southern Lumberman* wrote:

The trouble seems to grow worse every year. Each time the river gets higher. This is one of nature's ways of punishing man. For generations, armies of settlers have been occupied in cutting the timber along the banks of the Tennessee, Ohio, Monongahela, and Allegheny rivers. The mountain sources of these streams have been stripped of the trees—their natural covering. The result is ruinous. The trees which hindered the rush of waters, which absorbed much of the moisture of melting snows, are gone. No longer are the waters impeded. They rush in floods, carrying everything before them, and Dame Nature is avenged.

quainted with General Chittenden in 1895, when the officer was surveying canal routes across Ohio for the Corps; and in 1908 Roberts was installing drum weirs designed by the General atop dams on the Monongahela River. During the 1895 canal surveys, Chittenden had planned dams and reservoirs to supply water to the proposed canals, and that experience had influenced his 1897 report on improvement of the upper Missouri River basin, in which he revived Charles Ellet's reservoir scheme. Chittenden had proposed unified river basin development and federal construction of dams and reservoirs for multiple purposes.

The Chittenden report on the Missouri River basin and major floods on the Monongahela and Mississippi rivers in 1897 had stimulated new interest in flood control measures. The Pittsburgh Chamber of Commerce sent a representative to the National Board of Trade convention in 1898 to urge support for federal construction of flood control reservoirs. The National Board of Trade had given its support to the reservoir scheme, won approval from President Theodore Roosevelt, and secured enactment of the National Irrigation Act of 1902, which authorized federal funding for reservoir construction in the arid West, but not in the Ohio River basin.

The Pittsburgh Chamber of Commerce had also endorsed the old idea that reforestation was a flood preventive measure. It urged creation of federal forest reserves at the headwaters of the Monongahela and Allegheny basins as a means of reducing flood flows and improving river naviga-

General Chittenden had asked Thomas Roberts' opinions on the effects of forestation on river flows because in 1908 many conservationists, notably Gifford Pinchot, chief forester to President Theodore Roosevelt, were proposing federal purchase of timberland reserves as a benefit to navigation and a flood preventive measure. The General knew that Roberts had been involved with waterways projects since 1866 and that he had a collection of his father's papers dating back to 1820.

In preparing his response to Chittenden, Roberts first reviewed his long career on projects scattered across America from the Appalachians to the Rockies and also in Brazil. He had carried a transit miles across areas where forests had been cut off, but had never seen signs of gullying and erosion where brush and scub timber remained; that, he had seen only in plowed fields. Nor had he seen erosion on treeless plains where man had not bared the earth. He especially remembered the plains of the upper San Francisco River valley in Brazil, where



Fort Pitt Blockhouse

rainfall was heavy; he had seen no signs there that lack of forest cover had any major effect on runoff rates.

Expanding his study to Pittsburgh Engineer District records, Roberts learned that engineers had long questioned the idea that deforestation affected flows of major rivers. He found an 1843 report by Captain John Sanders on the subject. "I cannot discover that it was ever different," Sanders had reported, "and we have some knowledge of the river since 1760, fully eighty years. The forests of the Ohio remained in their native state more than half of that period; so there is no cause of alarm from the portentous prophecies of those philosophers who imagine our rivers are to dry up with the clearing of the forests."

Biology and botany textbooks directly contradicted Captain Sanders' opinion, so Roberts began assembly of personal records he and his father had maintained, examination of Pittsburgh Engineer District files, and intensive study in Pittsburgh libraries of materials relating to historic

floods. He hoped to compare flood elevations and flow records from times before forests had been depleted with those of a later date. Fortunately, the blockhouse built in 1763-64 at Fort Pitt still stood in 1908 (as it still does), enabling him to determine the approximate elevations of early floods.

The Flood of 1763 "This Morning ye Water was rose equal to ye Banks in some places," wrote trader James Kenney on March 8, 1763, but "notwithstanding some people would not believe that it would overflow, but toward Noon it got in ye Street & they began to muster off, but ye dead Faith of Several promp'd 'em to delay carrying away their Goods untill ye Water was got so high that they had to break in ye Roofs or Gable Ends of ye Houses to get them away in Battoes."

Thomas Roberts had seen the same thing many times. He had often wondered why people stayed in their homes until flood waters were so high that they had to be rescued by boat. Thumbing through his notes, he found a report on the 1763 flood by the commandant of Fort Pitt. The commandant mentioned the loss of workshops and boatyard that followed cabins from the village downriver, total erosion of three sides of the fort, the deaths of two men by drowning, one in Turtle Creek and the other in Two Mile Run, and the fact that the river crested 22 inches higher than it had in 1762. That would be, Roberts figured, about a 40.9-foot stage, the highest flood at Pittsburgh before 1907 and more than two feet higher than the March 1907 flood.

He wondered whether Colonel Bouquet had taken the Seneca ruse in 1762 seriously. Perhaps so, for Bouquet had not begun the floodproofing and bank revetment recommended by Colonel Eyre before the 1763 flood washed over the fort. He noted that Bouquet had appointed Thomas Hutchins as engineer in charge of restoring the fort and completing redoubts on the three sides of the fort exposed by the 1763 flood. Hutchins must have finished the job quickly, because about 150 soldiers in the fort withstood an attack and siege by perhaps 400 Indians in July and August 1763.

Roberts surmised that pioneers worried little about floods. In fact, it appeared they welcomed high water, for they could get their produce to markets more easily when floods covered rocks and snags and shoals that impeded low water navigation. Pioneers had been warned of floods by Indians, who pointed up into trees to show where they had once tied their canoes, but pioneers disregarded the warnings and built where they pleased, near the rivers where water supply was abundant and access to markets easier. "Pumpkin floods," the pioneers called them, because their principal losses were bottomland crops. General William "Tippecanoe" Harrison was apparently the only pioneer who worried about the Indian warnings. After study of Indian mounds, General Harrison had concluded the Ohio valley once supported a large and relatively advanced Indian civilization. He speculated that a great flood had swept away the Indian villages at riverside and thought it probable that tribal leaders had interpreted the flood as a warning from heaven and had led the tribes to refuge on smaller streams.

If flood frequency had not increased and floods had not reached higher crests than in pioneer times, then why did people believe they had? Perhaps,



Pittsburgh in 1760

Roberts thought, it was because losses due to floods had grown as more people settled along the rivers and built mills and factories near the water supply. By 1832, people had forgotten the record floods of 1762 and 1763, for they commonly thought the flood of February 1832 the highest ever. Certainly, it was the most damaging to that date and was thought a major calamity.

Newspaper accounts of the 1832 flood listed heavy damages in the Kiskiminetas basin: saltworks, the major area industry, were nearly ruined, the Pennsylvania Canal from Johnstown to Freeport was broken at several places, Blairsville and Freeport were evacuated in the face of rising water. The rivers rose so fast to their 38-foot crest of February 10 at Pittsburgh that people fled without saving movable property. Frame homes washed away, brick homes cracked, factories and mills were closed, and damages amounted to \$200,000 in 1832 currency. Some foolish businessman had built a factory on Smoky Island at the mouth of the Allegheny: both factory and island disappeared during the flood.

Bridgewater, Fallston, and Sharon in the Beaver River basin were inundated, their foundries and ironworks carried away. General Abner Lacock, a noted engineer on the Pennsylvania canals, had water to the ceiling in his home at Beaver, lost his barns, fences, crops, furnishings, and library. Roberts thought General Lacock, an old friend of his father's, should have known better than to build a home in the floodplain.

The 1832 flood inundated Wellsburg and Steubenville to ten-foot depths and destroyed most of Warrenton, leaving only seven houses standing. People driven from their homes at Wheeling had taken refuge on nearby hills and watched in awe as hundreds of homes and buildings floated toward Cincinnati. Newspaper accounts of the "terrible calamity" showed that floods had ceased to amuse the settlers by 1832. Men out of work because factories were flooded were not funny; and the sight of men in skiffs searching the rivers for their homes and children was no less than grim.

Floods of Record Thomas Roberts learned that floods occurred on one stream or another almost every year in the headwaters district. Most were forgotten a month after the water subsided, but old-timers remembered the remarkable double flood of 1852, the “barrel flood” of 1865, the “Butchers Run” flood of 1874, and the July 1888 Monongahela flood. He had personal reasons for remembering the floods of 1867 and 1884.

On April 6 and April 19, 1852, floods hit 28 feet and 34.9 feet on the Pittsburgh gage, causing severe damages in both the Allegheny and Monongahela basins. Roberts was especially intrigued by a reporter’s graphic description of the April 19 flood on the Allegheny at Pittsburgh:

We stood upon the St. Clair Street Bridge as the rafts were coming down and the scene was as unparalleled as it was deplorable. The entire surface of the river was thickly dotted with unbroken rafts, fragments of rafts and isolated logs and boards. Some of the rafts had three or four men on board, some two, some one, and many were guided only by the current of the stream. The latter were almost sure to strike a bridge pier, and the collisions invariably separated them into still smaller fragments. We saw probably a dozen that were manned strike upon the piers, and in several instances the courageous raftsmen were compelled to leap from one fragment to another to avoid being hurled amidst the crashing timbers. The coolness and self-possession of the hardy raftsmen was marked and admired by the hundreds who witnessed the unusual scene from the bridges and shores.

The “barrel flood” of 1865 was so named because Oil City, in the midst of the petroleum boom, was flooded to the hills on March 17. Oil Creek swept its valley clean: thousands of barrels, oil derricks and drill rigs, the McClintock and Oil City bridges, all went down the Allegheny. Meadville and Franklin on French Creek were inundated; all towns along the Allegheny suffered; and the Freeport canal



aqueduct was lost. Roberts chuckled when he read the last: General “Harry” White had gotten him in fiscal hot water in 1878 by hiring men to remove the Freeport aqueduct piers after all funds for the Allegheny project had been expended.

Not long after the “barrel flood,” Roberts had joined his father on the Ohio River project. His first professional experience with a flood had come in 1867 when General Henry L. Abbot ordered the Pittsburgh office to investigate the flood of March 1867 that set new records on the lower Ohio. General Abbot had been partner with General Andrew A. Humphreys in a ten-year study of Mississippi River floods, which they published in 1861 as the *Report upon the Physics and Hydraulics of the Mississippi River*. When Humphreys became Chief of Engineers in 1866, he established a special flood study section under General Abbot to continue study of floods.

Two major floods, one in February and the other in March, beset Pittsburgh in 1867. Neither set records, but with flow contributed by the Kentucky, Green, Wabash, Cumberland, and Tennessee rivers, the two floods had more or less merged downstream of Pittsburgh into one long flood of record duration at record stages below Louisville.

“The account of the flood will fill our office with a perfect flood of letters,” Roberts recalled commenting when he dropped a bundle of questionnaires to friends along the Ohio and its tributaries into the mail. As expected, reports of precipitation patterns, river stages, and flood damages poured into the



Butcher's Run Flood, July 26, 1874
Allegheny City (now North Side, Pittsburgh)
Carnegie Library of Pittsburgh

Pittsburgh office throughout 1867, and in late winter, after summer inspection work had ended, he had labored hours in the Pittsburgh office tabulating flood data. In December, he had mailed to General Abbot the first official Army Engineer report on a flood in the Ohio River basin.

Milnor Roberts had considered the effects Charles Ellet's reservoirs might have had on the 1867 flood crests and had concluded many more reservoirs would be needed to control floods than Ellet had thought. "Flood control by reservoirs," said Milnor Roberts, "within the practicable limits of cost is impossible." Colonel William Merrill had agreed: costs would be nearly prohibitive, building and operating a reservoir system to control Ohio and Mississippi floods would require a technology not then in existence, and reservoirs could not control local floods, such as the 1874 "Butchers Run" disaster at Pittsburgh.

The "Butchers Run" flood of Sunday, July 26, 1874, was never forgotten by those who saw it. Rain throughout that Sunday had soaked the ground and converted normally insignificant streams into torrents. Drizzle dwindled toward dark, but at nine that evening, after people had retired for the night, a violent cloudburst came from Chartiers valley across the Ohio and over the north side of Pittsburgh. Even the official report on the storm reflected the terror of that evening. It rained, the report said, "as if the very flood gates of heaven had been opened; the lightning flashed amidst deafening peals of thunder, imparting to the scene a dismal and terrific grandeur."

McLaughlins Run and Painters Run in Chartiers valley, Butchers Run and Spring Garden Creek in Allegheny City (North Side), and Woods Run in Pittsburgh became raging rivers, tumbling buildings from their foundations, crushing bridges, and sweeping families from their beds. All were lost together.

General James Moorhead, "Old Slackwater," organized work parties to dig the 150 dead from the debris and clear the streets; and directed relief work for the survivors. Congress had not then involved the Corps of Engineers in disaster recovery work, except as individual humanitarian efforts, but Colonel Merrill sent the dredges *Ohio* and *Oswego* to clear debris from the Allegheny at the mouths of the flooded creeks. They removed 19,201 cubic yards of wreckage and deposits from the creek mouths.

Memories flooded back to Thomas Roberts as he scanned through his notes on the July 1888 flood on the Monongahela. He had been chief engineer of the navigation company at the time and recalled the wreckage of his lock houses intermingled with broken coal barges spinning downriver on the flood crest. The more recent floods of 1897 and 1907 had been bad, but to his mind the July 1888 flood had never been surpassed on the Monongahela. That was the flood that convinced the Coal Exchange that Davis Island Dam was not "Merrill's folly." He paused to read a reporter's account of that flood:

The waters that have been sweeping the valley of the Monongahela and the valleys of its tributaries leave in their track scenes of desolation and ruin that have never had their counterpart in the same localities. From Pittsburgh to the mountain fastnesses of Randolph county, towns have been ravaged, manufactories have been inundated, boats have been sunk, houses and lumber have been floated off, fields with their wheat in shock and growing crops have been devastated, families driven to the hills for shelter, and in many instances the accumulation of years of toil and self-denial have been lost in an hour. The losses entailed by the flood will not fall short of

three million dollars, a large proportion of which falls with crushing effect upon the people of the thriving counties of Monongahela, [sic], Marion, Taylor, Harrison, Lewis, Barbour, Upshur, and Randolph in West Virginia.

The Anti-Forestry Corps Roberts at last finished his research. Records indicated that neither flood frequency nor flood heights measured on the Pittsburgh gage were increasing. In fact, the greatest flood of record at Pittsburgh before 1908 had occurred in 1763, long before John DuBois and other loggers had cleared the Appalachian forests at the headwaters of the Allegheny and the Monongahela.

The other side of General Chittenden's question was whether deforestation had caused low river flows of longer duration. Roberts had learned that low flows had practically suspended navigation down the Ohio even before the Revolution: British army units and George Morgan's "navy" had found it did not pay to try navigating the Ohio after June in any year. Roberts could also produce vivid accounts of problems with low water navigation written by General Anthony Wayne in 1793, by Major Andrew Ellicott in 1796, by Captain Meriwether Lewis in 1803, and by a state survey commission in 1819. He had no accurate discharge records for those years, but records for 1838 were abundant.

Captain John Sanders had gaged the discharge of the Ohio just below Pittsburgh in 1838 at 1400 cubic feet per second (cfs). Milnor Roberts had gaged the flow of the Monongahela at Brownsville on September 19 that year at 75 cfs. "My father," Roberts told Chittenden, "said every tributary of the Monongahela between Brownsville and McKeesport was dry at its mouth in 1838; precisely what I observed myself in 1895. The country along the river was still well forested in 1838; by 1895 perhaps over 70% was cleared and under cultivation."

"The forest men have always the best theories at their disposal and can indulge in the most patriotic

and glowing figures of speech, which almost everyone will concede ought to be true—even when recorded facts are arrayed against them," said Roberts in his summation. "I am ready at once to grant that with the deforesting of the country, saw mills on minor tributaries cannot be operated so many months of the year as before. I will go farther and state it as my belief that ordinary summer freshets, even on major rivers, may be higher and shorter lived than before the country was deforested, but the records do not show that the low water discharge of the Ohio is becoming less or that the great floods are more frequent and discharging more water per unit of time than formerly."

Using the report supplied by Roberts, General Chittenden published a paper debunking the idea that deforestation caused greater floods and lesser drought flows on larger streams. Roberts also published his findings in the *Proceedings* of the Engineers' Society of Western Pennsylvania and various engineering journals. The thrust of their argument was that, while creation of national forests might be desirable for many reasons, planting trees and preserving timber stands did not hold water.

Forest conservationists of the early 20th century pictured themselves to the public as crusaders engaged in a moral struggle against "evil" corporations and bureaucracies, and they made Chittenden and Roberts and other engineers persuaded by historical evidence appear as ogres who opposed the goals of forestry. That was never true. The Army Engineers merely said that forest conservation would not be a very effective method of achieving flood control or benefiting navigation. Conservationists, nevertheless, successfully pinned the "anti-forestry" label on the Corps.

Forestry enthusiasts won their battle against "evil" opposition on March 1, 1911, when Congress enacted the Weeks Appalachian Forest Act, which approved federal-state cooperation in acquiring lands at the headwaters of the Allegheny and the Monongahela and in other areas as forest preserves. Wording of the act showed that conservationists had

Valentine's Day Flood of 1884
Sixth Street and Penn Avenue, Pittsburgh
Carnegie Library of Pittsburgh

won their struggle with ogre Thomas Roberts: the stated purpose of the act was the acquisition of forest lands "for the purpose of conserving the navigability of rivers." By the time the St. Patrick's Day flood inundated the Pittsburgh District in 1936, the Federal Government owned some 1.25 million acres of forest lands in the Allegheny and Monongahela basins.



The Valentine's Day Flood

The farmers lost largely of their horses and cattle, nearly all their grain and feed, and all their fencing. The merchants and manufacturers lost their stocks, and the mechanics were thrown out of employment. Coal mines and salt works were flooded, and everything was desolate indeed. It will be weeks and months before business can be resumed and help will be needed long after the waters have subsided.

So one reporter described damages done in the Ohio basin by the Valentine's Day flood of 1884, so named because it climbed to a new record stage on that day at Cincinnati. It peaked at Pittsburgh on February 6 at 36.3 feet, not surpassing stages reached in 1762, 1763, or 1832, but certainly high enough. People in the Youghiogheny valley perhaps suffered most. In West Newton, some people lashed their homes to trees and fled to safety; others were rescued by boat from the second stories of buildings. At least 10,000 Pittsburghers were left homeless and 15,000 out of work. Wheeling was a "sickening spectacle," with 5,000 refugees and no communications or utility services. Conditions were even more serious farther down the Ohio, where private and municipal levees had been overtopped.

The issue that featured the flood problem
Carnegie Library of Pittsburgh

VALENTINE'S DAY
FLOOD OF 1884

Carnegie Library of Pittsburgh

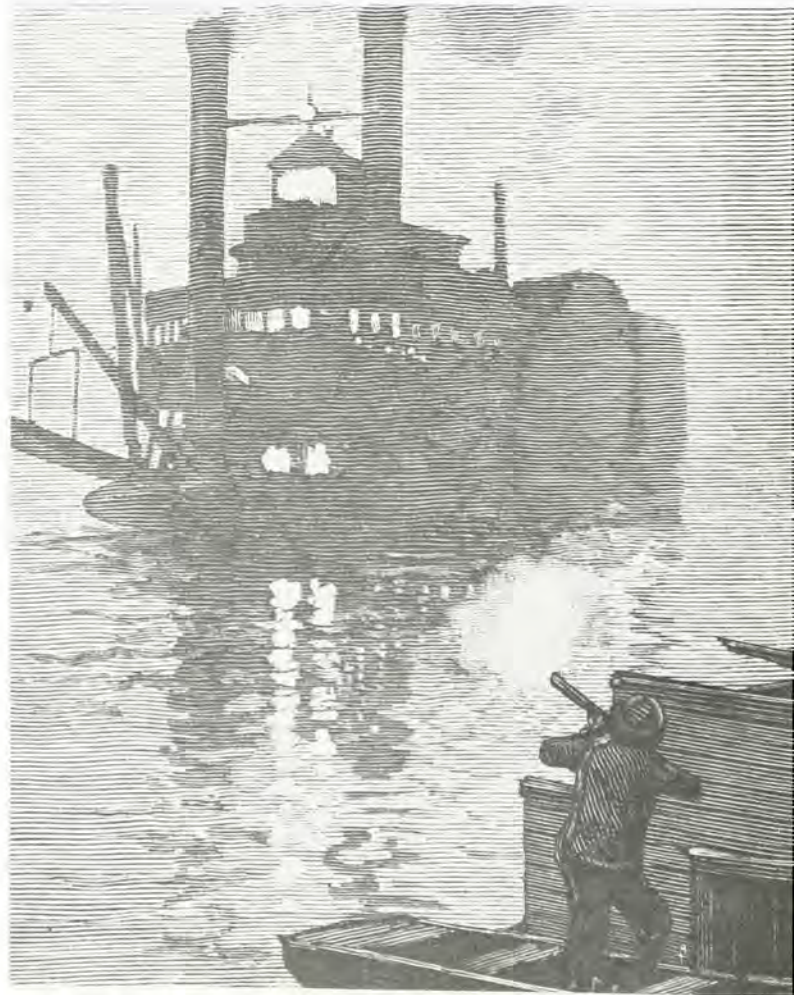


Relief boat at Newport, Kentucky
(across the Ohio from Cincinnati)

Mayor Robert Lyon of Pittsburgh on February 6 organized a disaster committee, which sent the steamers *Iron City* and *Resolute*, freighted with emergency supplies purchased with public donations, downriver for the relief of stricken communities along the Ohio. The American Red Cross, for the first time, joined in a flood relief mission on the Ohio. Clara Barton herself traveled to the Ohio and chartered the steamers *Josh V. Throop* and *Mattie Bell* for the job.

Congress had funded purchase of emergency supplies for disaster victims from time to time since 1811. It first provided assistance for victims of an Ohio River flood in 1884. Army Quartermaster officers purchased food, blankets, and other items and distributed the supplies aboard Army Engineer boats and the chartered steamers *Katie Stockdale* and *Granite State*.

The Valentine's Day flood also resulted in some new interest in the Ellet reservoir scheme for flood control. New York engineer Samuel McElroy declared it was unprofessional for engineers not to respond when the public demanded remedies for flood problems. During surveys of the upper Allegheny River basin, he had seen potential reservoir sites on the Mahoning, Redbank, Tionesta, Kinzua, Potato, and Conewango creeks. He admitted that costs of the Ellet reservoir plans might be high, but asked if the millions of dollars worth of property



Don't come near, you'll make waves!



Salvage? or looting?

saved from floods by such a system might not make the investment worthwhile.

Congress was not prepared in 1884 to undertake a massive flood control program. Many congressmen doubted that such a program would be legal under the Constitution. Public clamor for some flood protective measures was so intense, however, that in 1884 Congress took its first hesitant step down the long road toward control of floods in the Ohio River basin.

Since the constitutionality of federal navigation projects was no longer seriously questioned in 1884, Congress directed Colonel William Merrill to improve Ohio River navigation by raising and strengthening levees at Shawneetown, Illinois, and at Lawrenceburg and Jeffersonville, Indiana. "Padre" Merrill protested that, though he personally thought flood protection a laudable goal, building levees would not benefit navigation at all, except perhaps to keep boats in the channel and out of towns during high water. In each of his yearly reports, Merrill objected to the hypocrisy of building levees for flood protection on the pretext of improving navigation, but Congress ignored him.

A similar case occurred at Zanesville on the Muskingum River in central Ohio. A stone masonry wall built by Ohio to protect Zanesville from floods was overtopped and breached, and Senator Marcus

Hanna of Cleveland slipped an appropriation through Congress for restoration of the wall to improve the navigation of Cleveland harbor! The Corps of Engineers protested that restoring the wall would not improve navigation and that Zanesville was not part of Cleveland harbor, not even in the same watershed. The complaint was fruitless. The influential Senator Hanna, as usual, got what he wanted. At Zanesville, Wheeling Engineer District completed the first concrete floodwall in the Ohio River basin, perhaps the first federal project of its sort in the United States.

To protect his greatest engineering achievement, the Davis Island Dam, Colonel Merrill built the first federal levee in the Pittsburgh District after the 1884 flood. That flood struck the Davis Island project, then still under construction, on February 6, completely submerging Davis Island, clearing it of workshops and barracks where construction workers lived, and taking out the cofferdam around the dam weir foundation. Located between the movable wicket section and the fixed cribwork in the back channel, Davis Island actually formed part of the dam. To prevent further erosion of the island and damage to the project, Merrill directed William Martin to build an earthen levee, planted with locust and willow trees for stabilization, across the head of Davis Island and down to the dam abutments. The job was done in 1885 and the island behind the levee was later filled to raise its surface above ordinary flood levels.



"Johnstown...the city was practically destroyed."

Irving London, Johnstown, Pa.

The Johnstown Disaster President and Mrs. Benjamin Harrison spent Sunday, June 2, 1889, with the Secretary of War in a telegraph office reading the poignant and shocking news from Johnstown, where an old earthen dam had failed on the last day of May and unleashed a flood that killed 2,209 people. The South Fork Dam, built on a tributary of the Conemaugh in 1852 to supply water to the Pennsylvania Canal and purchased in 1879 by a fishing club, was filled in late May by a rainstorm that dropped up to eight inches of water over the Alleghenies. When the dam failed, it released a seething flood wave atop already swollen streams that smashed its way down the Conemaugh valley, ripping up trees, wiping out villages, and engulfing entire trains. A mass of debris was rolling on the flood crest when it hit Johnstown at the juncture of Stony Creek and Little Conemaugh River. The city was practically destroyed by the most memorable flood in American history.

The President and Mrs. Harrison were so moved by events at Johnstown that they presided at a public meeting in Washington to collect donations for the victims, and the President asked Governor James Beaver of Pennsylvania if the Federal Government could help. The Governor asked for temporary bridging because all bridges at Johnstown were gone except a stone bridge just below the city that was impassable because of debris lodged against it. Without bridges, people at

Johnstown were unable to learn the fate of relatives living across the streams and emergency work was gravely hampered. The President ordered the Army Engineers to attend to it immediately.

Superintendent John G. Parke had a 225-foot ponton bridge at West Point, where it was used for cadet training. General Parke had a personal interest in developments at Johnstown: his nephew John G. Parke, an engineering student at the University of Pennsylvania, had taken a summer job at South Fork Dam. Young Parke had made the near-legendary horseback ride down the valley to warn people the dam was failing, but, because he was a stranger, people had ignored the warning. General Parke had the West Point pontons aboard a train and on the way to Johnstown a few hours after he received the President's orders. Lieutenant John Biddle and thirty men from Company E, Corps of Engineers Battalion, had charge of the bridge.

Colonel William R. King had ponton and trestle bridge equipment stored at the Engineer School at Willett's Point, New York. It was surplus material that King had used to bridge the James River at Richmond in 1865. He loaded "all that could be trusted," 188 feet of ponton and 140 feet of trestle bridge, on a train in charge of Captain Eric Bergland, Lieutenants Mason M. Patrick and Thomas H. Rees, and sixty-nine enlisted men specially chosen for construction proficiency.



The breach through South Fork Dam
Carnegie Library of Pittsburgh

The pontoon bridge across Stony Creek
Irving London, Johnstown, Pa.



Captain Clinton B. Sears was given command of the mission and sent to Johnstown ahead of the bridges. He arrived June 5, conferred with Pennsylvania Adjutant General Daniel H. Hastings, and arranged for B. & O. Railroad engineers to bridge the Little Conemaugh while the Corps bridged Stony Creek. He selected sites for the ponton bridges across Stony Creek at Franklin and Poplar streets, where bridges had stood before the flood, built unloading ramps next to the rail track, and cut a road from the ramps to the creek bank.

Delayed for three days by congestion on the tracks that had not been broken by the flood, the Engineers and their pontons finally rolled into Johnstown on the night of June 7. They worked throughout that night moving the bridge equipment from the trains to the creek bank. Already exhausted by three nights of only intermittent sleep aboard the trains and soaked by continuing rain because boots and ponchos had been left behind in their haste to get to Johnstown, the men were bleary eyed and frazzled at sunrise on June 8, but the people who had survived the disaster were much cheered by the sight of the blue uniforms of Engineers, with the silver castles flashing on their kepis. Despite discomforts, the men worked with little complaint, save one old sergeant who had forgotten his plug and was distressed that every tobacco store in the vicinity had been destroyed.

Rains made the banks soft and slippery, Stony Creek was still running bankfull with swift current, and floating and submerged debris made the job somewhat hazardous, but the men were experienced professionals who had laid bridges under enemy fire. One by one, they launched the pontons on Stony Creek, anchored them in place across the stream, and laid down the timber stringers and chess plank decking. By 1:30 that afternoon, they had a 200-foot wagon bridge open to traffic, and at 5:00 they opened the second 320-foot bridge. Both handled a heavy and constant traffic.

Because coordinating the work of state, local, and volunteer workers presented problems, Captain Sears of the Corps was asked to take charge of all debris clearance and disaster recovery work. He refused, for his orders were to build the bridges; nothing else. He rode over the area, however, and devised an operations plan dividing the area into five sectors and assigning civil engineers, contractors, and volunteer workers to each sector. State Adjutant General Hastings adopted that plan.

After bodies had been removed, demolition expert Arthur Kirk began clearing the steel-wire tangled mountain of debris lodged against the stone bridge below the city. The blasts rocked the valley, broke windows, cracked walls, and people complained that dynamite might destroy what the flood had

Pennsylvania Railroad bridge
Irving London, Johnstown, Pa.

missed. Captain Sears observed the blasting was not removing the debris, merely changing its location, and, remembering how powerful snagboats cleared the rivers, he recommended that dynamiting be curtailed and steam engines with hoisting derricks be used to separate the debris, in combination with application of the torch to burn the debris and end the stench and potential health hazard of decaying animal carcasses. That plan also was accepted.

"As the work was now properly organized and well in hand," said Sears, "I could be of no further use, and asked for a recall, with General Hasting's assent." Sears and the West Point detachment left on June 15. Lieutenant Mason M. Patrick (who later became first chief of the Army Air Corps) and 53 men remained to replace the pontons with a temporary trestle bridge, finishing that job in July. The Chief of Engineers commended Sears and his men for their energetic work; President Harrison said he was pleased; and the Johnstown survivors presented a public resolution of thanks to the Corps.

A month after the flood, Governor Beaver told the Secretary of War that streams in the Johnstown vicinity were so filled with rock, sand, and debris that "great danger threatens the whole valley in case of an ordinary freshet." He asked assignment of the Army Engineers to a survey as a preliminary for a project to restore stream channels and increase their flood-carrying capacity.

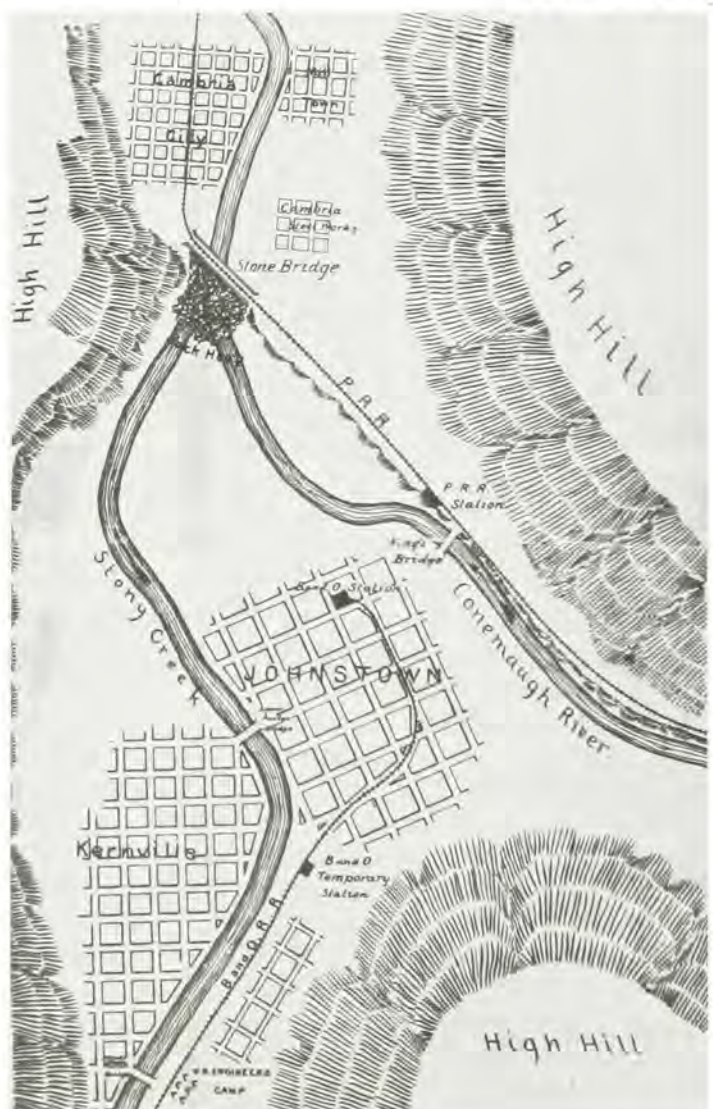
Thomas Roberts visited Johnstown on his own, not as a Corps representative, and he agreed with the Governor. "What is needed," he said, "is a new permanent course of ample section, to be secured in part by dredging, and in part by water-tight embankments."

The Secretary of War and Chief of Engineers explained to Governor Beaver, however, that law authorized only navigation improvements and his request for flood protection planning at Johnstown could not be honored. "It is certainly a matter that will require the action of Congress before steps can be taken to bring about the desired end," they told the Governor, with apparent regret.



Johnstown 1889

The Military Engineer



The Fifty Million Dollar Flood Rain-soaked, weary, and worried, Major William Sibert, John Arras, and Thomas Roberts trudged back into the District office on the evening of January 15, 1907, doffed their slickers, poured themselves a cup of hot coffee, and sat down at a conference table to mull over their troubles. Early that afternoon they had learned that a flood was undermining the abutment of Allegheny River Dam 3.

Major Sibert had first called the Pennsylvania Railroad, whose track passed near Dam 3, and asked for quick delivery of stone and slag to dump onto the bank at the abutment. He and his staff then went to the dam near Springdale a few miles from the office. By the time they arrived the abutment was gone and the bank was crumbling rapidly into the breach. The dam itself had held, but the flood pouring around one end of the dam was cutting the sandy bank so fast that by late afternoon buildings were dropping into the river. Nine homes, out-buildings, and 5.3 acres of land eventually caved in, and the erosion threatened to take the Pennsylvania track and the Heidenkamp Mirror factory.

Sibert, Arras, Roberts, and the District staff debated the problem throughout the evening. If the dam held, and it seemed it would, the flood would continue rushing through the breached abutment, caving the bank, cutting the railroad, and eating up a million dollar factory. Upstream gage readings and precipitation reports indicated the flood would continue. How could flow through the breach be reduced and bank erosion slowed? After hours of discussion amongst the staff, Major Sibert made his decision: the dam would have to go. He telegraphed the Chief of Engineers to explain the situation and issued orders for blowing the dam.

Blasting began the next morning. A few good men rowed a skiff loaded with dynamite onto the river, floated down on the flood, and dropped anchors above the dam. From those moorings, the men unreeled rope letting their skiff slip down to the dam, then placed 500-pound dynamite charges and detonated them one by one to blow out the dam crest. Dynamiting continued until a 560-foot section of the



Major W. L. Sibert

dam at midstream had been removed to a 12-foot depth.

"Now," Sibert advised the Chief of Engineers, "we have a fighting chance to save the Heidenkamp plant. We are placing stone on the bank as fast as we can unload it."

Placing stone had begun from a railroad siding 220 feet back from the caving bank on the morning dynamiting was begun. Caving was so swift that the track went into the river that afternoon. The 425 workers changed to a siding another 80 feet back, next to the main track, and resumed dumping stone. They dumped 23,479 tons of rock and slag before the bank stabilized. Sibert had saved the railroad and mirror factory, but at the cost of a dam.

The *New York Sun* printed an editorial on January 30 attacking slow progress on waterway projects. The editors commented, however, that "no charge of dilatoriness can be brought against the officer who a few weeks ago saved a million dollars worth of property by assuming the responsibility of blowing up \$80,000 worth of dam." Sibert was perhaps the only Corps officer ever commended by the Chief of Engineers for destroying a government dam, but Sibert was first to admit that the real heroes were the men who rowed a boatload of dynamite down a flooded river.

March 15, 1907
Pittsburgh, north side
Carnegie Library of Pittsburgh



March 15, 1907, Sixth
Street looking north
from Liberty Avenue
Carnegie Library of Pittsburgh

Bank stabilization at Dam 3 had just been finished when the "Fifty Million Dollar" flood seethed down the rivers, inundating 52% of the Golden Triangle business district of Pittsburgh. When it crested at 38.5 feet on the Ides of March, steamboats tied up in Wood and Water streets, ice floated through the downtown area, and water closed a hundred office buildings, 33 miles of streets, 17 miles of railroad track, 9 miles of street railway. Businessmen lost \$2 million because of damages to plants and work suspensions, their 100,000 employees lost \$1.3 million in pay, and damages in the Pittsburgh vicinity alone reached \$50 million.

When John Arras learned the March 1907 flood resulted from rains covering no more than half the watershed above Pittsburgh, he became alarmed, for he estimated that if heavy rains were to fall over most of the watershed, Pittsburgh might suffer a 45-foot flood. "Pittsburgh," he warned, "is in danger of a flood calamity similar to that which wrought such death and destruction at Johnstown."

Thomas Roberts came to a similar conclusion. "The possibilities of such a disaster are," he told the Engineers' Society of Western Pennsylvania, "extremely remote, as we have no record of great cloud-burst storms covering the entire latitude embraced between the heads of the Allegheny and Monongahela rivers, a distance on a north and south line of 240 miles. There is, however, food for serious thought."

In the aftermath of the flood, many people conceived innovative solutions to flooding problems. A riverman suggested sending sternwheelers to

tributary headwaters when floods seemed imminent, anchoring them with bows pointed downstream, and at the appropriate moment rolling the paddles at top speed to neatly back floods upstream? Others proposed excavation of huge gutters alongside rivers to carry superfluous water harmlessly to the ocean? An oilman recommended the "pit-hole" method: drilling 10-foot holes deep into rock strata and sending floods underground, either to join ground water or be converted into steam in the bowels of the earth? A young disciple of Thomas Edison proposed the "hot-wire" plan: simply suspending electric wires a few feet above normal river levels to be activated at floodtime to boil off the flood?

Professional engineers at Pittsburgh looked again at reservoirs for flood control. Thomas Roberts and John Arras, in 1907 and 1908, suggested Pittsburgh might be protected by many small reservoirs upstream from the city and levees around the Golden Triangle and low-lying areas. After study of General Chittenden's report on the upper Missouri basin, consulting engineer Morris Knowles suggested a multipurpose reservoir system to protect Pittsburgh from floods and to augment low-water flows, thereby benefiting navigation, reducing the effects of pollution, and increasing industrial water supply. He told the Engineers' Society of Western Pennsylvania that the "Fifty Million Dollar" flood "should be used to so agitate and prepare the public mind that funds for this purpose can be obtained. It is a worthy object in which this Society and other civic organizations can unite in a strong effort."

When a 33.7-foot flood occurred at Pittsburgh in February 1908, George M. Lehman, former assistant on Lake Erie to Ohio River canal surveys and Pittsburgh District employee, advised the Pittsburgh Chamber of Commerce it should begin immediate study of area flooding and flood damages. Five days later, on February 20, the Chamber appointed a committee to undertake the study: its chairman was industrialist Howard J. Heinz and members were General Albert J. Logan, A. J. Kelly, H. M. Brackenridge, Captain William B.

Rodgers, George M. Lehman, and Morris Knowles. Heinz, Lehman, and Pittsburgh District Engineer Henry C. Newcomer composed the engineering subcommittee, but Colonel Newcomer resigned in December after it became evident that the committee planned more than mere computation of flood damages.

The original committee became the Flood Commission of Pittsburgh, financed by donations from business and contributions from the city and county, and expanded its membership. Notable additions were newspaperman Wilmer M. Jacoby, irrigation expert George H. Maxwell, and engineers E. K. Morse, Emil Swensson, William G. Wilkins, George S. Davison, A. B. Shepherd, S. C. Long, Paul Didier, and Julian Kennedy. The Commission initiated full scale study of flood problems and remedial measures and employed Kenneth C. Grant as principal engineer. Grant traveled widely in Europe and learned that Germans had built reservoirs for flood control and low-flow augmentation in the Oder and Ruhr River basin and Russians had done the same in the Volga and Msta valleys. If European engineers could build multipurpose dams and reservoirs and make them work, surely Americans could do the same.

The Anti-Reservoir Corps At Ohio River Lock and Dam 13 dedication ceremonies in 1909, Wheeling District Engineer Frederick W. Altstaetter unleashed some of his pent-up resentment. He said:

The men who proposed and carried out the work so far done have been opposed at every point by contrary ideas. They have been accused of lack of knowledge, of lack of interest, of opposition to progress, of failure to appreciate the needs of the river--and, I might add, I feel a little sensitive on this subject, as I have been cited myself in a recent magazine as a horrible example of the petrified conservatism of the Corps of Engineers. From the beginning, the engineering features of the Ohio have been a source of discussion on the part of engineers and pseudo-engineers, projects

and counter projects have been advocated and ignorance seems never to have discouraged anyone from launching a new theory of improvement.

Changing views of the role of engineers in society and the purposes of waterway projects during the early 20th century impaled the Army Engineers on the horns of a dilemma. Progressives seemed to think engineers could solve the ills of society. "The engineering profession can contribute more than any other class of citizens, for the engineer is the true conservationist of society," said Morris Knowles, who thought engineers "better equipped, by training and habits of thought," than other citizens to determine public policy issues. Army Engineers had a less egotistical view of their functions, thinking of themselves as servants to the people, or at least to the representatives elected by the people. Before they undertook planning of any sort, they wanted approval from Congress; before they studied multiple purpose water resource projects, law required that they have authority and funding from Congress.

Captain Altstaetter was indeed a petrified conservative: he obeyed the law, which required the Engineers to review proposed projects only in the light of how they might benefit river navigation. The Corps reported many times that multipurpose reservoirs would be desirable, but the benefits they would provide for river navigation alone would be insufficient to defray their costs of construction.

"The Engineer Corps of the Army has been put in a strait-jacket by Congress itself," lamented Francis Newlands, the Nevada Senator who led a campaign in Congress for multipurpose reservoir construction. "In one of my speeches," he said, "I made numerous quotations from river and harbor bills absolutely forbidding the Engineer Corps to make any suggestions outside of the matter particularly submitted to them."

Benefits to navigation alone, the Corps contended, would never justify construction of reservoirs for

- 18 Allegheny River, Dam No. 1
- 19 Allegheny River, Dam No. 2
- 20 Allegheny River, Dam No. 3
- 2 Loyalhanna Lake Dam
- 3 Blacklick Creek Dam
- 4 Crooked Creek Dam
- 6 Mahoning Creek Dam, No. 2
- 9 Clarion River, Dam No. 1
- 10 Clarion River, Dam No. 3
- 11 Clarion River, Dam No. 4
- 14 French Creek Dam
- 16 North Branch Dam
- 17 Tionesta Lake Dam
- 29 Youghiogheny River, Dam No. 2
- 33 Cheat River, Dam No. 1
- 34 Cheat River, Dam No. 2
- 43 West Fork Dam

flood control, hydroelectric power development, water quality and navigation improvement; all project benefits would have to be considered before the benefit-cost ratio would be favorable. Because of that honesty, the Engineers were accused of being opposed to reservoirs and the officers were written off as "petrified conservatives." Upset by personal attacks upon him and his District, Captain Altstaetter said:

In its revised form, this project has been made a more attractive pill for the country to swallow by saying that great water power could be developed at the various reservoir sites, that floods would be reduced, and that the tributaries would be improved, while on the tail of the project we find tied a proviso that forests would have to be planted in the watersheds above the reservoirs to keep debris from washing into them and filling them up. In this scheme large districts are flooded, people are driven from their homes, towns and smiling valleys are ruthlessly turned into reservoir sites; highways and railways are covered with the penned-up waters, farms are turned into forests, and we are calmly told that all these things are to be done in the interests of navigation. Truly, navigation is asked to carry a heavy burden.

In 1907, Marshall O. Leighton, Chief Hydrographer of the U. S. Geological Survey and engineer for the Inland Waterways Commission, debated the reservoir question with Corps officers in various engineering journals. Each time he broached the subject of reservoirs, someone asked him, "Have you read Milnor Roberts?" He contended things had changed since Roberts so effectively quashed Ellet's plans. Roberts had complained high dams would destroy flatboat and raft traffic; Leighton said that traffic had virtually ended. Roberts argued that construction and land acquisition costs would be prohibitive; Leighton said costs would be less than benefits. Roberts contended management of a reservoir system would be too complex; Leighton thought the telegraph and telephone could overcome that problem. Roberts



warned that high dams could fail; Leighton argued that engineering advances had obviated that objection and said he would not worry at all if the dams were built by the Army Engineers. Leighton's ideas were welcomed at Pittsburgh, and he became consulting engineer to the Pittsburgh Flood Commission.

General William H. Bixby, the Central Division Engineer who served with Leighton on the Inland Waterways Commission, said the reservoir issue in 1907 was no longer one of possibility but one of practicability. Bixby pointed out that federal law tied all waterway projects to navigation alone. "The objection to the storage reservoir method," he said, "has not been due to the lack of suggestions by the U. S. Engineer Corps as much as to the fact that Congress, representing the general public, has been reluctant to enter upon an enterprise of such magnitude in cost and such great extension of Federal powers as would result." He thought multipurpose reservoir projects had enormous advantages and "should be looked forward to as something exceedingly desirable as soon as law and general public sentiment are ready for the same."

Editors of *Engineering News*, which carried the Leighton-Bixby debate, declared that further public argument would be fruitless, that the questions at issue could only be settled by surveys in the field. "If the reservoir system of river control can be made practicable anywhere in the Ohio River basin, it is on the rivers which meet at Pittsburgh,"

the editors concluded. "Here, then, is the place to make the first test."

Pittsburgh Flood Commission Report At a dinner at the Schenley Hotel on April 16, 1912, the Flood Commission of Pittsburgh released its monumental report on its four-year study. Speakers at the dinner were Senator Newlands and Marshall O. Leighton. First of its kind, the voluminous Commission report predicted Pittsburgh someday would experience a 40-foot flood and recommended construction of levees and reservoirs to protect the city. The Commission had found seventeen likely sites for reservoirs in the Allegheny and Monongahela basins. It estimated project costs at near \$24 million and benefits at about \$96 million, nearly a 4 to 1 benefit/cost ratio, to be achieved through flood damage reductions, water power development, and low flow augmentation to improve navigation and water quality.

In the year it issued its report, the Flood Commission received three major setbacks. On November 5, 1912, Pittsburghers rejected a bond issue that would have funded construction of a levee-floodwall to protect low-lying areas of the city. In December, a board of engineer officers appointed to review the Commission's report and determine how the proposed reservoirs would benefit navigation made an unfavorable report. "A system of impounding reservoirs at the headwaters of the Allegheny, Monongahela, and Ohio Rivers and their tributaries," the board reported, "while probably feasible, would be of such small benefit to navigation that the Federal Government would not be justified in cooperating with local interests for their construction."

The third setback came from farmers, lumbermen, railroad owners, and people living near the proposed reservoir sites who vigorously opposed the Flood Commission's plans to inundate their homes and businesses to save Pittsburgh. The Flood Commission report was "dam nonsense," abhorrent to the people of the upper Allegheny basin, said editors of the *Oil City Derrick*. Attorney T. F. Ritchey of Tionesta complained the proposed reser-

voirs would wipe out navigation, cripple the lumber industry, destroy railroads and businesses, and so divide Forest County that it could no longer exist as a county. "Five to ten million dollars damages," he estimated, "and it still would not, in our opinion, prevent floods."

Those setbacks did not deter the Flood Commission, nor those who supported the reservoir concept. "It is greatly to be desired," wrote General Hiram Chittenden, "that the scheme be fully tried out. Not only would it give Pittsburgh a large measure of relief, but the effect of the example, in settling many disputed theories, would be of great value to the engineering profession and the country at large."

General Chittenden had retired from the Corps of Engineers in 1910, because President Theodore Roosevelt, with his passion for physical fitness, had ordered every officer in the Army to ride a horse fifty miles. Chittenden had tried and failed; the experience crippled him for life. He continued his engineering career from a wheelchair, however, cooperating with Arthur E. Morgan in planning flood control dams in the Miami River basin of Ohio. In one of his last papers before his death in 1917, General Chittenden warned engineers about the obstacles in the path of flood control and indeed any public project:

The greatest obstacles that the promoters of public work have to overcome are not those of nature, but of men. Nature is sometimes a stubborn adversary, but she always acts in the open, without subterfuge or indirection. But human ignorance, prejudice and self-interest are handicaps of a different character. Ignorance is least important, because it may yield to instruction. Prejudice—that is, prejudgment of a case and then sticking to it regardless of facts—is immeasurably worse. But self-interest is the most insuperable obstacle of all. Public measures are judged by their effect on the private pocket-book, and the rarest phenomenon in the world is a willingness to subordinate personal interest to the public welfare.



Colonel F. R. Shunk (cadet photograph)

Chapter 13

WATCHDOGS AT THE HEADWATERS

After shuffling wearily through the letters from Sharon, New Castle, Warren, Niles and Beaver River basin towns piled a foot high on his desk, Colonel Francis R. Shunk read again the letter from Youngstown. "For many years the Mahoning River has been encroached upon by railroads, manufacturing plants and private individuals, narrowing the channel which has greatly increased the possibilities of floods, until at the present time the situation has become serious," wrote Youngstown city clerk M. H. Hyland. On behalf of the city council, Hyland begged the Army Engineers to prevent more encroachments on the stream.

The Colonel abruptly dropped the letter on the desk, asked his secretary to bring the Beaver River file, and called John Arras and Thomas Roberts to the office. When the two senior engineers arrived and were seated next to the desk, he read them the Youngstown letter and asked what they knew of the Beaver basin.

John Arras smoothed his mustache bristles with one hand while he pondered the question. "Colonel," he said, clearing his throat, "the March 1913 storm center came from Cincinnati up the Miami River, across central Ohio, and through the northern sector of this District. Dayton, Columbus, Zanesville had record floods and every town on Beaver, Mahoning, and Shenango rivers were flooded. Water was four feet higher at New Castle than ever before and took out a railroad and three highway bridges. Flood damages in Beaver basin exceeded \$2 million, which was only about 1% of the total damages in Ohio. The flood killed about 400 people."

Flipping through the Beaver River file, the Colonel found an old report, looked up, and asked, "Roberts, you were at Youngstown in 1909, weren't you?"

"Yes. Senator Theodore Burton and Congressman Aubrey Thomas arranged to send me there to inspect navigation."

"What did you see?"

"Mayor John Naylor of Niles told me they wanted snags cleared from the pools of Girard and Leavittsburg milldams. Seems the state stocked the river with fish, but fishing boats were hitting the snags. Turned some boats over and nearly killed the fishermen."

The Colonel smiled and asked, "Was that the only trouble?"

"No. Like the letter said, people are filling the banks, they have flooding problems and need help. But their big problem is low flow. River discharge at Girard milldam is less than 20 cfs, and Youngstown mills circulate the whole flow two or three times. Makes the water hot. Owners of the Girard milldam once closed it, cutting off Youngstown's water. Made people at Youngstown so mad they went to Girard at night and cut holes in the dam. Carnegie Steel at Youngstown, in self-defense, bought control of the millpond."

Route of the Beaver to Lake Erie Canal

Shunk nodded that he understood. "Did you make any recommendations?"

"I landed in hot water on the Mahoning, Colonel," said Roberts with a chuckle. "I found some fine reservoir sites there when I surveyed canal routes in 1895, and I told the people there they should build reservoirs to solve their water problems. Since I found no river commerce, nor prospects for any unless the Lake Erie and Ohio Canal is built, I told the people at Niles they should clear the snags out of the way of fishing boats themselves, with horses and blocks and tackle, then burn the snags so they wouldn't float to the Ohio and interfere with navigation. Senator Burton didn't like it; you've his letter in the file."

The Colonel turned through the 1909 correspondence and found the Senator's letter. Burton wrote, "I am frank to say that this stretch of river could be used for small launches and would probably develop more traffic than any stream now under improvement." Shunk found that amusing, for he knew the Senator and recalled the reputation he had as an opponent to "porkbarrel" projects. Apparently the Senator's scruples had not extended to projects in his own district.

"I went back up there in 1912," said John Arras. "James Getty and I boated 13 miles of the Mahoning above Warren. Saw a few canoes and motor launches on the millponds, found a hundred snags and some boulders, and estimated about \$1300 would clear that 13-mile stretch. But I agreed with Roberts: there is no commerce on that river and not likely to be any."

"How can we help these people?" asked Colonel Shunk, pointing to the stack of letters on the desk.

"Don't know how we can," replied Arras. "The nearest commercial navigation is at the mouth of the Beaver, a long way from Youngstown."

"What about the Beaver and Erie Canal?" Roberts asked. He explained his father had been engineer on



the canal, built between 1831 and 1844 up Beaver and Shenango rivers to Conneaut Lake and on to Erie, Pennsylvania, with connections by feeder canal to French Creek and by the Cross-Cut Canal up the Mahoning past Warren and Ravenna to the Ohio Canal at Akron.

"Sounds like a big project," the Colonel commented. "Did it carry much traffic?"

"It was 136.5 miles long from Beaver to Erie and had 133 locks. Fifty-ton canalboats pulled by three horse teams made the trip from Erie to Beaver in 36 hours. The boats carried farm produce, pig iron from Youngstown and Sharpsville, and up to 400,000 tons of coal a year. My father planned enlargement of the canal in 1869 to handle 300-ton boats, but it was sold to a railroad in 1870 and abandoned. Was still profitable when it was sold."

"I doubt traffic on the canal would make the river itself legally navigable," said the Colonel. "Have either of you ever heard of any interstate commerce on the Mahoning or Beaver?" Neither man had ever heard of any, so the Colonel dismissed them and prepared his reply to the City of Youngstown.

"Encroachments of the kind mentioned in your letter," he wrote, "are covered in the River and Harbor Act approved March 3, 1899, but whether these laws are applicable to the Mahoning River is open to doubt since it appears that neither it nor the Beaver River into which it flows is navigable except for short distances on isolated pools formed by power dams, where light draft boats may be operated." He explained his decision was administrative, not legally binding, for river navigability had to be determined in the end by the courts. He suggested Youngstown should seek to end stream encroachments by enforcing laws of the State of Ohio.

Mahoning River Navigation The Pittsburgh District Engineer's decision that the Mahoning River was not navigable and therefore not subject to federal jurisdiction stirred up a storm of protest from people in the Beaver basin, who remembered that grandpappy had floated the river in a flatboat, and from the Lake Erie and Ohio River Canal Board. In 1915, Pittsburgh industrialists, through the Canal Board, were seeking construction of a new canal between the Ohio and Lake Erie to move iron ore from the Great Lakes south to Pittsburgh and Monongahela coal north to Youngstown, Cleveland, and Chicago steel mills. More low bridges and channel encroachments on the Mahoning and Beaver rivers could increase costs of the proposed canal.

To secure federal protection for the rivers, it was necessary to prove they had supported an interstate commerce. Even commerce in flatboats, the craft that navigated the rivers when the authors of the Constitution gave the Federal Government power to regulate commerce, would do. Leaders of Youngstown, Warren, Niles, and New Castle and William A. Magee, chairman of the Canal Board and mayor of Pittsburgh, began collection of state laws, historical records, and notarized statements from oldtimers to prove the Mahoning and Beaver rivers had once been navigated by interstate commerce.

State legal records showed that the Beaver River and its tributaries had been navigable public



Beaver River packet *John L. Graham* (1875)

highways by law. Local histories mentioned that Moravian missionaries had ascended the Beaver during April 1770 in sixteen canoes to a camp a few miles below New Castle, that James Hillman had canoed up the Beaver regularly from Pittsburgh to trade with Indians from 1788 to 1796 and had joined with John Young in 1796 to found Youngstown, and that James Caldwell in 1801 supplied the settlers at Warren by poling a canoe up the Beaver and Mahoning rivers once a fortnight.

Oldtimers remembered flatboats carrying pioneers down the Mahoning, Shenango, and Beaver rivers to new homes on the Ohio and Mississippi. It was known that Joseph Antrim and six men had built a flatboat on Shenango River two miles above Sharon in 1810, loaded their families and household goods aboard, floated downstream on a spring flood, and continued down the Ohio and up the Miami River to settle in Champaign County, Ohio. The pioneers had also rafted logs down the rivers from points as far up the Mahoning as Newton Falls and had marketed their farm produce in flatboats.

Erwin Ladd, born at Warren in 1828, swore he had seen flatboats, 70 feet long, 14 feet wide, with 2.5-foot gunnels hewed from poplar logs, built on the



Monongahela River at foot of Liberty Avenue, Jan. 9, 1913

Mahoning at the Market Street bridge in Warren. He had seen fleets of seven boats, loaded with hay, pumpkins, potatoes, cheese, and cider, leave Warren for ports on the Ohio and Mississippi. He recalled that flatboat merchants had been Herman R. Harmon, Ira and Elijah Hull, Charles W. and Randa Simmons, and Cyrus Spencer, and that his father, Isaac Ladd, had been one of the flatboat captains. "On account of the dams at the grist and saw mills," he said, "the best men ran the boats as it required great skill to navigate at these places and at some of the sharp bends." Flatboating from Warren had ended when the Cross-Cut Canal opened about 1840.

John Boles and John Graham had owned boatyards at Bolesville and Bridgewater that turned out many flatboats, keelboats, and canalboats. They also built some of the steamers, the *Rhuamah*, *Fallston*, *Beaver*, *Itaska*, and *Rodney*, that plied the lower Beaver from Beaver Falls, New Brighton, Fallston, and Bridgewater to Pittsburgh during the late 1830's.

At least one steamboat, the *Isaphena*, was built on the Shenango River at New Castle in 1840, and records showed three steamboats built at Warren, Ohio. The listing of two, the 21-ton *Seagull* built in 1833 and snagged on Arkansas River in 1834 and the 30-ton *R. H. Barnum* built in 1862 and burned in 1864 on the Big Sandy River, could have resulted



Allegheny River below Sixth Street Bridge, Jan. 9, 1913

from errors in the records—confusion between Warren, Pennsylvania, and Warren, Ohio—but there was no question about the 34-ton *Warren Packard*, built in 1861. Named for its owner, a prominent Warren businessman who was ancestor of the builder of Packard automobiles, the *Warren Packard* had operated as an excursion boat on the Mahoning out of Warren for a year before its owner gave it up as a losing proposition.

William A. Magee of the Lake Erie and Ohio River Canal Board sent all the evidence collected to the Chief of Engineers in February 1915, convincing the Chief that the Beaver River and its major tributaries had been navigable in fact in the past. The Chief chided Colonel Shunk for overlooking the historical records of Beaver and Mahoning River navigation, reversed the Colonel's decision, and directed the Pittsburgh District to exercise jurisdiction over streams in the Beaver River basin as navigable waters of the United States. Thereafter, encroachments on stream channels in the Beaver River basin were regulated.

Ohio River Flood Board "We are spending millions for relief of flood victims, but not one cent to solve flood problems," thundered Theodore Roosevelt, while the flood of March 1913 was still receding. He declared that it was imperative for the Federal Government to build reservoirs to conserve flood waters to use for irrigation, hydroelectric

power generation, and improving dry-season flows. "All this might be done," he asserted, "by one act of the Federal Congress. We can lift the rivers out of politics by enacting a single adequate measure, establishing a policy, and providing continuing funds, exactly as was done in the case of the Panama Canal."

There were many who disagreed. Colonel Charles Townsend of the Corps warned the attractive idea of multipurpose reservoirs might be the "voice of a siren luring the people to an open pork barrel for every stream in the United States." Editors of the influential *Engineering News* feared a federal flood control program might cause cutthroat competition among congressmen for appropriations. "Each would aim," the editors warned, "to get the largest possible appropriation for his district, and, most unfortunate of all, the voters of his district would judge his usefulness as a legislator by this standard."

Public outcry after the March 1913 flood forced the Chief of Engineers to change from a passive to an aggressive approach to flood problems. The Chief sent a confidential letter to all District Engineers directing that they begin studies of multipurpose water uses, and on April 12, 1913, he issued a carefully worded order appointing an "Ohio River Flood Board" to report upon the "most practicable and effective measures for prevention of damage by floods to works constructed for the improvement of navigation, of interference with interstate commerce, and of other disastrous results thereof." The Secretary of War assured Senator Theodore Burton of Ohio that the study by the Flood Board would have wide scope. The Flood Board was chaired by Pittsburgh District Engineer Francis Shunk, and his deputy, Captain Harold C. Fiske, served as recording secretary. "The tendency of proposed legislation seems to indicate that the public wants a solution of these problems," commented Captain Fiske, "and that if this Board does not attempt to solve them someone else will and others may not solve them as well as we might." Captain Fiske later served as District Engineer at Chattanooga, Tennessee, and developed plans for multipurpose water resource development in the Tennessee River

basin that were subsequently implemented by the Tennessee Valley Authority.

Beginning at Pittsburgh and Wheeling, moving on to East Liverpool, Wellsville, New Castle, Youngstown, and Warren, and traveling west across the Muskingum, Scioto, Miami, and Wabash basins, the Flood Board visited some 52 cities that had suffered damages during the 1913 flood. The wreckage they saw indicated that most flood damages had been caused by encroachments that had reduced stream flood-carrying capacity. The encroachments had occurred because control of rivers was in a twilight zone between federal, state, and local governments and no one had exercised effective authority. "What was anybody's business became nobody's business," the Board reported, and it made the radical proposal that federal jurisdiction over rivers, limited to navigable waters, be extended to all streams, whether navigable or not. That recommendation, opposed by state governments that were jealous of their prerogatives, was shelved and quietly ignored for more than a half century after 1915.

Because conditions varied from basin to basin, the Board thought all feasible flood protection measures, including levees, flood walls, dredging, channel rectification, reservoirs, and floodplain zoning, would be used, but it could recommend no specific plan because data was insufficient. "Our first duty," the Board reported, "is to obtain definite and precise information on all these subjects, so that the people may know what can be done and what it will cost." Needed were complete drainage area maps, stream profiles and cross sections, water discharge curves, and precipitation records, collected systematically on the Ohio and all its tributaries; studies that would best begin in the Pittsburgh District where the Pittsburgh Flood Commission had made a start. Then a definite federal flood control policy should be established, "based not on uncertain and indefinite benefits that may accrue to navigation, but on the certain and positive benefits that will accrue in the protection of life and property from loss."

Mahoning and Shenango River Reservoirs The long range plans outlined by the Ohio River Flood Board did not please people in the Beaver River basin, who had been hard hit by the 1913 flood and who were desperate for improved water supply. Through studies of historical navigation, they obtained federal jurisdiction over stream encroachments in 1915, and in the same year they began construction of their first reservoir.

Youngstown city engineer Frank M. Lillie and consulting engineer J. W. LeDoux studied reservoirs for flood control and water supply upstream of Youngstown in 1912 and found several excellent reservoir sites: the Berlin and Milton sites on the Mahoning between Newton Falls and Alliance, two sites on Meander Creek and a site on Mosquito Creek, both tributaries that joined the Mahoning at Niles. Youngstown funded construction of the Milton Dam on the Mahoning after the 1913 flood. It was the first multipurpose reservoir in the Beaver River basin and first in the Pittsburgh Engineer District.

Because the 2,840 feet long and 40 feet high compacted sand and clay dam at the Milton site was to be located in a glacial valley, with fissures in the foun-

dation rock, engineers Lillie and LeDoux adopted the then novel techniques of grouting the foundation and building a cutoff wall. After drilling holes into the foundation rock, they forced cement grout down pipes to fill and seal the fissures. Steel sheetpiles were then driven to rock just upstream of the dam axis and a 30-inch wide concrete wall was then poured in a trench excavated behind the piles. With the foundation thus protected from leakage, the earthfill was rolled into place to form the dam. Completed in 1917 at a cost of \$1.2 million, Milton Dam stored 10 billion gallons of water during floods for release during droughts, increasing the minimum flow past Warren to 77 cfs (fifty million gallons a day).

Storage behind Milton Dam was insufficient, however, to meet the needs of industry sprouting along the banks of the Mahoning, and in 1921 consulting engineer Alexander Potter recommended building more reservoirs: at the Berlin site on the Mahoning, on West Branch of the Mahoning between Newton Falls and Ravenna, on Eagle Creek near Phalanx, on Meander Creek south of Niles, and on Mosquito Creek north of Niles. The Mahoning Valley Sanitary District was organized and in 1922 built a dam with 32,400 acre-feet reser-

Lake Milton reservoir





Tygart Dam

hillsides. Firmly planted in the rock and soil below, it stands guard over the tumbling waters of the Tygart River—and against their uncontrolled flow during seasons of extreme rain.

voir capacity two miles up Meander Creek south of Niles. Industrial and population growth continued at such a pace, however, that even augmented river flow was insufficient. By 1941, the river between Warren and Lowellsville was used and reused so many times that water temperatures sometimes reached 130° F.

Sharon and New Castle on Shenango River had problems similar to those of communities on the Mahoning. Floods caused heavy damages and flows past Sharon were sometimes as little as 8 cfs. New Castle city engineer C. H. Milholland, in a letter describing 1913 flood damages to Colonel Francis Shunk, said, "in my opinion, the construction of reservoirs, in suitable locations, will be the remedy for floods in this section." The Pennsylvania legislature passed an act that year approving a dam closing the outlet of Pymatuning swamp at the head of the Shenango to be operated for flood control and water supply. Because part of the reservoir would be in Ohio, legal complications delayed land acquisition until 1921, and construction did not begin until 1931 when federal funds for Depression work relief became available. Finished on January 23, 1934, Pymatuning Dam and its spillway cost \$368,139, but land acquisition and relocation costs drove the total price up to \$3.7 million. Pymatuning Dam reduced damages at Sharon and New Castle during the March 1936 flood and that summer maintained a 175 cfs flow past Sharon when natural flow would have been less than 40 cfs. "We feel that the dam has already paid for itself," said people at Sharon.

Watchdog on the Tygart *Between flanking hilltops in the Tygarts Valley of Northern West Virginia a sentinel stands—silent and strong. Broad of beam, its long arms reach across the valley and anchor themselves deeply in the towering*

So Tom Cummings, editor of *Grafton News*, described the dam he tagged as the "Watchdog of the Waters." A massive concrete and steel block plumped down in the riverbed just upstream of Grafton, at its completion in 1938 Tygart Dam was the largest concrete dam east of the Mississippi and first link in the chain of reservoirs and dams the Pittsburgh District was forging for protection of the headwaters district.

Planning for Tygart Dam and the reservoir chain, begun in 1849 by Charles Ellet and renewed in 1908 by the Pittsburgh Flood Commission, had been continued by the Pittsburgh District after 1913. Just as federal power to improve navigation had once been questioned, so federal power to undertake flood control projects was questioned during the early 20th century, but ever since Thomas Hutchins began his surveys of the Seven Ranges in 1785, the performance of surveys and planning studies had been accepted as a legitimate federal function.

Congress had approved the studies of flood problems and remedial measures begun in 1913 by Colonel Francis R. Shunk and the Ohio River Flood Board, but took little action on the findings of that board. Through lobbying in Congress and in the Pennsylvania legislature, the Pittsburgh Flood Commission secured a matching federal-state grant in 1924 to fund studies by the Pittsburgh Engineer District of multipurpose water resource development, including navigation improvement, flood control, low flow augmentation, and hydroelectric power generation, in the Allegheny and Monongahela basins.

Inspector James C. Getty had served for years before 1924 as practically a one-man survey branch for the Pittsburgh District. A touchy, independent fellow, highly critical of John Arras, Anson B.

McGrew, or any other superior who issued orders for field surveying from the comfort of an office, Getty commonly loaded his survey instruments into a horse and buggy to travel to survey sites. He scrambled through the brush, climbed bluffs, and waded creeks alone, though sometimes hiring local men to hold the ends of tape measures and the rods while he sighted through his theodolite.

To handle the expanded survey program in 1924, the District purchased a Peerless sedan, a Buick touring car, and saddle horses for transportation. The home office dispatched to the furthestmost ends of the District several survey parties of young and vigorous men, including Cliff Morrison, Bob West, Ben Walker, Paul Atkinson, Louis Yough, and Tommy Saddam, under command of Hugh Casey, an engineer officer who later became Ohio River Division Engineer and military governor of the Philippines. When that survey group finished preliminary fieldwork in 1929, a separate Survey Branch headed by Payson A. Perrin was established. It began using airplanes, cameras, and more sophisticated methods for performance of survey and mapping work.

As a result of intense lobbying by the Flood Commission and financial cooperation from the State of Pennsylvania, the Pittsburgh District had its first comprehensive river basin report ready by 1928, the year Congress approved similar studies throughout the nation. Known as "308 Reports," because proposed in House Document 308, 68th Congress, 1st Session, the basin studies, begun in 1928 and mostly finished by 1935, represented the complete commitment of the Army Engineers to the multipurpose water resource development concept.

"In these studies," said General Lytle Brown in 1930, "we seek to answer the questions: what are the ultimate possibilities of a certain river in terms of navigation, irrigation, power, flood control, and other possible uses of its water? How can this ultimate development be achieved—by what works, at what costs, and by what compromises between the different interests involved?" Limited by law to

planning studies and navigation projects, however, General Brown faced a difficult task in attempting to achieve some measure of flood control; he saw hope, nevertheless, in the "308 Reports." "The entire design may not be worked out in our lifetime or in our children's lifetime," he said, "but the entire design will be known to us now."

The District's 1928 report on the Allegheny and Monongahela basins was extremely conservative. Based on 1907 flood damages and low flood frequency rates, planning full development including 99% flood protection for Pittsburgh, estimating costs of multipurpose reservoirs high and their benefits low, the report found that costs of the program outlined would exceed benefits. The Pittsburgh Flood Commission, engaged in a fight to secure federal funding for flood control, attacked the 1928 report as too conservative and hired engineers Harold A. Thomas and Ross Riegel to prepare an alternate plan. By eliminating some of the more costly project features planned by the Engineers, reducing flood protection at Pittsburgh from the 99% proposed by the Engineers to about 87%, and estimating higher benefits, Thomas and Riegel produced an economically feasible plan in 1930. During the early Depression years, Pittsburgh District studied that plan, and a third, and a fourth, and more, but all planning studies were pointless unless some means of funding the proposed project were devised.

Bound by law to undertake only projects that would benefit navigation, General Lytle Brown cast about in search of ways to achieve flood control and came up with the idea of cooperative funding, allocating construction costs to those interests that would be benefited. That was the way it was done in Europe. The federal government could contribute funds proportionate to project benefits to navigation, local and state governments would pay for flood control features, and industry would pay for increased water supply or for hydroelectric power.

There were major obstacles, however, to cooperative funding for flood control. The economic depression that began in 1929 made business reluc-

tant to invest in new ventures and eroded the tax receipts of local government, thereby reducing their ability to participate in flood control projects. Legal tangles could be resolved where projects lay within a single state, and that was accomplished in the Miami River basin in southwestern Ohio, but flood control in the Pittsburgh District involved construction of dams and reservoirs in three or more states, which would provide benefits to people living as far away as New Orleans. West Virginians might well ask, and they did, why they should help fund construction of reservoirs in the upper Monongahela basin whose benefits would accrue to people living in Pennsylvania, Ohio, and even in Louisiana.

An opportunity for cooperative flood control arose in 1933 when President Franklin D. Roosevelt signed the National Industrial Recovery Act, providing funds for Depression work relief and economic recovery through construction of public works. Building flood control projects could employ thousands, even millions, of workers. The Federal Government could pay for benefits to navigation and loan money to local and state governments and conservancy districts to pay for flood control and water supply features. Agencies such as the Muskingum Watershed Conservancy District and the Pittsburgh Flood Commission jumped at the opportunity.

In December 1933, the Muskingum Watershed Conservancy District in central Ohio arranged construction of a fourteen dam system for flood control and other purposes, funded by assessments on property owners and grants from the state of Ohio and from the Public Works Administration (PWA). The PWA required that the Muskingum dams be built by the Army Engineers, and a special Engineer District at Zanesville, under command of Colonel Joseph D. Arthur, accomplished the feat of building those fourteen dams from scratch in five years, 1934-1938, by driving the engineers and work-relief laborers to the limit, except Saturday nights. And moreover, because hungry and unemployed engineers and workers were then a dime a dozen, the Zanesville District did the job with rare economy. Thanks to the remarkable work of its soils



Major W. D. Styer

laboratory, the Zanesville District also built the project with considerable technological flair.

Two days after President Roosevelt signed the National Industrial Recovery Act, Marshall O. Leighton, consultant to the Pittsburgh Flood Commission, was in the PWA Washington office with an application for funding construction of nine dams upstream of Pittsburgh: on Loyalhanna, Tionesta, French, Redbank, and Crooked creeks and Allegheny River, and on Tygart River and West and Middle Forks of the Monongahela River. Building the nine dams, the Flood Commission estimated, would put 46,000 men to work.

The PWA sent the Flood Commission's application to Major Wilhelm D. Styer, Pittsburgh District Engineer, for review. He eliminated the proposed dam on the Middle Fork of the Tygart, commented that without dams on the Conemaugh and Youghiogheny rivers the plan offered only limited flood protection for Pittsburgh, and sent the application on to the Ohio River Division. He recommended that the government cooperate with



Upper pool



Lower pool

October 2, 1930, Lock & Dam 11, Monongahela River

the Flood Commission in building seven dams and fund entirely the eighth, the Tygart River Dam, because of its large benefits for navigation.

The need for a dam on the Tygart had become clear during the 1930 drought when the upper Monongahela River went dry, suspending navigation above Lock 8 and threatening to close all locks. The District Engineer had been forced to ask officials of the West Penn Power Company, owners of Lake Lynn completed in 1926 on the Cheat River, to release lake water to maintain navigable pools on the lower Monongahela. The company cooperated fully, releasing 65,000 acre-feet of water from Lake Lynn, without charge, to keep barges moving until rains began in December. That gracious gesture saved the District much embarrassment. Without releases from Lake Lynn, river traffic would have ceased, steel and primary product plants lining the Monongahela and upper Ohio and relying on barge shipments would have shut down, secondary plants using steel would have closed, and the faltering depression-ridden national economy of 1930 would have received another severe blow.

