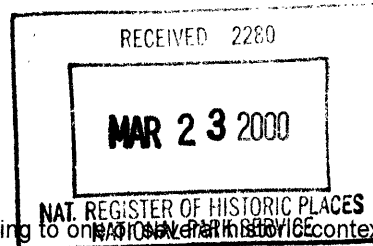


United States Department of the Interior
National Park Service
National Register of Historic Places
Multiple Property Documentation Form



This form is used for documenting multiple property groups relating to only one or more historic contexts. See instructions in *How to Complete the Multiple Property Documentation Form* (National Register Bulletin 16B). Complete each item by entering the requested information. For additional space, use continuation sheets (Form 10-900-a). Use a typewriter, word processor, or computer to complete all items.

☒ New Submission ☐ Amended Submission

A. Name of Multiple Property Listing

Historic Resources of the Allegheny River Navigation System 1739-1948

B. Associated Historic Contexts

Allegheny River Navigation System 1739-1948

C. Form Prepared by

name/title Douglas Dinsmore, Ph.D., Principal Investigator

organization Heberling Associates, Inc.

street & number 415 Church Street

city or town Huntingdon

state Pennsylvania

date May 12, 1998

telephone (814) 643-1795

zip code 16652

D. Certification

As the designated authority under the National Historic Preservation Act of 1966, as amended, I hereby certify that this documentation form meets the National Register documentation standards and sets forth requirements for the listing of related properties consistent with the National Register criteria. This submission meets the procedural and professional requirements set forth in 36 CFR part 60 and the Secretary of the Interior's Standards and Guidelines for Archeology and Historic Preservation. ([] See continuation sheet for additional comments.)

Paul D. Rubenstein, Federal Preservation Officer 13 March 2000
Signature and title of certifying official Date

Office of the Chief of Engineers, Washington, D.C.
State or Federal Agency or Bureau

I hereby certify that this multiple property submission form has been approved by the National Register as a basis for evaluating properties for listing in the National Register.

Edson H. Beall
Signature of the Keeper

4.21.00
Date of Action

E. Statement of Historic Contexts

Discuss each historic context listed in Section B.

PLEASE SEE CONTINUATION SHEET: E -1 (Page 5)

F. Associated Property Types

I. Name of Property Type: Locks, dams, esplanades, and operations buildings

II. Description

PLEASE SEE CONTINUATION SHEET: F II-1 (Page 68)

III. Significance

PLEASE SEE CONTINUATION SHEET: F-III-1 (Page 83)

IV. Registration Requirements

PLEASE SEE CONTINUATION SHEET: F-IV-1 (Page 86)

G. Geographical Data

The geographical area covered by this multiple property listing consists of the Allegheny River from its mouth at Pittsburgh to its origin near Coudersport, PA, and its immediate environs. The Pennsylvania counties of Potter, McKean, Warren, Forest, Venango, Clarion, Butler, Armstrong, Westmoreland, and Allegheny, and the New York counties of Allegany and Cattaraugus cover the area.

H. Summary of Identification and Evaluation Methods

This multiple property listing draws from research conducted May through September, 1997. Douglas Dinsmore conducted the field survey and photo-documentation. Each lock and dam was visited. All visible components were inspected. All powerhouses were inspected, interior and exterior. Selected visits were made to tunnels and machinery underneath the surface. At least one lockage was observed at each lock. Interviews with lock personnel were conducted at each lock, and original drawings of each lock were inspected. At Lock 4, a videotape of recent reconstruction and equipment changes was viewed. A second visit, with hydraulic engineer Gordon Warren of Gannett Fleming, and Heberling historian Judy Heberling, was conducted at seven of the eight extant locks and dams. The second visit involved discussions of the general historical and engineering contexts of the locks and dams.

Several Corps personnel contributed time during the field work and interviews. Lockmasters Lawrence Scafuri and Thomas Fancella provided access to the locks and their materials. Corps employees Charles Stoudt, Ron Coleman, and Todd Coudreau provided information and history of the locks and dams, as well as the Allegheny River in general.

Judy Heberling developed the historical contexts. She concentrated on the industrial and commercial development of the Allegheny River corridor, and the development of publicly-funded navigation improvements. She surveyed secondary literature on the subjects, and consulted a range of primary documents, including *Annual Reports* of the U.S. Army Corps of Engineers officer in charge of the Allegheny River. Other documents in Corps files and archives were reviewed. Related documents at local and regional repositories were also reviewed.

Douglas Dinsmore developed the technological contexts. He reviewed construction drawings of the locks and dams at the National Archives, and in the files of the Corps. He inspected historic photographs of the construction of each lock and dam. Secondary literature on lock and dam construction was also reviewed.

I. Major Bibliographical References

PLEASE SEE CONTINUATION SHEET I-1 (Page 88)

Primary location of additional data:

☒ State historic preservation office
☐ Other state agency
☒ Federal agency

☐ Local government
☐ University
☐ Other

Specify repository: U.S. Army Corps of Engineers, Pittsburgh District
1000 Liberty Avenue, Pittsburgh, PA 15222

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SUMMARY

Navigation improvements began on the Allegheny River in the last decade of the eighteenth century. Improvements consisted of private or local municipal efforts to remove snags and boulders, and constrict channels with wing dams. Mill dams also existed on the upper reaches. Beginning in 1879, the U.S. Army Corps of Engineers began active involvement. Between 1879 and 1903, Corps improvements primarily included removal of obstacles and construction of wing dams. In 1903, the Corps completed Herrs Island Lock and Dam (No. 1), the first lock and dam facility of the navigation system on the Allegheny River. By 1938, eight additional locks and dams (Nos. 2-9) provided a nine-foot depth for 72 miles, beyond East Brady. In the same year, the Emsworth Lock and Dam on the Ohio River was raised, eliminating the need for Herrs Island Lock and Dam, and it was removed. Seven of the eight extant locks and dams, Nos. 2-9, remain largely as constructed.

GENERAL BACKGROUND CONTEXT

The Allegheny River has its source near Coudersport in Potter County along the northern tier of Pennsylvania, flows northwest into New York for nearly 50 miles, and then turns southwest, back into Pennsylvania. It then flows about 250 miles to Pittsburgh, joining there with the Monongahela River to form the Ohio River. At its headwaters, the Allegheny flows through a broken plateau at an elevation of about 2500 feet, winding its way through rugged terrain in a well-defined valley until it reaches its mouth at Pittsburgh (Corps 1975: 8). The river flows through or touches ten Pennsylvania counties during its journey to become part of the Ohio: Potter, McKean, Warren, Forest, Venango, Clarion, Butler, Armstrong, Westmoreland, and Allegheny, and two New York counties, Allegany and Cattaraugus..

The area that is now Armstrong County is typical of the area through which the Allegheny River flows; many stream valleys cut through the high, heavily-timbered plateau, leaving few extensive level areas. The few flood plains that exist are unconnected and narrow (Armstrong County Historic Sites Survey, 1980, p. ii). The Allegheny, together with its principal tributaries the Clarion and Kiskiminetas Rivers, and French, Tionesta, Redbank, Mahoning, and Crooked Creeks, drains an area of about 11,778 square miles of western Pennsylvania and southern New York. The Allegheny was the major north-south transportation route in western Pennsylvania before the advent of the railroads in the mid-1850s.

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The history of the use of the Allegheny River as a navigation corridor began with the French expedition of Baron de Longueil in 1739. Native Americans certainly utilized the river for travel for millenia prior to the Baron's expeditions. European-descended traders had likely also moved trade goods and furs along the river before 1739. However, the Baron's expedition became the first of a series of French and English attempts to claim and hold the area, which became a focal point of the French and Indian War, 1754-1763.

When warfare between the thirteen colonies and England began in 1775, the unstable situation created unrest among the Native American allies of the English from Pittsburgh up the Allegheny into New York. American soldiers occupied the area at the forks of the Ohio and continued to hold this critical strategic position throughout the war. From there American forces were able to launch offensives and prevent incursions by the Native Americans allied with the English, ensuring firm American control of the trans-Allegheny area at the conclusion of hostilities in 1783.

Except for the areas around Pittsburgh and the site of the Native American Old Town of Kittanning, few European-descended settlers penetrated much of the Allegheny River Valley until after the Revolutionary War. Native American paths and natural rivers served as adequate transportation for those who had a need to travel. Following the American Revolution, however, settlers began to trickle back into the frontier areas of central and western Pennsylvania. Allegheny County itself was formed in 1788 from parts of previously-established Washington and Westmoreland Counties. At the time of the first United States Census two years later, there were 10,322 people in Allegheny County, only 206 of whom were located north of the Allegheny and Ohio Rivers (Allegheny County Survey 1982: 7). Armstrong County was then created from Allegheny, Westmoreland, and Lycoming Counties and was legally established in March of 1800, with a population of 2,399.

Successful military campaigns by the new United States Army against Native Americans in the Old Northwest Territory, which culminated with the Battle of Fallen Timbers in 1794, secured western Pennsylvania for European-descended settlement. By 1800 southwestern Pennsylvania boasted a population of nearly 100,000, and the thriving little town of Pittsburgh, which grew from 376 people in 1790 to 7248 in 1820, promoted itself as the natural center of trade with and embarkation for the West (National Park Service 1994: 28-30).

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GEO-POLITICAL-ECONOMIC CLIMATE OF INTERNAL IMPROVEMENTS, 1739-1898

As the population increased, so did the need for better and faster means and routes of transportation. The extraordinary costs of moving people and products across the mountains had served as an effective barrier to development in the trans-Allegheny west. Efforts turned first to improving land travel by building and maintaining better roads. By the 1780s Pennsylvania had begun to address the problem and, although it was obvious that the state did not have the funds to build all of the necessary roads at public expense, there was a common belief that government did indeed have an important role to play in the process. As a result, therefore, the state, prompted by the Pennsylvania Society for Promoting the Improvement of Roads, devised a system of public/private cooperation.

Under this arrangement, the state chartered and subsidized the formation and activities of private stock companies for the purpose of constructing toll bridges and turnpikes around the state. This mixed corporation policy, which first developed within the banking industry, was applied to transportation in Pennsylvania in 1806 (Hartz 1968: 82-83). Despite the potential for conflict between the public and private sectors, there was surprisingly little of it during the period when "public improvements" largely signified improved land transportation. This model served Pennsylvania extremely well in providing access to remote as well as heavily-populated areas throughout the state, and stock companies sprang up everywhere. It was only when the focus shifted to water-based transportation in the 1820s that conflict arose, largely as a result of sectional rivalries within Pennsylvania (Hartz 1968: 51-53).

This mixture of public and private enterprise became widely accepted as the norm for the first several decades of the 19th century. This system was challenged legally and philosophically in the 1840s and 1850s, however, as both practical and philosophical thinking about the economy changed. Public opinion and economic theory emphasized more and more the virtues of private enterprise in banking, transportation, and industry. The economic problems of 1839 and the state debt, the improvement-company stock liquidations in 1843, and the rise of the railroads in the 1840s and 1850s propelled the state out of the public improvements business and made transportation primarily the responsibility of private corporations. One of the developments that made this possible was an abundance of private capital newly earned and available for investment.

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Expanding Markets

Roads served for a long time primarily as connectors between farms and villages and the rivers, but they continued to have definite advantages over rivers and canals. They could, for example, provide the convenience of door-to-door pickup and delivery; they could, within some limits, be built just where they were needed, and they could be used throughout much of the winter when water routes were closed by ice (Stover 1980: 77). As previously mentioned, Pennsylvania's rivers, such as the Ohio, Juniata, West Branch of the Susquehanna, and Kiskiminetas flowed east and west through the state, while the Allegheny, Monongahela, North Branch and combined Susquehanna, and Youghiogheny took north-south routes. Shipping and travel began on these rivers before the end of the 18th century and increased as settlers moved west in larger numbers between 1790 and 1800. The Kiskiminetas, for example, was declared a public highway in 1771, as was the Allegheny in 1798 (Armstrong County Historic Sites Survey 1980: 3). These rivers and streams in their natural state, however, were unpredictable and dangerous, with flooding, drought, rapids, ice, snags, and boulders proving a hazard to all navigation. Small, light, shallow-draft boats could float down the rivers under normal conditions, but it was difficult to develop regular, dependable commerce under these circumstances.

As settlement in western Pennsylvania increased, the desire for trade with Baltimore and with the towns and cities along the Mississippi River grew. New Orleans was Pittsburgh's outlet to the sea, and there was a developing market for the natural resources and products of the West. Rafts, keelboats, and flatboats could float down the rivers to New Orleans and points along the way, getting products to market fairly easily, but it was extremely difficult and expensive to get products back upriver. As a result, until the 1820s and 1830s, manufactured goods still moved overland from east to west transported by teams of freight wagons, an expensive shipping method. During the first two decades of the 19th century in western Pennsylvania, then, the direction of trade was east to west by road across the mountains and downstream by river to Baltimore and out to sea or to the mouth of the Mississippi at the seaport of New Orleans. Western products would finally be unloaded at eastern ports, such as Baltimore and Philadelphia, where the cycle would start once again. This circular route was far cheaper than moving commerce both east and west by road across Pennsylvania (Reiser 1951: 4-5; Taylor 1968).

Events in New York would lead to the first major navigation improvements on the lower Allegheny River. In 1817 the New York state legislature passed a bill authorizing the

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construction of the longest canal in the world, which was to stretch from Albany to Buffalo on Lake Erie, a distance of 364 miles from east to west. The federal government declined to participate financially in this enterprise, and the state thus accepted the challenge of raising the money and supervising the construction of the entire canal system. From the beginning the Erie Canal was an unqualified success as traffic increased and revenues rose so fast that tolls financed its rapid completion (Taylor 1968: 34-36).

Pennsylvania planned a canal to connect the Susquehanna and Ohio River basins. Philadelphia merchants feared the economic superiority of New York City that was already firmly established by the outbreak of the War of 1812 (Lindstrom 1978 as cited in National Park Service 1994: 46). Although the trans-Allegheny trade was not yet well-developed or economically significant, Philadelphia's manufacturing base was expanding, and Philadelphia's business interests feared the competition the Erie Canal would produce in making commerce between New York and the Great Lakes easy and affordable. They also anticipated that the Erie would divert the potentially-lucrative western Pennsylvania trade north and away from them.

Philadelphia's business interests dominated state economic policies in the early 19th century, and her merchants and bankers, along with a rising chorus of voices from the interior of the state, clamored for the construction of their own canal system. In 1826, therefore, the state of Pennsylvania bowed to those influences and began work on what was called the "State Works" or the Pennsylvania Main Line Canal. By that date the general consensus within Pennsylvania had swung around to the idea that public ownership of improvements was actually advantageous to state citizens (Hartz 1968: 131). The canal was, like the Erie, built entirely with public funds, but, unlike the Erie, it was incredibly expensive and never returned the considerable investment that the people of the state made in it. The Pennsylvania Main Line Canal never became a serious competitor of the Erie.