Major Styer badly wanted Tygart Dam built to prevent recurrence of the near disaster of 1930, when only the generosity of the power company had saved Monongahela navigation. Division Engineer George R. Spalding concurred, recommending full federal funding and immediate construction of the Tygart Dam. He did not agree with Styer about the seven other dams, however, whose principal benefits would result from flood control. Because the Corps mission was limited to navigation, Spalding recommended that funds for the seven flood control dams be loaned by the PWA to the Flood Commission of Pittsburgh or to the Tri-State Authority, which had been founded in 1933 to unite local governments in West Virginia, Ohio, and Pennsylvania in support of flood control projects. Those agencies would have full authority to construct, operate, and maintain flood control reservoirs. The PWA did not fund the entire Pittsburgh flood control program, but on January 11, 1934, it gave the signal to proceed with Tygart.

Under the general direction of Major Styer and Charles Wellons, successor to John Arras as prin-

chief engineer, the Pittsburgh District worked out the design for Tygart Dam during 1934. Jack H. Dodds directed masonry design; William E. Sidney devised the crest gates and mechanical appliances; and Nicholls W. Bowden, aided by Harry E. Anderson and Emil P. Schuleen, took care of project hydraulics. The contractor, Frederick Snare Corporation, began building the largest concrete dam east of the Mississippi late that year, under local supervision of Majors William E. Potter and Benjamin F. Fowlkes, resident engineer Charles Wagner, and inspectors F. E. Barrett and Don D. Rait.

Built on seamed sandstone overlying soft shale, the construction of Tygart Dam presented interesting geologic challenges, solved by the District through extensive core-drilling and testing to establish foundation characteristics and rational design formulas.

The dam was located just above Grafton in Taylor County, West Virginia, and fifteen miles north of Philippi, where the first land battle of the Civil War had taken place. Tygart River had once carried a heavy logging commerce, and a small excursion steamer with a tea-kettle engine had operated at Grafton, but workmen swarming over the site in 1934 saw little evidence that the stream had ever been used for any purpose, other than water supply for the town of Grafton.

The workers relocated the Grafton-Belington branch of the Baltimore and Ohio Railroad and a few miles of highway and removed the buildings from the Yates, Stonehouse, Cecil, Cove Run, Moatsville, and Pleasant Creek communities that were to be inundated by the reservoir. Beginning in January 1935, the massive concrete monoliths began to sprout across the river bed and inch upwards, finally rising 230 feet and stretching 1,921 feet across the stream.

Completed in February 1938 at a cost of \$18.5 million, the "watchdog" on the Tygart served its first function during its construction. PWA had



Railroad relocation for Tygart Dam required a tunnel

funded the job to assist economic recovery, and about half the project costs were paid out to the 2,200 construction workers, not including the workers elsewhere who produced the cement, steel, and materials that went into the dam.

Responsibility for leashing the watch dog was handed as of January 1938 to a "Flood Control Group," with the kind of responsibility later assigned to the Hydrology Branch. The Flood Control Group was a subsection of the Projects Section in Engineering Division. The operations plan was simple in theory. The reservoir would be practically empty the first of each year, with 278,000 acre-feet of storage capacity ready to catch winter and early spring floods. Around the first of April, impoundment would begin at a rate sufficient to provide by July first, 100,000 acre-feet of storage available for slow release to maintain navigable pools on the Monongahela. During the first two weeks in December, the pool would be lowered to a level that would again provide full winter flood control. Simple in theory, but tough in practice, for droughts can occur in January, floods in July, and floods frequently follow one on the heels of another.

By early spring it was recognized that having an Engineering Division section responsible for day-to-day impoundments and releases at a structure assigned to Operations and Maintenance Division created a conflict of interest. It was recommended that "one especially selected employee (of the Projects Section) familiar with the Operations studies already conducted and who has been specializing on hydrologic and hydraulic studies, be transferred to the Operations Division..." The employee was

Robert M. Morris. He was placed in charge of routine operation of Tygart Dam, with the Flood Control Subsection to be called on only in emergency. One of the members of the subsection was Thomas L. Riley, who later became Chief of Hydrology Branch.

Morris and Riley had quite a workout in the second year Tygart Dam operated. They had to handle the third and fifth greatest floods of record at the site, a major test of operations methods. The February 1939 flood had a double peak, on January 31 and February 4, requiring discharge of the first peak through the dam before the second arrived. Impoundment to store water for low flow releases had begun before the April 16 flood arrived and gross storage reached 221,000 acre-feet, but Tygart Dam still had about 68,000 acre-feet of unused storage.

After preventing major flood damages in early 1939, the "watchdog" on the Tygart performed its other function from August to November 1939 when drought conditions nearly as severe as those of 1930 prevailed. Monongahela navigation continued during the drought solely because of Tygart Dam releases, that supplied 69.5% of river flow at Lock 15 and 38.2% of flow at Lock 5, and also much reduced the water supply and pollution problems normal to Monongahela droughts. During its first two years, Tygart Dam provided benefits aggregating more than \$3.3 million. "It is believed," said Tom Reilly, "that the results achieved thus far by the Tygart Dam, even in the experimental stage, amply justify the funds expended for its construction and operation and are the most conclusive proof that can be offered for the extension of the flood control system of the Upper Ohio River Basin."

The Saint Patrick's Day Flood Towards noon on St. Patrick's Day in 1936, water began to lap over the banks of Stony Creek and the Little Conemaugh and inch into Johnstown streets. Worried workers began to muster out of the valley, abandoning their cars in the flooded streets and wading home. Others, who had become accustomed to repeated flooding, thought the water would recede before quitting



Johnstown, Pennsylvania, March 1936

time, remained at their jobs, and were marooned in downtown buildings for the night. By dark, pianos were floating in the streets, currents were smashing abandoned automobiles about, and men were leaving their refuge atop streetcars and swimming for their lives. Marooned in the Capital Building, Mayor Daniel J. Shields looked out his office windows and helplessly watched as a man drowned. Power and telephone service ended, and apprehension increased amongst the stranded workers, who could see little save water rushing through the city and car lights moving on surrounding hills. Sleepy, cold, hungry, they welcomed the dawn.

The flood at Johnstown was receding by morning, on its way downriver to Pittsburgh, Wheeling, and other communities. "A scene of inconceivable desolation, following devastation by a flood that rivaled the deluge caused by the historic dam break in 1889," said a reporter from *Engineering News-Record* in his description of Johnstown. He said the waters of the Little Conemaugh and Stony Creek, racing through the business and industrial district and much of the residential area, had caused nearly thirty deaths in Johnstown, left 16,000 people homeless, destroyed 77 buildings, and damaged another 4,500. He estimated damages at Johnstown at \$33 million, about a third the assessed valuation of the city, but thought human suffering and shock a more serious consequence. Especially the needless suffering that occurred when rumor spread on the afternoon of March 18 that Quemahoning Dam above the city had broken and thousands panicked and fled to the hills in a cold, drenching rain.

The rivers crested at 46 feet at Pittsburgh on March 18, surpassing the 1763 record by more than

Upstream along the Allegheny River, Pittsburgh, March 1936



Downtown Wheeling, West Virginia, March 1936

Flood damages, Emsworth Dam reconstruction, March 1936



Erosion along left bank of Ohio River main channel, vicinity of Emsworth Dam, March 1936



5 feet and flooding 62% of the Golden Triangle. Power, phone, utility services were disrupted. Fires broke out. Boats on rescue missions cruised the streets of Pittsburgh, Verona, Oakmont, Sharpsburg, Etna, and other towns. Scattered looting and vandalism occurred in the evacuated areas. A man marooned in a Liberty Avenue building shot at boatmen who refused to take him out. State police were called; the National Guard mobilized.

Water entirely covered Wheeling Island and left Wheeling, Wellsville, Steubenville, and other towns along the upper Ohio "sodden masses of wreckage, mud and slime." The St. Patrick's Day flood took nearly 200 lives and caused damages in the Pittsburgh Engineer District amounting to \$199 million. President Roosevelt sent in thousands of Works Projects Administration and Civilian Conservation Corps workers to clear the debris and clean the mud from the stricken towns, and spent millions to assist in community recovery.

Major Wilhelm Styer and the Pittsburgh Engineers joined in the rescue work at the height of the flood, but devoted most of their attention to saving Emsworth Dam on the Ohio and Dam 4 on the Allegheny. A derelict barge slammed into and wrecked the lower lockgates at Emsworth, and the flood topped a cofferdam, in place while Emsworth Dam was being raised to provide a deeper harbor for Pittsburgh, pushed a whirler and gantry crane into the cofferdam, destroyed the concrete esplanade at the lock, and cut a large slice out of Neville Island at the main dam abutment. Erosion of the island menaced the dam, but the Engineers saved it by dropping 24,000 sandbags onto the island bank and stopping the scour.

Major Styer took personal charge of emergency work to save Allegheny Dam 4 at Braeburn-Natrona, where he faced a situation similar to that met by "Goliath" Sibert at Dam 3 in 1907. The flood breached Braeburn dike, which joined Dam 4 abutment to high ground, bypassing the dam and swiftly eroding the bank, threatening to consume the Pennsylvania Railroad track and the Braeburn Steel



Works. Major Styer arranged shipment of train loads of 5 to 20-ton stone blocks from quarries up to 60 miles away and dumped the stones into the breach. Swift current washed away the huge blocks as fast as they were placed, and Colonel Styer brought up six old railroad locomotives to push into the breach as a last resort. The stone blocks finally took hold, however, and stopped the erosion before use of the locomotives became necessary. Styer did not have to blow out Dam 4. The breach was closed and the dam remained in service.

An End to Hypocrisy "We are now living under a hypocritical fiction. Improvement of navigation being under federal control, is made the excuse for flood control," wrote Arthur E. Morgan in 1928. Morgan, president of Antioch College, had built the Miami River basin flood control project and in 1933 became chairman of Tennessee Valley Authority. "By gradual accumulation of precedent we are, in fact, amending the Federal Constitution, but in such a partial and inefficient manner that the Federal Government is acquiring obligation for flood control without the necessary powers for its proper execution," he explained. "The legal structure of flood control should be as well built and as comprehensive as the engineering design."

Morgan's assessment of the situation was fairly accurate. Congress had been backing toward a flood control program in the Ohio River basin since 1884, when it told "Padre" Merrill to build levees around some towns to improve navigation by keeping boats in the channel during floods. But the St. Patrick's Day flood, ending with a paper flood of letters and telegrams in Washington, put an end to that hypocrisy.

President H. B. Kirkpatrick called a meeting of the Pittsburgh Chamber of Commerce on March 27 at the Pittsburgh Athletic Association, because the Chamber office was still without power. He organized a Citizens' Committee on Flood Control and dispatched a telegram to federal dignitaries:
OUR ORGANIZATION REPRESENTING THE GREAT INDUSTRIES OF THE PITTSBURGH DISTRICT AS WELL AS THOUSANDS OF

Joseph Horne Company Department Store, Stanwix Street, Pittsburgh, March 1936



Lower Penn Avenue, Pittsburgh, March 1936



Ninth Street from Duquesne Way, Pittsburgh, March 1936

Wreckage along right bank of Allegheny River above Sixth Street Bridge, Pittsburgh, March 1936



SMALLER BUSINESS CONCERNS MOST EARNESTLY URGES THAT YOU COME TO PITTSBURGH AND SURVEY FOR YOURSELVES THE SHOCKING DESTRUCTION WORKED BY THE FLOOD IN THIS GREAT INDUSTRIAL AREA PERIOD SOBER ESTIMATES MADE BY MEN OF EXPERIENCED JUDGMENT CALCULATE PROPERTY DAMAGE IN ALLEGHENY COUNTY ALONE AT ONE HUNDRED FIFTY TO TWO HUNDRED MILLION DOLLARS PERIOD IF THE LOSSES SUFFERED BY THE INDUSTRIES WHICH LINE OUR THREE RIVERS FOR A DISTANCE OF FORTY TO FIFTY MILES BEYOND THE CITY ARE INCLUDED THE FIGURES REACH A SHOCKING TOTAL PERIOD BY PERSONAL INSPECTION YOU WILL BE BETTER ABLE TO MAKE A RIGHTFUL DECISION AS TO THE EXTENT BY WHICH THE WHOLE NATIONAL INTEREST IS INVOLVED IN THIS DEVASTATION OF THE MOST HIGHLY INDUSTRIALIZED REGION IN AMERICA PERIOD

Secretary of War George Dern and Chief of Engineers Edwin Markham accepted the invitation. They toured Johnstown and Pittsburgh on April 2-3 in company with Major Styer and his successor Colonel W. E. R. Covell. General Markham, on his return to Washington, graphically described the water levels and damages he saw in Horne's department store in Pittsburgh's Golden Triangle to the House Committee on Flood Control.

The Chamber of Commerce's flood control committee joined with the Tri-State Authority, headed by State Senator William B. Rodgers, Jr., uniting political and civic leaders of the Pittsburgh vicinity in a campaign for federal flood control. They pressed their campaign through the media. They distributed a hundred thousand pamphlets urging construction of the flood control project. They participated in a mass flood control rally organized by the League of Women Voters on May 18, 1936, in Washington.

Federal offices in Pittsburgh and Washington, in the meantime, were working their way out from under a paper flood of letters urging flood control and suggesting various solutions to the flood problem. President Roosevelt received a telegram reading: "HAVE THE OHIO FLOOD PROBLEM SOLVED STOP WILL WRITE YOU STOP WILL START ON THE MISSISSIPPI PROBLEM NEXT WEEK." Alas, the letter of explanation never arrived.

A Westmoreland County tailor suggested cutting a canal to divert Allegheny River floods from New Kensington through flat country south of Latrobe and by tunnel through the mountains to the Potomac River. Captain Lucius D. Clay, deputy to the District Engineer and later the military governor of occupied Germany, responded that costs of the canal and tunnel might exceed national financial resources and asked whether people living along the Potomac might not object.

Another interesting suggestion came from Thomas L. Pfarr, Chief Fire Marshal of Allegheny County, who recommended that the Engineers dredge the Allegheny, Monongahela, and Ohio rivers 25 feet deeper and remove "unnecessary

Flood damaged merchandise, March 1936



islands." Actually, the idea was not too far-fetched; something similar was done at Johnstown. One junior officer, weary from working through piles of letters from well-meaning people, finally devised a standard response: "We appreciate your suggestion, but there is no difficulty whatever in determining how to prevent floods, the only difficulty being to procure the wherewithal."

Congress had been studying and debating a flood control bill for several months before the St. Patrick's Day flood hit. Just after the flood, Senator Royal S. Copeland asked the Chief of Engineers if he would recommend reservoirs for flood protection of Pittsburgh and the Ohio River basin. General Markham replied that the proposed reservoirs were meritorious, but "it would appear that their authorization should be considered only in connection with such a general program, the terms of which thereafter may be construed as a basic policy definitive of Federal interest." In short, hypocrisy should end. Senator Copeland revised the bill, and the Flood Control Act, as passed by Congress on June 22, 1936, read:

It is hereby recognized that destructive floods upon the rivers of the United States, upsetting orderly processes and causing loss of life and property, including the erosion of lands, and impairing and obstructing navigation, highways, railroads, and other channels of commerce between the States, constitute a menace to national welfare; that it is the sense of Congress that flood control on navigable waters or their tributaries is a proper activity of the Federal Government....

One obstacle to flood control in the upper Ohio River basin remained. "It is my belief that, for many reasons," said President Franklin Roosevelt, "the Federal Government should not be charged with the cost of land necessary for levees, dams, and reservoirs." That policy, made part of the 1936 flood control act, forced state governments to buy the lands and easements for reservoir projects whose benefits would extend to other states.

Political and civic leaders at Pittsburgh bitterly opposed the President's cost-sharing plan for flood control and accused him of inconsistency. Why do you favor full federal funding of reservoirs in the Far West and in the Tennessee River basin, but not in the Ohio River basin, they queried. The population of Allegheny County, they said, is fifteen times greater than the population of Nevada, and equal to the combined populations of Nevada, Wyoming, Delaware, Vermont, and New Mexico, and we pay more taxes. Pennsylvania moved ahead and appropriated funds for purchase of lands at the Tionesta and Crooked Creek reservoir sites, but West Virginia and other states let Congress and the President know, explicitly, that they had no intention of cooperating.

Under questioning by the House Committee on Flood Control, Chief of Engineers Edwin Markham admitted the cost-sharing requirement for reservoirs might "seriously retard, if not prevent, the consummation of a flood-control program for the protection of the valley." He favored requirements of cooperation for local protection projects, construction of levees and floodwalls around individual communities, for if local interests were not sufficiently concerned to supply the lands and operate the projects after completion, then no one suffered but themselves. "Reservoirs," he said, "fall into a different category, for the benefits from these structures are not local but far-reaching."

After the record flood of January 1937 laid waste to the lower Ohio River basin, Roosevelt gave up his policy, and in 1938 Congress ended the cost-sharing requirement for reservoirs. In fact, in the 1938 flood control act Congress provided also that communities that had channel improvement projects approved in 1936, which included Johnstown, Punxsutawney, and Elkins in the Pittsburgh District, would not have to pay the costs of lands and project operation and maintenance.

Flood Free Johnstown "We want to keep you from having those floods again," said President Franklin Roosevelt. "The federal government, if I



Site of a dam that was never built

have anything to do with it, will cooperate with your state and community to prevent further floods."

The President, in company with the Secretary of War, the Chief of Engineers, Governor George H. Earle, Mayor Daniel Shields, and District Engineer W. E. R. Covell, motored through the Conemaugh valley on August 13, 1936. They stopped at a proposed reservoir site, where Colonel Covell explained the District studies of protective measures for Johnstown. At Roxbury Park, the President promised the people of "Flood City, U.S.A." they would have protection. That day, he signed an order allocating \$300,000 to the Pittsburgh District for planning a solution to Johnstown's flood problems.

The District found what at first seemed a desirable reservoir site on Stony Creek, eight miles upstream from Johnstown, but it would have affected Hollsopple and mining communities, flooded two major railroad tracks, and field investigation showed the site was honeycombed with mines that made a reservoir very costly. The District then planned a channel rectification project, involving deepening and widening 8.7 miles of Stony Creek, Little Conemaugh, and Conemaugh Rivers where they flowed through Johnstown, laying concrete bank slope paving, building low dikes and floodwalls, and relocating railroads, highways, and utilities.

Project engineers A. M. Hertz and C. E. Paul and resident engineer Charles H. Wagner supervised the five contractors who began work on the Johnstown project in August 1938. Thanks to the unique provision of the 1938 flood control act, Johnstown became one of the handful of cities in the nation that had all construction, operation, and maintenance costs funded by the Federal Government. President Roosevelt took personal interest in the project and visited Johnstown again in June 1940 in company with District Engineer Ludson "Goop" Worsham.

"When I visited Johnstown in 1936," said the President, waving his cigarette holder, "Colonel Covell told me a reservoir was planned. What happened?"

"That was the Hollsopple site," General Worsham replied. "It was abandoned because it would have caused more damages than flooding the area it was to protect."

The President then asked how deep the channels were being cut, what were the angles of their side slopes, how thick was the concrete paving, and what size floods the channels could handle.

Surprised by questions that normally only another engineer would ask, General Worsham explained the project at length and in detail, telling him it would carry a flood equal to that of March 1936 without trouble.

"Suppose we have a higher flood?" the President quickly interjected.

General Worsham paused a moment to consider the question, then responded, "Mr. President, we must have some faith in the Lord."

The President slapped his thigh and laughed loudly, pleased with the answer. General Worsham later recalled he had been so pleasantly surprised by Roosevelt's intense interest in the Johnstown project that "he almost made me a Democrat."

Many flood projects were suspended in 1942 because the workers and materials were needed for critical military projects, but not the work at Johnstown. District Engineer Gilbert Van B. Wilkes dedicated the project on November 27, 1943. "Today, Johnstown can boast that it has the largest and best channel improvement in the United States," he told a crowd at Johnstown. "We believe that the flood troubles of the city of Johnstown are at



Colonel W. E. R. Covell

an end. The work was prosecuted during wartime because of the immense importance to the war effort of the products produced here in this city. We salute the FLOOD FREE CITY OF JOHNSTOWN." One wonders, however, whether the President's special interest in the project might not have had more than a little to do with its early completion.

Watchdogs at the Headwaters The dapper Colonel W. E. R. Covell, in full uniform as usual, buttons shining and boots glistening, strode into Room 1026 in the Federal Courthouse Building, Pittsburgh District headquarters, took his chair at the head of the table, and opened the conference. "Gentlemen," he began, "in this District we expect to build dams that are *absolutely* safe at the *least* possible cost. You are the best engineers obtainable in the country, and we expect you to decide how to build the safest and most economical dams in the world." With that, he turned the meeting over to Charles M. Wellons, who was to serve as chairman of the Board of Consultants.

Charged with planning and building an unbreakable chain of dams upstream of Pittsburgh, Covell sought the best engineers he could find and brought them to Pittsburgh for their first meeting on December 16, 1936. Looking down the long table, he knew he had succeeded. First, there was his own staff: Wellons, the principal engineer; William E. Sidney, a mechanical genius; Jack Dodds, the practical engineer; Shailer Philbrick, a foundations expert; Emil Schuleen, the hydraulic operations man; and District stalwarts Harry E. Anderson, D. P. Grosshans, D. E. Oelschlager, Don D. Rait, and A. L. Alin.

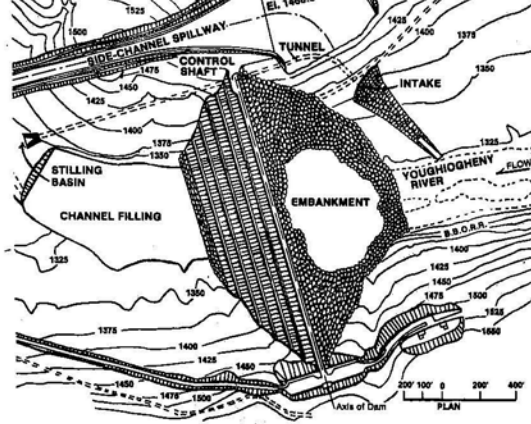
From Washington came William McAlpine, Edward B. Burwell, and William Gerig. McAlpine, a rasping, straightforward fellow, had rushed the Ohio River locks and dams to completion in 1929 and had directed the canalization of the Upper Mississippi. He became, by act of Congress, senior engineer in the Corps, and in 1965 the Ohio River dam at Louisville was named in his honor. Burwell, from Ohio River Division, became chief geologist for the Corps. Gerig had been a roving trouble-shooter

for the Corps since 1889 and had been division engineer under Goethals in Panama. Like McAlpine, Gerig's long experience with river engineering had made him extremely skeptical of theory. When younger engineers explained their theories, Gerig sometimes looked them in the eye and asked, "You don't believe all that damn stuff, do you?"

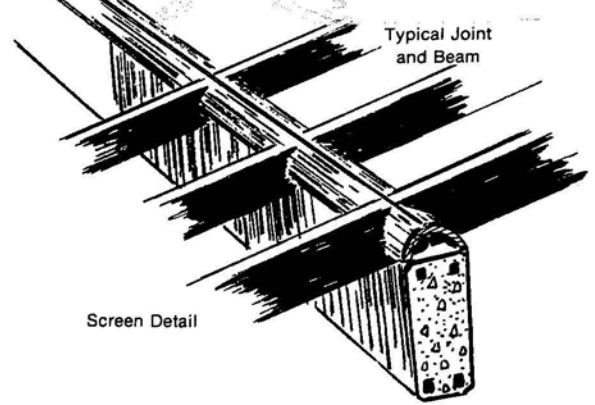
From outside the Corps, Covell had recruited James P. Growdon, William P. Creager, and Warren J. Mead. Growdon, tall, distinguished, outspoken, had built monumental rockfill dams as chief engineer for Alcoa, generally with free-hand experimental techniques. Creager, consulting engineer on a hundred different projects, had an unmitigated penchant for writing. While consultant for the Pittsburgh District, he completed a three volume work: *Engineering for Dams*. Mead, a sharp young geologist from M.I.T., had designed Boulder Dam on the Colorado River.

After Wellons completed the preliminaries, he introduced the speakers at the first session. Emil Schuleen described hydraulics operations planning: maximum probable floods, flood storage requirements, proposed operations methods. Ed Burwell outlined the geology of the Tionesta, Crooked Creek, and Redbank Creek reservoir sites and the feasibility of dam types: concrete, rockfill, or earth embankment. William Sidney discussed proposed outlet and conduit types and various valve, bulkhead, and crest gate systems. And last, Professor Harold A. Thomas from Carnegie Tech presented the flood routing model he was building for the District. The first meeting of the Board of Consultants then adjourned.

Next morning, the Board members, District staff, and officers from Division and the Chief's office, dressed in the warmest woollens they could find, piled into a dozen sedans, usually heaterless, parked along the busy downtown streets outside the District office and motored off up two-lane roads into the countryside for a first look at the dam sites. During the winter of 1936 the District had drill-rigs boring cores and inspection pits to reveal foundation con-



YOUGHIOGHENY DAM



ditions at sites on Tionesta, Crooked, and Redbank creeks northeast of Pittsburgh. Because of the high costs of relocating railroads and villages, the Redbank Creek site was abandoned for one on Mahoning Creek. When as near the dam sites as possible, the engineers piled out of the cars and hiked, with toes freezing, through the snow and muck to the drill-rigs to inspect cores taken from the rock. Some boarded metal cages hanging on cables and were let down into the inspection pits below the frost line to see the strata in place.

While thawing out in ramshackle hotels at night, the engineers discussed what they had seen during the day and argued geology and dam design. The arguments continued during a series of meetings and inspection trips throughout 1937 and 1938 until details were hammered out. Soils samples were shipped to the soils laboratory directed by Robert I. Phillippe, Frank Mellinger, and others at Zanesville until 1938, when the Muskingum project was finished, and the soils lab moved into a building on Susquehanna Street in Pittsburgh. The lab moved to Cincinnati in 1942 and became the Ohio River Division Laboratory at Mariemont.

After lengthy and heated debates about how much freeboard each dam should have above probable maximum flood storage, what the earthquake safety factor should be, the relative merits of concrete gravity, rockfill, and earthen dams, and other engineering features, the Board agreed on rolled earth embankment dams on Tionesta and Crooked Creeks and a concrete gravity dam on Mahoning Creek. District geologist Shailer Philbrick later recalled: "To me it was an interesting and well as sometimes almost a thrilling thing to be with those fellows and see how they worked out their problems, because in those days there were not computers and many of those things were worked out on the basis of feeling. Now whether this is good engineering or not I don't know but it was the art, and they practiced it exceedingly well."

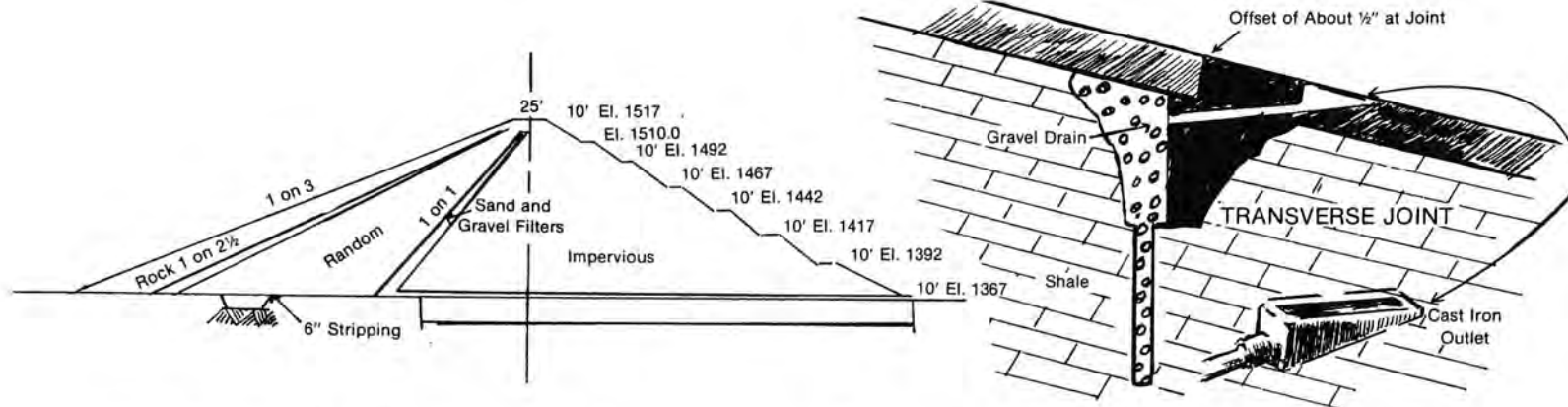
Pennsylvania finished land acquisition for reservoirs on Tionesta and Crooked creeks and the District began construction of rolled earthfill dams in

1938. Captain James K. Herbert and engineers W. B. House and G. P. Fleetwood directed contractors S. H. Groves and Sons and Lundin Brothers at the Tionesta Dam, 1.2 miles above the mouth of Tionesta Creek, and contractor George M. Brewster at the Crooked Creek Dam, 6.7 miles up Crooked Creek. Both were finished in 1940, several months ahead of schedule.

After the venture into earth dam construction, the District returned to the concrete gravity type on Mahoning Creek, 22 miles above its mouth. Resident engineers Charles "Wag" Wagner and James "Raucous Bill" Bowman watched the contractor, Dravo Corporation, as it began a search for access to the Mahoning Creek site in February 1939. The contractor built a 3.8 mile rail spur from the Pittsburgh and Shawmut Railroad to move thousands of tons of cement, sand, and gravel to the site, completed drilling the inspection and grouting holes, and had cellular steel pile cofferdams in place by the end of June. Whirler cranes, mounted on concrete piers that became part of the dam, began swinging buckets of concrete to the forms in July 1939, steadily inching the monoliths upwards. The \$6.5 million Mahoning Creek Dam was finished on June 2, 1941, a year ahead of schedule.

Congressman Robert G. Allen of Greensburg told the House Committee on Flood Control in 1937 that, because losses had been so high during the St. Patrick's Day flood, people of Vandergrift on the Kiskiminetas River moved their property to the second stories of their homes at every rain. He asked, and got, early construction of a dam on the Loyalhanna Creek, 4.5 miles above its confluence with the Conemaugh at Saltsburg. Engineer Ralph Patt inspected the work of the Great Lakes Dredge and Dock Company, when it began building the combined concrete gravity and earth embankment dam in February 1939 on the Loyalhanna.

As a result of planning and supervision problems, the Great Lakes Dredge and Dock Company, which had an excellent record in its field but no experience with big dam construction, was losing money on the Loyalhanna Dam contract. Company president Edwin Markham, who had retired in 1937 as Chief



of Engineers of the Corps, visited the District to see what could be done. Captain Herbert D. Vogel, then working with Herb Winn, D. P. Keelor, and Wilfred Bauknight in the District inspection division to prod contractors and maintain quality standards, asked District Engineer Ludson Worsham how the Loyalhanna contract and General Markham should be handled. "The first day," Worsham said, "we will extend to him all the respect and courtesy that is due an ex-Chief of Engineers. After that he's just another damn contractor!" General Markham and his firm were held to the grinder and completed the \$5.4 million Loyalhanna Dam in June 1942.

Last and largest of the six dams, including Tygart, that the Pittsburgh District began before December 7, 1941, was Youghiogheny Dam on the Youghiogheny River 1.2 miles above Confluence, Pennsylvania. Its reservoir was to extend south to Friendsville, Maryland.

A dam on the Youghiogheny had been advocated for years. As early as 1913, E. A. Schooley of the Connellsville Chamber of Commerce told District Engineer Francis R. Shunk that his town and the Youghiogheny valley had suffered many devastating floods and had severe water supply problems. "As a preventative measure," Schooley said, "we suggest immediate construction of the proposed reservoir south of Confluence and impounding the waters of the Youghiogheny River, thereby arresting flood crests and, incidentally, supplying about ten times the stream's present minimum flow during the dry period."

The Pittsburgh District thought the Youghiogheny Dam a key to flood protection for the upper Ohio basin, but relocations costs were high. After it became clear that West Virginia would not support construction of a dam and reservoir on the West Fork of the Monongahela, the District moved ahead with plans for the Youghiogheny Dam in Pennsylvania.

Youghiogheny Dam was to be built under two contracts: the outlet tunnel by Herman Holmes, the rolled earthfill dam and spillway by Hunkin Conkey

Company and Shofner, Gordon and Hinman. Resident Engineer Charles Wagner supervised construction of the outlet tunnel, beginning in November 1939, but difficulties encountered in locating proper fill materials for the dam delayed the start of that work.

At a Board of Consultants meeting just before Christmas, 1940, District soils expert Shailer Philbrick was directed to find another million and a half cubic yards of fill material. Unhappy with the assignment, because he had planned a Christmas trip with his family, he walked out of the meeting grumbling all the while and ran into William E. Sidney. Sidney was a character, who had learned mechanical engineering through correspondence courses and wide experience with Pittsburgh Plate Glass, Superior Machine Tool, and Army Ordnance before joining the District in 1925. He sometimes worked out designs in his home basement, while listening to his pet parrot, and often prefaced his remarks with "Last evening the parrot said...."

Philbrick explained his problem to Mr. Sidney, saying, "This is a helluva situation. I've got to find a million and a half cubic yards before I go off for Christmas."

"There's no problem with this at all," replied Sidney, with a straight face. "Just send a requisition over to Procurement Branch for a million and a half cubic yards of soil for Youghiogheny Dam."

Humor often relieved tensions generated by the hectic pace at which the engineers worked in 1940. With addition of Dam Design and Projects Sections, the Soils Laboratory, and various branches, the number of District employees in 1940 was nearly double what it had been in 1930; and the District had also been assigned airfield construction when President Roosevelt began improving the nation's defensive capability. Philbrick located materials for Youghiogheny Dam through some innovative engineering, but construction of the dam had just begun when the thud of bombs at Pearl Harbor brought the Pittsburgh District its greatest military challenge.

Chapter 14

ARSENAL OF THE ALLIES

"Last summer the repairs and maintenance of the lower six locks and dams on the Monongahela were declared to be important for purposes of national defense, thus placing this work in the same class as shipbuilding and cantonment construction," said Horton W. Stickle, Pittsburgh District Engineer in 1918. "The Monongahela is unique in its present usefulness. I know of no other interior stream in this country which is giving the same direct defense and service in this war. This is a war fundamentally of transportation."

The locks and dams on the Monongahela, Allegheny, and upper Ohio rivers, because they moved raw materials to armor and ordnance plants, were so important to supply of the Allies during the First World War that marshals and detachments of the Eighteenth Pennsylvania Infantry were stationed at the dams and lockmen were issued revolvers to deter sabotage. In early 1917 there had been an abortive attempt to destroy a navigation lock on Cumberland River, and suspension of navigation on the three rivers serving the heavy industry of the Pittsburgh District would certainly have been a blow to the Allies.

The British government ordered three million shells from Westinghouse Electric at Pittsburgh in 1914; orders from the French and Russian governments followed; and by the time President Woodrow Wilson brought the United States into the war about 250 plants in the headwaters district were turning out munitions and ordnance seven



days a week, winning the region the sobriquet "Arsenal of the Allies." Of all munitions used by the American army during the First World War, about 80% came from the Pittsburgh District. Carnegie Steel produced cannon and armor; Alcoa turned out cans and containers; and Mesta Machine, National Tube, Standard Steel Car, and other firms furnished propulsion machinery for 350 ships and 36 destroyers. Traffic on the three rivers was vital to that production.

Prior to 1940, the Army Engineers handled seacoast fortification and combat construction while the Quartermaster and Ordnance departments directed military projects in the interior of the country. When George W. Goethals became acting Quartermaster General in 1918, he sought to centralize all military construction under the Corps of Engineers and establish a separate "Service of Supply" for military procurement, but the Army did not adopt those plans until the Second World War. The Engineer civil works districts, including Pittsburgh, were therefore not mobilized for military construction during the First World War.

At American entry into the war, Pittsburgh District Engineer Edgar Jadwin, native of Honesdale, organized the 15th Engineers, the "Pittsburgh Pioneers," trained them at Oakmont on the Allegheny, and took them to France. There, he became advance engineer for General John J. Pershing and commanded 165,000 men building railways and improving waterways. (Jadwin became Chief of Engineers in 1926.) Joining Jadwin

Ice gorge on the Monongahela River. February 4, 1918



in France were Lieutenants William Arras and J. Milnor Roberts, sons of the senior engineers of the Pittsburgh Engineer District.

Since interior military construction was the responsibility of the Quartermasters, the Engineer civil works employees concentrated on expediting the movement of river commerce. The engineers often, however, submitted plans for dealing with the enemy to General William Black, Chief of Engineers. "Why not build reservoirs back of the lines in France," one engineer asked, "and connect them by pipeline to enemy trenches and flush out the Huns?" General Black replied that he had considered the idea, but fortifications were generally located atop hills and ridges, and water ran downhill. Tom Jeffries, senior engineer of the Wheeling District, asked General Black whether enemy aircraft might not be downed with electrified rays from searchlights, a sort of "laser beam." Black responded that aircraft usually flew too high and fast for electric beams to have effect.

Engineer officers were in short supply from 1917 to 1919. They were the first Americans to see action in France, first to suffer casualties, and the attrition of combat cost the Corps heavily. In addition, many Engineer officers directed new branches of the Army outside the Corps that were created to work with sophisticated weaponry: General Mason M. Patrick, who had built ponton bridges at Johnstown in 1889, became first chief of the Army Air Corps; "Goliath" Sibert became first chief of the Chemical Warfare Service; and General Harley B. Ferguson, who became District Engineer at Pittsburgh after the war, organized the Army Tank Corps. Because officers were busy elsewhere, civilians acted as District Engineers during the war years. William McAlpine was District Engineer at Louisville, Robert R. Jones at First Cincinnati, Benjamin Thomas at Second Cincinnati, and Anson B. McGrew at Nashville. The latter was sent to Nashville from Pittsburgh, where he had charge of harbor inspections and regulatory functions for many years.

Colonel Horton W. Stickle, one of Goethals' men in Panama before the war, was recalled from retirement to become Pittsburgh District Engineer upon the departure of Edgar Jadwin for France. When Stickle accepted command of the 216th Engineers in 1918, John W. Arras, senior engineer on the Allegheny since 1887, became District Engineer.

While they had no military construction or supply functions, the challenge of keeping materials moving on the rivers to supply war industry was sufficient to keep Colonel Stickle and John Arras busy. When the overburdened national railway system broke down in 1917, Stickle and Arras let the eleven movable dams in the District stay up in the winter of 1917-18 to prevent fuel shortages at the munitions and ordnance plants. That winter was the coldest on record up to that time. Ice packs swept continuously out of the Monongahela and Allegheny, taking a jumbled mass of river terminals and steamboats with them. The *Kittanning* and other District floating plant kept on the move, crunching open a channel and setting dynamite charges at ice gorges. And lockmen at the wicket dams had to maneuver them at temperatures as low as minus 19°, when a misstep and plunge into the river would have been sure death. The ice even breached Allegheny Dam 2, and Arras could not repair it until after the Armistice because workmen were in the Army or in the munitions plants.

After the Armistice in 1918, it was said, even by the U. S. Department of Commerce, that the First World War had been won on the rivers at Pittsburgh because those waterways had moved the raw materials which made the weapons used in France. In 1918, the Monongahela alone carried 16.5 million tons, more than the combined tonnage (15.3 million tons) of the Suez and Panama canals that year. Total river commerce in the Pittsburgh District in 1918 was 23,397,597 tons; and the total for the five war years, 1914-18, amounted to 98,857,078 tons.

General Lansing H. Beach, who as Division Engineer had been the sole Engineer officer in the

Colonel Herbert D. Vogel

Ohio River basin at one point during the First World War, was convinced that the waterways had been vital to the war effort. When he became Chief of Engineers in 1920, he told Congress the defense value of improved waterways had been the most important lesson of the war, and he said:

The interests of the Federal government in the construction of comprehensive road and interior waterway systems throughout the United States...is far greater as a measure of defense than for commercial reasons.... This statement is made advisedly, for the preservation of the life of the Nation is the central government's greatest responsibility in peace and in war, and hence every facility should be developed to allow a successful defense to be made. It fortunately happens that roads and waterways constructed solely to meet the needs of commerce are generally well adapted to the needs of defense, and the immediate interests of the people can be counted on to secure support for this great preparedness measure.

Two factors sparked interest in improvements to river navigation facilities: railway congestion created many problems in World War I; and it was found that waterways transportation could be expanded to meet any emergency since it was limited only by the speed at which locks could be operated. Canalization of the Ohio River was rushed to completion by 1929; and a nine-foot channel was available throughout its length in 1942, when it became extremely important to national defense. The Engineers were never allowed, however, to consider contributions to national defense when estimating the benefits of waterways projects, even though such benefits were sometimes credited to federal highway projects such as the interstate system authorized in 1957.

The Youghiogeny Dam Crisis "I want to point out first of all that since our last meeting we are operating under considerably different conditions," said Colonel Herbert D. Vogel in opening



the June 30, 1942, meeting of the Board of Consultants. "I would like to point out the problems the District is up against," he continued. "We are fighting now tooth and nail to get our jobs completed. I consider our No. 1 mission is to do everything possible to aid in winning the war; everything else we do is secondary to that."

Lining the conference table were William McAlpine, William Creager, and James Growdon, who had been with the Board of Consultants since 1936, and two new members: G. W. Hamilton, chief engineer for Samuel Insull, and geologist Charles P. Berkey of Columbia University, who had replaced William Gerig and Warren Mead. From the Washington and Cincinnati Corps offices came Colonel Lewis A. Pick, Bob Philippe, Ed Burwell, Ralph Bloor, and Edward McD. Moore.

Colonel Vogel had also assembled his top staff for the meeting, for it was to determine the fate of the Youghiogeny project. Seated at his right was portly Charles Wellons, acting chairman of the Board whose rare sense of humor and artistic talents had brightened many of its meetings. Next to Wellons were geology experts Shailer Philbrick and Bob Nesbitt, the redoubtable William Sidney, hydraulics master Emil Schuleen, the demanding operations engineer Jack Dodds, and Jim Neill, a neat, reserved fellow with, Vogel thought, a steeltrap mind. By 1942, with five big multipurpose dams completed, engineers on the District staff had about as much experience with dam design as the members of the Board of Consultants.



Youghiogheny River reservoir dam, June 9, 1942

of hydroelectric power facilities at Youghiogheny and construction of upstream power dams at the Crellin, Swallow Falls and Sang Run sites to supply additional power for war production, but that plan had been vetoed because it would have diverted equipment and men from military construction jobs.

After reviewing the situation, Vogel told the Board the work on Youghiogheny Dam had reached a critical stage in June 1942. If the dam were not finished, a flood might strike that would damage industry in the headwaters district as much as an enemy bombing raid. On the other hand, finishing the dam in a hurry would rob ordnance plants, airfields, training cantonments, storage depots, and other projects the District was building of critical manpower, machinery, and materials. Furthermore, if the dam were not raised at a sufficient rate to top it out before the spring of 1943, a flood greater than could be passed through the diversion tunnel might go over the dam, and perhaps destroy it and much of the valley below. Is Youghiogheny Dam of sufficient importance to our war effort to warrant continued construction, he asked, and can we finish it before the floods come?

The engineers debated the grim gamble at great length, some taking one side and some the other, but finally agreed the danger of flood disaster to war industry was so great that work at Youghiogheny Dam should continue, if the contractor could top it out before the spring floods came in 1943. Jim Growdon thought the contractor could do it; William McAlpine was dubious. At last, Jim Neill, armed with a report from the Acting Head of the Project Section, John W. Ford, showing the chances of a flood overtopping the dam before it was completed were about two out of a hundred, said: "Let's give the contractor what he needs and get on with the job." With that, the Board concluded to move ahead if the contractor could get the parts he needed for his machinery, and when William Sidney agreed to see to the contractor's mechanical needs the Board adjourned.

Colonel Vogel recapped the Youghiogheny situation for the Board. The shortage of fill materials for the dam embankment had been solved by locating the dam 1.2 miles above Confluence, Pennsylvania, designing a 310-foot vertical cut for the spillway through a bluff at the east abutment of the dam, and using the shale cut from the bluff in the dam. A 310-foot cut and use of shale, an easily fragmented rock formed of hardened clay, in a dam embankment were unprecedented, but tests at the District soils lab had shown shale could be safely used, and Philippe, Philbrick, and Nesbitt had made plans to move shale excavated from the 310-foot spillway cut into the dam, thereby saving at least \$200,000. The plans had been threatened when a 150-foot railroad cut through shale near Brilliant on the Allegheny failed and 100,000 cubic yards of materials had slipped down onto the railroad, for Philbrick and Nesbitt had based their design for the Youghiogheny spillway cut on that at Brilliant. William Creager of the Board saved the plans, however, by devising special provisions for drainage through the concrete lining the Youghiogheny spillway, thereby preventing water pressure buildup behind the concrete lining.

Contractor Herman Holmes had begun work on the outlet tunnel for Youghiogheny Dam in 1940 and a year later Hunkin-Conkey and Shofner, Gordon and Hinman companies, under the local direction of Gilbert P. Fleetwood, began cutting shale from the spillway and moving it to the dam. A few days after Pearl Harbor, Colonel Vogel had sent a security classified report to Washington urging installation



Lordstown Ordnance Depot
National Archives

said: "Far be it from me to attempt weighing the relative ranks of a Congressman and a Brigadier, so I'll just wear this coat myself. Now let's get going." Both visitors got soaked.

Colonel Hall's personal quirk was apparent in his review of the Youghiogheny situation:

On the assumption that the protection given by the dam will assist the war effort, I have decided to concur with the consultants, and go ahead. If the Department does not like my decision there is still time to stop. The dam can be left alone and equipment moved to other fields of usefulness, and no vast amount of harm will be done; but this is the last chance the Department has to stop it. If the dam gets a very few feet higher it will not be possible to withdraw equipment, or indeed to refuse priorities required to replace damaged equipment. It will not be possible to delay the work for any cause, no matter how badly some military project might need the equipment. If the Department is not thoroughly prepared to see the Youghiogheny Dam through, it is better to direct work be stopped at once.

Charles Wellons, Herb Winn, Jim Neill, Paul Gettys, and Gilbert Fleetwood met contractors Floyd Shofner, S. E. Hunkin, and Dale Hinman at the Youghiogheny site a few days after the Board meeting and inspected the equipment. The contractors had power shovels gouging shale from the spillway and dumping it into crushers on the side of the bluff, from which the crushed rock was delivered by a long belt conveyor system (first use of belt conveyors for delivery of fill materials for a dam in the United States). The conveyors spilled the crushed shale onto the east dam abutment, from whence it was spread into place by dozers and carrying scrapers and packed by rollers at a rate of 18,000 cubic yards per day. About 3.5 million cubic yards would have to be placed before the dam was completed. Colonel Vogel sent that information along with a transcript of the Board meeting and his recommendation that construction of Youghiogheny Dam be continued to Colonel C. Lacey Hall, Ohio River Division Engineer.

Colonel Hall, Division Engineer throughout the Second World War, was an able technical engineer who distinguished himself in a dozen different posts, but who had a penchant for needling his superiors. He and Vogel once took a congressman and a general from Washington to inspect a Pittsburgh District military project, and when they arrived at their destination it was pouring rain. Lacey Hall, with raincoat on his arm, looked for a moment at the two guests who had no raingear, and

Chief of Engineers Eugene Reybold was a gambling man, who thought the danger of a flood stopping war production greater than possible loss of the dam, and he ordered the job done with dispatch. With 500 men operating machinery around the clock, the contractors built the dam to a point above the spillway elevation without problems before winter set in in late 1942 and had the dam ready to operate as a detention reservoir in 1943. Work then stopped because a critical steel shortage, caused by tank and ship construction, made it impossible to get steel for the Highway 40 bridge over the reservoir at Somerfield. Youghiogheny Dam was operated as a detention reservoir, holding floods for short times and then releasing them, until the bridge was finished in 1948 and impoundment of summer pools could begin. Built at a cost of \$10.2 million, Youghiogheny Dam prevented flood

"Pittsburgh Aerodrome"
National Archives

damages totalling more than eight times its cost during its first thirty years of operation, and through its summer releases made the Youghiogheny one of the most exciting whitewater canoeing streams in the country.

The Military Mission "There was strict censorship after Pearl Harbor of any mention of the weather on the radio," Herbert Vogel recalled. "I remember well that on early morning inspection trips, starting often at four or five o'clock, I would listen to the car radio to hear whether they were playing *You Are My Sunshine*, *Singing in the Rain*, or even *Jingle Bells*. It was as good as a formal weather report. It seems odd now, but people then were jittery and fearful of an air raid and that is why we were ordered to build airports in a hurry for fighter planes at Connellsville, Coraopolis, and Bradford."

In retrospect, fears of air attack on the industrial heartland might seem as groundless as the fears in 1863 that General Lee might turn west, but in 1942 when memories of Pearl Harbor and the Battle of Britain were fresh it was another story. And perhaps General Jimmy Doolittle's April 1942 raid on Tokyo from the carrier *Hornet* showed that Pittsburgh's fears of an air raid were not entirely chimerical.

The Pittsburgh District first got into the airfield construction business during the Second World War, but the Corps had some earlier associations with the business. Colonel John Macomb, who directed river snagging on the Ohio in 1866, had built the first "airfields," for the Balloon Corps of the Army of the Potomac during the Civil War; and General Mason M. Patrick of the Engineer Corps had become first chief of the Army Air Corps in 1917. Military airfield construction was handled by the Quartermasters prior to 1940, however, and they built the first military airfield at Pittsburgh.

Lieutenant Clifford Smith, Constructing Quartermaster, built an airfield on a 43-acre site in rugged terrain selected by the Air Corps in 1922



about 8 miles northeast of Pittsburgh. Smith and contractor Walter S. Rae had a tough job, for their horse-drawn scrapers could only scratch the hard yellow clay and they had to dynamite it into fragments for placement. Their water source for the concrete mixers was a stream that went dry that autumn, and water, along with all construction material, had to be hauled in wagons from Aspinwall. Smith was proud to report the job completed on November 18, 1922, with two corrugated iron hangars in place. Each building had been painted by hand: gray interiors, ivory window trim, green sides, and maroon roofs. And, for the benefit of fledgling aeronauts, PITTSBURGH AERODROME had been painted in four-foot letters atop the roofs. The first planes landed on January 1923.

The Quartermasters supervised airfield construction until October and November of 1940, when President Roosevelt transferred the work to the Engineers. The Pittsburgh District inherited the Connellsville airfield project at that time. The Connellsville field, begun in 1935 as a municipal W. P. A. project, had been converted to a military base by Quartermaster officers Albert J. Wick, J. H. Osterman, and M. E. Townes between 1938 and 1940. The Pittsburgh District sent engineer Howard P. McKown and assistants Joseph Statzula and Sophia Kauchuk to Connellsville to finish the job. They inspected contractor construction of a radio beacon range building, transmitter building, roads, fences, and utility lines supplementing the hangars, barracks, and administration buildings already in place.

After America entered the war, the District began airfields at Bradford in McKean County and in Moon Township in Allegheny County and a filter center in Pittsburgh for the First Interceptor Command of the Air Force.

The filter center, forerunner of radar systems for warning of enemy aircraft approach, was built in April 1942 on the 12th floor of the First National Bank building at 511 Wood Street in the Golden Triangle. Inspector Howard A. Kennedy supervised Landau Brothers Building Company who installed room partitions, utilities, and a balcony around the control room. Four switchboards, serving the four sectors of the First Interceptor Command, were located on the balcony to take incoming calls from civil defense plane spotters, who scanned the skies around the city and reported aircraft movements by phone. Paths of the aircraft were then plotted on a large map on the main floor of the center.

Construction of Bradford-Kane and Moon Township airfields also began in April 1942. Bradford field, completed that same year, served its purpose during the war, but was converted to a municipal field by the city after the war with less than happy results: safety problems did develop and two major accidents occurred within a short time. The District spent \$5.3 million leveling the 1,100 rugged acres in Moon Township supplied by Allegheny County and in building three runways, each a mile long, plus taxiways, hangar, control tower, and the barracks, mess halls, and repair shops necessary for military units. The contractor on that job could neither read nor write, and Colonel Vogel took care not to take advantage, but he needn't have bothered: the contractor could add dollars and figure profit percentages like a computer and was a superb mover of dirt, important because the work involved moving mountains and filling gorges. The field became the base of the 71st Interceptor Squadron and the 81st Airbase Squadron, and in postwar years was converted by Allegheny County into the Greater Pittsburgh International Airport.

As airfield construction got underway, the Engineers began to try their hands at airfield design. Their first challenging design assignment involved development of storage facilities for aviation gasoline reserves. The District designed underground storage tanks camouflaged to resemble a farm, and such facilities were built in Hawaii and

elsewhere. Prewar experience with soils, foundations, and concrete mixes at flood control projects also came in handy in designing runways that could withstand the impact of heavy bombers.

At the Dayton, Ohio, municipal airport in late 1941, Bob Philippe rode in the bombardier's seat of a B-26 Martin Marauder while the pilot made repeated near-crash landings on a concrete airstrip, and through accelerometer readings, high-speed photography, and tire imprint measurements, proved that the greater the speed of landing, the lighter the load on paved runways, a finding that had major impact on airfield engineering. At Wright and Lockbourne airfields, engineers from the Pittsburgh and other Districts experimented with various asphalt and concrete pavements to determine how they would bear up under landings by planes weighing up to 150 tons. Since such giant aircraft were still being developed at the time, William Sidney designed for testing purposes a rig weighing two and a half times as much as the largest commercial earth mover and equipped it with interchangeable single, dual, and twin tandem wheels to duplicate aircraft weight and landing gear systems. Those studies and tests ended with establishment of a rigid pavement laboratory headed by Philippe at Mariemont near Cincinnati, with world leadership in airfield design for the Engineers, and with the use of heavily loaded super-fortress bombers during the final phase of the war in the Pacific.

As the Pittsburgh District's military workload burgeoned in mid-1942, Colonel Vogel sought Engineer commissions for his executive staff and succeeded fairly well, though accepting a commission at that time meant personal sacrifice. Experienced engineers were in demand for many high-salaried jobs, and it was to the advantage of the Corps to commission personnel and hold them at their jobs or at other required duties.

In the ensuing war years, assignments were very fluid. When Colonel Vogel became District Engineer, Major J. H. Quirk moved into direction of



Testing airfield pavement

the Engineering Division. Within less than a year, he was succeeded by Major William "Ike" English, who worked with a civilian counterpart, Jim Neill. Captain Herbert Winn headed the Construction Division, later to be succeeded by Captain Wilfred Bauknight. Captain Joseph W. Carlson, after initial service at Keystone Ordnance Works, was to become Chief of the Specifications Branch; and Major Jack Dodds continued as Operations Chief. Some of the field assignments included Captain F. E. Smith, Area Engineer for the Ravenna Ordnance Plant and Portage Depot, and later for the Lordstown Ordnance Depot; Major A. H. McCarnes for the Crile General Hospital in Cleveland; and Major Don D. Rait at the Newton D. Baker General Hospital in Martinsburg, West Virginia. Charles Wellons, Principal Engineer in 1942, was Lieutenant Colonel and Executive Officer in 1943. He was Acting District Engineer from December 1944 to October 1945.

The war wrought many changes at the District office. James N. Martin, the strait-laced Chief Clerk of the old school, more military it was said than the officers, retired in 1942, after service with the Corps since 1896. Responsible for accounting, personnel, and a hundred details of daily office work, the old Chief Clerks had perhaps the most "ulcerous" jobs in the Corps, and Martin was the last of his breed. Scott Harvey, a sparkplug with a sixth sense for short-cuts, was Martin's successor. When an officer died in an automobile accident, without leaving record of the combination to his safe in the District office, Harvey waited until the Army Inspector General visited the office and asked that the safe be opened. When Harvey said he could not open the safe, the I.G. asked what was in it, and Harvey replied he didn't know, but, confidentially, he thought it was where the District Engineer hid his booze. In short order, the I.G. found a safe-cracker to open the empty safe.

With military projects mushrooming throughout the District, work at Youghiogheny Dam and Johnstown underway, and construction beginning at Berlin and Mosquito Creek dams in the Mahoning River basin, District personnel climbed in 1942 to an all time high of more than 3400. Many men left the District to enlist in the armed services, and some, beginning with Lieutenant William J. Bloomgren, a surveyman who joined the Air Corps and died in a plane crash in 1942, never returned. And the District manpower shortage was alleviated with womanpower. Women had served the District since its beginning, but they were actively recruited in 1942. In their Veronica Lake and Rita Hayworth styles, the new employees were somewhat shocking to their older male colleagues. William E. Sidney, perhaps inspired by his parrot, issued a special memo to his office staff in 1942: "Your attention is invited to the circular letter of April 20, 1942, which states that use of paint for decorative purposes should be discontinued."

Things were done in a hurry during the war years. Verbal agreement was often made with contractors, who frequently began work before formal paperwork was concluded, and the District sometimes took unusual measures. As traffic supplying war industry on the Monongahela swelled, Colonel Vogel realized the operating machinery was sadly inadequate at some of the Monongahela locks. Jack Dodds knew where to find some donkey engines, so Vogel ordered them and had them installed, then asked for approval from his superiors. Weeks passed, river traffic accelerated, then word that the request for purchase of donkey engines had been disapproved arrived. Vogel got on the phone to Lacey Hall at Division, explained the engines were in place and there was no way in the world he could pay for them. Colonel Hall personally settled that matter with the Chief's office.

Colonel Hall did not always come out on top in his dealings with Washington. He was called to the Chief's office in 1942, where General Thomas Robins informed him that a special Manhattan Engineer District (to produce the atomic bomb) would be formed within Ohio River Division bound-



Lieutenant Colonel
Charles M. Wellons

aries but would report directly to the Chief, not through Division. "I object strenuously to an organization in my Division being outside my jurisdiction," said Colonel Hall. General Robins smiled sweetly and replied: "That's too damn bad, Lacey, but that's the way it's going to be." And so it was.

When President Roosevelt assigned all military construction to the Corps of Engineers in December 1941, the Pittsburgh District inherited from the Quartermasters a TNT plant at Meadville and several other projects. One was Camp Dawson at Kingwood on the Cheat River, where in July 1942 the District renovated the tent covered buildings, built a post exchange, battalion headquarters, latrines, mess hall, and infirmary and installed water wells, pumps, utilities and surfaced roads. Done in a month, the project supplied complete camp facilities for training 1300 men.

Colonel Vogel remembered the Keystone Ordnance Works at Meadville as his "meanest" job and the biggest headache acquired from the Quartermasters. He found mismanagement and irregularities there, including favoritism in awarding subcontracts. The plant had been located on marshy farmland, and slag from steel towns had to be trucked in to form roadbeds. To obtain and hold laborers, barracks had to be built at the site and free bus service furnished for commuters. In addition to the plant for TNT production, Area Engineer Lieutenant Colonel John J. O'Connor supervised construction of a self-contained city, with administration buildings, a three-truck fire department, cafeteria, hospital, first-aid stations, and heating, power, and water plants. At the outset of the war, TNT for bombs and shells was in short supply, but at Keystone Ordnance a "reverse nitration" process was used for the first time in the United States, which trebled TNT production and halved its cost.



Captain Wilfred Bauknight

The Pittsburgh District was also involved in construction of a shell-loading plant at Ravenna, Ohio, and Morgantown Ordnance Works on the Monongahela, which produced chemicals used by the Manhattan Engineer District. Other major projects included the Shenango Replacement Center about 6 miles southwest of Greenville, Pennsylvania, and an ordnance depot at Warren, Ohio.

For Lordstown Ordnance Depot, five miles south of Warren, the District designed wooden mobilization type warehouses with tarpaper roofing to conserve critical materials and speed construction. Bids for the job from responsible contractors, who apparently could not think in terms of short life structures, were high, and, though the District had qualms about it, the contract went to a movie theater operator whose bid was \$1 million less than his competitors. The contractor began work on April 30, 1942, and by November 14 had completed eight warehouses, each 960 feet long and 180 feet wide, eight open storage sheds, a motor pool shop, two administration buildings, cafeteria, sentry boxes, fire stations, infirmary, utility lines, and 31 miles of railroad track inside the depot. The contractor then went to Columbus and slapped a million dollar check down on the Division Engineer's desk. He told Colonel Vogel it was worth a million to see the look on Lacey Hall's face. Of course, the money was excess profits the contractor knew would be taken from him in any case. Though speedily and cheaply built, the project served well, except the 12-inch wooden stave watermains used to save metal; they would not hold water and had to be replaced.

The District was also ordered to locate and build two military hospitals, one north of Pittsburgh and the other near Cleveland. After map study, Colonel Vogel decided Butler, Pennsylvania, which had both road and rail service and was blessed with a healthy atmosphere, had potential so he drove to that city. As if in a dream, he found a new hospital on the north side of Butler, with complete kitchens, dental facilities, and laboratories. What's more, it was unoccupied and so new the hallways even had paper strips to protect the walls. He learned it had



Berlin Dam

been built as a State tubercular hospital by one administration but left idle by the succeeding administration. Next day, the Colonel went to Harrisburg, obtained release of the hospital to the Army, and put Bob Kline in charge of building more wards to increase bed capacity; then opened it for business.

Vogel also drove to Cleveland to inspect potential hospital sites recommended by reconnaissance teams. It rained heavily that day and he found every recommended site standing in water. But, on his drive back toward Cleveland, on the west side of town he saw from the window of the car a dry spot marked for a subdivision with a power line passing directly overhead. He went to the Mayor's office immediately, told him he wanted the site for a hospital, and the Mayor agreed on the spot. There, the District built Crile General Hospital.

By the end of 1942, military construction in the United States was under control and emphasis switched to construction in the combat theatres. Colonel Gilbert Van B. Wilkes succeeded Vogel as District Engineer in 1943, and Vogel went to the Southwest Pacific Theatre, where he was joined by Bob Kline, A. H. McCarnes, and Ike English for front line construction. A third of a century later, General Vogel recalled:

I remember my year as District Engineer as filled with extremely hard work over long hours. Rising during hours of morning darkness I had long distances to travel and many projects to keep on schedule. Even at night, it was necessary to check security measures. The results obtained would have been impossible without the superb assistance rendered by all members of my staff and employees of the District as a whole. Everyone felt the responsibility demanded by war and each contributed eagerly to the over-all effort. The District could well take pride in all that it accomplished.

Dams to End the Steel Shortage "Mr. President, you will surely recall crossing the Mahoning River two or three times during your visit to Youngstown's busy steel plants last fall," wrote Congressman Mike Kirwan in his May 1941 letter to Franklin Roosevelt. "The Mahoning River is now at the point of drying up after its flood waters threatened interruption of production in January. That river is 80% sewage, and we are called the 'wonder people of America' because we drink it and it doesn't kill us. I was foreman in a steel plant here for twenty years and can recall sending men to shunt sewage away from the water intakes."

Michael J. Kirwan was appealing to the President and Congress and to anyone who would listen in 1941 for quick action on Mahoning basin water troubles. He declared that repeated flooding interfered with steel mill production, that strong men collapsed from the stench of the polluted stream, and that low water flows hampered national defense. He said that steel mills used and reused the Mahoning so many times that both water taps in Youngstown homes delivered hot water, that ducks never landed on the Mahoning for fear of being cooked alive. People and industry in the Mahoning basin had built Milton and Meander Creek dams without a cent contributed by the Federal Government, though the Mahoning Valley paid more in taxes than some states. Floods and droughts in the Mahoning basin disrupted production of 10% of the nation's steel, essential to any defense program. "There is only one way to remedy this threatening situation," Kirwan told the President, "and that is by the immediate construction of Berlin and Mosquito Creek dams on the Mahoning and one of its principal tributaries."

Roosevelt had William A. Knudsen of the Office of Production Management investigate the Mahoning situation, and Knudsen agreed with Kirwan: mills in the Mahoning basin did produce 10% of the nation's steel and water problems were about as bad as Kirwan described them. "We accordingly," said

Clearing operations, Mosquito Creek damsite

Knudsen, "would welcome by any measure that might be taken to avoid any future shortage of water needed in the defense program, especially in the Mahoning Valley where so much of our steel is now being produced."

To help end the critical shortage of steel, on October 27, 1941, President Roosevelt approved construction of Berlin Dam on the Mahoning River upstream of the steel mills as a national defense measure. Ten days after Pearl Harbor, Congress supplied funds for the job; and by the end of 1941 the Pittsburgh District had Berlin Dam under contract with E. J. Albrecht Company, with completion scheduled for early 1943.

The Albrecht Company had built other projects for the Corps and had a reputation for fine work. At Johnstown, for example, District inspectors had observed that Albrecht was using expansion joint materials between concrete slab bank revetments that differed from specifications, and an argument had ensued. It ended with confrontation between Albrecht and District Engineer Ludson Worsham. Mr. Albrecht, who had a German accent, became angry during the conference, jumped from his chair shaking his fist and shouting: "I used dot material on Sardis Dam and by God, Colonel, if it's goot enough for General Moses it's goot enough for you!" Worsham, a quick-tempered fellow, was about ready to climb over his desk after the contractor when he realized the humor of the situation. The expansion joint material used at Sardis Dam in Mississippi was more expensive and of higher quality than that specified for the Johnstown revetment.

To speed the Berlin project, Payson Perrin and the District surveys branch used photogrammetry, stereo photography from aircraft, for mapping the reservoir area, which was among the first in the United States so mapped, and the Engineering Division worked out final project designs while construction was in progress. Albrecht built Berlin Dam, 96 feet high and better than a mile long, including the central concrete section flanked by earth embankments, and had it nearly finished by late 1942.



It appeared for a time that the District might have trouble getting the steel needed for the tainter crest gates to close the Berlin Dam spillway, and William Sidney devised a system of wooden stop logs to use in lieu of steel tainter gates, if the steel were not delivered. Colonel Vogel and Charles Wellons got on the phone to Washington, however, and won a top priority A-1—a rating from the Army-Navy Munitions Board for Berlin Dam as a defense project. The crest gates were delivered, installed, and in the spring of 1943 impoundment began. The entire storage of Berlin Dam was exhausted that year to keep the steel mills running, clearly demonstrating the need for additional storage capacity.

Mosquito Creek Dam, located northwest of Warren in Trumbull County, was built as a defense project in 1943 at what seems, in comparison with other dams, blazing speed; yet, the project had some unique design features. Built in a gently sloping valley where foundation rock was buried beneath a hundred feet of glacial deposits, the dam was a 47-foot high rolled earthfill about a mile long. The design protected against seepage by placing a filtered limestone rock foundation drain along the toe of the dam and a blanket of impervious materials in the old stream channel upriver from the dam. Most unique was the fact that the dam had no spillway! Normal flows passed through a pentagonal intake tower in the reservoir and conduits under the dam, and advantage was taken of a swampy depression near the upper end of the reservoir that would serve as a natural outlet or wasteway. Extreme flood flows would pass out of the reservoir through the depression into Baughman Creek, a tributary of Grand River, and eventually end up in Lake Erie.

Chief of Construction Captain Wilfred Bauknight, Alva J. Armstrong, head of the Civil Construction Section, and resident engineer Gilbert

P. Fleetwood directed contractor D. D. Mullett, who built Mosquito Creek Dam in record time. The contract for the dam and outlet works was awarded in July 1943, and the reservoir was ready for impoundment by January 1944. The contract for clearing timber from the reservoir went to Herman Holmes, and it required more money and manhours than did construction of the dam. Power chainsaws were not then available and the timber was felled by hand. Holmes had trouble finding workers and impoundment began before he finished the job. He brought in lumberjacks from Minnesota to keep ahead of the rising water and salvaged about 10 million board feet of lumber, hauling the logs out on tractors, trucks, and even horse-drawn skids.

Berlin and Mosquito Creek dams kept the Mahoning Valley steel mills running full blast during the last two years of the war, but it was apparent the growing Youngstown-Warren-Niles area would need additional water supply. The reservoirs supplied 99% of the river flow at Youngstown during the 1953 dry spell. At the close of the war, the Pittsburgh District began planning a third dam in the basin on Eagle Creek north of Newton Falls. Mike Kirwan met opposition on that project from Pennsylvanians who saw the reservoir as part of the proposed Lake Erie and Ohio River Canal. Senator Joseph F. Guffey of Pennsylvania told the House Flood Control Committee: "I am opposed to this dam because it is an adjunct to the canal that the Youngstown Sheet & Tube people in Youngstown are trying to get built to get their freight rates lowered." Despite Kirwan's protests that the project was for flood control and improved low flows, not for the proposed canal, the Pennsylvanians beat the Eagle Creek project.

Ships from the Arsenal of the Allies While boat whistles and factory sirens screamed, Mrs. Robert Hughes, wife of the Naval Officer in charge, shouted "Good Luck" and cracked a bottle of champagne against the PC-490, first of fifteen submarine chasers built at Neville Island during the Second World War. The crowd, drenched by heavy rain, cheered as the fast 165-foot craft scraped down the

ways on October 18, 1941, and splashed into the Ohio to begin its 2,000 mile trip to saltwater. The PC-490, fully equipped for combat with a 60-man crew, was the first warship built at Pittsburgh since 1865 and first of more than 300 submarine chasers, mine sweepers, destroyer escorts, LSTs, and even full size floating drydocks produced by Dravo and American Bridge for Admirals Ben Moreell and S. S. Robinson of the Navy during the war.

Of the 1,058 LSTs (Landing Ship, Tanks) built for the Navy during the war, 724 were completed at inland river ports. LST-1, a 327-foot long and 50-foot wide vessel, with 32-foot gunnels, 12-foot draft, and double doors in its bow, was launched at Neville Island on Labor Day, 1942. Coast Guard ferry crews, mostly rivermen in the Navy Reserve, took it to New Orleans where combat crews boarded to go to sea. Hundreds followed the first downriver and overseas to become the backbone of American amphibious assaults on enemy beaches. One LST spearheaded the Leyte landing and was lost on that distant beach in the Philippines four months after its launch at Pittsburgh. Frank Stocker, a Coraopolis native, was amazed when he boarded an LST in the Mediterranean and found aboard a calendar from the Coraopolis National Bank. Colonel Herbert Vogel wrote J. Smith Miller of Dravo in 1944 to comment:

I just returned from New Guinea where I saw your big old ungainly, but thoroughly capable hulks drawn up along the beach disgorging great quantities of supplies from their yawning mouths. Every soldier knows the LST and the work it's doing and all gain courage from the knowledge that they have such monsters to back them up. The homely things are doing as much to win this war, if not more, than the glamorous items of equipment. When it's all over, we'll remember the 2½ ton dump truck, the bulldozer, the C-47, and the LST.

Oldtime steamboatmen were not entirely thrilled by wartime developments on the river. "This war's worse than the first one," said Captain Fred Way of

Sewickley. "The last war you could get on and off a lock, leastways; this time they look at a river fellow like he was an alien." Jack Dodds, speaking for the Pittsburgh District, explained that navigation locks were constantly guarded and trespass forbidden to prevent chance of interruption of traffic in service to the "Arsenal of the Allies." The grumbling of rivermen might have ceased, if Dodds could also have explained that a German agent, landed from a U-Boat on the Carolina coast and captured by the F.B.I., had on him detailed plans for one of the Ohio River locks and dams.

Why might the Germans have been interested in disrupting inland river traffic? Because the rivers had become a major shipping lane for petroleum. Enemy submarines sank about forty oil tankers passing through the Gulf of Mexico and around Florida and closed the ocean lanes, causing a daily oil shortage of 175,000 barrels on the eastern seaboard during March 1942. General Eugene Reybold and the Board of Engineers for Rivers and Harbors sent a special report to Congress urging diversion of petroleum shipments to the inland and intracoastal waterways, free from enemy attack. All available towboats and tank barges were pressed into that service and the Defense Plant Corporation hastily built 21 identical steam-prop towboats (DPCs) and scores of steel-framed wooden tank barges to move southern oil to Pittsburgh and east. That traffic and more, generated by railroad congestion and gasoline and rubber rationing, caused river commerce to swell during the war years, reaching a volume 233% greater than that of the First World War.

The Engineers, at their navigation locks, kept oil from Oklahoma, Monongahela coal, and other raw materials moving up and down the rivers to industrial ports, especially to Pittsburgh and vicinity, supporting unparalleled military production. Colonel Robert C. Downie, chief of the Pittsburgh Ordnance District, announced at the end of the war that, in addition to warships, tank armor, and aircraft components, area industry had produced 53 million artillery shells, or better than 50% of the heavy artillery ammunition used in Europe, about



Launching LST 1 at Dravo boatyard, Neville Island
Western Pennsylvania Historical Society

783,000 tons of bombs, approximately half of the Army's heavy cannon, and 95 million tons of steel, which was 30% of national wartime production. "Victory was won in Europe and in the Pacific in 1945," said Colonel Downie, "but that achievement has been due, in a large part, to the miracle of production in this great Arsenal of Democracy."

It Can't Be Done But Here It Is Military supply procurement for the Corps of Engineers during the First World War was handled by the General Engineer Depot in Washington, D. C. At the peak in 1918, 200 officers, 700 enlisted men, and 600 civilians worked in rooms at the Depot Building at 14th and U Streets. In each room, prominently displayed, were placards displaying the slogan of Engineer supply: **IT CAN'T BE DONE BUT HERE IT IS.**

Many of the supplies needed by the Engineers in France came from Pittsburgh District steel mills, and Pittsburgh Testing Laboratories performed the inspection work for the Corps at area plants. The Engineer District was not involved in military supply work at that time, though for years it had inspected materials fabricated at Pittsburgh for civil works projects. In 1914, for example, Anson B. McGrew, who also had charge of regulatory functions for the District, inspected 9,200 tons of steel and metal products sent from the Pittsburgh vicinity to other Districts. In 1924, decentralized Engineer Procurement Districts were set up at Schenectady, Philadelphia, New York, Chicago, San Francisco, and Pittsburgh.

The Pittsburgh Procurement District was responsible for all of the Ohio River Division except northern Illinois and Indiana. Its commanders were Colonel H. L. Beach, 1924-25, Colonel J. W. Hallock,



Industrial mobilization planning and procurement for bridges, boats, landing mat, buildings and metal items



Industrial mobilization service planning for all Corps of Engineers items
Material Inspection
Contract Administration

the Second World War. Personnel in the Purchasing office jumped in a two-month period from 12 up to 65 men and women, working in cramped quarters four and five nights a week, and weekends too, to fill orders for military supplies always, it seemed, demanded "yesterday."

1925-1937, and Colonel Rodney H. Reese, assisted by Captains John F. Ploeger and P. A. Agnew, from 1937 until the Procurement Districts were merged with the Engineer organizations.