Several problems made failure almost inevitable for the Pennsylvania system, despite the fact that it did considerable business until about 1850. First of all, the mountainous topography of the state was totally unsuited to canal-building and operation over most of its area. This required a higher-than-average initial expenditure, as well as high repair, maintenance, and operating costs. The canal, which was 395 miles long, incorporated a series of inclined planes to lift the boats over the Alleghenies at a height of 2200 feet; the Erie, by way of contrast, had a maximum elevation of 650 feet. The Erie Canal had 84 locks through which the canal boats had to pass, while the

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Pennsylvania had 174 on its western division alone (Taylor 1968: 43-44). Additionally, the Susquehanna and Juniata Rivers, the two rivers comprising the longest stretches of the canal, were prone to serious spring flooding, and there were several years when all activity had to stop for miles along the route when entire sections of the canal were washed out.

Despite all of these problems, the Pennsylvania Main Line Canal did provide a faster, more direct, and less expensive way to move commerce back and forth across Pennsylvania and to connect the port of Philadelphia with the Allegheny and Ohio Rivers, thus making Pennsylvania part of a broad transportation network and giving its citizens a wider world view. The canal ran from Philadelphia via canal and railroad to Columbia on the Susquehanna River. From there it continued along the Susquehanna to Harrisburg, where it then followed the Juniata River to Hollidaysburg and climbed up the Alleghenies via the Portage Railroad (inclined plane). On the western side of the Alleghenies, the Pennsylvania Canal followed the Conemaugh and Kiskiminetas rivers to the Allegheny at Freeport, where it crossed the river on an aqueduct and turned south to the canal basins at Pittsburgh. Thus the Pennsylvania Main Line Canal became the first major navigation improvement on the lower Allegheny River.

Transportation Financing

The canal network was not the only form of transportation that was chartered to benefit a specific business and/or political interest group. Many turnpikes, river improvements, and railroads, for example, were organized by vested interests to make money, often largely at public expense. The Monongahela Navigation Company was a private stock company begun in the 1820s whose ultimate purpose was to improve navigation on that river in order to make it possible to ship coal easily and economically.

The railroad, as well as canal, system in the United States also grew dramatically during the 1830s, providing yet another method of moving people and commerce across its vast expanses. The world's first railroad, the Stockton and Darlington, was constructed in England in 1825, the year in which the Erie Canal opened in the United States; in 1829 the Liverpool and Manchester Railroad proved the commercial viability of the new technology. From the beginning, in the United States, canals and railroads competed and sometimes complemented each other as Americans eagerly searched for efficient and inexpensive forms of transportation. In some states railroads, like roads and canals, were built with public funds, but it became increasingly common

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for private corporations to undertake the task, aided by liberal charter guarantees from the states. Pennsylvania became an early leader in railroad development; railroads were much better suited to the state's uneven terrain than were canals, were far more direct in terms of routes, and could operate all year around (Taylor 1968). The Pennsylvania Railroad purchased Pennsylvania's state-owned canal system in 1857. By 1865, the Western Division of the Main Line, from Johnstown to Pittsburgh, closed. The first major navigation improvement on the lower Allegheny River, from Freeport to Pittsburgh, had failed to generate enough revenue to maintain its existence.

ALLEGHENY RIVER CONTEXT, 1739-1898

In the period between 1739 and 1790, few people lived in the Allegheny River Valley. As noted above, most of the traffic before the American Revolution consisted of traders and soldiers, both European-American and Native American. With the assurance of American independence and control of the Ohio country and the elimination of the Native American threat by the mid-1790s, settlement began in earnest in the trans-Allegheny region.

The earliest settlers often claimed land along rivers and streams that could provide water power for small industrial operations, such as grist, linseed oil, fulling, and saw mills, and for transportation when water conditions were just right. Most times of the year, they continued to use the centuries-old Indian paths that ran along the ridges and valleys, sometimes enlarging them enough for use by teams and wagons. Settlers were few, and trading was normally done within a small local area since transportation was arduous. Only non-perishable resources could be shipped successfully over any distance, and specie was generally scarce on the frontier. As a result, barter and the use of whiskey as currency were common during the settlement period. The grain that was not distilled into whiskey was normally ground into flour locally.

River and streamside mills of all kinds required minor modifications to the water sources to produce enough power to turn the wooden wheels that operated the shafts, belts, and pulleys. Mill dams and races were constructed to channel the water to the mill and store it at the proper height to produce the needed force. In an attempt to make the rivers and creeks at least somewhat passable, wing dams were built out from the shore, and logs, snags, and boulders were cleared where possible, all with local labor and private resources. Since little capital was available

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for river improvement, there were no extensive efforts at navigation improvements made on western Pennsylvania rivers before about 1824.

The growth rate in the United States as a whole and of the western territories in particular increased explosively during the first half of the 19th century. In the West, the numbers doubled every ten years between 1810 and 1830, and, by 1840, one-third of the entire population lived beyond the mountains (National Park Service, 1994: 74). The western cities grew along with the population, and the river ports of Pittsburgh, Cincinnati, Louisville, St. Louis, and New Orleans were important centers of commerce and industry by the time war broke out in 1860.

Growth and Development of Western Pennsylvania

Pittsburgh became the focus of economic life in western Pennsylvania. It looked south down the Mississippi River for its markets until the completion of the Pennsylvania Railroad in 1852, when it became economically feasible to make routine shipments eastward over the mountains.

Pittsburgh's location in reference to the Ohio, Allegheny, and Monongahela Valleys, the limitations placed on the city by the vagaries of the developing economic system, the mountain barrier, the lack of effective transportation, and the needs for goods and supplies by the increasing numbers of emigrants who passed through on their way west all combined to encourage the establishment of small industrial manufacturing operations there at the forks of the Ohio. The increasing population provided Pittsburgh with a necessary labor supply of both craftsmen and unskilled workers; it had natural resources, such as iron ore, timber, grain, glass sand, coal, and wool, in abundance, and it had ready markets for the city's products.

The iron--and, beginning in the 1860's, steel--industries in Pittsburgh continued to grow unchallenged. In 1800 bar iron was generally hauled in from the Juniata region of central Pennsylvania and from the Allegheny River Valley to the north. As the century progressed, however, iron furnaces, forges, and rolling mills were established in Pittsburgh itself. The demand for nails and other iron building supplies, agricultural equipment, tools, and machinery produced an ever-growing market for the city's products.

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The rise of the railroads created another market for Pittsburgh's mills. Although until after the Civil War most railroad rails came from Britain as American iron companies could not compete effectively, the rails were made of iron and wore down quickly. As a result, Pittsburgh's rolling mills found rerolling British rails for use on American railroads lucrative. The city's dominance of the late 19th to mid-20th century steel industry in the United States was based upon the conjunction of steel mills and railroad lines--access to natural resources and the ability to transport both them and the finished products to market (National Park Service 1994: 100).

The Allegheny River Valley north of Pittsburgh grew more slowly than the areas along the Monongahela and Ohio Rivers. Few people lived in along the Allegheny until after 1800, and the terrain along the river is generally rugged and not conducive to agriculture. The Allegheny Valley, however, was found to be rich in natural resources. Timber, sand, aggregates, salt, and iron ore were important products that were shipped down the Allegheny as early as 1806 to Pittsburgh and the markets beyond on the Ohio and Mississippi Rivers. The Allegheny's tributaries, especially the Kiskiminetas which enters 45 miles above Pittsburgh at Freeport, served as important connectors with both the central part of the state and with the more remote sections of the area drained by the Allegheny.

As the first few settlers moved into the upriver area, they depended for some time upon the Allegheny River for transportation of people and products. The first road, for example, was not built in Armstrong County until 1824 when it was necessary to connect Freeport and Kittanning. Not until eleven years later was a second road constructed, this time between Kittanning and Indiana along the old Kittanning Path. In 1839, one of Armstrong County's earliest bridges was constructed across Redbank Creek in the northern part of the county (Armstrong County Historic Sites Survey 1980: 4-5). All of these improvements stimulated settlement north of Pittsburgh, but settlement remained sparse, entering from the southwest and spreading out to the north and east.

The rise of Pittsburgh as a manufacturing and commercial center also encouraged settlement as well as the development of markets north along the Allegheny. Pittsburgh thus had another outlet for her products, and the upriver areas had a market for their raw materials and agricultural produce. Once technology in the form of steamboats and railroads made upriver navigation and northern travel less difficult, Pittsburgh merchants and manufacturers were able to

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extend their economic influence throughout all of northwestern Pennsylvania into parts of New York State.

River Navigation

In its natural state the Allegheny River was difficult to navigate; channels were narrow and shoals wide; snags and boulders were common. In the winter ice closed vast stretches of the river, and in the summer low water could make it nearly impossible for boats to travel any distance. Floods often came roaring down the river making any travel at all dangerous. The Allegheny was somewhat deeper and swifter than its neighbor the Monongahela, and, overall, flooding tended to be more of a problem than low water. Three feet was considered navigable by many boatmen, but the river was rarely that high over its full length. Only shallow-draft vessels, such as canoes, rafts, flatboats, and keelboats could normally be used successfully on it in its unimproved state.

Rafts and flatboats carried the bulk of the commerce on western rivers such as the Allegheny from settlement until nearly the middle of the 19th century. They were commercially useful only on down-river journeys and were normally broken up and sold as lumber at their destination. Flatboat and raft navigation was very imprecise and depended primarily upon the vagaries of the current; rudimentary steering was done with long oars. River hazards were constant threats. Flatboats were the vessels of choice for carrying both freight and people downstream until steamboats proved reliable on western rivers.

Some boats did travel back upriver, of course, but the process of moving them against the current was an arduous one, and the boats could carry little or no cargo. The trip from New Orleans back to Pittsburgh could last as long as four months and was accomplished by means of sails, poles, oars, and, sometimes, the cordelle. With the latter, a heavy rope was tied to an object ahead on the bank, and the boat then pulled or "warped" past it; this method would be repeated as many times as necessary. Boatmen also pulled their craft along by grabbing overhanging tree branches and bushes and by towing with a rope from the bank. Whatever method was used required a strong crew and usually many weeks or months (Taylor 1968: 57).

The keelboat was the first vessel developed that was intended to carry a significant amount of cargo upstream. It was built somewhat like a sailing ship with a keel and hull, was

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between 30 and 75 feet long and five to ten feet wide, and carried masts and sails. A board ran the length of each side, upon which the crew walked while poling the boat upriver (Johnson 1974: 27). A writer described the process,

. . . The boats were commonly propelled by a crew of men with long, iron-tipped poles. Standing at the prow of the boat, the crew rammed the poles into the streambed, braced them against their shoulders, and walked the boat upstream under their feet. At the stern, they picked up the poles and returned to the prow to repeat the process (Johnson 1974: 27).

Keelboats, however, were narrow and their cargo capacity very limited. Because they required intensive labor to get them back upstream, shipping was still very expensive (Taylor 1968: 57).

Bills of lading and receipts from some of the early Allegheny River shipping interests provide a glimpse of what kinds of products were being shipped upriver on keelboats and steamboats at mid-century. The keelboat *Albion*, for example, owned by R. Robison and Company, ran from Pittsburgh up to Tionesta carrying ten barrels of flour, one barrel of syrup, one barrel of sugar, and one keg of white sugar. Siebert and Morgan's steamboat *Romeo* hauled one barrel of sugar, one bag of coffee, one caddy of tea, one barrel of hams, and three barrels of pitch, as well as sundries, soap, starch, fish, raisins, baking powder, and brooms between the same two towns. Other cargoes on various boats at that time included bacon, candles, nails, molasses, coils of cable, tobacco, buckwheat, rice, bags of codfish, chain, linseed oil, white lead, dry goods, dried peaches, candles, trout, mackerel, timothy seed, and shovels. Rates ranged from \$0.45 to \$0.75 per 100 pounds and about \$0.70 a barrel (May Papers 1839-1862).

Much of the commerce on the Allegheny River proved to require little draft. Timber became the predominate resource moved down river. Tied into rafts, logs moved during spring high waters. Later, lumber mills constructed parts of barges, also floated downstream during high water. Because this type of commerce could be easily stockpiled and required no vessel, the unimproved Allegheny River suited the lumber industry.

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Steamboats

Americans experimented for years trying to adapt steam technology to the problems of river navigation. Although many people developed steam engines that could power boats, it was not until 1807 and 1809 that two inventors, Robert Fulton and John Stevens respectively, proved that steamboats had a commercial future. The advantage of steamboats, of course, was the fact that they could move back upstream under their own power and could carry a full load of both passengers and cargo. These new vessels were adopted enthusiastically, and the period between 1815 and 1860 was "the golden age of the river steamboat." Taylor noted that "by 1830 it dominated American river transportation and for two decades thereafter was the most important agency of internal transportation in the country. For the most part turnpikes and canals proved feeders rather than effective competitors and not until the fifties did railroads become a serious threat" (Taylor 1968: 58). Steamboats were the driving force behind the industrial development of the Allegheny-Monongahela-Ohio-Mississippi Valleys during the forty-five years preceding the Civil War (Taylor 1968: 63). "Steam navigation, by quickening transportation and cutting distances, telescoped a half-century's development into a single generation" (Robinson 1983: 7).

The passenger steamboats developed on the rivers along the East Coast were not suitable for use on shallow western rivers like the Allegheny. The hulls for the western boats, upon which sat large wooden superstructures, had to be broad and draw as little water as possible; light, compact high-pressure engines were placed on deck, and the propeller wheel was mounted on the stern to save weight and permit the vessel to operate in low water, sometimes no deeper than thirty inches. The main decks on these steamboats were open, unlike those on eastern steamers, and the space not taken up with machinery could be used for stacking cargo. These steamboats were relatively inexpensive to build and operate and could carry large cargoes, as well as a significant number of passengers (Taylor 1968: 66-67; Corps of Engineers 1979: 9).

Major Stephen H. Long, who is often better known for his exploration of the Rocky Mountain West, played a role in the development and design of steamboats that were used on western waters. The *Western Engineer*, built in 1819 for military reconnaissance and scientific exploration, drew only 19 inches of water and successfully made the trip from Pittsburgh down the Ohio and up the Missouri River. Long continued to be an innovator in the field of steamboat design and engineering; he was one of the developers of boats used to remove snags from western

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rivers; and he worked on methods to increase steam power and efficiency (Robinson 1983: 7; Taylor 1968: 66).

Despite the fact that steamboats quickly became familiar sights on western rivers, they did not threaten the flatboat industry and, in fact, actually encouraged it. Boatmen could now get back upriver by steamboat without the time-consuming and exhausting trip they had previously faced. Many people who lived on streams and smaller rivers and still had to use a flatboat for at least part of the trip often found it easier to keep on going downstream to port rather than break the trip to transfer their cargo to other types of vessels. Despite technological and navigational improvements, moreover, more commerce still moved downstream than up. The peak of flatboat traffic on western rivers did not come until 1846-1847, but it then declined rapidly over the following decade as barges took over as the primary haulers of bulk freight. Steamboats were the dominant type of river vessel very early on the Ohio and Mississippi, and, as a result, shifted more flatboats and keelboats onto the Allegheny and Monongahela Rivers where they were thought to be safer. These boats were generally smaller and lighter than those that had been used on the larger rivers (Reiser 1951: 54).

The method of financing steamboats followed a different path from earlier transportation improvements in the developmental phase. Each boat was generally owned by individuals or small partnerships and financed by local capital. Steamboats proved their value early in hauling passengers and freight and, in a development that came to be particularly important on western Pennsylvania rivers, began serving as towboats on the Ohio, Monongahela, and Allegheny carrying coal and other resources to markets north, south, and west of Pittsburgh. From their inception, steamboats towed keelboats both behind and beside them and by the 1840s it was common to see them pushing barges up and down the western rivers. Originally, barges, like flatboats, had floated with the current and were used only in downriver commerce (Corps of Engineers 1979: 19).

In 1830 the steamboat *Allegheny* made the trip upstream from Pittsburgh to Olean, New York, and in 1837 the *New Castle* accomplished the same feat in addition to carrying 16 tons of freight and 60 passengers while towing a 40-ton keelboat with 20 tons of cargo. The latter boat made several more trips and demonstrated that regular steamboat service on the Allegheny River was possible. Although a boat did not make the complete trip up the Allegheny again for nearly a century, steamboats established frequent service as far as Warren in northern Pennsylvania, and

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the trade was profitable during the late 1830s and throughout the following decade, despite several low-water years (Reiser 1951: 55-56).

Not only were steamboats quickly pressed into service on the western Pennsylvania rivers, but the Pittsburgh area also jumped into the boat-building business early in the 19th century. In 1815 the *Enterprise*, a steamboat built on the Monongahela in Brownsville, completed a round trip between Pittsburgh and New Orleans, demonstrating the vessel's usefulness in western trade. Fifteen years later Pittsburgh had no rival as the center of the western steamboat-building industry, a position it held for the next two decades. Several other towns in the Monongahela Valley besides Brownsville developed impressive construction operations.

Between 1840 and the outbreak of the Civil War, Pittsburgh expanded her shipyard businesses and produced innovative iron steam warships, other Navy vessels, and government revenue cutters, as well as freighters for east coast shipping companies and other types of iron boats and ships. Other area companies specialized in steamboat engines, ship fittings, and machinery. The shipping industry was an important part of Pittsburgh's economy, and the Allegheny River Valley provided raw materials used in constructing oceangoing sail and steam ships (National Park Service 1994: 75-77).

River Traffic

The traffic and commercial tonnage carried on western Pennsylvania rivers was, from the beginning, heavier on the Ohio and Monongahela, and the pressure for organized river improvements occurred much earlier along those more-heavily used rivers, particularly the Monongahela. Although vessels plied the Allegheny regularly as far north as Warren, the busiest stretch was the section that runs through Allegheny County. The low population density of northern Pennsylvania and the fact that its products were primarily natural resources intended for markets in Pittsburgh and beyond meant that most of the traffic on the Allegheny was downstream.

There were on-going local attempts made to clear the river of snags and boulders to improve navigation, but the lower population density of the Allegheny Valley resulted in less political and financial influence and thus less commercial potential. The low Pittsburgh bridges with their narrow, obstructive spans and the proliferation of obstructive mill-dams and temporary

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wing-dams built by individuals up and down the river were all factors in delaying official Allegheny River improvements for commercial navigation until more than a decade after the Civil War. This led to the continued use of smaller vessels on the Allegheny, which, in turn, resulted in less commercial activity and lower tonnage totals.

Allegheny River Valley Products

The Allegheny corridor, however, was rich in natural resources, and, as development proceeded, secondary industries--those that process raw materials into finished products--located more and more frequently along the Allegheny River to take advantage of access to those raw materials, including cheap sources of fuel, as well as to the water and rail systems that could provide the transportation that was essential at all stages of the manufacturing process. Industrial development provided the stimulus for improving navigation on the Allegheny River.

The earliest and overall most important resource of the Allegheny Valley was timber. The northwestern counties were thickly wooded, and before 1800 the earliest settlers in the area had begun floating logs and wooden rafts loaded with lumber down the river to Pittsburgh. Sawn lumber, shingles, and lath in huge quantities were shipped along with logs down the Mississippi Valley; rafts and flatboats were disassembled and sold as lumber as well at the end of the trip. At least 150 million board feet of lumber went through Pittsburgh alone between 1826 and 1850 (Reiser 1951: 57-58). Vast amounts of wood were also burned to make the charcoal that fueled the western Pennsylvania iron industry, and charcoal, iron ore, and limestone, the three components of charcoal iron, were sent down the river from the north. Although many of the areas were over-timbered during the 19th and early 20th centuries, the industry has continued to the present day in most of the northern Pennsylvania counties.

The extractive industries have played a significant role in the economy and river commerce of western Pennsylvania since the early 19th century. Salt was the first of these important products to be discovered and marketed. Beginning in 1811, when the first salt deposits were discovered along the Conemaugh River, and lasting until nearly 1860, the Allegheny Valley supplied salt, a critical product for home and industrial use, to much of the West. Salt wells were drilled up and down the Allegheny River Valley and those of its tributaries, and, after the salt had been evaporated out of the brine and packed in barrels, it was shipped out by flatboat to Pittsburgh or sent east by land. In 1830, the beginning of the peak salt-production years, there

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were 24 salt wells operating in Armstrong County alone, and in 1848 the salt inspector in Pittsburgh, who saw only a fraction of the production that went through the city, examined nearly 50,000 barrels (Armstrong County Historic Sites Survey 1980: 7 and Reiser 1951: 58-59). Salt was a significant portion of Allegheny River commerce for the first 60 years of the 19th century.

Limestone was first quarried in the Allegheny River Valley to serve as flux in the charcoal iron furnaces, and it was also used in making the cement for the locks and dams of the Pennsylvania Canal in the 1830s. Subsequently, most of the limestone produced in northwestern Pennsylvania was shipped on the river or by rail to Pittsburgh for use by the iron, steel, cement, and glass industries. Many of the most important limestone beds were located in the more northern part of the valley around Templeton, Rimerton, and East Brady.

Sandstone, sand, and gravel have been quarried near or dredged from the Allegheny River since the 19th century and have been used extensively in construction and in the plate glass manufacturing industry, which grew up along the river in Allegheny, Westmoreland, and Armstrong Counties. As early as 1809 Pittsburgh was the center of the western glass industry, shipping the finished product to market by water. In 1881 Captain John B. Ford established a plate glass plant in Creighton, north of Pittsburgh in Allegheny County, and in 1887-89 opened a large factory in Ford City, Armstrong County. The latter works once held the distinction of being the largest in the world and became the heart of the Pittsburgh Plate Glass Company. This particular operation began its decline in 1950 as PPG bypassed the Ford City plant in upgrading plate glass technology, and the works have since been closed. Hard, sharp sand was mined in the Allegheny Valley for plate glass. PPG established an extensive sand-quarrying operation across the river from its plant in Ford City, and it transported much of this sand across the river in buckets on heavy cables.

The J.K. Davison and Brother sand and gravel business was established in Pittsburgh in 1854, to collect the Allegheny River sand from river banks, bars, and islands. The company began digging sand from the river channels in 1873 and in 1882 purchased a new sternwheel steam dredge to supply sand and gravel for the water filtration plant at Aspinwall. Dredging was quite common from the early 1870s on, and many companies and dredges have continued to operate on the western Pennsylvania rivers, particularly on the Allegheny for much of its length in Pennsylvania. Gravel for construction purposes has remained one of the most important products shipped on the river.

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Clay, the basis of the refractory industry, has also been dug and used in northwestern Pennsylvania since about 1800. Manufacturers of all types of bricks, drain, flue, and sewer pipes, pottery, and ceramic plumbing fixtures have operated both small and large plants throughout the Allegheny River Valley for nearly two hundred years. The fire-clay industry figured prominently in the projections for increased trade on an improved Allegheny River, and towns such as Mahoning, Templeton, Cowanshannock, and Kittanning were refractory centers. Much of the output of these factories was shipped to Pittsburgh and on to other western markets by river, canal, and, ultimately, by railroad.

Coal has also been an important resource of the Allegheny Valley, particularly in the 20th century. The first coal mine in Armstrong County opened in the 1850s to dig cannel coal, from which lamp oil was extracted. Bituminous coal was not mined extensively until after the arrival of the railroads in Westmoreland, Armstrong, Butler, and Clarion counties in the late 1850s and succeeding decades; indeed, many of the mines were actually owned and operated by railroad companies, and their product was obviously shipped over their lines, often north and east, rather than south to Pittsburgh. Although coal has long been the most important commodity shipped on Monongahela River barges, on the Allegheny it began to play a significant role in commerce only after the completion of the navigation system. The promise of further development of the Kittanning Upper and Lower coal beds was long given as a reason for improving the river, and by the mid-1990s, coal made up approximately 50 % of the commercial shipments on the Allegheny.

The occurrence of iron ore in northwestern Pennsylvania gave rise to the iron and steel industry in that part of the state. Armstrong County was home to a number of charcoal iron furnaces, beginning in 1825 and lasting until about 1855. Towns, such as Rimerton and Bradys Bend at the northern edge of the county on the river, grew up around the iron furnaces. In the late 1850s the furnaces began replacing charcoal with coke in the iron-making process, and, after the Civil War, iron manufacturers imported iron ore from the Great Lakes region to mix with the native product.

The Bradys Bend Iron Company, a pioneer in the manufacture of coke iron and the rolling of railroad rails, was an extensive operation, employing 1500 men at its height; it was the first to combine a blast furnace with a rolling mill. The company did not survive the economic dislocations caused by the Panic of 1873, and by 1880, the iron industry as a whole had moved to Pittsburgh.

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The iron ore, limestone, and wood for charcoal or coal for coke, the primary ingredients in the production of iron, were all produced and, for a long period of time, consumed in the local area in which the iron furnaces were located. The products of the furnaces, forges, and rolling mills, however--the pig and bar iron, the rails, and castings--were shipped down the Allegheny to Pittsburgh. The river was an extremely important factor in the success of Allegheny Valley iron.

Iron's metallurgical cousin, steel, also had a presence along and near the Allegheny River, at Kittanning, Apollo, Vandergrift, and Leechburg, all but one of which were also old salt-producing towns on the Pennsylvania Main Line Canal. Some of the steel operations included tin works to make tin plate. Many of the steel plants of the late 19th and early 20th centuries began as iron rolling mills and furnaces before the Civil War or after the Panic of 1873. The availability of good water transportation to ship both raw materials and finished products was significant in the development of these plants (Armstrong County Historic Sites Survey 1980: 10-16).

Northwestern Pennsylvania became known worldwide as the birthplace of the United States petroleum industry when oil was discovered in Venango County in 1859. Speculation was rampant, as wells were sunk on farmland from Armstrong County on up the Allegheny River. Parker City, in extreme northern Armstrong County, was the center of the boom in the southern part of the oil fields between 1869 and 1878, with an active Oil Exchange to handle the trading in oil stocks and futures and with six pipelines running into town. Several refineries operated along the Allegheny in the Kittanning area in the 1860's and 1870's, as well as related industries that manufactured such products as machinery for the oil fields (Armstrong County Historic Sites Survey 1980: 12-13). As the wells in the southern part of the region began to run dry in the late 1870's, the industry concentrated on the more-northern areas up the river.

When the boom began, barrels of oil moved from the drilling fields on flatboats down Oil Creek to its mouth at the Allegheny and on to Pittsburgh (Kussert 1938: 215-216). To aid navigation on the shallow waters of Oil Creek, flatboat operators created artificial freshets by moveable dams to float their oil-barrel-laden flatboats. Pipelines and railroads, however, were quickly extended farther and farther into the oil fields, and they soon took over some of the responsibility for transporting oil, although much of it was shipped by barge to refineries in the Pittsburgh area and some sent north by railroad through New York to ports on the Great Lakes.

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Natural gas became another resource found in relative abundance in northwestern Pennsylvania, and the ease of access to it influenced the location and development of many other industries along the Allegheny, including iron, steel, plate gas, and aluminum. Although it was not shipped on the river (but did go under and along it via pipeline), natural gas has had a direct impact on the development of the counties that border it by providing a source of inexpensive and clean fuel to the companies and people who are located there.

The aluminum industry also began along the banks of the Allegheny River. In the late 1880's the Pittsburgh Reduction Company began producing aluminum in a building on Smallman Street in Pittsburgh's Strip District. By 1891 the company had moved its infant industry upriver to a new plant in the newly-developed town of New Kensington, drawn there by the availability of cheap power in the form of natural gas and coal, room for expansion, and access to river and railroad transportation. This company, which became the Aluminum Company of America, or Alcoa, in the 20th century, expanded the New Kensington works until the mid-1940's. By 1971 it had closed the entire plant and sold off its property in that area (HABS/HAER 1994; McVarish and Meyer 1993).

Various kinds of other significant industries have been located along the banks of the Allegheny River since the early 19th century. Schenley and Freeport were home to large distilleries; and Tarentum had a paper mill as well as a bottle works and other glass factories. The Pittsburgh Typewriter Company's plant operated in Kittanning at the turn of the 20th century.

Allegheny-Genesee Corridor

The development of an Allegheny-Genesee water corridor could have been an influence on river improvement had it ever materialized. Many proposals were put forward to improve navigation on the Allegheny and connect the river with the Erie Canal by digging another canal between Olean and Rochester, New York. This part of the plan actually was carried out when construction was begun in 1837 on the Genesee Valley Canal. After numerous delays, the builders of the line finally reached the end, a point on the Allegheny seven miles southeast of Olean, in 1861, just seventeen years before the whole line was closed permanently. Most of it was then sold to the Genesee Valley Canal Railway and finally to the Pennsylvania Railroad (Genesee Valley Council on the Arts 1976: 35-38; Anderson 1978: 7-11, 19).

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Many reasons contributed to the failure of this northern link. Most goods still moved east and west between the population and distribution centers, and the timber, coal, and oil interests, among others, already had adequate outlets through existing corridors and on other kinds of carriers. Passengers were normally interested in reaching their destinations as rapidly as possible, and they could travel much faster by railroad than by ship or boat. The rugged terrain was also an impediment to improving the Allegheny through the remote regions of Pennsylvania and New York; the costs were extremely high and the engineering problems difficult. The Genesee Valley Canal faced many of the same geographical and timing problems as the Pennsylvania Main Line Canal, and the results were virtually identical.