During the Second World War, the Military Supply Division of Pittsburgh District was created to furnish Engineer troops with vital equipment. The Division negotiated contracts, inspected production, and arranged delivery for Engineer materials produced in the Pittsburgh, Wheeling, and Youngstown industrial centers. To support Engineer combat units in Europe and the Pacific, the supply organization procured 1,475 Bailey bridges, which were steel panel bridges that could be assembled with manpower alone, about 33,000 ponton bridge floats, and enough steel and plywood treadway to build a single hundred-mile long bridge. For military construction projects, the division supplied some 25,000 canvas and glass fabric water tanks, 2,500 steel fuel tanks, 2,000 miles of culvert pipe, and 14,000 miles of four and six-inch pipes. To support the Corps' airfield construction mission, astronomical quantities of aircraft landing mats were delivered: 350 million square feet of steel mat, 12 million square feet of aluminum mat, and 125 million square feet of welded wire mat.

During the 1946 demobilization, military supply work moved to the Ohio River Division, which had relocated from Columbus back to riverside at Cincinnati. But during the Korean War this mission was assigned to the District Supply and Procurement Division under Wilfred Bauknight to procure bridges, pontons, landing mats, prefabricated buildings, and metal products for the Engineers in Korea. C. W. Blankenbuehler and Meryl Watt of the Supply Division remembered the Korean emergency as even more demanding and hectic than that of

On a typical inspection trip in 1951, Wilfred Bauknight looked over production of metal tubing at Mahoning Valley Steel, landing mats at National Gypsum Company, sheet steel at Niles Rolling Mill, Bailey bridges at Commercial Shearing and Stamping, highway forms at Hetzel Steel Form Company, and hose and belting at Republic Rubber Company. He inspected fire extinguisher charges at Pittsburgh Plate Glass, insulated pipe at Ric-Wil in Barberton, Ohio, trucks at Euclid Road Building Company, cranes at Browning Crane in Cleveland, heavy duty trailers at Rogers Brothers Company, and boat oars at the Swanson Factory in Albion; clamshell buckets at Erie Steel, crane parts at Bucyrus-Erie, generators at Marathon Electric, hose at Goodyear Tire, and well-drilling rigs at the Star Machine Company in Akron. After which, he returned to a pile of paperwork at the Pittsburgh office.

"The missile age is contributing considerably to the 'aging' of District personnel," Bauknight complained in 1961. He meant that the work of the Supply Division had actually increased during the late 1950's as the armed forces tool up for the new missile weaponry. In some years, the workload of Pittsburgh Supply Division exceeded the work volume in some Engineer civil works districts. Area offices for supply were opened at Buffalo, New York and Cleveland, Youngstown and Massillon, Ohio.

At the end of 1960, Bauknight and his staff were administering more than ninety missile supply contracts, worth more than \$40 million and all extremely urgent. Inspection work ranged from simple nuts and bolts to 90-ton cryogenic vessels for handling liquids at minus 300° F. The vessels were a maze of plates, piping, and valves that had to be surgically

clean of contamination. Bauknight borrowed workers from the District Construction Division to keep up with the job, and sent thirty people to special schools in California and Kansas, where they were trained for efficient inspection of complex missile equipment. In 1963, the Army reorganized military supply functions and thereupon the Pittsburgh District lost Bauknight and the military supply mission, by transfer to the Army Materiel Command.

Civil works supply activities remained at a high level in the Pittsburgh District, because from the outset of the space race the Pittsburgh-Wheeling-Youngstown industrial triangle was a focal point for supply of materials needed by NASA. The Corps of Engineers had a special District at Cape Canaveral (Kennedy) that built the launching pads for Alan Shepherd, John Glenn, and other astronauts who were building a bridge to the moon.

For the Manned Spacecraft Center at Houston, the District supply office furnished space-simulation chambers manufactured by Chicago Bridge at Greenville, Pennsylvania, for astronaut training, and the largest (6,700 h.p.) electric motor and generator ever built, by Westinghouse for the flight acceleration facility at Houston. Other items supplied for the space program by the District included steel fabricated at American Bridge for the vertical rocket launch assembly structures, flame deflectors for the Saturn rockets made at Blaw-Knox, and high-pressure vessels, fittings, and pipes turned out by Pittsburgh-Des Moines Steel at Warren, Ohio, and Neville Island, by Babcock-Wilcox at Barberton, Ohio, and by the Struthers-Wells plant at Titusville, Pa. When Neil Armstrong placed his footprints on the moon in July 1969, the men and women of the Pittsburgh District, who glued themselves to their television sets that night to anxiously watch that giant step, took immense pride in the role they played in winning the space race.

As Circumstances Might Require In 1946, military construction work in the Ohio River Division was centralized at the Louisville District, but hospitals for returning veterans were needed and

General Omar Bradley, head of the Veterans Administration, asked the Corps of Engineers to build eighty hospitals throughout the nation. The Pittsburgh District was made responsible in 1946 and 1947 for building three of those hospitals: a general hospital at Altoona and a general and a neuropsychiatric hospital at Pittsburgh. The Engineers located the sites, awarded contracts to architect-engineering firms for design, and negotiated construction contracts. The general hospital at Altoona, smallest of the three, was completed in July 1950 at a cost of \$5.7 million and turned over to the VA. The Neuropsychiatric Hospital and General Medical Hospital at Pittsburgh followed in short order. The designs were thought so well done that other Engineer Districts used the plans, adapting them to different terrain as necessary.

When the Cold War warmed in Korea in 1951, the Pittsburgh District was again mobilized for military construction. In November of that year, Wilfred Bauknight moved into the supply and procurement area and Jacque Minnotte became Chief of the Construction Division. As part of the massive emergency buildup for the counterattack toward the 38th parallel, the Engineers at Pittsburgh began "retreading," as the expression went, facilities at the ordnance plants at Morgantown, Ravenna, and Meadville, meaning renovation of the existing plants and construction of additions. At Youngstown and Greater Pittsburgh airfields, originally built as fighter interceptor bases, the District installed facilities for refueling and rearming the big bombers and cargo planes of the Strategic Air Command and the Military Air Transport Command.

In April 1952, a column of soldiers and heavy equipment, the first elements of the Pittsburgh Air Defense Command, rumbled through the streets of McKeesport toward Pittsburgh to set up a ring of 90mm antiaircraft guns on twelve sites selected by the Engineers. District Executive Assistant Frank Stocker recalled the antiaircraft sites were chosen in such a hurry that their locations were identified relative to the red, orange, or green belts of a Gulf

U.S. Army Reserve Center, Brookville, Pa.



Missile Master and support facilities, Oakdale, Pa.

Oil highway map. The “ack-ack” boys lived in tents during the winter of 1952-53 and coordinated the air defense system through ground observers on hilltops and skyscrapers, while the Engineers built permanent gun sites and installed a radar system. Joe Renouf, as Resident Engineer, nursed these projects through the winter for occupancy in late February 1953.

The “brinksmanship” policies of Secretary of State John Foster Dulles during the first Eisenhower administration seemed to make surprise air attack an even greater threat, and in 1954 the NIKE surface-to-air missile, which resembled a telephone pole with fins, was added to the defensive arsenal. The Pittsburgh District located twelve NIKE launching and control sites around Pittsburgh and eight around Cleveland. At a cost of around a million dollars per site, the District hastily built three underground missile storage structures, personnel shelters with 6.7-foot cinder walls and heavy blast doors to withstand shock waves, missile-assembly test buildings, generator buildings, latrines, administration buildings, and access roads. Because it was necessary that the troops, known as the “Buck Rogers” boys, be no more than ten minutes from their missiles, housing and necessary electric, water, and sewerage facilities were later added.

In 1959, the system became more elaborate when sophisticated NIKE-HERCULES missiles were placed at six sites and a Missile Master, a fire direction center and headquarters for the 31st Artillery Brigade, was built at Oakdale. Work on the Missile Master, under local direction of resident engineer Ralph Patt, involved construction of an operations building for radar and communication paraphernalia, big radar towers, a power generator building, plus support facilities: barracks, messhall, warehouse, repair shops, heating plant, utilities, and roads.

The Missile Master control center and six missile batteries were operational by late 1960. The 3rd Missile Battalion of the First Artillery manned the batteries at Elrama, Irwin, and Herminie south and east of Pittsburgh; and the Duquesne Greys (2nd Missile Battalion, 178th Artillery, Pennsylvania National Guard) manned the batteries at Coraopolis, West View, and Dorseyville north and west of the city. Army Family Housing units were constructed in the vicinity of eight of the Pittsburgh sites.

The Pittsburgh District also became responsible in 1955 for construction of Army Reserve Centers, for reserve unit training, throughout the area. The Engineers first finished construction of reserve



Douglas Army Ordnance Nike-Hercules

centers at Uniontown and Washington, Pennsylvania, and Akron and Canton, Ohio. Reserve centers typically had classroom and office space, assembly buildings, maintenance shops, paved parking areas and access roads, and were built for permanent use with tile-covered concrete floors, brick-faced block walls, and beautifully landscaped grounds. By 1961, the District had completed or had under contract the Army Reserve Centers at Akron, Bellaire, Cadiz, Canton, Cleveland, Geneva, Painesville, and Warren, Ohio; at Altoona, Brookville, Butler, Clearfield, Du Bois, Farrell, Franklin, Greensburg, Indiana, Johnstown, Meadville, New Castle, New Kensington, Oil City, Punxsutawney, St. Marys, Uniontown, and Washington, Pennsylvania; and at Weirton and Wheeling in West Virginia.

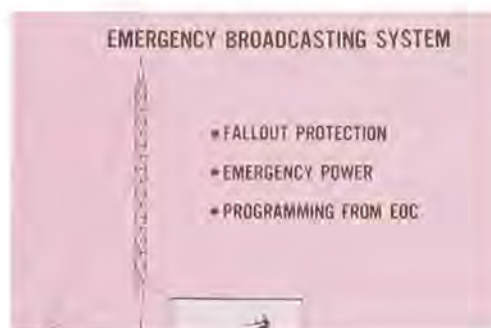
Military construction by the District ended in 1961 when the Chief of Engineers made an effort to reduce administrative costs through consolidation of military functions. Among the twelve Engineer Districts that lost military construction was Pittsburgh, when such work in the Ohio River Division was centralized at Louisville. For the same reason of economy, further consolidation occurred in 1970 and the military projects in the Pittsburgh area were thereafter handled out of the Baltimore District.



"Nike" Missile

Survival Insurance "The history of this planet, and particularly the history of the twentieth century, is sufficient to remind us of the possibilities of an irrational attack, a miscalculation, an accidental war, or a war of escalation," declared President John F. Kennedy in his special message to Congress on May 25, 1961. "It is on this basis that civil defense can be readily justifiable as insurance for the civilian population, in case of an enemy miscalculation." The abortive Bay of Pigs invasion had failed the previous month and the President was planning a visit to the Berlin wall and talks with the stout Soviet Nikita Krushchev. He placed the Office of Emergency Planning for civil defense under the Secretary of Defense and appealed to Congress for funds to build fallout shelters, stock them with survival necessities, and establish a warning system.

Because the Corps of Engineers was in close contact with local authorities, the President selected it to perform most of the urgent civil defense work; and the Pittsburgh District became responsible for 25 western counties of Pennsylvania. As a result of an unconventional organizational setup, the District reported to the Navy Bureau of Yards and Docks at Philadelphia, which in turn reported to the North Atlantic Division of the Corps of Engineers at New York. The job involved locating and preparing fallout shelters and planning post-attack rescue,



damage assessment, debris clearance, mass burials, radiation detection, and recovery.

The Pittsburgh District sent engineers George Cingle and Bert Maher to Fort Belvoir for a fallout shelter survey technique course, held a seminar at the Fort Pitt Hotel for local architect-engineer firms, and in October 1961 established a Civil Defense Support Branch headed by Frank Stocker, who was assisted by Bert Maher, Quintin Witt, Frank Fetchak, Tom DeLong, and Dave Rhodes. That staff and representatives of twelve architect-engineer firms took crash courses, described as an "unholy mixture of descriptive geometry and new math," at Fort Belvoir and elsewhere to learn fallout shelter analysis. The object was to locate structures with sufficient shielding to minimize radiation doses, then mark them as fallout shelters and stock them with survival supplies.

Under contract, the twelve architect-engineer firms examined some 16,000 structures in the 25 county area and selected and marked the best sites as fallout shelters. Stocker and his men negotiated contracts with radio stations for emergency warning systems and worked with local and county authorities in devising master plans for community shelters and post-attack operations. Interest in the civil defense effort peaked during the Cuban "missile crisis" of October 1962, then languished during the Viet Nam war and further decreased when President Richard Nixon's "detente" policies seemed to reduce the risk of atomic war. The Pittsburgh District had finished its basic civil

defense mission when the job was transferred to the Naval Facilities Engineering Command at Philadelphia in November 1968. Dave Rhodes became an employee of the Navy and continued work on civil defense out of the Pittsburgh District office until June 1975, when nuclear attack defense planning was consolidated at Olney, Maryland.

As survival supplies in fallout shelters deteriorated, they were seldom replaced, for they could have no value...until they were needed. The Soviets, on the other hand, pursued a continuing civil defense effort that won them an ace up the sleeve in the diplomatic poker game known as the Strategic Arms Limitation Treaty (SALT) talks. President Kennedy in 1961 had described civil defense as survival insurance that might never be needed, "but insurance which we could never forgive ourselves for foregoing in the event of catastrophe."

The end of civil defense support made the Pittsburgh District again a strictly civil works organization. It had responded effectively, however, to the urgent construction missions of 1942 and 1951, to the esoteric engineering challenges of ordnance and airfield and missile projects, and to intensive demands for military supply and civil defense support. District personnel took great pride in their response during the historic defense emergencies that had occurred while the District had a military mission, and they were convinced the record of their achievements showed they were qualified to handle future emergencies as circumstances might require.

Chapter 15

RIVERS ARE HIGHWAYS THAT MOVE

The reporter nosed his Studebaker cautiously across ice patches into the parking area next to the Lock 10 operations building near Steubenville, and, heaving a sigh of relief, switched off the key. What a night to hunt a river story, but he had to have it for the Sunday supplement and tomorrow, or rather today for it was past midnight, was his deadline. His editor had heard that Pike Island Dam on the Ohio would be finished in 1965 and the men at old Locks 10 and 11 would lose their cushy jobs. Get the story, the editor had ordered.

He peered out the window through fine wind-driven snow at the light-bathed lock and saw men in orange life jackets moving carefully along ice-slick walkways as a towboat, its searchlights stabbing into the wall of snow, moved out of the chamber. Pulling on his parka, he raised the hood to cover his ears, snapped the fasteners, slipped his hands into black gloves, and reluctantly left the dying warmth of the car to dash for the door of the lock building. Zero, the radio had said at midnight, and to be minus ten before morning.

The lockhouse was empty when he entered, except for a gray government issue table and chairs, a radio squawking intermittently on the table, and maps and memento photos tacked on the walls. Unsnapping his parka, he dropped the hood and stood at the window watching the tow, twenty barges of coal probably bound for Wheeling mills, gliding out of the chamber and the lock gates closing behind. Minutes later, lockmen crowded through the door, nodding to him as one does to a stranger. They entered and quickly doffed their white hardhats emblazoned with the crimson castle, their orange life preservers, dirty parkas, and gloves to warm themselves before the next tow arrived. Recognizing the lockmaster was easy: older than the others, perhaps about fifty, solidly built, fairly tall and with an ever-present cigar in his mouth.



Ice Conditions, Lock and Dam 10, Ohio River

The reporter identified himself. "Bill Shilts sent me," he said, extending his hand and wincing when the lockmaster grabbed it with his sinewy, half-frozen paw.

"Shilts said you'd be down, but we didn't look for you tonight," replied the lockmaster, smiling as he would at any man who would get out in such weather. "Pull up a chair and have a cup," he said cheerily, plopping down at the table and unscrewing his thermos to pour two scalding coffees. "Got a tow of twenty empties upbound for Harmarville, but it'll be a few minutes."

The reporter dragged up a chair, warmed his hand on the coffee, and, anxious to get his business done, pulled a notepad and pencil from his pocket to begin his list of questions. "How long does it take you to lock a tow through?" he began.

"That last one took an hour and a half. Had to double lock it in two sections—too big for the lock—and had to fish ice chunks out of the way of the gates before we moved them," said the lockmaster, still shivering from cold misery. "If this ice gets worse, we'll have to put the dam down."

"In this kind of weather?"

"In any kind of weather. Can't let the ice pack on the wickets. Takes seven men on the maneuverboat about six hours to put it down. We open the beartraps to reduce the difference in head between the pools and draw off ice, then take the boat out to the beartrap pier. It has a capstan and cable on the stern and pulls itself back toward the lockwall four foot at a time as the wickets are dropped."

The reporter stopped his scribbling and took a swallow of coffee. "Isn't that sort of risky?" he asked.

"It is right now," the lockmaster said, waving his hand toward the snow still shuffling against the windows. "As the wickets go down, current at the head of the boat and ice pressure behind it increases. Can build up enough to break the lines and let the boat go around the end of the wickets and over the dam. And the wind freezes spray from the river, coating everything with glaze. Have to watch your step."

The reporter had done his groundwork, reading some old articles in the dead file before starting his interviews. He began to understand why John Arras had said that lockmen had to be trustworthy, reliable, and fearless. "Have you seen many accidents on this job?" he queried.

"One is too many," said the lockmaster. "Things have improved considerably since I first went to work on the river. Why, we didn't even wear life vests before 1936. Back in '42 I saw a repair boat break loose and go over a dam in rough water, but all the men aboard had preservers on and all survived. Saw a maneuverboat crew in the summer of '43 take off their vests because of the heat. Something underwater hit the catching hook and threw the man handling it into the river. He could swim but never came up. Found his body two days later at the next dam downstream."

The reporter snapped the lead in his pencil and fumbled through his pockets for another. "What would you say is the most dangerous job at these movable dams?"

"Hard to say. Who was it—Jack Paar?—that said if something can happen it will? Before we motorized the beartrap valves, we opened and closed 'em by hand. We rowed across the river above the dam, walked down to the abutment and out on the catwalk to pier 3, closed the valves on that pier, climbed in a bos'n chair hanging on a cable and pulled over the beartrap to the second pier to close those valves, and on the same way to pier 1. Crossing the open bear-

traps was scary, but not really dangerous. The danger was opening the valves. I've heard that men were killed doing it back around 1910, but it never happened in my thirty years on the river."

Seeing the puzzled look in the reporter's eyes, the lockmaster explained. "We use a long metal wrench to turn the valves, and if pressures are right and the lockman loses his grip on the wrench the valve closes itself, whipping the wrench handle in circles. Saw it happen about 1942 at Lock 9. Dewey McPherson sent a couple of young fellows, Lyle Cosgrove and Tommy Carrol, to close the filling valve on beartrap pier 1. The two were having too much of a good time and lost hold of the wrench. It spun around, whacking Cosgrove on the backside and catapulting him off the pier into the upper pool. Carrol dove in after him and they both swam back to the pier. But Dewey had his mouth open yelling at the two to stop their horseplay when it happened, swallowed his Mail Pouch cud and became violently ill; Leonard Martin ripped his britches and bruised his shoulder when he fell running up the catwalk, and "Bulldog" Drummond, who pulled the two out of the river and told them off, got a bloody nose from Carrol. The two fellows had to finish their shift in wet clothes."

The lockmen standing by the heater and listening were convulsed by laughter, and the lockmaster chuckled at his memories. "Super. Gaylord Watson," he continued, "gave Leonard Martin the job of leading daily safety and first aid lectures on the Quarterboat *Kiski*, and, after that, men who worked without hardhats or life vests, or who removed grease with gasoline, and such like, had to take the consequences."

Taking another swallow of coffee, the reporter scanned his question list. "What's your routine here?"

"Ain't none. If the dam is up, we tend the lock, keep drift off the wickets, take care of the maneuverboat. When the dam is down, we nurse the machinery, fire the furnaces, mow the grass, keep the weather records, and do the paperwork. Always is something that needs doing, and never know when

we'll have double work. Suppose word comes the river is falling fast and the dam is down; we work night and day to raise the wickets. If the dam is up and a big rise comes, we work around the clock to lower the dam."

"Where do your men live? I saw only two houses here at the lock."

"They're scattered about, some in Steubenville and some across the river. Would be nice to have houses for them all, but they go home and we have to call them for emergencies, always it seems at night and during bad weather. Will probably have to call them this morning before daybreak to put the dam down out of the ice."

"You make your reports to the District Engineer?"

A grin creased the lockmaster's red face. "Don't know what you mean by reports," he said. "Lots of paperwork though—it goes to different branches of the District office. Most District Engineers get around to see us before their three-year tour ends, but my boss is Whitey Whitehead, the Chief of Operations. Before him, it was Mike Harrington. But I work under Area Chief Bill Shilts up at Emsworth, who has charge of the Allegheny and Ohio. Harry Maple at Maxwell Lock runs the Monongahela. Those two, together, have worked for the Corps about a century. Used to be three Area offices. Joe Carlson and Ed Crowley ran the Allegheny back in the '30s. Howard McCullough and Lafayette Wills were before Shilts in the Ohio office; I. C. Bell ran the Monongahela Area, and there were others I don't remember right off."

The lockmaster paused to fire up a fresh cigar, while the reporter caught up with his notes. The reporter looked up and asked, "You and your men handle the repairs here?"

"Some, but the big jobs are done by repair parties sent down from PEWARS, that's Pittsburgh Engineer Warehouse and Repair Shops on Neville Island below Emsworth—used to come down from

Lock 2 Depot years ago. They have machine, carpenter, blacksmith, and welding shops there, store spare lockgates and parts in the yard, and tie up the fleet there. Okey Sholes runs it now. Before 1946 there was a boatyard and repair shop at Charleroi for the Monongahela Area that Bill Fels ran. Had better than a hundred men working there before the war, but it was closed and consolidated at PEWARS in '46. Bobby Whigham supervises the repair party, about forty men lead by Fred Black, Ray Pike, Emil Berry, William Celli, Archie Mayfield, and others, who travel around the District with barges and derrick boats to make repairs and handle emergencies."

"You say they keep a fleet at Neville Island?"

"Yeah. People don't know the Engineers have more boats than the Navy and Coast Guard combined, but ours are mostly small work boats. We have a few derrick and workboats at Neville Island. Largest is the *Monallo II*, big enough to handle lock gates and sunken boats. Captain Walter Maund with the towboat *Chartiers* pushes the fleet where its needed. Forty years ago we had four steamboats, the *George S. Nutt*, *Swan*, *Kittanning*, and *Pennova*, a couple of dipper dredges, a dozen derrickboats, some pump boats, concrete mixer boats, and a

Warehouse and repair shops, Neville Island, Pa.





bunch of barges and small craft. There were four repair parties then, two on the Ohio and two on the Monongahela, with better than a hundred men total."

Scribbling furiously, the reporter got most of it down, then asked, "Why has repair work decreased? Because of these dams like New Cumberland?"

The lockmaster bent over a can next to the table, propelled into it the chewed end of his cigar, and replied. "I doubt it," he mumbled. "Some repair work is contracted out now. When I came to the District, we had yearly damage from ice on the Allegheny, acids on the Monongahela, and lots of trouble with these rolling lock gates on the Ohio. But everytime we made a repair, we tried to improve the damaged part so it would last longer. Back then, the wheels on these rolling gates turned on fixed axles and couldn't be greased. Had to unwater the locks and repair the wheels about every two years. They fixed the wheels to the axles, let the axles turn, and ran grease tubes from the top of the gates to the axles. That extended the time between repair jobs to four and five years. They've made more improvements so, with some work by divers, the gates now last eight or nine years between repair jobs. Stretching the repair cycle, they call it."



"You do a lot of diving?" said the reporter, and he was startled by laughter from the lockmen.

"Not me!" said the lockmaster. "Gives me a chill to think of it, but some guys like it; make extra money. Divers make underwater repairs and often save the cost of a cofferdam. Never heard of a diver drowning in this District, but I've heard some bad stories. Albert Peters was trapped in a tunnel behind a beartrap valve once when the current shut the valve behind him. The valve had a broken stem, couldn't be opened topside, so Albert had to sit down there until another diver went down and opened the valve. Harold "Pus" Lane, years ago, was working underwater on a poiree trestle and lost a finger without knowing it. Learned about it when he went topside and pulled off his glove. He went to the doctor, had the hand taken care of, went back to the job that afternoon, and got mad when the foreman wouldn't let him dive again that day."

"Lot more traffic on the river than there was when you started work before the war?"

"Sure is. Had time to do some work around here between tows thirty years ago, but no more. Don't even have time to get good and warm on nights like this. Tows are mostly too long for this 600-foot lock now; have to put them through in two sections. That's why they're building Pike Island and the new locks and dams. Same story on the Monongahela. Towboats cost something like \$200 an hour to operate, and we've got to keep 'em moving."

"How about the Allegheny?"

"Well, they've more commercial traffic now than years ago, but the big thing up there, upriver from Pittsburgh mostly, is pleasure boating; you know, houseboats, motorboats, and fishing boats. Got to watch those kind carefully. They'll try to lock through without preservers, or tie their boat to a post or rail and get left hanging on the side of the lockwall when the lock empties. Over the years, I guess we've saved better than a hundred people from drowning. Back in 1950, Hull Wright at



Opekiska Lock and Dam, Monongahela River

Allegheny Lock 3 lost his own life rescuing pleasure boaters from the river."

The voice of the pilot on the upbound tow came squawking over the radio, and the lockmen began donning their gear, grumbling with good humor about the cold hours ahead of them on the lockwalls. The lockmaster stood and jammed his hardhat on his balding head.

"One more question," said the reporter. "When they finish Pike Island and tear out this lock, what are you going to do?"

"This lock was built in 1912, has been in service a half century. It's obsolete and it's time to retire it. Think I'll do the same."

The reporter snapped his parka, jammed his hands into gloves, and followed the lockmaster out into the raw wind that was blowing the snow upriver. He ran to his Studebaker, fired it up, flicked the heater and wiper switches, and eased back down the road to the newspaper office. Back at the office, he typed out his story, quoting the lockmaster almost verbatim, and, toward dawn, dropped it on the editor's desk and left for home. Next evening, he found the story back on his desk with a bluepenciled note from the boss: "No one wants to read this garbage. Get up to Kinzua and get a story on the plight of the Senecas."

Monongahela Flyover In May 1975 a distinguished group visited the Ohio River Division to inspect progress of the navigation modernization programs on the Monongahela and Ohio Rivers. The visitors included members of the Sub-Committee on Water Resources of the Senate Public Works Com-

mittee, Major General John W. Morris, Director of Civil Works at the Office of the Chief of Engineers, and Brigadier General Wayne S. Nichols, Ohio River Division Engineer. To save time, a small plane was chartered for the inspection. Colonel Scott Smith, Huntington District Engineer, served as guide to explain in detail what the dignitaries were seeing as they passed down the river at low altitude.

As the plane banked left over West Fork and approached its confluence with Tygart River, the head of the Monongahela, Colonel Smith began his description:

Here you are 128.7 miles above the mouth of the Monongahela at Pittsburgh. Slackwater is available on lower West Fork and Tygart rivers. Straddling the river, you see Fairmont, West Virginia, which receives cement, gasoline, and salt via the river. Sharon Steel has a small plant on the right bank, nearly opposite the mouth of Buffalo Creek. On your left at the mouth of Paw Paw Creek is Rivesville, where a Monongahela Power Company plant receives fuel by river. Prickett Creek comes in on the right; we have a recreation area there. On the left is the Mountaineer Coal Company tipple and conveyor for their Loveridge mine, which averages 13,000 tons production a day. Indian and Whiteday creeks below enter the river above Opekiska.

OPEKISKA LOCK AND DAM
115.4 miles above the Pittsburgh Point, is the newest navigation structure on the river and replaced old locks and dams 14

and 15. We completed the four-gated dam and 84' x 600' lock with 22' lift in June 1967. Opekiska handled a half million tons of traffic in 1973, of which 70% was coal upbound for Rivesville Power Station and 20% was building cement destined for Fairmont.

As we proceed downstream, you see three coal tipples on the left bank, two owned by Christopher Coal Company for their Booth mine and the third by South Union Coal. Following the river along the left bank is the Monongahela Railroad and along the right is the Chessie Railroad.

HILDEBRAND LOCK AND DAM at Mile 108 eliminated old locks and dams 12 and 13. We finished the 84' x 600' lock in 1959 and the dam, with six crest gates and two fixed weirs, in 1960. Eighty percent of the million tons that passed through Hildebrand in 1973 was coal moving downstream to Fort Martin Power station. We estimate this lock will have to be replaced around the year 2010.

Further downstream you see Interstate 79 crossing at Uffington. On the left bank is Morgantown Ordnance Works with a coal loading dock, and on the right is a dock used to load limestone mined locally. About half a million tons of limestone are shipped from here by river each year. The industry of Morgantown, below you, consists of glass manufacturing, coal and limestone mining, and several gasoline tank farms. Petroleum products come into here by river from New Orleans and Galveston.

MORGANTOWN LOCK AND DAM was first of our modernization structures. We built it in 1950 to replace old locks 10 and 11. It has another 84' x 600' lock and a six-gated dam. Traffic at the lock in 1973 totaled 1.5 million tons, 70% coal and 25%

limestone downbound for Neville Island on the Ohio. This lock will need replacing around the year 2000.

On your right is the University of West Virginia. On the left bank are loading docks for Christopher Coal's Arkwright and Purseglove mines, which have 35 year life expectancy and high production. Downriver is a tank farm on the right bank, and on the left is the loading dock for the Humphrey mine. Below is the site of old Lock 9, the first built by the Engineers on the Monongahela. As we cross the Pennsylvania-West Virginia boundary, you see the two cooling towers on the left of the Fort Martin Power Station.

LOCK AND DAM NO. 8 has a single 56' x 360' lock built in 1925. We rebuilt the dam with six crest gates and raised the pool four feet in 1959. We need a new and large lock here. Of the 7.5 million tons that used the lock in 1973, 70% was West Virginia coal bound downriver for steel mills and power stations.

Point Marion is at the mouth of Cheat River. You can see Lake Lynn, owned by West Penn Power, two miles up the Cheat. Now, on the left bank is the mouth of Dunkard Creek and the loading dock of Jones and Laughlin's Shannopin mine, with average 4,200 tons daily output that is barged to the Vesta plant for washing and sent on to steel mills at Pittsburgh and Aliquippa.

LOCK AND DAM NO. 7 at Mile 85 is a fixed crest dam with a single small lock completed in 1926. We need a new gated dam and larger lock here. About 90% of the 9.5 million tons which passed this lock in 1973 was coal headed for steel mills and power stations. Located below the lock are the towns of Greensboro and New Geneva.

Old Lock 6, Monongahela River



On the left bank is the Duquesne Light Company Warwick mine that ships 7,400 tons daily to power plants. There is Grays Landing, where we propose to build the lock and dam to replace No. 7. At the mouth of Whiteley Creek is U.S. Steel's Robena mine that produces 15,000 tons daily and ships to the mills and power stations. Downstream of the Highway 21 bridge is the Hatfield Power plant, fueled by river-barged coal. Nemacolin mine ships its production to Aliquippa on the Ohio, where it is transferred to rail for shipment to Youngstown Sheet and Tube Company in Ohio. National Steel Corporation's Isabella mine on the right bank ships to their Weirton steel plant on the Ohio. The old Crucible and new Dilsworth mines are on the left bank and downstream are the docks of the Gateway and Luzerne mines. Several marinas and launching ramps are located there on Ten Mile Creek. There is the town of Millsboro and Republic Steel's Clyde mine, which also ships to Aliquippa and from there by rail to Youngstown. On the right bank is Jones and Laughlin's Vesta mine that produces 5,600 tons daily.

MAXWELL LOCKS AND DAM at Mile 61.2 replaced old Lock 6 in 1965. It has double locks, each 84' x 720', and a five-gated dam. Coal from the mines we have flown over is shipped to mills and power stations by river through this lock, accounting for 80% of the 17 million tons that passed Maxwell in 1973.

Locking through Lock 4, Monongahela River



Below on the right bank is the Emerald Coal and Coke dock and the Hillman Barge Company. That's the Highway 40 National Pike bridge crossing the river at Brownsville, which was once the head of steamboat navigation on this river. Dunlap and Redstone creeks enter on the right bank. The town of California is on the left bank and across the river is an Allied Chemical plant. The complex on the left bank below California is the Wheeling-Pittsburgh Steel plant at Allenport. The Interstate 70 bridge crosses there at Belle Vernon and on the right bank below the bridge is the Wheeling-Pittsburgh Steel Corporation dock.

LOCKS AND DAM NO. 4 below us at Mile 41.5 was built in 1932 and has two 56-foot wide locks, one 360 and the other 720 feet long. We placed five crest gates on the dam in 1967 to raise the pool six feet and eliminate Lock 5. When we rebuilt the dam, we left space for locks, both 84 feet wide and 720 feet long. The larger locks will be needed in a few years, for in 1973 about 19 million tons passed through the old locks.

Downstream of Locks 4 are the docks of the Wheeling-Pittsburgh Steel's Monessen plant on the right and, on the left bank, American Oil Company has a dock at the site of old Lock 4. The towns of Donora and Webster straddle the river at Mile 36. Pigeon and Mingo creeks enter from the left and between their mouths are the town of Monongahela and the docks of U.S. Steel's

Maple Creek mine that ships coal to the Clairton plant. Below the mouth of Mingo Creek are the docks of the Mathies mine and West Penn Power's New Eagle power station that receives fuel from the Humphrey mine near Morgantown. The Mathies mine ships to Clairton and Aliquippa. At Elrama on the left bank is Duquesne Light Company's power station.

LOCKS AND DAM NO. 3 at Mile 23.8 was built in 1907 and needs rebuilding before it collapses. Traffic through it in 1973 amounted to 23 million tons, and structural failure here would be disastrous to area industry. We propose to replace the two 56-foot wide locks, one 360 and the other 720 feet long, with double locks, both 84' x 720'. Construction should begin at the earliest possible date.

Opposite Elizabeth is Consolidation Coal's storage area. Along the left bank at Clairton are the U. S. Steel docks and marine ways. Opposite Glassport is the Ohio Barge Line terminal. Youghiogheny River enters from the right at McKeesport, and there are several docks on the lower mile of the stream. On the left bank, you see the Boswell Oil and Gateway Asphalt docks, another U. S. Steel plant, and the GM Fisher Body plant. At Duquesne is a giant U. S. Steel plant and downstream of it at the two railroad bridges is where Union Railroad transfers coal from barge to rail for shipment northward, some to Canada. Turtle Creek, where General Braddock was defeated in 1755, enters from the right.

LOCKS AND DAM NO. 2 at Mile 11.2 is last on the river. We took out Lock 1 when we raised Emsworth Dam on the Ohio in 1938. This Lock 2 was built in 1905 and we reconstructed it in 1953, removing a midstream pier and improving the locks. The dam has a fixed crest, with two lock

chambers measuring 110' x 720' and 56' x 360'. The dam should be reconstructed in the next few years and the locks replaced around the year 2000. Lock 2 handled 24 million tons in 1973, about 60% coal.

On the right bank is U.S. Steel's Braddock works and Rankin plant, on the left their Homestead works. The American Wind Symphony that tours the river on a barge in the summers giving concerts has a dock at Rankin. American Oil Company has a tank farm at the left end of the Glenwood bridge. Jones and Laughlin Steel facilities line both banks of the river as we continue downstream. On the right bank at the Golden Triangle is the old Monongahela wharf, where the Gateway Clipper docks.

During the ten years ending in 1970, annual tonnage volume traveling the Monongahela increased 59.4%, commerce on the Ohio increased 56%, and tonnage on the Allegheny increased 31.4%. In 1973, better than 63 million tons, about 70% of it coal, passed through the port of Pittsburgh and traveled the three rivers. Modernization of the Monongahela, begun about 1948, is now approximately 50% completed. Before we continue down the Ohio, we will circle the city of Pittsburgh.

Monongahela Modernization The Monongahela carried throughout the late 19th and early 20th centuries a greater tonnage than any other inland river in America. Relatively short, 128.7 miles, in comparison with streams like the Ohio and Mississippi, it was called the "Little Giant" because of the tonnage its brawny waters transported. When long haul coal barging from the Monongahela to Cincinnati, Louisville, Memphis, and New Orleans ended in 1916, slashing Ohio River traffic by half, Monongahela commerce had not faltered and in fact increased, the coal moving to new steel mills at Midland, Aliquippa, and other ports on the upper Ohio.

Boatyard and storehouse at old Lock 4, Monongahela River



Although the "Little Giant" carried more tonnage than other streams, federal funding for its improvement was minimal and the Engineers limped along on the Monongahela until 1947, largely making do with what it had in the way of locks and dams. Planning for modernization of Locks 2 was actually initiated prior to World War II, but with delay caused by the war, it was not until October 1947 that an updated plan was approved and construction could proceed. In the meantime, when a dam threatened to wash out, the Engineers built a new dam; when a lock wall caved in, they built a new and sometimes larger lock. Monongahela slack water in 1947 was essentially a 19th century steamboat project patched up to handle 20th century barge-tow commerce, and a testimonial both to the ingenuity of engineers and the parsimony of Congress.

Milnor Roberts had planned canalization of the lower Monongahela in 1838, and the Navigation Company had built Locks and Dams 1 through 4 to Brownsville in the 1840's, adding 5 and 6 in 1856. No. 7, which extended slack water to the State line, was completed in 1884. Except for addition of second lock chambers for faster handling of coal fleets, the project the Engineers acquired from the company in 1897 was fundamentally the same as that planned by Roberts in 1838. Improvements the Corps made in the early 20th century, rebuilding or strengthening dams and enlarging locks, did not much alter the original project: six structures were still in service, all at or very near sites selected in 1838.

Colonel William E. Merrill planned canalization of the middle section, extending slack water from the head of the company project on to Morgantown in 1875, and he supervised construction of Locks and

Dams 8 and 9 during the 1880's. Locks and Dams 7, 8, and 9 served until 1926, when major coal mining operations moved upstream into West Virginia, and the Corps removed them and built replacement structures numbered 7 and 8 at new locations with higher dams and larger locks having 56 by 360-foot chambers, then the Monongahela standard.

Colonel Merrill also recommended canalization of the upper river between Morgantown and Fairmont in 1875 to open regular steamboat navigation to the river's head, but Congress did not fund that work until 1895. The Pittsburgh District built six small steamboat locks and dams, numbered 10 to 15, on the upper river between 1895 and 1904. That project, however, provided only a seven-foot depth for steamboats, not the nine-foot channel required by fully loaded barge tows.

During the early 20th century, the Engineers extended the service of the fifteen locks and dams, planned in three sections chiefly for steamboat traffic, as long as possible. Repair and maintenance costs were very high, however, and required the continuous attention of the large repair force and workshops at Charleroi (old Lock 4). Other than structural renovations, the major changes made in the 19th century project before 1947 were relocation of locks and dams 7 and 8 to eliminate No. 9 in 1926, rebuilding of No. 4 in 1932, and elimination of Lock and Dam 1 near the mouth of the river in 1938 by raising Emsworth Dam on the Ohio.

Complex shafting and gearing systems powered by water turbines and small steam engines helped lockmen on the lower river move barges through the locks, but lockmen on the upper river maneuvered the locks and hauled tows out of the chambers by hand. It was necessary to break all tows at the six small locks on the upper river into individual units, pull a single barge at a time through the locks, and reassemble the tows above or below the dams. Superintendent Ike C. Bell directed that hard work during the late 1930's. The lockmasters and chief enginemen at each lock in 1937 were: Mike O'Hare and Frank Herrlein at Lock 1, David Longsdon and

Hildebrand Lock and Dam, Monongahela River

William Gates at 2, William Sypherd and Alfred Price at 3, Anderson Caseber and Robert Hill at 4, Charles Kerbler and Frank Marker at 5, Claude Hains and Delbert Williams at 6, John Sedgwick and Elmer Beckham at 7, Charles Boyle and Roy Martin at 8, Alva Hoke at 10, Walter Floyd at 11, David Lane and John Anderson at 12, William and Jesse Shaffer at 13 and 14, and Silas Sayre at 15. These fellows moved enough traffic through the Monongahela locks in some years to generate savings to shippers, ultimately to consumers, greater than the total federal investment in the navigation project. Historian Richard Wiley estimated that in 1937 shippers saved about \$27 million through use of the Monongahela, that the total federal investment to that year aggregated about \$16 million, and that operations and maintenance costs averaged less than a million a year.

With traffic swelling and the old locks and dams approaching the ceiling of their capacity and the limit of their useful life, modernization of the Monongahela became imperative at the end of the Second World War. Starting with reconstruction of Locks and Dam 2, the Pittsburgh District prepared plans to replace the thirteen remaining locks and dams on the Monongahela in 1945 with nine modern structures, beginning with replacement of the six tiny locks above Morgantown and raising the seven-foot pools to a nine-foot depth for barge traffic.

Plans prepared for the upper river in 1947 called for three new high-lift dams at the Morgantown, Hildebrand, and Opekiska sites, and raising Dam 8 to obtain a nine-foot depth to Morgantown. Construction proceeded in a regular fashion during a twenty-year period, 1948 to 1967, with few major problems, though the river lived up to its Indian name, meaning "river of falling banks," when an unstable bank slid into the lock chamber while Morgantown lock was under construction. Work began at Morgantown Lock and Dam in 1948; it eliminated old locks 10 and 11 when it opened to traffic in 1950. Second was Hildebrand Lock and Dam, built from 1956 to 1960 to replace old locks 12



and 13. Opekiska Lock and Dam, at the head of the river, was built between 1961 and 1967 to supplant old locks 14 and 15.

The new locks at all three sites were 84 feet wide and 600 feet long, able to pass a standard six-barge tow in twenty minutes. (Six-barge tows at old Locks 10 to 15 had required triple lockage.) Design of the three new locks and dams generally followed the principles being developed for the modern gated structures on the Ohio River, with lock chamber dimensions suited to the sites. This included recognition of a need for, and development of, an emergency bulkheading system capable of placement in flowing water. At Hildebrand an independent emergency bulkhead and hoist structure were permanently installed upstream of the upper lock gate. At Opekiska the closure structure was an extension of the emergency bulkhead and traveling hoist system serving the dam crest gate openings, and was also located just upstream of the upper gate. These emergency closures also served a secondary but vital function during construction of the dam when a large part of the river was obstructed by a cofferdam. The requirement to provide additional waterway opening during periods of high water for free passage of flood flows was met by using the lock chambers for this purpose, since navigation must be suspended at these river stages anyhow. Placement and withdrawal of the bulkheads in flowing water permitted simultaneous opening of both lock gates, which could be securely latched into their recesses.

At Opekiska, a procedure was even developed for early placement of a bulkhead section and its use as an upper lock gate on a rising river, to reduce time of preparation and premature suspension of traffic.

Records' do not show that this procedure was ever implemented, and the requirement for a lock floodway does not now exist. The presence of the emergency closures, however, is an independent addition to dependable operation.

To provide deeper and longer pools for navigation, without increasing flood stages, the District installed movable steel crest gates between concrete piers at the three new dams. The crest gates rested on the concrete sills of the dams, holding pools of the required depth during normal and low river flows, and were pulled up between the piers clear of the water surface to allow passage of flood water and ice unobstructed through the dam. Morgantown and Hildebrand dams each had six crest gates, each sixty feet wide, while Opekiska had four 84-foot crest gates, allowing use of the same size emergency bulkheads for both the crest gates and the lock chamber.

Establishing a nine-foot depth below Morgantown Dam required the raising of Dam 8 to increase the depth of its pool by four feet. Lock 8 had been built in 1926 and had service life left, so the Engineers simply rebuilt the dam there in 1958 and 1959 by installing six movable crest gates between piers. The 1926 lock, with 56 by 360-foot dimensions, remained, but the Engineers left space for construction of a larger lock when necessary.

Modernizing the middle and lower river sections proceeded less systematically than on the upper Monongahela because available funds had to be applied to reconstruction of the old locks and dams as they approached collapse or became intolerable bottlenecks to river traffic. Work first became necessary at No. 2, lowermost lock on the river where traffic was dense.

Each chamber at Locks and Dam 2 was 56 by 360 feet, built in 1905, and the locks could handle only four barges at a time. It took forty minutes to pass the normal six-barge tow in two sections. The Engineers decided to leave the old dam in place, and in 1949 contracted with Dravo Corporation for con-

struction of new locks, one to be the same size as the old locks and the second to be 110 feet wide and 720 feet long, the latter large enough to handle a towboat and fourteen barges in a single lockage.

Located adjacent to U. S. Steel's Edgar Thomson Works and a mainline railroad track, where the river bank was unstable, all materials for new Locks 2 had to be delivered by river and use of floating construction equipment was mandatory. Wilfred Bauknight, Chief of Construction Division, and resident engineer R. W. Comfort working with Dravo met the construction challenge at Locks 2 by mixing the 2500 cubic yards of concrete that went into the new locks aboard a barge placed next to the cofferdam. Concrete was delivered to the forms in dinkey cars running on temporary tracks laid around the site.

Two construction contracts were awarded to Dravo for this project: the first, for the narrower river chamber in December 1948; the second, for the 110-foot chamber in May 1951, a month before completion of the first. By November 1951, the District's supervisory staff had changed: Wilfred Bauknight had moved on to become Chief of Supply and Procurement Division and Jacque Minnotte had stepped up from Assistant to Chief of the Construction Division. E. P. Daugherty had become resident engineer at Locks 2. The new river chamber opened to traffic in July 1951, and the new land chamber in November 1953. First boat through was the sternwheeler *Homestead*, pushing a twelve barge tow.

The next trouble spot was at Locks and Dams 5 and 6, built in 1907 and 1916, which were in a sad state of repair and operating at top capacity. Traffic at Locks and Dam 5 often suffered six hour delays while awaiting turn to use the locks. The best site for a replacement structure was at Maxwell, 4.8 miles upstream, so in 1957 the District planned new locks at that site, plus raising Dam 4 to carry the required nine-foot depth up to the new locks. Locks and Dams 5 and 6 were thereby eliminated.

The Engineers completed Maxwell Locks, two 84 by 720-foot chambers, in 1963 and finished the dam, which had five movable crest gates, in 1966. That took out old Lock and Dam 6, and when the pool of Dam 4 was raised six feet in 1967, through construction of five movable crest gates between piers, Lock and Dam 5 was removed. Lock 4 had two 56-foot wide chambers, one 360 feet and the other 720 feet long. Those locks, completed in 1932, were still serviceable, so they were left in place with space provided in the new dam for later replacement with 84-foot locks.

Progress on the Monongahela modernization project stopped in 1967, after twenty years work. During the Nixon-Ford administration, Congress provided no funds for completing the project, and for a decade the Engineers made the half-completed project serve as best it could.

From 1948 through 1967, the Engineers had reduced the number of navigation structures from thirteen to nine and had established a full nine-foot project depth throughout the length of the river. But only four of the nine, Morgantown, Hildebrand, Opekiska, and Maxwell, were fully modern structures. At No. 8, they had a 1925 lock and a 1959 dam; at No. 4 a 1932 lock and a 1967 dam; and at No. 2 a 1953 lock and a 1905 dam. No significant improvements had been completed at Lock and Dam 3, built in 1907, or at Lock and Dam 7, built in 1926.

Because Monongahela coal had been hauled by two 25-foot wide coalboats lashed together during the early 19th century, the Monongahela Navigation Company had made the 56-foot lock chamber width standard for the river, and that standard had forced barge tows to conform by placing two barges abreast. In planning the modernization project, the Engineers selected an 84-foot width as standard, to admit tows that were three barges wide, with 110-foot wide chambers at the lower locks, the same as on the Ohio, to allow tows that were four barges wide to move between the mills on the lower Monongahela and the Ohio without breaking and reassembling the tows. In point of fact, the only 110-foot wide chamber so far constructed was the land

chamber of Locks 2. But with modernization only half finished, and some locks still in use that had the old 56-foot width, rivermen were forced either to form their tows two barges abreast to begin with, or break and reassemble their tows at the narrower locks. Considering that the Monongahela in 1977 resembled a partially completed interstate highway where traffic had to detour around old bridges that had not been raised, rivermen put up with the situation quite patiently.

The District Engineer had, in 1970, transmitted a report proposing a new lock and dam at Grays Landing (below Lock and Dam 7) and a new lock at Lock and Dam 8. The report was approved and construction authorized by the Secretary of the Army in October 1973 under the provision of the River and Harbor Act of 1909. Both projects were brought to a halt by a significant development at Dam No. 26 on the Mississippi River--some 1,000 miles distant. There the Corps' proposal for the replacement of Dam No. 26 was challenged by railroad and environmental interests who questioned, among other things, the use of the 1909 Act as authority for the replacement project. In January 1977 the District was advised that the Secretary of the Army would seek new authority from Congress for the construction, and that preconstruction planning studies must be amplified with a system-wide analysis of economic and environmental factors.

Maxwell Locks and Dam, Monongahela River



DATE	LOCKAGES (Number)			STEAMBOATS								OTHER BOATS WITH POWER								BARGES—Standard																
				PACKET		EXCURSION		TOW		GOV'T		OIL		GASOLINE		DRAFT																				
Large lock			Small lock			3 to 5 feet		5 to 7 feet								Less than 2 feet		2 to 5		5 to 7		7 to 9		Total		Less than 2 feet		2 to 5		5 to 7		7 to 9		Total		
						Up	Down	Total	Up	Down	Up	Down	Up	Down	Up	Down	Up	Down	Up	Down	Up	Down	Up	Down	Up	Down	Up	Down	Up	Down	Up	Down	Up	Down	Up	Down
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Lockmaster log

In that same year, simply because the 70 year old Locks and Dams 3 facility was on the verge of collapse, some very critical repair work was accomplished. District Engineer Max R. Janairo had declared that the deterioration of Number 3 was "of a sufficiently critical nature to warrant immediate and expedited attention". The critical rehabilitation features included provision of a new upper guard wall expansion and major repair work in the filling flume located landward of the land wall. Additional major rehabilitation of the Locks Number 3 project was scheduled in 1978.

Whether Congress would fund the much needed overall modernization at a rate sufficient to finish the job by the end of the century before the first structures built reached the end of their service life was still uncertain. Morgantown Lock and Dam, for example, completed its first quarter century of service in 1975 and would reach the end of its half century estimated service life in the year 2000.

Ohio River Flyover After circling downtown Pittsburgh, the plane crossed over Point State Park, old Fort Pitt, and headed down the Ohio. Colonel Smith resumed his narrative description of points of interest along the rivers:

The Ohio is formed here at the Point and flows 981 miles in a southwest direction to

the Mississippi. First island you see is Brunot Island, which contains the Duquesne power plant. In the channel left of the island is the mouth of Chartiers Creek and McKees Rocks. Next is Davis Island, where Lock and Dam 1 was built in 1885, and immediately downstream is Neville Island, which contains over two dozen major industries and the Pittsburgh Engineer Warehouse and Repair Shops. Interstate 79 is being built across the island.

EMSWORTH LOCKS AND DAM 6.2 miles below the Point, creates Pittsburgh harbor. The locks were built in 1922: the larger is 110' x 600' and the smaller is 56' x 360'. In 1938, we rebuilt the dam, using the old fixed dam as an apron, closing the main channel with eight crest gates and the back channel with five gates. That allowed us to raise the pool and remove Locks and Dams 1 on the Allegheny and Monongahela. Traffic through Emsworth in 1973 was about 25 million tons. We have real traffic jams here and need larger locks.

At the toe of Neville Island on the left bank is Coraopolis and a Texas Company

CRAFT PASSING (Number)																MONTH OF <i>December</i> , 19 <i>72</i>								
BARGES—SMALL OR FLATS				OTHER CRAFT EXCEPT SKIFFS								SKIFFS		TOTAL		PASSENGERS						DAM		
DRAFT				DRAFT								CRAFT		PACKET		EXCURSION		DAM						
Less than 1 foot	1 to 2 feet	2 to 3 feet	Total	Less than 1 foot	1 to 2 feet	2 to 3 feet	3 to 4 feet	4 to 5 feet	Total	Less than 1 foot	1 to 2 feet	2 to 3 feet	3 to 4 feet	Total	Through	Over	Tons	Number	Number	Number	Number	Hours	Up	Down
Up	Up	Up	Up	Down	Down	Down	Down	Down	Down	Up	Up	Up	Up	Up	Lock	Dam	Up and Down	Up	Down	Up	Down	Up	Down	
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dock. That's the Sewickley bridge at Mile 12 and a mile below it is Dashields Locks and Dam.

DASHIELDS LOCKS AND DAM completed in 1929, has double locks the same size as those at Emsworth and a fixed weir type dam. Dashields passed nearly 24 million tons of freight in 1973, and the structure will need replacement before long.

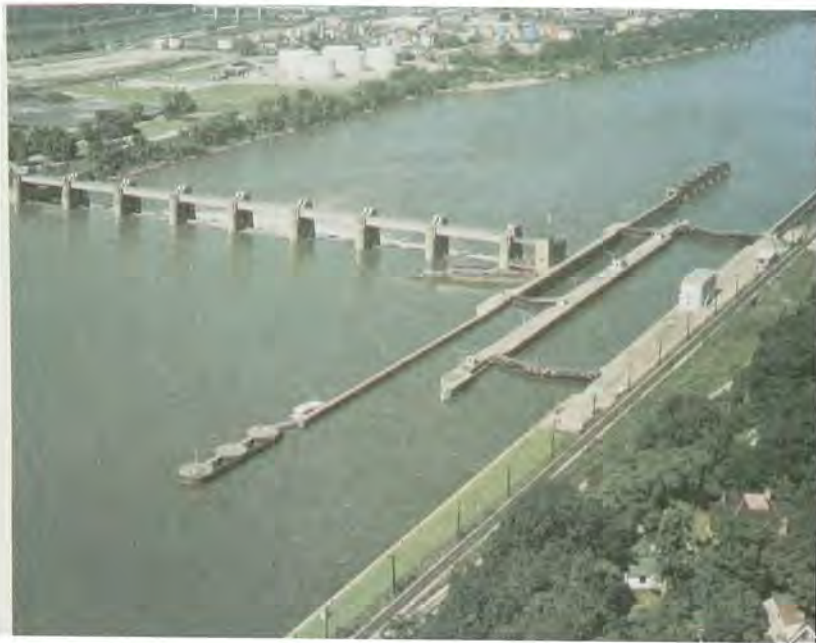
On the right bank opposite Glenwillard is the Bethlehem Steel dock and downstream from it is the American Bridge plant at Ambridge. Across the river is Jones and Laughlin's Aliquippa plant with several large docks.

Here at Conway, Rochester, and Freedom, the Ohio makes its northernmost bend, and we have the mouth of Beaver River. North Star Coal and the Pittsburgh and Lake Erie Railroad have docks on the left bank opposite Freedom. On the right bank below the mouth of the Beaver, are the towns of Beaver, Vanport, and Merrill, the latter named after a Pittsburgh District Engineer. In this section are the docks of

the Koppers, St. Joseph Lead, Sun Oil, and Limco companies.

MONTGOMERY LOCKS AND DAM at Mile 31.7, built in 1936, has ten crest gates and two fixed weirs. Lock size is the same as Emsworth and Dashields. They handled about 23 million tons of freight in 1973.

A mile below Montgomery on the left bank are the docks of Pennsylvania Power. Other docks are at the Shippingport bridge above the head of Phillis Island. On the right bank, you see the giant Crucible Steel complex at Midland. Dravo and Campbell Barge Line have docks on the left bank at Georgetown, opposite the mouth of the Little Beaver. The Pennsylvania, Ohio, West Virginia boundary crosses at Mile 40, a half mile below the Little Beaver. Several coal and oil docks serve East Liverpool, there below Babbs Island. There is Wellsville on the right bank, where we built the pilot project for floodwalls on the Ohio River. As we approach New Cumberland, you see Cluster Islands left of the channel and Ohio Edison docks on the right at Port Homer.



Emsworth

Dashields

Montgomery OHIO RIVER LOCKS AND DAMS

NEW CUMBERLAND LOCKS AND DAM at Mile 54.4, eliminated old locks 7, 8, and 9 in 1963. It was first of the new super dams we're building on the Ohio. The small lock is the same size as the large lock at Montgomery; the large lock is 1200 feet long. The dam has eleven tainter crest gates, each 110' long, which permits use of the same size bulkhead we use for the locks. About 25 million tons of freight passed through here in 1973.



Downstream from New Cumberland, you see the towns of Empire, Toronto, and New Cumberland, and that is Browns Island, where we built our first dam on the Ohio in 1836. Left of Browns Island is Weirton and the National Steel Corporation docks, and downstream on the right is Steubenville, another steel town. The two towns have taken from Pittsburgh the dubious honor of having the worst air pollution in the nation. Mingo Junction is at the mouth of Indian Cross Creek on the right. Wheeling-Pittsburgh Steel has a dock there, and on the left bank is a Weirton Steel dock. Wellsburg, on the left, is at the mouth of Buffalo Creek. On the right bank are docks of Ohio Power and Ohio Ferro Alloys companies. Indian Short Creek comes in from the right at Warrenton. Wheeling-Pittsburgh Steel, Valley Camp Coal, and Standard Oil own the terminals you see.



PIKE ISLAND LOCKS AND DAM at Mile 84.2 replaced old locks 10 and 11 in 1965. It's named for an island that was submerged when we built Dam 12 in 1917. It has large modern locks, nine crest gates, and a fixed weir. The locks handled around 28 million tons in 1973.

Those are Sisters Islands below the dam and Warwood on the left. You can see the U. S. Navy Training Base at Warwood

New Cumberland

Pike Island

Hannibal

and Lock 12, one of the old single locks and wicket dams that is under contract for removal. Here, we enter the heavily industrialized Martins Ferry, Bridgeport, Wheeling, Bellaire, and Benwood stretch. That is Wheeling Island that has a large population and always suffers damages when the river floods. Interstate 70 crosses the island, and you can see the old suspension bridge next to it.

Lock and Dam 13 at McMechen is the last wicket dam in Pittsburgh District and handled 29 million tons of freight in 1973. We are getting ready to demolish it and have already removed No. 14.

Glendale and Moundsville are on the left bank. Valley Camp Coal has a dock at Moundsville, and across the river is an Ohio Edison dock. North American Coal, Hanna Coal, Riverside Coal, and Allied Chemical own some of the docks you have seen in this section above Powhatan Point and Captina. That is Fish Creek Island left of the channel, and Clarrington on the right bank below the Quarto Mining Company dock. Those are the towns of Proctor, Steelton, and Rockport, and docks owned by Pittsburgh Plate Glass, Mobay Chemical, and Ormet Corporation.

HANNIBAL LOCKS AND DAM at Mile 126.4, just above New Martinsville, is the lowermost navigation project in Pittsburgh District. The cofferdam is in the third and final stage, and we expect to finish the job in 1976. The locks were completed in 1971. The dam will have eight crest gates when finished. Building the project has employed about 900 people since we began work in 1966. About 485,000 cubic yards of concrete went into the locks and about 140,000 cubic yards will go into the dam. In 1974, the locks will pass about 30 million tons, mostly coal,

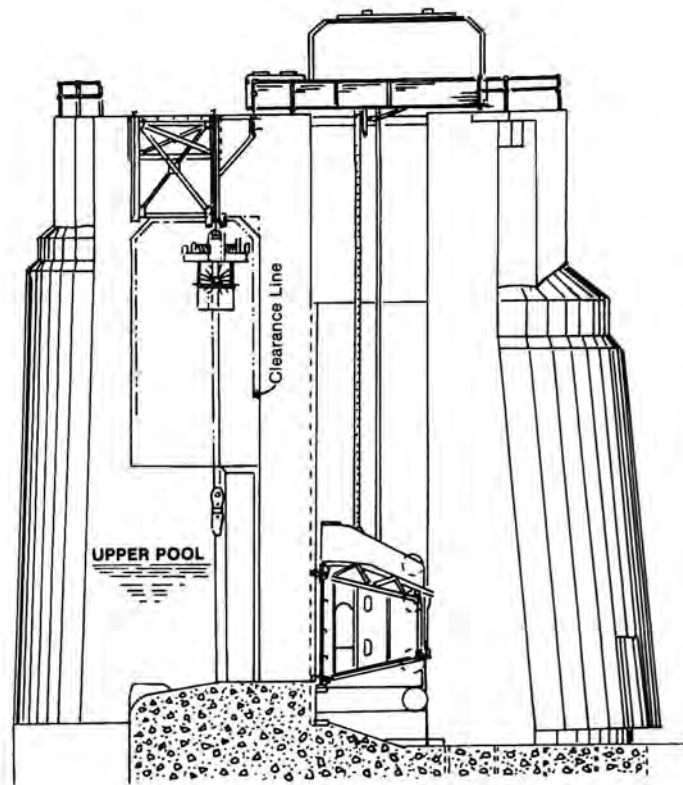


petroleum, and steel. When Hannibal is finished next year, Pittsburgh District will have finished its share of the Ohio River modernization project begun in 1954. We have urgent work ahead of us on the Monongahela, and improvements at Emsworth, Dashields, and Montgomery dams will be necessary by the end of this century.

With that, Colonel Smith ended this part of the narrative, and the pilot dropped the plane in low over Hannibal so the Washington delegation could see the third-stage cofferdam, with construction equipment and men swarming atop the steel cell cofferdam and down in the pit. The plane then crossed the imaginary line dividing the Pittsburgh from the Huntington District.

First High-Lift Dams on the Ohio "Because of the steep slope and the shortness of the pools," Acting District Engineer Harry Hill reported to Division Engineer George Spalding, "the stages are susceptible to flashing rises, so that the dams in this reach require constant maneuvering with temporary deficiency of pools. The hazards of obsolescent structures and the ill effects of temporary deficient pools are magnified in this reach because it constitutes a collecting and distributing point for large industries with a high density of riverborne traffic."

Captain Hill wrote to Colonel Spalding on September 3, 1931, to explain why the Pittsburgh District wanted to replace wicket dams 4, 5, and 6 on the Ohio with a high-lift dam to modernize navigation on the upper river. He told Spalding the best site for the new dam was at Montgomery Island, two miles downstream of Lock 6 and 31.7 miles below Pittsburgh. A fixed dam at that site, high enough to maintain a nine-foot channel to Dashields dam, would cause flood damages at Bridgewater, New Brighton, Rochester, and Freedom, but the engineers at Pittsburgh had devised a solution. They had planned placement of a concrete foundation and low sills with movable crest gates, about fifteen feet high, atop the sills to form the dam. At nor-



Vertical lift gate

mal and low water stages, the metal crest gates resting on the sills would dam the river and form the pool, but at the approach of floods or ice they would be hoisted up between piers to allow passage of flood waters and ice gorges without damage. Double locks, like those at Emsworth and Dashields, would pass the river traffic.

After a week's study, Spalding approved construction of Montgomery Locks and Dam. General Lytle Brown, Chief of Engineers, stamped his approval on the project designs a week later, and the following day, September 18, 1931, the Secretary of War approved. Fifteen days from the desk of the Pittsburgh District Engineer to the desk of the Secretary of War and full approval; a record not likely ever to be surpassed by any navigation project.

Booth and Flinn Company won the contract for building Montgomery Locks and Dam and began work in May 1932 under local inspection of resident engineer Don P. Keelor. The contractors had used towers and cableways to build George Westinghouse bridge at Pittsburgh and adopted the same system at the Montgomery project for handling excavated spoil, erection of forms, and placement of concrete. A deep gravel bed overlay foundation rock at the Montgomery site, so the contractors adopted the old Ohio River box cofferdams, double rows of wooden sheeting held together with metal tie rods, and had few problems with them, except overtopping by floods. With experience as bridge contractors, they chose to erect the eleven piers of

the dam on open caissons sunk to rock with steel sheetpiles driven across the spaces between the caissons.

While the old chanoine wickets had been dropped under the river surface against the dam foundations at the approach of floods or ice gorges, the new Montgomery Dam had ten 100-foot long and 16-foot high vertical-lift gates which were pulled straight up clear of the river level to pass flood and ice flows. Vertical-lift gates, which were steel bulkheads rectangular in shape weighting ninety tons, were raised by chains in concrete piers at the ends of each gate, powered by electric hoisting machinery mounted atop the piers. Damtenders and a gasoline-driven locomotive crane moving along a steel service bridge connecting the piers at the top handled emergency bulkheads and serviced the gates.

Some people worried that Montgomery Dam, with piers in the river channel, would block passage of ice and create great ice gorges. When a huge gorge occurred on the Ohio between Vanport and Sewickley in February 1936, the media blamed it on the new dam. Senator James J. Davis of Pennsylvania complained to Congress that the dam had caused the gorge, resulting in suspension of river traffic, unemployment at closed mines and mills, and some property damages. In fact, the gorge had grounded on a shoal at Vanport, three miles above the dam, and when it broke free on February 26 it smashed apart on the dam piers. Had the dam been finished, its deep pool would have prevented formation of the gorge at Vanport and moved it on south without serious problems. In the end, District personnel, especially Superintendent R. C. McCullough, received commendations for their hard work during the ice gorge at saving boats and equipment carried away by the ice.

Montgomery Dam was finished in the summer of 1936 and the Pittsburgh District began building a second high-lift dam at Emsworth, to permit removal of the lowermost locks and dams on the Allegheny and Monongahela with resulting enlargement of Pittsburgh harbor. Contractors Seeds and Durham and American Bridge Company

under direction of resident engineer Ralph Patt built the new dam at Emsworth, which actually was two dams, one on each side of Neville Island. The crest of the old dam, built in 1922, was cut down sever feet and it became an apron directly below the new structure, and the contractors had the new concrete foundation in place and the steel crest gates suspended between the piers by January 1938. The 967-foot main channel dam was closed by eight vertical-lift gates, each 100 feet long and 12 feet high. The 750-foot backchannel dam was closed by five crest gates; four were vertical-lift and the fifth an experimental crest gate invented by William E. Sidney.

Sidney's invention arose from the experimentation with movable crest gates for dams that was underway during the Depression years. The Corps of Engineers tried three different types of crest gates, roller, tainter, and vertical-lift, at its projects; and the Sidney gate was a hybrid of the tainter and vertical-lift types.

Huntington District and its senior engineer Harry Pockras thought roller gate dams superior, and built four of them, three on the Kanawha River and Gallipolis Dam on the Ohio, to replace chanoine wicket dams. Roller gates were metal cylinders or drums that were rolled by chains and hoists up and down inclines in concrete piers to open and close the dams. German engineers had built the first roller gate dam in 1902 at the Main River near Schweinfurt, and the Krupp and Maschinenfabrik Augsburg-Nurnberg firms held the patents.

Tainter gates, sometimes called sector gates, had an upstream face formed of sheet metal shaped in the sector of an arc and supported by girders connected to an axle or trunnion fixed between two piers. They did not slide or roll up piers to get out of the way of floods or ice; instead, the trunnion stayed in place between the piers and the upstream metal sheet rotated upwards until it cleared the water surface. French engineers had used crude tainter gates as early as 1853, but Wisconsin lumberman Thomas Parker, who also invented the Parker beartrap that was tried at Ohio River Dam 13, independently in-

vented the American sector gate for use in splash dams on Wisconsin logging rivers. The invention became known as the tainter gate because Parker sold his rights to Jeremiah B. Tainter, who patented the device in 1886 and collected royalties for its use. William L. Marshall (Chief of Engineers, 1908-10) installed the first tainter gates used by the Corps on Fox River in Wisconsin in 1890. By 1939, the Corps was using massive steel tainter gates on the spillways of its flood control dams.

The vertical-lift gates Pittsburgh District installed at Emsworth and Montgomery Island dams in 1936 and 1938 were simply modern and large-scale versions of a crest gate for dams used by engineers since ancient times. They were steel bulkheads, rectangular in section, placed in slots in concrete piers and raised up and down from concrete sills by chains and hoisting machinery.

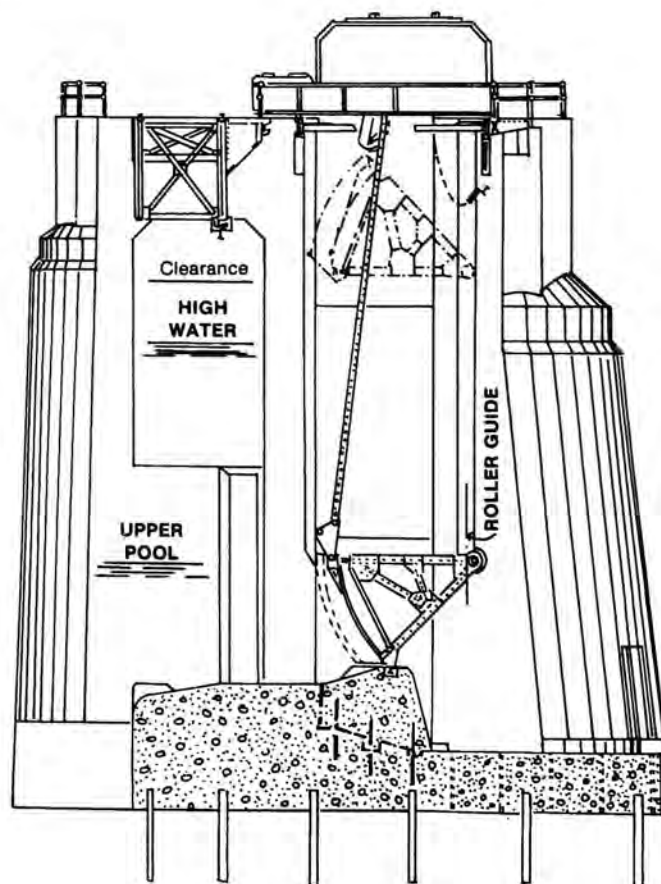
The Pittsburgh District began experiments in 1935 with the movable crest gate invented by William Sidney, the self-trained mechanical expert who joined the District in 1925 and became head of the Design Branch. His invention combined the advantages of the tainter and vertical-lift gates. It was a tainter gate that opened and closed by rotating on a trunnion to maintain normal pool levels, but which could also be hoisted up piers at flood times like the vertical-lift gates.

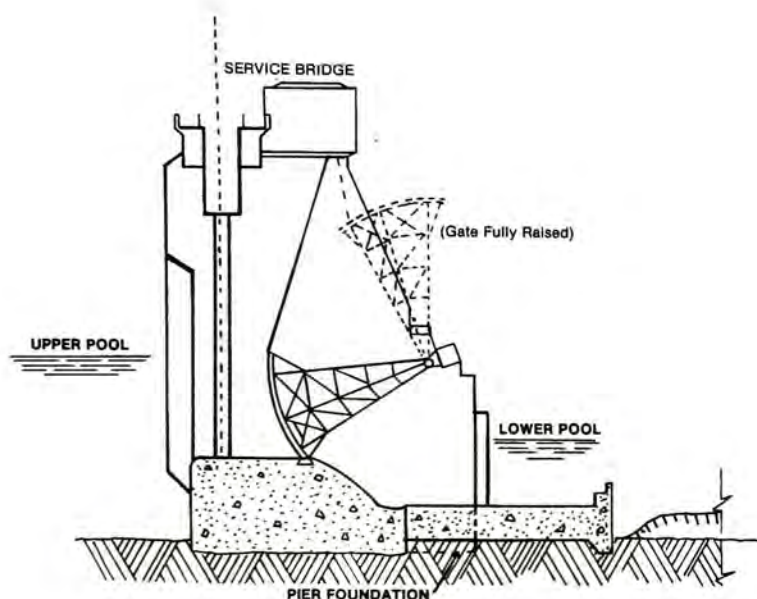
The District installed a one-fifth scale model of the Sidney gate at Allegheny Dam 3 in 1935, and Wilfred Bauknight reported it worked fine. Because it was light-weight, it could be raised from piers smaller than those needed for vertical-lift gates, and, because it lifted out of the path of floods instead of rotating on fixed trunnions like tainter gates, it needed less metal and smaller piers than did tainter gates. The District therefore installed a full size Sidney gate in the back channel dam at Emsworth in 1937 to continue experiments.

The engineers at Pittsburgh began studies of replacing the wicket dams and single locks below Montgomery Island dam in 1936, and District Engineer W. E. R. Covell reported in January 1937

that replacement of the old structures would become necessary about 1945. The Division Engineer assigned Pittsburgh responsibility in 1938 for replacement studies of old locks and dams 7 through 14, and on May 10, 1941, District Engineer Ludson Worsham recommended building three high-lift dams with double locks, similar to the Montgomery Island project, at the New Cumberland, Pike Island, and Opposum Creek sites. The present Hannibal Locks and Dam site, about six miles downstream, was later substituted for Opposum Creek. Thus, just as federal work on the inland rivers in 1824 and the Ohio River canalization project in 1874 had begun at Pittsburgh, the Ohio River modernization project, replacement of the chanoine wicket dams, also began at Pittsburgh before the Second World War.

Sidney gate



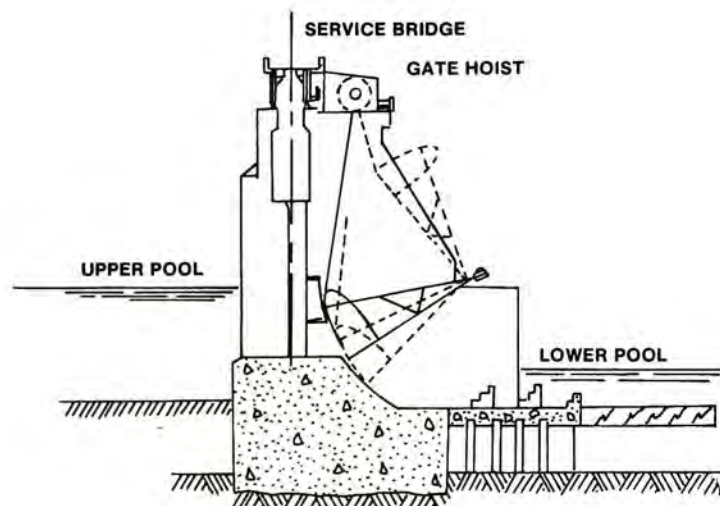


Tainter gate

Ohio River Modernization "Even though the war emergency stopped all construction but the most urgent maintenance work, we have continued to plan for better structures, hoping for that day when our fully prepared plans could be made a reality," said Division Engineer Douglas L. Weart, shortly after the defeat of the Axis powers. "The largest of these proposed projects," he continued, "is the new dam within the Pittsburgh District, planned for construction near New Cumberland."

At a public hearing at Pittsburgh on December 1, 1943, Colonels Lacey Hall and Gilbert Van B. Wilkes had heard rivermen's opposition to the New Cumberland project, proposed to replace old locks and dams 7, 8, and 9. John Howder of Hillman Transportation, speaking for rivermen, said that pilots actually feared passing high-lift dams like those at Emsworth and Montgomery, because of dangerous currents in the approaches to the locks. Colonel Wilkes had assured rivermen, however, that the Pittsburgh District would devise safer approaches to the locks at New Cumberland.