The Allegheny Valley Railroad was also intended as a link between Pittsburgh and the Erie Canal and, ultimately, New York City. Built between 1853 and 1859, with some additional track added during the 1860's, it reached Kittanning, a distance of 44 miles, by the mid-1850's and Oil City in 1866. Its orientation was originally different from that of the Pennsylvania Railroad, and, although it reached markets along the northern Allegheny Valley, it never became the magic link to New York City. Its success in the 1850's and 1860's did, however, further delay the implementation of navigational improvements on the Allegheny River by diverting traffic from the river (Johnson 1979: 124). The Allegheny Valley Railroad was eventually purchased by the Pennsylvania Railroad and incorporated into its system (Carlisle draft 1995: 125).

Further Reasons for Improvement Delay

As noted above, although river shipping has always been a constant in the Allegheny corridor, the railroads came to dominate the transportation industry in the Allegheny corridor during the second half of the 19th century. They were a much cheaper way of moving people and of transporting both raw materials and manufactured products when the capabilities for large-scale bulk shipping did not exist (as on the unimproved rivers). Because they did not suffer from the same geographical limitations as rivers, they could provide direct lines to industrial plants and to remote areas where natural resources were cut, mined, or drilled.

The Pennsylvania Main Line Canal did not pose a threat to the shipping industry on the Allegheny River, nor did it stimulate river improvements because it was not a commercial success, for the many reasons noted above. It connected with the Allegheny at Freeport and then ran beside it for about thirty miles to Pittsburgh. The canal's engineers rejected the idea of creating a

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slackwater navigation system to use the river itself for canal boats because the costs would have been prohibitive. As noted, the Main Line Canal was already costly to build and maintain; it was completed late in the canal-building era, and it faced competition almost immediately from railroads. There also was not a large volume of bulk commerce needing to be shipped between Pittsburgh and Freeport in the 1830's and 1840's, and the canal never realized its proponents' expectations. As a result, the Pennsylvania Main Line Canal provided no incentives for continuing improvements to navigation on the Allegheny River.

ALLEGHENY RIVER IMPROVEMENTS, 1824-1898

River improvement, like other forms of transportation-related projects, remained within the jurisdiction of state governments and private enterprise until after the Civil War. Internal improvements were caught up in the continuing political controversy of the Early Republic, and occasionally the federal government took a hand in constructing roads, canals, and river and harbor improvements if it could be demonstrated that the works benefitted a national rather than a local constituency. The line between the two was frequently rather blurred, and in 1823 James Monroe, a strict constitutional constructionist, declared that Congressional appropriations for "national" internal improvements were legitimate so long as the actual control over the contractors remained in state hands. Before 1824 the federal role in navigation had been restricted almost entirely to such activities as building lighthouses and improving harbors (Robinson 1983: 11).

Eighteen twenty-four became a landmark year in the area of river improvement. On April 30 Congress passed the General Survey Act, which authorized the use of both military (Army) and civil engineers in surveying and planning land and water improvement projects. On May 24, 1824, in a move that was to have a significant impact on western Pennsylvania, a bill providing \$75,000 to remove snags and sandbars from the Ohio and Mississippi Rivers using "engineers in the public service" made its way through Congress. The President then assigned the Army engineers this task, thus beginning their involvement in domestic water projects. On May 20, 1826, Congress passed the first omnibus rivers and harbors bill, an act that became an annual occurrence through 1838. Under these bills, Congress authorized and provided funding for further surveys and improvement projects on rivers, harbors, and canals (Parkman 1983: 43-44, 101). It was largely the rapid development and subsequent impact of the steamboat on western

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rivers that led Congress to pass the waterways improvement legislation as early as 1824 (Corps of Engineers 1979: 7).

On March 3, 1834, the United States House of Representatives received a memorial from "citizens of Pennsylvania, praying for an appropriation to improve the Alleghany [*sic*] river for steamboat navigation." The Erie and Pennsylvania Canals were open by this time, and these citizens were clearly concerned about the competition from the former, as well as the current inability to connect Western Pennsylvania with the proposed Genesee Canal.

That the expediency and usefulness of internal improvements are now no longer problematical; experience has delineated, in colors too vivid and brilliant to escape our observation, that they are a source of wealth and prosperity to any country. At the present crisis, when the funds of the National Government are ample, and her public debt nearly extinguished, can there be a more important subject for national legislation? We confidently answer, none, when the object in view is *clearly of a national character*. Under the expectation that your honorable bodies will coincide with us in these opinions, and that the surplus revenue of the Union could not in any other manner be more advantageously expended, and the public good more immediately promoted, we beg leave to present you the propriety of *improving the navigation of the river Alleghany, from the city of Pittsburg, in the commonwealth of Pennsylvania, to Olean point, in the State of New York*.

It appears that the State of New York contemplates making a canal from the Genesee River, where the grand Erie canal crosses that stream, to a Olean point, a distance of about ninety miles, the cost of which is estimated at \$900,000. When this shall have been completed, which is expected to be done in the course of the next year, a canal communication to the Alleghany river will be effected by means of the Erie, the Welland, and Champlain canals with the Lakes Erie, Ontario, and Champlain, and with the Hudson and St. Lawrence rivers. . . .

A complete interior inland water communication would be effected from one end of the Union to the other, affording a safe, expeditious, and easy passage

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for the various and rich productions of our happy and flourishing country, and for munitions of war, in case of invasion, that superceding the necessity of our open sea navigation. Nor would it be all; it would have a tendency to draw together the constituencies of our common country in a closer bond. . . . With a firm conviction that the object for which we pray is clearly of a national character, we ask your honorable bodies to pass a law authorizing an appropriation for that purpose. . . (House of Representatives Document 151 1834: 1-2).

Ohio River Improvements

The 1824 survey and appropriations acts led directly to federally-funded navigation improvements, such as snag boats, wing and back-channel cut-off dams, and rock and boulder removal in the Ohio. No other federal work was done in the Pittsburgh area until 1874, when a new survey led Major William E. Merrill to recommend the construction of a six-foot deep channel and a series of locks and dams to run down the Ohio River from Pittsburgh to Wheeling. In 1875 Congress appropriated \$100,000 to begin the project, but due to considerable opposition by the coal industry, construction was blocked until 1877.¹ It took political pressure by the Pittsburgh Chamber of Commerce to convince the state legislature to transfer jurisdiction over the lock and dam site to the federal government so that building could actually begin (Johnson 1974: 165).

The Army Corps of Engineers thus started construction in 1878 on the first of these Ohio River projects and completed the Davis Island Lock and Dam in 1885. Merrill suggested that the Corps construct the first dam as an experiment, and he insisted that it be designed with the concerns of the coal shippers in mind. The Davis Island Lock and Dam proved to be a great success, and, as a result, turned the coal industry into one of the strongest proponents of continuing such river improvements (Johnson 1974: 168). Between 1885 and 1910 the Corps of Engineers constructed twelve more locks and dams on the Ohio River prompted by the need to further canalize the river to accommodate the needs of the deep-draft barge tow industry (Robinson 1983: 34).

¹The coal companies initially objected to a lock and dam because it would slow traffic. After the companies discovered that they could ship more per barge, and use larger barges, they became enthusiastic supporters of additional locks and dams (Johnson 1974:165).

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Monongahela River Improvements

The success of river clearance on the Ohio and Mississippi led Congress to extend the authorization of the 1824 legislation to work on the Monongahela River. An 1828 survey performed by Edward F. Gay and funded by the state of Pennsylvania had recommended a series of locks and dams be constructed on the Monongahela to canalize the river from Pittsburgh to [West] Virginia. A second survey was conducted in 1833 to investigate the possibility of the state or federal government improving steamboat navigation on that river from Pittsburgh to the intersection of the Cumberland, or National, Road at Brownsville. Again, the recommendation was to construct locks and dams, but neither the federal nor state government followed through.

The interest in navigation improvements did not diminish, however, and in 1836 the state chartered a private corporation, the Monongahela Navigation Company, to construct a slackwater navigation system incorporating a series of locks and dams and extending ninety-two miles from Pittsburgh to the [West]Virginia state line. The Monongahela was, at that time, already carrying a heavier load of commercial traffic than nearly any other U.S. river because it crossed a formation containing an exceptionally rich coal bed.

The completion of Locks and Dams Nos. 1 through 4 in the period 1840-1844 permitted slackwater navigation as far as Brownsville. Locks 5 and 6 were completed before the outbreak of the Civil War, and the amount of traffic and commercial tonnage on the Monongahela continued to increase. Five basic types of goods were shipped on this slackwater navigation system: agricultural products, extractive resources, manufactured goods, livestock, and eastern merchandise (Reiser 1951: 62). The most important of the products continued to be coal.

In 1843 the state sold off all of its shares in the Monongahela Navigation Company; in 1872, with the passage of the Rivers and Harbors Act of that year, the federal government became directly involved in constructing Locks and Dams Nos. 8 and 9, which were completed by 1889. The system operated under two different authorities between 1879 and 1889, numbers 1 through 7 being run by the Monongahela Navigation Company, and 8 and 9, by the federal government. These locks and dams made slackwater navigation between Pittsburgh and Morgantown, West Virginia, possible.

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In 1897 after a decade of litigation, the federal government won the right to condemn the property of the Monongahela Navigation Company and, upon payment of just under \$4 million to the company, took possession of Locks and Dams Nos. 1 through 7, creating a single free navigation system between Pittsburgh and Morgantown (Gannett Fleming 1980: 5-12). Traffic volume continued to increase as the improvements were made, and slackwater was extended to the upper part of the river in West Virginia. Throughout the late 19th and early 20th centuries more tonnage moved on the Monongahela than on any other inland waterway (Robinson 1983: 47). The Monongahela slackwater system played an invaluable role in the development of trade, particularly of the coal industry, and in stimulating the growth of the valley in general (Reiser 1951: 67).

Allegheny River Open Channel Improvements

For reasons discussed above, the Allegheny River was largely ignored by the state and federal governments in terms of improvements until 1879, when Congress authorized some channel clearing and the construction of deflecting dikes at a few troublesome locations. The Panic of 1873 and the resulting economic depression in the United States, which lasted about six years, might have played at least some role in congressional reluctance to fund more internal improvements. By 1879, however, prosperity had returned, and subsequent legislation involved the federal government more heavily than ever before in river navigation.

In 1826 and 1828 the state and federal governments, respectively, conducted surveys of the river, both of which recommended some minor work to improve steamboat navigation, but nothing was done at that time. Other surveys in the early and mid-1830's confirmed the results of the previous ones and further recommended the construction of several locks and dams and the removal of sandbars, snags, rocks, and other hazards. In 1798 the Pennsylvania legislature had designated the Allegheny River a public highway over its entire length in Pennsylvania, and New York did the same in 1807 for its fifty miles. This status was challenged in the courts in the 19th century, and in the case *United States v. Union Bridge Company*, the U.S. Supreme Court confirmed the fact that the Allegheny is a navigable waterway. A Pennsylvania court ruling in 1874 clarified the legislature's 1798 declaration (Allegheny River Basin Navigability Report 1975: 14).

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Other than private efforts at clearing and channelizing the Allegheny, however, little was done until 1875 when Congress authorized a new survey of the lower part of the river (below Freeport) as part of the annual Rivers and Harbors Act of that year. The 1878 act funded another survey, this time from Pittsburgh to French Creek, and, finally, in 1879, from French Creek the rest of the way up the river to Olean, New York. Major William E. Merrill of the Army Corps of Engineers based his recommendation for a single movable lock and dam in the Allegheny at Pittsburgh on the information gathered from the 1828 and 1875 surveys. Merrill's 1879 report to the chief of engineers stated

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.

The laws of Pennsylvania on the subject of bridges may be models of legal wisdom, but their results, as seen in the structures built under their authorization, are disastrous. The United States has not interfered, and the Allegheny is merely one of a number of rivers on which cheap transportation has been injured or destroyed by sheer negligence.

Should the commerce of this river be revived, the reconstruction of some of the bridges will be a matter of vital necessity (Report of the Chief of Engineers 1879: 1372).

Merrill suggested that the Allegheny improvements be based upon those in progress on the Monongahela and that the work be modest and designed to add one-and-a-half to two months to the shipping season on the river. This could be accomplished by constructing low-wing dams and dikes at various locations and by removing obstructions to channelize the river above an experimental full-length movable dam at Pittsburgh. These improvements were all designed in such a way as to assuage the fears of the lumber interests, who wanted no obstructions blocking the movement of the logs and lumber rafts that constituted such a large portion of the commerce on the Allegheny. The Corps received many letters from Pittsburgh businessmen, including one from the Chamber of Commerce, pleading for river improvement near Pittsburgh (Report of the Chief of Engineers 1880: 1766).

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Merrill's 1880 report on his survey of the Allegheny River between French Creek and Olean, New York, emphasized these concerns:

The rafting of lumber, as before said, is the sole business done on the river above Warren. Below that point steamers occasionally use the river for the transportation of coal &c., in flat boats, to the Venango County, Pennsylvania, oil regions. The transportation of oil by rail and by pipe-lines has effectually destroyed the river shipment of this extensive article of commerce, except for that portion destined for the Ohio Valley. . . . The proprietor of this line assures me that a large increase in the trade would result from the improvement of the river, particularly by the removal of the dangerous rocks which cause them to withdraw, while there may otherwise be for weeks a reliable depth in the channel. . . . The furnaces at Pittsburgh, chiefly located on the Allegheny, consume annually thousands of tons of limestone, which is brought to them in barges from above. . . . There yet remain to be developed valuable quarries of building-stone, of limestone for furnaces, and of glass-sand, mines of coal and iron ore, and thousands of acres of hemlock timber, the bark of which is extensively used for tanning. . . . The market is near, but the extensive development of such natural resources must await cheaper transportation, which can only be obtained by an improved river (Senate Executive Document No. 89 1880).

In 1879 Congress appropriated a small amount of money to build two dams, a crib dam at Six-Mile Island near Pittsburgh and a rip-rap dam thirty-five miles up the river, as well as to dredge a channel and purchase a boat to remove river obstructions. Ice damaged both of these dams shortly after they were completed, and the Rivers and Harbors Acts of 1880 and 1881 authorized repairs and the construction of replacement dams; river improvements of this kind to aid open-channel navigation continued to be made up and down the Allegheny between Pittsburgh and Olean through the 1890's, and, actually, until 1932. The low dams and dikes and the channel-clearing activity benefitted the commercial interests who shipped their raw materials and manufactured products by river. The Corps' annual reports mentioned the fact that the flatboat men had given their unqualified approval to the improvements being made on the Allegheny (Report of the Chief of Engineers 1883: 1553). Despite these testimonials, however, open-channel navigation could not compete with slackwater systems like those already in place on the Ohio and Monongahela.

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The Corps' engineers complained frequently in their reports about the problems the lack of federal control over the river created. Natural gas suppliers, for example, laid cast iron pipes in the stream bed where they had no protection and could interfere with navigation. Manufacturing companies, railroads, the City of Pittsburgh, and other groups constantly dumped refuse into the Allegheny, creating blockages at certain points in the river. The companies that dug sand from the riverbed and banks caused even more serious problems for boats and for the Corps of Engineers.

Some early and decisive steps should be taken to restrict the work of sand digging in the river. The manner in which this is now being done is absurd and an outrage of public rights. They anchor their boats wherever they please and proceed with their excavation, screening the sand into flat-boats, and throwing the gravel and boulders back into the river, where it is left piled up in huge mounds, which constitute a most serious obstruction to all commerce (Report of the Chief of Engineers 1885: 1820-1821).

An 1892 letter from Amos Stickney, Major of Engineers, expressed his opinion that the Allegheny River should be improved.

. . . . The banks of the Allegheny River are built up for almost the entire distance from Pittsburgh to Tarentum, and there are many manufacturing establishments located here, whose products would go to swell the commerce of the river if it were made navigable at all stages. The river at this point is deemed to be eminently worthy of improvement not only for the benefit of the immediate locality, but as a point of the system of slack-water navigation on the lower part of the river (House of Representatives Executive Document No. 37 1892).

Another constant theme in business petitions and Corps reports aimed at promoting Allegheny River improvements was the issue of cost. Everyone emphasized the fact that railroad shipping was much more expensive than on the river, and estimates of savings began at 10 percent and went up, depending upon the product and the author's interests (Report of the Chief of Engineers 1885).

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The 19th century saw the rise of the steamboat on western rivers, its dominance over all other forms of transportation for about thirty years, and its decline following the Civil War as railroads on land and barges on the rivers took over its role in the cargo trade. Both could haul more freight and at cheaper rates than ever before. Passengers left the river for the railroads in the 1850's, leaving water transportation largely to commercial shippers. The river trade also became more regional in nature as a whole transportation network developed in the United States. No longer was commerce oriented toward the south downstream on the rivers; it increasingly moved east and west across the state and the nation, and it could now also flow north without difficulty (Corps of Engineers 1979: 8). By 1860 direct east-west and regional trade had almost completely displaced the old circular route down the rivers to New Orleans, out to sea, and back to the East Coast. The country's commercial life then began to focus on the West, rather than east across the Atlantic (Taylor 1968).

The three major rivers of western Pennsylvania, all of which played a critical role in the development of the region, benefitted from the internal improvements movement of the second quarter of the 19th century, as the term "river improvement" took on a new and broader meaning (Robinson 1983: 22). Surveys were first made of the rivers in the 1820's, and channel-clearing began in 1824 on the Ohio; in the 1830's construction of a slackwater navigation system commenced on the Monongahela, the first such improvement in western Pennsylvania.

By the end of the century, the rivers were used heavily for commercial shipping, and industry was well-developed along the banks. As influential business interests impatient with the delays caused by seasonal navigation continued to exert pressure for further improvements to aid navigation and shipping on the Pittsburgh rivers, Congress approved the continuation of lock-and-dam building on the Ohio and Allegheny Rivers and the upgrading of those already in place on the Monongahela.

ALLEGHENY RIVER IMPROVEMENTS, 1898-1938

In 1886 Congress appropriated the funds necessary to build a lock and dam at Herr's Island in the Allegheny River at Pittsburgh at the backwater from the Ohio River's Davis Island Dam. As a result of jurisdictional problems--the refusal of Pennsylvania to cede the land needed for the lock and abutment and the fact that Congress did not authorize the purchase of the land

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until 1888 (and finally bought it in 1890)-- and the realization that the original design was inadequate, the Herr's Island Dam was not even begun until 1893. Construction lasted for ten years because of engineering and weather-related problems.

As the movement for improving navigation of the Allegheny gathered momentum, the Corps of Engineers, under congressional authority, performed another survey of the Allegheny River between 1896 and 1898. The report proposed canalizing the river by building a series of eight locks and dams, similar to those on the Ohio and Monongahela, between Natrona and Monterey in northern Armstrong/southern Clarion Counties, since it was generally felt that the 65-mile stretch of water between the latter and Pittsburgh carried most of the bulk commerce that passed up and down the Allegheny. Although calls for improving the river as far as the Pennsylvania state line or to Olean, New York, had been made for nearly a century, at this point it was "deemed unworthy and not justified by the interests of commerce at present involved" (Report of the Chief of Engineers 1898: 2412). At that time, Congress had already authorized three locks and dams to provide slackwater as far as Natrona, 24.2 miles up the river, although nothing had as yet been built, and the 1898 report proposed continuing the system into the northern Allegheny Valley. The owners of the large industries along the river also supported the proposal (Report of the Chief of Engineers 1898: 2214-2215).

Freight movement on the river at the time the Herr's Island Dam was under construction was made up primarily of the following: boat bottoms,² gravel, sand, rough lumber, stone, timber, and manure. Lesser amounts of bark, barrels, cattle and horses, coal, fire clay, gas pipe, hay, lath, piles, posts, shingles, and staves were also shipped by water. The northern Allegheny Valley manufactured rafts, boat bottoms, and coal barges and sent them loaded with other products down the river to Pittsburgh. The Corps annual report explained, "All minerals and materials other than timber products are generally transported in guypers and flats drawing from 1.5 to 4 feet and having a carrying capacity of from 75 to 200 tons. These guypers and flats are usually towed by small boats" (Report of the Chief of Engineers 1892). This was the type of traffic that the Allegheny River locks and dams were designed to support, and John F. Dravo, the chairman of the River and Harbor Committee, expressed the views of the members of the Pittsburgh Chamber of Commerce in saying that these resources could not be developed to a greater extent

²Because of the low bridges and shallow water, only the bottom part of boat hulls were constructed and moved down river. The rest of the hull was completed on arrival in Pittsburgh.

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until a cheaper means was found of transporting them to Pittsburgh, *i.e.* slackwater navigation far up the Allegheny (Report of the Chief of Engineers 1892).

Herr's Island Lock and Dam

The plan as finally approved for the Herr's Island project called for a movable dam designed to please both the lumber interests and the residents of the riverside communities on the Allegheny. Allegheny City sold its portion of the land to the government for \$1.00 provided that the dam be built as a movable one; the City of Pittsburgh, the Pittsburgh Chamber of Commerce, and the Engineers' Society of Western Pennsylvania all concurred in that decision, the fear being that a fixed dam would increase the height of floods in the river (Report of the Chief of Engineers 1890: 2366).

The final design included a concrete lock and a 500-foot navigable pass consisting of a Chanoine wicket-dam with beartrap weirs/sluices, each of which were 94 feet long. These Chanoine-style wickets lay flat on the foundation of the dam during times of high water so that they did not impede navigation in the river channel; when the water level dropped, the wickets were raised manually the entire width of the channel to create a dam and a slackwater pool for navigation (Corps of Engineers 1979: 32; Johnson 1974: 164). The weirs/sluices were designed to regulate upstream pools and allow debris to pass through. Those on the Herr's Island Dam were a then-new form of beartrap made of steel leaves and with compressed air for added buoyancy (Johnson 1979: 145).

The Herr's Island Dam posed one problem after another for both the Corps of Engineers and the contractor. An exasperated Major Charles F. Powell, the engineer responsible for the project reported, "Although the conditions were exceptionally favorable, the progress made was discouragingly slow. . . . The contractor sought for some cause other than his incompetency on which to place the blame. . . . On the 18th construction work was commenced on the foundations, nearly three months later than might have been under proper management." He continued his report, describing another incident a few months later, "Although the contractor had timely warning of the approach of the November freshet, he removed none of his machinery to a place of safety, and consequently most of it was dislodged, the derricks knocked down, and several articles carried away by the water" (Report of the Chief of Engineers 1901: 2702). These and other routine problems caused the contractors to lose a large amount of money on the construction of

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this dam, forcing them to ask their bondsmen to bail them out (Report of the Chief of Engineers 1902: 20).

When the water level dropped in April of 1903, it was necessary to raise the dam for the first time to create the navigation pool. The wickets worked perfectly, locking into place as they were designed to do. The beartrap weirs were another case, however, and, when the air was pumped into them, nothing happened. The engineers tried everything they could think of, including modifying the culverts and changing the valves, and, after several more trials, still could not get the weirs in place. They concluded that the weir gates were leaking somewhere and that attaching thin boards to their undersides would stop the leaks and solve the problem. Another test in early June proved this theory correct as both of the beartrap weirs responded promptly and rose to the top (Report of the Chief of Engineers 1903: 1684-1685). For as long as the Herr's Island Dam was in operation, routine maintenance required that the beartrap gate boards be replaced every few years.

The Herr's Island Dam, later to be known as Lock No. 1, was finally put into operation on January 1, 1903 and dedicated nearly seven months later on July 28, 1903. It extended the Pittsburgh harbor 4.5 miles above the slackwater created earlier by the Davis Island Dam on the Ohio and provided unimpeded slackwater navigation for six miles up the river, serving Pittsburgh and Allegheny City. Operation of Lock and Dam No. 1 was relatively uneventful, except for an episode in July of 1905 when, as the dam was being lowered, 200 feet of the retaining wall immediately below the abutment fell into the river (Report of the Chief of Engineers 1906: 16).

This new (and experimental) dam, despite short-term problems, did not noticeably increase the chances of river flooding and proved to be entirely workable as far as moving logs and lumber rafts past the dam was concerned. The citizens of the Pittsburgh area quickly and enthusiastically endorsed the new navigation improvements and petitioned Congress and the Corps of Engineers to continue building slackwater pools farther and farther up the Allegheny.

The Issue of the Pittsburgh Bridges

One of the primary obstacles to the improvement of navigation on the Allegheny River continued to be the number of low and poorly-placed bridges in the Pittsburgh area. Bridge replacement became enmeshed in the issue of jurisdiction and the transfer of land from the city

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and state to the federal government for lock and dam construction; the long-term controversy and Pittsburgh's chronic unwillingness to replace its low bridges slowed the progress of river improvements north of the city. It was also, as mentioned earlier, one of the major reasons for the demise of regular steamboat service and the lower volume of commercial traffic on the Allegheny.

One of the Corps' annual reports noted that when the federal government took over the ownership and operation of the entire Monongahela slackwater system and eliminated the tolls, the (only) two Allegheny River packet boats were transferred to the former river and had not yet been replaced. He concluded by saying, "It is not likely that packets will run on the Allegheny above Pittsburgh until the river improvement is more satisfactory or the numerous low bridges be raised" (Report of the Chief of Engineers 1897: 2204). Nearly every annual report from the 1890's through World War I mentioned the Allegheny River bridge problem.

The bridge issue began to simmer again in 1902 when the Allegheny River Boatmen's Association, an organization of local river men and businessmen, such as Edward Davison and John Dravo, whose companies were tied to the river, entered the fray, lobbying both for higher bridges and completion of the slackwater system to the upper reaches of the river. The Boatmen's Association officially changed its name to the Allegheny River Improvement Association in 1919--although it had already been using it for some time-- and continued its lobbying efforts (Kussert 1938: 339-342; Johnson 1979: 149-150).

In 1910 the Pittsburgh Civic Commission asked retired Corps of Engineers Colonel Thomas W. Symons and the eminent city planner Frederick Law Olmstead to study the bridge issue and make independent and informed recommendations as to ideal heights and locations of Allegheny River bridges. Their final report analyzed the nature and amount of traffic on the river and the problems associated with leaving or raising the bridges. Although they did recognize the fact that the bridges interfered with navigation on the Allegheny, they also stated that the potential for commerce was not great enough to expend the sums or inconvenience necessary to replace all of the bridges, particularly at that time. They suggested raising two bridges, deferred decisions on others, and established height and width standards for floors, spans, and piers (Symons and Olmstead 1910: 5, 29-30). The Corps' Board of Engineers also studied the problem in 1910/1911 and recommended raising the Allegheny River bridges at Pittsburgh to aid navigation.

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Their recommendations were not accepted at the War Department, and the bridge controversy was not settled completely until 1923 (Johnson 1979: 151).

Original Locks and Dams Nos.2 and 3

Before the Herr's Island Dam had even been built, Congress authorized the construction of two more locks and dams on the Allegheny above Pittsburgh. The plan was to extend slackwater navigation seventeen more miles, as far as Natrona, Allegheny County. Thanks to legal and jurisdictional problems, (old) Lock/Dam No.3 at Springdale was begun (1898) and completed first (1904). These new projects were designed to be fixed-crest flat-top dams instead of movable ones like L/D No.1 at Herr's Island. Because the lumber interests no longer had the political influence they once had, and, since by this time it was clear that the dams designed for slackwater navigation did not increase the incidence of flooding, the Corps was authorized to build the type of dam that had proved successful on the other rivers.

Construction on Lock/Dam No.3 moved along well for the first year or two, then slowed for several years due to river conditions including freshets and rises that made the water level too high to permit work on the lower sections. In late 1903 boats experienced great difficulty in navigating over the unfinished dam but were finally able to move through the lock, which was also not finished. They suffered slight damage during this passage, but other boats which were waiting for higher water were destroyed by the large amount of ice that soon moved downriver. The high water level also prevented many coal boats from passing under the low bridges around Pittsburgh. In 1904 the water conditions were favorable for construction, and Lock No.3 was completed and placed in operation on September 29, as was the dam exactly two months later. During that winter as ice and snow caused the water to rise several times, a total of three houses on the bank near the dam were undermined and fell into the river; the Heidenkamp Mirror Company nearby also had two of its buildings damaged or destroyed (Report of the Chief of Engineers 1905: 1855-1856).

In mid-January of 1907, the most serious problems occurred at Lock and Dam No.3. Although the flood stage was only moderate at that time, the abutment failed for some reason, and, in order to limit damage to surrounding areas as much as possible, the decision was made to blow a hole 560 feet long in the dam. As a result of the break, nine houses, outbuildings, and other kinds of property, as well as 5.3 acres of land were washed down the river. The

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Heidenkamp Mirror Factory, which had sustained damage three years earlier in a flood, suffered further destruction. The federal government was involved in litigation for several years with property owners whose buildings and land were carried away by flood waters.