On May 2, 1944, William McAlpine from the Chief's office and Colonel Robert G. West and Ralph Bloor from Division met Charles Wellons, Jack Dodds, Ike English, William Sidney, Jim Neill, and Harry Anderson of the Pittsburgh District at the New Cumberland site to seek solutions to the lock approach problems. They boarded the *Tennessee*



Submergible tainter gate

and rode it upriver to Neville Island to inspect lock approaches at the old locks, and at Montgomery and Dashields, then returned to the District office to discuss the problem. They concluded the hazardous lock approaches resulted chiefly from locating double lock chambers in the river, where they actually damned the river and created currents setting out away from the upper lock gates toward the dam and caused eddies below the lower lock gates. They agreed the hazardous currents could be reduced by indenting the locks into the river bank, excavating space for the locks and their approaches from the bank and thereby leaving the river the same width it was before the locks were built. They also agreed that the main locks at the modern navigation structures should be 110 feet wide and 1200 feet long, same width as the old locks but double the length and adequate for handling the optimum size barge tows on the river. They were not certain, however, whether the auxiliary lock should be 56 by 300 or 56 by 600 feet in the chamber. (After study of traffic projections, the larger 110 by 600-foot size auxiliary lock was selected.)

Traffic on the Ohio River during and following the Second World War, especially long-haul petroleum barging, increased so rapidly that by 1949 tonnage on the middle and lower Ohio surpassed the tonnage moving on the three rivers within the Pittsburgh District. In that same year, however, Pittsburgh, handling about 12% of all

James A. Neill

waterborne commerce in the United States, was still the inland river port with the most tonnage, following Houston and New Orleans on the seacoast; but big shipments of West Virginia coal from Huntington to Cincinnati and other traffic was increasing the importance of those ports. In 1953, Huntington actually surpassed the Pittsburgh Port as then defined.

Because of skyrocketing traffic all along the Ohio during the postwar years, the Ohio River Division made planning for the New Cumberland, Pike Island, and Hannibal locks and dams in the Pittsburgh District part of overall plans for modernizing the river, replacing the chanoine wicket dams with 19 new structures. Emsworth, Dashields, Montgomery Island, and Gallipolis locks and dams in the Pittsburgh and Huntington Districts would remain in service and fifteen new "super" dams would be constructed. The Pittsburgh District would build New Cumberland, Pike Island, and Hannibal on the upper river; Huntington District would build Willow Island, Belleville, Racine, Greenup, and Meldahl dams on the middle section; and Louisville District would build Markland, McAlpine, Cannelton, Newburg, Uniontown, Smithland, and Mound City on the lower river. Because of high traffic density, the first three constructed would be New Cumberland, Greenup to serve the port of Huntington, and Markland to serve Cincinnati.

Modernization was needed because maintaining and repairing the old wicket dams would be very expensive in the long run. With an average 23-foot lift at the new dams, as compared with 9.5 feet at the wicket dams, each new dam would eliminate two or more wicket dams, reducing operating expenses and cutting the number of lockages necessary to pass the length of the Ohio by more than half. The high-lift dams with deeper pools would permit barge loading to a full nine-foot draft and speed the movement of tows, provide a more stable water supply, allow recreational development, and have other benefits. Jim Neill, successor to Charles Wellons as senior engineer at Pittsburgh, explained

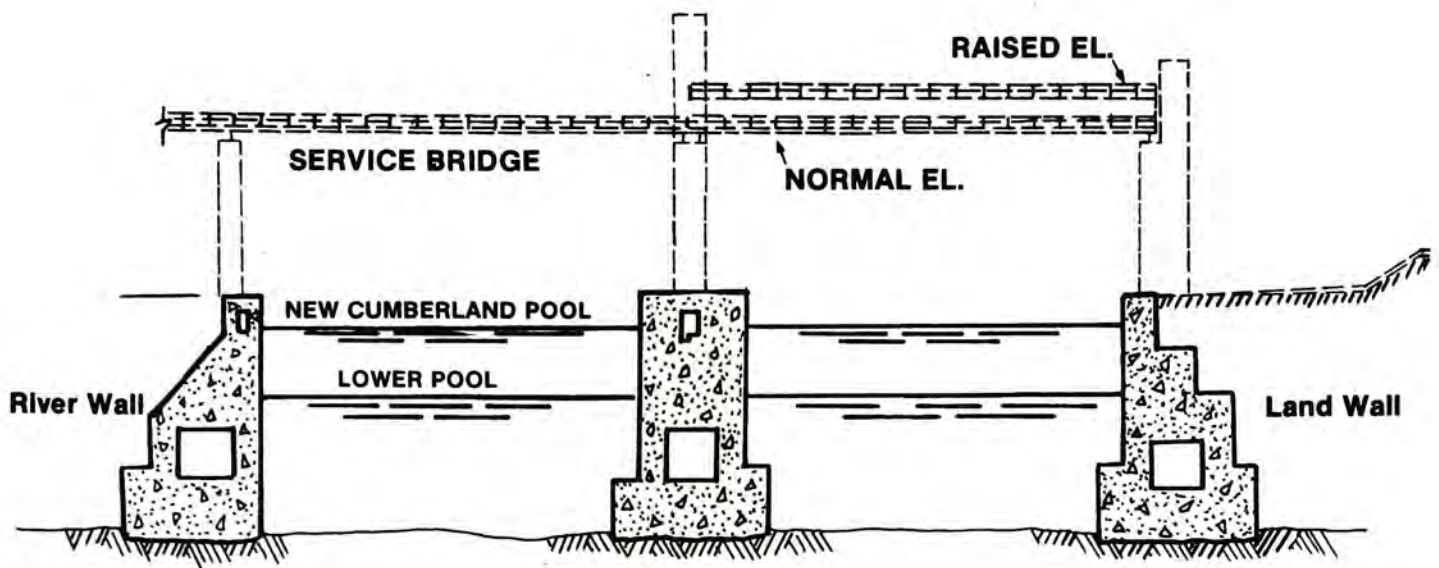


the need for modernizing the Ohio to members of Congress in 1953:

I suggest we consider the Ohio River as a highway—an industrial highway comparable in importance to some of our interstate highways. Fifty years ago we were designing and building highways which to the best of the designer's ability were laid out to provide for the needs of traffic far into the future. I wonder how many of those highways are adequate for present day needs? I wonder if there are any of the really important ones which have not been rebuilt and perhaps rebuilt again in the past 50 years? Yet, it is widely recognized that our highway system falls short of our needs. I think our Ohio River situation is similar.

Tonnage passing through Lock 7 nearly doubled, from 6.8 million tons to 12.3 million tons, between 1945 and 1951, and in early 1952 Chief of Engineers Lewis A. Pick visited the river and asked accelerated planning for New Cumberland, Greenup, and Markland dams so construction could begin in 1954. Just after the Chief's visit, the senior engineers from the Districts—Jim Neill from Pittsburgh, Harry Pockras from Huntington, and Sam Bailey from Louisville—met at Cincinnati on March 12, 1952, with William McAlpine and Ralph Bloor and the Ohio River Division staff: Ed E. Abbott, F. R. Jones, James W. Bruce, Dwight W. Keller, and C. F. Michaels.

The Division office wanted plans for the new "super" dams standardized as far as possible for



SECTION THROUGH LOCKS

Converted lift span - New Cumberland locks

economy and speed of design and construction and wanted project plans to aim at the goal of slashing operation and maintenance costs to the bone. The Division staff wanted Pittsburgh District to devise standard crest gate and hoisting equipment designs for the entire Ohio. "I objected," Jim Neill said, because Pittsburgh had plans for the New Cumberland project well in hand and the other Districts were just beginning at Greenup and Markland, "but Division will probably do it anyway." Division did.

In a series of conferences from 1952 through 1957, Jim Neill, P. G. Quedens, and other engineers from Pittsburgh met frequently with Ed Abbott, senior engineer at Division, and engineers from other Districts to iron out design details for the modernization structures. They agreed upon a culvert system to permit filling and emptying of the locks in eight minutes without undue turbulence in the lock approaches, a hydraulic piston system for opening and closing the steel mitering lock gates in about a minute and a half, and a hundred other details. Their goal was operation of the locks by one man from a central control panel, though an assistant would be on the job for reasons of safety. With that goal in mind, the engineers adopted floating mooring bits that moved up and down with the water level in the lock chambers, ending the need for lockmen on the walls to handle mooring lines. And they even planned such items as elevators and kitchenettes at the new locks and dams for the comfort and convenience of the lockmen and damtenders.

The engineers disagreed, however, about the type of crest gates to be used at the new dams. Ed Abbott and the Division staff wanted tainter gates with fixed trunnions because such gates, with fewer moving parts than other types, would need less maintenance. Division also proposed use of some submergible tainter gates, that would go several feet under the river level, to pass drift and heavy ice. The Pittsburgh engineers preferred the Sidney gate, which had worked well at Emsworth, because it would cost less to construct. Pittsburgh also opposed submergible tainter gates, which might be subject to "pulsating hydrodynamic forces" that could cause damaging vibrations.

The crest gate question was still unresolved when Chief of Engineers Samuel Sturgis broke ground on November 1, 1955, for construction of New Cumberland Locks. Division had assigned design of tainter gates for Markland Dam at Cincinnati to the Seattle District, which had used such gates on dams in the Columbia River basin. The Pittsburgh District had, through contract with its retired engineer Charles Wellons, come up with a design for a divided Sidney gate, which had a lower section that would remain in place on the concrete sill to serve as fixed weir for passage of ice flows after the top half of the gate was raised up the piers.

The question was referred to the Chief of Engineers in 1957. Division Engineer R. E. Smyser contended the Sidney gates planned for New Cumberland would not pass heavy ice flows, such as had occurred during the winter of 1917-18.



Pittsburgh District Engineer H. E. Sprague warned that submergible tainter gates would be damaged by vibrations. When the Division office agreed to study solutions to possible vibration problems, the Chief of Engineers approved use of tainter instead of Sidney gates at the new dams on the Ohio.

Savin and Dravo corporations under a succession of resident engineers, E. P. Daugherty, Charles Wagner, and Roy Klingebiel, built New Cumberland Locks and Dam between 1955 and 1961. On October 22, 1959, Captain Fred Way and his *Lady Grace* had the honor of the first lockage at New Cumberland.

A challenging redirection was encountered as the New Cumberland project neared completion. The service bridge over the locks, with a 57.5-foot clearance over normal pool elevation exceeded the American Waterway Operators' requirement for 55-foot clearance, but other organizations, chiefly the Ohio Valley Improvement Association, wanted a greater clearance. A 68-foot clearance was designed for the Pike Island project, and the same clearance achieved at New Cumberland by converting the span over the auxiliary lock to a lift span with a vertical movement of 10.5 feet. This bootstrap operation was undertaken and completed by Dravo Corporation.

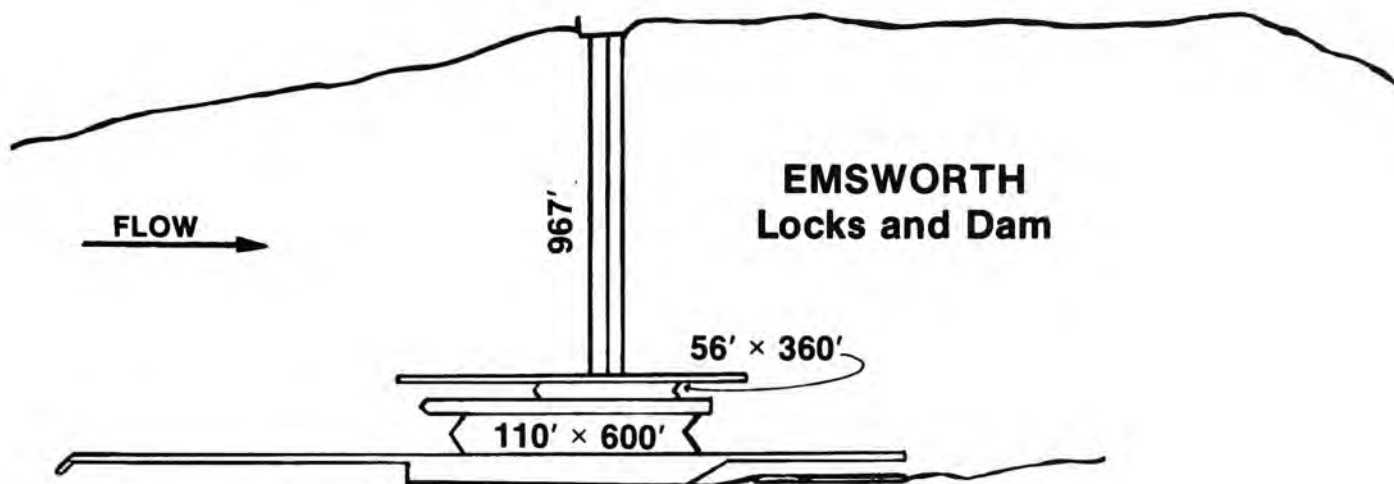
The submergible tainter gates vibrated from the time they were first put in service, tearing away part of the concrete sill at New Cumberland. The engineers at Pittsburgh repaired the sill and stiffened the gate to reduce vibrations, but the problems persisted. At a September 1964 conference, Ed Abbott of Division concluded that the prospect for solving vibration problems was poor, and, "inasmuch as vibration-free operation of submergible tainter gates as presently designed cannot be assured, no

further installation of this type of gate should be made."

Pike Island Locks and Dam, built between 1959 and 1965 by Dravo Corporation under local inspection of Leo Wilsbacher, Everett M. Thompson, and Russel W. Comfort, was named for a low island at the site that resembled the shape of the pike fish. The structure appeared quite similar to the New Cumberland project to laymen, though engineers would recognize differences. After a towboat parade, lead by the *Louis Fiore*, from Wheeling, Chief of Engineers William F. Cassidy and Senators Jennings Randolph and Robert C. Byrd dedicated the Pike Island project to replace old Locks 10 and 11 on September 3, 1965.

On April 16, 1966, ground was broken for Hannibal Locks and Dam, the replacement for locks 12, 13 and 14. Blount Brothers built the locks and Arundel-Dixon the dam. The resident engineers in succession were R. W. Comfort, James B. Lloyd, Carl S. Mallow, John J. Speaker, and C. R. Orr. Senator Jennings Randolph, Assistant Secretary of the Army Victor Veysey, and Division Engineer E. R. Heiberg III spoke to a crowd of about 3,000 gathered on September 27, 1975, to witness dedication of the Hannibal Locks and Dam, the last element of Pittsburgh's share of the Ohio River modernization project. The dedication lacked one day of being exactly fourteen years after completion of the New Cumberland project.

"With their passing an era in the history of navigation will come to a close," Colonel Janairo said of the closing of old locks and wicket dams at completion of the Hannibal project. Lockmaster William Campbell put down the wickets of Dam 13 on July 10, 1975, and demolition of the old structure, long cursed by operations personnel as the most cantankerous dam on the river, began. Lock 15 in the



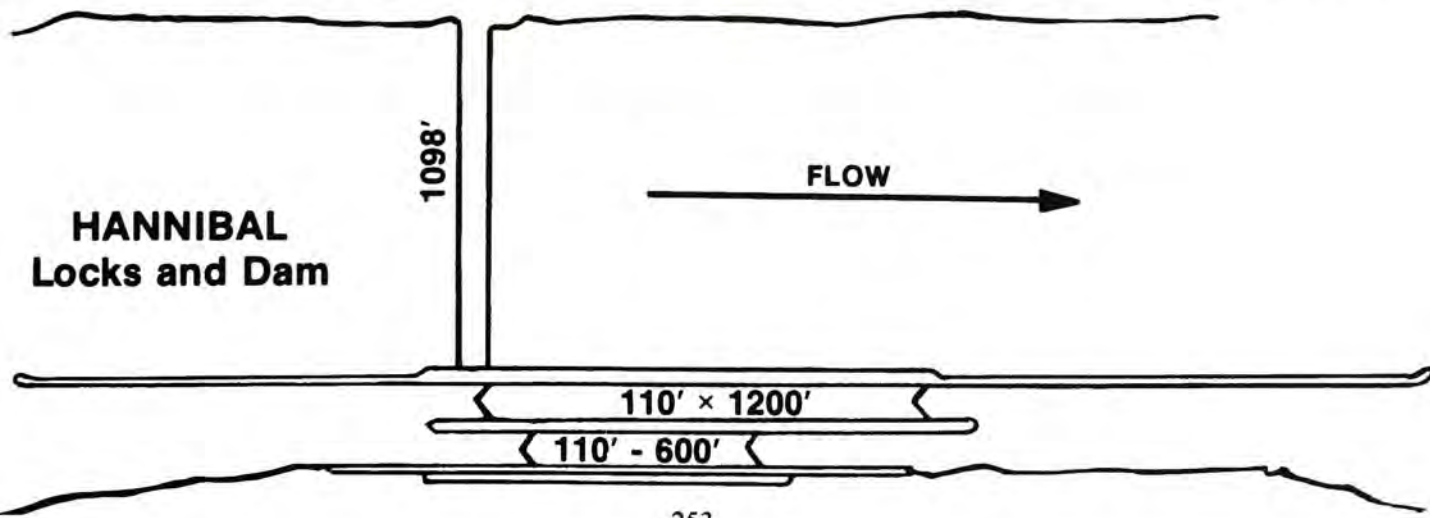
Huntington District continued in service until 1976 and was the last wicket dam in operation on the upper Ohio.

Twelve of the fifteen new locks and dams planned in 1952 to modernize the Ohio were in operation in 1976, and construction of Willow Island and Smithland Locks and Dams was well along toward completion. While further study was made of the fifteenth, Mound City Locks and Dam on the lower river near Cairo, temporary 1200-foot locks, resembling a steel cell cofferdam in construction, were installed at Dams 52 and 53 to handle traffic, and thus two of the old chanoine wicket dams remained in operation.

By the time Hannibal Locks and Dam was finished, Emsworth, Dashields, and Montgomery Island Locks and Dams at the head of the Ohio had been in service for an average of nearly 50 years. Maintenance costs at those structures were increasing and their locks, 56 by 360 feet and 110 by 600 feet, were inadequate for a burgeoning commerce that had adapted to 1200-foot locks.

Displaying a riverman's impatience with overage facilities, Leonard Martin, Chief of Operations at the Pittsburgh District, commented in 1976 that traffic projection planners really blew it at Emsworth, where monumental delays, sometimes as long as 36 hours, occurred when the 600-foot lock closed for repairs. At those times, tows were locked through in three sections and the District towboat *Chartiers* hauled the sections out of the chamber.

When Emsworth Locks were planned in 1917, Ohio River traffic was at its nadir and few men could have predicted a time when 1200-foot tows would string up and down the river minutes apart. It appeared in 1977, nevertheless, that both the Pittsburgh District and river commerce would have to live with the conservative projection made in 1917 for years to come and extend the life of the old locks to the limit. It is worthy of note that the Pittsburgh District in May 1971 transmitted a report containing the replacement studies for Emsworth, Dashields, and Montgomery Locks and Dams. The plans contemplated installation of double locks at each facility, 110 by 1200 feet and 110 by 720 feet.



Chapter 16

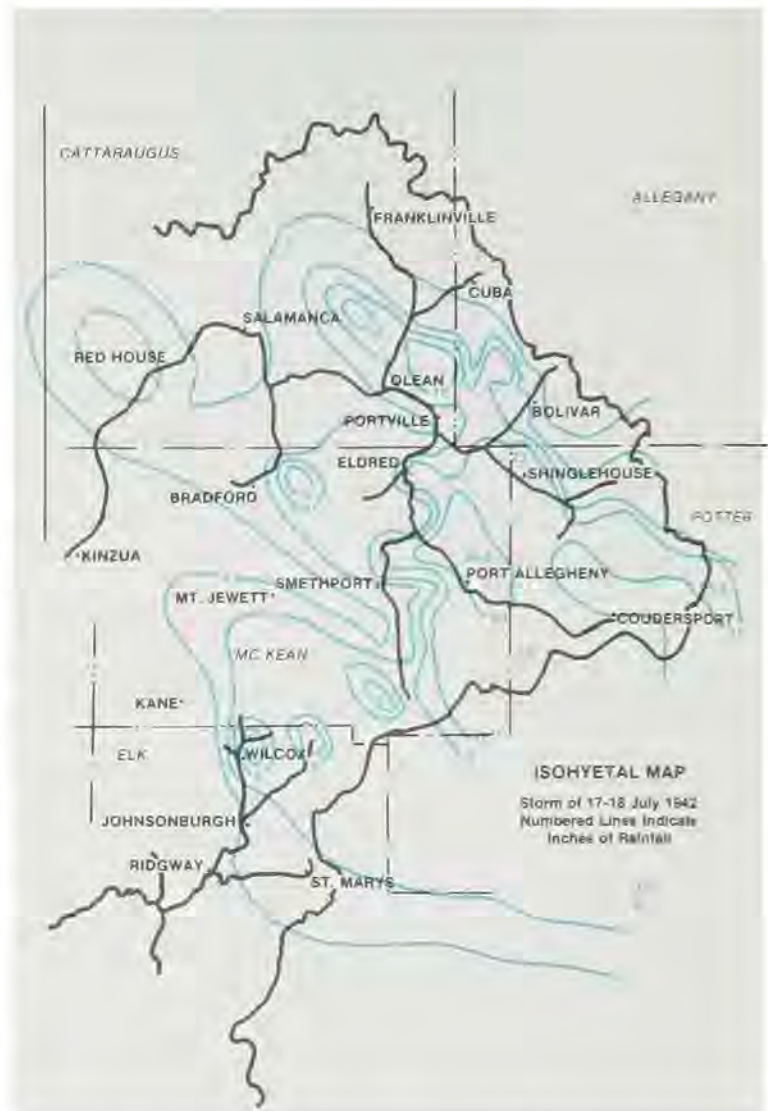
POSTWAR PROJECTS AND POLITICS

General Douglas MacArthur, who began his career as an Army Engineer, once commented that the reputation of the Engineers rested not on the projects they built but on those they did not build. He meant that, before the comprehensive planning era, the Engineers reported unfavorably on better than half the projects proposed by Congress. But, while politics may not have influenced the preparation of feasibility studies, they often affected the selection of projects for construction and the amount and timing of appropriations.

General Lytle Brown, the blunt Tennessean who served as Chief of Engineers from 1929 to 1933, commented on the subject of politics:

It may be said with equal truth that politics may further the adoption of a project, and may prevent it. Furthermore, as may be claimed without disturbing the equanimity of a citizen or his faith in government, politics is involved in everything that affects the welfare of the people of the Republic. Otherwise there would be no democratic principle in government.

When a congressman won approval from his colleagues for survey of a proposed public works project, the Army Engineers undertook the study and made their report, basing their findings on economic, engineering, and, after 1970, on environmental considerations. If their report were favorable, project proponents praised them and opponents berated them; if unfavorable, the reverse occurred. The Engineers, in short, were always caught in the middle of a political controversy. The greatest political struggles began, however, after the Engineers sent their feasibility reports to Congress where the final decisions were made. Whether it was dams for flood control, local protection projects, or "Kirwan's Big Ditch," the program carried



out by the Pittsburgh Engineer District during the decades after the Second World War met politics on every hand.

East Branch of the Clarion River Dam Every member of Congress worth his salt tried to obtain public works projects that his constituents, or at least those he heard, wanted. Congressman Leon H. Gavin of Oil City was doing that in 1946. "I was at Johnsonburg during the July 1942 flood," he told a House committee, "and saw houses bowled right over one against another. These people in this valley have suffered for 40 to 50 years from floods. They deserve relief from these terrific recurring and damaging floods."

A cloudburst on July 17 and 18, 1942, dropped up to twenty inches of rain on parts of Elk, McKean, Potter and Cameron Counties, Pennsylvania, and Allegany and Cattaraugus Counties, New York. (There were unofficial reports of as much as 35 inches in the northeast portion of the storm area).

Local flood protection at Johnsonburg, Pa.



There resulted record flood flows on the Clarion and upper Allegheny rivers and better than \$10 million damages. Ridgway and Johnsonburg on the Clarion were inundated, Coudersport and other communities on the Allegheny were flooded, thousands were left homeless, and fifteen people died. The flood resulted in a groundswell of public support for flood control projects in the Clarion basin.

Clarion River people had once welcomed floods, for the rises washed logs down tributaries to the main stem for rafting to supply hard cash for the lumberjacks of Elk, Jefferson, Forest and Clarion Counties. The Clarion and its tributaries were navigable by law during the 19th century; and in 1857 A. I. Wilcox, Nicholas Brockway, and others had organized the Clarion River Navigation Company to clear the stream, its east and west branches and other tributaries, for log driving and rafting. And from 1845 to 1870, flatboats carrying as much as 20,000 tons of pig iron a year had taken advantage of floods to descend the Clarion on the way to markets.

When Colonel William E. Merrill first surveyed the Clarion for the Corps of Engineers in 1882, he found staggering tonnages of forest products floating out of the river. Rivermen wanted Merrill to improve Clarion River navigation by building beartrap sluice dams; he turned them down. John Arras went back for another look in 1894, and, finding that 125,000 tons of timber, farm produce, and coalboat bottoms navigated the Clarion each year, he thought clearing the stream of rocks would be a worthwhile contribution to Clarion valley industry, but the Chief of Engineers rejected the idea.

Clarion valley timber had been largely depleted by 1912 when J. R. Paull formed the Clarion River Power Company. That firm later merged with the H. D. Walbridge Company and the Pennsylvania Electric Corporation and built Piney Dam on the lower river in Clarion County during the 1920's to produce hydroelectric power.

In its early studies of Clarion basin flood control, the Pittsburgh District also studied dams for both flood control and power production on the main stem of the Clarion, but the area coal industry and state government opposed the idea, the latter objecting that main stem reservoirs would flood timber stands in state forest parks. Clarion River flood control was therefore deferred while the Engineers built on other streams in the Allegheny basin where they had full political support from the state. Then came the flood of July 1942.

Congressman Leon Gavin expressed the wish of the people of Ridgway, Johnsonburg, and the Clarion valley for flood protection after 1942, and in 1944 he won approval from Congress for construction of a dam on the East Branch of the Clarion, together with local protection for Ridgway and Johnsonburg. Between 1947 and 1952, the Pittsburgh District built a dam for flood control and low flow improvement on East Branch of the Clarion, 7.3 miles upstream of its junction with the West Branch at Johnsonburg. Ridgway and Johnsonburg also cooperated financially in improving flood-carrying capacity of stream channels at those communities.

East Branch Clarion River Dam
The emergency Remedial work



The \$9 million East Branch of the Clarion Dam was built of an impervious fill core with random fill both upstream and downstream and blanketed on the upstream face with riprap stone. It rose 184 feet above the streambed and was 1,725 feet long. The lake it impounded, 6.2 miles long, in 1952 covered the village of Instanter and a few miles of road that were not relocated in Elk County, Pennsylvania. An acre-foot of water is the amount of water that will cover the area of one acre to a depth of one foot. East Branch of the Clarion Dam could store as much as 84,300 acre-feet of water. A concrete control tower located in the lake had four sluice gates used to maintain proper lake levels. When damtenders raised the sluice gates, they released lake water into a concrete-lined tunnel, ten feet in diameter, passing under the right abutment of the dam to an outlet and stilling basin below the dam. To prevent overtopping of the dam, flood flows too great to be passed through the tunnel overflowed through a lined spillway in the left natural abutment of the dam.

Five years after it was completed, the East Branch Dam developed a leak, the most serious leakage that had occurred at any flood control dam built by Pittsburgh District. On May 8, 1957, damtender Frank R. Johnson called project operations chief Carl A. Wheelock at the District office and said that muddy water was coming from a rock drain at the toe of the dam. Johnson had seen woodchucks in the area, but he thought the muddy water was a real leak. Geologist Shailer Philbrick and resident engineer J. P. Renouf went to the dam, built a small weir below the leak, and measured the leakage at 1.1 cfs. The sluice gates were opened, the



lake drawn down, and rotary drill rigs were placed to bore test holes down into the dam and abutment to locate the source of the leakage.

Water from the lake apparently had worked its way through fractures in the natural rock under the dam, percolated up through the earthfill dam embankment, and eroded soil from the core of the dam, coming out through the drain at the toe. District Engineer H. E. Sprague and his staff called in soils and engineering experts from Washington and Cincinnati for a conference on June 20, and the men decided to plug the leak with a cement grout mixture forced under pressure down drill holes into the cavity formed by the leak. By August 19, that procedure had sealed the leak, and in November the District resumed normal operation schedules for the reservoir. During the Tropical Storm AGNES flood of June 1972, 100% of the storage capacity of East Branch Dam was used, with water through the spillway, to protect the Clarion valley and downstream areas.

Keystone on the Conemaugh Author James Parton in 1868 described Pittsburgh as "Hell with the lid taken off." Conditions had not much improved down to 1939, when architect Frank Lloyd Wright suggested it might be best to abandon Pittsburgh and build a new city elsewhere. Plagued by floods and serious air pollution, blighted by urban decay, "Smoky City" was not a fit place to live.

Business, civic, and political leaders of Pittsburgh began meeting with Richard K. Mellon in 1942 to plan revitalization of the community and in 1946

organized the Allegheny Conference on Community Development and secured full support for urban rebuilding from Mayor David L. Lawrence. The revival of urban life they planned, that became known as the "Pittsburgh Renaissance," had many features, but the pillars of reconstruction were urban renewal, smoke abatement, and flood control.

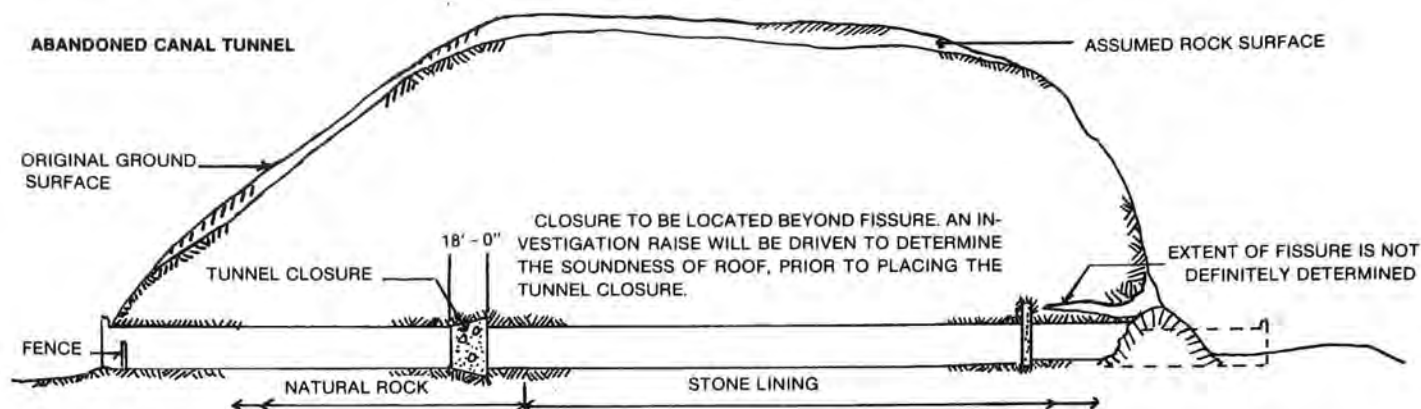
The leaders of the "Renaissance" planned rebuilding on 23-acres of the downtown Golden Triangle district adjacent to Point State Park, removing decaying buildings and erecting a complex of office buildings, underground garages, and landscaped plazas to be known as the Gateway Center. That project, the key to downtown redevelopment, would require a large private investment, and representatives of the Equitable Life Assurance Society were reluctant to commit funds of the size needed to building in an area with inadequate flood protection. The "Pittsburgh Renaissance" was thereby pegged to the proposed dam for flood control on the Conemaugh River, 7.5 miles upstream of Saltsburg. Pittsburgh Engineer District studies showed that the dam on the Conemaugh would have lopped 4.6 feet off the crest of the St. Patrick's Day flood of 1936; and Pittsburgh political and civic leaders, calling the project the keystone to flood protection for their city, began an intense lobbying campaign on behalf of Conemaugh Dam.

The Pittsburgh District had completed six dams for flood control, Tygart, Tionesta, Mahoning Creek, Crooked Creek, Loyalhanna, and Youghiogheny, by the end of 1942, and in that year the Pittsburgh Chamber of Commerce unanimously resolved that construction of Conemaugh Dam should begin at the end of the war. A shock came in 1945, however, when Congress cut an appropriation for the Conemaugh project from the public works bill. William B. Rodgers, Jr., son of the river captain who had gotten the Allegheny River bridges raised and a leader of Pittsburgh's campaign for flood control, jumped on a train to Washington, where he learned that political opposition to the Conemaugh project was coming from Blairsville and Indiana County.



Rodgers returned to Pittsburgh and, along with other members of the Chamber of Commerce, took Shailer Philbrick and representatives of the Pittsburgh District to Blairsville to reconnoiter the situation. They learned that people of Indiana County were not even aware they would be paid for lands taken for the project. Rodgers and Philbrick assured the people they would be paid fair market value for their properties. "I would question whether very many cases have ever developed where the Government has bought land that will be inundated as result of building a reservoir where people were not satisfied," Rodgers told them. "They always seem satisfied, and these people invariably will build a home within a mile or so of where they are already living because it is their home. They build a finer home because it is Government money, more money than they ever had before; it is cash on the barrel head, and the towns have profited as a result of every one of these dams so far."

People resent leaving their ancestral homes, no matter how worthwhile the project, and invariably oppose public projects requiring the exercise of eminent domain. Land acquisition for projects becomes therefore a very sensitive and difficult business, requiring friendly and frank contacts with people living at the site of a proposed project from the beginning.



The District Surveys Branch starts the process, sending parties of men armed with shovels, saws, axes, and survey equipment to the project sites to locate boundary lines, caves, springs, structures, graves, and to make precise measurements of the ground to check the results of aerial photogrammetry. Living a rugged outdoor life, the surveyors make their own paths as they move, risking insect, snake, and dog bites, and occasionally farmers waving shotguns. They always proceed with permission of landowners, though a court order for entrance can be obtained when necessary. For the most part, surveyors are an adventurous, gregarious lot who take pains to establish friendly contacts with the people they meet.

That first contact is followed up by men and women of the District Real Estate Division who have the fascinating job of dealing directly with human reactions, whims, and caprices not at all subject to engineering formulas. They make every effort to acquire land amicably through direct negotiation with owners, resorting to court action only when owners can not be located or when amicable settlement is unobtainable. Then, the courts determine fair market value, or "just compensation" under the Fifth Amendment to the Constitution, and like as not the market value set by the courts will be the same or even less than the amount first offered by Corps negotiators.

People often complicate matters by clinging to their homes to the last moment. A favorite story among the Real Estate people concerns an elderly woman who plumped down in a rocker next to her fireplace and told the Corps negotiator: "No, I ain't a-goin' to sell. I'm jist a-goin' to set right here in this room rockin' and let the water come up 'round me and drown me." At each of several visits, the negotiator found her sitting in her homestead defiantly rocking at top speed. At last, he explained at great length how the dam would benefit people, how it would save property and lives of people living below it, and asked, "Why won't you cooperate?" The rocking ceased abruptly and the lady tartly replied, "Cooperate! Why, I'm a-goin' to die for the Government! What more do you want?"

Employees of the Real Estate Division perform much time searching church, family, and genealogical records and reading tombstones, for all graves in a reservoir area must be moved, a job usually handled by contract with morticians who relocate the graves to the nearest well-kept cemeteries. Effort is made to identify the graves and locate next-of-kin, a big job in some years; in 1965, for example, 53 cemeteries containing 6,300 graves were moved in the Pittsburgh District. This also is sensitive work, but it has its lighter moments. Some of the most surprising epitaphs pop up: "I expected this but not just yet." "May he rest in peace until we meet again." "Died Feb. 4, 1891. A true blessing for all."

Funds for land acquisition and relocations at the Conemaugh Dam project were made available in 1946, after Pittsburghers again traveled to Washington to engage in politics on behalf of the project. The Conemaugh project had been left out of the House appropriations bill, but William Rodgers, Ralph Edgar, and a bipartisan group of Pittsburgh leaders lobbied with congressional committees, and Senators Joseph Guffey and Francis Myers restored funding for the project to the bill when it reached the Senate.

Relocations at the Conemaugh project cost twice as much as the dam. Two railroad tunnels and the old Pennsylvania Canal tunnel through the bow in the Conemaugh where the dam was built had to be plugged with concrete and sixteen miles of railroad doubletrack mainline had to be moved. Resident engineers Don D. Rait and W. C. Sale directed relocation work by the contracting team, Herman Holmes, Hunkin-Conkey, and Shofner, Gordon and Hinman, that had earlier built Youghiogheny Dam. Holmes drilled a new half-mile long tunnel for the railroad, and the other contractors made the huge cuts and fills in the rugged terrain and built six new bridges for the rail line.

Wilfred Bauknight, Chief of Construction Division until 1951, explained that at jobs like Conemaugh the resident engineer and a skeleton staff were sent to the site at the time bids were advertised

to begin control surveys, preparation of progress charts, and preliminary work. When the contractor moved his people and equipment to the site, the District sent a full inspection force, normally consisting of a field engineer, office engineer, safety engineer, and inspection, survey, and clerical staff. Contractors typically had a project manager, project engineer, general superintendent, office manager, and assistant superintendents. "Successful construction rests," said Jacque Minnotte, Bauknight's successor, "on three pillars: good plans and specifications, competent contractors, and a capable resident office staff." Resident engineers at Conemaugh Dam were, in succession, R. B. Jenkinson, C. E. Paul, and E. M. Thompson.

While work was underway, the resident engineer office monitored contractor progress and maintained quality control, reporting to the Construction Division in the District office, which acted as liaison between the field staff and the several other elements of the District that were concerned with the work. After the bulldozers shut down, the last concrete was placed, or the last spike driven, Construction Division recommended acceptance of the work to the District Engineer, who thereupon made final inspection, acceptance and payment to the contractors and turned the project over to Operations Division.

Problems crop up at every construction job, and Conemaugh was no exception: troubles ranged

there from rat extermination to major landslides. Because Conemaugh Reservoir would take the Blairsville public dump, the Engineers had to buy the dump and Blairsville had to open a new landfill. The Engineers had to contract for extermination of rats at the old dump and coordinate timing of the work to kill the rodents before use of the old dump ceased; otherwise, the creatures might have run out of edibles and migrated into the town.

A landslide problem eventually forced the Chief of Engineers to appear before a committee of Congress to defend the Pittsburgh District. During relocation work at Conemaugh, earth sloughed off the side of steep hills down into the cuts, and one such slide cracked two concrete piers built for a bridge on the relocated Pennsylvania Railroad track. Congressman James G. Fulton of Dormont attacked the Pittsburgh District for negligence in connection with the slides in the newspapers. District Engineer Francis Falkner pointed out that slides were common at projects built in rugged terrain, and mentioned that General George Goethals, who had dealt with massive slides at the Panama Canal, had been rushed to Pittsburgh to advise city engineers about what to do at slides on Bigelow Boulevard, the "Dream Highway." Goethals' advice was: "Let 'er slide."

Chief of Engineers Raymond A. Wheeler explained to an investigating congressional committee that core-drilling and foundation exploration on the

1950

View across the Conemaugh River

1834



Ernest
Coleman



West portal of relocated Pennsylvania Railroad tunnel

hillside above the bridge piers would have cost \$350,000, so the Pittsburgh engineers had gambled that the hill would not slide and had lost. Since damages were about \$150,000, the Pittsburgh District was still ahead of the game financially. General Wheeler said that, based on hindsight, he would have asked the \$350,000 for foundation exploration from Congress if only to have avoided the controversy. He assured the committee that foundation investigations for structures where human life might be at stake would never be neglected.

While relocation work was underway at Conemaugh from 1946 to 1948, delegations from Pittsburgh made yearly pilgrimages to Washington to plead for accelerated funding. When they won funding for construction of the dam in 1948, Equitable Life Assurance Society approved funding for the Gateway Center, cornerstone of the "Pittsburgh Renaissance." Plans for the Center, however, wisely called for floodproofing the buildings by installing floodgates, sewer cutoff valves, submersible power units, and waterproof foundations. First floors of the buildings were also located at least a foot higher than the maximum flood of record would reach after the flood control dams had cut off its head.

Indiana County Commissioner Steele Clark, General Joseph C. Mehaffey, and Colonel Francis Falkner broke ground for Conemaugh Dam on May 9, 1949. General Mehaffey, Ohio River Division Engineer, spoke to the people crowded around the

site, explaining that, while Conemaugh Dam was known as the keystone for flood control at Pittsburgh, it was not big enough for complete control of floods. He thought, nevertheless, that major reductions in flood crests could be achieved through prudent operation of Conemaugh Dam in conjunction with other dams upstream of Pittsburgh. The ceremonies then adjourned and the participants joined a motorcade back to Pittsburgh for dinner with Governor James H. Duff and Mayor David Lawrence at the Gold Room of the Roosevelt Hotel.

The Board of Consultants organized to advise on big dam construction in the Pittsburgh District had not met since 1942, when it made its decision on Youghiogeny Dam, but it reconvened in 1949 at the District office to consider plans for Conemaugh Dam. James Growdon, William McAlpine, William Creager, and Charles Berkey returned. Leroy F. Harza, founder of Harza Engineering of Chicago, was the new member of the Board. Ralph Bloor and Ed Burwell, who had moved from Division to the Chief's office, returned, and Bob Philippe, Oscar Yates, and General Mehaffey from Division attended.

Shailer Philbrick, Jim Neill, and the District engineering staff had devised an innovative plan for the foundation of the concrete dam to be built on the Conemaugh. The sheer weight of water impounded by high dams creates stresses always trying to force the dams downstream, and classic dam design, to prevent such sliding action, involved excavating the

bedrock under the dam so it was lower at the upstream end than at the downstream toe and thereby more closely at right angles to the stresses. At the Conemaugh site, however, foundation rock dipped downstream and the strata varied from claystone and siltstone to limestone, coal, and sandstone. The District wanted to build Conemaugh Dam with a 3% downstream inclination so the entire structure would rest on essentially the same rock stratum.

Ed Burwell, Charles Berkey, and most of the consultants questioned the District plan and wanted to build the dam in the classic fashion, cutting across the strata to obtain an upstream inclination. Philbrick defended the District's plans against the entire Board, arguing that if the dam were built in the classic manner and rested on different rock strata with varying resistances to pressures it might settle into place at different rates, perhaps cracking the concrete. Philbrick maintained his position and the Board, after observing that the toe of the dam would be embedded about twenty feet into foundation rock, finally approved the District's plans and adjourned for sandwiches and coffee.

Conemaugh Dam was built as the District designed it: on a downstream dipping siltstone layer. After the Conemaugh meetings, the Board of Consultants faded out of the picture. By 1953, the engineers of the Pittsburgh District had about as much experience with big dams as any engineers, public or private, in the nation.

A special train from Pittsburgh and a motorcade from Wheeling traveled to Conemaugh Dam on September 18, 1953, for dedication ceremonies. Savin Construction Company had built the 137-foot high and quarter-mile long concrete dam between 1949 and 1953. It backed a lake seventeen miles up Conemaugh River and twelve miles up Black Lick Creek. Chief of Engineers Samuel D. Sturgis, William B. Rodgers, and District Engineer Ralph A. Lincoln presided at the dedication ceremonies, opening the dam's sluice gates to let water gush through for the entertainment of the crowd. They returned to Pittsburgh that evening for dinner at the William Penn Hotel, where Governor John S.

Dedication of Conemaugh Dam



Fine and Mayor David Lawrence spoke to honor the people who had built Conemaugh Dam as the keystone of the floodwall of dams growing around the headwaters district.

Reservoir Operations When Charles Ellet proposed his reservoir scheme in 1850, he said that reservoir operations would be simple. All that would be needed was one damtender at each dam to close the gates to hold floods and open the gates to release. One central superintendent and a telegraph communication system would complete the outfit. Reservoir operation, in practice, proved far from simple, but Ellet had the principles right.

After Conemaugh Dam was finished in 1953 it became the responsibility of the District Flood Projects Operations Branch. Normally, three damtenders were stationed at each dam to operate the gates and perform routine maintenance. All three worked the day shift except during floods and emergencies. They were linked to the District office by telephone and radio communications and had diesel generators for emergency power supply.

Carl A. Wheelock, Chief of Flood Project Operations, explained the setup. Twice daily, more often during floods, the District office contacted damtenders throughout the District by radio and told them to "open certain gates at a certain opening at a certain time." The damtenders then went to the control panels in the operations buildings and pushed buttons activating electric motors that moved the gates up and down in their housings. In the event of power failure, the gates could be moved by standby generators or by hand. If mechanical problems prevented proper gate operations, steel bulkheads could be lowered across the gate openings so repairs could be made. If communication with the District office were broken for some reason, the damtenders had emergency instructions on hand for use until communications were restored.

Emil Schuleen, R. M. Morris, and Tom Reilly worked out five separate operations schedules for the dams and reservoirs: for routine operation, minor rises, flood storage, water supply storage, and release of low flow storage.

Information needed for scheduling reservoir operations was collected by the Hydrology Branch, headed for many years by Thomas L. Reilly, a Bellevue native who joined the District in 1935 and who could amaze laymen by reeling off a century's flood stage records in the Pittsburgh District from memory. Precipitation and stream flow measurements poured into the Hydrology Branch daily from the National Weather Service, stream gaging stations, and the dams. During unusual weather conditions, surveyors from the Hydrology Branch went scouting across the watersheds above Pittsburgh, driving perhaps 2500 miles in three days, tramping on snowshoes through the mountains to ascertain snow accumulations and marching along flooded streams to measure runoff rates. After the data was assembled at the District office, it was analyzed to determine the best long and short range reservoir operation schedules.

The normal annual operations program planned low reservoir levels allowing maximum flood

storage during the winter and early spring, then impoundment of late spring rains for release during summer and autumn low flow periods. Few years have completely normal precipitation patterns, however, and challenges to operations came when floods occurred in quick succession, or during summers after impoundment for low flow had begun, or when precipitation did not occur in the amounts expected. Erratic weather usually meant around the clock work at the Hydrology and Projects Operations Branches and midnight calls to the damtenders, who stumbled through cold and snow and wet weather to operate the gates. That's why damtenders welcome summer sunshine more than most.

Operation of Conemaugh Dam furnished several benefits in addition to flood control. Its 274,000 acre-feet of storage was devoted entirely to flood control, but its releases made significant contributions to downstream water quality and reductions in fishkills. Conemaugh River was notorious for its high acid and manganese content, and, before the dam was built, local rains over the Conemaugh basin sent slugs of polluted water into the Allegheny and Ohio rivers that caused trouble all the way to Wheeling. Division Engineer Walter P. Leber, in an address to the Pittsburgh Sanitary Engineering Conference in 1963, explained that runoff stored temporarily by Conemaugh Dam for subsequent slow release reduced acid water problems downstream of the dam.

Local Protection Clifford Davis, chairman of the House Committee on Flood Control, opened the July 25, 1955, hearing with the remark: "The Chair has been under tremendous pressure during the last six weeks, and I am sure some of you do not know the extent of the pressure."

Congressman John J. Dempsey asked, "Mr. Chairman, could we take action, subject to a favorable report by the Board of Engineers?"

"We have not done that before," said the chairman.

"I have never had so much threatening before, either."

"No," said Mr. Davis, "I tell you he nearly broke my eardrum one time, and I do not want him to break it again."

The butt of the committee's humor was Congressman Leon H. Gavin, who rose to defend himself, saying his people at Brookville, Pennsylvania, were very unhappy that work on a local protection project at nearby Reynoldsville was underway and they were left out. "When it comes to a colossal project, something that is gigantic or monumental," said Gavin, "the engineers become greatly concerned about it, but when it comes to some little project where a town is flooded out every spring and fall due to heavy rains and the snows, and it requires the relocation of highways and telephone poles and sewer lines and lot of detailed work, they seemingly are not too concerned about those little troublesome projects. They should be concerned, because those small projects are just as important as the projects of a gigantic or monumental nature."

The record of the Pittsburgh Engineer District indicates that Congressman Gavin's charges were groundless. In fact, environmentalists during the 1970's would probably argue the reverse: that Pittsburgh District built too many local protection projects, which involved dredging stream channels to widen, deepen, and straighten them to increase their flood-carrying capacity. Congressman Gavin was practicing politics, however, and he got the local protection project for Brookville on schedule. When Brookville met local cooperation requirements in January 1960, the Engineers began construction and turned the completed project over to Brookville for operation and maintenance in October 1962.

In general, three types of local protection projects were built by the Pittsburgh Engineer District. Channel rectification projects, of the sort built at Brookville, were most common. Levees, the ancient device of building nearly continuous earth dams



Channel improvement - Reynoldsville, Pa.
Portville, N.Y. before improvement



Portville, N.Y. after improvement



Colonel Ralph A. Lincoln
Flood wall at Wellsville, Ohio



from high ground to high ground to protect low-lying areas, were built by the District at Olean and Portville, New York, and a few other places. The third type, concrete floodwalls, that replaced levees where towns crowded up to riverbanks, were built at Wellsville on the Ohio and Kittanning on the Allegheny. There were, of course, many complex combinations of all three types to meet specific needs and varying terrain most economically and effectually.

Local protection projects were nearly always initiated by the communities that desired them through contact with their congressmen, who shepherded an appropriation for a survey through Congress. The Pittsburgh District then studied various plans to provide protection and held public meetings to find out what the communities wanted and if they were willing to pay their share of the costs. If a community was willing to cooperate and estimated project benefits exceeded estimated costs, the District returned a favorable report to Congress and somewhere down the line Congress funded the work. The process usually took several years.

One of the first local protection projects built by the Pittsburgh District was at Wellsville on the Ohio, which had wanted such a project since the flood of 1913. Just after the 1913 flood, attorney P. M. Smith, for the Wellsville city council, wrote the District Engineer that Wellsville, in Columbiana County, 48 miles downstream from Pittsburgh, had suffered heavy flood damages and wanted help with building dikes for protection. "Can you Engineers

help us?" he asked. The District Engineer replied, "Yes, we can. Enclosed is a map showing accurately the areas of Wellsville that were flooded, from which your city engineer can work out plans for a dike to prevent flood water from entering the low section of your town." That was the extent of it. The Engineers could do no more because before 1936 Congress did not approve nor fund local protection projects except in odd instances where it did so under the guise of improving navigation. In 1936, Wellsville was first in line for a local protection project, and the Wellsville flood wall became a pilot project for the Ohio River basin.

During a visit to Pittsburgh in January 1937, William McAlpine from the Chief's office recommended that planning for the Wellsville project be conducted with the goal of establishing standards for similar projects throughout the Ohio River Division. With that goal in mind, Bob Philippe and the District soils laboratory were assigned model studies to analyze standard flood wall designs, and William McAlpine returned to the Pittsburgh District for a series of conferences during 1937 and 1938 at which general design criteria for flood wall and levee construction in the Ohio River basin were worked out. Colonel Paschal Strong, Bob West, and Ralph Bloor generally represented Ohio River Division at the conferences. Harry Pockras came from Huntington District, and Sam Bailey and John Kurrasch from Louisville. Charles Wellons, Emil Schuleen, Bob Philippe, D. P. Grosshans, H. A. Vierheller, and Captain Ralph A. Lincoln usually represented the Pittsburgh Dis-



Close-up of gate closure and bulkhead timbers - Wellsville, Ohio

trict. Captain Lincoln, a distant relative of President Lincoln, was there because he had charge of the Wellsville project during planning and early construction phases. He returned to Pittsburgh as District Engineer in 1952.

At the 1937-38 conferences, the engineers debated flood wall and levee design at length. They agreed that earth levees should have a top width of eight feet, side slopes of at least 1 on 2, and should be constructed of compacted fill with a center-line exploration trench, drainage system, and sodded or protected slopes. Concrete flood walls were to be of the reinforced cantilever design, or the steel-piling cantilever type devised by Sam Bailey of Louisville District. All walls and levees were to be built to a height at least three-feet above the maximum flood stage of record, with freeboard allowed for wave action and settlement. Road openings through the walls were to be closed during floods by poiree needle bulkheads designed by the Pittsburgh District or with timber stop logs.

Under local direction of Captain Lincoln, Lieutenant John Schermerhorn, and C. A. Nutter, construction began at Wellsville in 1938. The 1,977 feet of concrete wall, 5,700 feet of earth levee, 3 gate closures, 4 pumping plants, and drainage structures were turned over to Wellsville in August 1942 for operation and maintenance.

When he returned as District Engineer in 1952, Colonel Ralph Lincoln went to Wellsville to see how the project he began in 1938 was performing. In the years between his tours at Pittsburgh, Lincoln, as part of his military engineering duties, had drafted the blackout regulations used during the Second World War to prevent visual location of cities from the air and had devised functional packaging of complete military buildings and bridges for use of the combat Engineers. Colonel Lincoln was pleased with the Wellsville project. By 1952, it had held seven major floods out of Wellsville and prevented flood damages estimated to be double the amount of project costs.

Because the benefits of a local protection project accrue chiefly to a specific area, citizens of that area must tax themselves to fund their share of project costs before the Engineers begin work. Raising local taxes often has serious political consequences, and local governments frequently neglect flood protection work until a major flood generates public support. At Olean and Portville in Cattaraugus County, New York, as an instance, local governments with state assistance built low dikes along the Allegheny and the creeks which join the river at those towns after suffering serious flooding in 1913 and 1916. The Engineers warned that those low dikes were inadequate in 1936, but nothing was done until the July 1942 flood overtopped and breached the dikes, causing \$3.7 million damages at Olean and better than half a million dollars damages at Portville.

In the aftermath of the 1942 flood, the communities requested federal assistance, and the Pittsburgh District recommended stronger levees providing protection to a river stage three feet above the maximum flood of record. Congress approved local protection for Olean and Portville in 1946, with the New York Department of Public Works acting as local cooperating agency; and the Pittsburgh District built the two levee projects between 1948 and 1952.

The work at Olean involved improving six miles of old dikes along the Allegheny River and Olean Creek, building one and a half miles of new earth levee and a half mile of concrete flood wall, plus relocations, dredging, and pumping plants to handle internal drainage. At Portville, the District improved old dikes and built new levees and flood walls along Oswayo and Dodge creeks and the Allegheny, also installing pumping plants and rebuilding bridges. That investment paid off in June 1972, when a flood greater than that of July 1942 occurred.

Local governments generally launch local protection projects through appeals to their congressmen, but individuals have sometimes begun campaigns

for specific projects. It apparently happened at Punxsutawney, Pennsylvania, a town on Mahoning Creek 52 miles above its mouth. Punxsutawney is always remembered on Groundhog Day. In a January 1937 letter to the President, Ed A. Murray, department store owner of Punxsutawney, wrote: "As I sit in my window and look out over Big Mahoning which rose three feet in the night, a stream that has been filled and refilled with rubbish, I-beam bridges and iron works slag, and one place just below our house, there are twelve acres of slag and a part of a bridge-fill in the stream way, which more than doubles the hazard."

Mr. Murray bombarded the President, Congress, and the Corps of Engineers with letters, even sending sketches of conditions along Mahoning Creek. On his own, he collected signatures of 328 property owners in the vicinity on a petition asking federal help with flooding problems.

The community petition and Mr. Murray's personal efforts culminated in 1938 with assignment of the Pittsburgh District to a study of the Punxsutawney project. The District learned the borough suffered annual floods and \$1 million damages during the March 1936 flood alone, and in 1941 it reported favorably on providing flood protection through construction of 2.5 miles of flood wall and

earth levee and 3.5 miles of channel improvements. After a wartime delay, construction of the project began in 1946 and was completed in 1950.

The Pittsburgh District built more than three dozen local flood protection projects in all five states served by the District, ranging from a project at Portage, Pennsylvania, at the head of Conemaugh River on the eastern District boundary, to Salamanca, New York, at the northernmost bend of the Allegheny, to Amsterdam, Ohio, on the western border of the District, and Elkins, West Virginia, on the Tygart River in the southern sector of the District. The District built one local protection project in Maryland at Friendsville in the Youghiogheny River basin.

The largest local protection project of recent date was on Chartiers Creek, that joins the Ohio River at McKees Rocks. The creek was navigated by traders during the 18th century. George Washington owned much land in Chartiers Creek valley and encouraged the early settlements in the region, and pioneer riverman George Morgan had settled in the valley at Morganza.

The Chartiers valley suffered heavy flood damages in 1874, 1912, 1936, and 1943. As industry located along the floodplain, the consequences of

Channel improvement - Punxsutawney, Pa.





Chartiers Creek local protection project - June 1972

flooding became serious, culminating in August 1956 when a flood caused near \$5.7 million in damages. The Chartiers Valley District Flood Control Authority was organized to assume local responsibility for a flood protection project on the creek in the Carnegie-Heidelberg-Bridgeville vicinity, and Washington County acted as cooperating agency for work on the Canonsburg-Houston section of the stream. Congressman James G. Fulton of Dormont and Senator Edward Martin obtained study funding from Congress in 1957, the Pittsburgh District made a favorable report in 1963, and Congress approved the projects in 1965.

At the Collier Street bridge in Heidelberg on July 26, 1968, District Engineer Wayne Nichols and Congressman Fulton broke ground for the Carnegie-Bridgeville work, later named the James G. Fulton project in honor of its chief sponsor in Congress. Flood protection was provided through dredging more than eleven miles of Chartiers Creek, building concrete walls and drop structures, placing bank slope revetment, plus the usual relocation of bridges, rail tracks, and sewer and utility lines. Similar work on 4.5 miles of the creek in the Canonsburg-Houston vicinity began in 1968.

The District bicentennial project was located on Girtys Run, an Allegheny River tributary that flows through Millvale on the Pittsburgh North Side. The stream was named for Thomas Girty, brother to Simon, James and George Girty, who, unlike his infamous brothers, remained at Pittsburgh during the Revolution and served with the American army

as a scout. Thomas settled on Girtys Run, raised a family, and died there in 1820.

Flash flooding was common on Girtys Run. On September 15, 1911, for instance, five inches of rain fell on the area in three hours and Girtys Run and neighboring streams sent a flood flow into the Allegheny so quickly that John Arras was caught with his wickets up at Herr Island Dam. Arras tried to batter the wickets down from below with two wooden barges, but the sole result, he lamented, was two barges ruined. The major flood of record on Girtys Run occurred in July 1950. It damaged Millvale to the tune of \$1 million.

After a study of alternatives such as a diversion tunnel or a reservoir, the Pittsburgh District settled on channel improvement as the best method of protecting Millvale against floods that occurred at an average interval of about twenty years, though full protection against all floods was not economical. District Engineer Max R. Janairo, Congressman H. John Heinz, County Commissioner Thomas Foerster, and Millvale mayor Regis McCarthy broke ground for the Girtys Run project on July 16, 1976, at Millvale.

From Johnstown and Wellsville to Girtys Run, politics at all levels, whether federal, state, or local, have had impact upon the construction of local protection projects, and that is not necessarily evil, for politics, ideally, express the will of the people. General Joseph C. Mehoff, Ohio River Division Engineer in 1948, said it this way:

The Corps of Engineers is the servant of the people as their desires are expressed through the Congress. We recommend to the Congress what the people want when the desired improvement can be economically justified, not what we think they should have. We may recommend a certain improvement or a given type of construction, but the residents of the city or other political subdivision concerned have absolute veto power. They have exercised this more than once.

Kirwan's Big Ditch September 30, 1941. The House Committee on Rivers and Harbors was hearing the arguments about the proposed Lake Erie and Ohio River Canal, and Congressman Louis E. Graham from Beaver, Pennsylvania, had the floor.

"That is all it is," Graham said, "a pork barrel."

"You think this is 'pork?' " asked William Pittenger of Minnesota.

"It reeks with it," replied Graham, "and you, from Duluth, ought to go back and read Proctor Knott's speech on the Glories of Duluth."

"I have memorized it."

"Then you ought to apply it."

Michael Kirwan of Youngstown interjected, "Mr. Graham, you said when you started to talk that we are all selfish and were seeking to get a better advantage than the other; is that correct?"

"Not quite that way."

"Well, that is the way you put it, I think."

"No, I do not think so. You may refer to it. But if you want to take it that way, take it that way."

"You would not say that the district of Youngstown is doing that, would you?" Congressman Kirwan asked. "You talk about taxes. We

paid more in the Youngstown district in the '20s than four States did, and in that paying we helped your town of Beaver by letting them canalize the Ohio. And they did that for the Monongahela, and some of that big tax money came out of Youngstown."

"Out of Youngstown? Out of 48 States of the United States and 132,000,000 people, of which you are only a part!"

"But of those taxes Aliquippa paid very little," said Kirwan.

"How utterly absurd it is for you," countered Graham, "to argue to me that the one little place, Youngstown, paid all this debt."

"No, she did not and I did not say that."

"Well, it did not pay it."

"But Aliquippa was not even built, so it was paying no taxes. We paid plenty of them and let you build the plant. We canalized or helped to canalize the Ohio River without one bit of opposition from our district."

"You will be the sole beneficiary of this, and we will reverse it and pay it to you," said Graham.

"Oh, no!"

"Exactly what it is. That is it."

"At no time in the history of the United States," Kirwan summarized, "after all the taxes that we have paid in, did the Federal Government ever spend a dime on the river in the Youngstown, Ohio, district, but we certainly helped to canalize the river for you people down on the great Ohio that you say God gave you. That was true. You just left it there. We gave you a good hand to canalize it."

Few, if any, of the public works ever proposed caused greater acrimony and political infighting, no holds barred, than the Lake Erie and Ohio River

Canal. The history of the project had many twists and turns, and perhaps the greatest paradox of all was that Pittsburgh spent thousands during a half-century fight to get the canal built, then worked for almost another half-century to prevent it.

The idea of building canals along the routes of old portages to link Lake Erie with tributaries of the Ohio spread just after the nation was founded. The portages from the lake to the head of French Creek, Beaver River, and the Scioto, Muskingum, Miami, and Wabash rivers all seemed likely sites for canals. George Washington, after study of Thomas Hutchins' maps in 1788, decided that the best of all the routes was that from the lake to the Beaver River. After intensive studies and detailed surveys lasting from about 1881 to 1934, the Army Engineers concluded that Washington had been right.



Congressman Michael J. Kirwan

The first canal survey performed by the Army Engineers, by General Simon Bernard and Colonel Joseph Totten in 1824, was of a canal route between the Ohio and Lake Erie via the Beaver River and its tributaries. That survey was used by the Pennsylvania canal engineers who in 1844 completed the Beaver and Erie Canal, with terminals at Rochester on the Ohio and Erie on the lake. Branch canals were built to connect with French Creek at Meadville and the Ohio Canal at Akron, and the project operated successfully from 1844 to 1871.

After he reopened the Corps of Engineers office at Pittsburgh in 1866, William Milnor Roberts, who had served as construction engineer and first chief of operations from 1839 to 1845 on the Beaver and Erie Canal, was asked by the canal owners to plan modernization of the project to serve larger watercraft. In 1868, he recommended construction of Pymatuning dam on the Shenango River to furnish more water supply, rebuilding the canal to a minimum 70-foot width and 7-foot depth, and replacing the old locks, which were 15 by 90 feet in the chamber, with locks 20 feet wide and 110 feet long to handle 300-ton boats.

General James K. Moorhead, Benjamin F. Jones, W. Harry Brown, and other Pittsburgh industrialists formed a committee to support enlargement of the old canal, and Pittsburgh newspapers eloquently boosted the project. On February 3, 1870, the *Pittsburgh Gazette* declared: "An enlarged channel between this place and Erie, to float craft which can navigate the lakes and pass down to New Orleans is so palpably one of the grand conceptions of the age, to create wealth, increase comfort, multiply our resources, that it baffles the utmost ingenuity to find a substantial objection against it. Objections to it looks like hostility to our most vital municipal interests."

The canal company needed government loans to fund the enlargement project, however, and efforts of Pittsburgh businessmen to obtain the funds from the Pennsylvania legislature were frustrated by railroad interests, notably "canal wrecker" William L. Scott, president of the Erie and Pittsburgh

Proposed Lake Erie
and Ohio River Canal -
1965 Edition

Railroad with which the canal competed. Scott bought control of the canal company in 1870 and stopped its operations in 1871 after a canal aqueduct collapsed, and converted most of the canal towpath into a railroad track.

Pittsburgh baron Andrew Carnegie revived the idea of building an enlarged canal in 1889. "Of all the works that could most advance the interests of the western portion of the State," he said, "I know of nothing involving so little expenditure which would be so beneficial as a ship canal between the lakes and the Ohio River at Beaver." He predicted that such a waterway would carry an immense tonnage of iron ore south from Lake Erie to Pittsburgh and Monongahela coal north to the Great Lakes.

In 1889, Andrew Carnegie generally got what he wanted, and Pennsylvania appropriated \$10,000 for a survey to be performed by Thomas P. Roberts and John M. Goodwin. As part of the study, Roberts collected statements from various Pittsburgh leaders about the canal and the potential tonnage it might carry.

"I'll tell you right now that if the terminus of the former canal had been at Pittsburgh instead of Rochester, it would have been in operation today," river captain John A. Wood told Roberts. "But in those days we did not have dams on the Ohio, and time and again I have seen canal boats lie for weeks at Rochester waiting for a rise. That was what killed the old canal; but now we have a remedy for this."

Henry C. Frick, Carnegie's lieutenant, was plainspoken as usual. "I have not the least doubt but that it would be a great thing for Pittsburgh manufacturers," he declared, "and whatever is for the interests of manufacturers is for the good of the people of Pittsburgh. The railroads ought not to complain, as they have been claiming a shortage of cars, and have been unable to give prompt attention to their patrons for some time."

Whether Carnegie actually wanted the waterway built, or whether he used it as leverage to obtain



better rail service and lower rates, is not clear, but after he built the Bessemer and Lake Erie Railroad in 1896, he lost interest in the canal project. Thomas Roberts, however, was convinced by the surveys he made in the 1890's that such a waterway was feasible and would be profitable. So much so that in 1905 he organized the Lake Erie and Ohio River Ship Canal Company. Engineers George Lehman and Emil Swensson joined Roberts in the company, and they won a national charter from Congress and financial support for surveys to the tune of \$60,000 from Pittsburgh businessmen. The national depression that began in 1907, however, killed their hopes of obtaining sufficient private capital for construction.

The Pittsburgh Engineer District made its first study of the canal project in 1911 at the request of the National Waterways Commission. District Engineer Henry C. Newcomer came up with plans for a 12-foot canal with 56 by 360-foot locks, following Beaver River, Mahoning River, and Mosquito Creek to a summit at Jefferson, Ohio, and down Indian Creek to Lake Erie. Project costs were estimated at \$60 million and traffic volume, mostly coal and iron ore, at 50 million tons annually.

The National Waterways Commission recommended the project in 1912, though by a complicated funding scheme. Federal participation

Mahoning River at Youngstown, Ohio
The way it was The way it might have been



would be limited to dredging a harbor at the mouth of Indian Creek, increasing the depth of Ohio River slackwater above the mouth of the Beaver to 12 feet, and project planning and supervision by the Army Engineers. Funds for canal construction would come from Pittsburgh, Youngstown, and other communities along the canal line through local bond issues. As gestures of cooperation, Pennsylvania in 1914 established the Lake Erie and Ohio River Canal Board, first headed by Mayor William A. Magee of Pittsburgh and subsequently by William H. Stevenson and Alexander Dann, with George M. Lehman as chief engineer; and in 1919 Ohio approved formation of local canal districts, with power to issue tax-supported bonds and cooperate with the Federal Government in construction of canal projects. The hope of cooperative federal-state-local construction of the canal gradually faded, however, as major changes in the steel industry put the Youngstown and Pittsburgh steel districts at loggerheads.

Until 1924, a steel pricing system known as "Pittsburgh Plus" gave steel producers in the Pittsburgh area certain advantages. Under "Pittsburgh Plus," purchasers in New York had to pay the cost of a steel product plus the amount of rail

charges from Pittsburgh, whether the product was made in New York or Pittsburgh. The Federal Trade Commission in July 1924 ordered the "Pittsburgh Plus" pricing system abandoned. Steel companies, without recognizing the jurisdiction of the Commission, agreed to conform and to quote thereafter FOB (freight-on-board) prices. Steel plants not located on navigable waterways were placed in a disadvantageous position because rail rates had nearly doubled during the First World War; and favorably located steel industries began increasingly to rely upon waterways for transport of materials.

"Survival of our industry is at stake," said J. C. Argetsinger of Youngstown when he appealed in 1933 for construction of the Lake Erie and Ohio River Canal. He pointed out that in 1930 Chicago had supplanted Youngstown behind Pittsburgh as the No. 2 steel production center in the nation, that no new steel plants had located in the Youngstown area since 1918, and that some plants there had closed to relocate on navigable waters. "The cheaper transportation furnished by the rivers saved the life of the Pittsburgh district as the country's greatest steel-producing center, caused the expansion of that district, and benefited the railroads even more than the river carriers," he concluded.

George Mahaney of Sharpsville, chairman of the Ohio River-Lake Erie Canal Association of the Shenango, contended the same thing was happening at New Castle, Farrell, Sharon, and Sharpsville on the Shenango River. Sharpsville, where in 1855 iron from Lake Superior ore had first been successfully smelted, Mahaney said, was becoming a "ghost town" as the steel plants shut their doors.

The Pittsburgh Engineer District made several studies of the Lake Erie and Ohio River Canal during the 1930's, finally settling on a route up the

Beaver and Mahoning rivers and Mosquito Creek to a reservoir on Grand River, then through locks down the north slope to a harbor at the mouth of Wheeler Creek. The engineers proposed beginning with construction of the "stub canal," canalizing the Beaver and Mahoning as far upstream as Struthers and building the remainder of the project at a later date.

In its review of the District report in 1939, the Board of Engineers for Rivers and Harbors pointed out that, though the waterway could save as much as 70¢ per ton of freight over comparable rail rates, if railroads would reduce their rates 29¢ a ton the canal would lose its favorable benefit/cost ratio. "It would be advantageous to both the railroads and the United States," the Board reported, "for such reductions to be made before large obligations are incurred for construction work on the through canal." President Franklin Roosevelt therefore ordered the Interstate Commerce Commission to investigate rail rates and determine if reductions were possible before construction of the canal began.

In October 1939, the Interstate Commerce Commission advised the President that railroads could not afford to make the reductions needed, nor could they afford the loss of the \$35 million per year income received from the 56 million tons of traffic that would move annually on the canal. The I.C.C. concluded that the railroads should be protected from waterways competition.

Railroads organized the Upper Ohio Valley Association to fight the canal project, and by 1935 Pittsburgh had joined the railroads in opposition. The Pittsburgh Chamber of Commerce labelled the proposed canal a "vicious" subsidy to Youngstown industry at public expense. "The theory that the Government should spend money for a waterway to equalize transportation costs among competitors is novel," commented the editors of *Greater Pittsburgh*, the Chamber of Commerce journal. "It has no economic justification and if applied as a reason for constructing this waterway, would have far-reaching effects which could create a dangerous and

inexcusable precedent." Captain Fred Way, the sage of Sewickley, said that shudders ran up and down the spines of Pittsburgh steel executives at the very thought of the Youngstown mill owners extending their steely fingers down the canal into the Ohio and Mississippi river markets.

Thus matters stood when Congressmen Mike Kirwan of Youngstown and Louis Graham of Beaver fought it out in 1941 before the House Committee on Rivers and Harbors, and thus matters continued for the following quarter-century. Opponents of the canal derisively called it "Kirwan's folly," or "Kirwan's Big Ditch," and Kirwan responded in kind with tongue-lashings for the opposition at frequent intervals. "Pittsburgh is famous for the Golden Triangle," said Kirwan, "but we have spent a million dollars on Pittsburgh, connecting it to its markets and its sources of supply with good navigation channels and protecting it from being flooded and everything like that. However, when we go to do something outside of Pittsburgh, the Chamber of Commerce up there comes in and claims we are wasting the taxpayers' money."

When the Pittsburgh District reports favorably or unfavorably upon some project, some of the opponents or proponents of that project may even call for removal of the District Engineer, perhaps in the belief that he personally prepared the report and that a new officer in charge of the District might reverse the findings of the report. In 1947, about two weeks before a favorable review report on the Lake Erie and Ohio River Canal was to be completed by the District, Colonel Walter Lorence received abrupt orders sending him to China. Advocates of the canal claimed the transfer came as a result of political pressures from the railroad lobby. The Chief of Engineers said, however, that Lorence had been on the top of the list for overseas duty for better than a year and a top-flight river engineer was needed in China. At any rate, Lorence, who had become allergic to the medicines used to combat malaria during his quarter-century as an Engineer officer, resigned from active service, rather than accept overseas duty.



Canal lake boat at Monongahela River wharf at Pittsburgh - if the canal had been built

Colonel Francis "Frank" Falkner succeeded Lorence as District Engineer and the favorable report on the canal, showing a 1.2 to 1 benefit/cost ratio, was submitted on schedule.

While the 1947 report was under review at Washington, the River-Lake Belt Conveyor Company of Akron, Ohio, announced plans to build a two-way conveyor belt from Lorain on Lake Erie to East Liverpool on the Ohio, shipping the iron ore and coal that would move on the proposed canal. That much publicized conveyor belt system was never built, but it temporarily stopped the canal project while the Engineers completed a study of the comparative costs of shipping by canal and conveyor belts.

During the Eisenhower administration, Mike Kirwan carried on his fight for the canal before committee after committee without much luck, but in 1961 he won funds for a new study that would consider the impact of completion of the St. Lawrence Seaway on the canal economic justification. According to John W. Barriger, president of the Pittsburgh and Lake Erie Railroad, President John Kennedy had ordered the new survey solely to placate that "gracious, eminent, and politically useful Congressman from the Ohio 19th district." Barriger predicted building the canal would sound the death knell for railroads in the eastern United States and said he could conceive of "no more wasteful use of the taxpayers' money."

The Pittsburgh District completed its canal study in 1965 and found the project still had a favorable benefit/cost ratio despite an inflationary trend that had raised estimated costs to nearly a billion dollars. Project opponents promptly labeled it the "world's biggest boondoggle." Justice William O. Douglas, in his broad attack on the Army Engineers and Congressman Kirwan printed in *Playboy* magazine, called the canal the "most brazen project of all." The refusal of the Commonwealth of Pennsylvania in

1967 to support construction of the project killed hopes for the canal.

At Sewickley, Captain Fred Way commented, with tongue-in-cheek, that he thought he heard a sigh of relief coming downriver from Pittsburgh when Congressman Kirwan died in 1970, meaning that Pittsburghers hoped the canal project had also died. Like a phoenix, Kirwan's successor Charles Carney continued support for the project, however, and in 1972 the House Committee on Public Works approved another review study of the "stub canal." But no funding for the study was furnished, and it appeared that after two centuries of study the dream of linking of the Great Lakes and the Ohio River by canal was, at long last, dead.

On a hot July day in 1976, the subject of the Lake Erie and Ohio River Canal came up at Al Layton's table in Stouffers Restaurant in the Golden Triangle, where Pittsburgh District oldtimers frequently gathered to reminisce over lunch. Richard "Dick" Thalimer, an engineer retired from the District who had worked on the several canal surveys completed after 1946, said he had become discouraged about the canal, that he doubted it would ever be built. A visitor from the Nashville Engineer District mentioned the Tennessee-Tombigbee Waterway, a project similar in scope and function to the Lake Erie and Ohio River canal, that was under construction, with completion scheduled in 1985; if it proved as successful as predicted, reconsideration of the canal in Pittsburgh District might be in order.

"Let's not forget," said Frank Stocker, who was involved with the District's energy conservation efforts, "that watercraft operate quietly and economically and use less energy for freight movement than highway or rail equipment." He implied that if efficient use of energy were to become an imperative national goal, then the Lake Erie and Ohio River Canal would have attractive advantages in addition to savings in transportation costs.

Chapter 17

LAKE PERFIDY AND AGNES

After gobbling their breakfasts quickly, the employees of the Pittsburgh District, carrying their coffee cups, rushed to television sets to watch the NBC TODAY show. District Engineer Bert deMelker had visited Washington a few days earlier to discuss the Kinzua controversy with the TODAY show staff, and, on February 21, 1963, emcee Hugh Downs was to explain what he had learned on the network.

The people of Pittsburgh District eagerly waited until Frank Blair finished the newscast and the camera switched to Hugh Downs. Downs sat at his desk with a map of Kinzua Dam and Allegheny Reservoir tacked on the wall behind him. He began:

That brings us to the place that I've waited for for quite a while. We have, as you know if you follow the show, had much on this program about the controversy between the Seneca Indians and the Government, mostly the Army Corps of Engineers, in connection with a dam that is to be built, which is being built, on the upper Allegheny River near Kinzua, Pennsylvania. It's for flood control. It will cause water to back up to Salamanca, New York.

I want to explain the nature of the controversy first, the background, and then tell you what we found when we looked into it. We did look into it for quite a while, seemingly one-sided because we were able. We told the Indian story. We talked to representatives of the Indians and had Dr. Morgan on the program who had been retained by the Indians to investigate alternatives to this proposal.

In a trip to Washington, the Engineers explained that they did not want to bring a representative on the program but did want to give a thorough access to the facts and we could judge from the facts that they provided. So, that's what was done.



Hugh Downs explains

But first, as background, just to explain so we'll know what we're talking about when we mention the Kinzua Dam controversy, we find from these maps, I think you can see, this is a line between Pennsylvania and New York states. Kinzua is here. The dam will be constructed about here, and when the gate is closed a reservoir will be formed backing up along this river to Salamanca, New York. Now, the dark place outlined here is the Indian Reservation. This is the home of the last surviving Seneca Indians and this land was given to them in a treaty, the first treaty the United States made as a nation. I can give you a glimpse of the treaty. You can't read it from this, but it was signed by General Washington.

The reason the Society of Friends are involved in this present dispute is because the Senecas would not sign in 1794 unless the Quakers, who are the Friends, guaranteed the United States Government's word. So, today the Friends still feel committed to do what can be done for the Indians in this controversy. Now, the Quakers, the Indians, Dr. Morgan, everyone, has made clear that they are not going to stand in the way of something that would represent a clear and present danger to an awful lot of people in an area that could be flooded and has been flooded disastrously in 1936; that, if it were absolutely necessary the Indians would yield the land gracefully. The big bone of contention was whether or not this



particular project was necessary to provide the people with adequate flood control.

Mr. Downs explained that the Seneca Nation, which would lose major parts of its reservation if the Kinzua project were constructed, had employed Dr. Arthur E. Morgan to devise suitable alternatives to the Kinzua project. The Corps of Engineers and an independent consulting engineer firm had reviewed five of the alternative plans suggested by Dr. Morgan and had reported them feasible but costly. Dr. Morgan then submitted a sixth alternative, involving diversion of flood water from the upper Allegheny basin through the Conewango and Cattaraugus Creek valleys to Lake Erie, and the Engineers again reported the alternative was feasible but would cost millions more.

During his meeting with the Pittsburgh District Engineer in Washington, Hugh Downs said several of his questions had been answered. He asked if the Corps had ever reported unfavorably upon the Kinzua site for a flood control project. The answer was yes, but that had been before the 1936 flood and the 1936 Flood Control Act had changed federal policies. He asked if the Corps had told Congress that construction of the Kinzua project would require breaking the Treaty of 1794 with the Seneca tribe, and the answer was yes, for Congress had been informed in the very earliest project reports, printed as congressional documents. He asked if President John F. Kennedy had been fully informed about the situation, and the answer was yes and the President believed the Kinzua project was necessary.

Now, where can the blame be placed if a wrong is being done to the Indians? I now believe it's not proper to load the blame on

"the Seneca Nation...would lose major parts of its reservation"

the Corps of Engineers. The Seneca Nation has said from the beginning that it would peacefully give up its lands and dissolve the treaty if it is really necessary for the safety of a great number of people.

What is truly necessary? The Corps of Engineers says that Dr. Morgan's plans are feasible but that the best of them would cost \$91 million more. Dr. Morgan says it would cost millions of dollars less and I cannot settle an engineering dispute. The TODAY show is not an arbiter of engineering disputes.

But, let's assume the Corps of Engineers is right and Dr. Morgan is wrong. The feasible alternative would cost each American 51¢ more. In other words, the Treaty of 1794 could be saved and the homes of a small handful of Seneca Indians for about half a dollar apiece. But, since it seems unlikely that a majority of congressional leaders would ask this of their constituents, and also it is tragically unlikely that a majority of voters would vote them back into office if they did, we have to conclude that the national honor rests, as it always has, with the people and that it isn't regarded so highly now as it has been in the past, and should be.

Well, that is the end of that. We'll follow with interest what happens to the Indians. But, the Kinzua Dam will be built. Ten minutes before the hour, and a commercial announcement....

The people of the Pittsburgh Engineer District were pleased to hear Hugh Downs present their side of the controversy, for they had received a generous share of lumps because of those troubles. The Senecas and their friends had tagged Allegheny Reservoir, the lake to be formed by Kinzua Dam, "Lake Perfidy" because its construction required abrogation of an honorable treaty made in 1794. On

their radios, the Engineers heard singers moaning about the Kinzua project in a ditty entitled "Cornplanter Can You Swim," because the grave of the famed chieftain was located in the area that would be covered by the lake. Perhaps most irritating to the Engineers was the unmitigated corn of the Hollywood Indian stereotyped language used to dramatize the plight of the Senecas. It was said that General Washington, who never spoke with "forked tongue," had guaranteed in 1794 that the Senecas would possess their lands "as long as the sun shines and the rivers run," and that Kinzua Dam was needed only to "flush white men's toilets in Pittsburgh." Those words grated, because the Engineers knew the Senecas were an advanced and literate people.

After months and years of listening to friends of the Senecas and to Dr. Morgan attacking the plans and motives of the Engineers on the TODAY show and in other media, the people of the Pittsburgh District were gratified that at last their side of the controversy had been presented. They were also pleased by a letter from Hugh Downs, in which he said he was convinced the Corps of Engineers was innocent in the treaty-breaking matter and that he was "impressed with the individual consciences of many of the men in the Corps concerning the Indians."

Planning for Kinzua The Pittsburgh District first studied a multipurpose dam and reservoir on the upper Allegheny River in 1928. Congress approved the Kinzua Dam, nine miles upstream of Warren, in 1936, with project modifications in 1938 and 1941.

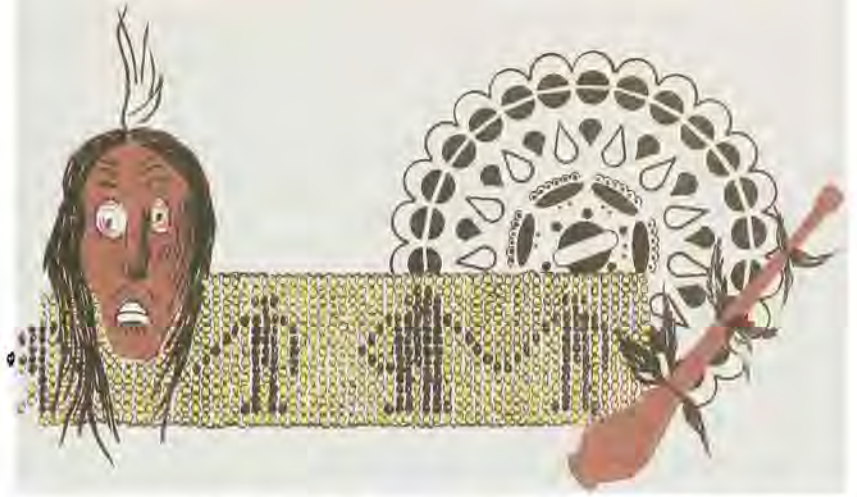
Early opposition came chiefly from rivermen, such as Captain Fred Way of Sewickley and Harold C. Putnam of Warren, who did not want navigation to Olean blocked by a flood control dam. "What is proposed for the river above Warren is," said Harold Putnam, "to my way of thinking, a very poor substitute for the navigation dams we are entitled to." Putnam and his friends argued that flood control dams should be built only on tributaries of the Allegheny, or navigation locks should be placed in Kinzua Dam, but the Engineers could not conceive

Cornplanter monument - on the
Cornplanter Grant, Pennsylvania



that commercial navigation to Olean would ever resume.

In their early reports, the Engineers warned Congress that construction of the Kinzua project would be contingent upon arrangements with the Seneca Nation, which had rights in the project area guaranteed by treaty. In testimony before the House Committee on Flood Control in March 1940, District Engineer W. E. R. Covell explained the Cornplanter reservation in Pennsylvania was held by Senecas under a state grant and could be acquired through exercise of eminent domain, but the Allegheny reservation was a Federal grant. "In the Allegheny Reservation it is what might be termed a Federal Indian Reservation, and it is quite complicated," Colonel Covell told the Committee. "The legal section of the Office of the Chief of Engineers is now studying as to whether it would be necessary to get an act of Congress to clarify the matter. My own personal opinion is that it probably would because they have a treaty. The Indians have the right of possession forever, and they cannot alienate that without the approval of the Federal Government."



Pennsylvania in 1791 granted Chief Cornplanter about 860 acres on the Allegheny River in Warren County, which passed on to descendants at the death of the chief in 1836. The Cornplanter reservation was still held by descendants of the chief at the time Kinzua Dam was planned. In the Pickering Treaty of November 11, 1794, the Federal Government had granted the Senecas reservations in western New York, one of which, the Allegany reservation, included 30,189 acres bordering the river in Cattaraugus County. In the 1794 treaty, the government declared it would never claim the Seneca lands, "but it shall remain theirs, until they choose to sell the same to the people of the United States, who have the right to purchase."

With help from the Society of Friends, the Senecas became farmers, laborers, and businessmen and established their own republican government in 1848, complete with elected president, legislative council, and judiciary. They leased lands of their reservations for railroads, highways, utility lines, and towns occupied mostly by whites. Except for stands marketing Indian crafts, the Seneca reservations by 1950 did not differ much from rural white areas, but the Senecas had preserved their heritage and the unique Handsome Lake religion and still collected small sums and "treaty cloth" from the Federal Government.

Indian legal status in the United States had also changed since 1794. Congress ceased making treaties with Indian tribes as separate sovereignties in 1871, and in 1924 declared all Indians born in the United States to be full citizens. Many Senecas had accepted full citizenship long before 1924 and had served their country well. Seneca sachem Ely Parker had served as Army Engineer officer, aide to General U. S. Grant, and Union Army general during the Civil War. Parker had written out the terms of surrender accepted by General Robert E. Lee at Appomattox in 1865. The Bureau of Indian Affairs classed the Senecas in 1950 as among the most advanced tribes in America, recommended an

end to Federal supervision of tribal affairs, and closed its Salamanca office.

"Whites build up a fortune to find contentment or peace of mind. The Indian doesn't bother building a fortune; his contentment is right here and now," said George Heron, president of the Seneca Nation of Indians, explaining the Seneca life style in 1962. "Those who like a fast buck--no pun intended--are likely to become steelworkers. A lot of them work on the railroads; some stay here and farm, or just hunt and fish or pick up odd jobs. About twenty of them do a lot of drinking, and the people in Salamanca think that's what all of us do."

When the Pittsburgh Engineer District began negotiations with the Senecas in 1940, it quickly learned there was no hope of amicable settlement. In fact, negotiations went so badly that District Engineer Herbert D. Vogel was quite surprised in 1941 when he received a Christmas card from a member of the tribe. On the card, the Seneca explained that his mother had directed him to send it, and he wished Vogel all the blessings of the season to which "he might be rightfully entitled."

After Pearl Harbor, Colonel Vogel dropped preliminary work on the Kinzua project because the men were needed for the military construction mission. In postwar years, the District was busy with the East Branch of the Clarion and Conemaugh dams and did not concentrate attention to the Kinzua project until Hurricane HAZEL turned inland.

In October 1954, Hurricane HAZEL sent rains inland over the Pittsburgh District, causing a flood that, without the reductions made by the ten reservoirs then in operation, would have been the second greatest of record. The reservoirs lopped 8.7 feet off the 1954 flood crest at Pittsburgh and 9 feet off the crest at Wheeling, but heavy damages still occurred. The reservoirs in service in 1954 controlled about 23% of the watersheds above Pittsburgh, and water from the uncontrolled watershed areas



crested at 32.4 feet on the Point gage, 7.4 feet above the 25-foot flood stage.

Leaders of Pittsburgh and other flooded communities began an intensive campaign in 1955 for construction of Kinzua. Further support developed in the aftermath of the March 8, 1956, flood, greatest of record at the proposed site of Kinzua Dam, which inflicted about \$2 million damages on the Warren, Pennsylvania, area. President Dwight D. Eisenhower approved funding for Kinzua Dam in 1956, and Lawrence "Al" Layton and the Pittsburgh District Legal Branch started condemnation proceedings to obtain the parts of the Seneca reservations needed for the reservoir.

Most of the Cornplanter reservation was needed, and of the 30,189 acres in the Allegany reservation, 3,520 acres were to be purchased outright for inundation and easement acquired on another 5,557 acres that would be inundated to various extents when floods filled the reservoir. The Senecas could still use the acreage subject to only periodic flooding for hunting, fishing, and limited farming, but could not live upon it. Of the 177 homes on lands needed, 13 were empty and 26 were occupied by non-Indians. Relocation of from 200 to 300 Senecas would be necessary.

The U. S. District Court for Western New York decided on January 11, 1957, that Congress had been fully informed about Seneca treaty rights when it approved the Kinzua project and that it intended to take lands for the project regardless of the provisions of the 1794 treaty. That decision was not without precedent. The Seneca Nation appealed through a series of courts seeking injunction against the Kinzua project all the way to the Supreme Court, which, on June 15, 1959, denied the injunction.



While the court hearings were in progress, a wave of intense public sympathy for the Senecas rippled through the news media, but people at Pittsburgh and communities downstream of the dam site fumed at the delays. Editors of the *Pittsburgh Press* said the Senecas deserved no more consideration than the 2,500 whites, ten times the number of Senecas to be relocated by Kinzua, who had been forced to move to make way for the Conemaugh project. The editors had no sympathy for the view that "Indians were so poorly treated by white men that we shouldn't take their lands now—even to save ourselves from flood disaster—as if tender solicitude now could wipe out the ancient injustices." Editors of the *Pittsburgh Post-Gazette* declared: "This project has waited long enough. Flood waters are not nearly so patient."

At the May 1957 hearings before the House Public Works Committee, Sherman P. Voorhees of the Pittsburgh Chamber of Commerce said the fact that more than a hundred people had lost their lives to Allegheny River floods since 1937 proved the need for the Kinzua project. John T. Mansmann of East Liberty argued that the Senecas were Americans and that no Americans should be permitted to obstruct the building of Kinzua Dam. "Those of us who went through the flood of 1936," said Robert T. Griebeling of Tarentum, "will never rest easy until all precautions have been taken."

The Seneca Nation employed Dr. Arthur E. Morgan and Barton M. Jones, eminent engineers who had designed the Miami River flood control project in southwestern Ohio and who had been principal organizers of the Tennessee Valley Authority in 1933, to study alternatives to the Kinzua project. Morgan and Jones devised a plan to achieve flood control by diverting floods from the upper Allegheny basin through a canal into the Conewango basin, where the water would be stored in a reservoir for subsequent diversion into Lake Erie or for release into the Allegheny during droughts. The plan was not entirely new. The Pittsburgh Flood Commission had studied a reservoir on Conewango Creek in 1911, the Pittsburgh Engineer District had looked into the matter in 1928, and Nelson M. Fuller

of Olean in 1945 had proposed such a reservoir as part of a navigation canal between the Allegheny and Lake Erie.

Cornelius V. Seneca, president of the Seneca Nation, told the House Committee on Appropriations on May 10, 1957, that he could not see why Kinzua Dam should be built and the Seneca lands taken if Dr. Morgan's plans might be equally as effective. In view of that statement and public interest in Dr. Morgan's proposed alternatives, the Army Engineers contracted with Tippetts-Abbett-McCarthy-Stratton (TAMS), a well established firm of consulting engineers of New York City, to make an independent review of the storage potential and economics of a project in the Conewango basin. The Seneca Nation and its consultants concurred in the selection of that firm for the review.

TAMS studied five alternative plans. Three were versions of Dr. Morgan's proposal, involving construction of a diversion dam on the Allegheny River, a diversion channel through the divide between the Allegheny and Conewango basins, a dam on Conewango Creek near Waterboro to create a storage reservoir, and a control structure and outlet channel to convey flows exceeding reservoir capacity into Lake Erie. Two other plans called for a bigger dam on Conewango Creek to eliminate diversion into Lake Erie. In April 1958, TAMS reported that all five plans were feasible as engineering projects, but any of the five would cost at least 25% more than the Kinzua project, would require taking at least 51% more land, and would require the relocation of at least 150% more people.

Dr. Morgan responded with an attack upon the integrity of TAMS and its review report. He said that at the time the firm was selected he had not known that three members of the firm had been employed by the Corps of Engineers at various earlier times, nor that the firm frequently performed engineering studies under contract with the Engineers. He claimed the TAMS review had not considered all possibilities nor developed the best plan. Morgan suggested a sixth plan, somewhat similar to one of

the plans studied by TAMS, but changing the outlet to Lake Erie from Silver Creek to the Cattaraugus Creek valley. He insisted the sixth plan could be built at less cost than the Kinzua project.

When Dr. Morgan said that lands in the Conewango basin were swampy and of such little value that "it would be a good fortune to the owners of land in this area to have it purchased as a reservoir," the Conewango Flood Control Association immediately protested, asserting the Conewango valley was valuable agricultural land; about a third highly productive bottomland with hills suitable for grazing. District Engineer W. W. Smith's studies showed that Dr. Morgan's sixth plan would affect about 32,000 acres in the Conewango basin, plus property in the Cattaraugus Creek valley, and would require relocation of 4,490 people, as compared with displacement of 1,780 people by the Kinzua project.

Dr. Morgan presented his sixth plan to Chief of Engineers Emerson C. Itschner in Washington in October 1958. After review of the plan, General Itschner concluded it had little more merit than the earlier proposals. "Dr. Morgan is a very fine and eminent engineer," the General told the House Committee on Public Works. "In making a study of the type he has attempted to make, he has not had the means of making an elaborate report such as we would make. I am sure he is very sincere in the report he has submitted."

Senator Wayne Morse of Oregon introduced Dr. Morgan's proposals into the *Congressional Record* in 1960. But Senator Joseph S. Clark of Pennsylvania, a proponent of Kinzua Dam, countered with a warning that Congress should not suffer the delusion that Dr. Morgan, a paid consulting engineer hired by the Senecas, was impartial. At a hearing before the Committee on Indian Affairs, while Dr. Morgan was present, Senator Clark went so far as to describe Dr. Morgan as an "irresponsible publicity seeker," whose plans were little more than a nuisance.

That attack upon his integrity deeply wounded Dr. Morgan, and, blaming it upon a Corps con-

spiracy to discredit him, he embarked upon a study that resulted in publication in 1971 of an interesting book entitled *Dams and Other Disasters: A Century of the Army Corps of Engineers in Civil Works*. In it, he wrote off the Army Engineers as a narrow-minded military bureaucracy, and concluded that all Corps officers since the founding of the Republic, with the possible exceptions of Generals Robert E. Lee, Lytle Brown, Harold C. Fiske, and Herbert D. Vogel, were incompetent at best and blundering idiots-at worst.

The Seneca Relocations Halsey W. Harmon, Engineering Division project engineer for the Kinzua project, took the stand at the District Court at Erie, Judge Joseph P. Willson presiding, on March 24, 1964, to explain the steps taken to relocate the Cornplanter cemetery, containing the grave and monument of the great chief. Harmon had come to court in company with District Engineer Bert deMelker and District Counsel Al Layton. Merrill W. Bowen, president of the Cornplanter branch of the Senecas, had brought about thirty of his clan and three attorneys with him to present his side of the dispute over the cemetery relocation.

As early as 1956, Jim Neill and Al Layton of the Pittsburgh District had attended a reunion of the Cornplanter Indians to explain plans for removal of the cemetery to higher ground. Halsey Harmon told the court the District had considered ten sites for the relocation, eliminating some sites because they were inaccessible or the Cornplanters had not wanted them. George Heron had offered the Cornplanters space in the Seneca Nation cemetery, but the clan had not been interested.

Because the Riverview and Corydon cemeteries were to be located to a new site across the Allegheny from the Cornplanter reservation, the Engineers recommended in 1962 that the Cornplanter cemetery be moved to the same spot, contiguous to the white cemeteries but separated by an access road, a separation the Senecas wanted. George Plesko of the District Real Estate Division visited the descendants of the people interred in the Corn-

planter cemetery and obtained the written consent necessary for relocation of the cemetery to the Riverview-Corydon site for about 95% of the graves. One of those who signed a consent form was Merrill W. Bowen, president of the Cornplanters.

Merrill Bowen admitted to Judge Willson that he had signed the consent form, but he and other clan members had not been entirely happy with the Riverview-Corydon site, preferring an entirely separate cemetery with space available for reunions and other communal functions. He had asked the Engineers to let the clan keep certain hilly parts of the reservation that would not be flooded for burial and communal purposes, and the Engineers had agreed but would not build an access road for entry to the site. In the autumn of 1963, Latham Weber, publisher of the Salamanca newspaper, had donated to the Cornplanters 65 acres of land located adjacent to the Allegheny Reservoir near State Line Run. Bowen accepted the offer and circulated a petition among the clan for relocating the cemetery to the Weber site.

When District Engineer Bert deMelker took the stand, he testified that the Engineers had bent regulations to allow the Cornplanters to keep parts of the reservation, but before the cemetery could be relocated to the site the Indians would have to organize a legal cemetery association to provide perpetual care and build an access road. He explained that without authorization from Congress the Engineers could not build a quarter million dollar road with the taxpayers' money to provide access to land worth much less. Since the Indians had not organized a cemetery association under law and had not the funds to build the access road, the District had proceeded with the Riverview-Corydon plans, obtained signed consent from Cornplanter descendants, and sent final plans to Washington.

In September 1963, when Colonel deMelker learned of the Weber gift of land to the Cornplanters, he immediately wrote Merrill Bowen to explain that site could not be used as a cemetery because it was to be acquired as a project



Colonel Bert de Melker

recreational area. Bowen had continued his plans, however, obtaining signatures on a petition of many of the tribe who, like himself, had earlier signed consent forms for removal of the cemetery to the Riverview-Corydon site. The Engineers thereupon went to the U.S. District Court at Erie for settlement of the dispute.

Both the Engineers and Bowen claimed they had the signatures of a majority of the Cornplanter clan. Judge Willson asked a vote in the courtroom, and of the thirty Indians present, 20 favored the Weber site and 10 the Riverview-Corydon site. Colonel deMelker contended that the Corps had been patient but time had run out. Kinzua Dam would be closed in October, begin storing water, and the cemetery had to be moved before it was flooded. The Indians could not afford an access road to the hilly parts of the reservation, the Weber site was reserved for recreation of the living, and the Indians had no definite plans for cemetery relocation and had not organized a legal cemetery association to provide perpetual care for the graves.

"I think we should mention," District Counsel Al Layton told the court, "that any of the next of kin of these deceased, who are not satisfied with the Government plan, have the right to have a relocation to another cemetery, and we will pay up to the amount we would have paid to relocate in accordance with the Government plan. Any next of kin who wants to take a body somewhere else can do so."

At the end of the day, Judge Willson summarized: "It seems to the court it is too late to do anything. In any event, now there is no formulated plan, it is just a nebulous hope of some kind, a great thought in the minds apparently of the descendants. They hate to see the land taken. That destroys their heritage in the communal land and so on in the reservation. I don't blame them; I sympathize with them, but the court can do nothing about it. That is in the hands of Congress." Judge Willson ordered that the Government plan for relocation to the Riverview-Corydon site proceed.

Relocation of the Cornplanter cemetery began on August 26, 1964. To prevent controversy over the handling of the remains of Chief Cornplanter, the District arranged for several descendants of the chief, a former president of the tribe, and an expert archaeologist to be present when the grave was moved. The archaeologist identified the body in the grave as that of an old man afflicted with rheumatism, a disease that Chief Cornplanter had suffered. In spite of precautions, a rumor of improper handling with disrespect of the body circulated afterwards, and so did a contradictory rumor that the body of the chief had been spirited away by descendants for secret interment and the body in the grave was not that of the chief.

Relocation of the living presented as many problems as relocation of the dead. Senecas, including Calvin John, Donald Kenjockety, Earl Redeye, Webster Lee, DeForest Billy, and Warren Jimerson, were recruited for some jobs in connection with the relocation and every effort was made to learn what the Senecas wanted.

At the recommendation of President John F. Kennedy, Congressmen James A. Haley and John P. Saylor introduced House bill 1794, by coincidence echoing the date of the Pickering treaty, in 1963 to fund relocation, rehabilitation, and the further economic and social development of the Senecas. Brill Engineering Company had prepared a report for the Bureau of Indian Affairs recommending, among other features, construction of an educational and historical institution, similar to Colonial Williamsburg in Virginia, on the Seneca reservation near the reservoir to demonstrate Indian cultural contributions and provide employment opportunities for the Senecas.

Pittsburghers worried about the bill, fearing it might delay Kinzua. "It is another step in the long fight of a small group of bleeding hearts to block the largest of Western Pennsylvania's flood control projects," fulminated the *Pittsburgh Press*. "This group isn't fighting for justice for the Indians, for



Typical new Indian home

they are assured of that by law. They are fighting to knock out the flood control project."

"I can't remember hearing anyone say a word," wrote columnist William A. White, "about helping the hundreds of other persons in the Kinzua reservoir ares, aside from the Indians, except by offering them going value for properties they are losing." The Seneca rebuttal pointed out that the Pennsylvania Railroad would receive about \$20 million for relocation of its track that was on rights-of-way leased from the Senecas.

The bill making a \$15 million payment to the Senecas passed on August 18, 1964, without delaying the Kinzua project. District Engineer James Hammer, Al Layton, George Baker, and Halsey Harmon presented the first payment to George Heron at Salamanca in September. "We are stepping into a completely new era," said Heron, "one that I am sure will bring prosperity—at least employment and a decent standard of living—to the Senecas."

Heron conceded the new ranch-type homes, replete with fireplaces, paneled dens, modern kitchens, and carports, built for the 100 Seneca families that relocated in the Jimersontown and Steamburg communities, were the best Indian housing in America. Each new home was located on

three acres of land, but some Senecas commented that it was *only* three acres, hardly breathing space for an Indian, and said they sadly missed the rabbits that had romped around their old homes.

Alvin M. Josephy, Jr., a noted historian of Indian cultures, published in 1968 an article highly critical of the role of the Pittsburgh District in the Seneca Indian controversy. "In working with the leadership of the Senecas," he commented, "the engineers behaved properly and according to orders and regulations, but many Senecas today remember only their cold and officious manner and recall them as the Sioux recall Custer." That may be true. On the other hand, the Cornplanter Indians at their annual reunion in 1965 formally adopted George Plesko of the District Real Estate Division into the tribe, giving him the Seneca name "Ha-jo-dos."

Kinzua Construction Beneath a canopy of red, yellow, and brown leaves, a crowd gathered in the yard of Mrs. Blanche Brownell's home on October 22, 1960, to break ground for Kinzua Dam. Mrs. Brownell's ancestors had operated a ferry and hotel for raftsmen at the site as early as 1826. Though she was to lose her home to the project, she graciously consented to use of her home and yard for the ceremonies.

The "last train" to Kinzua had brought 1400 people from Oil City to Mrs. Brownell's yard, where they gathered to hear brief remarks by Merl Kremer and William Chase, of the Warren and Pittsburgh Chambers of Commerce, State Senator L. E. Chapman, Pennsylvania Senators Hugh Scott and Joseph Clark, Governor David L. Lawrence, and Secretary of the Army Wilbur M. Brucker. After the usual speeches, the dignitaries turned spades of earth from the yard to launch construction of the dam, and the Cornplanter Drum and Bugle Corps lowered the flag to end the ceremonies. Shuffling around the yard, the crowd carried away in matchboxes, envelopes, and pockets all the freshly turned earth. Someone even stole a ceremonial shovel. So began construction of Kinzua Dam,



Relocation of New York Southern Tier Expressway bridge

largest civil works project in the history of the Pittsburgh Engineer District.

Relocation of a highway from the construction area had begun in February 1960. A total of 37 miles of rail track, 83 miles of highway, 34 miles of pipeline, 65 miles of power lines, and 66 miles of telephone lines were eventually relocated.

Final inspection of the abutment geology took place during freezing weather and a blinding snowstorm on December 1, 1960, when District geologist Shailer Philbrick and his assistants inspected the rock strata. With pumps running to clear the hole of water, Philbrick boarded a steel cage held by a winch and A-frame and descended 149 feet down a 36-inch drill hole for first-hand inspection. He pronounced the rock strata excellent.

Hunkin-Conkey Construction Company won the contract in 1961 for building the dam. The resident engineer at Kinzua was Joseph P. Renouf, assisted by Ed Kovanic, and Armando C. Lardieri was Construction Division project engineer. Larry Sowles was project manager for Hunkin-Conkey.

After a dizzy swirl of bulldozers and carryalls completed excavations behind the cofferdams, the contractors began, on August 3, 1962, placing concrete into the monoliths of the dam. A. C. Lardieri

explained that because the solid rock foundation dipped sharply on the north side of the valley at the site, Kinzua was a combination concrete and earthfill dam, with concrete placed where the rock foundation was nearest the surface and earthfill on the north side. Kinzua Dam, he pointed out, contained enough concrete to build 300 miles of two-lane highway and the earthfill section represented 300,000 trips by 20-ton dump trucks.

Probably the most significant engineering innovation at Kinzua Dam was the concrete cutoff wall built upstream of the earthfill section. The reason the wall was built, according to Garth A. Fuquay, chief of the District Foundations and Materials Branch, was that the natural foundation of alluvial materials, 150 feet deep at places, was more pervious, or subject to seepage, than the earthfill dam section.

Professor Arthur Casagrande, renowned soil mechanics consultant from Harvard University, was called in as consultant on the foundations treatment methods. The Engineers considered such methods as driving sheetpiles down to rock to form a wall, placing a blanket of impermeable materials over the reservoir floor upstream of the dam, drilling holes and pumping cement grout into the foundation, and cutting a deep open trench in the founda-

Relocated Willowdale Cemetery - Bradford, Pa.





"a trench three feet wide and 1,100 feet long"

tion and filling with impermeable materials. In the spring of 1964, the District rejected conventional methods and selected the then relatively new ICOS method, never before used by the Corps, for building a concrete cutoff wall upstream of the earthfill dam section.

The ICOS (Impresa di Constuzioni Opere Specializzate, Milano, Italy) process somewhat resembled a method used by men drilling for water, who pump a mud or slurry down the drill pipe into the bore hole to prevent caving in of the sides of the bore hole. The slurry supports the sides of the hole until the drill pipe is removed and the well casing inserted.

During late 1964, the contractor, Icanda, Ltd., of Montreal, using percussion drill rigs and special clamshell buckets, dug a trench three feet wide and 1,100 feet long upstream of the dam. The trench went as much as 160 feet straight down! That feat was accomplished by filling the trench with the

mud, bentonite slurry, to prevent its sides caving in as the digging went deeper. After the trench reached rock bottom, concrete was pumped down through pipes and as the trench filled with concrete the mud slurry was forced up and out of the trench, the concrete forming when it set a 30-inch wide curtain to prevent seepage under the earthfill dam section. A blanket of dense materials was also placed upstream of the dam, filling depressions in the reservoir floor, as further protection against seepage.

Albert Jones, leader of the cult of Handsome Lake, appeared at the Seneca Long House in a corn-husk mask when work began at Kinzua, predicting the "little people," the gremlins of Seneca lore, would prevent construction of the dam. "We Indians got something to protect us," said Jones. "We'll do some little things and there'll be a lot of people dead down there at the dam, without anybody touching them." Nothing of the sort occurred; nonetheless, the project, perhaps as a result of its sheer physical size, did seem to have more than a normal share of problems.



Colonel James Hammer

Halsey W. Harmon noted there were scattered incidents of vandalism and mysterious fires in the Kinzua project area, and the culprits were never apprehended. Harmon recalled one night, when he and District Engineer James Hammer were in Warren, he answered a knock at the door and confronted two carloads of armed men, who appeared to be Indians and were drinking. They asked the whereabouts of the Colonel, and Harmon lied that he didn't know. The men then raced away to continue their search, but if they intended harm to the Colonel they never found him. Colonel James Hammer, a precise, militarily correct officer, who had participated in the Rhine River crossing in 1945 and was also a veteran of the Korean War, served as District Engineer while Kinzua Dam was built. He made a convenient target and bore patiently the barbs thrown his direction by those who opposed the Kinzua project.

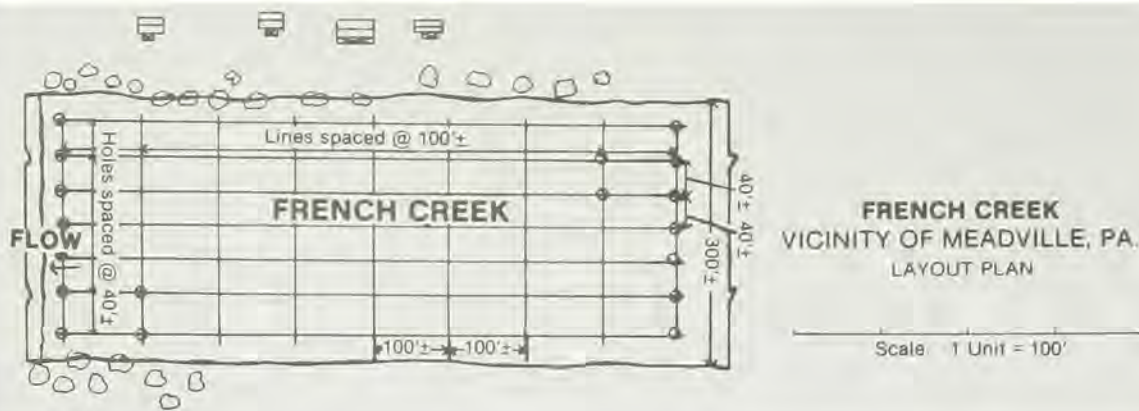
On September 16, 1966, Governor William Scranton and other dignitaries formally dedicated Kinzua Dam. A true multipurpose project, the dam and



Kinzua Dam

reservoir provided flood control, low flow and water quality augmentation, and recreational benefits. During the summer recreation season it held a 24-mile long lake with a 12,000 acre surface area. Under license from the Federal Power Commission, the Pennsylvania Electric Company and the Cleveland Electric Illuminating Company built the Seneca Power Plant for pumped storage at Kinzua Dam. Penstocks, or tunnels, from the dam carried water to the powerhouse, which pumped the water through an underground tunnel up to a reservoir atop a hill on the left bank, some 800 feet above the powerhouse. Water stored in the hilltop reservoir was released during peak demands for electric power to flow back down through the tunnel and spin turbines generating up to 400,000 kilowatts of power sent through transmission lines to people in five surrounding states.

Benefits from the \$108 million Kinzua project accrued slowly for seven years until June 1972, at which time it promptly reimbursed the taxpayers' investment in full.



The Peak of Flood Control Construction The spring thaw came quickly in 1959. Heavy rain fell on snow-covered ground and ice-packed streams in the northern sector of Pittsburgh District on January 21, causing serious flooding in the Allegheny and Beaver River basins. Ice 16 inches thick barreled out of the Allegheny, breaking 124 barges from their mooring and carrying them downstream to smash against bridge piers and Emsworth, Montgomery, and New Cumberland dams. Some were recovered 200 miles down the Ohio. Sharon and Youngstown were hard hit by floods, and ice gorges on French Creek dammed the stream, threatening to back water into Meadville.

1918 ice gorge on the Monongahela, District Engineer Horton W. Stickle and his assistant William D. Fairchild had cleared a gorge at Brownsville by chiseling holes in the ice, dropping in dynamite to shatter the pack, and ramming continuously with the steamers *Swan* and *Slackwater*.

Dick Thalimer and the Engineers used helicopters to clear French Creek, beginning at the Cochranon jam. A helicopter landed on the ice pack, a "shooter" jumped out, planted explosive in the ice, lit the fuse, and reboarded the helicopter in one helihurry. The helicopter flew up and hovered until the charge exploded, then returned for place-



Operation Ice Crusher

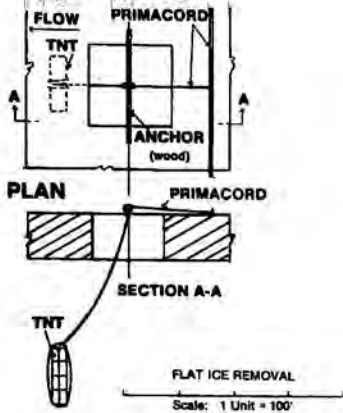
The Pittsburgh District started emergency operations on the morning of January 22. District Engineer W. W. Smith and Emil Schuleen headed northwest to inspect the flood situation at Youngstown, Warren, New Castle, and Sharon. Jim Neill and Jacque Minnotte checked the barge retrieval work on the Ohio. Richard "Dick" Thalimer, Fred Burfoot, Joe Murray, Ed Reed, and Bob Conley took off for Meadville to organize "Operation Ice Crusher."

French Creek had crested at 62.5 feet at Meadville, equalling the flood of record, and piled ice into two gorges, one at Meadville and the other near Cochranon. Working with local authorities, the Engineers decided to blast channels through the gorges, which was not a novel method. During the



ment of another charge. While results were spectacular, the job didn't go fast enough. Demolition teams from the 19th Engineer Battalion at Fort George Meade landed from helicopters on January 28 to work at the Meadville gorge. The combat engineers divided into teams, one group cutting holes in the ice with chainsaws, another preparing and delivering TNT charges, and a third placing and firing the charges, while the helicopters hovered downstream to make sure floating ice did not again jam. In a few days, with 1,800 pounds of dynamite, 22,300 pounds of TNT, the crews cleared a 200-foot wide channel through the four-mile long icepack. Meadville was safe.

A few days after the January 1959 flood, Congressman Mike Kirwan called Chief of Engineers



Michael J. Kirwan
Dam and Reservoir



Emerson C. Itschner to account before the House Committee on Public Works. Kirwan was upset by what he thought was slow progress on the multipurpose dams planned on the West Branch of the Mahoning and the Shenango rivers. Sharon and Youngstown and other Beaver basin towns had been flooded twice in three weeks in early 1959. "They were hardly back in the homes," Kirwan complained, "before they had to evacuate them again in boats."

General Itschner's defense was that the ten reservoirs in the Pittsburgh District had prevented flood damages of nearly \$79 million in January and February 1959, and the \$32 million damages resulted chiefly from floods coming from uncontrolled tributaries. He said the Berlin and Mosquito Creek dams, built in 1942-43 at a cost of \$10.3 million, had cut 5.3 feet off the 1959 flood crest at Youngstown, preventing \$34 million in damages. He estimated that a dam on West Branch of the Mahoning could have prevented \$3.3 million damages in the Warren and Youngstown area, and the proposed dam on the Shenango River would have averted \$6.6 million damages, mostly at Sharon and New Castle.

Congressman Kirwan admitted that Berlin and Mosquito Creek dams had done their jobs, but demanded early attention to construction of the West Branch of Mahoning Dam. Kirwan was specially interested in that project because the steel industry in the Mahoning valley, plagued by water supply shortages, was willing to contribute a substantial part of the costs of building the dam so as to improve the flow of the Mahoning.

Kirwan had won approval in 1955 for an engineering study of the West Branch of Mahoning project, as substitute for a project in the adjoining Eagle Creek basin where high-grade silica deposits would be inundated by a reservoir. Fearing that the Eagle Creek project might become part of "Kirwan's Big Ditch," the Lake Erie and Ohio River Canal, Pennsylvanians had opposed the Eagle Creek Dam, and they opposed the West Branch project for the same

reason. The Board of Engineers for Rivers and Harbors in its 1957 review report, however, found that additional flood control and low flow storage was desperately needed in the Mahoning basin and that the West Branch Dam could not contribute to the proposed canal project. Congress approved the West Branch Dam and Reservoir in the Flood Control acts of 1958 and 1960.

Congressman Kirwan presided over ground breaking ceremonies at Wayland, Ohio, on April 27, 1962, and land acquisition and relocation work started. Construction of the rolled earthfill dam, nearly two miles long and 83 feet high, began in May 1963. Dick Thalimer was Engineering Division project engineer and Rudy Kroft was resident engineer for the District.

When the earth embankment had been raised to within five feet of its planned crest in November 1964, rapid spreading and settlement of the outlet works occurred. According to Ed Thomas, assistant chief of the District Engineering Division, the contractor had placed a greater load on the foundation than planned and a 60-foot clay stratum in the foundation reacted under the pressures. That problem was solved, Thomas said, with an electro-osmotic stabilization system, engineering jargon for placing electrodes in the clay stratum and passing electric current between them to dry out the clay.

West Branch of the Mahoning Dam was completed in November 1966, backing a ten-mile reservoir through Portage County, Ohio, to a point near Ravenna. The \$20.6 million project was later renamed by Congress the Michael J. Kirwan Dam and Reservoir in honor of its chief proponent, who died in 1970.

First interest in building a dam on the Shenango River, which joins the Mahoning at New Castle to form the Beaver River, came after Easter Sunday rains in 1913 sent an 18.6-foot flood seething through the streets of Sharon and destroyed an old canal dam on the river at Sharpsville. The old canal dam no longer served commercial traffic but was

important for area recreation, and George Mahaney, a Sharpsville businessman, launched a single-handed campaign for restoration of the dam.

For twenty years, Mahaney sought restoration of the Sharpsville dam without success, but after the 1936 flood he gained several allies, notably Henry A. Roemer, president of Sharon Steel Corporation, who wanted a dam built on the Shenango for flood control. Roemer had been in New York trying to negotiate a loan for plant expansion when news of the damages at his plant done by the March 1936 flood frightened investors and killed his hopes for a loan. Roemer concluded the prosperity of his company and the industrial-economic development of the Shenango basin rested on adequate flood control, and he and Mahaney began a series of trips to Washington to lobby for an Engineer project on the Shenango.

After rains from Hurricane HAZEL devastated the Shenango valley in October 1954, Mahaney and Roemer gained strong support from various Shenango valley civic groups; and Senator Edward Martin in 1955 pushed an appropriation for study funding through Congress. Serious flooding in June 1958 and the spring of 1959 generated more public interest in the project, and in the autumn of 1959 Congress appropriated funds for construction of Shenango Dam over the veto of President Dwight D. Eisenhower.

The dam, to be located just below the confluence of Pymatuning Creek with Shenango River, would back a lake up the Shenango to New Hamburg in Mercer County, Pennsylvania, and up Pymatuning Creek to Kinsman in Trumbull County, Ohio. In 1960, the Pittsburgh District began the relocation of 11 miles of railroad, 20 miles of highway, and utility and pipe lines from the Shenango Reservoir area. Better than a thousand graves were moved and about 600 people, mostly from the Clark, Big Bend, New Hamburg, and Orangeville communities, went to higher ground; thus, more dead than living people were dislocated by the Shenango project.



Shenango Dam

The John G. Ruhlin Construction Company in March 1963 began building the concrete dam in eighteen monoliths. The resident engineers for the Pittsburgh District were Vance T. Aitken and John C. Staples, and the office engineer was Peter P. Kuzma.

On a sunny September 17th in 1965, Shenango Dam, 720 feet long and 68 feet high, with a strikingly sculptured appearance, was dedicated by Congressman Joseph P. Vigorito, Secretary of the Army Stanley R. Resor, Chief of Engineers William F. Cassidy, and Ohio River Division Engineer Walter P. Leber. But the men of the hour were Henry Roemer and George Mahaney.

Congressman James Weaver had asked Congress to name the dam on the Shenango after George Mahaney, but policy did not permit naming a dam after a living man. Mahaney quipped that he was not at all disappointed. He preferred living. Besides, during his half century fight for Shenango Dam, he had been called more names than any man in Mercer County. Mahaney told of receiving a letter saying, "Since you got the appropriation for this dam, I hope you are the first to drown in the lake." At the request of the Shenango Valley Chamber of Commerce, a recreation area at the dam was named for George Mahaney.

East of the Shenango, in the French Creek basin, the Pittsburgh District recommended a very large dam for flood control on the main stem of French Creek in 1936, but the plan was intensely opposed by landowners and the people of the town of Cambridge Springs whose property would have been inundated by the project. After an April 1947 flood set records in the upper French Creek basin, new interest in securing some measure of flood protection for the basin developed, and Congress directed the

Pittsburgh District to restudy French Creek and come up with a plan that might be substituted for a main stem dam. Those studies were still in progress when the January 1959 flood and ice jams caused damages at Meadville and other points along the stream. In 1960, the District proposed a three-phase plan to provide partial flood protection for the people of the French Creek basin. The plan called for construction of three dams, one at Union City near the head of French Creek and two on tributary streams, Woodcock Creek and Muddy Creek.

Congress approved the three-phase plan in 1962, and the District began construction in 1968 of the Union City Dam near Erie, Pennsylvania. Because there was no interest in recreational and conservation features when Union City Dam was planned, the District designed its first detention dam at the site. Detention dams have the sole function of flood control and therefore have no summer pools for recreation or other purposes. They impound water only during floods for slow release after the danger of downstream flooding has passed. Such dams are not new, for Arthur E. Morgan built five of them in 1919-22 in the Miami River basin of Ohio.

S. J. Groves and Sons won the contract for building the Union City Dam, and John C. Staples was resident engineer. They finished the rolled earthfill dam, 88 feet high and 1,420 feet long, on September 24, 1971.

While the dam was under construction, District Engineer Edward C. West at a Union City public meeting learned that the people of Erie County had become interested in a permanent pool for recreation. The District redesigned the sluice intake of the dam to allow future construction of a control room and installation of sluice gates to hold a summer pool. Speaking at dedication ceremonies in 1971, Congressman Joseph P. Vigorito said he would seek congressional approval for a conservation pool at the project.

Construction of Woodcock Creek Dam and Reservoir, the second phase of the French Creek basin

program, began in July 1970. Lane Construction Company was the contractor and John C. Staples and Jerry McDaniels the resident engineers. Located in Crawford County about three miles northeast of Meadville, 4.1 miles above the mouth of Woodcock Creek, the 90-foot high, 4,650-foot long rolled earth dam was completed in July 1973. Most of its storage capacity was reserved for flood control, but a small summer pool for water quality control was maintained and recreational facilities were developed. The Chief of Engineers awarded the District the Award of Merit in the landscape-architectural design category in 1974 for the aesthetic effects achieved at the Colonel Crawford Recreation Area on the lake.

Fifteen years after Congress approved the three-phase program for the French Creek basin, the Union City and Woodcock Creek dams were in operation. In December 1977, however, the District reported that "a dry-bed reservoir on Muddy Creek cannot be justified under present conditions of development in the Meadville-Kerrtown districts," and, basing the decision on the then-current project costs and benefits, recommended that the Muddy Creek dam project be placed in the inactive category.

AGNES Was No Lady In his office in the federal skyscraper on Liberty Avenue in Pittsburgh, Tom Reilly pondered the weather reports and forecasts. He had been watching carefully the progress of AGNES, first hurricane of the season, for several days, for precipitation from hurricanes had caused flooding and damages in the Pittsburgh Engineer District on several occasions since he had joined the District in 1935. When AGNES slammed into the Gulf Coast on June 19, 1972, danger to Pittsburgh had seemed remote, but the following day, while the storm center was still over Florida, its currents forced moist Atlantic Ocean air inland, dropping widespread rains on Pennsylvania. A cool air front was approaching the Pittsburgh District from the west.

The cold front stalled on June 21 along the Ohio and Pennsylvania border and AGNES moved into

North Carolina, its counterclockwise circulation sending increasing amounts of moisture inland. When reports of intense rain over the upper Allegheny and Clarion River basins arrived at the District office, Reilly concluded the Pittsburgh District was about to have a flood. He deployed his hydrologists to the northeast sector of the District to secure first-hand reports on the flood situation and alerted the Reservoir Regulation Center. The damtenders at District reservoirs were directed to stand by for flood action.

AGNES arrived over New Jersey on June 22. It had lost its hurricane winds and become a tropical storm, but its rains hammered New Jersey, Delaware, Pennsylvania, and New York all that day. Storms such as AGNES commonly moved up the coast and passed out to sea off Cape Hatteras, but AGNES was uncommon. It moved west and inland on Thursday night, and when Pittsburgh District employees donned their raingear and splashed to their work on Friday morning, June 23, AGNES was centered directly over the upper Allegheny basin and its rains were lashing the entire District. In three days as much as 11 inches of rain fell on parts of the District, averaging from 5 to 9 inches in a 50-mile band along the western slope of the mountains from a point south of Pittsburgh to New York state. Tom Reilly's analysis of the reports flowing across his desk indicated the floods moving down swollen tributary streams on the way toward Pittsburgh and Wheeling would bring the region the greatest flood in its history.

While the wipers slapped monotonously back and forth across the windshields, the men Reilly had dispatched from the District office to measure precipitation and stream flow eased by downed power lines and around road washouts into the flood-stricken towns northeast of Pittsburgh. Paul Hein, Paul Yeloushan, Ralph Falino, and Walter Leput on June 22 pulled up and parked outside Eldred in McKean County. Water was three feet deep over roads into town, so they found a boat and went in to warn the mayor the water was rising two inches an hour, with no end in sight.

Ralph Mucci and Joe Violi boated into Eldred the following day. They found water seven feet deep in the main street and someone firing a gun to signal for rescue. "We are completely isolated," said Mrs. William Luce of Eldred. "The only way in is by helicopter or boat. I've never seen anything like this before. And it's raining hard here yet!"

Carl Hackett and Werner Loehlein of the Hydrology Branch went into Brookville and Punxsutawney, where the District had built local protection projects. Better than 6 inches of rain had fallen at Punxsutawney, but the project had held damages there to a minimum. The same was true at Brookville, where rainfall had exceeded 7 inches. They also made it into DuBois and found several feet of water standing in the business district. A local protection project was authorized for DuBois, and Joe Butchko of the District Construction Division was in town at the time of the flood. He waded out with pictures of the high water.



Salamanca, New York - June 1972

Paul Hein and friends drove into Salamanca on the Allegheny, where the District had built dikes and walls to protect against floods of record. Hein reported the river at Salamanca was 7.5 feet higher than ever before known. It had overtopped the dike by two feet and left the town in shambles. The District Engineering Division sent Ed Kovanic to Salamanca to help with sandbagging and pumping out the flood water.

"Woodcock Creek Dam...reduced flood damages at Meadville."



Francis Duffy and Clayton Ott were sent to Olean and Portville on the Allegheny, where the river was within a foot of overtopping the dikes. They boated into Olean, met with local officials, arranged continuous patrol of the dikes, and had sandbags sent in from Pittsburgh District. When a leak under the dike developed, 6,000 people were evacuated from low-lying sections of Olean. Duffy and Ott directed hasty construction of an emergency dike around the leak to hold the water while it was pumped back into the river.

On June 24, Duffy and Ott set out for Portville. Roads were flooded, so they made a harrowing ride on a section car along a railroad embankment with water up to the ties on both sides. On arrival at Portville, they found water 8 inches from the top of the dikes and interior runoff accumulating behind the dikes. They obtained more pumps to handle the interior drainage.

Reports coming into the District office from the south also looked bad. Uniontown, Connellsville, and West Newton had serious damages. Fayette City, Sutersville, Masontown, Brownsville, McKeesport, and other communities were partially under water.

The District opened its emergency operations center, under C. Dayle Miller, on the morning of June 23. By the end of that day, the District had fifteen engineers and technicians in the flooded areas

Flooded cofferdam at Hannibal



helping fight the flood, collecting hydrologic data, and estimating the amount of damages. Runoff into the reservoirs was continuing at alarming rates. The reservoir on East Branch of the Clarion River was soon completely full, with water discharging through the spillway. Tom Reilly knew the dams were safe, however, and decided to keep the dams closed and hold the water until the flood crest was passing Pittsburgh.

The first concern of Jacques S. Minnotte, chief of the Engineering Division, was preservation of the District's projects, especially Hannibal Dam on the Ohio and Woodcock Creek Dam near Meadville, which were then under construction. Orders went out to move construction equipment to safety and flood the cofferdam at Hannibal before the flood waters arrived. Resident engineer Jerry McDaniels at Woodcock Creek called Ralph Weise and Halsey Harmon at the District office on June 23 to warn that flow into the reservoir was greater than the outlet conduit pipes could pass and water was rising fast behind the half-finished dam. It appeared the flood would go over the top and damage the dam. The engineers at the District office debated whether to let the dam be overtopped and repair the damages later, cut a diversion ditch, or bulldoze a temporary dike into place atop the dam.

McDaniels, in the meantime, sent men to the streams pouring into the reservoir to measure their flow, allowing estimation of the rate and amount of

rise that could be expected at the dam. When McDaniels reported the reservoir would rise to a point about two feet over the unfinished dam, the office engineers told him to put a four-foot temporary earth dike atop the dam.

McDaniels put the contractor's bulldozers to work at noon and by 2:45 p. m. they had pushed a temporary dike, about 4 feet high and 250 feet long, into place. The reservoir level climbed up the dam, onto the dike, and crested two feet up the side of the dike at 5:45 that afternoon. Fast work had prevented damage to the dam. And incidentally reduced flood damages at Meadville.

Dams in the District were storing immense water volumes. East Branch of the Clarion was more than full. Water was within three feet of the top at Kinzua Dam. Tygart Reservoir was 85% full, and other dams had stored water to 90% of their capacity. The deluge falling over uncontrolled streams still pushed the rivers at Pittsburgh and Wheeling to flood stage and beyond.

Some very nervous men waited it out in the Equitable Life Assurance Society's Pittsburgh office. Equitable had, since 1948, invested millions in the Gateway Center for the revitalization of the Golden Triangle after the Corps of Engineers promised that control of major floods would be achieved. Equitable had floodproofed the buildings in the Gateway Center, locating first stories about a foot above the level the Army Engineers had predicted major floods would reach after the upstream reservoirs had cut off the crests. There was still the question of whether the Engineers had been right.

People in the Golden Triangle watched apprehensively as the flood crept up the Point and into Fort Pitt Museum. Mayor Pete Flaherty asked all businesses to get their employees out of the downtown area. Equitable executives Vince Gieger and Bill Mueller roused their maintenance staff for flood duty. They bolted steel flood doors over entrances to underground garages, closed low level

vents, trucked in and stacked sandbags, shut down elevators, and moved switchboards, computers, and other equipment to higher floors in the Gateway Center buildings.

The AGNES flood crested on June 24 on the Pittsburgh gage at 35.85 feet, eleven feet above flood stage, and Pittsburghers, especially the executives of Equitable, watched with great relief as it began to recede. A headline in the *Pittsburgh Press* the next day read: "The Engineers Were Right."

The flood wave moved on down the Ohio, heavily damaging McKees Rocks, Coraopolis, Wellsburg, Wheeling, and unprotected towns all along the upper river. At noon on June 24, Tom Reilly, noting another rainstorm developing in the west, ordered releases from the District reservoirs to begin. Water released from the dams would not reach flooded areas until after the flood crest had passed, and reservoir flood control storage had to be regained before more rains arrived.

President Richard Nixon, on June 23, had declared Florida, Virginia, Maryland, Pennsylvania, and New York to be major disaster areas, qualifying them for federal assistance. After reports came in from the Pittsburgh Engineer District, he added parts of West Virginia and Ohio. The Army Engineers established the Susquehanna District for emergency and recovery work east of the mountains. The Ohio River Division called Jacques Minnotte at Pittsburgh on Saturday, June 25, to ask if the District wanted the help of military officers for the recovery effort. Minnotte thought it over quickly and asked for thirteen officers and some civilians on temporary duty from other Districts.

District Engineer Norman G. Delbridge confirmed Minnotte's decision when he arrived on June 26. Colonel Edward West had retired on April 30 and Colonel Delbridge was scheduled to take over on July 1. He reported several days early for service during the emergency.

Someone had told Delbridge before he came to Pittsburgh that "once you get up there it won't take



June 24, 1972 - Pittsburgh Point

you long to get your feet wet." Delbridge later quipped, "They must have known something I didn't know." He was, at that, more fortunate than an earlier District Engineer, W. E. R. Covell, who had not arrived at Pittsburgh in time to join in the March 1936 flood fight, but who had sent his furniture on ahead and it did. He lost it all.

During and after the AGNES flood, District personnel were constantly on the road performing "windshield surveys," meaning assessing the costs of repairing the flood damages and reporting to local civil defense officials, who forwarded the information to General George "Abe" Lincoln, a former Engineer officer who was director of the Office of Emergency Preparedness. When the Corps officers from West Point and the Engineer School at Fort Belvoir arrived at Pittsburgh, Colonel Delbridge sent them to field offices, staffed by District personnel and men loaned from other Districts. Field offices opened at Olean, New York, Smethport, Pittsburgh, Uniontown, Kittanning, and Meadville, Pennsylvania, and Wheeling and Kingwood, West Virginia. Those offices helped local government with urgent recovery work, then began flood damage surveys of buildings and service utilities eligible for federal assistance. They laid plans for repair and restoration work and employed local contractors for the work. Those offices and the Pittsburgh Engineer District completed 1,509 damage surveys and contracted for repairs totalling \$1.6 million, contributing materially to quick recovery from the flood.

By Sunday, July 2, the rivers had returned to their banks, the sun had begun to dry things out, reservoirs were returning to normal levels ready for the next flood, and the Pittsburgh District was helping people dig out from under the mud and debris. That afternoon at watersoaked Point State Park, Thomas Hutchins' old outfit, the Royal Americans marched

Green - March 1936 Flood
Yellow - June 1972 Flood (Actual)
Brown - June 1972 Flood (No Flood Control)



again. A column of soldiers clad in scarlet and blue marched across the parade ground to the tune of fifes and drums, just as Hutchins' 60th Regiment of Foot might have done after the flood of 1763.

AGNES was no lady. It killed 122 people and caused catastrophic damages, especially in eastern and central Pennsylvania where even Governor Milton Shapp had to evacuate his Harrisburg mansion. The AGNES flood would have crested at Pittsburgh two feet above the 46.0 foot record stage set on the day after St. Patrick's Day in 1936, had it not been for the upstream reservoirs. They clipped about twelve feet off the top of the flood, holding it ten feet below the record set in 1936. More gratifying to the Engineers was that fact that not a single person died in the District as a result of the greatest flood of record.

The Pittsburgh District announced that its reservoirs during the AGNES flood had prevented \$849,219,800 in damages, nearly four times what it had cost to build the projects, and, adding local protection projects, the flood damages prevented swelled to better than a billion dollars. Kinzua Dam on the Allegheny, built at a cost of \$108 million, saved people living downstream of the dam a tidy \$247 million.

District Engineer Max R. Janairo during the 1976 bicentennial year reported that Pittsburgh District projects had provided flood control benefits aggregating five times their costs, not including benefits credited to recreation, navigation, water quality and other functions. Men and women of the Pittsburgh District with forty or more years of service, who had participated in the District's flood control work since the beginning, saw their life-long labor bear its greatest fruit during AGNES, a privilege rarely granted to most mortals on this earth.

RIVER AND HARBOR ACT OF 1899
Section 10

Sec. 10. That the creation of any obstruction not affirmatively authorized by Congress, to the navigable capacity of any of the waters of the United States is hereby prohibited; and it shall not be lawful to build or commence the building of any wharf, pier, dolphin, boom, weir, breakwater, bulkhead, jetty, or other structures in any port, roadstead, haven, harbor, canal, navigable river, or other water of the United States, outside established harbor lines, or where no harbor lines have been established, except on plans recommended by the Chief of Engineers and authorized by the Secretary of War; and it shall not be lawful to excavate or fill, or in any manner to alter or modify the course, location, condition, or capacity of, any port, roadstead, haven, harbor, canal, lake, harbor of refuge, or inclosure within the limits of any breakwater, or of the channel of any navigable water of the United States, unless the work has been recommended by the Chief of Engineers and authorized by the Secretary of War prior to beginning the same.

Mr. Major Powel,

I want to Rite you for some information in Reguard to and imstruction across a navenigle stream on the west fork River near Clarksburg. There is a mill damn across this River with out sloop or sluice. It is imposible to get over this dam with Raves or lumber of eny Kind with out taring it to peaces. This dam is 9 ft in hith perpendickier. On the loer side it stopes the navegeation of fish Boats and Crafts. It is a Bout half mile Below elk creek. This river is large enoug to float Raves with 50,000 ft of lumber in a fleet. I want to know if and instruction like this wood come under the gubermment controle. I am inersted in the lumber buisness from ten miles a Bov Clarksburg to Elizbowt and wood Bee Pleased to hear from you at once.

Chapter 18

THE WATER CRISIS

An increasing number of pressure groups were politically active in the water resources field during the decade before the bicentennial year, 1976, and satisfying those interests made the work of the Pittsburgh Engineers more complex. Business and industry wanted more flood control and water supply while opposing stringent water quality standards. Waterways shippers wanted improved navigation facilities, while railroads opposed such projects. Environmentalist groups urged preservation of wilderness and streams, while leaders of riverside communities asked for more flood control, recreation, and water supply. Political progressives supported centralization of water resource development, asserting the Army Engineers were too responsive to public opinion and local interests. Others complained the Corps was an unfeeling bureaucracy running roughshod over local interests. The fixed amount of water resources in the face of growing and conflicting public demands sent the Pittsburgh Engineer District in several new directions in search of solutions.

Protecting the River Environment Major Charles F. Powell, Pittsburgh District Engineer in 1899, realized that news of the provisions of the River and Harbor Act of 1899 had reached the backwoods when he received a letter from a West Virginia lumberjack that read:

The lumberman's spelling left something to be desired, but his meaning was clear. He wanted the West Fork of the Monongahela protected as a navigable river of the United States under the River and Harbor Act of 1899, which directed the Army Engineers to prevent the obstruction of navigable waters.

Under authority granted in 1890, the Pittsburgh District had first embarked on a program to reduce encroachments upon navigable waterways. A Pennsylvania commission created in 1858 had established harbor lines at Pittsburgh beyond which encroachments were not to be permitted, but the limits set by that commission had not been observed. Encroachments continued to such an extent that John F. Cox, attorney for the workers who in 1892 shot it out with Pinkerton detectives on the river bank at the Carnegie Homestead plant, argued that his clients had a right to be on that bank because it was not company property but public property expropriated by the company for private use by dumping and filling into the Monongahela River. "An idea of the manner in which the river channel has been appropriated," said senior engineer John Arras in 1892, "may be gained from the stories of old residents who tell of having seen steamboats moored

where the Pittsburgh and Lake Erie Railway depot stands."

Colonel William E. Merrill directed John Arras to establish new harbor lines at Pittsburgh and to vigorously prosecute violators. Arras loaded the U. S. District Attorney and a grand jury aboard a boat and toured Pittsburgh harbor, obtaining some 50 indictments against people dumping into the three rivers.

Among the firms indicted in 1892 were Carnegie Steel Company, Republic Iron Works, Jones & Laughlin Steel Company, Oliver and Roberts Wire Company, Rosedale Foundry Company, and Pittsburgh Locomotive Works. Fines assessed by the courts ranged up to \$100,000. Public dumping ceased, but still the encroachments into the rivers mysteriously continued. Arras learned the companies were piling debris atop the banks during the day and pushing it into the rivers at night. He put a stop to that practice by sending Anson B. McGrew out in a fast boat with powerful searchlights on night patrol.

Imogene B. Oakley, secretary of the Women's Health Protective Association, complained in 1894 to District Engineer R. L. Hoxie that the cities of Allegheny and Pittsburgh were barging their garbage to Brunot Island and dropping it in the river. "Household garbage, refuse of wholesale commission and slaughter houses, wagon loads of decaying melons, fruit and vegetables, carcasses of animals, all go into the Ohio River above Davis Island Dam," she protested. She could get no help from the State Board of Health so she appealed to the Engineers.

Major Hoxie met with Mayor William M. Kennedy of Allegheny and Mayor B. F. McKenna of Pittsburgh, who objected that the complaint was exaggerated--very few dead animals were dumped in the river--and refused to stop the practice because the cities would have to build furnaces to dispose of the offal. Hoxie stopped it anyway, by prosecuting contractors who dumped the garbage in piles sufficient to obstruct boat traffic.

RIVER AND HARBOR ACT OF 1899

Section 13

Sec. 13. That it shall not be lawful to throw, discharge, or deposit, or cause, suffer, or procure to be thrown, discharged, or deposited either from or out of any ship, barge, or other floating craft of any kind, or from the shore, wharf, manufacturing establishment, or mill of any kind, any refuse matter of any kind or description whatever other than that flowing from streets and sewers and passing therefrom in a liquid state, into any navigable water of the United States, or into any tributary of any navigable water from which the same shall float or be washed into such navigable water; and it shall not be lawful to deposit, or cause, suffer, or procure to be deposited material of any kind in any place on the bank of any navigable water, or on the bank of any tributary of any navigable water, where the same shall be liable to be washed into such navigable water, either by ordinary or high tides, or by storms or floods, or otherwise, whereby navigation shall or may be impeded or obstructed: *Provided*, That nothing herein contained shall extend to, apply to, or prohibit the operations in connection with the improvement of navigable waters or construction of public works, considered necessary and proper by the United States officers supervising such improvement or public work: *And provided further*, That the Secretary of War, whenever in the judgment of the Chief of Engineers anchorage and navigation will not be injured thereby, may permit the deposit of any material above mentioned in navigable waters, within limits to be defined and under conditions to be prescribed by him, provided application is made to him prior to depositing such material; and whenever any permit is so granted the conditions thereof shall be strictly complied with, and any violation thereof shall be unlawful.

Though specifically exempting liquid discharges, Sections 10 and 13 of the 1899 Act directed the Engineers to prevent unauthorized changes in stream environments. Through court actions, the Engineers learned that to enforce the law it was necessary to prove that streams were navigable and that the dumping directly obstructed navigation. They could not prevent liquid pollution unless the discharges deposited materials in the stream channels. Unfavorable court decrees and meager funding limited the enforcement program generally to streams actually carrying commercial steamboat and towboat commerce.

Pittsburgh District Engineer Francis Shunk and the Ohio River Flood Board strongly recommended in 1914 that Corps jurisdiction be extended to include all streams, whether navigable or not, but the

reaction of Congress to that proposal was underwhelming and nothing was done in that regard for better than a half century.

As public concern for protection of the environment increased during the early 1970's, the Engineers began to search for ways to extend and improve the protection afforded streams by the 1899 Act. Because courts had defined navigable waterways as any stream that had ever been navigated by interstate commerce, be it canoes, flat-boats, floated logs, or steamboats, the Pittsburgh District in 1974 initiated intensive historical studies designed to extend Engineer administrative jurisdiction as far up streams in the District as possible. The District also contracted with H. R. B. Singer, Inc., for a pilot program to plan aerial surveillance with special equipment on streams to locate unauthorized changes made in stream environments.

The Corps of Engineers in 1976 proposed to extend its jurisdiction under Section 10 of the Rivers and Harbors Act of 1899 in three phases to practically all streams and waterways in the nation, without regard to their navigability. Just as there had been in 1914, however, there was in 1976 substantial political opposition to the expanded jurisdiction, and President Gerald Ford ordered the program delayed.

Patrol of the three rivers in the District that were navigated by commercial tows continued long after John Arras and Anson McGrew retired. In 1975, Lieutenant Al Whitehouse, chief of the District Surveillance and Enforcement Section, practically lived aboard a 44-foot houseboat, equipped with maps, aerial photographs, water quality equipment, and a communications network. The boat and its crew plied the waterways, stopping at riverside communities to get acquainted with people and hear their complaints and constantly searching for damage to the river environment.

Water Quality Thomas P. Roberts was sickened by the gross pollution of the Allegheny River he

saw during his 1879 survey of the stream. In his report to Colonel Merrill, he explained:

Next to the bridges, the rivermen complain most of the refuse from oil refineries and acid works which is permitted to be wasted into the river. The oil refuse is a tarry substance which contaminates everything with which it comes in contact. It does great damage to the rafts of sawed lumber, and even the shingles piled on the rafts are frequently damaged by this substance. The horses employed by the guyper men in the seasons of low water, in towing their boats of limestone, staves, barrels, etc., become smeared with this tar; while at other places the unfortunate animals have their legs cut with the acid. This acid, diluted as it is in the river, still accumulates in places sufficiently concentrated to disintegrate the fibers of cables, which frequently break as though cut with a knife. For a long distance below one of the manufactories, it is unsafe to bathe in the river. The case of a loss of life from this cause was reported last year at Oil City. It

Tidioute, Pennsylvania, on the Allegheny

Drake Well Museum



Aerial view of Pittsburgh, 1952, depicting Monongahela River pollution

Carnegie Library of Pittsburgh - Photographer, Paul Slantis

certainly is a gigantic nuisance to which thousands can testify, and which should be abated.

Many rivermen have called my attention to these annoyances, with the hope, I suppose, that mentioning them in a report might aid them in securing them relief.

Colonel Merrill could do nothing about the problem. Neither he, nor the Corps of Engineers, nor any other federal agency had the legal authority necessary to stop water pollution until nearly a century after the Allegheny rivermen asked that it be done. The 1899 Act specifically denied jurisdiction to the Corps of Engineers over liquid effluents.

Thomas Roberts tried to do something about acid pollution on the Monongahela River in 1911. He and his assistant Charles E. Ashcraft measured the acidity of the Monongahela at as much as 4.6 grains per gallon, meaning that about 64.5 tons of acid daily passed downriver. He learned the acid came from two sources: drainage from abandoned coal mines and discharges from steel mills. The Monongahela, he concluded, was the reverse of a cesspool, for its acids killed every living organism in it.

Roberts recommended that Congress enact legislation to prevent acid discharges into the rivers, following the reasoning that the acids corroded steamboat boilers, quickly ate away metal parts of navigation locks, and thereby formed a distinct obstruction to navigation. The Pittsburgh District Engineer concurred with Roberts' recommendation, but no remedial legislation was enacted. To reduce acid damage to locks and dams, the Pittsburgh District was forced to use metal parts clad in chrome or stainless steel.

The District's measurements in 1925 indicated that an average of 404 tons of free acid passed Dam 2 on the Monongahela each day, and that year the District participated in a pilot project to reduce acid drainage by sealing abandoned coal mines. During the Depression years, the Bureau of Mines and work-relief agencies such as the W.P.A. spent \$6



million to seal old coal mines, but the seals were later broken by natural forces and by bootleg miners who reopened the old mines when coal prices jumped. No completely satisfactory solution to the acid mine drainage problem was ever devised, and the trouble persisted where mining activity continued.

The U. S. Public Health Service in 1914 began the first official federal water quality studies in the Pittsburgh District. Those studies continued intermittently for thirty years without much result in the form of remedial action.

Chief of Engineers Edward M. Markham asked President Franklin Roosevelt in 1937 to let the Corps investigate water pollution in the Ohio River basin. He told the President the Engineers were completely familiar with streams in the basin; had the necessary basic information; and the personnel of the Districts, who spent most of their lives on the rivers, were vitally interested in reducing water pollution. "The feasibility of using this organization becomes apparent," said General Markham, "when it is realized that the solution of the pollution problem is an engineering matter."

The President ordered a joint study effort by the Corps and the Public Health Service and appointed a supervisory commission composed of Dr. Abel Wolman, consulting engineer of Baltimore, Ralph Tarbett, Public Health Service sanitary engineer, and General Max C. Tyler, succeeded by General Thomas M. Robins, for the Corps of Engineers. Pittsburgh District Engineer W. E. R. Covell and Don D. Rait took that commission on a tour of the District's rivers in December 1937, travelling aboard the towboat *Tecumseh* commanded by Captain Raymond C. Peck, to plan the study. Colonel Covell assigned a small staff to the collection of data and water samples and converted the Quarterboat *Kiski* into a floating water quality laboratory. That work continued for five years.

The *Ohio River Pollution Control* report, widely acclaimed as the best of its sort ever written, detailed the extremely serious water quality deterioration in the Pittsburgh District and elsewhere in the Ohio River basin, pointing out that resulting damages were far more widespread than previously thought. "In addition to direct economic damages, there are other less tangible damages of a more or less psychological nature," the report said. "For example, aquatic recreational facilities convenient to large population centers are of value to public morale, may lessen juvenile delinquency, and in other ways contribute to the general public welfare. It follows that their destruction by stream pollution is detrimental to public welfare in these respects."

In its report, the Corps of Engineers recommended that the Federal Government contribute matching funds to state and local governments for construction of waste treatment plants, support the cooperative regional pollution reduction efforts of state governments, fund continued research and education by the Public Health Service, fund the Bureau of Mines program to reduce acid mine drainage, and permit the Corps to operate its flood control reservoirs to provide maximum summer flows. The report received little attention when it appeared in 1943, but in postwar years most of its recommendations were implemented.