At the height of the emergency, the Corps of Engineers asked the Pennsylvania Railroad to rush to the site to dump great quantities of stone, slag, and other materials in an effort to stabilize the bank (as well as the main railroad tracks). For four days 425 men, two wrecking cranes, and a derrick worked feverishly (and ultimately successfully) to riprap the entire remaining bank. The dam was largely destroyed, both by the dynamite and by another flood in March, and had to be repaired at the same time the work was being completed on Lock and Dam No.2. Needless to say, the large hole in the dam created navigational difficulties at that location until the rebuilding was completed in the fall of 1908 (Report of the Chief of Engineers 1907: 1704-1705; 1909: 1771).

The legal problems blocking the acquisition of the land for Lock No.2 at Sharpsburg/Six Mile Island (Aspinwall) involved the City of Pittsburgh, who demanded that the federal government reroute a large storm sewer to a point below the location of the dam. While the negotiations were taking place, the contractor decided to begin work on Lock and Dam No.3 instead. The delay lasted so long that, although the City of Pittsburgh finally deeded the land for Lock No.2 to the federal government in 1902, the Corps felt obligated to void the construction contract it had negotiated in 1897 and start over.

Once the property issues had finally been resolved, the Corps of Engineers was able to begin actual construction in the spring of 1903. The new primary contractor for the lock project was the Dravo Contracting Company of Pittsburgh. Old Lock No.2 was their first such contract with the Army Corps of Engineers, but the company went on to build Allegheny River Locks/Dams Nos. 5, 6, and 7, as well as many of the Corps' other projects on the Ohio River and its tributaries (Dravo Corporation 1947). Construction proceeded at a normal pace, and Lock No.2 and the abutment were completed in the spring of 1905 and went into service on November 10, 1906, while finishing work continued on the dam. The entire project was completed in October of 1908. During construction work on Lock No.2, however, the Pennsylvania Railroad dumped hot slag and ashes, as it commonly did, between the shore and the lock; the fill somehow ignited and continued to burn for several years, eventually putting itself out (Report of the Chief of Engineers 1913: 2566).

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In April of 1910, Lock No.2 was closed to navigation for nearly a day due to a major break in one of the Pittsburgh city water mains. The resulting flood deposited so much gravel in the lock chamber that the gates could not be operated, and it created a huge maintenance problem for the Corps in terms of clearing the lock and restoring the surrounding banks (Report of the Chief of Engineers 1910: 1934).

Delay in River Improvements

Although the plan resulting from the river survey of 1896-1898 proposed the extension of the slackwater navigation system 80 miles up the Allegheny to Monterey, little happened between the completion of Lock and Dam No.3 and the end of World War I. The channel-clearing work continued, including the dynamiting of the old Corydon mill dam 209 miles upriver and removal of snags and boulders as needed. A 1911 survey reassessed the situation and recommended new locks and dams on the Monongahela model as far as Rimerton, at approximately mile 61. The Rivers and Harbors Act of 1912 authorized these improvements if local money could be found to match the federal expenditure. When local money did not materialize, Congress rescinded that provision and in 1913 ordered that before further improvements could be authorized for the Allegheny, the Pittsburgh bridge owners, including the city, would be required to assure the War Department that the obstructive bridges would be brought into compliance.

The Corps' annual reports claimed increased traffic and savings of as much as twenty-five cents per ton of coal on the Allegheny's slackwater system, although the reports also discussed the difficulties commercial interests faced from the low bridges, the railroad monopolies, and the lack of improved navigation on the northern portions of the river. The 1912 report to Congress stated, "The amount of commerce that would make use of the river, if it is slackwatered, can only be conjectured. There are two companies, however, the Pittsburgh Plate Glass Co. and the Allegheny River Mining Co., which indicate that their probable shipments by water would aggregate at least a couple million tons. This alone would probably justify the cost of building the necessary locks and dams" (House of Representatives Document 540 1912: 6).

In 1912 Assistant Engineer J. W. Arras reported a profound sense of apathy among the representatives of Allegheny River commercial interests after he tried to collect information and endorsements for promoting the extension of slackwater navigation. Many of these people seemed to be discouraged because nothing was happening, but others were hesitant to become

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publicly involved in promoting river transportation for fear of alienating the railroads, who held a virtual shipping monopoly and could retaliate against them. Arras argued that once the navigational improvements had been made, however, these shippers would quickly transfer their business to the river. He concluded, "It is believed that this condition will not have been fulfilled until at least practically the entire Ohio River Basin has been comprehended in one complete, dependable navigation as [is] now in considerable measure contemplated" (House of Representatives Document 540 1912: 10).

Arras further concluded that those most interested in extending the slackwater system on the Allegheny fell into three categories: "the owners of the mineral resources, those who have established manufactories, and those contemplating the establishment of manufactories." He pointed out that all of the available factory land near Pittsburgh was already occupied along all three rivers and that the upper Allegheny was the logical place for expansion--if the navigational improvements were made. He also took aim once again at the low bridges on the river (HR Doc. 540 1912: 11,16).

Nothing further was accomplished until 1917, when the Secretary of War ruled that his issuing of orders to alter the obstructing Pittsburgh bridges satisfied the intention of the 1913 congressional act. The deadline he had imposed was suspended during World War I, but in 1919, the Secretary again ordered the bridges be raised in accordance with the engineers' previous recommendations and set new deadlines of from two to five years. He then decided that these orders constituted local compliance and approved the plans for dams 4 through 8. Work proceeded to determine the placement of these new structures, and, in 1919, Congress appropriated the funds with the understanding that no work would actually take place until the bridges had been modified. Between 1917 and 1919, when no Corps field engineers were available for civilian projects, the Corps drew plans, determined land titles, and made test borings for dams 4 through 8 (Report of the Chief of Engineers 1919: 1393, 3077).

Locks and Dams Nos. 4, 5, 6, 7, and 8

After World War I, in March of 1920, construction began on Lock and Dam No.4 at Natrona, 24.2 miles upriver from the mouth of the river, and No.5, which, when completed, provided barge and other commercial access to Freeport at mile 30.4 just above the junction of the Kiskiminetas and the Allegheny Rivers. Both locks were built between 1920 and 1927;

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financial problems slowed the work between 1923 and 1925, but both were put into operation in 1927, although some minor work on each remained to be finished.

Lock and Dam No.6, above Freeport, moved from the planning stages in 1926 to the opening of the lock in 1928 to completion of the entire project in 1930 with little controversy. This lock and dam brought slackwater to the Pittsburgh Plate Glass works at Ford City, one of the major manufacturing plants on the Allegheny above Pittsburgh. Although barge traffic was not then moving at particularly high levels on this portion of the river, the Corps and Congress felt that it was high enough and had enough potential for increase to justify further construction upstream. Lock and Dam No.6 demonstrated the value of river improvements for slackwater navigation on the Allegheny and was built, like the Monongahela locks and dams, with the potential for adding a second lock if it ever became necessary.

The next two locks and dams were also completed quickly. No. 7 at mile 45.7 at Kittanning was built between 1928 and 1931 and opened to traffic in November of 1930. Lock/Dam No.8 was put into operation in May of 1931 and fully completed in 1933. It was located just below the town of Templeton, 52.6 miles from Pittsburgh. These new locks and dams were also constructed in such a way that a second lock could be added easily, but the deepening Depression in the United States resulted in a significant decline in commercial traffic on the Allegheny, and even after prosperity returned, the volume of traffic never matched the planners' expectations.

Replacement of Locks and Dams Nos.2 and 3

By the time of the construction of Locks/Dams Nos.4 and 5, Congress voted to enlarge and modify the system to create a deeper navigation channel in the Allegheny. Shoreline industries and resulting current changes had made navigation and lock-throughs increasingly hazardous around Lock No.2. The original discussion, as late as 1929, involved choosing one of three plans:

- 1) Modernizing the existing structures at Locks No.2 and 3, and eliminating No.1.
- 2) Constructing new locks and dams at Nos.2 and 3, and eliminating No.1.
- 3) Replacing Locks Nos.2 and 3 with one structure, locks and dams with movable crest, and eliminating No.1.

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Choice number 3 was rejected for practical (including cost) and safety reasons, and in 1930 a modification of plan No.2 was unofficially adopted. This meant that Locks and Dams Nos.2 and 3 would be replaced with larger, standard-size locks and low fixed-crest dams at "suitable locations" (not necessarily on the same sites) and that No.1 would be eliminated (General Correspondence Files 1929-1933; Report of the Chief of Engineers 1931, 1934).

By 1931 the locations for new Locks and Dams Nos.2 and 3 had been determined. New No. 2 would be built between the existing dam and the Highland Park Bridge 6.7 miles up the Allegheny. New No.3 would be placed approximately 7.8 miles upriver from L/D No.2 at Fourteen Mile Island, two miles downstream from the Springdale site of Old Lock and Dam No.3 and across from Acmeonia. New No.3 would also have a slightly higher (1 ½ feet) crest elevation than the old one.

Members of the Pittsburgh Coal Exchange were included in conferences with "navigation interests" to discuss conditions during construction. These men represented steel, sand and gravel, coal, shipping, glass, and construction companies, and the Corps' district engineer corresponded with them frequently to clarify decisions and to inform and reassure the business community. The Coal Exchange, for example, had been opposed to the construction of a single new dam, believing that two dams would provide larger pools and thus better serve their needs. The district engineer was instructed by his superiors to take the views of the Coal Exchange into consideration in making recommendations.

Allegheny County commissioners were given the opportunity to build a new highway bridge across Dam No.2, but they declined, citing the increased costs involved with this plan, as opposed to building such a bridge in an independent location. The corps notified a long list of newspapers, commercial interests, railroads, banks, public officials, contractors, engineers, utilities, and others with riparian interests of the construction plans and schedule so that they could modify their operations when necessary (General Correspondence Files 1929-1933).

After several years of study and a congressional reauthorization, the proposal for the new locations and construction was approved in 1932, and work began in December of that year on L/D No.2 and in January 1933 on L/D No.3. New channel dredging was completed in 1933, and both locks opened in October of 1934. All of the remaining construction on the dams was completed in 1935, and old Dams 2 and 3 were subsequently removed. These new projects also

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were built so that a second lock could be added. By 1932 as well, the remaining seven obstructive bridges across the Allegheny at Pittsburgh had been removed and rebuilt, bringing the city into compliance with the earlier orders issued by the Secretary of War (Report of the Chief of Engineers 1932: 1262).

Planning for Lock and Dam No.9

With eight locks and dams in place on the Allegheny by 1935, the Corps turned its attention to extending the navigation improvements farther up the river to create slackwater as far as East Brady. There was some discussion about building two more low dams, but the engineers decided that one new dam with a higher lift would serve the purpose, provided that Dam No.8 could be raised by three feet and the channel dredged enough to create the appropriate slackwater pool. The Pittsburgh Coal Exchange and other riparian interests were consistently involved in the planning and approval of construction elements of Lock and Dam No.9. They were particularly interested in the design of the lock walls and approach conditions at the site (General Correspondence Files 1930-1935; Report of the Chief of Engineers 1934).

Depression-Era Public Works Legislation

After 1932, Allegheny River lock and dam construction took a new turn, like public improvement projects all over the United States, as the continuing work there was included in the national relief effort to create jobs for the millions of unemployed workers who were victims of the Depression. The Emergency Relief and Construction Act of 1932 passed by both houses of Congress was published as part of the "Laws Relating to Improvement of Rivers and Harbors," and the Public Works section was designed "for the purpose of providing for emergency construction of certain authorized public works." The National Industrial Recovery Act was passed "to encourage national industrial recovery, to foster fair competition, and to provide for the construction of certain useful public works, and for other purposes." Under Title II of this act, the President was authorized to create a Federal Emergency Administration of Public Works, which, in turn, would prepare a "comprehensive program of public works" that included the "construction of river and harbor improvements and flood control and also the construction of any river or drainage improvement." The act required that any such river or harbor improvement must already have been approved or subsequently be authorized by Congress or recommended by the Chief of Engineers of the United States Army.

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The Corps' Pittsburgh District budget for the Allegheny River improvements (and everything else) between 1933 through 1945 itemized the amount of money appropriated and spent under the Emergency Relief and Construction Act and from Public Works Funds which was further broken down into allotments from the National Industrial Recovery Act, as well as from agency funds. The amounts appropriated in each category were well over \$1 million a year and made up a substantial part of the construction budget for completing Locks and Dams Nos. 2, 3, and 9 and for improving some of the others.

Construction of Lock and Dam No. 9

Once Congress had authorized the project in August of 1935, work began on the final (No. 9) Allegheny River lock and dam; it was put into operation in October of 1938. The lock was of uniform dimensions, 360 feet long by 56 feet wide, and the fixed-crest dam had the highest lift--22 feet--of any on the river. Built between Templeton and Rimerton, 62.2 miles from the mouth of the Allegheny, Lock and Dam No. 9 permitted slackwater navigation for 72 miles upriver from Pittsburgh and provided access to the important limestone quarries at East Brady. Dam No. 8 was successfully raised by three feet to complete the plan.

Removal of Herr's Island Lock and Dam (Lock and Dam No. 1)

Only one project then remained in the series of Allegheny River improvements. When the Emsworth Dam on the Ohio River was rebuilt in 1938, it raised the pool at the Pittsburgh harbor, permitting the removal of Herr's Island Lock and Dam, No. 1, as well as Lock and Dam No. 1 on the Monongahela. The new pool depth gave boats access to Pittsburgh without having to go through locks to enter the harbor. As a result, the removal of both Lock and Dams Nos. 1 (on the Allegheny and Monongahela) created a harbor with more than fifty miles of shoreline. The slackwater navigation system on the Allegheny River was complete, and the elimination of the Herr's Island Lock and Dam left the remaining eight locks and dams between Pittsburgh and Rimer a uniform size, a convenience to both the shipping interests and to the Corps of Engineers, who maintained the navigation system (Corps of Engineers 1939: 5).

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ALLEGHENY RIVER NAVIGATION, 1938-1997

The Allegheny River slackwater navigation system was completed in 1938/39 with the installation of Lock and Dam No.9 and the removal of old Lock and Dam No.1. The responsibility of the Army Corps of Engineers from that date on involved operating and maintaining the structures that were in place and continuing channel-clearing up and down the river. Pittsburgh is the largest inland navigation port in the United States, and the Allegheny River system is part of an extensive network of year-round navigation on the rivers that make up the Ohio River drainage basin.

Traffic

Although the rationale for constructing the eight existing locks and dams was primarily the potential commercial use of the Allegheny, that river has never carried the amount of freight that its supporters predicted. As has been discussed, the population base of the Allegheny River Valley was always considerably lower than that of the Monongahela and Ohio, and the primary reason for developing a slackwater navigation system was to reach the mineral and timber-producing areas of northern Pennsylvania and get the raw materials downstream to market. The amount of upriver trade anticipated was always small.