In 1948, eight states joined in the Ohio River Valley Sanitation Commission (ORSANCO) with headquarters in Cincinnati. When ORSANCO organized, only 1% of all communities in the basin had sewage treatment facilities; the other 99% discharged raw sewage into the rivers. The ratio had been reversed by 1967: only 1% of municipalities in the basin discharged untreated sewage into streams. As part of its "Renaissance," Pittsburgh and 71 nearby communities formed the Allegheny County Sanitary Authority (ALCOSAN) in 1946 and built a county-wide sewerage system that ended all raw sewage discharges in 1959.

Control of industrial water pollution was attempted by state governments, with minimal



District plant joins river clean-up, April 1973

federal assistance, until 1965 when a Federal Water Pollution Control Act amendment established water quality standards, providing legal means for action against polluters. "Today, we proclaim our refusal to be strangled by the wastes of civilization. Today, we begin to be master of our environment," proclaimed President Lyndon Johnson when he signed the 1965 act.

The Army Engineers had no direct role in the water pollution fight until 1970, when a federal court reinterpreted the word "refuse" in the 1899 Act to apply to all foreign substances and pollutants. President Richard Nixon signed an executive order for a permit program in December 1970, directing the Engineers to force people or businesses discharging effluents into rivers to meet federal water quality standards or face legal action.

The Pittsburgh District had long operated a small water quality laboratory for testing water samples in connection with project operations. Tom Reilly obtained new laboratory space in 1972 for work in connection with the permit program. The new lab began running hundreds of chemical and biological tests in May 1972, and a water quality network and computer program were added to support the effort. Data for thousands of actions against polluters was collected by the District before the job was turned over to the Environmental Protection Agency (EPA) in February 1973.

After transfer of the permit program to EPA, the District Water Quality Laboratory in the Federal Building continued in operation under section head Alex Barna, who reported to Gene Armocida, Chief of the Hydrology and Hydraulics Branch. Biologists and technicians of that lab travelled from stream to stream throughout the District during summers, collecting water samples for laboratory analysis.

District Engineer Francis R. Shunk, in a 1914 report, commented: "There appears to be no great

necessity for regulation of fishing from the lock walls in this District as there are very few fish. It may be that fishing will be found possible at some of the lower dams but the acid conditions of the waters around Pittsburgh has left nothing but a few catfish, usually caught near the mouths of sewers."

If fish life can serve as an index to water quality, then improvements since 1914 have been significant. The Environmental Protection Agency reported in 1972 that the Ohio River fish population had doubled in fourteen years. Aquatic biologist H. R. Preston also noticed astounding improvements on the Monongahela. In 1967, he found not a single fish in the three-acre chamber of Maxwell Lock; in 1973, he found fish weighing 91.5 pounds in the lock, including 16 different species and about 25% were largemouth bass. "The Monongahela River fishery, once dead," declared the West Virginia Fish and Wildlife Division, "is now on the active list and coming back strong." Thomas Roberts would have been pleased.

Ecological Considerations Just after enactment of the National Environmental Policy Act (NEPA) in 1970, when *ecology* was a relatively new word in most people's vocabulary, the Engineer District executives who regularly gathered around Al Layton's table at Stouffers for lunch tried to improve upon Webster's definition. Ed W. Thomas, assistant chief of Engineering Division, offered, "The relationship which exists between living organisms and their environment—ecology—is comprised of a delicately balanced series of interactions, through which no species fails or succeeds entirely by its own hand." Executive Assistant Frank R. Stocker suggested, "Ecology has become a rallying cry for a return to primitive wilderness, which is obviously impossible. What is really important is to start from where we are now to avoid future mistakes and, where possible, to repair past damage."

While the word may have been new to most Americans, the concept was not. In 1912, worried by the disappearance of fish from Pittsburgh's rivers, Thomas Roberts had commented: "There is such a

thing in nature, the biologists tell us, as an equilibrium of beasts, birds, fish, insects, preying on each other in the happiest manner imaginable to the great relief of the boss animal, man; but if the series be disturbed by the elimination of certain of the predatory species, other and perhaps very objectionable life forms, free to propagate, may come to afflict us."

Most human activities alter the environment to some extent. Building a home ordinarily destroys vegetation, insects, earthworms, and changes the configuration of the land, but those damages are accepted because people must have shelter to survive. But, as the population and the needs of the technological civilization of America increased, environmental damages multiplied. In 1960, General Omar Bradley commented: "Year after year our scenic treasures are being plundered by what we call an advancing civilization. If we are not careful we shall leave our children a legacy of billion dollar roads leading nowhere except to other congested places like those they left behind. We are building ourselves an asphalt treadmill."

As public concern about environmental damages swelled after 1960, attacks by environmentalist groups upon the Army Engineers' water resource development program received wide media coverage. They accused the Engineers of having a "beaver complex," of conjuring up benefits to gain approval for projects, of exploiting and destroying the natural environment. Supreme Court Justice William O. Douglas described the Corps of Engineers as "Public Enemy No. 1."

The Army Engineers were shocked. Because of their attention to scientific management and use of water, they had for years thought of themselves as heirs of the conservation movement begun early in the 20th Century by Theodore Roosevelt, Gifford Pinchot, and others.

To men like Roosevelt and Pinchot, however, water conservation commonly meant storing water behind dams for beneficial economic and social pur-

poses, rather than letting it waste in annual floods. The heritage of the environmentalists, on the other hand, came chiefly from men such as John Muir, founder of the Sierra Club, who urged preservation of an undisturbed environment, rather than management of resources for the service of technological society. The preservationists questioned the equation of industrial and economic growth with social progress and were inclined to view resource management simply as resource exploitation and destruction. Through publicity, public protests, and legal action, environmentalists sought suspension or reassessment of water resource projects.

Public support for environmentalist views climaxed in 1970 with enactment by Congress of the National Environmental Policy Act, making environmental protection a national goal and requiring that federal agencies, including the Engineers, give full consideration to project impact upon natural features, both zoological and botanical. An Environmental Impact Statement (EIS) was to be prepared for each dam, channel rectification, or other project to assess both beneficial and adverse impacts and to consider feasible project alternatives including the alternative of no project at all. The EIS was to be part of each project feasibility study, along with engineering and economic aspects, for public review and for submission to higher authorities and Congress.

"After reading recent Corps of Engineers publicity wherein we are increasingly pictured as Public Enemy No. 1 or worse, I fully expected to grow horns shortly after reporting for duty," quipped Colonel Edward C. West in 1970, when he succeeded Colonel Wayne Nichols as Pittsburgh District Engineer. "For the long run, our major objective and involvement is clear," West continued. "I am of course referring to the significant problems we have with environment, ecology, pollution and recreation. I challenge you to come up with the fresh thoughts and new ideas that will make the Pittsburgh District the leaders. I feel strongly that environment is where our future lies."

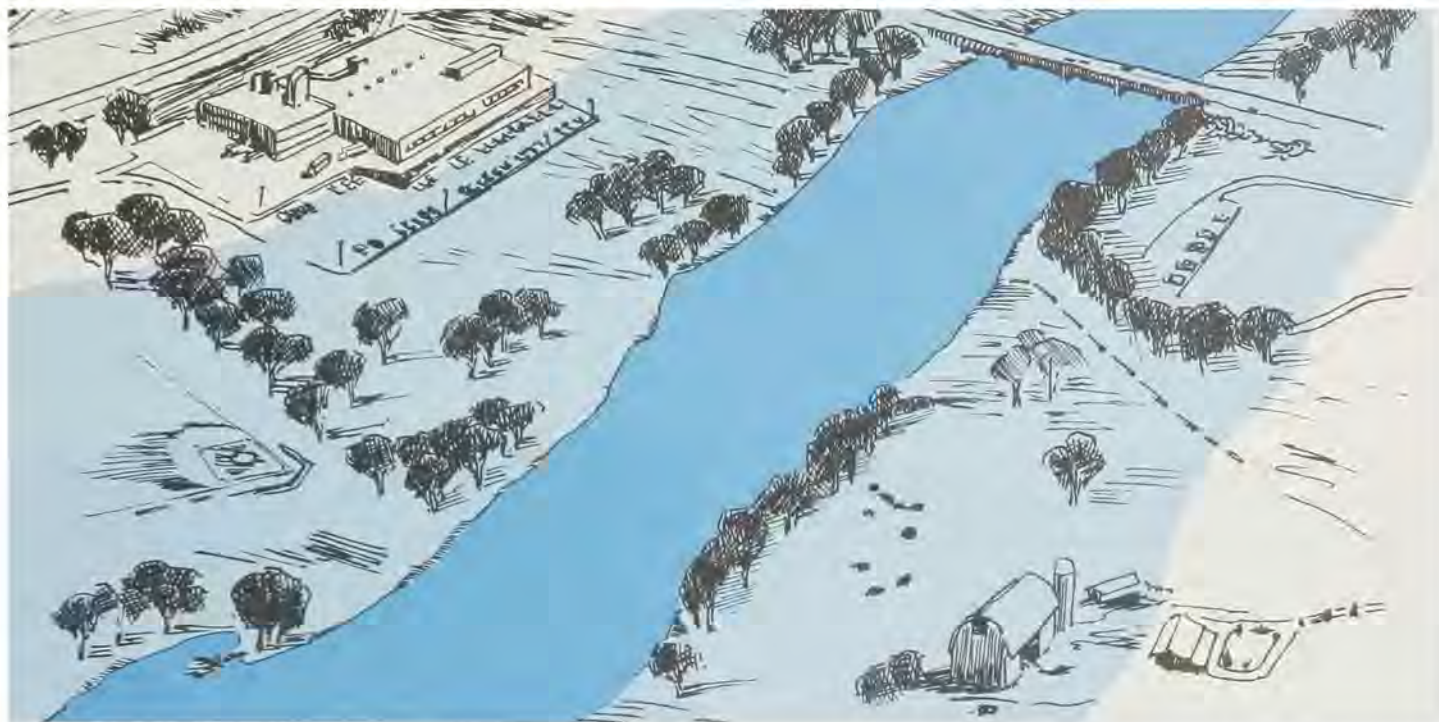
After enactment of NEPA, General Frederick J. Clarke, Chief of Engineers, had directed Corps personnel to get out in the field, listen to what environmentalists had to say, and involve them in planning processes. He directed Engineer Districts to comply not only with the letter of NEPA but also with its spirit by preparing Environmental Impact Statements not only for projects begun after enactment of the law but also for projects then under construction.

District Engineer Edward West established an Environmental Council in the District and began a series of public meetings with environmentalist groups. He pushed environmental studies and preparation of EIS reports at a feverish pace. District oldtimers, such as the voluble Ben Netzer, plunged into the environmental whirl to their necks.

The backlog of environmental studies and impact statements in the District had been pared down by 1973, when public attention was diverted from environmental concerns to a growing energy crisis. NEPA was permanent, and most Engineers admitted, much needed legislation. It opened the door for a fresh mission for the Corps.

Various new facets of the District mission growing out of the public demand for environmental protection included application of the permit program to water pollution, more concentrated study of non-structural flood control methods, waste water management and urban studies, and, in 1974, an Environmental Resources Inventory. The latter represented an effort to identify and locate natural, scenic, and historical-archaeological resources throughout the District. With the cooperation of universities, museums, the academic community, and even school children, the resources inventory sought to develop a reference source for conducting environmental assessments and preparing impact statements.

Non-Structural Flood Control and Urban Studies In 1762, after reviewing flood damages at Fort Pitt, British Army Engineer William Eyre



A floodplain

predicted that floods would again occur and recommended that the fort either be relocated to higher ground or its buildings raised so their floors were above the flood of record. In 1884, Colonel William E. Merrill made similar recommendations after the major flood of that year. He said buildings in the floodplains should be reserved for business and industry and be constructed with the strongest foundations to withstand flooding. "The most important point," Merrill said, "is to get the laboring people away from the flooded district so as to lessen the appeal for charity, which cannot always be met with the abundant resources that were poured out this year."

Relocating residential areas from floodplains to higher ground and allowing only "floodproof" buildings in low-lying areas were not at all new concepts, but people of the rugged headwaters district found them controversial. The people built on the level floodplains where the need for hauling and pumping water supply up mountain sides was avoided. Though the Pittsburgh and other Districts often considered floodplain evacuation as an alternative for local protection projects, in very few cases were communities interested in relocating.

By 1956, the Engineers had become aware that the benefits of flood control dams were being offset by continuing development in the floodplains. In spite of reservoir reductions in flood crests, the amounts of flood damages still increased. That year, Emil Schuleen of the Pittsburgh District and General Herbert D. Vogel published papers urging more use of non-structural flood control, meaning floodplain zoning and flood proofing of buildings.

Congress directed the Engineers in 1960 to provide, at request, floodplain information reports to communities for rational floodplain zoning. The reports were to show possible flood heights and frequencies, areas inundated, potential damage zones, and related information. Armando C. Lardieri, Chief of the Pittsburgh District Flood Plain Management Services Branch, explained: "In the past, the decision to occupy the lowlands was left largely to the individual. Often without realizing the risk, new developments were constructed in the flood hazard areas. To escape the dismal cycle of losses, partial protection, and further induced development, old attitudes had to be transformed into positive actions."

The Engineers hoped the floodplain reports would be used by communities to decide where, because of high flooding potential, construction should not be permitted and the land used for parks or other purposes, where only floodproofed buildings would be allowed, and where construction would be flood free. Zoning regulations and building codes were sensitive local political issues, however, and the Engineers had no power to dictate that floodplains would be evacuated or floodproof buildings constructed. Because of political complications, local governments often failed to act upon the flood information reports after they had been furnished.

After the Hurricane AGNES disaster in 1972, Congress put teeth into the non-structural flood control program by requiring that communities adopt proper floodplain zoning regulations before they became eligible for low-cost Federal Flood In-

insurance. By the end of 1977, the Pittsburgh District had prepared 55 community floodplain information reports, providing detailed flood hazard information for communities in the Allegheny, Monongahela, and Upper Ohio Valleys, including many major tributary areas. Flood hazard information was provided to more than 3,000 business and property owners. The Department of Housing and Urban Development employed the District to prepare Flood Insurance Studies. One of the most widely distributed publications of the Corps of Engineers was the "Flood Proofing Regulations" booklet prepared by the District in 1972.

In 1976 the District's nomination for a pilot Expanded Floodplain Information Study was selected as one of 10 nationwide research and development efforts intended to display the hydrologic, economic, and environmental impact associated with land use changes on a basin wide scale. The study area selected was the Upper Sewickley Creek Basin in Westmoreland County, Pennsylvania, primarily because of the Volkswagon development near New Stanton. A Plan of Study was completed in January 1977, the study started in August 1977, with the scheduled completion near the end of 1979.

The Corps Cares Three-quarters of a million people visited Tygart Dam, first reservoir project in the Pittsburgh District, while it was under construction. The contractor bulldozed off a level parking lot for the visitors at his own expense and let them use the toilets he furnished for his workers. When the job was done, he took his equipment, including the toilets, with him.

"We have a mess up at Tygart," Colonel W. E. R. Covell told the Chief of Engineers. He said that as many as a thousand automobiles came to the dam in good weather almost every day, and on one day 25,766 visitors had been counted. Their cars cut ruts in the unpaved parking lot after every rain, their feet beat muddy paths to the dam. And the stench around nearby bushes was becoming intolerable, perhaps even a health hazard. Colonel Covell asked permission to pave the parking lot and footpaths and



build toilets and a concession stand for the visitors. The Chief turned him down, explaining that Congress had not approved use of public funds to serve a fun-seeking public. Colonel Covell managed to arrange provision of public facilities at Tygart and other projects, however, through cooperation with the Works Progress Administration.

After 1945, an unexpected surge in public recreation at reservoir projects overwhelmed the limited facilities. The people cut new roads and trails across public lands to get to the lakes everyday. They were coming, regardless of whether the Corps was ready or not. Thanks to increased leisure time and the mobility afforded by the automobile, public use of Engineer projects during the decade after 1945 grew at a rate six times the rate of population growth. About a million people visited Pittsburgh District reservoirs in 1949, and the number had more than tripled by 1958.

"At the time we built our projects," Ohio River Division Engineer John L. Person told a Senate committee in 1957, "we did not anticipate and I think could not have anticipated the very extensive and growing use and enjoyment by the public of the water areas in these reservoirs. They are used for fishing, boating, swimming, camping, picnicking, and related activities."



General Person and other Engineers asked Congress to allow them to provide more facilities for public recreation and to consider recreation in project planning. Perhaps, through cooperation with local and state governments, they could meet the needs of the people swarming like lemmings to the lakes in the summer and even winter. In 1962, Congress approved Corps plans for expanding recreational features at water projects, and in 1965 approved a plan for recreational development through cost sharing with local and state agencies.

Symbolic of the growing emphasis on recreation was the bill, sponsored by West Virginia Senator Jennings Randolph in 1967, that changed the names of Engineer reservoirs in his state to "lakes." Senator Randolph thought the word "lake" was more clearly identified with recreation than "reservoir." Tygart Reservoir thereby became Tygart Lake. That policy was applied nationwide in 1970, except where Congress had specifically named a project a "reservoir" by law.

Another new feature of Pittsburgh District's environmental protection mission was the urban study program begun in 1973 as an outgrowth of earlier waste water management studies. Justice William O. Douglas, an acid critic of the Corps flood control program, suggested in 1969 that the technological expertise of the Engineers should be directed toward devising improved sewage disposal methods instead of dam building. Other critics of the Corps made similar suggestions. Congress, while unwilling to surrender the flood control work, found the idea attractive and in 1972 assigned the job to the Engineers. The Corps launched pilot waste water management studies at eight metropolitan areas scattered across the nation. The Engineers learned that waste water management could not easily be separated from such urban problems as water supply, floodplain management, recreation, and similar water-based activities. Study scope therefore expanded to all aspects of urban water use problems, and Congress funded such studies for additional cities.

The Pittsburgh District began its first urban study in 1974 at Wheeling. An Urban Studies Unit, composed of Jack Goga, Jim Mershimer, Mark Gera, and Ardelle Hopson, was established in the District Planning Branch, headed by George Cingle. The Urban Studies Unit conducted a complex study in cooperation with other federal agencies, and state and local governments in Belmont County, Ohio, and Marshall and Ohio Counties, West Virginia, which include the Wheeling metropolitan area. Maximum public involvement in the search for various short and long range solutions to the water resource needs of the Wheeling area was sought through frequent open meetings that were continuing in 1977.

Engineer projects hosted about 410 million people in 1977, more than any other federal agency including the National Park Service. That year, the Engineers were operating over 2,400 day-use and camping areas and managing some eleven million project acres. The fifteen Pittsburgh District lakes that year were visited by 12 million people. Berlin

Colonel Norman G. Delbridge, Burl McVicker and the Keep America Beautiful award



led with 1.46 million. Kinzua, Mosquito Creek, Shenango, and Youghiogheny lakes each had better than a million visitors.

During the first decades of reservoir operations, the District merely provided the most basic facilities, such as access roads and boat-launching ramps. The passive program changed to an active policy about 1965. Eventually, the District organized a recreation resource management branch and employed rangers, wildlife experts, foresters, and environmentalists to help the projects better meet public demands.

At Mahoning Creek Lake, for instance, built in 1938 in a rugged wilderness area strictly for flood control, simple facilities for fishing, hunting, canoeing, bicycling, and back-packing were furnished at low-cost through cooperation with local government, the Pennsylvania Game Commission, and the American Youth Hostels. County government supplied day-use areas for hunters and fishermen, the wildlife agency opened access to Mahoning and Little Mahoning creeks at the head of the reservoir for canoeists, and the American Youth Hostels, after initial reluctance resulting from exposure to anti-Corps literature, marked hiking trails on project lands and provided trail-side shelters for back-packers.

At Shenango River Lake, as another example, the District developed two public recreation areas and three campgrounds. The Engineers reforested 65 acres of open project lands with pine and spruce, planted autumn olive and multiflora roses to feed and shelter pheasants, quail, rabbits, and squirrels, and, with the help of the Pennsylvania Fish Commission, stocked the lake and tailwaters with 4 million walleye, pike, bass, muskie, catfish, blue gill, and trout. In June 1976, District Engineer Max Janairo and Pete Colangelo, Chief of Recreation Resource Management, opened the District's first nature trail, named for conservationist Seth Myers of Sharon, at Shenango Lake. The trail was a foot-path laced with flowers and trees, with rustic bridges, seventeen marked natural attractions, and guidebooks for the convenience of visitors.

Burl McVicker, resource manager at Youghiogheny Lake, took advantage of public concern about the environment in 1967 by organizing a cleanup day involving the public in litter removal from the lake and shoreline. It became an annual event at the lake, including boat parades, beauty contests, musical entertainment, and civic activities. The event became so popular that similar activities were organized at other lakes in the District and across the nation, merging with the "Johnny Horizon" environmental program. For that work, Burl McVicker was awarded special recognition in 1973 by the environmentalist organization named Keep America Beautiful.

Another annual event begun in 1973, which District Engineer Norman G. Delbridge described as a real embodiment of the Engineer civil works motto "The Corps Cares," provided recreational opportunities for handicapped children. With the cooperation of the Western Pennsylvania School for Blind Children, the Pittsburgh Home for Crippled Children, the Easter Seal Society of Fayette County and other agencies, District recreation personnel organized fishing derbies, boat rides, swimming and other outdoor activities for the children. Many District employees volunteered their own time for that project.

Recreational use of the Allegheny, Monongahela, and upper Ohio rivers intensified as fishing and water quality along those streams improved. Al Rogalla, Chief of the Waterways Management Branch, said that approximately 34,000 pleasure boats were registered in 1977 in southwestern Pennsylvania and that most of them seemed to converge on the three rivers on summer weekends. In 1977, which was not atypical, Pittsburgh District locks handled about 46,000 pleasure boats in 25,000 lockages. That recreation traffic, mixed with the 102,000 commercial lockages in 1977, caused some hazardous situations. Small boats crossing in front of commercial tows were run down, or swamped by the wake from the big towboats. The District joined with the local Coast Guard auxiliaries, power squadrons, and other agencies to promote safer handling of small craft.



Perhaps symbolic of the revitalization of the three rivers at Pittsburgh was the *Gateway Clipper*, that began excursion tours in May 1958 from the Monongahela wharf. The Three Rivers Improvement and Development Corporation (TRIAD), a nonprofit group headed by Arthur V. Harris, began its annual "River Renaissance" festival in June 1968. Except when interrupted by AGNES in 1972, the festivities drew thousands of spectators to the rivers each summer to watch boat parades and water ski shows, listen to concerts, and join in other activities.

A Dense Haze of Knowledge Major Lewis H. Rand received orders in 1913 from the Chief of Engineers to submit a comprehensive report on multipurpose water resource development in his District. Major Rand thought the idea lacked merit. "A survey which would contain *all* the information with the absolute accuracy that seems to be desired would be so expensive in time and money that no one would be willing to start it with the positive knowledge," the Major complained, "that it would never be available for his own purposes and would cost more than those purposes would justify." He predicted that such a survey would result in "so dense a haze of knowledge that the ordinary wayfarer would totally lose his way himself long before reaching the conclusion."

The Chief of Engineers had no funds in 1913 for comprehensive surveys and he thought they might be done by employees of the Districts in their spare moments. The reports he received were therefore very sketchy. Colonel Francis R. Shunk's report on all waterways in the Pittsburgh Engineer District was merely four pages long, and it was better than some. Major Rand, for instance, did not report at all, merely sending a letter commenting that comprehensive surveys would involve "an immensity of detail totally beyond the grasp of the human mind."

Handicapped Day



But if development of water resources for multiple purposes was desirable, then comprehensive surveys and planning to determine the extent of available resources and their optimum uses was imperative.

At the recommendation of the Ohio River Flood Board in 1916, comprehensive surveys of the Cheat, Tygart, and West Fork rivers began in the Pittsburgh District. Similar surveys of the Allegheny and Monongahela basins began in 1925, and were performed by a small staff in the District headed by Lieutenant Hugh J. Casey. Those studies merged into the "308 Reports," authorized by Congress in 1927 for 200 major river basins throughout the country. Those studies, performed through on-the-ground field surveys, meticulous map drafting by hand, and slow data and statistics compilation by clerical staffs without much assistance from business machinery, were completed during the Depression years and established a solid framework for the District flood control and multiple purpose water resource program that began at Tygart Dam in 1934.

2020^{AD}



The comprehensive studies were cumulative. Information about smaller streams became part of the Allegheny and Monongahela basin reports, which in turn became part of the Ohio River basin reports, which, after 1960, became part of a nationwide water use planning program.

President John F. Kennedy established an *ad hoc* committee in 1961 to resolve conflicts in national water use policy, conflicts sometimes pitting city against farm, industry against wildlife, headwaters areas against lowlands, state against state, region against region, and federal agency against federal agency. Congress continued that program in 1965 by creating the Water Resources Council, composed of the chairman of the Federal Power Commission and the Secretaries of Army, Interior, and Health, Education and Welfare, to coordinate national water resource planning and the work of individual river basin commissions, which in turn were to coordinate federal, state, and local water resource planning.

The Engineers had begun a review of flood control planning throughout the Ohio River basin in 1955, and in 1962 that study merged into a framework study of all water needs undertaken cooperatively by the Corps, the Soil Conservation Service, the Federal Power Commission, the National Park Service, and other federal agencies. The Ohio River Division at Cincinnati printed that cooperative study, fourteen volumes entitled the *Ohio River Basin Comprehensive Survey*, in 1968. The summary pamphlet for public distribution was entitled *2020 AD* because the report projected trends in transportation, industry, agriculture, and population in the basin a half century into the future, to the year 2020 A. D., allowing assessment of future water needs. The report estimated, for instance, that the population of the Ohio River basin, 20 million in 1965, would be 35 million in fifty years. To keep pace with population growth, the study estimated that 50 million additional acre feet of water storage would be needed.

After the Water Resources Council approved the comprehensive framework report, the Ohio River

Basin Commission (ORBC), headed by Fred E. Morr, was established in 1971 at offices in Cincinnati. The ORBC took up consideration of specific water problems at local levels, holding public workshops throughout the basin—at Bradford, Beaver Falls, and Wheeling in the Pittsburgh Engineer District.

While the Ohio River basin survey was in progress, the Pittsburgh Engineer District also became involved in the Appalachian Studies, authorized under the 1964 Appalachian Regional Redevelopment Act, part of the “War on Poverty” of the Lyndon Johnson administration. Many people thought water resource development the key to the solution of the economic woes of Appalachia, the mountain region stretching from north Alabama to New England where per capita income was half the national average. Kentucky author Harry Caudill, for example, told Congress the forests of Appalachia had been plundered, its lands gouged out for coal, and its people systematically exploited. “Water research and development,” he said, “are absolutely necessary to any program prescribed for Appalachia.”

The Office of Appalachian Studies, headed by Colonel John C. H. Lee, opened at Cincinnati in 1965. With information supplied by the Engineer Districts and acquired from other sources, the Office of Appalachian Studies produced a 25-volume report in 1970 that recommended spending some \$2.4 billion on water resource development for conservation and enhanced economic growth in the thirteen state Appalachian region. By the time the report was finished, however, the national administration had changed and the “War on Poverty” had ended. The report went to the back burner where it remained.

As Major Rand had predicted in 1913, the sheer volume of data collected by the Pittsburgh Engineer District and other Engineer installations during a half century of comprehensive surveys and studies was mind-boggling. The Engineers turned increasingly to electronic aids to handle the information.



The Navy had developed the first crude electromechanical computer, Mark I, to generate firing tables in 1944, and in postwar years the Engineers and private industry entered the field of computer technology. UNIVAC, the first modern general purpose computer, was installed at the Census Bureau in 1951 to process the 1950 returns. In 1952, the Federal Government had five computers. By 1962, it had 1,000 and by 1974 it operated 7,800. Army Engineers put computers to work at a variety of repetitive tasks, including design and engineering jobs and production of engineering drawings.

The Pittsburgh District Automatic Data Processing (ADP) Center acquired a Harris Data Communications COPE 1200 computer terminal in 1975, gaily decorated in patriotic red, white, and blue paint. The District's computer terminal was able to communicate with a Univac 1108 computer at Chicago, a Honeywell 600 computer at the Vicksburg Waterways Experiment Station, an IBM 370/195 computer at St. Louis, and an ORD G3-437 computer at Cincinnati.

Though the District's computer could converse with other computers, it could not communicate directly with towboat captains, professors, canoeists, community leaders, and government executives. The District staff therefore found it necessary to continue the sometimes dreary round of executive meetings and public workshops in search of elusive public opinion.

District Engineer Edward West and project engineers Jack Goga and Jim Purdy began comprehensive studies of the Monongahela and Youghiogheny River basins in 1970 at meetings with executive boards composed of representatives of state and federal agencies concerned with water resource planning. To secure public input, they organized local advisory councils, with memberships consisting of civic leaders, environmentalist representatives, and people from the news media. A similar comprehensive study began in 1973 for the Beaver River basin.

Cynics asked just how comprehensive, coordinated basin planning was superior to uncomprehensive, uncoordinated planning. Was it merely semantics? Primarily, it was a matter of establishing priorities. Suppose on a single stream, a community located near its mouth wanted the Engineers to build a flood control dam, while farmers at the head of the stream wanted the Soil Conservation Service to build a series of small dams for water supply, and a group of canoeists wanted the stream preserved by the National Park Service as a wild and scenic river. The job of the river basin planners was to determine if the stream could serve all three purposes, and if not what purposes it could best serve. To do that, the planners had to assemble complete data on the stream, consider possible developments on adjacent streams, determine how the stream could fit into plans for the entire river basin, and coordinate planning with national policies set by the Water Resources Council and Congress. "Difficulties are great," said one river historian, "in engineering, in organization, in finance, in the plain selfishness and obstinacy of the human animal, but overall, river basin development is one of the most hopeful changes taking place in present-day America."

Sociologist Carl F. Kraenzel of the University of Texas thought river basin planning had wide social significance. He wrote:

Above all, then, it would appear that river basin development in the United States is symbolic of greater social justice,



greater opportunity for individual self-development and realization, both economically and socially, everywhere in the nation, but particularly in the disadvantaged areas. Viewed somewhat differently, river basin development is aimed at curbing the exploitation of one area by another and at introducing a greater measure of economic and social, as well as political, democracy than now prevails.

Unfinished Business "Let us cross over the river and rest under the shade of the trees," were the last words of Confederate General "Stonewall" Jackson, who died at Chancellorsville in 1863. Perhaps he thought at that moment of the West Fork of the Monongahela, for he had played on that river as a child. He was a relative of General John G. Jackson, who had built a short-lived slackwater navigation project on the West Fork, the first slackwater project in the Ohio River basin, during the early 19th century. The Pittsburgh Engineer District had a multipurpose project named for "Stonewall" Jackson ready for construction in 1977 on the West Fork of the Monongahela.

After Congress first approved a dam for flood control on the West Fork in 1936, District Engineer W. E. R. Covell had called on Governor H. G. Kump of West Virginia to discuss the project. The Governor said he had heard opposition to the project from farmers who did not want to lose their lands merely to protect Clarksburg, Pittsburgh, and Wheeling from floods, but said he might support the project if a summer pool for recreation and low flow improvement were added. Colonel Covell had projects in Pennsylvania that had full public and state support,

so he put the dam on the West Fork at the bottom of his list of priorities.

Scotland G. Highland and the Clarksburg Water Board launched a publicity campaign in 1939 for construction of the West Fork dam. They reminded people of the terrific flood damages the West Fork valley had suffered, especially in 1888 when most bridges and mills along the stream had been destroyed. They pointed out that during droughts Clarksburg had to import water in railroad tank cars, and they argued that water supply furnished by the proposed dam could be the key to area industrial and economic growth.

Pittsburgh District Engineer D. Lee Hooper held a public meeting at Clarksburg in 1941 and learned that the people of Clarksburg wanted the project but the farmers who would be relocated from the reservoir area were opposed. The conflict in Harrison and Lewis counties, between businessmen who wanted the project and farmers who opposed, persisted.

The Pittsburgh District surveyed seventeen separate sites for a dam on the West Fork and considered alternative development proposals for years, finally settling upon a site above Weston for the multipurpose Stonewall Jackson project. The plans required cost sharing with local and state government for water supply and recreation features. Weston and Clarksburg agreed to participate on a cost-sharing basis to obtain improved water supply, but cost-sharing for recreation proved an obstacle.

Federal policy demanded specific and continuing commitment for funding of recreational features from the state, but the West Virginia constitution prohibited one legislature from obligating future legislatures for debts. Senator Jennings Randolph, an ardent proponent of the Stonewall Jackson project, arranged amendment of federal policy to permit participation by West Virginia in recreational cost-sharing, and in 1975 Governor Arch A. Moore indicated he was ready to sign the cost-sharing agreement. The project was then held up by court action.



Historic St. George Academy in the proposed lake area - a focal point of the opposition to Rowlesburg Dam

The Upper West Fork Watershed Association filed suit in Federal Court in July 1974, alleging that the project's Environmental Impact Statement was inadequate. The Association urged the substitution of small watershed dams for the multipurpose project.

Judge Robert E. Maxwell of the Northern District of West Virginia made his decision on May 3, 1976. "The Court is satisfied that the EIS is adequate and meets the full disclosure standards and requirements of the National Environmental Policy Act," he concluded. "If the decision to construct the Stonewall Jackson Dam is reversed or modified," he commented, "this must be solely by action in the Congress." The Watershed Association appealed to the Fourth Circuit Court of Appeals, which, a year later affirmed the District Court's decision. In August 1977, the U. S. Supreme Court was petitioned to review the case. In January 1978, that highest court announced its denial of the petition.

The Pittsburgh District also had a second multipurpose project in West Virginia that was awaiting construction in 1977. Senator Jennings Randolph in 1936 obtained the original authority for a study of a dam on Cheat River at Rowlesburg to form a lake extending through Preston and Tucker counties to Parsons. No major opposition to the project was expressed during the early studies, and project proponents asked that the project have hydroelectric power production capabilities. Preliminary plans the Pittsburgh District completed in 1944 called for a multipurpose project at Rowlesburg, for flood control, water quality, and

power production. Public interest in the project languished until damaging floods occurred in the Cheat River valley in 1960, 1963, and 1964 and Congress authorized the project in 1965.

The Rowlesburg Dam Association, composed of representatives of local governments and business interests, organized in 1967 to lobby for the project. They presented their case to members and committees of Congress at every opportunity and in 1970 won an appropriation to begin land acquisition preliminary to construction.

At a public hearing at Parsons on February 27, 1971, Colonel Edward West and Senator Jennings Randolph heard the first significant opposition to Rowlesburg Dam. It came from the Cheat Valley Conservancy, which had the support of the Sierra Club, the Izaak Walton League, the Wilderness Society, and other environmental groups. They argued the Rowlesburg project would take too much land from Tucker County, that project benefits were overstated, that the Environmental Impact Statement was inadequate, and that it would ruin the wild and scenic Cheat River valley.

West Virginia Governor Arch Moore thereupon asked for a reevaluation of the Rowlesburg project. Since a university professor, who spoke for the opposition, had asked selection of members of the academic community to undertake an independent review of the plans for Rowlesburg Dam, the Pittsburgh District contracted with a firm composed of members of the faculty of the University of Massachusetts at Amherst to prepare a new Environmental Impact Statement.

THE
PITTSBURGH GAZETTE
SATURDAY, OCTOBER 26, 1793

Ohio Packet Boats

TWO BOATS for the present will let out from *Pittsburgh* for *Cincinnati*, and return to *Pittsburgh* in the following manner, viz.

First Boat will leave *Pittsburgh* on Monday next, the 21st instant, at eight o'clock in the morning, and return to *Pittsburgh* so as to be ready to sail again in four weeks from the above date.

Second Boat will leave *Pittsburgh* on Monday the 5th of November next, and return to *Pittsburgh* in four weeks as above.

And so on regularly, each Boat performing the voyage to and from *Pittsburgh* to *Cincinnati* once in every four weeks.

Two Boats, in addition to the above will shortly be completed and regulated in such manner, that one Boat of the four will let out weekly from *Pittsburgh* to *Cincinnati*, and return in like manner.

The Proprietor of these Boats having maturely considered the many inconveniences and dangers incident to the common method hitherto adopted of navigating the Ohio, and being in-

fluenced by a love of philanthropy and desire of being serviceable to the public, has taken great pains to render the accommodations on board the Boats as agreeable and convenient as they could possibly be made.

No danger need be apprehended from the enemy, as every person on board will be under cover, made proof against rifle or musket balls, and convenient port holes for firing out of. — Each of the Boats are armed with six pieces carrying a pound ball; also a number of good muskets, and amply supplied with necessary ammunition, strongly manned with choice hands, and the masters of approved knowledge.

A separate cabin from that designed for the men, is partitioned off in each Boat for accommodating Ladies on their passage. Conveniences are constructed of board each boat so as to render landing unnecessary, as it might at times, be attended with danger.

Rules and Regulations for maintaining order on board, and for the good management of the Boats, and Tables

accurately calculated of the rates of Freightage for passengers, and carriage of Letters to and from *Pittsburgh* to *Cincinnati*, also a Table of the exact time of the arrival and departure to and from the different places on the Ohio, between *Pittsburgh* and *Cincinnati*, may be seen on board each Boat. Passengers will be supplied with provision and liquors of all kinds, of the first quality, at the most reasonable rates possible. Persons desirous of working their passage will be admitted on finding themselves subject, however, to the same order and directions from the master of the Boats, as the rest of the working hands of the Boat's crew.

An OFFICE OF INSURANCE will be kept in *Pittsburgh*, *Limestone*, and *Cincinnati*, where persons desirous of having their property insured may apply. The rates of insurance will be moderate.

For Freight or passage apply at the Insurance Office, or to the Master on Board.

JACOB MYERS.

Pittsburgh, October 14, 1793.

Ohio River Division Engineer William L. Starnes told the Senate Committee on Appropriations that the Pittsburgh District would continue its study of Rowlesburg Dam and alternative plans. "This is an extremely important reservoir so far as flooding is concerned in the Pittsburgh area and on down the Ohio," the General said. "And, of course, that's also the problem with the project. In other words, the people who have to give up their land don't live in Pittsburgh or downstream on the Ohio. They live in Rowlesburg, and so it's a little difficult for them to see the particular logic."

In October 1977, District Engineer Max R. Janairo, Jr., submitted a summary of the District's re-evaluation studies to Moore's successor, Governor John D. Rockefeller, IV. By letter of November 9, 1977, Governor Rockefeller replied: "Having weighed carefully the benefits and drawbacks associated with this proposal, I have concluded that the costs in all aspects outweigh the benefits that could come from the Rowlesburg Project. I respectfully request that all planning on the Rowlesburg Project be terminated, and that it be placed on 'inactive status.'" After interchange of the appropriate in-house correspondence, Colonel Janairo was in a position to notify the Governor on January 25, 1978, that

Rowlesburg Lake, Cheat River, West Virginia, "has been reclassified from the active to the inactive category by the Chief of Engineers, Washington, D.C. on 9 January 1978." So Rowlesburg Lake was put on the shelf with Redbank Creek Reservoir in Pennsylvania, and Eagle Creek Reservoir in Ohio.

The Multipurpose Missions At the request of General Anthony Wayne and Secretary of War Henry Knox, General Rufus Putnam, the second Chief Engineer of the American Army and the founder of Marietta, Ohio, had contracted with Jacob Myers to deliver the mails swiftly and safely by river. After General Wayne had moved the American Army from Pittsburgh and Legionville to Cincinnati in 1792, to launch the Fallen Timbers campaign against the hostile Indians of the Northwest Territory, communications between the expeditionary force and headquarters had been broken on several occasions. Messengers following overland trails were waylaid, vital correspondence delayed, and the situation was intolerable, for then there were no other means of communication.

With temporary authority from the Postmaster General, Rufus Putnam arranged with Jacob Myers to move the mails in armed boats up and down the



Pittsburgh Bulk Mail Center

Ohio River in relays, with stops at some intermediate ports. Myers built small keelboats, about 24 feet long, with sides boarded up to protect heavily armed crews. Each packet would have a steersman and four sturdy oarsmen who would keep the boats moving fast at all times. His precautions paid off. Indians attacked the mailboats when they neared shore in 1794 and 1795, killing and wounding some of the crews, but the remaining crewmen were able to row to safety and deliver the mail on schedule.

Though an Army Engineer had organized the first regular mail service west of Pittsburgh in support of the operations of the frontier army, the Engineers were not again involved with the mail service in the Pittsburgh area until 1971, when the Pittsburgh Engineer District took on the job of building new facilities for the U. S. Postal Service. While awaiting the decisions of courts and the Congress on the Stonewall Jackson, Rowlesburg, and Muddy Creek projects, the Pittsburgh District undertook other work assigned it to take advantage of its engineering-construction expertise. Those jobs included work for the Postal Service, for the Bureau of Mines, and for the Nashville and the New Orleans Engineer Districts.

On September 26, 1970, the Postmaster General asked the Corps of Engineers to serve in a role similar to that of a general contractor for rapid construction of new mechanized postal facilities. Congress had reorganized the Post Office Department as the United States Postal Service, a public corporation expected eventually to operate on self-produced revenues. For the post office work, the Engineers would report not to Congress but to Postal Service authorities. The Chief of Engineers established the Corps of Engineers Postal Construction Support Office (CEPCSO) to coordinate the work at the national level.

Jacque S. Minnotte and a small staff in the Pittsburgh District familiarized themselves quickly with the unusual procedures and requirements of

the post office mission. They worked out design details and began contract negotiations, letting contracts for the \$7 million job at Akron, Ohio, in early 1972. By 1973, they had the Akron postal facility ready for use. It consisted of a main parcel distribution center and vehicle maintenance building, for service of postal service trucks, built in a new industrial park near Akron.

In August 1972, construction began at the \$38 million Pittsburgh Bulk Mail Center, located at Warrendale several miles north of the Golden Triangle. One of 21 similar centers built for the postal service across the nation, the Bulk Mail Center was built to permit mechanized handling of parcels for a four state area, and would handle the third largest volume of bulk mail in the nation.

Resident engineer Albert L. Zupon directed construction of the Center in three phases. About 600,000 cubic yards of material was first excavated to provide a level building site. Placement of the foundations and outer shell and installation of utility service lines began in April 1973. In the final phase, the roof was erected, the heating, cooling, fire alarm, and public address systems were installed, and \$9 million worth of bulk mail handling machinery was assembled and installed. Through aggressive construction management, the District completed the Pittsburgh Center on August 14, 1975, closer to schedule than any similar project in the country.

During the bicentennial year, 1976, the Pittsburgh District accepted two rather unusual engineering-construction jobs, one at Bruceton in Allegheny County and the other in Harlan County, Kentucky, on the headwaters of the Cumberland River.

"It will be the only one of its kind in the United States," said Major Mike Patten, resident engineer for the work at Bruceton. "When completed it will provide for the first time a complete testing area above ground for deep coal mining equipment and test new concepts in coal movement."

The U. S. Bureau of Mines assigned the \$10.3 million Bruceton project to the Pittsburgh District, which was to supervise the work of the contractor, Dick Corporation, and subcontractors beginning in the spring of 1977. Building the Mine Surface Test Facility and the Hydraulic Transport Research Facility would require construction of five buildings, access roads, utility lines, a power substation, and special equipment for testing purposes. The Bureau of Mines would use the facility to test support systems for the roofs of deep coal mines and to test the hydraulic transportation of bulk coal through pipes.

The Nashville Engineer District transferred the Martins Fork Dam and Lake project, located in rugged Harlan County, Kentucky, where Martins, Poor, and Clover Forks join to form the Cumberland River, to the Pittsburgh District for construction. Transfer of work between Engineer Districts to equalize workloads was a common practice, and at the time of the transfer the Nashville District was undertaking the massive Tennessee-Tombigbee Waterway project, linking the Tennessee River with the Tombigbee River and the port of Mobile on the Gulf.

Hydraulic Research Transport Facility



Jacque S. Minnotte

The Pittsburgh District dispatched resident engineer Jerry McDaniels and a small group of employees to Harlan to direct the Lane Construction Company, contractor for the 97-foot high, 504-foot long concrete dam that was to form a lake on Martins Fork. The project was unusual in that it was one of the few water resource projects that grew out of the plans for redevelopment of the Appalachian region, but the actual work did not differ much from that at the dams previously built in the Pittsburgh District. The men and women sent there from Pittsburgh no doubt felt quite at home, for Harlan County is rugged coal mining country very much resembling parts of the Pittsburgh Engineer District.

A Glance at the Future The Army Corps of Engineers is a year older than the nation. Founded on June 16, 1775, when Richard Gridley was appointed Chief Engineer to the Continental Army, the Corps celebrated its bicentennial in 1975. During that celebration, Pittsburgh District Engineer Max R. Janairo reviewed the Royal Americans, Thomas Hutchins' old regiment, performing at Point State Park, and christened the new District survey boat the *W. E. Merrill*, in honor of the officer



The W. E. Merrill

who had planned the first Engineer locks and dams on the three rivers which meet at Pittsburgh.

"The Corps of Engineers takes great pride in its heritage and close ties which are anchored to the very foundations upon which this nation was established," Colonel Janairo said to a crowd assembled for the bicentennial festivities. He explained how Army Engineers had served in the vanguard of every American army in every war since the founding of the Republic. He described the historic role of the Engineers in the improvement of the nation's waterways and the development of its water resources. He pointed out that the Corps was a multiple service organization, which had explored and mapped the American West, planned and built some of the first roads, railroads, and canals, and built all sorts of facilities, ranging from airfields, hospitals, and post offices to radar systems, national monuments, and space-rocket launchers. "Our District covers 26,000 square miles in parts of five states," he said, "and I am not going to detain you by elaborating on all of our achievements because that would take a very long time." Indeed, he was right.

General John W. Morris, who in 1976 became one of the long line of colorful men who have served as Chief of Engineers, thought the Corps in 1976 was on the threshold of a new era. Looking back at the previous decade, he noted that two laws enacted by Congress in 1965 had been a sort of turning point. Over the years, Congress had passed a series of laws identifying individual purposes for water resource projects, beginning with navigation, continuing with flood control, hydroelectric power, fish and wildlife conservation, water supply storage, and water quality, and finally ending in 1965 with recreation on a cost-sharing basis. The Water Resources Planning Act of 1965 directed the blending of individual project purposes for optimum

resource development. "So we ceased," said General Morris, "looking at the pieces that made up the whole of water resource development and began considering water resources as a part of another bigger unit - our total natural resources."

"If I were to look into the future," he continued, "I'd say navigation may become the leader among program elements. I would hope we can develop a full national water transportation system. Flood control and power will grow, particularly when non-structural solution flood control is included. Water supply for people and industry will remain steady. Recreation facilities will slowly but surely deteriorate under present cost-sharing arrangements and newly applied constraints on federal investments. I would also say the specter of a water crisis remains over us. Therefore, use and full conservation of water is a number one water program objective."

Jacque S. Minnotte, successor to John Arras, Charles Wellons, and James Neill as senior engineer in the Pittsburgh District, shared General Morris's quiet optimism. After forty years of service under eighteen different District Engineers, Minnotte had seen rough waters on all the rivers in the headwaters district, and he viewed the troubles of the present and the challenges of the future with considerable equanimity.

"Within the Corps the Pittsburgh District has long enjoyed an enviable reputation for its high level of competence, and it has demonstrated on many occasions its ability to react to emergencies and to be responsive to changing public needs," Minnotte said. "I am confident that the Corps and the District will continue to be called upon to apply its many skills in the nation's efforts to solve some of its water resource and other problems."

Chapter 19

RETURN TO JOHNSTOWN

"I feel a little apprehensive because anyone coming to Johnstown and talking about floods and flooding has a difficult task set for him," said Colonel Max R. Janairo. "It's a little like someone going to Punxsutawney and speaking as an authority on groundhogs."

Colonel Janairo, the Pittsburgh District Engineer, had traveled to Johnstown on March 30, 1977, to speak to the Rotary Club and urge their support for a sound floodplain management program.

"In early February, when I was invited to talk to you, the primary area of concern was the impending flood everyone was talking about," the Colonel continued. "This past severe winter had us primed with a potential for one of the worst flooding situations ever. But a few combinations clicked off just right and we're out of the jam posed by the severe icing and snowmelt."

January of 1977 had been the coldest month of record in the Pittsburgh Engineer District. About 450 miles of the Allegheny and 225 miles of the Monongahela and their major tributaries had been blocked by ice up to two feet thick. Navigation had slowed and stopped. Snow had accumulated in the upper Allegheny basin to an average depth of thirty-five inches, and the upper Monongahela basin had an average snow depth of sixteen inches. The potential was great for flooding of disastrous proportions in the headwaters district when the snow melted and the ice broke.

In early February, at the request of the Federal Disaster Assistance Administration (FDAA), the Pittsburgh District had mobilized for snow removal. Basically, the job was to open roads through drifts into isolated communities where supplies of food and fuel were dwindling and life was threatened. The District sent twenty-eight engineers to snow-buried communities in Pennsylvania and Ohio to help people survive the snow

Colonel Max R. Janairo, Jr.



and cold. By February 16, a total of 202 contracts for snow removal had been awarded.

While the snow removal work was underway, the District had braced for the spring thaw and the expected flooding. Sandbags were stockpiled and distributed to towns where the flood threat was greatest. Ten engineers went to critical areas in the Allegheny River basin to furnish technical assistance to communities and to study engineering solutions to the ice gorge problem. Breaking the ice with explosives, lasers, and hover craft was investigated, and eventually rejected.

Through meetings with community leaders and a media blitz, the District had kept the people of the headwaters district fully informed about the dangerous situation.

The snow began melting and the ice jams began to crunch downriver in late February. An eight-mile ice gorge broke on February 24 on Wheeling Creek. On February 25, ice floes began running down the Allegheny and the ice on the Youghiogheny began to move. The engineers manning the District's Emergency Operations Center became very anxious when the Weather Service predicted a heavy rain for February 26.

The predicted rain luckily passed north and west of Pittsburgh into Canada, ice moved on down the Ohio in a timely manner, serious flooding did not occur, and the headwaters district escaped a major disaster by a slim margin.

By the time Colonel Janairo spoke to the Johnstown Rotary Club at the end of March, trees were budding, the sun occasionally shining, and the worst winter in the history of the Pittsburgh Engineer District had ended. But the Colonel reminded the Rotarians that the Johnstown *Tribune-Democrat* had headlined a February 12 story about the threat of flooding with: "BE READY AND PRAY...AND CLEAR OUT THE BASEMENT." He said that headline was still good advice.

Colonel Janairo reviewed the history of flooding in Johnstown and the record of the Johnstown Flood Protection Project for the Rotary Club. He mentioned that the project had prevented major damages in the city during the floods caused by Tropical Storm HAZEL in October 1954 and Tropical Storm AGNES in June 1972, but warned that many parts of Cambria and Somerset Counties had no protection against flooding.

To counter publicity about flooding in Johnstown, civic leaders had widely advertised their city after 1943 as "Flood Free". Serious flooding had continued, however, outside the area protected by the channel improvement project.

The Pittsburgh Engineer District had completed a Flood Plain Information Study in 1974 for Cambria and Somerset Counties. Graphically illustrated with pictures showing the heights which flood waters could reach on buildings in and near Johnstown, the report provided a vivid description of the type and scope of damages that could be expected in the city. Engineers, however, could not predict just how soon such a flood would occur.

Colonel Janairo urged the Rotarians to support a program to regulate development in flood prone areas. "Johnstown has passed into a new area as far as flood planning is concerned," he continued. "The task now is not devising new protection for the city,

but regulating encroachment on the floodplain and in the areas of unavoidable flooding. The Corps of Engineers stands ready to assist you."

It Was the Strangest Thing Many people in Johnstown were enjoying the 1977 All-Star Baseball Game on television during the evening of July 19. At least, the National League fans were—the Nationals won 7 to 5. Some noticed that rain began while they were watching the game and were pleased; it had been a hot, dry summer. Drizzle continued until late evening, but fans who watched the news after the game heard no flood warning. Most switched off their sets and retired for the night.

National Weather Service meteorologists at Pittsburgh had begun tracking heavy thunderstorms moving from Lake Erie toward the southeast during the afternoon of July 19. Precipitation was intense but scattered. The meteorologists became concerned when their radar showed the storm system had stalled over Johnstown and the rains had persisted.

"It was like a conveyor belt," one private meteorologist said, "with thunderstorms developing on the northwest sector of the radar screen, moving to the southeast, stalling against a blocking high pressure center, and dumping their contents along the crest of the Appalachians."

Pittsburgh Engineer District Flood Plain Information Study

Johnstown Flood Museum



Johnstown City Hall



"It was the strangest thing," said a man who was marooned in a Johnstown motel. "It started to rain at 9:00 P.M. and it was the hardest constant rain I have ever seen. It rained until 4:00 A.M. in the morning. There was solid thunder and lightning the whole time. It seems like the city was being bombed--like London in World War II."

An official of the Pennsylvania Department of Environmental Resources said it was the worst rainstorm of which he had ever heard. "It just kept on raining and raining. I don't think we've ever had a rainstorm like it."

Intense July storms and floods are not rare in western Pennsylvania. Records were set by floods in July 1874, July 1888, and July 1942. Smethport at the head of the Allegheny River received an estimated thirty-five inches of rain in fifteen hours in July 1942, a record for the United States. Still, Johnstown had never had a storm of the intensity of that of July 1977 since the settlement of the Conemaugh River Basin.

More than twelve inches of rain fell on Johnstown in eight hours on the night of July 19-20, 1977. The runoff caused flooding of all types except tidal in the Johnstown vicinity, generating flood flows that far surpassed previous records in the Conemaugh Basin and resulting in the failure of seven dams.

The Flood A Civil Preparedness official at Johnstown said: "We are getting flooded by streams that I never heard of!" Innocuous brooks had become high velocity torrents that gouged out streambeds, carving the mountain sides as a plow cuts a new field. Those streams washed rocks, boulders, trees, homes and vehicles down the mountain sides into communities on the hill sides and in the floodplains.

Flood debris lodged against culverts, bridges, and other structures, damming streamflow, causing backwater flooding and sewer backup, and diverting the flow down highways and streets. When the structures gave way or the streams gouged a new channel, the debris moved on to ram another structure and repeated the process. Over thirty railroad



cars were washed into the Little Conemaugh River and some were carried two miles downstream where they lodged under a railroad bridge crossing the Conemaugh River.

Debris, mud, and water dashed into Johnstown. At the Point, where Stony Creek and the Little Conemaugh River form the Conemaugh River, the flood ran up to six feet deep in the business district. It inundated every riverside community along the Conemaugh below Johnstown until it reached Conemaugh Dam, 44.5 miles downstream.

"This flood came from the top down" said Johnstown Mayor Herbert Pfuhl. "It was not a flood of river water, it was a flood of rain water. It was runoff."

The flood began along the crest of the ridge dividing the Conemaugh and Mahoning Creek watersheds from the Susquehanna River Basin. Major flood damages occurred in eight Pennsylvania Counties: in Somerset, Westmoreland, Cambria, Indiana, and Jefferson Counties west of the Appalachian divide, and in Clearfield, Blair, and Bedford counties east of the divide.



The media devoted most of its attention to the damages at Johnstown, but damages north of Johnstown were proportionately as great, though affecting fewer people. The northern edge of the storm system caused damages in Sandy Lick Creek Basin near Reynoldsville and Brookville. Big Run, Sykesville, Sportsburg, and unprotected areas in the Upper Mahoning Creek Basin experienced significant damages. The local flood protection project in Big Run was overtopped, but the Punxsutawney project performed satisfactorily and prevented some \$1.8 million in damages. Water along the upper reaches of Crooked Creek reached a stage 2.5 feet higher than 1972 floods of record, and several small towns were inundated.

Flood depths along Blacklick Creek and its major tributary Two Lick Creek were formidable. Homer City, Clymer, Nanty Glo, Vintondale, Dilltown, and Josephine on Blacklick Creek and its tributaries suffered very heavy damages. The estimated flow of Blacklick Creek at Josephine on July 20 reached 55,000 cubic feet per second, more than *double* the previous maximum recorded in June 1972.

Damages Near Johnstown At Portage in the Little Conemaugh River Basin upstream of Johnstown, flood water and debris took out several bridges, lodging against others with low clearance to dam part of the flow and flood parts of Portage to

a depth of four feet. Wilmore was flooded by the North Branch of the Little Conemaugh to a five foot depth.

On South Fork of the Little Conemaugh, which flows through the gap in the dam that failed in 1889, water averaged 3.5 feet deep in Sidman, tearing away buildings located nearest the stream. More than half the homes at Creslo were flooded and a bridge destroyed. Debris collected against bridges near St. Michael, diverting flow into nearby towns. Swift currents carried automobiles down river.

Further south, in the Stony Creek Basin, Little Paint Creek, which drops 880 feet in its short course, flooded Elkton and a coal mine, sending automobiles and steel mine cars spinning down into the Village of Scalp Level. Homes and a church there were ripped asunder and at least three lives taken. A state-built flood protection project at Windber on main Paint Creek was overwhelmed, and the water ran seven feet deep in Windber, tearing out a major railroad bridge and inundating homes and businesses.

Heavy damages also occurred at Seanor and Hillsboro on Shade Creek and at communities clustered along the main stem of Stony Creek as it snakes to and through Johnstown.

Just after daybreak on July 20, the Little Conemaugh River and Stony Creek at their mouths surged to flows greatly exceeding the records set in 1936. But many parts of Johnstown were already under water when the record flows from the Little Conemaugh and Stony Creek arrived. Streams such as Peggys Run, Sams Run, Solomon Run, and Laurel Run, that plunge precipitously off the hillsides into Johnstown and its suburbs, had become killers.

Peggys Run, which drains a watershed of no more than six square miles, was little more than five feet wide where it cascaded down into Franklin Borough and the Little Conemaugh River on the Johnstown northside. On the morning of July 20, it washed out a gorge fifty to sixty feet wide in places,



Solomon Run Valley

demolished a small dam near its mouth, and rushed into a steel plant and homes located far enough up the hillside to be safe from Little Conemaugh River floods.

There was no record that Sams Run, which falls about 1,000 feet in its course through the Lorain, Geistown, Stonycreek, and Moxham communities clustered on the Johnstown east side, had ever before left its banks. Twelve inches of rain in eight hours changed that.

Sams Run picked up debris and slammed it against bridges and culverts damming its own course. Each time, its flow moved down nearby streets, inundating and washing out houses until pressures increased and the flood bypassed the bridges, releasing the debris to strike the next bridge downstream until Sams Run had cleared a path to Stony Creek.

Solomon Run, a four-mile long stream that falls about a thousand feet to its mouth in Hornerstown, was also a quiet little run that had never flooded. Its valley had filled with homes, schools, businesses, and apartments. It became a river on July 20, tearing away all in its path. It cut out half of the road fill of State Route 56 leading into Johnstown, destroyed countless homes along Solomon Street, and sliced off parts of houses and apartment buildings.

One family marooned that night in their home in Solomon Run, watched the stream carry screaming people in floating automobiles to their deaths. They saw fires break out in homes across the street where the fire department could do nothing, and they concluded they were witnessing the end of the world.



Laurel Run Dam

On Laurel Run in West Taylor Township on the Johnstown west side, the flood flow was augmented by the failure of a water supply dam containing 101 million gallons of water. Rainfall over Laurel Run that night totalled 11.87 inches, greater than the previous record for an entire month—June 1972 during AGNES. Laurel Run Dam failed without warning about 3:00 A.M. on July 20, sending water cascading through Pole Hollow and destroying about 80% of the homes in the Village of Tanneryville. Forty-one people lost their lives.

One strong lad escaped from his collapsed Tanneryville home, grabbed a log and rode the flood some 15 miles down the Run and the Conemaugh River, then swam to safety. His dog was found two days later still perched in a tree 17 feet from the ground. His mother and two sisters perished in the collapse of their home.

If precipitation had been less, or its fall spread over a longer time, the Corps' flood protection project might have spared Johnstown the low land floodplain inundation that occurred, but it could not have prevented the damages caused by such streams as Sams and Solomon Run. Water entered the project channels from all directions. The rivers at the Point rose quickly from a dry weather stage of about a foot to a thirty-five foot stage, cresting at 8:00 A.M. at a flow estimated to be 44% greater than the 1936 flow of record.

The channel project did reduce the flood crest at the Johnstown Point by eleven feet, thereby preventing water from entering the second and third stories of buildings near the Point. The damages that might have occurred if floating debris had impacted



against buildings at second and third stories can be visualized. Property damages would have been unsurpassed and loss of life might have rivaled the 2,209 deaths resulting from the 1889 flood. As it was, the final tally was 77 dead and 10 reported missing.

The preliminary estimate of damages in Johnstown alone was \$117 million, and the estimate of damages that would have occurred without the channel project was about four times those experienced. The Corps' Johnstown project, even overtopped, was therefore credited with preventing an estimated \$325 million in damages.

The Conemaugh River went over its banks for 95% of its length between Johnstown and the head of Conemaugh Lake at Blairsville. It destroyed a major bridge at Huff along with that village. It submerged Robindale, leaving that town merely three blocks of empty shells. It crested at Seward 5.25 feet higher than the 1936 record.

About 100 trailers were lost in mobile home parks at New Florence and Seward. The trailers filled and floated away with families riding the roof tops. Some people climbed from their trailers to refuge in

trees, from which they were rescued hours later by helicopters.

Carrying pieces of frame buildings, wrecked trailers, furnishings, flotsam of every variety, and several bodies, the flood entered Conemaugh Lake and pushed the debris down the lake to hang against the trash boom a few hundred feet upstream of Conemaugh Dam. There the Johnstown flood of 1977 stopped.

Conemaugh Dam held it all, reducing the flood crest on the Kiskiminetas River and preventing about \$16.4 million in damages at riverside communities along the Kiskiminetas below the dam and along the Allegheny River from Natrona to Pittsburgh.

The freak nature of the flood was underlined by data recorded at Conemaugh Dam. The flood rushed into Conemaugh Lake at a peak rate nearly double the previous record, set during AGNES in June 1972. But the flood receded just as quickly, filling the lake to only 64% capacity and not at all taxing the capabilities of the project.

In the basins to the north, adjacent to the Conemaugh Basin, Crooked Creek Lake crested at 19% full and Mahoning Creek Lake filled to 41% of its flood control capacity. No other flood control reservoir in the Pittsburgh Engineer District, not even Loyalhanna Lake, which is just seven miles from Conemaugh Lake, had a significant rise in its pool.

Emergency Operations Not even the people in Johnstown at first recognized the full scope of the disaster. The police and emergency network, located on the first floor of the City Safety Building, was flooded out. The staff of the Johnstown *Tribune-Democrat*, marooned on the second floor of their downtown Johnstown office building without telephone service, put out an issue on the afternoon of July 20 listing only two dead and five missing. No one knew what had happened at Tanneryville on Laurel Run, merely four miles from the central Johnstown business district, for a day after the disaster.

Because communications within the disaster area to the outside were largely disrupted by the floods, the Pittsburgh Engineer District Office had only scattered reports of minor flooding when it opened on the morning of July 20. District Engineer Max Janairo was out of the office on a motor tour of the southern sector of the District, and C. Dayle Miller, the Emergency Operations Planner, was on vacation.

Lieutenant Colonel Paul W. Tomiczek, Deputy District Engineer, and Jacque Minnotte, Chief of Engineering, considering the meager information available, concluded that a disaster had occurred and opened the District Emergency Operations Center at 9:00 A.M. They selected George Cingle, Jr., Chief of Planning, for service as Emergency Coordinator pending the return of Dayle Miller.

As a result of its experiences during AGNES, the Pittsburgh District had installed an Emergency Operations Center fully equipped with communications, working space, maps, and graphic wall displays. Maps, necessary gear, and the familiar white hard-hat and red jacket uniform labeled "Emergency Operations" were conveniently stored in the Center for supply of disaster survey teams.

Eugene Armocida, Chief of Hydrology and Hydraulics, sent teams toward the Mahoning Creek, Crooked Creek, and Blacklick Creek Basins, and toward Johnstown to check the extent of flooding and to collect hydrologic data. George Cingle sent Jack Goga and Joe Harchar from Planning Branch for a firsthand look at the Johnstown situation.

When Goga and Harchar arrived outside Johnstown and saw the erosion along the highways, they recognized the seriousness of the situation and located a phone to pass the grim news on to the District office. They then boarded a National Guard truck, went into the city and became involved in the rescue evacuation effort.



Emergency Operations Center - Pittsburgh





Scalp Level



Johnstown

Captain Glenn Lloyd and Paul Yeloushan of the Hydrology and Hydraulics Branch, traveling in a van with high road clearance, drove into Johnstown by State Route 53, negotiating by washouts and over trees and rubble. Water was several feet deep in town. Police, firemen, National Guardsmen, and anyone with a semblance of authority performing rescue work had closed the streets to traffic. Mayor Pfuhl had given the order to shoot looters on sight.

Captain Lloyd's military uniform and the red emergency operations jacket were passports through security check points, however, and the team drove through mud and water to the Public Safety Building, where Captain Lloyd waded in hip boots into the building to meet with the police chief. The police told Captain Lloyd that damages were high, several people had drowned, and the area was without telephone, power, or water service. The team returned to a phone outside Johnstown, informed the District Office a major catastrophe was at hand, and then boarded a rescue helicopter for aerial reconnaissance. Hank Edwards and Dave Turcsanyi accompanied Mayor Herbert Pfuhl on another helicopter flight to assess damages.

By late afternoon on July 21, the District had 22 people in, or on the way to, the disaster area. Ralph Weise, Jim Mersheimer, Frank Bailey, George Gimera, Captain Mike Carr, Barbara Wilson Lengyel, and Joe Butchko opened a field emergency operations office at the Johnstown National Guard Armory.

With communications largely destroyed, the immediate rescue evacuation and body recovery work was handled by volunteers, local officials and National Guard units. The first National Guard unit to arrive at Johnstown from outside the disaster area was the 876th Engineer Battalion of the Pennsylvania National Guard commanded by Colonel Robert Irvin. That unit reached Johnstown near midnight on July 20.

The Army Engineer troops sent to Johnstown in 1889 had aided with street security patrol, debris



Emergency Operations Center - Johnstown

clearance, and construction of temporary bridges to replace those washed out by the flood. The 876th Engineers performed similar work in July 1977, maintaining street patrols, clearing debris from the streets, and finally constructing Bailey Bridges over the Conemaugh River at Huff and over Two Lick Creek at Homer City.

News of the failure of the Laurel Run Dam and preliminary damage estimates made the full scope of the disaster apparent by the morning of July 21. That day, District Engineer Janairo and the Ohio River Division Engineer, General E. R. Heiberg, III, toured the area by helicopter and landed to confer with public officials. Governor Milton Shapp, Senators H. John Heinz and Richard Schweiker flew to Washington with video tapes of the destruction to show the White House staff. President Jimmy Carter quickly declared Cambria, Bedford, Clearfield, Indiana, Jefferson, Somerset, and Westmoreland Counties a Federal Disaster Area. Blair County was added on July 29.

The Pittsburgh District shipped pumps and contracted for delivery of electric wire and plastic pipe for emergency restoration of the Johnstown water supply. Water service was restored, but the supply was contaminated. For more than a month after the flood, potable water was delivered in National Guard tank trucks and plastic bottles.

The Johnstown channel project is one of a handful in the United States which are operated and maintained by the Corps of Engineers. Fortunately, a contracting firm which had recently completed a clearance contract on the project was readily available for debris clearance work. Ralph Weise, with a contractor's representative and men from the Federal Disaster Assistance Administration,

walked up Laurel Run into Tanneryville on July 21 and discussed the emergency with local officials. The contractor was engaged on the spot to open the mouth of Laurel Run and assist in body recovery.

After news of the Laurel Run Dam failure became public, rumors about the safety of other major dams near Johnstown circulated. Oran K. Henderson, Director of the Pennsylvania State Council of Civil Preparedness, requested that the Pittsburgh Engineer District cooperate with Pennsylvania Department of Environmental Resources (PDER) in swift inspection of dams in the vicinity to allay public concern.

Congressman John Murtha of Johnstown made a helicopter available for dam inspections, and Stuart Long of the Pittsburgh District joined the PDER engineer to perform the mission. Aerial inspection followed by ground inspections showed that no major dam in the disaster area was in imminent danger of collapse. Of the sixty-seven dams that were examined, seven had totally failed and four had suffered major damages. Laurel Run Dam was by far the largest of the dams that had failed.

On July 22, the Pittsburgh District relocated its operations center from the National Guard Armory to space in the Greater Johnstown Area Vocational-Technical School building in Richland Township and established a radio communication network. With the arrival of Richard Sanderson, Federal Disaster Assistance Coordinator, and the assignment of missions to the Corps by the FDAA, the emergency operations phase ended and disaster recovery work began.

Moving It Out The first debris clearance work assigned to the Corps was in the devastated Laurel

Run and Solomon Run basins. All of Johnstown was later added to the Corps debris removal job at the request of Mayor Herbert Pfuhl.

Because most of the food and drugs contaminated by the flood or spoiled for lack of refrigeration posed a serious health threat, FDAA directed the Corps to remove those materials to secure disposal sites. The Corps awarded contracts for that work on July 26. Five contractors removed over eight million pounds of contaminated consumables from Johnstown in less than a week.

Robert Conley, Chief of Procurement and Supply Division, Ralph Mucci of the Specifications and Estimates Section, Design Branch, and other specialists joined Ralph Weise in the engineering-inspection staff at Johnstown in drawing up and awarding contracts. They divided Johnstown into sectors, estimated the amount of debris in each sector, and prepared contract specifications and bid packages.

The contract award process was systematized. Bid packages for various sectors were prepared each day. Contractors submitted their proposals each morning and by early afternoon learned who among them was the successful bidder. Contractors appeared at Johnstown from as far away as Louisiana, Alabama, Kentucky, Arkansas, Colorado, but local contractors were given preference. Because the situation was urgent, the contractors were allowed very limited time to begin and complete their jobs. If they did not begin on time and proceed on schedule, their contracts were cancelled and the jobs awarded to other contractors.

"Boulders, cars, trees, you name it, we're moving it out," one Corps inspector told a reporter. Clad in their red and white uniforms, the inspectors spent their days, from dawn to dusk, standing ankle deep in slime and wearing face masks to filter the dust swirling up behind the heavy equipment.

Johnstown became by the end of July a massive traffic jam of emergency vehicles, local traffic, and construction equipment. Bulldozers and front end



loaders scraped several feet of mud and debris from streets and piled it into trucks. They paraded bumper to bumper to the disposal sites.

As soon as the streets were cleared, home owners tossed water damaged furniture out onto the streets for removal, followed by piles of warped paneling and wall plaster, followed by a third debris wave of slime shovelled out of cellars. Contractors cleared the same areas several times.

At the peak on August 5, contractors had 238 personnel and 178 equipment units at work. By the same date, Pittsburgh District had 115 people committed to the recovery mission. Army engineers poured into the area from the District Office and from Corps installations at Nashville, Louisville, Huntington, Savannah, Baltimore, Philadelphia, Mobile, and San Francisco. The District Office was stripped of tables, chairs, typewriters, and equipment to furnish the disaster offices and supply the field personnel with necessary gear.

By mid-August, the District had supervised the removal of approximately 300,000 cubic yards of mud and flood debris in Johnstown alone. At the request of the FDAA, the District also contracted for the demolition and removal of 62 flood damaged buildings.

Under its responsibility for the maintenance of flood protection projects, the District also contracted for clearing the Johnstown project channels of mud and for removal of the mass of debris piled against the trashboom upstream of Conemaugh Dam. By alternately raising and lowering the pool of Conemaugh Lake, the debris at the trashboom was beached for removal by a contractor. Three bodies were recovered from the debris in the trashboom area, and the work proceeded very cautiously.

Housing the Refugees The Department of Housing and Urban Development (HUD) requested the Corps on July 30 to begin the acquisition of real estate and the design and construction of mobile home parks at sites selected by HUD to house some of the nearly 5,000 people forced to evacuate their homes. The public had frequently criticized the Federal Government during previous disaster recovery operations for tardy provision of housing for the homeless, so that work at Johnstown was rushed at a frantic pace to get people quickly out of the refugee centers.

Under supervision of Jim Purdy of the District Planning Branch, Corps personnel established a mobile home site office in the East Hills Elementary

School at Johnstown. Survey teams developed maps and layouts of potential sites even before the real estate was acquired. John Fadool of the Real Estate Division negotiated with land owners for the park sites chosen by HUD, while the designs for trailer pads, utility services, and road layouts were being prepared.

Contracts for the construction for the first mobile home parks were awarded on August 8. They carried stiff penalties for late completion with offsetting bonuses for early delivery. By late August, a steady stream of trailers began moving into place on sites that two weeks before had merely been open fields. At the end of September, contracts had been awarded and most completed for the construction of 18 mobile home parks, with space for 970 trailers. There was little criticism of the Corps mobile housing mission, except from people who did not understand that new water, sewer, and power lines had to be placed underground, in some instances by blasting trenches through rock, before the trailers could be occupied.

Damage Survey Reports At places where direct Federal disaster assistance was not provided, local governments undertook work on their own and requested Federal reimbursement for the costs.





their mission with compassion. One inspector, for instance, noticed a cabinet filled with china in a Solomon Run apartment building without walls where all else had been destroyed. He took the time to locate the former tenant and helped move the cabinet to safety. It was the only item the lady saved from the flood.

The job did have its lighter moments. One Corps inspector answered a call from a lady who demanded that the Corps come and get the garbage out of her house. He asked if the material was flood debris. "No," the lady responded, "just the sort that comes out of my kitchen every day."

Mrs. Mary Strayer of Johnstown, whose telephone number resembled that of the Corps office, received many calls for the Corps and became a volunteer answering service, relaying calls and important messages. Mrs. Frank Bailey, whose husband worked in the Corps office, purchased a box of chocolates, which the District Engineer personally delivered to Mrs. Strayer along with the thanks of the Corps.

Bleary eyed from lack of sleep and with nerves frayed by the continual pressures to get the job done,



the Army Engineers at Johnstown still managed to maintain a positive attitude. "Our men were good emissaries," recalled Ralph Weise at the end of the disaster mission. "I don't know of one person we had down there that didn't go out of his or her way to prove we mean what we say...the Corps Cares."