The Depression of the 1930's had an immediate impact on Pittsburgh-area industries and thus on all of the transportation systems including river freighting. Just as the new locks and dams were completed, the amount of traffic available to move through them fell off drastically. The Depression affected the western Pennsylvania steel industry profoundly, but it rallied to meet the military's demand for steel during World War II. From 1946 through 1950, river traffic on the Ohio system climbed to new levels, but the ensuing decline in the steel industry toward the end of the 20th century ended the potential for the development of the Allegheny River corridor as compared to that of the Monongahela (Corps of Engineers 1979: 36).

The inland waterway system in the United States as a whole has experienced a renaissance since World War II, but not all of the canalized rivers have shared in that growth and revitalization. Although the Ohio and Monongahela navigation systems have undergone modernization and replacement since 1938, the locks and dams on the Allegheny River have remained substantially the same structures for the past sixty years; the recent replacement of the

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machinery and power source at Lock No.4 is the single exception (Corps of Engineers 1990: 13). The table below illustrates the historical difference in activity on the Allegheny and Monongahela Rivers.

**COMPARISON OF COMMERCIAL ACTIVITY ON THE ALLEGHENY AND MONONGAHELA RIVERS
FOR SELECTED YEARS BETWEEN 1927 AND 1986**

	<i>ALLEGHENY</i>	<i>MONONGAHELA</i>
YEAR	MEAN TONNAGE	MEAN TONNAGE
1927-1936	3,192,544	20,254,978
1940-1941	9,615,791	97,971,204
1982-1986	3,740,000	37,000,000*

* Rounded by Corps.

Sources: Captain J. H. Dodds, Operations & Maintenance Division, U.S. Army Corps of Engineers. "Summary of Lockages and Tonnage, Pittsburgh District." 1944; U.S. Army Corps of Engineers, Ohio River Division. *Ohio River Navigation System 1988 Report: Commerce on the Ohio River and Tributaries*. 1988.

Five primary reasons contribute to the large and continuing differential. One reason was the vast difference in heavy industry along the rivers. In the latter part of the nineteenth and early twentieth centuries, steel mills, glass works, potteries, and brick works lined the Monongahela River. Although substantial industry existed along the Allegheny River, the amount was small when compared to the Monongahela River.³

The second reason continued as an extension of the first one. The industry that located along the Monongahela River did so because great coal reserves existed upstream, and the River was already improved. Improvements on the Monongahela River began in 1837, providing an

³U.S. Army Corps of Engineers, *Navigation on the Monongahela and Allegheny Rivers*, 1939 (Corps of Engineers, U.S. Army, Pittsburgh District), AR 1-2, MR 1-5. The list of terminals along each river in the appendix shows over five times the number of terminals along the Monongahela than along the Allegheny.

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infrastructure already available to the substantial later industrial development. Coal reserves within easy access to the River provided the initial impetus for improvement. Lumber interests generally preferred an unimproved river, at least without locks and fixed dams. However, the potential of the coal reserves attracted sufficient capital to begin improvements to the Monongahela River despite the opposition from lumber interests.⁴

The third reason compared natural conditions on the two rivers. The flow of the Allegheny River at the Point in Pittsburgh has been about three times that of the Monongahela River over the last 60 years. The differential in flow increased markedly above the Monongahela's confluence with the Youghiogheny River at McKeesport. Fifteen miles above the Point, the Monongahela River has a flow one-sixth that of the Allegheny River, at a comparable distance.⁵ In addition, the larger watershed of the Allegheny coupled with its northern reach into the uplands of the Allegheny Plateau where lake-effects snows occur, resulted in large ice flows, some of which reached considerable proportions.

The large water flow of the Allegheny River and the yearly ice flows combined to make river improvements costly. The technology of lock and dam construction prior to the use of heavy machinery and concrete consisted of wooden timber cribs, constructed with mortise-and-tenon joinery and pinned together with wooden dowels, floated into position. Steam-, horse-, or hand-powered cranes then were used to fill the cribs with rock. If possible, wooden piles might be driven into the river bed to help anchor the bed. The filled crib would then be finished with a

⁴U.S. Army Corps of Engineers, *Navigation on the Monongahela and Allegheny Rivers*, 1939, AR 1-2, MR 1-5. Forty-five coal terminals are listed for the Monongahela, nine for the Allegheny.

⁵Joseph B. Lescinsky, Martin B. Coll, Jr., and Raymond W. Siwicki, *Water Resources Data, Pennsylvania Water Year 1994, Volume 3, Ohio River and St. Lawrence River Basins*. U.S. Geological Survey Water Data Report PA-94-3 (Lemoyne, PA, 1995), 77 (Allegheny River at Natrona, mile 24.3, showing average daily flow of 19,760 cubic feet per second (cfs) for the years 1939-1994), 98 (Monongahela River at Sutersville, mile 15.2, showing average daily flow of 3,068 cfs for the years 1921-1994), and 100-102 (Ohio River at Pittsburgh, showing 46, 520 cfs in 1994, with 17, 990 cfs from the Monongahela, and approximately 28,000 cfs from the Allegheny).

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coping or timber planks, often angled to the river bottom on the upstream side to prevent the accumulation of water-borne trash.⁶ Locks would have also been built of cribbing, to which gates would have been attached. Such crib construction would have to be built on a massive scale to withstand the higher water flows and yearly ice flows of the Allegheny River, making such improvements costly.

Lumber interests generally preferred an open river. To float logs, rafts, or arks, lumber workers waited until high water and shepherded their logs down the river. Fixed crest dams without log chutes created a difficult and dangerous obstacle. Locking logs through was only slightly less difficult. Although lumber interests floated logs on the Monongahela River, the extensive forests of the Allegheny Plateau furnished timber for much of the last half of the nineteenth century. Major Merrill's 1876 *Report* noted the opposition of the lumber interests to locks and dams.⁷ Herr's Island Lock and Dam, completed in 1903, featured a moveable dam with both bear traps and Chanoine wickets, constructed in part to placate lumber interests. By 1898, though, Major Powell noted that timber rafting had declined, "primarily on account of decrease of supply" in the upper reaches of the Allegheny.⁸

As outlined above, low bridges provided the fifth reason for the lack of development on the Allegheny River. The 1828 aqueduct carrying the Western Division of the Pennsylvania Canal over the Allegheny began the problem with low bridges. By the time of the Civil War, additional low bridges crossed the Allegheny. The bridges that Major Merrill noted in his 1879 *Report* included primarily pedestrian and traction-animal traffic, with one railroad bridge (the canal aqueduct had been removed in 1865).⁹ A private entrepreneur could not hope to provide funds to

⁶Illustrated in David Macaulay, *Mill*, 1983 (Houghton Mifflin, Boston, MA), 31-33.

⁷William E. Merrill, *Report of the Chief of Engineers, U.S. Army*, 1876, 148-149.

⁸Charles F. Powell, *Report of the Chief of Engineers, U.S. Army*, 1898, 2212.

⁹William E. Merrill, *Report of the Chief of Engineers, U.S. Army*, 1879, 1372. He wrote, "Steamboat commerce on the Allegheny has almost been extinguished by railroad competition, by natural obstructions in the river, and by obstructions that man has placed there in the shape of low bridges, with narrow spans badly located."

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raise the seven bridges. Only the Federal government could have the jurisdiction to force the raising of the bridges.

By the time that the City of Pittsburgh finally replaced or removed all of the bridges, the year was 1929. The Great Depression and the subsequent stagnation of the steel industry, except for World War II and the Korean Conflict, resulted in little additional investment in the Allegheny River corridor. The already-existing facilities on the Monongahela River proved adequate. Eventually, many of the facilities on the Monongahela would be removed. By the time that all the obstacles to slackwater on the Allegheny had been overcome, the need for a new corridor with additional natural resources had diminished.

Lock and Dam Nos.2 through 4, those closest to Pittsburgh and the other rivers, have consistently shown the highest volume of traffic in terms of both the number of lockages and total tonnage. As of the mid-1990's Lock No.2 handled about 4.2 million tons of freight and Lock No. 3, 3.7 million tons. Coal is the primary product shipped on the lower section of the river, along with petroleum, ore, steel, sand, and gravel, which move both up and downstream, and chemicals, salt, flour, limestone, grain, fertilizer, slag, and minerals, which are sent upriver (Corps of Engineers Brochure 1997).

The annual traffic at Lock No.4 is currently about 1.8 million tons, and at Lock No.5, 1.3 million. The products are generally the same as those traveling through the lower locks: coal, petroleum, sand and gravel, ore, steel, chemicals, fertilizer, salt, flour, lime, and slag. According to the Corps' statistics, total tonnage is on the rise because "of revitalization of the sand and gravel industry and an increase in the industrial base of the Freeport and Kittanning regions" (Corps of Engineers Brochure 1997).

Above Lock and Dam No.5, the amount of annual shipping decreases to about 100,000 tons of freight apiece at Nos.6 and 7. These locks also handle approximately 1,400 lockages each of pleasure boats each year, about two hundred a month during the summer. Fuel oil, sand, gravel, fertilizer, farm products, waste, scrap, and manufactured material make up the commercial tonnage moving through the locks, and some of the local industries maintain small shipping docks in the upper pool (Corps of Engineers Brochure 1997).

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Lock No.8 moves about 400,000 tons of freight annually through its gates and averages two commercial lockages a day, along with 1,200 recreational boats during the summer season. The primary commodity along this northern section of the Allegheny navigation system is gravel. Lock No.9 does almost exclusively recreational business, handling about 1,100 pleasure boats in the summer, and normally operates only on weekends (Corps of Engineers Brochure 1997).

Commercial traffic has decreased on the Allegheny River since 1980. The 3.3 million tons of freight carried in 1988 was a 34% drop from that of eight years previously. Most of the activity has continued to be at the lower end of the river below Dam No. 5 (Corps of Engineers 1990: 13-14).

Recreational use of the Allegheny River, particularly above Lock/Dam No.5, has grown significantly during the past decade, and indications are that it will continue to do so as leisure time increases and as the northern Pennsylvania counties realize the tourism potential of outdoor activities, such as boating, water-skiing, fishing, camping, hunting, and hiking. Public hearings held by the Army Corps of Engineers periodically as part of the development of Operation and Maintenance Plans and environmental impact statements have made it clear that the residents of the Allegheny River Valley are passionately attached to the river and its recreational opportunities, including the continued operation of all of the locks and dams (Corps of Engineers Operation and Maintenance 1975, 1982).

The chart on the next page compares projected commercial traffic on the Allegheny River from 1982 through 2033 with the figures published as approximate actual use in the mid-1990s. In 1982 the Corps projected Allegheny River lock tonnage through the year 2033 in thousands of tons:

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Lock No.	<i>Actual</i>			<i>Projected</i>		
	1979	1983	1990	2000	2020	2033
2	3,946	4,420	5,280	5,990	7,160	7,550
3	3,056	3,720	4,770	5,490	6,450	6,750
4	1,820	2,010	2,380	2,320	2,480	7,550
5	1,315	1,400	1,600	1,400	1,400	1,400
6	36	1,100	1,300	1,300	350	300
7	34	100	200	200	50	30
8	275	500	500	500	120	60
9	0	0	0	0	0	0

Source: U.S. Army Corps of Engineers. *Operation and Maintenance Study*. 1992.Flood Control and Navigation in the Allegheny Basin

Residents of the riverside communities of the Allegheny River Valley have long been concerned about floods, and flooding has traditionally been a more serious problem there than along the Ohio or Monongahela Rivers. The ice gorges on the Allegheny have been historically a major source of winter and spring flooding; 19th-century accounts often dramatically described the most spectacular and destructive events (Smith 1883: 122-124). The flow of the Allegheny and its tributaries varies widely with the season, and significant floods of several days' duration can occur at any time (Corps 1975: 8).

In 1908, following the serious flood of 1907, the Chamber of Commerce of Pittsburgh created a Flood Commission, with H.J. Heinz as president. Its purpose was "ascertaining means of relief from the floods which have so frequently occurred, with damaging results, to this community." The Flood Commission was subdivided into committees, each headed by a prominent Pittsburgh citizen: Executive, H.J. Heinz; Finance, Julian Kennedy; Engineering, E.K. Morse; Legislation, W.G. Wilkins; Rules and Membership, A.J. Kelly, Jr.; Real Estate, D.P.

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Black; Publicity, W.H. Stevenson, and Sewage Disposal, Morris Knowles. The Engineering Committee comprised seven professional engineers.

The opening paragraphs of the 1912 report of the Flood Commission of Pittsburgh stated

The regulation and control of the flow of navigable rivers in aid of interstate commerce is an important factor relation to the conservation, development and use of the natural resources of the United States, and the enlargement of its internal trade and commerce. When such a national policy has been adopted on a scale commensurate with the magnitude of the problem, it will not only promote navigation and water transportation, but must also necessarily include the storage of flood waters for flood prevention and for all other beneficial uses, and the protection of watersheds from denudation and erosion and from forest fires.

Much has already been done, in a disconnected and inadequate way, toward the inauguration of such a comprehensive national policy for river regulation; and the work done and measures advocated by the Flood Commission of Pittsburgh are in the direction of an ultimate enlargement of that policy which will be vastly beneficial to the entire country (Flood Commission of Pittsburgh 1912: 1).

The report then identified three national movements that had been primarily responsible for the improvements in flood control to that point: the National Irrigation Movement, the Appalachian Forest Reserve Movement, and, most importantly, the National Storage Reservoir Movement. The latter the report said, "was inaugurated by the Chamber of Commerce of Pittsburgh, through the National Board of Trade, in December, 1898. . . and 'urged the storage of flood waters on the upper branches of navigable streams, to be held in use for irrigation, for checking damaging floods and liberating water in times of drought that will preserve streams in navigable condition'" (Flood Commission of Pittsburgh 1912: 1).

The Flood Commission foresaw a coordinated, cooperative construction plan involving all Pennsylvania counties of the Ohio River Basin affected by serious flooding. It also proposed state legislation and lobbied both the Pennsylvania legislature and the United States Congress in its

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attempts to protect the area before another devastating flood actually occurred. The report included studies of all aspects of the flooding problem, including cost-benefit analyses. The major recommendation stated, "This comparison leads to the final conclusion that the best method of flood relief is the construction of seventeen selected storage reservoirs, supplemented by a river wall at Pittsburgh, eliminating the back channels at the three islands, at a total net cost, in round number of about \$20,000,000" (Flood Commission of Pittsburgh 1912: 15).

The Flood Commission continued its lobbying efforts and its attempts to obtain congressional funding for flood-control projects. In 1930 the Commission produced another document questioning the results of a 1924-1929 study conducted by the Corps of Engineers, Pittsburgh District, of flood protection for the Allegheny, Monongahela, and upper Ohio Rivers. The Corps concluded that the cost of constructing the eleven reservoirs it identified would exceed the benefit of flood protection and was thus not justified. George S. Davison of the Davison Coke and Iron Company (and of the sand and gravel company family) was then the president of the Flood Commission. The conclusion this time was that the Corps of Engineers' study was "written from the point of view of extreme conservatism" and that many of its recommendations could be challenged (Flood Commission of Pittsburgh 1930).