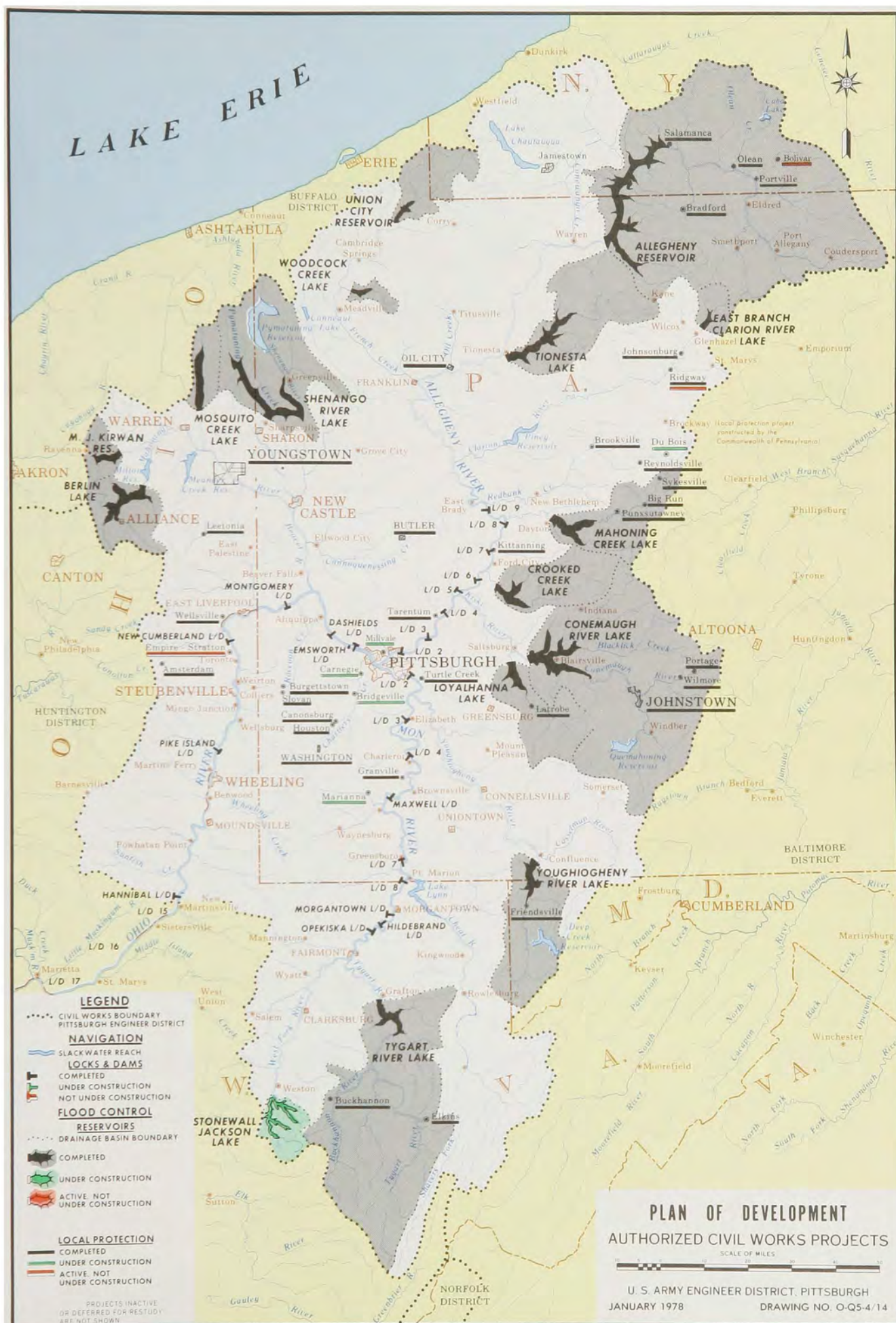
The Johnstown Flood Problem The flood of 1977 threw 20,000 people temporarily out of work. Some of that unemployment became permanent. Bethlehem Steel, an employer of about 11,000, declared it would not reopen some of its Johnstown facilities, cutting employment back by 3,500 jobs. The Penn Traffic Department Store in downtown Johnstown did not reopen; another 400 jobs lost.

Bill Glosser announced, however, that the Glosser Department Store would reopen. "What happened here last month," he said, "was a freak; it could have happened anywhere. The flood control walls they built here after 1936 did what they were supposed to do."

Like Glosser, the public in general recognized that the Corps channel improvement project had performed as designed and had simply been overwhelmed by the volume of water entering the channels in too short a period. Jacque Minnotte of the Pittsburgh District put it in a nutshell: "We control 30 percent and Mother Nature controls 70 percent."

Several people live in Johnstown who have survived the floods of 1889, 1936, 1977, and the lesser floods in between. Daise Heslop was born in 1883 and lost her father and grandmother in the 1889 flood. An unknown rescuer carried her to safety. In 1936 and 1977, she escaped without loss except separation from her family. She said she did not plan to relocate, floods or no floods, because she loved the city.

The axiom in Johnstown in 1977 was that the city is like the steel it produces: the harder it is hammered, the tougher it gets.



River and Harbor Projects

on the

OHIO RIVER

Locks and Dams	River Mile	Built	Placed in Operation	Description	Cost of Construction
No. 1 Davis Island	4.7	1877-1885	Oct. 1885	Navigable pass, one lock 50'×158'	\$870,034
Emsworth	6.2	1919-1922 1935-1938	Sep. 1921	Fixed crest; two locks: river, 56'×360'; land, 110'×600' Original structure eliminated Davis Island L/D and L/D 2. Structure was rebuilt to provide a gated crest and to raise the pool. This permitted the elimination of L/D 1, Monongahela River, and L/D 1, Allegheny River.	\$5,861,765 (Includes re- construction)
No. 2 (Glenfield, Pa.)	9.0	1898-1906	Oct. 1906	Navigable pass; one lock 110'×600'	\$976,767
No. 3 (Osborne, Pa.)	10.9	1899-1907	Feb. 1908	Navigable pass; one lock 110'×600'	\$1,144,588
Dashields	13.3	1927-1929	Aug. 1929	Fixed crest; two locks: river, 56'×360'; land, 110'×600' Eliminated L/D 3	\$8,531,478
No. 4 (Legionville, Pa.)	18.6	1898-1908	Feb. 1908	Navigable pass; one lock 100'×600'	\$1,071,472
No. 5 (Freedom, Pa.)	24.1	1898-1907	Nov. 1907	Navigable pass; one lock 110'×600'	\$1,080,132
No. 6 Merrill	29.3	1892-1904	Aug. 1904	Navigable pass; one lock 110'×600'	\$1,123,442
Montgomery	31.7	1932-1936	Jun. 1936	Gated crest; two locks: river, 56'×360'; land, 110'×600' Eliminated L/Ds 4, 5 and 6	\$5,737,611
No. 7 (Midland, Pa.)	36.5	1910-1914	Sep. 1914	Navigable pass; one lock 110'×600'	\$1,075,000
No. 8 (1.7 mi. below Newell, W.Va.)	46.4	1904-1911	Jul. 1911	Navigable pass; one lock 110'×600' Transferred to Pittsburgh District, August 1910.	\$1,167,456

Locks and Dams	River Mile	Built	Placed in Operation	Description	Cost of Construction
New Cumberland	54.4	1955-1963	Nov. 1959	Gated crest; two locks: river, 110'× 1,200'; land, 110'×600' Eliminated L/Ds 7, 8 and 9	\$39,099,688
No. 9	56.1	1910-1914	Nov. 1914	Navigable pass; one lock 110'×600' Construction commenced by Pittsburgh District, November 1910.	\$1,177,000
No. 10 (1.8 mi. above Steubenville, W.Va.)	66.2	1912-1916	Oct. 1915	Navigable pass; one lock 110'×600' Construction commenced by Pittsburgh District, November 1912.	\$1,138,000
No. 11 (2.5 mi. below Wellsburg, W.Va.)	76.9	1904-1911	Aug. 1911	Navigable pass; one lock 110'×600' Transferred to Pittsburgh District, June 1922.	\$1,162,165
Pike Island	84.3	1959-1965	Nov. 1916	Gated crest; two locks: river, 110'× 1,200'; land, 110'×600' Eliminated L/Ds 10 and 11	\$56,616,066
No. 12 (Warwood, W.Va.)	87.4	1911-1917	Jan. 1917	Navigable pass; one lock 110'×600' Transferred to Pittsburgh District, June 1930.	\$1,166,104
No. 13 (McMechen, W.Va.)	96.1	1901-1911	Aug. 1911	Navigable pass; one lock 110'×600' Transferred to Pittsburgh District, June 1930.	\$1,222,389
No. 14 (Woodland, W.Va.)	114.0	1911-1917	Aug. 1917	Navigable pass; one lock 110'×600' Transferred to Pittsburgh District, July 1965.	\$1,133,371
Hannibal	126.4	1966-1975	Jul. 1975	Gated crest; two locks: river, 110'× 1,200'; land, 110'×600' Eliminated L/Ds 12, 13 and 14	\$87,449,800

River and Harbor Projects
on the
MONONGAHELA RIVER

Locks and Dams	River Mile	Built	Placed in Operation	Description	Cost of Construction
No. 1 Mon. Nav. Co.	1.9	1838-1841 1848-1851 1909-1912	Oct. 1841	Fixed crest; one lock 50'×158' Additional lock 56'×216' New double locks (ea.) 56'×360' Eliminated by reconstructed Emsworth Dam, Ohio River 1936-1938	\$439,500 ¹
No. 2 Corps of Engrs. (Braddock, Pa.)	11.2	1904-1905 1949-1953	Aug. 1905 Jul. 1951 Nov. 1953	Adjustable crest; two locks (ea.) 56'×360' Locks and dam reconstructed; fixed crest, two locks River chamber, 56'×360' Land chamber, 110'×720' Eliminated L/D 2 Mon. Nav. Co.	\$17,872,212 ²
No. 2 Mon. Nav. Co.	11.8	1838-1841 1848-1854	Oct. 1841	Fixed crest; one lock 50'×158' Additional lock 56'×216'	\$442,000 ¹
No. 3 Corps of Engrs. (Elizabeth, Pa.)	23.8	1905-1907 1922-1924	May 1907	Adjustable crest; two locks (ea.) 56'×360' Land chamber lengthened to 720' Eliminated L/D 3 Mon. Nav. Co.	\$1,681,538 ²
No. 3 Mon. Nav. Co.	25.0	1840-1844 1883-1884	Nov. 1844	Fixed crest; one lock 50'×158' Additional lock 56'×277'	\$454,000 ¹
No. 4 Mon. Nav. Co. (N. Charleroi, Pa.)	40.9	1840-1844 1885-1886 1913-1916	Nov. 1844	Fixed crest; one lock 50'×158' Additional lock 56'×227' Two locks rebuilt (ea.) 56'×360'	\$425,000 ¹
No. 4 Corps of Engrs.	41.5	1931-1932 1964-1967	Aug. 1932 Jun. 1967	Fixed crest; two locks: land, 56'×720'; river, 56'×360' Eliminated L/D 4, Mon. Nav. Co. Pool raised and gated crest provided; <i>See Maxwell</i>	\$17,254,071 ²
No. 5 Corps of Engrs. (Brownsville, Pa.)	56.5	1907-1910	Dec. 1909	Fixed crest; two locks (ea.) 56'×360' Eliminated L/D 5 Mon. Nav. Co.	\$1,074,812 ²
No. 5 Mon. Nav. Co.	58.3	1854-1856	Nov. 1856	Fixed crest; one lock 50'×165.5'	\$215,000 ¹
Maxwell	61.2	1960-1965	May 1964	Movable crest; two locks (ea.) 84'×720' Maxwell L/D along with recon- struction of L/D 4, which raised Pool 4, per- mitted elimination of L/D 5, as con- structed by the Corps of Engineers, and L/D 6, as constructed by the Mon. Nav. Co.	\$30,110,889 ²
No. 6 Mon. Nav. Co. (Rice's Landing, Pa.)	68.3	1854-1856 1914-1916	Nov. 1856	Fixed crest; one lock 50'×165' Reconstructed with fixed crest, two locks (ea.) 56'×360'	\$175,000 ¹ \$770,449 ²
No. 7 Mon. Nav. Co. (Martin, Pa.)	82.3	1883-1884	1883	Fixed crest; one lock 50'×159'	\$171,200 ¹

Locks and Dams	River Mile	Built	Placed in Operation	Description	Cost of Construction
No. 7 Corps of Engrs.	85.0	1923-1926	Nov. 1925	Fixed crest; one lock 56'×360' This lock and dam, along with L/D 8, also constructed in 1925, permitted elimination of Mon. Nav. Co. L/D 7 and Corps of Engineers L/D 9 (1879)	\$2,639,804 ²
No. 8 Corps of Engrs. (Point Marion, Pa.)	87.1	1882-1889	Nov. 1889	Fixed crest; one lock 50'×161.6'	\$245,900 ²
No. 8 Corps of Engrs.	90.8	1923-1926 1958-1959	Oct. 1925	Fixed crest; one lock 56'×360' Dam raised; movable crest provided <i>See notes for L/D 7 Corps of Engrs.</i>	\$5,408,495 ³
No. 9 Corps of Engrs. (Hoard, W.Va.)	92.4	1874-1879	Nov. 1879	Fixed crest; one lock 50'×160'	\$191,000 ²
No. 10 Corps of Engrs. (Morgantown, W.Va.)	101.5	1897-1903	Dec. 1903	Fixed crest; one lock 56'×182'	\$210,445 ²
Morgantown	102.0	1948-1950	Jul. 1950	Movable crest; one lock 84'×600' Eliminated L/D 10 and 11	\$8,778,000 ²
No. 11 Corps of Engrs. (Uffington, W.Va.)	104.1	1901-1903	Dec. 1903	Fixed crest; one lock 56'×182'	\$227,668 ²
Hildebrand	108.0	1956-1960	Jun. 1959	Movable crest; one lock 84'×600' Eliminated L/D 12 and 13	\$12,506,829 ²
No. 12 Corps of Engrs.	109.1	1901-1903	Dec. 1903	Fixed crest; one lock 56'×182'	\$200,550 ²
No. 13 Corps of Engrs.	111.6	1901-1903	Jan. 1904	Fixed crest; one lock 56'×182'	\$190,691 ²
No. 14 Corps of Engrs.	115.0	1901-1903	Dec. 1903	Fixed crest; one lock 56'×182'	\$210,127 ²
Opekiska	115.4	1961-1967	Aug. 1964	Movable crest; one lock 84'×600' Eliminated L/D 14 and 15	\$25,179,622 ²
No. 15 Corps of Engrs.	124.2	1901-1903	Dec. 1903	Fixed crest; one lock 56'×182'	\$175,829 ²

¹ Construction costs were prepared by T. P. Roberts, who was at that time Chief Engineer of the Monongahela Navigation Company. His report was dated December 29, 1886. The estimates include the costs of the original construction, real estate, and additional locks where appropriate, but not the repair of breaches in Dams 1, 2, and 3.

² Construction costs reported in the 1977 Annual Report of the Chief of Engineers:
Cost for Locks and Dam 2 includes \$16,967,114 for reconstruction of locks,

Cost for Locks and Dam 3 includes cost of extending land chamber,
Cost for Locks and Dam 4 includes \$15,080,304 for reconstruction of dam,
Cost for Locks and Dam 6 includes the reconstruction of both locks and dam.

³ Construction cost as reported in "Project Maps and Data Sheets:"
Original construction (1923-1926) \$2,086,438,
Reconstruction (1958-1959) \$3,322,057.

River and Harbor Projects
on the
ALLEGHENY RIVER

Locks and Dams	River Mile	Built	Placed in Operation	Description	Cost of Construction
No. 1 Herr's Island	1.7	1893-1903	Dec. 1902	Movable dam; one lock 55'×286'	\$591,187
Six Mile Island	6	1879		Low earth dam, 700' long	(1)
No. 2 Existing (Aspinwall, Pa.)	6.7	1932-1934	Oct. 1934	Fixed crest; one lock 56'×360' Replaced original L/D 2	\$1,763,485
No. 2 Original	7.0	1902-1908	Nov. 1906	Fixed crest; one lock 56'×289'	\$544,929
No. 3 Existing (Cheswick, Pa.)	14.5	1932-1934	Oct. 1934	Fixed crest; one lock 56'×360' Replaced original L/D 3	\$1,875,665
No. 3 Original (Springdale, Pa.)	17.0	1897-1904	Nov. 1904	Fixed crest; one lock 56'×289'	\$310,103
No. 4 (Natrona, Pa.)	24.2	1920-1927	Sep. 1927	Fixed crest; one lock 56'×360'	\$1,707,690
No. 5 (Freeport, Pa.)	30.4	1920-1927	Oct. 1927	Fixed crest; one lock 56'×360'	\$1,940,537
No. 6 (Clinton, Pa.)	36.3	1927-1928	Oct. 1928	Fixed crest; one lock 56'×360'	\$1,523,959
Nicholson's Island	37	1880		Low earth dam, 1,000' long	(1)
No. 7 (Kittanning, Pa.)	45.7	1928-1931	Nov. 1930	Fixed crest; one lock 56'×360'	\$1,460,008
Cowanshannock, Pa.	47-47.4 48	1893-1895 1893		Two spurdikes, 510' and 525' long Low earth dam, 402' long	(1) (1)
No. 8 (Templeton, Pa.)	52.6	1929-1931	May 1931	Fixed crest; one lock 56'×360'	\$2,848,920
No. 9 (Rimerton, Pa.)	62.2	1935-1938	Oct. 1938	Fixed crest; one lock 56'×360'	\$2,510,373
Red Bank Creek	64.0	1889		Dike, 1,739' long	(1)
Pithole	143	1891		Low earth dam, 1,132' long	(1)
Tionesta	152	1893		Low earth dam, 298' long	(1)
Hickory	157	1891		Low earth dam, 730' long	(1)
Cornplanter	204	1890		Low earth dam, 334' long	(1)
Corydon	209	1887		Log chute, 370' long	(1)

(1) From the Report of the Chief of Engineers for fiscal year ending June 30, 1897. The estimated total cost of improvements up to that date was \$218,000.

DISTRICT ENGINEERS

Pittsburgh District

No Picture Available:

BG Godfrey Weitzel, Jul. 1869 - Nov. 1869
 MAJ Daniel W. Lockwood, Dec. 1891 - Feb. 1892
 CPT H. W. Hill (Acting), Jul. 1931 - Sep. 1931



Mr. William Milnor Roberts
 Aug. 1866 - Jun. 1870



COL William E. Merrill
 Jun. 1870 - Dec. 1891



MAJ Amos Stickney
 Feb. 1892 - Dec. 1893



MAJ Richard L. Hoxie
 Dec. 1893 - Apr. 1897



MAJ Charles F. Powell
 Mar. 1897 - Dec. 1901



MAJ William L. Sibert
 Dec. 1901 - Mar. 1907



LTC Henry C. Newcomer
 Mar. 1907 - Aug. 1912



LTC Francis R. Shunk
 Aug. 1912 - Jun. 1916



LTC Edgar Jadwin
 Jun. 1916 - Jul. 1917



LTC Horton W. Stickle
 Jul. 1917 - Sep. 1918
 Nov. 1918 - Aug. 1919



Mr. John W. Arras
 Sep. 1918 - Nov. 1918



LTC Harley B. Ferguson
 Aug. 1919 - Aug. 1920



LTC Curtis W. Otwell
 Aug. 1920 - Oct. 1920



MAJ J. Franklin Bell
 Oct. 1920 - Jun. 1923



MAJ Edmund L. Daley
 Aug. 1923 - Aug. 1926



COL Charles W. Kutz
 Jun. 1923 - Aug. 1923
 Aug. 1926 - Apr. 1927



LTC Jarvis J. Bain
 Apr. 1927 - Jul. 1931



MAJ Wilhelm D. Styer
Sep. 1931 - May 1936



LTC William E. R. Covell
May 1936 - Apr. 1940



LTC Ludson D. Worsham
Jul. 1940 - May 1941



COL D. Lee Hooper
May 1941 - May 1942



COL Herbert D. Vogel
May 1942 - Jul. 1943



COL Gilbert Van B. Wilkes
Jul. 1943 - Dec. 1944



LTC Charles M. Wellons
Dec. 1944 - Oct. 1945



COL Walter E. Lorence
Oct. 1945 - Oct. 1947



COL Francis H. Falkner
Oct. 1947 - Aug. 1949



COL Conrad P. Hardy
Sep. 1949 - Dec. 1952



COL Ralph A. Lincoln
Jan. 1953 - Jul. 1955



COL Harold E. Sprague
Aug. 1955 - Jul. 1958



COL William W. Smith, Jr.
Jul. 1958 - Jun. 1961



COL Bert de Melker
Jun. 1961 - Jul. 1964



COL James E. Hammer
Jun. 1964 - Jun. 1967



COL Wayne S. Nichols
Jun. 1967 - May 1970



COL Edward C. West
May 1970 - Jun. 1972



COL Norman G. Delbridge
Jun. 1972 - Feb. 1975



COL Max R. Janairo, Jr.
Feb. 1975 - Jul. 1978



COL Joseph A. Yore
Jun. 1978



BIBLIOGRAPHICAL ESSAY

The principal sources for the history of the Pittsburgh Engineer District and the Corps of Engineers in general are the Records of the Office of the Chief of Engineers, Records Group 77, National Archives (cited hereinafter as RG 77, NA), and the annual reports of the Chief of Engineers. The Records of the Office of the Chief of Engineers (RG 77, NA) prior to 1917 are located in the Old Military Records Branch, National Archives, Washington, D. C. Records for the years since 1917 are located at Washington National Records Center of the National Archives at Suitland, Maryland, and in several Regional Federal Records Centers, especially the centers at Philadelphia, Pennsylvania, and Kansas City, Missouri. The annual reports of the Chief of Engineers prior to 1837 are printed in the *American State Papers: Military Affairs* (7 vols.; Washington, 1834-1860). From 1837 to 1867, the annual reports were printed in congressional documents, usually accompanying the annual message of the President to Congress. Since 1867, the annual reports have been printed separately in a serial set commonly known as the *Annual Report of the Chief of Engineers* (cited hereinafter as *ARCE*, followed by the year of the report). Each annual report is multivolume, but pagination is usually consecutive.

Most divisions and branches of the Pittsburgh District office in the Federal Building, 1000 Liberty Avenue, Pittsburgh, maintain limited records, which are eventually retired to the National Archives. Those of special historical interest are located in the Engineering Division, Public Affairs Office, and the District Library.

Older general histories of the Corps of Engineers, which furnish a framework for the history of the Pittsburgh Engineer District, are W. Stull Holt, *The Office of the Chief of Engineers of the Army: Its Non-Military History, Activities, and Organization* (Baltimore, 1923); Henry P. Beers, "A History of the U. S. Topographical Engineers, 1813-1863," *Military Engineer*, XXXIV (June-July, 1942), 287-91, 348-52; Edward Burr, "Historical Sketch of the

Corps of Engineers, U. S. Army," *Occasional Papers: The Engineer School* (No. 71, 1939); William P. Craighill, "Corps of Engineers, United States Army," *Transactions of the American Society of Civil Engineers*, VIII (1897), 429-35; Henry C. Jewett, "History of the Corps of Engineers to 1915," *Military Engineer*, XIV (September-December, 1922), 304-06, 385-88; and Andrew A. Humphreys, "Historical Sketch of the Corps of Engineers," in U. S., Congress, House, *Reorganization of the Army*, H. Rept. 555, 45 Congress, 3 Session, 1878, pp. 327-49.

Space limitations prevent the listing of all sources, but principal sources are outlined hereinafter for those who might wish to pursue a specific subject mentioned in the text at greater length. Organization is by chapter and thereunder follows the subject matter order of the text.

Chapter 1

ENGINEERS AT THE HEADWATERS

Ralph B. Buzzaird, "America's First Chief Engineer," *Military Engineer*, XXIX (December, 1947), 505-10, reviews the career of General Richard Gridley.

General accounts of the action at the Forks of the Ohio, which include discussions of the roles of Francois Le Mercier and George Washington, are Charles M. Stotz, *Point of Empire: Conflict at the Forks of the Ohio* (Pittsburgh, 1970); Charles M. Stotz and Alfred P. James, *Drums in the Forest* (Pittsburgh, 1958); and Walter O'Meara, *Guns at the Forks* (Englewood Cliffs, New Jersey, 1965).

Activities of French Engineers in America are described in John F. McDermott, ed., *The French in the Mississippi Valley* (Urbana, 1965). The French forts in Pennsylvania are described in William A. Hunter, *Forts on the Pennsylvania Frontier, 1753-1758* (Harrisburg, 1960). Correspondence pertaining to the 1739 Longueuil expedition is printed in Sylvester K. Stevens and Donald H. Kent, eds., *Wilderness Chronicles of Northwestern Pennsylvania* (Harrisburg, 1941).



Documents relating to the activities of George Washington in the Ohio River basin are printed in Hugh Cleland, *George Washington in the Ohio Valley* (Pittsburgh, 1955).

Harry Gordon's account of Braddock's Defeat is quoted from Charles M. Stotz, ed., "A Letter from Will's Creek," *Western Pennsylvania Historical Magazine*, XLIV (June, 1961), 129-37. Washington's 1758 report on the capture of Fort Duquesne is quoted in Charles W. Dahlinger, "Fort Pitt," *Western Pennsylvania Historical Magazine*, V (January, 1922), 8. Charles M. Stotz, "Defense in the Wilderness," *Western Pennsylvania Historical Magazine*, XLI (Autumn, 1958), 59-203, furnishes authoritative details about the construction of Fort Pitt.

The Thomas Hutchins Papers are in the Historical Society of Pennsylvania, Philadelphia. His career is outlined in Anna M. Quattrochi's articles: "Thomas Hutchins in Western Pennsylvania," *Pennsylvania History*, XVI (January, 1949), 31-38, and "Thomas Hutchins, Provincial Soldier and Indian Agent in the Ohio Valley, 1758-1761," *Western Pennsylvania Historical Magazine*, XLV (September, 1962), 193-207.

Documents relating to the 1766 expedition down the Ohio River are Thomas Gage to Harry Gordon, May 9, 1766, William L. Clements Library, University of Michigan; George Morgan to Molley Morgan, June 28, 1766, Illinois Historical Survey, University of Illinois; Beverly Bond, Jr., ed. *The Courses of the Ohio River taken by Lt. T. Hutchins, Anno 1766* (Cincinnati, 1942); and "Extract from the Journal of Captain Harry Gordon... in 1766," *Journal of the Illinois State Historical Society*, II (1909), 55-64.

Peter D. Keyser, ed., "Memorials of Col. Jehu Eyre," *Pennsylvania Magazine of History and Biography*, III (1879), 296-307, 412-25, describes bateaux construction at Fort Pitt in 1760.

Two accounts of bateaux fleet trips down the Ohio are John Jennings, "Journal from Fort Pitt to Fort

Chartes in the Illinois Country, March-April, 1766," *Pennsylvania Magazine of History and Biography*, XXXI (1907), 145-56, and "Diary of Matthew Clarkson, West of the Alleghanies, in 1766," in Henry R. Schoolcraft, *History, Condition and Prospects of the Indian Tribes of the United States*, Part IV (Philadelphia, 1856), 265-77.

The correspondence of Lieutenant George Phyn about his voyage down the Ohio in 1767 is printed in Clarence W. Alvord and Clarence E. Carter, eds., *Trade and Politics, 1767-1769* (Springfield, 1921), pp. 21-23, 118. That volume also prints George Morgan's commercial correspondence, and materials pertaining to the ship/keelboat *Three Friends* on pages 140-41, 274-75.

The commercial affairs and shipbuilding activities of Baynton, Wharton and Morgan are reviewed in Lawrence S. Thurman, ed., "An Account Book of Baynton, Wharton, and Morgan at Fort Pitt, 1765-1767," *Western Pennsylvania Historical Magazine*, XXIX (September, 1946), 141-46; Max Savelle, *George Morgan, Colony Builder* (New York, 1932); Thomas P. Abernethy, *Western Lands and the American Revolution* (New York, 1959); and Leland D. Baldwin, *The Keelboat Age on Western Waters* (Pittsburgh, 1941).

The Benham/Brown story is related in C. Hale Sipe, *The Indians Wars of Pennsylvania* (Harrisburg, 1929), pp. 535-36. Accounts of the ambush of Captain David Rogers are found in Consul W. Butterfield, *History of the Girty's* (Cincinnati, 1890); Randolph C. Downes, "Indian War on the Upper Ohio, 1779-1782," *Western Pennsylvania Historical Magazine*, XVII (June, 1934), 96-97; Lawrence Kinnaird, ed., "Spain in the Mississippi Valley, 1765-1794," *American Historical Association Report, 1945*, II (Washington, 1949), 241-42, 248-50, 362-64.

On the campaigns begun in the Fort Pitt vicinity during the Revolution, consult Walter R. Fee, "Colonel George Morgan at Fort Pitt," *Western Pennsylvania Historical Magazine*, XI (October,

1928), 217-24; Louise P. Kellogg, ed., *Frontier Advance on the Upper Ohio, 1778-1779* (Madison, 1916); R. G. Thwaites and Louise P. Kellogg, eds., *Frontier Defense on the Upper Ohio, 1777-1778* (Madison, 1912); John W. Caughey, "Willing's Expedition down the Mississippi, 1778," *Louisiana Historical Quarterly*, XV (1932), 5-36; James A. James, *The Life of George Rogers Clark* (Chicago, 1928); John Bakeless, *Background to Glory: The Life of George Rogers Clark* (Philadelphia, 1957); Rufus B. Stone, "Sinnontouan, or Seneca Land, in the Revolution," *Pennsylvania Magazine of History and Biography*, XLVIII (1924), 201-26; William Y. Brady, "Brodhead's Trail Up the Allegheny, 1779," *Western Pennsylvania Historical Magazine*, XXXVII (March, 1954), 19-31; and James A. James, "Pittsburgh, A Key to the West during the American Revolution," *Ohio Archaeological and Historical Publications*, XXII (1913), 64-79.

Events at Beaver and Wheeling during the Revolution are outlined in Louis E. Graham, "Fort McIntosh," *Western Pennsylvania Historical Magazine*, XV (May, 1932), 93-119; Delf Narona, "A Forgotten Account of the Sieges of Fort Henry," *West Virginia History*, VIII (April, 1947), 305-14; and Glenn F. Massay, "Fort Henry in the American Revolution," *West Virginia History*, XXIV (April, 1963), 248-57.

George Washington's letter on river navigation improvements is printed in John C. Fitzpatrick, ed., *The Writings of George Washington*, XXVIII (Washington, 1938), p. 11. His 1784 visit to the Monongahela basin is described in C. W. Beerblower, "General George Washington's Last Trip Across the Allegheny Tableland, 1784," *West Virginia History*, XIX (April, 1958), 186-93. See also Robert M. Ewing, "Washington's Western Journeys and Their Relation to Pittsburgh," *Western Pennsylvania Historical Magazine*, V (July, 1922), 220-35.

Thomas Hutchins' services as Geographer to the United States are detailed in William D. Pattison, *Beginnings of the American Rectangular Land Survey System, 1784-1800* (Chicago, 1957).

Chapter 2

THE GATEWAY TO THE WEST

Printed biographies of Rufus Putnam include Raleigh B. Buzzaird, "Washington's Favorite Engineer," *Military Engineer*, XL (March, 1948), 115-18; E. O. Randall, "Rutland--The Cradle of Ohio," *Ohio Archaeological and Historical Publications*, XVIII (1909), 54-78; S. P. Hildreth, *Biographical and Historical Memoirs of the Early Pioneer Settlers of Ohio* (Cincinnati, 1852), pp. 13-119; and Gordon R. Young, "Rufus Putnam," *Professional Memoirs, Corps of Engineers*, X (January-February, 1918), 65-67.

General information about flatboats and their uses is supplied in Dale Van Every, *Ark of Empire: The American Frontier, 1784-1803* (New York, 1963); and quantitative analysis is attempted in Erik F. Haites, James Mak, and Gary M. Walton, *Western River Transportation: The Era of Early Internal Development, 1810-1860* (Baltimore, 1975). See also Alan S. Brown, "The Role of the Army in Western Settlement: Josiah Harmar's Command, 1785-1790," *Pennsylvania Magazine of History and Biography*, XCIII (April, 1969). Thomas Ridout's journal is printed in "An Account of My Capture by the Shawanese Indians," *Western Pennsylvania Historical Magazine*, XII (January, 1939), 3-31.

Scores of journals by flatboatmen have been printed and scores remain unpublished in the manuscript sections of libraries in the Ohio River basin. The Tilly Buttrick journal is printed in John W. Harpster, ed., *Pen Pictures of Early Western Pennsylvania* (Pittsburgh, 1938), pp. 265-67.

Materials relating to the commercial ventures of Barthélemi Tardiveau and early traffic to New Orleans are Howard C. Rice, Jr., ed., "News from the Ohio Valley as Reported by Barthélemi Tardiveau in 1783," *Bulletin of the Historical and Philosophical Society of Ohio*, XVI (October, 1958), 267-92; Howard C. Rice, *Barthélemi Tardiveau, A French Trader in the West* (Baltimore, 1938); Leland D. Baldwin, "The Rivers in the Early Development of Western Pennsylvania," *Western Pennsylvania*

Historical Magazine, XVI (May, 1933), 79-98; Thomas P. Abernethy, *Western Lands and the American Revolution* (New York, 1959); E. Earl Moore, "An Introduction to the Holker Papers," *Western Pennsylvania Historical Magazine*, XLII (September, 1959), 225-39; and George W. Hughes, "The Pioneer Iron Industry in Western Pennsylvania," *Western Pennsylvania Historical Magazine*, XIV (July, 1931), 207-24.

Records of flatboats arriving at New Orleans are fairly complete. Consult the "Flatboat Registers," Louisiana Division, New Orleans Public Library, New Orleans, Louisiana, and Customs Collection Records available in RG 36, the Legislative, Judicial and Fiscal Branch, Civil Archives Division, National Archives. An article based on the latter records, which emphasizes the role of Wellburg, West Virginia, as a river port is W. F. Galpin, "The Grain Trade of New Orleans, 1804-1814," *Mississippi Valley Historical Review*, XIV (March, 1928), 500.

Articles outlining the general significance of the flatboat trade are Frank P. Goodwin, "Building a Commercial System," *Ohio State Archaeological and Historical Quarterly*, XVI (1907, 331-32; Randolph C. Downes, "Problems of Trade in Early Western Pennsylvania," *Western Pennsylvania Historical Magazine*, XIII (October, 1930), 261-71; and Catherine E. Reiser, "Pittsburgh's Commercial and Industrial Development during the Opening Years of the 19th Century," *Pennsylvania History*, XVIII (January, 1951), 51-52.

The authoritative work on keelboats is Leland D. Baldwin, *The Keelboat Age on Western Waters* (Pittsburgh, 1941).

General Anthony Wayne's experiences at Pittsburgh and with Ohio River navigation are best traced in his papers at the Historical Society of Pennsylvania, Philadelphia. Part of that correspondence is printed in Richard C. Knopf, ed., *Anthony Wayne: A Name in Arms* (Pittsburgh, 1960). See also Harry E. Wildes, *Anthony Wayne: Trouble Shooter of the American Revolution* (New

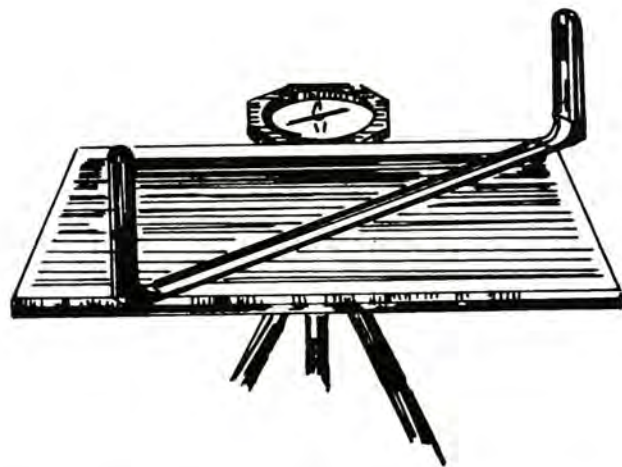
York, 1941). The comment of Secretary of War James McHenry on the value of training engineers is printed in *American State Papers: Military Affairs*, I, 129.

Catherine Mathews, *Andrew Ellicott: His Life and Letters* (New York, 1908), and Charles B. Stuart, *Lives and Works of Civil and Military Engineers of America* (New York, 1871) supply biographies of surveyor Ellicott. The records of Ellicott's voyage down the Ohio River are in Andrew Ellicott, "Southern Boundary, U.S. and Spain" (3 vols.; manuscript in Department of State Records, National Archives); his journal was printed in 1807.

On General James Wilkinson and the galleys, see Thomas R. Hay and M. R. Werner, *The Admirable Trumpeter: A Biography of General James Wilkinson* (New York, 1941); "General James Wilkinson's Order Book, 1796-1808," Record Group 94, National Archives; Bob Stearns, "Pittsburgh's Fighting Ships," *Pittsburgh Press*, May 2, 1976; William F. Trimble, "From Sail to Steam," *Western Pennsylvania Historical Magazine*, LII (April, 1975), 147-67; Isaac Craig Papers, Carnegie Library, Pittsburgh; and James Wilkinson, *Memoirs of My Own Times* (Philadelphia, 1816).

Shipbuilding in the Ohio River basin is reviewed in Leland D. Baldwin, "Shipbuilding on the Western Waters, 1793-1817," *Mississippi Valley Historical Review*, XX (June, 1933), 29-34; Richard T. Wiley, "Ship and Brig Building on the Ohio and Its Tributaries," *Ohio Archaeological and Historical Publications*, XXII (1913), 54-64; W. Espy Albright, "Early Development of Transportation on the Monongahela River," *Western Pennsylvania Historical Magazine*, II (April, 1919), 115-24. The records of individual ships arriving at New Orleans, 1804 to 1870, are compiled in Works Projects Administration, *Ship Registers and Enrollments of New Orleans, Louisiana* (6 vols.; Baton Rouge, 1941-42).

The history of the gunboats built 1805-07 must be traced in Navy Records, RG 45, National Archives;



see especially Secretary of Navy, "Miscellaneous Letters Received, 1801-84," Microfilm 124. On Aaron Burr and his visit to Canonsburg, see Mark Van Doren, ed., *Correspondence of Aaron Burr and His Daughter Theodosia* (New York, 1929); Max Savelle, *George Morgan, Colony Builder* (New York, 1932); and testimony at the Burr trial, printed in *American State Papers: Miscellaneous*, I, 556.

The Jonathan Williams Papers are located in the Lilly Library, Indiana University, Bloomington, Indiana. Selections are printed in Dwight L. Smith, ed., "The Ohio River in 1801: Letters of Jonathan Williams, Junior," *Filson Club Historical Quarterly*, XXVII (July, 1953), 199-222. See also Thomas P. Abernethy, *Western Lands in the American Revolution* (New York, 1959), pp. 183, 208-09. Secretary of War James McHenry is quoted in *American State Papers: Military Affairs*, I, 142-43.

On the Lewis and Clark expedition, see James C. King, "Pittsburgh: Gateway to the Far West in 1803," *Western Pennsylvania Historical Magazine*, L (October, 1967), 301-03; Milo M. Quaife, ed., "The Journals of Captain Meriwether Lewis and Sergeant John Ordway Kept on the Expedition of Western Exploration, 1803-1806," *Wisconsin Historical Society Collections*, XXII (1916), 31-402; John Bakeless, *Lewis and Clark, Partners in Discovery* (New York, 1947); and Donald B. Chidsey, *Lewis and Clark: the Great Adventure* (New York, 1970).

Chapter 3

REDUCING THE RISKS OF NAVIGATION

Details of the ambush of the Sharpe family are to be found in *Pennsylvania Archives*, Second Series, VI, 677-78; *Pittsburgh Gazette*, June 7, 1794; Francis B. Harbison, "The Allegheny Valley," *Western Pennsylvania Historical Magazine*, XXVII (September-December, 1944), 145-47.

The "Journal of Col. John May, of Boston, 1789," *Pennsylvania Magazine of History and Biography*, XLV (1921), 101-79, describes troubles with

Monongahela navigation. Timothy Flint, *Recollections of the Last Ten Years* (Boston, 1826), pp. 19-21, described his flatboat trip to Deadman's Ripple. Flatboat losses are estimated in Leland D. Baldwin, *The Keelboat Age on the Western Waters* (Pittsburgh, 1941), pp. 83-84.

Governor Thomas Mifflin's message on waterway projects is printed in *Pennsylvania Archives*, Fourth Series, IV, 152. Contracts, correspondence, and other materials pertaining to the Pennsylvania river improvement projects are located in River Improvement Papers, Record Group 26, Pennsylvania State Archives, Harrisburg, Pennsylvania. The Matlack, Maclay, and Adlum report of 1790 is printed in *Pennsylvania, House Journal*, 1815-1816, Appendix, pp. 28-41. See also Samuel Maclay, *Journal of Samuel Maclay while Surveying the West Branch of the Susquehanna, the Sinnemahoning, and the Allegheny Rivers in 1790* (Williamsport, 1887), and Donald Kent and Merle Deardorff, "John Adlum on the Allegheny: Memoirs for the Year 1794," *Pennsylvania Magazine of History and Biography*, LXXXIV (July, October, 1960), 265-324, 434-80.

The John Badollet survey is printed in *Pennsylvania, House Journal*, 1815-1816, Appendix, pp. 58-81. Biographical information is from Gayle Thornbrough, ed., *The Correspondence of John Badollet and Albert Gallatin, 1804-1836* (Indianapolis, 1963). *Pennsylvania, House Journal*, 1815-1816, Appendix, pp. 44-57, prints the Findley and Smith survey of the Conemaugh.

For Marcus Hulings and keelboating on French Creek, see Serepta Kussart, *The Allegheny River* (Pittsburgh, 1938). Henry Bouquet's improvements to French Creek navigation are mentioned in *Michigan Pioneer and Historical Collections*, XIX (Lansing, 1911), 39, 52, 74. Kussart, *The Allegheny*

River, is authoritative on French Creek navigation history; Pennsylvania improvements of the stream must be traced in River Improvement Papers, Record Group 26, and Internal Improvements File, Record Group 2, Pennsylvania State Archives, Harrisburg. The same collections contain information on the Monongahela and Youghiogheny projects, for which see also correspondence between Albert Gallatin and John Badollet in "The Papers of Albert Gallatin" (New York Historical Society microfilm), and Joshua Gilpin, "Journal of a Tour from Philadelphia thru the Western Counties of Pennsylvania," *Pennsylvania Magazine of History and Biography*, LI (1927), 185-87.

Materials relating to the slackwater project on West Fork of the Monongahela are Monongalia Navigation Company Papers, Virginia State Archives, Richmond, Virginia; Virginia Board of Public Works, *Fifth Annual Report*, 1820, pp. 35-55.

Files of the *Pittsburgh Gazette* in Carnegie Library, Pittsburgh, provide information about the local and state project on the upper Ohio River, 1818-1824. See also Record Groups 2 and 26, on internal and river improvements, in Pennsylvania State Archives, Harrisburg.

The original report of the state commissioners on the Ohio River in 1819 is on file in Cartographic Division, National Archives; it is printed in *Pennsylvania Archives*, Fourth Series, V, 167-75. See also James W. Fawcett, "Magnus Murray," *Western Pennsylvania Historical Magazine*, L (October, 1967), 273-80.

Chapter 4

STEAMBOATS AND THE WESTERN ENGINEERS

Robert Buchanan's memories of the *New Orleans* are quoted in Frederick B. Read, *Up the Heights of Fame and Fortune* (Cincinnati, 1873), p. 65. Other information about the 1811 voyage is found in John H. B. Latrobe, *The First Steamboat Voyage on the Western Waters* (Baltimore, 1871); F. Van Loon

Ryder, "The New Orleans, the First Steamboat on Our Western Waters," *Filson Club History Quarterly*, XXXVII (January, 1963), 29-37; and many other sources.

Ramsey's mechanical boat is described in John W. Jordan, ed., "Journal of James Kenney, 1761-1763," *Pennsylvania Magazine of History and Biography*, XXXVII (1913), p. 16. The connections between Hutchins and Fitch and Washington and Rumsey are revealed in the Papers of John Fitch, Library of Congress, Washington, and James A. Padgett, ed., "Letters of James Rumsey," *Maryland Historical Magazine*, XXXII (March, June, September, 1937), 10-28, 136-55, 271-85.

The McKeever steamboat story is related in Fred E. Dayton, *Steamboat Days* (New York, 1925), pp. 333-34, and in Serepta Kussart, "Navigation on the Monongahela" (bound collection of newspaper clippings; Carnegie Library, Pittsburgh), p. 35.

The voyage of the *Enterprise* to New Orleans is described in Frederick B. Read, *Up the Heights of Fame and Fortune* (Cincinnati, 1873), and in Harvey B. Gaul, "The Minstrel of the Alleghenies," *Western Pennsylvania Historical Magazine*, XXXIV (March, 1951), 10-13.

The most complete biography of Shreve is Florence Dorsey, *Master of the Mississippi: Henry Shreve and the Conquest of the Mississippi* (Boston, 1941). Louis C. Hunter, *Steamboats on the Western Rivers: An Economic and Technological History* (Cambridge, Mass., 1949), is definitive on most aspects of steamboat history. Charles H. Ambler, *A History of Transportation in the Ohio Valley* (Glendale, Calif., 1932) is an older but still useful study. The thirteen volumes of the *S&D Reflector*, published 1964-1976 by the Sons and Daughters of Pioneer Rivermen, Frederick Way, Jr., editor, are invaluable for steamboat history.

Materials pertaining to the voyage of the *Western Engineer* are John T. Starr, "Long's Expedition to the West," *Military Engineer*, LIII (March, 1961),

116-18; Roger L. Nichols, "Army Contributions to River Transportation, 1818-1825," *Military Affairs*, XXXIII (April, 1969), 242-49; Stephen H. Long, "Report of the Western River Expedition, February 20, 1821," RG 77, NA; Richard G. Wood, *Stephen Harriman Long, 1784-1864: Army Engineer, Explorer, Inventor* (Glendale, Calif., 1966). See also the correspondence between Long and John Calhoun in W. Edwin Hemphill, ed., *The Papers of John C. Calhoun*, IV (Columbia, 1969), 31, 74, 118.

On the significance of the steamboat as a technological innovation, see Louis C. Hunter, *Steamboats on the Western Rivers* (Cambridge, Mass., 1949), and William Gephart, *Transportation and Industrial Development in the Middle West* (New York, 1909). Captain Poussin is quoted from Guillaume Tell Poussin, *The United States: Its Power and Progress* (Philadelphia, 1851), p. 350.

Albert Gallatin's 1808 report is printed in *American State Papers: Miscellaneous*, I, 724-921. Reports of the engineer board and John C. Calhoun are printed in the same series, Vol. II, 305, 533-37. See also William R. Willoughby, "Early American Interest in Waterway Connections Between the East and the West," *Indiana Magazine of History*, LII (December, 1956), 319-42. The Bernard-Totten 1821 survey report is printed in U. S., Congress, House, *Message from the President transmitting a Report of the Board of Engineers*, H. Ex. Doc. 35, 17 Congress, 2 Session, 1823; see also "Totten Papers," Entry 146, RG 77, NA.

Forest G. Hill, *Roads, Rails & Waterways* (Norman, 1957) outlined the Corps of Engineers operations under authority of the General Surveys Act of 1824.

Congressional action on the waterways bill of 1824 is described in Curtis Nettels, "The Mississippi Valley and the Constitution, 1815-1820," *Mississippi Valley Historical Review*, XI (December, 1924), 332-38. The debates on the bill are printed in *Annals of Congress*, 18 Congress, 1 Session, and Henry Clay's role therein may be traced in James F.

Hopkins and Mary W. M. Hargreaves, eds., *The Papers of Henry Clay*, III (Lexington, 1963).

The details of the construction of the Long wing dam, the Contest of 1824, and the Contract of 1824 are outlined in Leland R. Johnson, "19th Century Engineering: The Contest and Contract of 1824," *Military Engineer*, LXV (May, July, 1973), 166-71, 252-57; and in Leland R. Johnson, *The Falls City Engineers: A History of the Louisville District, Corps of Engineers, United States Army* (Louisville, 1975). The latter supplies full bibliographic information.

Chapter 5

THE THIRTY INCH PROJECT

Benjamin A. Botkin, ed., *A Treasury of Mississippi River Folklore* (New York, 1955), pp. 93-95, relates the story of Shreve and the *Heliopolis*. The reports of Shreve on his operations and the reports of inspecting engineer officers are printed in *American State Papers: Military Affairs*, Vols. IV, V, VI, VII. See also Florence Dorsey, *Master of the Mississippi* (Boston, 1941), and U. S., Congress, House, *Henry M. Shreve-Snag Boat*, H. Rept. 272, 27 Congress, 2 Sess., 1843.

The Dutton and Sanders reports on the upper Ohio River project are printed in U. S., Congress, House, *Cumberland Road and Ohio River*, H. Ex. Doc. 52, 24 Congress, 1 Session, 1836, and in *American State Papers: Military Affairs*, Vols. IV, V, VI, and VII. See also James St. Clair Morton, *Memoir of the Life and Services of Capt. and Brevet Major John Sanders* (Pittsburgh, 1861).

Opposition to the Browns Island Dam is explained in George Dutton to Charles Gratiot, October 10, 1835, in Chief of Engineers, Letters Received, RG 77, NA. Sanders' paperwork at the Pittsburgh office has been preserved: see "Register of Letters Received by Office of Ohio River Improvements," Entry 334, RG 77, NA; "Ohio River Contracts," Entry 335, RG 77, NA; and "Abstracts of Disbursements," Entry 337, RG 77, NA.

MARIETTA ISLAND A Configuration from Report of 1819

660 Yards to One Unit

(Copied from report of Lt. George Dutton to the Chief of Engineers, Oct. 26, 1835)

Details of the Sanders-Fuller 1838 survey of the Ohio are found in U. S., Congress, House, *Message from the President*, H. Ex. Doc. 2, 25 Congress, 3 Session, 1838, p. 319. The maps made during that survey are still available at Ohio River Division, Cincinnati, Ohio.

U. S., Congress, Senate, *Message from the President*, S. Doc. 1, 26 Congress, 2 Session, 1840, pp. 201-02, prints commercial statistics for the ports of Pittsburgh and Wheeling. Andrew Jackson's comment on the Corps of Engineers is located in *American State Papers: Military Affairs*, IV, 150-55. Discussions of Jackson's and Van Buren's waterways policies are provided in Carlton Jackson, *Presidential Vetoes, 1792-1945* (Athens, Ga., 1967), pp. 15-27; Max M. Mintz, "The Political Ideas of Martin Van Buren," *New York History*, XXX (October, 1949), 433; and Joseph H. Harrison, "Martin Van Buren and His Southern Supporters," *Journal of Southern History*, XXII (November, 1956), 438-58. A. L. Kohlmeir, *The Old Northwest as the Keystone of the Arch of the American Federal Union* (Bloomington, Ind., 1938), pp. 48-50, analyzed Tyler's policies.

Ella H. Ellwanger, "One of Kentucky's Gallant Old-Time River Captains," *Ohio River and Inland Waterways Magazine*, II (July, 1920), 20-24, furnishes a biography of John W. Russell.

The 1842 Hughes report on the Ohio River is printed in U. S., Congress, House, *Survey of the Ohio River* H. Doc. 50, 27 Congress, 3 Session, 1843. See also Hughes' correspondence in Topographical Bureau, "Letters Received, 1824-1865," (M506), RG 77, NA.

The McCarty dredge is described in U. S., Congress, Senate, *Message from the President*, S. Doc. 1, 28 Congress, 1 Session, 1843, pp. 216-20.

Colonel Long's snagboat operations are best traced in his correspondence, located in Office of Western River Improvements, "Letters Sent and Received," Entry 336, RG 77, NA. See also Richard

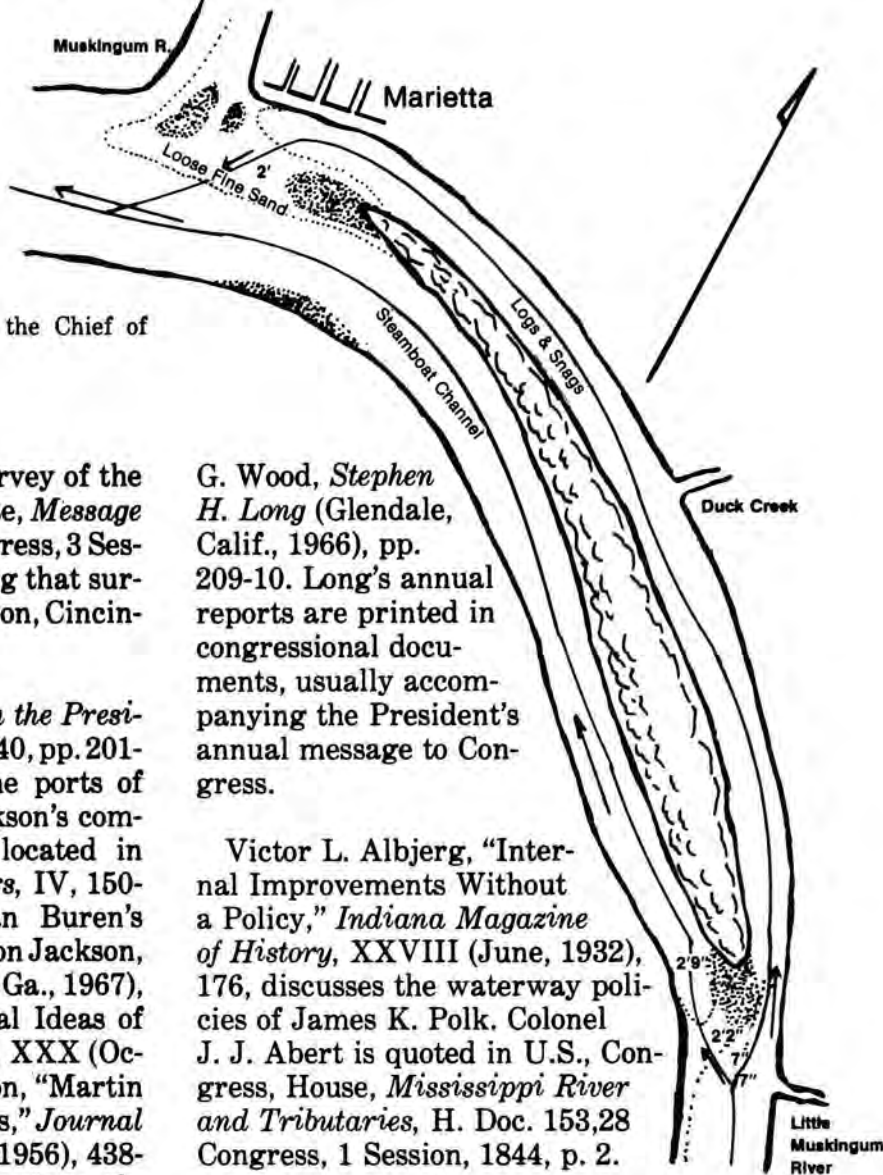
G. Wood, Stephen H. Long (Glendale, Calif., 1966), pp. 209-10. Long's annual reports are printed in congressional documents, usually accompanying the President's annual message to Congress.

Victor L. Albjerg, "Internal Improvements Without a Policy," *Indiana Magazine of History*, XXVIII (June, 1932), 176, discusses the waterway policies of James K. Polk. Colonel J. J. Abert is quoted in U.S., Congress, House, *Mississippi River and Tributaries*, H. Doc. 153, 28 Congress, 1 Session, 1844, p. 2.

Sanders' views on the military values of improved waterways are printed in U. S., Congress, Senate, *Message from the President*, S. Doc. 1, 28 Congress, 1 Session, 1843, p. 223. The steamers built by Colonel Long during the Mexican War are listed in *S&D Reflector*, IV (December, 1966), pp. 22-23. See also Morton E. Steans, "Pittsburgh in the Mexican War," *Western Pennsylvania Historical Magazine*, VII (October, 1924), 235-44.

Millard Fillmore is quoted from U. S., Congress, Senate, *Message from the President*, S. Ex. Doc. 1, 31 Congress, 2 Session, 1850, pp. 14-15. See also U. S., Congress, House, *Memorial from a Meeting of Citizens of the West*, H. Misc. Doc. 3, 31 Congress, 2 Session, 1850.

The criticism of Fuller's work by the Board of Western Rivers and Lake Harbors is printed in U. S., Congress, House, *Message from the President*, H. Ex. Doc. 1, 33 Congress, 2 Session, 1854, pp. 301-02. Colonel Long's comments on the requirements for government service are found in U. S., Congress, House, *Message from the President*, H. Ex. Doc. 1, 34



Congress, 1 Session, 1856, pp. 287-98. Roy Nichols, *Franklin Pierce: Young Hickory of the Granite Hills* (Philadelphia, 1958), pp. 354-55, 374-75, comments on Pierce's waterways policy. On James B. Eads, see "Western River Improvement and Wrecking Company," *River Drift* (St. Louis, 1969).

Chapter 6

ALLEGHENY, MONONGAHELA, AND YOUGHIOGHENY

The Cornplanter and *Allegheny* story is located in Neville Craig, *The Olden Time*, I (January, 1846), 41-44. See also Henry K. Siebeneck, "Cornplanter," *Western Pennsylvania Historical Magazine*, XI (July, 1928), 180-93; and Serepta Kussart, "The Centennial of a Steamboat," *National Waterways*, VIII (June, 1930), 22-24, 62.

For all aspects of Allegheny River traffic, consult Serepta Kussart, *The Allegheny River* (Pittsburgh, 1938), and Frederick Way, *The Allegheny* (New York, 1942). Also useful are Harold C. Putnam, *Improvement of the Allegheny River and Flood Control* (Warren, 1944), and E. L. Babbitt, *The Allegheny Pilot* (Freeport, 1855).

Two interesting journals of Allegheny raftsmen are Ernest C. Miller, ed., "Down the Rivers: A Rafting Journal of 1859 from Warren, Pa., to Louisville, Ky.," *Western Pennsylvania Historical Magazine*, XL (Fall, 1957), 149-62; and Frances Baxter, ed., "Rafting on the Allegheny and Ohio, 1844," *Pennsylvania Magazine of History and Biography*, LI (1927), 27-78, 143-71, 207-43. Two accounts of flat-boating from Jamestown down the Allegheny are "Arthur Johnston, His Book," *Western Pennsylvania Historical Magazine*, XXVI (September-December, 1943), 151-58, and Arthur W. Anderson, "Nathan Brown and his Yankee Notions," *New York History*, XVI (April, 1935), 178-88.

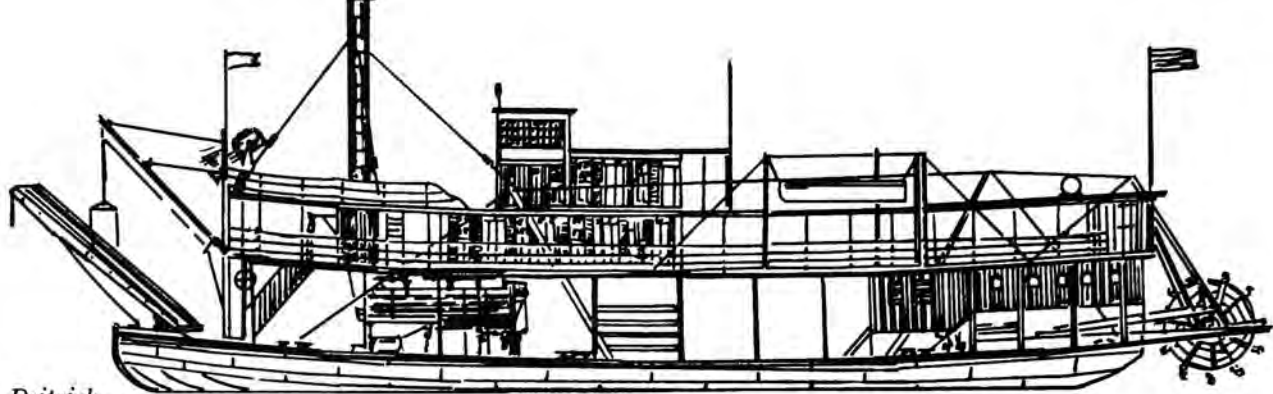
Joseph Totten's survey report on the Allegheny is located in "Letters and Reports of Col. Joseph G.

Totten," (Vol. 1, 432-36), RG 77, NA; see also U. S., Congress, House, *Chesapeake and Ohio Canal—Extension of*, H. Rept. 216, 19 Congress, 1 Session, 1826. The Geddes survey is printed in *Pennsylvania, Second Report of the Canal Commission*, No. 3, p. 48, and the Gay survey in *Hazards Register of Pennsylvania*, III (March 14, 1829), 166-70. The survey by James Kearney is U. S., Congress, House, *Survey of Allegany River*, H. Doc. 343, 25 Congress, 2 Session, 1838. See also, U. S., House, Committee on Roads and Canals, *Survey—Canal Route—Olean Point to Erie Canal*, H. Rept. 151, 19 Congress, 1 Session, 1826.

Canal literature is voluminous. Some of the more interesting studies relating to canals in the Pittsburgh Engineer District are Jesse L. Hartman, "The Portage Railroad National Historic Site and the Johnstown Flood Memorial," *Pennsylvania History*, XXXI (April, 1964), 139-56; Antes Snyder, "Pittsburgh—Her Waterways and Her Railways," *Transactions of the American Society of Civil Engineers*, XVIII (1903), 24-25; Clarence D. Stephenson, *Pennsylvania Canal, Indiana & Westmoreland Counties* (author, 1961); Myron B. Sharp, "Troubles on the Pennsylvania Canal," *Western Pennsylvania Historical Magazine*, LII (April, 1969), 153-59; Moncure Robinson, "Early Surveys and reports in Reference to the Transmission of Trade across the Allegheny Mountains," *Transactions of the American Society of Civil Engineers*, XV (1886), 181-22; and Solomon W. Roberts, "Reminiscences of the First Railroad over the Allegheny Mountain," *Pennsylvania Magazine of History and Biography*, II (1878), 370-93.

The Hughes 1837 survey is printed in U. S., Congress, House, *Survey of Allegany River*, H. Doc. 343, 25 Congress, 2 Session, 1838. See also, U. S., Congress, House, *Memorial for Improvement of Allegany River from Pittsburgh to Olean*, H. Doc. 84, 24 Congress, 2 Session, 1837.

A virtually complete collection of materials pertaining to Monongahela River navigation is located



Steamer *Jas. Deitrick*
From the James Rees & Son Company, Pittsburgh catalog

in Serepta Kussart, "Navigation on the Monongahela" (bound volumes of newspaper clippings, Carnegie Library, Pittsburgh). Richard T. Wiley, *The Monongahela* (Butler, 1937) is also useful.

The 1814 Monongahela survey is printed in Pennsylvania, *House Journal*, 1815-1816, pp. 59-60. Papers of the commissioners who improved the Monongahela in 1822 are located in Record Group 26, Internal Improvements File, and Record Group 2, River Improvement Accounts, Pennsylvania State Archives, Harrisburg. Edward Gay's survey of the Monongahela is printed in *Hazards Register of Pennsylvania*, III (March 21, 1829), 181-84. The 1832 Howard survey is printed in U. S., Congress, House, *Navigation of the Monongahela River*, H. Doc. 351, 23 Congress, 1 Session, 1834, and U. S., Congress, House, Committee on Roads and Canals, *Steamboat Navigation--Monongahela River*, H. Rept. No. 443, 23 Congress, 1 Session, 1834. Maps produced by Dr. Howard now decorate the walls of the Pittsburgh Engineer District. See also, U. S., Congress, House, *Pennsylvania--Brownsville*, H. Doc. 130, 23 Congress, 2 Session, 1835.

Principal sources for the history of the Monongahela Navigation Company are its annual reports on file in Carnegie Library, Pittsburgh, and elsewhere. Also valuable are the papers of William Milnor Roberts and Thomas P. Roberts in possession of General James Milnor Roberts, Reserve Officers Association, Minuteman Building, Washington, D. C. See also James Veech, *A History of the Monongahela Navigation Company*, (Pittsburgh, 1873); Thomas P. Roberts, "The Monongahela River," *Proceedings of the Engineers' Society of Western Pennsylvania*, XXIV (May, 1908), 201; and miscellaneous papers acquired in 1897 by the Pittsburgh Engineer District from the navigation company, which have been retired to Philadelphia Federal Records Center, in RG 77, NA.

The accounts of Kussart and Wiley of Monongahela navigation supply much material

about the coal shipping business. See also, Frank F. Davis, "Something About the Old Coal Boats of the Ohio," *National Waterways*, VIII (April, 1930), 22, 53. Kussart also provides much information about the Youghiogheny slackwater project. More information is available, however, in W. C. Armstrong, *The Youghiogheny Improvement* (Connellsville, 1908), and in the printed volumes of the *Laws of Pennsylvania*.

The efforts to obtain extension of Monongahela slackwater to Virginia are outlined in James M. Callahan, *Semi-Centennial History of West Virginia* (Charleston, 1913), pp. 120-21, and in the Virgil A. Lewis Papers, West Virginia State Library, Charleston, West Virginia.

Chapter 7

THE WATERWAYS AND WAR

The ram fleet action at Memphis is described in John S. C. Abbott, "Heroic Deeds of Heroic Men," *Harper's Monthly*, XXXII (February, 1866), 295-312; U. S., Navy Department, *Official Records of the Union and Confederate Navies*, Series I, Vol. 23 (Washington, 1910), 133-35; and Alfred W. Ellet, "Ellet and His Steam-Rams at Memphis," *Battles and Leaders of the Civil War*, I (New York, 1884), pp. 453-59.

The definitive biography of Ellet is Gene D. Lewis, *Charles Ellet, Jr.: The Engineer as Individualist, 1810-1862* (Urbana, 1968). John Sanders' report on the Wheeling Bridge is printed in U. S., Congress, House, Committee on Roads and Canals, *Bridge at Wheeling, Virginia*, H. Rept. 993, 25 Congress, 2 Session, 1838.

The Wheeling Bridge controversy is reviewed in Clifford M. Lewis, "The Wheeling Suspension Bridge," *West Virginia History*, XXXIII (April, 1972), 203-33; Earl Chapin May, *Principio to Wheeling, 1715-1945* (New York, 1945), pp. 155-59; Benjamin P. Thomas and Harold M. Hyman, *Stanton: The Life and Times of Lincoln's Secretary of War* (New York, 1962), pp. 60-63; and Charles H.

Ambler, *A History of Transportation in the Ohio Valley* (Glendale, 1932), pp. 214-30.

The contribution of Ellet to the science of hydrometry is emphasized in Steponas Kolupaila, "Early History of Hydrometry," *Journal of the Hydraulics Division, ASCE* LXXXVI (January, 1960), 12-14.

The Ellet-Roberts dispute may be traced in Charles Ellet, "Of the Physical Geography of the Mississippi Valley, with Suggestions for the Improvement of the Navigation of the Ohio and Other Rivers," *Smithsonian Contributions to Knowledge*, II (Washington, 1852); U. S., Congress, Senate, *Reports in Reference to the Inundations of the Mississippi River*, S. Ex. Doc. 20, 32 Congress, 1 Session, 1852; Elwood Morris, *Treatise on the Improvement of the Ohio River* (Pottsville, 1857); W. Milnor Roberts, *Practical Views of the Proposed Improvement of the Ohio River* (Philadelphia, 1857); U. S., Congress, Senate, *Report of Select Committee on Memorial of Charles Ellet*, S. Rept. 191, 31 Congress, 1 Session, 1850; U. S., Congress, House, Committee on Roads and Canals, *Reservoirs on Main Affluents of the Ohio River*, H. Rept. 94, 32 Congress, 1 Session, 1852; Charles Ellet, Jr., *The Mississippi and Ohio Rivers* (Philadelphia, 1853); U. S., Congress, Senate, *Improvement of Ohio River*, S. Rept. 319, 34 Cong., 3 Session, 1857; and Felix R. Brunot, "Improvement of the Ohio River," *Journal of the Franklin Institute*, XCVII (April, 1874).

Herman Haupt's plans are reviewed in *Report on the Improvement of the Ohio River Made to the Board of Trade of Pittsburgh* (Pittsburgh, 1864); Josiah Copley, *Letters to the Pittsburgh Board of Trade on the Improvement of the Ohio River* (Pittsburgh, 1856); *An Act to Incorporate the Ohio River Improvement Company* (Philadelphia, 1855); and *ARCE*, 1881, pp. 1926-43.

Milledge L. Bonham, "Morganalia," *Louisiana Historical Quarterly*, LVII (October, 1934), 706-11, relates the story of the burning of New Madrid by James Morgan. Colonel Long's annual report for 1861 is printed in U. S., Congress, Senate, *Message*

from the President, S. Ex. Doc. 1, 37 Congress, 2 Session, 1861, pp. 508-10.

Sketches of Engineer operations during the Civil War are Leland R. Johnson, "Civil War Railroad Defenses in Tennessee," *Tennessee Valley Historical Review*, II (Summer, 1972), 20-26; Philip M. Thienel, "Engineers in the Union Army," *Military Engineer*, XLVII (January-March, 1955), 36-41, 110-15; William M. Robinson, "The Confederate Engineers," *Military Engineer*, XXII (July-November, 1930), 297-517; and George T. Ness, Jr., "Army Engineers of the Civil War," *Military Engineer*, LVII (January, 1965), 38-40.

Materials pertaining to the Civil War in the Pittsburgh Engineer District are Fred Way, "Where It All Started," *S&D Reflector*, XII (September, 1975), 21-22; Louis Vaira, "Some Aspects of Pittsburgh's Industrial Contributions to the Civil War," *Western Pennsylvania Historical Magazine*, VI (January, 1923), 9-20; Earl Chapin May, *Principio to Wheeling* (New York, 1945), pp. 126-34; Mark Reinsberg, "Descent of the Raftsmen's Guard," *Western Pennsylvania Historical Magazine*, LIII (January, 1970), 1-32; Joseph A. Borkowski, "Camp Wilkins, Military Post, 1861," *Western Pennsylvania Historical Magazine*, XLV (September 1962), 229-39; George E. Moore, "The West Virginia Incident," *West Virginia History*, XXVI (January, 1965), 80-85; Theodore R. Parker, "Western Pennsylvania and the Naval War on the Inland Rivers, 1861-1863," *Pennsylvania History*, XVI (July, 1949), 221-29; Theodore R. Parker, "William J. Kountz, Superintendent of Western River Transportation under McClellan," *Western Pennsylvania Historical Magazine*, XXI (December, 1938), 237-54; Richard O. Curry, "McClellan's Western Virginia Campaign of 1861," *Ohio History*, LXXI (July, 1962), 95-96; Phil Conley, "The First Land Battle of the Civil War," *West Virginia History*, XX (October, 1958), 120-23; Charles H. Ambler, "General R. E. Lee's Northwest Virginia Campaign," *West Virginia History*, V (October, 1943), 101-15; Festus P. Summers, "The Jones-Imboden Raid," *West Virginia History*, I (October, 1939), 15-29.



Details of the fortification of Pittsburgh are provided by John P. Cowan, "Fortifying Pittsburgh in 1863," *Western Pennsylvania Historical Magazine*, II (January, 1919), 59-64; Henry K. Siebeneck, "Pittsburgh's Civil War Fortification Claims," *Western Pennsylvania Historical Magazine*, XXVII (March, 1944), 1-19; George Swetnam, "Thirty Days of Panic," *Western Pennsylvania Historical Magazine*, LI (October, 1968), 329-43. Craighill's orders are printed in U. S., War Department, *Official Records of the Union and Confederate Armies*, XXVII, Pt. III, p. 53.

Colonel Parsons' tribute to rivermen who served in the Civil War is printed in U. S., Congress, House, *Message from the President*, H. Ex. Doc. 1, 39 Congress, 1 Session, 1865, pp. 212-16. U. S., Congress, House, *Vessels Bought, Sold, and Chartered by the United States*, H. Ex. Doc. 337, 40 Congress, 2 Session, 1868, is a complete list of steamboats used and sunk in action during the Civil War.

General Richard Delafield's report on resumption of river improvements is U. S., Congress, House, *Harbors on the Sea and Lake Coasts*, H. Ex. Doc. 59, 39 Congress, 1 Session, 1866. The operations of Colonel John N. Macomb at Cincinnati are outlined in *ARCE*, 1867, pp. 376-95; *ARCE*, 1868, pp. 590-94; *ARCE*, 1869, pp. 207-08, 285-91; *ARCE*, 1870, pp. 65-66.

Thomas P. Roberts' diary for 1867 is in the Roberts Papers, in possession of General James Milnor Roberts, Reserve Officers Association, Washington, D. C. The operations of Thomas and Milnor Roberts at the Pittsburgh office, 1866-1870, are outlined in the *Annual Reports of the Chief of Engineers* for those years. See also correspondence in Engineer Department, "Letters Received, 1866-70," RG 77, NA, and U. S., Congress, House, *River and Harbor Improvements*, H. Ex. Doc. 56, 39 Congress, 1 Session, 1867. W. C. Dugan, "Great River Pilots of the Past: Captain George W. Rowley," *National Waterways*, X (May, 1931), 45-46; is a short biography of the captain.

Biographical data is supplied in Margaret E. Merrill, "William E. Merrill," *Professional Memoirs, Corps of Engineers*, IX (November, 1917), pp. 639-42. Merrill's operations at Pittsburgh and Cincinnati offices of the Corps of Engineers are outlined *Annual Reports of the Chief of Engineers*. His correspondence and some of his papers are located in Addison M. Scott Papers, Marshall University Library, Huntington, West Virginia; Records of the Chief of Engineers, RG 77, National Archives; and in the records of the Pittsburgh and Cincinnati Engineer Districts that have been retired to Philadelphia Federal Records Center, RG 77, NA.

Chapter 8

THE UNMENTIONABLE RIVERS

The debate over the appropriation for the Kiskiminetas and Conemaugh rivers is reported in *Congressional Record*, 45 Congress, 2 Session, VII, Pt. 3, pp. 2748-52. Newspaper coverage of the debate was summarized in *Engineering News*, V (May 2, 1878), 138. The Worrall survey is printed in *ARCE*, 1879, pp. 1388-89.

Merrill's reports on the Buckhannon River project are printed in the *Annual Reports of the Chief of Engineers* for the years 1884 to 1892. D. T. Farnsworth's letter is printed in *ARCE*, 1884, pp. 1719-22.

Richard Wiley, *The Monongahela* (Butler, 1937), p. 152, describes the loss of the Warman steamboat on the Cheat River. Serepta Kussart, "Navigation on the Monongahela" (bound clippings, Carnegie Library, Pittsburgh), reports the history of Cheat River navigation. Accounts of the Cheat River project performed by Pennsylvania are located in the Pennsylvania State Archives, Record Group 2, Internal Improvements File, Harrisburg.

Reports on the Army Engineer project on Cheat River are printed in the *Annual Reports of the Chief of Engineers* for the years 1889 to 1895. Subsequent reports are printed in *ARCE*, 1904, pp. 2538-40;

Federal Power Commission, *Third Annual Report* (Washington, 1923), pp. 150-52; and U. S., Congress, House, *Cheat River and Tributaries, West Virginia*, H. Doc. 645, 78 Congress, 2 Session, 1944.

Colonel Merrill's comment on the importance of improvements to logging streams is printed in *ARCE*, 1888, pp. 1796-98. On the "pork barrel," see Edward L. Pross, "A History of Rivers and Harbors Appropriations Bills, 1866-1933," (Ph.D. dissertation, Ohio State University, 1938), and *American Engineer*, IX (February 20, 1885), 85.

Serepta Kussart, "Petroleum Transportation on the Allegheny," *National Waterways*, X (February, 1931), 30-35, 52, describes the Oil Creek freshets. See also Ernest C. Miller and T. K. Stratton, "Oildom's Photographic Historian," *Western Pennsylvania Historical Magazine*, LV (January, 1972), 1-54. For Allegheny oil barging, in addition to Kussart's and Way's standard histories of the Allegheny, see notes in *S&D Reflector*, IX (March, 1972), 23, and XII (June, 1975), 3.

Serepta Kussart, "General White—The Man Who Started Improvement of the Allegheny River," *National Waterways*, IX (November, 1930), 56, 80, furnishes a short biography of Harry White. Engineer surveys of the Allegheny River are printed in the *Annual Reports of the Chief of Engineers* for the years 1876, 1879, and 1880. The history of the open-channel project on the Allegheny River must be traced through the *Annual Reports of the Chief of Engineers* from 1880 to 1915. Correspondence between Merrill and Thomas Roberts, plus other pertinent materials, is stored as "Letters Received, Allegheny River," in Entry 1283, RG 77, NA, at Philadelphia Federal Records Center. The quote from Fred Way comes from his *The Allegheny*, pp. 209-11.

Colonel Merrill's 1871 Monongahela survey is printed in *ARCE*, 1872, pp. 412-19. The history of the construction of Locks and Dams 7, 8, and 9 must be traced through the *Annual Reports of the Chief of Engineers* for the appropriate years. Merrill's cor-

respondence relating to the Monongahela project is "Letters Received, Monongahela River," Entry 1281, RG 77, NA, stored at Philadelphia Federal Records Center.

The opening of the Pittsburgh District Engineer office is mentioned in *ARCE*, 1894, p. 1903; Robert Seedlock, *Genesis of the Pittsburgh Engineer District* (Pittsburgh District, 1938), p. 18; and *Pittsburgh Dispatch*, February 20, 1894.

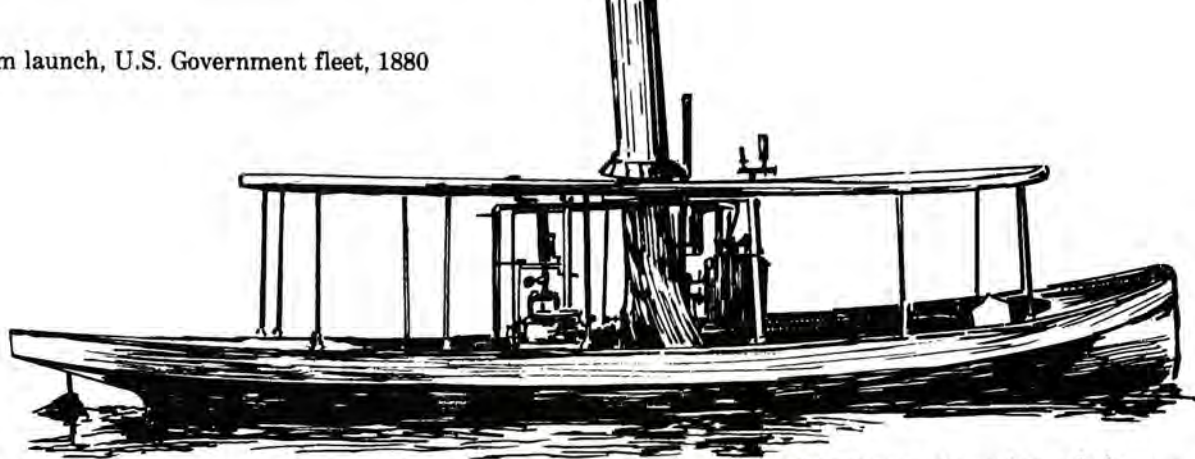
Chapter 9

THE RADICAL PROJECTS

Details of the Davis Island Dam dedication pageant are found in Pittsburgh Chamber of Commerce, *Reports to the Chamber of Commerce upon the Opening of Davis Island Dam* (Pittsburgh, 1886); Frederick Way, "Davis Island Dam Celebration," *S&D Reflector*, III (June, 1966), p. 1; *ARCE*, 1886, pp. 1528-29, 1540-42; and newspaper coverage. See also "Iron Pioneer: Henry W. Oliver," *Greater Pittsburgh*, XXIII (September, 1942), 4-5.

Studies of movable dam designs are outlined in William E. Merrill, *Improvement of Non-Tidal Rivers*, *Memoirs of S. Janicki, L. Jacquet, A. Pasqueau* (Washington, 1881); William E. Merrill, "Movable Dams," *Engineering News*, V (March 28, 1878), 100-01; *ARCE*, 1874, pp. 415-81; "American Hydraulic Gates," *Journal of the Association of Engineering Societies*, XVI (June, 1896), 189; Felix R. Brunot, "Improvement of the Ohio River," *Journal of the Franklin Institute*, XCVII (May, 1874), 315-17, 327; U. S., Congress, House, *Plans for the Improvement of the Ohio River*, H. Misc. Doc. 33, 46 Congress, 2 Session, 1880; Ellwood Morris, "Description of the Bear Trap Sluice Gates of the Lehigh Descending Navigation," *Journal of the Franklin Institute*, XXXII (December, 1841), 361-68; and *American Engineer*, VII (March 21, 1884), 120.

The economic need for the Ohio River slackwater project is reviewed in Ohio River Commission, *Memorial to Congress* (Cincinnati, 1878); U. S., Con-



gress, Senate, *Report of the Select Committee on Transportation Routes to the Seaboard*, S. Rept. 307, 43 Congress, 1 Session, 1874, pp. 87-90, 218-20, 531-35; and *Pittsburgh Commercial*, May 18, 1875. Merrill, on the value of low-cost grain shipment, is quoted in *Transactions of the American Society of Civil Engineers*, XIV (March, 1885), 103. Howard B. Schonberger, *Transportation to the Seaboard: The "Communication Revolution" and American Foreign Policy, 1860-1900* (Westport, Conn., 1971), is a scholarly analysis of the relationship between federal waterways policy and foreign policy.

James A. Henderson, "Reminiscences of the Rivers," *Western Pennsylvania Historical Magazine*, XII (October, 1929), 235-36, describes the opposition to the Davis Island Dam. See also *ARCE*, 1874, pp. 416-17; *ARCE*, 1876, p. 14; and *ARCE*, 1877, pp. 637-56.

The Pasqueau hurter case is *Alfred Pasqueau v. The United States*, U. S. Court of Claims No. 14765, January 29, 1886. A copy of the brief and related materials is on file in Box NA16, RG 77, NA, Kansas City Federal Records Center.

The *ARCE* for 1878-1886 provides considerable information about the construction of Davis Island Dam. Colonel Merrill's correspondence and records are in Entry 1281, RG 77, NA, Philadelphia Federal Records Center. See also William Martin, "Description of the Cofferdam Used at Davis Island Dam," and James H. Harlow, "Description of a Derrick Used at Davis Island Dam," in *Engineers' Society of Western Pennsylvania Proceedings*, I (1882), 25-28, 275-79. The Goethals story is related in Joseph B. Bishop and Farnham Bishop, *Goethals, Genius of the Panama Canal* (New York, 1930).

The events leading to the federal condemnation of the Monongahela Navigation Company property may be traced in the *ARCE*, especially *ARCE*, 1897, pp. 2417-19, which reviews the case. Pittsburgh newspapers and correspondence in RG 77, NA, provide details about the events of July, 1897, in connection with the Free Monongahela celebration.

Plans for reconstruction of the company locks and dams are in *ARCE*, 1897, pp. 2419-24.

The *ARCE*, from 1882 to 1903, outlines the construction of Herrs Island Dam. See also "The Foundations of the Herr Island Lock and Dam," *Engineering News*, XXXVI (August 20, 1896), 127-28; William L. Sibert, "Artificial Waterways in the United States," *Transactions of the American Society of Civil Engineers*, LIV (1905), 277-78; John W. Arras, "Pittsburgh Waterway Improvement Problems," *National Waterways* (October, 1929), 65-66; and the John W. Arras Papers (material loaned by descendants; copies in Pittsburgh District Library). Fred R. Herr, "Herr's Island," *Western Pennsylvania Historical Magazine* LIII (July, 1970), 211-26, supplies a history of the island.

Chapter 10

A GOLIATH AT THE FORKS

The effects of the July 1888 flood are described in *ARCE*, 1888, p. 1666, and *ARCE*, 1889, p. 1870-74.

The operations problems at Davis Island Dam are described in the *ARCE* from 1886 to 1919 and are summarized in William L. Sibert, "The Improvement of the Ohio River," *Transactions of the American Society of Civil Engineers*, LXIII (1909), 388-428; John W. Arras, "Locks and Movable Dams of the Ohio River," *Professional Memoirs, Corps of Engineers*, III (October, 1911), 546-50; William Martin, "Bear-Trap Gate in Davis Island Dam," *Journal of the Association of Engineering Societies*, XVI (June, 1896), 208-10; John W. Arras, "The Ohio River," *Engineers' Society of Western Pennsylvania Proceedings*, XXIV (June, 1908), 250-51; and John W. Arras to District Engineer, "Dam No. 1, Ohio River: Its Condition and Need for Radical Repair or Reconstruction," in Box 16, Entry 1289, RG 77, NA, Philadelphia Federal Records Center.

The Allegheny River Bridge controversy may be traced in Edward B. Clark, *William L. Sibert, The Army Engineer* (Philadelphia, 1930); William L. Sibert, "Full Use of the Rivers at Pittsburgh and the



Removal of the Obstructions to Such Use," Engineers' Society of Western Pennsylvania *Proceedings*, XVIII (1902), 345-60; John W. Arras Papers, Pittsburgh Engineer District; "Federal Authority over Rivers," *Engineering News-Record*, XCII (May 22, 1924), 884-85; V. R. Covell, "The Bridge-Raising Program on the Allegheny River in Allegheny County," Engineers' Society of Western Pennsylvania *Proceedings*, (March, 1925); War Department, *Opinion of the Secretary of War in Re Elevation of Bridges over the Allegheny River at Pittsburgh* (Washington, 1917); *Pittsburgh First*, IV (February 3, 1923), 12; and the many cubic feet of correspondence in File 34428, General Correspondence, 1894-1923, RG 77, NA.

The reconstruction of the locks and dams on the lower Monongahela River may be traced through the *ARCE* from 1897 to 1920 and the following materials: Lewis M. Adams, "An A-Frame Movable Top to Provide Increased Depths above Fixed Dams," *Professional Memoirs, Corps of Engineers*, III (April, 1911), 315-55; Horton W. Stickle, "Monongahela River Navigation," *Professional Memoirs, Corps of Engineers*, X (November, 1919), 695-713; Jarvis J. Bain, "What the Corps of Engineers, U. S. Army, Have Done in the Pittsburgh District," *National Waterways*, (October, 1929), p. 86; Thomas P. Roberts, "The Monongahela River," Engineers' Society of Western Pennsylvania *Proceedings*, XXIV (May, 1908, 202-06; Lewis M. Adams, "A Complete Floating Concrete Plant," *Professional Memoirs, Corps of Engineers*, III (January, 1911), 83-88; Henry C. Newcomer, "Movable Tops for Fixed Dams," *Professional Memoirs, Corps of Engineers*, II (April, 1910), 202-12; and records in Entry 1289, RG 77, NA, Philadelphia Federal Records Center.

Some of the sources listed in the previous paragraph also furnish information on the extension of Monongahela slackwater to Fairmont. See also the *ARCE* from 1894 to 1906; U. S., Congress, House, *Monongahela River, Pa.*, H. Doc. No. 288, 67 Congress, 2 Session, 1922; and project records in En-

try 1281, RG 77, NA, Philadelphia Federal Records Center.

The story of the boat jam at Lock 9 is printed in *S&D Reflector*, V (September, 1968), 36. Monongahela lock operations problems are covered in the *ARCE*; J. L. Callard, "Dam No. 10, Monongahela River Damaged by Burning Oil," *Professional Memoirs, Corps of Engineers*, III (January, 1911), 74; Thomas Roberts, "The Monongahela River," Engineers' Society of Western Pennsylvania *Proceedings*, XXIV (May, 1908), 198-99; and correspondence in Entry 1289, RG 77, NA, Philadelphia Federal Records Center.

Records of the formation of the Wheeling District and the transfer of Ohio River dams to Pittsburgh District are in Box NA1130, RG 77, NA, Kansas City Federal Records Center; Entry 1348, RG 77, NA, at Washington National Records Service, Suitland, Maryland; and Files 19832, 37227, and 41804, General Correspondence, 1894-1923, RG 77, NA.

George Spalding's account of his 1903 interview with W. L. Sibert is located in Ohio Valley Improvement Association, *Proceedings of the Thirty-Sixth Annual Convention* (Cincinnati, 1930), pp. 71-72. The report in which Sibert proposed a nine-foot depth for navigation on the upper Ohio River is printed in *ARCE*, 1903, pp. 1688-94. See also Edward B. Clark, *William L. Sibert, The Army Engineer* (Philadelphia, 1930), pp. 81-82; and Thomas Roberts, "Some Practical Views as to Transportation on Western Rivers," *Engineering News*, LXIII (February 17, 1910), 185-88.

Senator Ransdell's memories of the 1905 trip down the Ohio are printed in Ohio Valley Improvement Association, *Proceedings of the Thirty-Sixth Annual Convention* (Cincinnati, 1931), pp. 42-43. The Lockwood Board report on the nine-foot project is printed in U. S., Congress, House, *Ohio River*, H. Doc. 492, 60 Congress, 1 Session, 1908. See also, John L. Vance, "Sketch of Ohio River Improvement,"

Ohio Archaeological and Historical Publications, XVIII (1909), 418-20. Peyton and Taft are quoted in *Engineering News*, LXIII (February 17, 1910), 188-202.

Chapter 11

SLACKWATER TO CAIRO AND OIL CITY?

Thomas Roberts and others debated the reasons for the decline of traffic on the Ohio River in "Discussion: Locks and Movable Dams on Ohio River," *Transactions of the American Society of Civil Engineers*, LXXXVI (1932); see also "Relation of the Ohio River and Its Tributaries to Transportation in the United States: A Symposium," *Transactions of the American Society of Civil Engineers*, LX-XXIX (1926). The history of the "Combine" is reviewed in Edward H. Scheibler, "The Monongahela River Consolidated Coal & Coke Company" and "Decline and Fall of the Combine," in *S&D Reflector*, III (September, 1966), 6-10, 13, and V (September, 1968), pp. 6-10.

The *Pittsburgh Commercial Gazette*, September 20, 1892, describes the launch of the first steel barge. The comments of John Arras are printed in *ARCE*, 1896, p. 2212. See also "Steel Barges for Transporting Steel Products on the Ohio," *Engineering News*, LXIII (June 9, 1910), 684; and "Steel Supplants Wood in Boat Construction," Ohio Valley Improvement Association, *Official Program: Ohio River Pageant and Dedication, October 19-25, 1929* (Cincinnati, 1929), pp. 69-70.

The "Steel Argosy" and subsequent ventures were given full coverage in *Pittsburgh First*; see especially the issues of December 27, 1919, December 31, 1921, January 7, 1922, and February 11, 1928. Arthur E. Crockett is quoted in the July 1, 1922, issue. See also Frederick Way, Jr., "Profile of Charles T. Campbell," *S&D Reflector*, X (June, 1973), 25-28; Earl C. May, *Principio to Wheeling* (New York, 1945), pp. 259-74; E. C. Jennings, "Great Steel Corporations Prove Feasibility of River Transportation," *Manufacturer's Record*, LXXXIII (February 15, 1923), 67-74; and Charles H. Ambler,

A History of Transportation in the Ohio Valley (Glendale, Calif., 1932), pp. 416-17.

Records of the Ohio River Board, 1907 to 1915, are located in NA1048, RG 77, NA, Kansas City Federal Records Center. A history of that board written by William McAlpine in 1924 is located in NA1074 in the same collection. Some of the many articles about the Ohio River canalization project are: Lytle Brown, "Surveys for Lock Locations, Ohio River," *Professional Memoirs, Corps of Engineers*, III (July, 1911), 418-31; B. G. Cope, "Prospecting on the Ohio River," *Engineering Record*, LXII (November 26, 1910), 592; G. C. Graeter, "The Ohio River Survey," *Engineering News*, LXXI (March 19, 1914), 604-05; P. S. Bond, "The Permanent Improvement of the Ohio River," *Engineering Record*, LIX (January 23, 1909), 97-99; William M. Hall, "Some Notes on the Location and Construction of Locks and Movable Dams on the Ohio River," *Transactions of the American Society of Civil Engineers*, LXXXVI (1923), 107-08; Karl H. Shriver, "Contract Methods and Equipment for the Typical Ohio River Dam," *Engineering News*, LXXIII (April 29, 1915), 806-11; E. N. Johnston, "New River and Harbor Improvement Programs," *Professional Memoirs, Corps of Engineers*, III (January, 1911), 44-45; Edmund L. Daley, "The Mastery of the Ohio River," *Military Engineer*, XIX (May, 1927), 188-93; C. W. Kutz, "Ohio River Canalization," *Engineering News-Record*, CIV (March 13, 1930), 436-37; and "Ohio River—An Economic Epic," *Military Engineer*, XXI (November, 1929), 509-10.

The construction of Emsworth Dam is reviewed in the *ARCE*, 1915 to 1923. The Beach-Shunk discussion of the project plans, and other materials pertaining to the project are in File 6938, General Correspondence, 1894-1923, RG 77, NA, and Entry 1289, RG 77, NA, Philadelphia Federal Records Center; see especially John Arras to District Engineer, June 6, 1916. Other pertinent items include U. S., Congress, House, *Ohio River*, 64 Congress, 2 Session, 1916; *Pittsburgh Gazette Times*, January 17, 1915; J. Franklin Bell, "The Emsworth and Davis Island Dams," *Military Engineer*, XV (September, 1923), 405-08; and "Fixed Dams to

Replace Movable Dams on the Upper Ohio," *Engineering News*, LXXVII (March 22, 1917), 486-87.

Thomas Roberts, "Construction of Cofferdams," *Engineers' Society of Western Pennsylvania Proceedings*, XXI (1905), 305-18, describes his meeting with the salesman. On the history of cofferdams, see Carl B. Jansen, "Century of Progress Marks Many Improvements in Construction of Locks and Dams," *Civil Engineering*, XVIII (October, 1948), 628-33, 672; Contracting Division, Dravo Corporation, *Locks and Dams* (Bulletin 402-C; Pittsburgh, 1947), pp. 28-30.

The construction of Dashields Locks and Dam should be traced through the *ARCE*, 1922 to 1930, and correspondence in Entry 1289, RG 77, NA, Philadelphia Federal Records Center. See also Edmund L. Daley, "The Mastery of the Ohio River," *Military Engineer*, XIX (May, 1927), 188-93; and Charles M. Wellons, "Armoring of Lock Walls," *National Waterways*, XI (December, 1931), 28-29.

Accounts of the Ohio River Dedication Pageant, 1929, include: *Pittsburgh First*, X (October 26, 1929); "River Minded President on the Raging Ohio," *Literary Digest*, CIII (November 9, 1929), 8-9; and *S&D Reflector*, VIII (December, 1929), 54-55. The history of the canalization project on the lower Ohio is recounted in Leland R. Johnson, *The Falls City Engineers: A History of the Louisville District, Corps of Engineers* (Louisville, 1975).

Voyages of the *Monongahela* and *Kittanning* up the Allegheny River are described in George D. Stuart, "Navigation Improvements Move up the Allegheny," *National Waterways*, VIII (January, 1930), 45-46, 76; and in Serepta Kussart, *The Allegheny River* (Pittsburgh, 1938). Kussart dedicated her monumental history of the Allegheny to Colonel Jarvis J. Bain.

For construction of the Allegheny slackwater project, see the *ARCE* for the construction period. Other related materials include Harold C. Putnam,

Improvement of the Allegheny River and Flood Control (Warren, Pa., 1944); Charles M. Wellons, "Construction and Operations of a Modern River Lock," *National Waterways*, V (January, 1929), 57-58; "Progressive Cofferdamming for Long Low Dam," *Engineering News-Record*, CXIV (April 4, 1935), 473-77; and Jarvis J. Bain, "What the Corps of Engineers, U. S. Army, Have Done in the Pittsburgh District," *National Waterways*, VI (October, 1929), 86-87. Useful documents are U. S., Congress, House, Committee on Rivers and Harbors, *Allegheny River*, Comm. Doc. 16, 72 Congress, 1 Session, 1932; U. S., Congress, House, *Allegheny River*, H. Doc. 721, 71 Congress, 3 Session, 1931; U. S., Congress, House, *Allegheny River*, H. Doc. 27, 73 Congress, 2 Session, 1934; and U. S., Congress, House, *Allegheny River--Allegheny Reservoir*, H. Doc. 300, 76 Congress, 1 Session, 1939. See Fred Way's opinions in *The Allegheny* (New York, 1942), 210-11.

Chapter 12

YE DELUGE OR INUNDATION

The findings of Thomas P. Roberts on the subject of deforestation are included in Roberts to Hiram M. Chittenden, May 12, 1908, and his "Comments on Prof. Swain's Article on Floods and Forests," in the Roberts Papers in possession of General James Milnor Roberts, Reserve Officers Association, Washington, D. C. See also Thomas P. Roberts, "Pros and Cons on the Forest and Flood Question," *Professional Memoirs, Corps of Engineers*, V (September, 1913), 583-84.

The James Kenney journal is printed in John W. Harpster, ed., *Pen Pictures of Early Western Pennsylvania* (Pittsburgh, 1938). See also "Colonel Eyre's Journal of His Trip from New York to Pittsburgh, 1762," *Western Pennsylvania Historical Magazine*, XXVII (March, 1944), 37-50.

Gordon B. Dodds, *Hiram Martin Chittenden: His Public Career* (Lexington, 1973), emphasizes the role of the General in the national campaign for flood control and water resource development.



General William H. Harrison's speculation about prehistoric floods is printed in Charles Lyell, *Travels in North America in the Years 1841-2* (New York, 1845). General information about floods is supplied in William G. Hoyt and Walter B. Langbein, *Floods* (Princeton, 1955); E. K. Morse and Harold A. Thomas, "Floods in the Upper Ohio River and Tributaries," *Transactions of the American Society of Civil Engineers*, CIII (1938), 632; and in many other sources.

The best source of information about the February 1832 flood is Ebenezer S. Thomas, *Reminiscences of the Last Sixty-Five Years* (Hartford, Conn., 1840), which reprints most newspaper coverage of the disaster. Newspaper coverage on many other floods at Pittsburgh have been collected by Serepta Kussart in her *The Allegheny River* (Pittsburgh, 1938) and "Navigation on the Monongahela" (bound clipping collection in Carnegie Library, Pittsburgh).

W. Milnor Roberts to Chief of Engineers, December 21, 1867, "Letters Received, 1865-70," RG 77, NA, is the report on the 1867 flood. The "Butchers Run" flood of 1874 is reviewed in *Report of the Citizens' Executive Relief Committee of the Cities of Pittsburgh and Allegheny for the Relief of Sufferers by the Flood of July 26th, 1874* (Allegheny, Pa., 1876). Samuel Hays, *Conservation and the Gospel of Efficiency: the Progressive Conservation Movement, 1890-1920* (Cambridge, Mass., 1959), summarized the national controversy over forestation as a benefit to navigation.

Events of the 1884 flood are reviewed in Citizens' Relief Committee of Pittsburgh, *The Flood of 1884 in the Ohio Valley* (Pittsburgh, 1884); John L. Vance, *The Great Flood of 1884 in the Ohio Valley* (Gallipolis, 1884); Cincinnati Relief Committee, *The Flood in the Ohio, February, 1884* (Cincinnati, 1884); and Fred Way, "Adventures in the 1884 Flood," *S&D Reflector*, X (March, 1973), 39-41.

Levee projects on the lower Ohio, built in the aftermath of the 1884 flood, are described in Leland R. Johnson, *The Falls City Engineers: A History of*

the Louisville Engineer District (Louisville, 1975). The Davis Island levee is described in *ARCE*, 1884, pp. 1679, 1701, and *ARCE*, 1885, pp. 1784-85.

David G. McCullough, *The Johnstown Flood* (New York, 1968), is the authoritative history of that disaster. For details about the work of the Engineers at Johnstown, see Leland R. Johnson, "19th Century Engineering: The Johnstown Flood," *Military Engineer*, LXVI (January, 1974), 42-45.

The floods of 1907 are reviewed in *ARCE*, 1907, p. 1700; Sibert's correspondence in File 15732, General Correspondence, 1894-1923, RG 77, NA; Edward B. Clark, William L. Sibert, *The Army Engineer* (Philadelphia, 1930), pp. 94-95; and Thomas P. Roberts, "Floods and Means of Their Prevention in Our Western Rivers," *Engineers' Society of Western Pennsylvania Proceedings*, XXIII (July, 1907), 316-20. See also Pittsburgh Flood Commission, *Report of the Flood Commission of Pittsburgh, Pennsylvania* (Pittsburgh, 1912), and Roland M. Smith, "The Politics of Pittsburgh Flood Control, 1908-1936," *Pennsylvania History*, XLII (January, 1975), 8-9.

The controversy over reservoirs as a benefit to navigation may be traced in F. W. Altstaetter, "The Ohio River," *Professional Memoirs, Corps of Engineers*, II (January, 1910), 35-44; M. O. Leighton, "The Relation of Water Conservation to Flood Prevention and Navigation in the Ohio River," *Engineering News*, LIX (May 7, 1908), 498-504; Henry C. Newcomer, "Proposed Reservoir System in Ohio River Basin," *Engineering News*, LX (October 8, 1908), 376-80; Morris Knowles, "Public Utility Regulation and Its Relation to Water Conservation," *Engineers' Society of Western Pennsylvania Proceedings*, XXIX (January, 1913), 795; William L. Sibert, "The Improvement of the Ohio River," *Transactions of the American Society of Civil Engineers*, LXIII (1909), 397; Thomas Roberts, "The Reservoir System for Control of the Ohio River," *Engineering News*, LIX (June 25, 1908), 697; Samuel Hays, *Conservation and the Gospel of Efficiency* (Cambridge, Mass., 1959), p.

214; and *Final Report of National Waterways Commission*, S. Doc. 469, 62 Congress, 2 Session, 1912, pp. 22-25.

U. S., Congress, House, *Reservoirs at the Headwaters*, H. Doc. 1289, 62 Congress, 3 Session, 1912, is the Engineer review of the Pittsburgh Flood Commission report. Some opposition to the plans of the Flood Commission is printed in *Engineering News*, LXXVIII (November 7, 1912), 876-77; more may be located in NA2293, RG 77, NA, Kansas City Federal Records Center. Chittenden is quoted from "Flood Prevention Plans," *Engineering News*, LXXVI (November 9, 1916), 906-10; see also Gordon B. Dodds, *Hiram Martin Chittenden* (Lexington, 1973), pp. 201-02.

Chapter 13

WATCHDOGS AT THE HEADWATERS

Beaver and Mahoning River navigability studies are located in Box 7, Entry 1289, RG 77, NA, Philadelphia Federal Records Center. Correspondence and records relating to the 1913 flood are in Box NA2295, RG 77, NA, Kansas City Federal Records Center.

Theodore Roosevelt's comments on the 1913 flood are printed in *Outlook*, CIII (April 5, 1913), 765-66. Colonel Charles Townsend's comments are printed in *Professional Memoirs, Corps of Engineers*, V (July, 1913), 429.

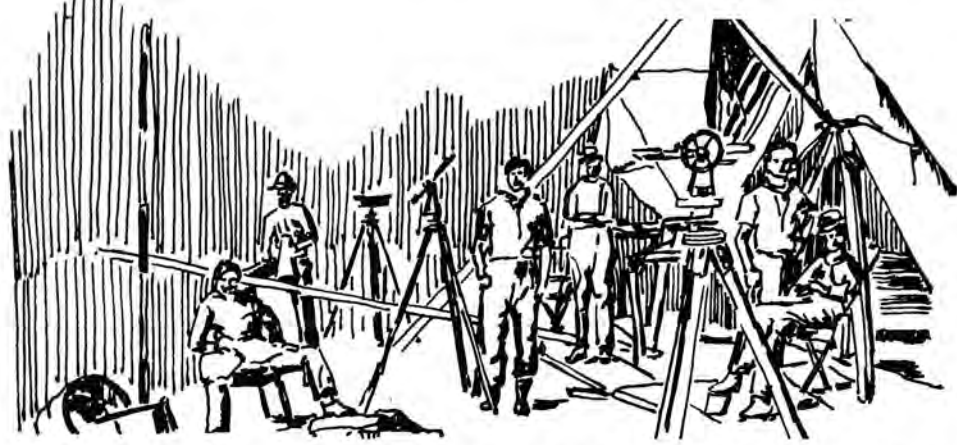
Ohio River Flood Board records are in Boxes 1133, 2295, 2293, RG 77, NA, Kansas City Federal Records Center. The reports of the Board are: U. S., Congress, House, *Report of Ohio River Flood Board*, H. Doc. 246, 63 Congress, 1 Session, 1913; U. S., Congress, House, *Prevention of Damage by Floods*, H. Doc. 914, 63 Congress, 2 Session, 1914; and U. S., Congress, House, *Flood Protection and Prevention*, H. Doc. 1792, 64 Congress, 2 Session, 1916.

Information about the construction of Milton, Meander Creek, and Pymatuning dams is found in "Cutoff Wall and Rock Grouting at Milton Reservoir Embankment," *Engineering News*, LXXIII (March

11, 1915), 468-70; "A City River-Control Reservoir and Plans for Operation," *Engineering News*, LXXVI (December 7, 1916), 1084-85; Charles E. Ryder, "Low Flow Regulation by Pymatuning Reservoir," *Proceedings of the American Society of Civil Engineers*, LXIV (January, 1938), 22-23; and Nathan B. Jacobs, "The Economic Aspects of Flood Control," *Transactions of the American Society of Civil Engineers*, CIII (1938), 573-74. Early engineering studies are also available in the Pittsburgh Engineer District Library.

Cliff Morrison, retired from the Pittsburgh District, supplied information about James Getty and the District's 308 studies. See also records in Boxes 642 and 1252, Civil Works Files, RG 77, NA, at Suitland, Maryland. General Lytle Brown is quoted from *Congressional Record*, April 9, 1930, p. 7092. The 1928 Pittsburgh District report on the Allegheny and Monongahela basins is on file in Engineering Division Files, Pittsburgh District. See also Harold A. Thomas and Ross M. Riegel, *Review of Report of the United States Army Engineers on Flood Control Survey, Allegheny and Monongahela Rivers* (Pittsburgh, 1930); W. D. Styer, "Pittsburgh Area Inaugurates Its Flood-Control Program," *Engineering News-Record*, CX-III (July 12, 1934), 48-50; Wilmer Jacoby, "What We Have Learned About Flood Control," *National Waterways*, VIII (March, 1930), 35-39; and Roland M. Smith, "The Politics of Pittsburgh Flood Control," *Pennsylvania History*, XLII (January, 1975), 15-19.

"When Power Aids Navigation," *National Waterways*, IX (October, 1930), 38-40, reviews the 1930 drought on the Monongahela. For Tygart Dam history, see W. D. Styer, "The Tygart River Reservoir Project," *Civil Engineering*, V (June, 1935), 342; Flood Commission of Pittsburgh, *Flood Control and Employment* (Pittsburgh, 1933); File 7402 (Bulkies), Civil Works, RG 77, NA, Suitland, Maryland; Tom Cummings, "Watchdog of the Waters," *Greater Pittsburgh*, XIX (April, 1939); and J. E. Deignan, "Measuring Bed Rock Action under Tygart Dam," *Engineering News-Record*, CXVI (May 21, 1936), 731.



Operations of Tygart Reservoir are reviewed in "Pittsburgh Area Inaugurates Its Flood-Control Program," *Engineering News-Record*, CXIII (July 12, 1934), 48; Pittsburgh District, *Tygart Dam: Review of Operations, 1938-39* (Pittsburgh, 1940); and Robert M. Morris and Thomas L. Reilly, "Operations Experiences, Tygart Reservoir," *Transactions of the American Society of Civil Engineers*, CVII (1942), 1349-73.

Accounts of the 1936 flood include Ramon Cooper, *The Flood and the Future* (Johnstown, 1937); Dale H. Custer, "A Document on the Second Johnstown Flood," *Pennsylvania History*, XXX (July, 1963), 347-54; "Record Floods from New England to the Potomac," *Engineering News-Record*, CXVI (March 26, 1936), 441-46, 466-69; H. W. Richardson, "After the Floods in the Pennsylvania Region," *Engineering News-Record*, CXVI (April 23, 1936), 599-603; Charles W. Garrett, *History of the Floods of March 1936 and January 1937* (Philadelphia, 1937); and "Allegheny River Cuts New Channel Around Braeburn Dam," *Engineering News-Record*, CXVI (April 2, 1936), 506. Records of Pittsburgh District activities during the 1936 flood are in Box 1243, Civil Works, 1923-1942, RG 77, NA, Suitland, Maryland.

Arthur E. Morgan is quoted in Samuel S. Wyer, *Study of Inland Waterway Situation* (Columbus, 1931), p. 12. Correspondence with the public about the 1936 flood is filed in Box 1243, Civil Works, 1923-1942, RG 77, NA, Suitland, Maryland. See also Roland Smith, "The Politics of Pittsburgh Flood Control," *Pennsylvania History*, XLII (January, 1975), 19-22. The contribution of local and state governments to land acquisition for reservoirs was discussed at length in U. S., Congress, House, Committee on Flood Control, *Comprehensive Flood Control Plan for Ohio and Lower Mississippi Rivers*, Hearings on H.R. 7393 and H.R. 7646, 75 Congress, 1 Session, 1937.

For the Johnstown project, consult Ramon Cooper, *The Flood and the Future* (Johnstown, 1937); Joseph B. Tiffany, "Model Study Helps Prevent

Johnstown Floods," *Civil Engineering*, XV (July, 1945), 30-32; Emil P. Schuleen, "Address to Hydraulic Committee of Pennsylvania Electric Association, Johnstown, February 4, 1954" (Public Affairs Office files, Pittsburgh District); Pittsburgh District, *Johnstown Channel Improvement* (Pittsburgh, 1940); *Johnstown Daily Tribune*, November 29, 1943; and "Flood Control Is on the Way," *Greater Pittsburgh*, XVII (August, 1936), 17, 36.

Minutes of the Board of Consultants meetings are in File 7402, Civil Works, 1923-1942, RG 77, NA, Suitland, Maryland. Dr. Shailer Philbrick supplied his memories of the meetings and activities of the Board. Engineering Divisions Files, Pittsburgh Engineer District, contain design and construction records on each dam and reservoir. Other worthwhile sources include Wilfred Bauknight, "Construction for Flood Control at Pittsburgh," *Civil Engineering*, XI (November, 1941), 637-40; Pittsburgh District, *Flood Control for Western Pennsylvania* (Pittsburgh, 1938); Pittsburgh District, *Tionesta Dam: Tionesta Creek* (Pittsburgh, 1939); "Mahoning Dam Model Studied at Case School," *Engineering News-Record*, CXIX (December 23, 1937), 1003; Pittsburgh District, *Mahoning Dam, Mahoning Creek, Analysis of Design* (Pittsburgh, 1938); Kenneth C. Cox, "Cantilever Forms Preferred at Mahoning," *Engineering News-Record*, CXXVII (October 23, 1941); Contracting Division, Dravo Corporation, *Locks and Dams* (Bulletin 402-C, Pittsburgh, 1947); "Crooked Creek Dam Placed in Service," *Greater Pittsburgh*, XXI (November, 1940), 14; Pittsburgh District, *Crooked Creek Dam, Crooked Creek* (Pittsburgh, 1939).

Chapter 14

ARSENAL OF THE ALLIES

Horton W. Stickle, "Monongahela River Navigation," *Professional Memoirs, Corps of Engineers*, X (November, 1919), 712-13, comments on the defense role of the river. War materials production at Pittsburgh, 1914-1919, is summarized in Frank R.

Murdock, "Some Aspects of Pittsburgh's Industrial Contribution to the World War," *Western Pennsylvania Historical Magazine*, IV (October, 1921), 214-23; and in Frank C. Harper, *Pittsburgh: Forge of the Universe* (New York, 1957), pp. 251-52.

Correspondence about the application of technology to warfare is in File 90789, General Correspondence, 1894-1923, RG 77, NA. The definitive work on military construction by the Corps of Engineers in the United States is Jesse Remington and Lenore Fine, *The Corps of Engineers: Construction in the United States* (Washington, 1972). For the services of the Engineers during the First World War, see Edgar Jadwin, "Modern Military Engineering," *Journal of the Franklin Institute*, CC (July, 1925), 1-33; and "What the American Army Engineers Did in the War," *Engineering News-Record*, LXXXII (May 15, 1919), 953-54. Materials relating to activities in the Pittsburgh Engineer District during the war include the *ARCE, 1917-19*; District Circulars in Entry 1310, RG 77, NA, Philadelphia Federal Records Center; and the John W. Arras Papers (Copy in District Library). Lansing Beach is quoted in *ARCE, 1920*, p. 24.

Minutes of the June 30, 1942, meeting of the Board of Consultants are in File 7402, Box 1803, Civil Works, RG 77, NA, Suitland, Maryland. Other information was supplied by Dr. Shailer Philbrick and General Herbert D. Vogel. Details of the construction of Youghiogheny Dam can be located in Engineering Division Files, Pittsburgh District; Pittsburgh District, *Pertinent Data: Youghiogheny Dam* (Pittsburgh, 1940); U. S., Congress, House, *Youghiogheny River*, H. Doc. 644, 78 Congress, 2 Session, 1944; Ralph Edgar, "Flood Control and Our War Effort," *Greater Pittsburgh*, XXIII (January, 1942), 12-13; "Belt Delivers Fill for Earth Dam," *Engineering News-Record*, CXXIX (December 3, 1942), 75-78; and "Youghiogheny Dam Completed in Two Years," *Engineering News-Record*, CXXXII (January 6, 1944), 3.

General Herbert D. Vogel supplied a memoir of his services in Pittsburgh District. Information on

the airfield and filter center projects is located in Entry 391, Completion Reports, RG 77, NA, Suitland, Maryland; and in Box 650, Civil Works District Files, RG 77, NA, Suitland, Maryland. See also "Pittsburgh Airport Job Postponement Probable," *Engineering News-Record*, CXXXII (January 6, 1944), 11; and "The Saga of Pittsburgh's Airport," *Greater Pittsburgh*, XXXIV (June, 1952), 4. Runway pavement testing is described at length in Remington and Fine, *The Corps of Engineers: Construction in the United States* (Washington, 1972).

Activities within Pittsburgh District during the Second World War are outlined in some detail in the District's monthly publication *Check Posts* printed during the war years. Copies are available in the Herbert D. Vogel Papers, Syracuse University, and in the personal papers of Mary "Skip" Ploeger.

Details of construction of military installations are found in Entry 391, Completion Reports, RG 77, NA, Suitland, Maryland.

U. S., Congress, House, Committee on Flood Control, *Flood Control Plans and New Projects*, Hearings on H.R. 4911, 77 Congress, 1 Session, 1941, pp. 306-10, prints Congressman Kirwan's testimony. For the Berlin and Mosquito Creek projects, see Engineering Division Files, Pittsburgh District, and Emil P. Schuleen, "Control of Floods at Pittsburgh Planned," *Civil Engineering*, XV (October, 1945), 455; Alva J. Armstrong, "Mosquito Creek Flood Control Dam," *Engineering News-Record*, CXXXIII (August 10, 1944), 96-99; and U. S., Congress, House, Committee on Flood Control, *Flood Control Bill of 1946*, Hearings on H.R. 6597, 79 Congress, 2 Session, 1946, pp. 242-54.

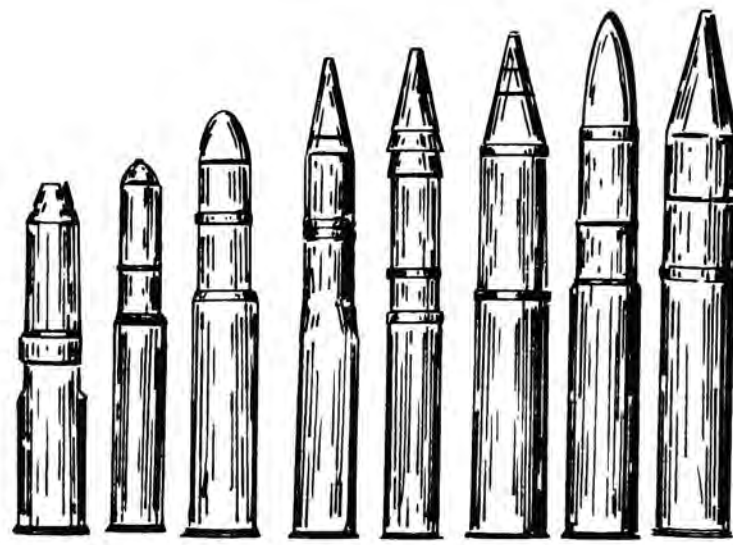
The role of Pittsburgh District waterways during the Second World War can be reviewed in "U. S. Sub-Chaser Is Launched Here," *Greater Pittsburgh*, XXII (November, 1941), 16; Harry Anderson and J. H. Dodds, "The Monongahela River as an Indispensable Artery of National Defense" (19 page manuscript, Pittsburgh District Library); Alex-



ander W. Dann, "Transport by River Today," *Greater Pittsburgh*, XXIII (June, 1942), 26-27; Fred Way, "Ol' Man River Jes' Keeps on Rolling," *Greater Pittsburgh*, XXI (January, 1941), 8-9, 41; J. H. Dodds, "Let Us Safeguard Our Rivers," *Greater Pittsburgh*, XXV (January, 1944), 34-35; U. S., Congress, House, *Use of Barge Transportation for the Movement of Petroleum Products*, H. Doc. 731, 77 Congress, 2 Session, 1942; C. W. Stoll, "The LST," *S&D Reflector*, XIII (March, 1976), 46-47, and (June, 1976), 5-6; and P. W. Loveland and T. P. Bailey, "Navigation on the Ohio River," *Military Engineer*, (May, 1949), 174. Robert C. Downie, "Pittsburgh's Production for Victory," *Greater Pittsburgh*, XXVII (February, 1946), 20-21, summarized Second World War production in Pittsburgh Ordnance District.

For the history of military supply activities, see the John Ploeger Papers in possession of Mary "Skip" Ploeger, retired from Pittsburgh District, and the papers of Wilfred Bauknight, retired from Pittsburgh District. See also Thomas M. Pitkin and Herbert R. Rifkind, "Procurement Planning in the Quartermaster Corps, 1920-1940," *Q. M. C. Historical Studies*, I (March, 1943). The Pittsburgh District *Information Bulletin*, printed monthly and bimonthly, furnishes considerable information about military supply activities, and construction of VA Hospitals, Army Reserve Centers, NIKE Missile installations, and the Missile Master Center. See also M.R. McCarthy, "Air Defense--Pittsburgh," *Greater Pittsburgh*, XLIX (May, 1967), 9-13; C. W. Ogden, "Bailey Bridge Mass Produced," *Civil Engineering*, XV (May, 1945), 203-05; and "Pittsburgh District Corps of Engineers since 1868," *Greater Pittsburgh*, XXXVIII (June, 1956), 18.

President Kennedy's address on civil defense is printed in *New York Times*, May 26, 1961. Information on the Civil Defense Mission was supplied by Frank R. Stocker, retired from Pittsburgh District. See also U. S. Army, Corps of Engineers, *The Corps of Engineers: The Contributions of Its Civil Works to National Preparedness* (Washington, 1964).



Chapter 15

RIVERS ARE HIGHWAYS THAT MOVE

Information on the District's operations history was supplied by Harry Maples and Bill Shilts, retired from Pittsburgh District, and by Leonard Martin, Chief of Operations Division. Printed materials relating to locks and dams operations include John W. Arras, "The Ohio River," *Engineers' Society of Western Pennsylvania Proceedings*, XXIV (June, 1908), 257-63; C. Lacey Hall, "Pack Ice and Movable Dams," *Military Engineer*, XXVI (July, 1934), 245-47; Ohio River Division, *Navigation of the Ohio River* (Cincinnati, 1938); Charles M. Wellons, "Operation of Ohio River Movable Dams," *National Waterways*, VI (July, 1929), 20-24, 64; Andruue H. Berding, "Those Dam Lockmasters," *Ohio River and Inland Waterways Magazine*, III (October, 1921), 7-9; Charles W. Kutz, "Ohio River Canalization--Its History and Possibilities," *Engineering News-Record*, CIV (March 13, 1930), 437; and John W. Arras, "Locks and Movable Dams of the Ohio River," *Professional Memoirs, Corps of Engineers*, III (October, 1911), 535-45.

The transcript of the 1974 Monongahela and Ohio River flyover narrative is located in the Public Affairs Office files, Pittsburgh Engineer District. Information on each lock and dam is summarized in Pittsburgh District, *Project Maps and Data Sheets Covering Authorized Projects* (Pittsburgh, 1975).

The ARCE provides yearly progress reports on the Monongahela River modernization work. Printed materials include R. B. Jackson, "New Lock and Dam Provide for Expanding River Traffic," *Civil Engineering*, XX (December, 1950), 21-22; Jacque S. Minnotte, "Lock No. 5, Monongahela River, Refaced by Grout-Intrusion Method," *Civil Engineering*, XXII (October, 1952), 50-53; Wilfred Bauknight, "Heavy Industrial Development Dictates Tough Construction Site for Monongahela Locks No. 2," *Civil Engineering*, XXI (September,



1951), 516-20; L. L. Brink, "Construction Difficulties Overcome in Completing Monongahela Locks No. 2," *Civil Engineering*, XXIV (April, 1954), 37-40; U. S., Congress, House, *Monongahela River*, H. Doc. 288, 67 Congress, 2 Session, 1922; U. S., Congress, House, Committee on Rivers and Harbors, *Monongahela River*, Committee Doc. 22, 70 Congress, 2 Session, 1928; U. S., Congress, Senate, *Monongahela River*, S. Doc. 100, 81 Congress, 1 Session, 1949; U. S., Congress, House, *Allegheny and Monongahela Rivers and Tributaries*, H. Doc. 491, 83 Congress, 2 Session, 1954; and Pittsburgh District, *Information Bulletin* (inhouse publication, bimonthly).

Details about the construction of Montgomery and Emsworth Locks and Dam may be located in Engineering Division Files, Pittsburgh Engineer District, and File 7245, Civil Works, RG 77, NA, Suitland, Maryland. Available printed materials on the subject are Pittsburgh District, *Emsworth Locks and Dams, Ohio River* (Pittsburgh, 1939); Wilfred Bauknight, "New Crest Gate for Dams," *Engineering News-Record*, CXVIII (May 6, 1937), 665-66; W. E. R. Covell, "The Government and Pittsburgh's Rivers," *Greater Pittsburgh*, XVII (December, 1936), 11, 26; Roger G. Powell, *Lock and Dam Replacement* (Cincinnati, 1939); "Three Long-Span Cableways Place Concrete on Ohio River Locks," *Engineering News-Record*, CXIII (October 25, 1934), 515-18; Herbert P. Winn, "Open Caissons for Ohio River Dam Successfully Sealed," *Civil Engineering*, XV (October, 1945), 459-60; and Pittsburgh District, *Montgomery Locks and Dam, Ohio River* (Pittsburgh, 1939).

Progress of the Ohio River Modernization program should be traced in the *ARCE*. Design and construction details are located in Engineering Division Files, Pittsburgh Engineer District. Printed sources include John W. Lane, "Lifeline to Mid-America," *Water Spectrum* (Summer, 1969), 15-18; Charles F. Michiels, William F. Lail, and Robert E. Mytinger, "Current Trends in Ohio River Traffic," *Journal of the Waterways and Hydraulics Division, ASCE*, LXXXVII (December, 1956), paper 1123; Office of Chief of Engineers, *New*

Cumberland Locks and Dam, Ohio River (Washington, 1947); James W. Bruce, Dwight W. Keller, and James A. Neill, "Modern Facilities for Ohio River Navigation," *Journal of the Waterways and Hydraulics Division, ASCE*, LXXXIII (May, 1957), paper 1239; James Wolfe, "The Damming of Pittsburgh," *Greater Pittsburgh*, L (October, 1968), 36-40; E. E. Abbott, "Design for a New Ohio River," *Civil Engineering*, XXXII (October, 1962), 46-49; Douglas L. Weart, "The Ohio River Today," *National Waterways*, VI (March, 1947), 12-14; "End of an Era," *S&D Reflector*, XII (September, 1975), 19; and files of the Pittsburgh District *Information Bulletin* (bimonthly inhouse publication) and the *Waterways Journal*.

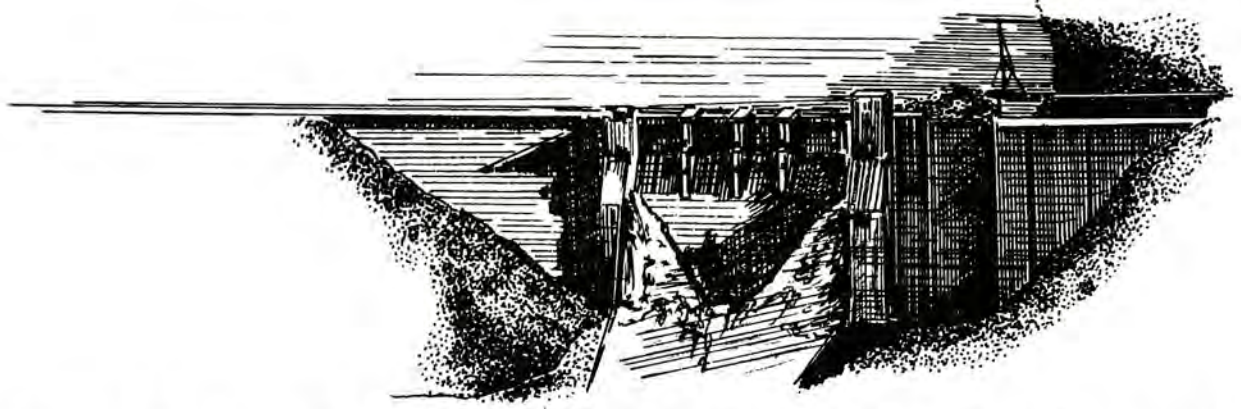
Chapter 16

POSTWAR PROJECTS AND POLITICS

Lytle Brown's comments on politics are printed in "Federal River and Harbor Policies," *Civil Engineering*, V (August, 1935), 462. The best treatment of the relation of politics to public works projects is Frank E. Smith, *The Politics of Conservation* (New York, 1966).

Pennsylvania, Department of Forests and Waters, *The Flood of July 1942 in the Upper Allegheny River and Sinnemahoning Creek Basins* (Harrisburg, 1943), furnishes damage estimates. For the Clarion basin, see *ARCE*, 1882, p. 1944; U. S., Congress, House, *Preliminary Examination of Clarion River*, H. Doc. 187, 54 Congress, 1 Session, 1896; Federal Power Commission, *Second Annual Report* (Washington, 1922), and *Fifteenth Annual Report* (Washington, 1935); Theophilus L. Wilson, "The Iron Industry in Clarion County," *Western Pennsylvania Historical Magazine*, XX (March, 1937), 15-30; U. S., Congress, House, *Allegheny and Monongahela Rivers and Tributaries*, H. Doc. 491, 83 Congress, 2 Session, 1954, pp. 85-86; and information in Engineering Division Files, Pittsburgh Engineer District.

Details of the campaign for construction of Conemaugh Dam are provided by U. S., Congress, House, Committee on Appropriations, *War Depart-*



ment *Civil Functions Appropriations Bill for 1947. Hearings*, 79 Congress, 2 Session, 1946, 385-400; and articles in *Greater Pittsburgh*, XXVII (February, 1946), supplement 5; XXVIII (September, 1947), 14-15; and XXXI (June, 1949), 28-32.

The Pittsburgh "Renaissance" and its connection with flood control are reviewed in Francis C. Murphy, *Regulating Flood Plain Development* (Chicago, 1958), pp. 3-5; Frank C. Harper, *Pittsburgh: Forge of the Universe* (New York, 1957), "Gateway to Pittsburgh's Renaissance," *Greater Pittsburgh*, LII (January, 1970), 18-19; Roy Lubove, *Twentieth Century Pittsburgh: Government, Business, and Environmental Change* (Pittsburgh, 1969), 119-20; Park H. Martin, "The Allegheny Conference--Planning in Action," *Transactions of the American Society of Civil Engineers*, CXVIII (1953), 235-44; Park H. Martin, "Pittsburgh's Comprehensive Improvement Program," *Transactions of the American Society of Civil Engineers*, CXXI (1956), 885-98; Carl B. Jansen, "The Greater Pittsburgh Renaissance Program," *Civil Engineering*, XXXVIII (September, 1968), 35-42; and Roland Smith, "The Politics of Pittsburgh Flood Control," *Pennsylvania History*, XLII (January, 1975), 19-22.

Information about the operations of the District Surveys Branch and Real Estate Division is supplied in Pittsburgh Engineer District, *Information Bulletin* (bimonthly inhouse publication), February, 1961, March-June, 1965. Articles by Wilfred Bauknight and Jacque S. Minnotte on the work of the Construction Division are printed in *Information Bulletin*, April, 1958, and Pittsburgh District, *Engineer Officers Advanced Class, Fort Belvoir* (Pittsburgh, 1947).

The Conemaugh project relocations work is outlined in "Railroad Relocated Above Conemaugh Dam," *Engineering News-Record*, CXXXIX (August 7, 1947), 176-78; "Conemaugh Flood Control Project," *Greater Pittsburgh*, XXVIII (March, 1947), 8-9; "Rapid Progress on Conemaugh Dam," *Greater Pittsburgh*, XXVII (September, 1946), 20-21; and U. S., Congress, Committee on Ap-

propriations, *Civil Functions, Department of the Army Appropriation Bill for 1949, Hearings*, 80 Congress, 2 Session, 1948, pp. 390-92. Construction of the Conemaugh Dam is reviewed in articles in *Greater Pittsburgh*, XXXIV (November, 1952), 9-10, and XXXV (September-October, 1953), 13-15, 18.

Reservoir operations are explained by Emil P. Schuleen, "Control of Floods at Pittsburgh Planned," *Civil Engineering*, XV (October, 1945), 455-48; a series of articles in the Pittsburgh District, *Information Bulletin* (bimonthly inhouse publication); and in several manuscript reports in Public Affairs Office Files, Pittsburgh Engineer District.

Pittsburgh District, *Flood Wall for Wellsville, Ohio* (Pittsburgh, 1939), supplies details about the Wellsville project. Minutes of the Engineer conferences on floodwall and levee design are in Box 1244, Civil Works, 1923-42, RH Files, RG 77, NA, Suitland, Maryland. General information about local protection projects is furnished in H. K. Barrows, *Floods, Their Hydrology and Control* (New York, 1948), pp. 346-47; and S. M. Bailey, R. E. Karlen, and Harry Pockras, "Local Flood Protection Projects, Ohio River Basin," *Journal of the Waterways and Harbors Division, ASCE*, LXXXVII (December, 1956), paper 1128. Specific facts on each local protection project in the Pittsburgh District are available in *Project Maps and Data Sheets Covering Authorized Projects* (Pittsburgh, 1974). Engineering Division Files, Pittsburgh Engineer District, contain the project records.

For the Olean and Portville projects, see "Flood Protection at Olean," *Engineering News*, LXXVI (October 12, 1916), 721, and U. S., Congress, Senate, *Allegheny River Flood Control at and in the Vicinity of Olean, N.Y.*, S. Doc. 245, 79 Congress, 2 Session, 1946.

Ed A. Murray's correspondence concerning local protection for Punxsutawney is in Box 814, File 7243, Civil Works, RH Files, RG 77, NA, Suitland, Maryland. Congressman Leon H. Gavin's testimony about the Brookville-Reynoldsville projects is in U. S., Congress, House, Committee on Public Works,

Flood Control Omnibus Bill, Hearings on H.R. 9859, 83 Congress, 1-2 Sessions, 1954, pp. 111-15, and U. S., Congress, House, Committee on Public Works, *Flood Control, Rivers and Harbors Miscellaneous Projects*, Hearings No. 84-10, 84 Congress, 1 Session, 1955, pp. 199-207. See also U. S., Congress, House, *Sandy Lick Creek at and in the Vicinity of Reynoldsville, Pa.*, H. Doc. 716, 81 Congress, 2 Session, 1950; and U. S., Congress, House, *North Fork, Redbank, and Sandy Lick Creeks, at Brookville, Pa.*, H. Doc. 166, 85 Congress, 1 Session, 1957.

Important printed materials concerning Chartiers Creek protection project are Gilbert F. White, *et. al.*, *Changes in Urban Occupation of Flood Plains in the United States* (Chicago, 1958), pp. 101-07; U. S., Congress, House, Committee on Public Works, *Chartiers Creek at Washington, Pa.*, H. Doc. 286, 85 Congress, 2 Session, 1957; and U. S., Congress, House, *Chartiers Creek Basin, Pa.*, H. Doc. 302, 88 Congress, 2 Session, 1964.

For Girty's Run, see Consul W. Butterfield, *History of the Girtys* (Cincinnati, 1890), pp. 11, 330-32; *ARCE*, 1912, p. 2313; Pittsburgh District *Information Bulletin*, August, 1976; and materials in Public Affairs Office Files, Pittsburgh Engineer District.

The debate between Congressmen Kirwan and Graham over the Lake Erie and Ohio River Canal project is reported in U. S., Congress, House, Committee on Rivers and Harbors, *Beaver and Mahoning Rivers, Hearings*, 77 Congress, 1 Session, 1941, pp. 166-69. Practically all of the many reports upon the proposed canal are available, some still in manuscript, in the Pittsburgh District Library. Important materials are also in the Thomas P. Roberts Papers, in possession of General James Milnor Roberts, Reserve Officers Association, Washington, D. C. Information can also be supplied by Richard M. Thalimer, retired from Pittsburgh District.

Interesting statements of opposition to the proposed Lake Erie to Ohio River Canal include James H. Greene, "Why We Oppose that Stub-End Canal,"

Greater Pittsburgh, XXV (June, 1944), 11; William O. Douglas, "The Public Be Damned," *Playboy* Magazine, July, 1969, reprinted in Walt Anderson, ed., *Politics and Environment: A Reader in Ecological Crisis* (Pacific Palisades, Calif., 1970), 282; and Theodore L. Humes, "The Pork Barrel Road to Bankruptcy," *Greater Pittsburgh*, XLVIII (October, 1966, 20, 79. See also *S&D Reflector*, X (September, 1973), 41.

Chapter 17

LAKE PERFIDY AND AGNES

The transcript of the February 21, 1963, TODAY show on NBC is filed in Public Affairs Office Files, Pittsburgh Engineer District. See also Pittsburgh District, *Information Bulletin*, January-February, 1963.

Many of the men involved in the Kinzua project are available for interview, and Frank Stocker, Al Layton, Halsey Harmon, and others have supplied information. Files of the Public Affairs Office and Engineering Division also contain pertinent correspondence and data. For early action on the Kinzua project, see U. S., Congress, House, *Allegheny River--Allegheny Reservoir*, H. Doc. 300, 76 Congress, 1 Session, 1939; Harold C. Putnam, *Improvement of the Allegheny River and Flood Control* (Warren, 1944); and U. S., Congress, House, Committee on Flood Control, *Status of Flood Control Legislation and Works*, Hearings on Amendments, 76 Congress, 1 Session, 1939, pp. 126-27.

Correspondence with Dr. Arthur E. Morgan and actions on his proposed alternatives are in Engineering Division Files, Pittsburgh Engineer District. Dr. Morgan's opinions are presented in his *Dams and Other Disasters: A Century of the Army Corps of Engineers in Civil Works* (Boston, 1971). See also U. S., Congress, House, Committee on Public Works, *Public Works Appropriations for 1960*, Hearings, 86 Congress, 1 Session, 1959, p. 36; and U. S., Congress, House, Subcommittee on Indian Affairs, Kinzua Dam, *Seneca Indian Relocation*, Hearings on H.R. 1794, 88 Congress, 1 Session, 1963.

The transcript of the hearing on March 24, 1964, by the U. S. District Court for the Western District of Pennsylvania on the Cornplanter cemetery relocation, along with copies of all other legal actions and many other items pertaining to the Kinzua project, are in the Lawrence Layton Papers, Pittsburgh District Library. See also Alvin M. Josephy, Jr., "Cornplanter, Can You Swim?," *American Heritage*, XX (December, 1968), 4-9, 106-09.

Kinzua Dam design and construction records are in Engineering Division Files, Pittsburgh Engineer District. See also "Chamber Climaxes 24-Year Struggle," *Greater Pittsburgh*, XLII (November, 1960), 13; Pittsburgh District, *Final Report on Upstream Concrete Cut-Off Wall, Allegheny Reservoir Dam* (Pittsburgh, 1965); and Garth A. Fuquay, "Foundation Cutoff Wall for Allegheny Reservoir Dam," *Journal of the Soil Mechanics and Foundations Division, ASCE*, XCIII (May, 1967), 37-60.

Engineer activities during the 1959 flood and ice jams on French Creek are described in Pittsburgh District, *Information Bulletin*, January-March, 1959. See also W. W. Smith, "The 1959 Flood," *Greater Pittsburgh*, XCI (March, 1959), 13; and "What Are We Doing about Floods," *Engineering News-Record*, CLXII (February 5, 1959), 21.

The conversation between General Itschner and Congressman Kirwan is printed in U. S., Congress, House, Committee on Public Works, *Public Works Appropriations for 1960*, Hearings, 86 Congress, 1 Session, 1959, pp. 16-17, 55, 517. For the design and construction of West Branch (Michael J. Kirwan) Dam and Reservoir, see Engineering Division Files, Pittsburgh Engineer District, and U. S., Congress, House, *Mahoning River Basin, Ohio: West Branch Reservoir*, H. Doc. 191, 85 Congress, 1 Session, 1957.

Best sources for the Shenango River Dam and Lake project are Engineering Division Files, Pittsburgh Engineer District, and the John C. Staples Papers, which include extensive newspaper coverage clippings relating to the project. Mr.

Staples is retired from Pittsburgh District and loaned his papers.

For the French Creek project, including Union City, Woodcock Creek, and Muddy Creek dams, see Engineering Division Files and Public Affairs Office Files in Pittsburgh Engineer District. Public documents include U. S., Congress, House, *Allegheny and Monongahela Rivers and Tributaries*, H. Doc. 491, 83 Congress, 2 Session, 1954, pp. 85-88; and U. S., Congress, Senate, *French Creek Basin, Pa.*, S. Doc. 95, 87 Congress, 2 Session, 1962.

Nearly complete coverage of the AGNES disaster in Pittsburgh District, the emergency response of the Engineers, and their role in disaster recovery operations is presented in Pittsburgh District, *Post Flood Report: Tropical Storm Agnes, June 1972* (2 vols.; Pittsburgh, 1974).

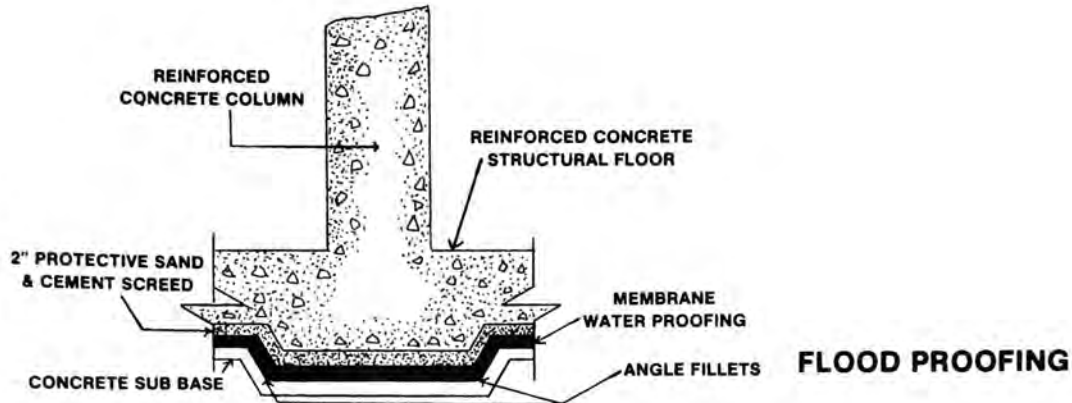
Chapter 18

THE WATER CRISIS

Water user conflicts are discussed in Frank E. Moss, *The Water Crisis* (New York, 1967); Jim Wright, *The Coming Water Famine* (New York, 1966); and Frank E. Smith, *The Politics of Conservation* (New York, 1966).

For harbor lines and regulatory functions enforcement, consult the *ARCE*; the John W. Arras Papers (copy in Pittsburgh District Library); "Federal and State Power over Harbor Lines," *Professional Memoirs, Corps of Engineers*, IV (July, 1912), 536-37; and Albert E. Cowdry, "Pioneering Environmental Law; The Army Corps of Engineers and the Refuse Act," *Pacific Historical Review*, XLIV (August, 1975), 331-49. Correspondence relating to enforcement is located in RG 77, NA, and in Pittsburgh District files. The historical reports on stream navigability on file in the District Waterways Management Branch are thorough and important historical sources.

Thomas Roberts' report on Allegheny River pollution is printed in *ARCE*, 1880, p. 1773. His study of



acid conditions on the Monongahela is "Acids in Rivers from Mines and Mills, with Special Reference to the Monongahela," *Professional Memoirs, Corps of Engineers*, IV (July-August, 1912), 501-04. Other materials pertaining to acid mine drainage include "Mine-Sealing Program to Reduce Acid Pollution in Streams," *Engineering News-Record*, CXVI (January, 1936), 42-43; and U. S., Congress, House, Committee on Public Works, *Acid Mine Drainage*, H. Rept. 18, 87 Congress, 2 Session, 1962.

General information on water quality studies is provided in Harold W. Streeter, "Surveys for Stream Pollution Control," *Proceedings of the American Society of Civil Engineers*, LXIV (January, 1938), 5-21; U. S., Congress, House, *Ohio River Pollution Control*, H. Doc. 266, 78 Congress, 1 Session, 1943; U. S., Congress, House, *Pollution Affecting Navigation or Commerce on Navigable Waters*, H. Doc. 417, 69 Congress, 1 Session, 1926; A. H. Horton, "Pollution of the Ohio River," *Engineering News*, LXIX (January 23, 1913), 186-87. Records of the Ohio River pollution survey of 1938-43, are in Box 1238, Civil Works, RH Files, RG 77, NA, Suitland, Maryland. J. Clarence Davies III, *The Politics of Pollution* (New York, 1970), summarizes the political struggle over water quality issues.

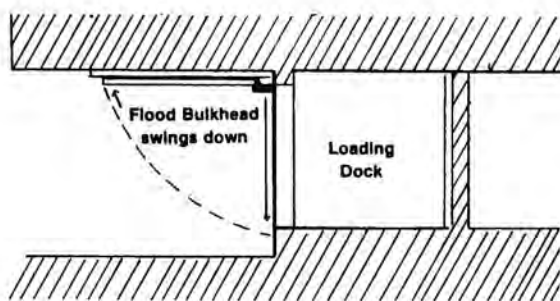
Actions of local and state governments on water quality improvements are described in Edward J. Cleary, *The ORSANCO Story, Water Quality Management in the Ohio Valley Under an Interstate Compact* (Baltimore, 1967); and in George P. Gregory, "A Study in Local Decision Making: Pittsburgh and Sewage Treatment," *Western Pennsylvania Historical Magazine*, LVII (January, 1974), 25-42.

Colonel Francis Shunk's comment on fishing in the Pittsburgh District is quoted from his letter of July 9, 1914, in Box NA16, RG 77, NA, Kansas City Federal Records Center. A report on fishing improvements is H. R. Preston, *Monongahela River Basin Aquatic Biology: Fish Population Studies of the Monongahela River* (Wheeling, 1974).

The comment of Thomas Roberts on ecology is printed in *Professional Memoirs, Corps of Engineers*, IV (July, 1912), 518. On the differences between early conservationists and modern environmentalists, see William G. Berberet, "The Historical Framework of Environmental Politics" (Paper presented at Duquesne History Forum, Pittsburgh, October 29, 1971). The reactions of the Engineers to environmentalists' criticisms can be traced in "Engineers and the Environmental Movement," *Military Engineer*, LXIV (May, 1972), 175-76; "Interview with Lieutenant General Frederick J. Clarke," *The Engineer*, I (Summer, 1971), 5; Oliver A. Houck, "New Roles for the Old Dam Builder?" *National Wildlife*, (August, 1975), 13-15; "The U. S. Army Corps of Engineers...Guardians of Western Pennsylvania's Rivers," *Greater Pittsburgh*, LIV (January, 1972), 10, 29; and John Lear, "Environment Repair: The U. S. Army Engineers' New Assignment," *Saturday Review*, May 1, 1971, pp. 47-53.

Materials furnishing general information about nonstructural flood control are Armando C. Lardieri, "Flood Proofing Regulations for Building Codes," *National Water Resources Engineering Meeting, ASCE* (January 29 - February 2, 1973), Meeting Preprint 1915; R. A. Hertzler, "Corps of Engineers' Experience Relating to Flood Plain Regulation," in Gilbert F. White, ed., *Papers on Flood Problems* (Chicago, 1961); Francis C. Murphy, *Regulating Flood-Plain Development* (Chicago, 1958); John R. Sheaffer, *Flood Proofing: An Element in a Flood Damage Reduction Program* (Chicago, 1960); Robert W. Kates, *Hazard and Choice Perception in Flood Plain Management* (Chicago, 1962); and Emil Schuleen, "Flood Plain Zoning as Supplement to Flood Control," *Proceedings of the American Society of Civil Engineers*, LXXXII (April, 1956), paper 954.

Correspondence relating to recreational needs at Tygart Dam and other early projects is located in File 7402, Civil Works, RH Files, RG 77, NA, Suitland, Maryland. Some of the printed sources pertaining to recreational developments are Clayne



R. Jensen, *Outdoor Recreation in America: Trends, Problems, and Opportunities* (Minneapolis, 1970); U. S., Congress, Senate, Committee on Public Works, *Evaluation of Recreational Benefits from Reservoirs*, Hearings on S. 1164 and S. 1221, 85 Congress, 1 Session, 1957; Eugene W. Weber, "Recreation—A Purpose of Water Resource Development," *Civil Engineering*, XXXII (September, 1962), 57-59; "Pleasure Boating in River City, Pa.," *Greater Pittsburgh*, LV (May, 1973), 20; Dale K. Williams, "Pleasure Boating on Commercial Rivers," *Military Engineer*, LXIV (May, 1972), 161; "Pittsburgh's Boating Craze," *Greater Pittsburgh*, XLI (August, 1959), 44-45; "TRIAD: Getting It All Together on the Rivers," *Greater Pittsburgh*, LII (September, 1970), 26. Specific information on recreation resource development in the Pittsburgh District is printed in the *Information Bulletin* and is available in the files of the Public Affairs Office and the Recreation-Resource Management Branch, Pittsburgh Engineer District.

The original efforts at comprehensive planning are filed in Box NA1044, RG 77, NA, Kansas City Federal Records Center. Basic information on comprehensive planning is furnished in Wendell E. Johnson, "Water Resources Program Management," *Military Engineer*, LV (November, 1963), 391-92; Frank E. Smith, *The Politics of Conservation* (New York, 1966); and *Journal of the Waterways and Harbors Division*, ASCE, XCIV (May, 1968), which presented several papers on the subject. Historian Albert E. Cowdry is quoted from his *The Delta Engineers* (New Orleans, 1971). Professor Kraenzel is quoted from his "The Social Consequences of River Basin Development," in *Law and Contemporary Problems*, XII (Spring, 1957), p. 222.

The history of the Stonewall Jackson project is based on Scotland G. Highland, Clarksburg Water Board, *Treatise of Water Resources* (Clarksburg, 1942), and records in Engineering Division Files, Pittsburgh Engineer District. Engineering Division Files were also examined for the Rowlesburg project. See also U. S., Congress, House, *Cheat River*

and Tributaries, H. Doc. 645, 78 Congress, 2 Session, 1944; Arthur J. Parker, "The Case for Rowlesburg Dam," *Greater Pittsburgh*, LII (October, 1970), 19-22; and U. S., Congress, Senate, Committee on Appropriations, *Hearings on Public Works, FY 1974*, 93 Congress, 1 Session, 1973, p. 575.

Jacob Myers' advertisement for his packet service was printed in Pittsburgh, Cincinnati, and Kentucky newspapers beginning in October 1793. See also the Anthony Wayne Papers, Historical Society of Pennsylvania, Philadelphia; and Charles H. Ambler, *A History of Transportation in the Ohio Valley* (Glendale, Calif., 1932), pp. 43-45.

Information about the Pittsburgh District post-office construction work can be located in Office of the Chief of Engineers, Circular No. 415-1-4, March 19, 1971; Pittsburgh District, *Information Bulletins*, October, 1975, June and August, 1976; and EIG briefings in Public Affairs Office Files, Pittsburgh Engineer District. The Pittsburgh District, *Information Bulletin*, November, 1976, and January, 1977, summarizes the work for the Bureau of Mines at Bruceton and the Nashville Engineer District at Martins Fork Dam.

A transcript of Colonel Max R. Janairo's remarks on Engineer Day, 1975, is located in Public Affairs Office Files, Pittsburgh Engineer District. The address of General John W. Morris in which he reviewed developments during 1965-1975 and speculated upon the future was distributed by Public Affairs Office, Office of the Chief of Engineers, Washington, D. C. The comments of Jacques S. Minnotte are quoted from the Pittsburgh District, *Information Bulletin*, January, 1977.

Chapter 19

RETURN TO JOHNSTOWN

District Engineer, Colonel Max R. Janairo, Jr., *Johnstown Tribune Democrat* "Be ready and pray -- and clear out the basement." Portion of 1974 Flood Plain Information Study for Cambria and Somerset Counties.

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