When the final plans for building Lock and Dam No.9 and raising the crest on Dam No.8 were drawn up, the Corps of Engineers made it very clear that the locks and dams they were building on the Allegheny were designed to provide slackwater navigation and would be of no use in flood control. The district engineer mentioned the subject twice in his report saying, "There are no other special subjects such as land reclamation, flood protection, and irrigation, which enter into consideration of this improvement and which might involve cooperation by local interests." The conclusion stated, "Water power, flood control, or other possibilities do not have an important bearing on the proposed improvement" (Report of the Chief of Engineers 1931: 30).

Local and federal efforts to devise a plan for flood control and prevention continued, but before anything significant could be developed, the St. Patrick's Day Flood of 1936 hit Western Pennsylvania and threatened to destroy Lock and Dam No.4 on the Allegheny and Emsworth Dam on the Ohio. Nearly two hundred people died as a result of this flood, and the Corps of Engineers had to cope with monumental damage (Johnson 1979). This devastating event pushed Congress to pass the Omnibus Flood Control Act of 1936, in which it assigned responsibility for flood-control projects to the Corps of Engineers.

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Flood control was also included for funding as part of the Depression-relief public works appropriations. The 1936 act authorized the construction of five reservoirs in the Allegheny River basin: the Allegheny River above Warren, Tionesta Creek, French Creek, Redbank Creek, and Mahoning Creek, and between 1940 and 1975 ten such reservoirs were built on the Allegheny River and its major tributaries. Individual projects have not had much effect on river flow, but combined they have "significantly altered flow characteristics" of the Allegheny (Corps of Engineers 1975: 10). The Flood Control Act of 1938 directed that a flood wall be constructed "at and above the abutment of Dam No. 7, Allegheny River, Kittanning, Armstrong County, Pennsylvania" (Corps of Engineers 1938). The construction of this type of local protection project has continued up and down the Allegheny Valley since 1936, and these and other similar Corps flood-control work have reflected a change in national priorities and use of resources.

Continuing Improvement Studies

Some interests in the northern Allegheny River Valley between East Brady and the Pennsylvania State line, particularly in the area around Oil City in Venango County, continued to press for river improvements and a connecting system to New York and the Great Lakes. Studies done in 1898, 1922, 1926, 1930, 1938, and 1945-53 were consistently unfavorable to the idea of extending slackwater navigation beyond Lock and Dam No. 9 and pointed to a Beaver River/Ohio route as a more-promising connection. The construction of the controversial Kinzua Dam between 1958 and 1966 on the far-northern section of the Allegheny in Warren County, Pennsylvania, effectively blocking any through navigation on the river beyond that point. The subsequent creation of the Allegheny Reservoir--extending north into New York--should have ended once and for all the possibility of improving navigation on the upper reaches of that river to provide a link to the Great Lakes and the sea. In 1975, however, the idea surfaced once again, and yet another report on the possibility of northern Allegheny River navigation was commissioned. The authors reached no definite conclusions this time, primarily summarizing existing information on the subject (Corps of Engineers, Allegheny River Basin Navigability Report 1975).

Environmental Concerns

The environmental movement of the past twenty-five years has also affected the management and use of the Allegheny River for navigation and commercial purposes, in terms of

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both the commercial activity on and beside it and the impact of the navigation improvements on the river itself. Historically, the public and commercial dumping of refuse, slag, chemicals, and other materials into the Allegheny was commonplace. Major Powell's report of his Allegheny River survey in 1896-1898 contained his observation of conditions at Natrona. "The Pennsylvania Salt and Manufacturing Company has a large chemical manufacturing plant opposite [the] lower end of Jacks Island. Large quantities of refuse, such as caustic ashes, cryolite, waste, etc., have been dumped over the banks for a distance of about 2,000 feet, and in one place extend into the river for over 100 feet from the original bank line" (Report of the Chief of Engineers 1898: 2438). Other contemporary 19th-century reports and photographs painted pictures of water pollution that would be unacceptable to late 20th-century Americans.

The Rivers and Harbors Act of 1899 made it unlawful to deposit refuse of any kind 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. . . ." This legislation, however, specifically excluded liquid discharges, including sewage, from federal--Corps of Engineers, primarily-- jurisdiction. The Corps and other concerned organizations tried over the years to have the legislation rewritten to include all streams and rivers regardless of their navigational status and to include previously-exempt pollution, but Congress balked until the late 20th century (Johnson 1979: 295-296). The City of Pittsburgh dumped its storm-water sewage into the Allegheny just below Lock and Dam No.2, and took its drinking water from the river immediately above the dam. The city, in fact, found it necessary to reposition its large storm-sewer outlet pipe when the site of L/D No.2 was moved downstream in 1903 (Report of the Chief of Engineers 1900: 3260). Many of the municipalities along the river still draw their water supplies from the Allegheny.

Many individuals and organizations expressed concern about the state of the nation's waterways throughout the 20th century, but conflicting opinions about the most appropriate use of the rivers and confusion about how to cooperate in solving the problems, led to study after study but little or no action. Water quality, then, had been an issue on the Allegheny for at least a century by the time the federal government actually addressed the problem with legislation in 1970 through the National Environmental Policy Act. Subsequent studies and legislation have led to public awareness of environmental problems and a demand for practical solutions to water-quality issues.

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The question of mining and dredging has also been a long-time concern of those interested in the Allegheny. This was one of the earliest commercial enterprises involving the river itself, and as early as 1885 Corps engineers complained about the practices of sand and gravel mining companies as they dumped rejected material back into the river in huge piles that created traffic obstructions. In her 1938 book, *The Allegheny River*, Sarepta Kussert remarked, "The statement that river sand and gravel are replenished annually has been found untrue by experienced river operators. They have found it necessary, each year, to go farther away from the base of former operations; and the added expense involved makes it highly desirable that producers of sand and gravel should understand and use the best excavation methods, in order to protect from exhaustion the available supply of these valuable deposits." She emphasized again later that "A policy of conservation should be adopted by the sand and gravel operators in the Pittsburgh district" (Kussert 1938: 294, 295). These concerns, of course, were prompted primarily by fears of resource depletion rather than damage to the riparian environment.

The "Commercial Sand and Gravel Dredging Operations" section of the *Final Environmental Statement on Allegheny River*, issued by the Corps of Engineers in June of 1980, stated that the Department of the Army issues permits required under Section 10 of the Rivers and Harbors Act of 1899 and Section 404 of the Clean Water Act to allow the continued commercial sand and gravel dredging. "Two firms currently maintain four commercial dredging operations under permit from the Pittsburgh District which operate at various points within or adjoining the lower Allegheny River, below Mile 62.2" (Corps of Engineers 1980). In the early 1980's the Pennsylvania Department of Environmental Resources refused to allow any more dredging on the river above Lock and Dam No.9 (Schafer and Sajna 1992: 110-111).

The dredging issue also involved environmental concerns in the issue of the destruction of fish-spawning and general habitats, the release of pollutants contained in sediments, siltation, and the loss of natural vegetation each year from land disposal of sludge. The Pennsylvania Fish and Boat Commission, as well as other entities and organizations with environmental responsibilities, have been engaged in long-term studies of the impact of various kinds of activities on the health of the Allegheny River, and the Commission went so far as to issue a moratorium on dredging in Pool 6 (Schafer and Sajna 1992: 110-111).

The Corps' 1982 Operation and Maintenance Study addressed the direct impact of the locks, dams, and channel clearing and dredging operations on the river. It stated, "Construction

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of the navigation system converted the free-flowing lower Allegheny River into a series of slackwater pools. This major change in river habitat resulted in compositional changes in the aquatic community, which is now dominated by organisms that have adapted to a deeper and slower flowing environment.” It also concluded that water quality was better on the upper reaches of the river, farther from the urban areas, and that both aquatic and terrestrial biological populations were also more abundant upriver (Corps of Engineers 1982: 42). Some experts also remained concerned about the ability of migratory fish to negotiate their way upriver through the locks and dams (Corps of Engineers 1982:43).

Construction History

As noted above, improvements to the Allegheny River to aid navigation had been proposed as early as 1828. However, when the western portion of the Pennsylvania Canal was constructed from the mouth of the Kiskiminetas River at Freeport to Pittsburgh, the engineers chose to dig a prism on the western bank of the Allegheny. They did not attempt to dam the river for slackwater, as they had the Kiskiminetas. The Allegheny’s high rate of flow and the limited technology of the period lead the canal’s engineers to place the canal on the bank of the Allegheny, avoiding the vagaries of the river.

Prior to the construction of Herr’s Island Lock and Dam (later called No. 1), navigation improvements to the Allegheny River consisted of removal of channel obstructions and construction of wing dams to increase flow in the main channel. The channel-clearing activities and wing dams provided, during times of low water, about one to three feet of draft. Such improvements permitted only small boats and shallow-draft steamers to utilize the river. The barges, increasingly common for bulk hauling, required drafts of at least six feet. Barges, at over 100 feet in length and 25 feet wide, required a much larger waterway than that provided by the old Pennsylvania Canal, whose locks averaged 90 feet long and 17 feet wide. Slackwater navigation, which had worked well on the Monongahela River, was proposed in 1876 by Major William E. Merrill, the Corps of Engineers officer in charge of improvements on the Allegheny, Monongahela, and Ohio Rivers.¹⁰

¹⁰William E. Merrill, *Report of the Chief of Engineers, U.S. Army*, March 9, 1876 (Government Printing Office, Washington, D.C.), page 148-149.

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As noted above, construction began in 1893 on Herr's Island Lock and Dam. By 1938, eight locks and dams, Nos. 2-9 permitted slackwater navigation from Pittsburgh to East Brady, 72 miles. Herr's Island Lock and Dam, designated No. 1, was removed in 1938-1939, following the rebuilding of Emsworth Lock and Dam on the Ohio River. The Emsworth Lock and Dam raised the pool, eliminating the need for Herr's Island Lock and Dam. By 1938, the size of the locks, 360 feet by 56 feet, became standard along the entire Allegheny River slackwater system. The minimum sill depth was 9.5 feet.

EXTANT ALLEGHENY RIVER LOCKS AND DAMS¹¹

Lock and Dam	Location	River Mile	Pool Elevation	Lift in Feet	Year Opened
No. 2	Highland Park	6.7	721.0	11.0	1934
No. 3	Oakmont	14.5	734.5	13.5	1934
No. 4	Natrona	24.2	745.0	10.5	1927
No. 5	Freeport	30.4	756.8	11.8	1927
No. 6	Clinton	36.3	769.0	12.2	1928
No. 7	Kittanning	45.7	782.1	13.1	1930
No. 8	Templeton	56.6	800.0	17.9	1931
No. 9	Rimer	62.2	822.0	22.0	1938

The expectations of sharply increased growth of manufactories along the Allegheny River as a result of slackwater failed to occur. Although the lower Allegheny carried between three to

¹¹Taken from U.S. Army Corps of Engineers, Ohio River Division, *Ohio River Navigation System, 1988 Report*, 1988 (U.S. Army Corps of Engineers, Ohio River Division, Cincinnati, OH), 21; and U.S.G.S. 7.5-minute quadrangles of Pittsburgh East (1993), New Kensington West (1993), New Kensington East (1993), Freeport (1993), Leechburg (1954, photo inspected 1977), Kittanning (1993), Templeton (1969, revised 1993), and East Brady (1993).

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five million tons of commerce annually after 1941, the Monongahela River carried about ten times that amount. In addition, little major construction of industrial sites occurred along the Allegheny. Several factors contributed, including geography, hydrology, geology, and the low bridges, as noted above.

Technological Context

The technology evident at Allegheny River Locks and Dams 2-9 resulted from a century's experience with canal and slackwater construction. The fixed-crest concrete dams, the concrete land and river walls, the hydraulically-operated gates and valves, and the use of the dam's head to operate the system, all evolved as new technologies and procedures became available.

The concrete dams that impound the Allegheny River for slackwater navigation resulted from similar dam construction that had occurred for over a century. Timber cribs, filled with stone and gravel, provided mass to anchor them to the river's bottom. The cribs were generally faced with timber planks or masonry to prevent damage from water-borne trash. Mass created stability.

The engineering concepts of such dams grew from the practical, rather than theoretical, American engineering background (Kranakis 1995: 280-287). Americans drew on concepts that had worked in the past. In the case of the timber crib dam, it had worked in the British Isles in the eighteenth century. Mass held the dam in place. When concrete became a substitute for timber cribs, engineers used the same concept, that mass equaled stability.¹²

Although the Romans first developed concrete, its use in the modern era began in the 1870's. However, use as a building structure first occurred in the 1890's. Herr's Island Lock (later Lock No. 1) utilized concrete in 1896. However, the proposed use of a concrete dam at

¹²Stone could also be massed to perform the same function as the timber crib. Some example of massed stone dams also remain. Likely, the timber crib was less expensive to build than a massed stone dam, because more of the labor could be unskilled.

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Herr's Island was declined by the conservative Corps of Engineers review board (Johnson 1979: 144).¹³

Herr's Island Dam consisted of a timber crib, faced with masonry, with moveable wickets on top. The moveable dam permitted the shallower-draft barges of the day, in addition to lumber rafts and log booms, to pass over the dam during high water. In times of low water, the wickets would be raised, permitting the use of the lock. The use of a moveable dam also allayed fears of local citizens that a dam would increase flooding in Pittsburgh.¹⁴

The moveable dams required extensive maintenance and repair. Floods and water-borne debris damaged the wooden wickets. In addition, rafts, log booms, and arks diminished on the Allegheny as timber resources declined. Fixed-crest dams became a simple, low-cost method of providing slackwater for navigation. Dams 2-9 would be concrete fixed crest.¹⁵

The river walls of the locks followed a similar sequence of development. When slackwater had been chosen for the Pennsylvania Canal, such as along the Kiskiminetas River, a timber crib river wall would be faced with masonry. Generally, the method used for building piers, cut stone facing with a rubble core, worked best only when in compression. The lateral tension resulting from the attachment and movement of lock gates often worked to pull the stone away from the rubble core.¹⁶ As a result, the timber cribs, which contained internal reinforcing,

¹³Johnson noted (same page) that the concrete of the lock had been placed under water. A circa 1911 drawing detailing buttresses for the lock walls, located in the National Archives, stated the following note: "Lock foundation is concrete placed under water. Results were poor, and method not recommended." Drawing A-3-12, RG-77, Pittsburgh District Office, Plans of Locks and Dams, Allegheny River, Herrs Island Lock (Lock #1), A-3-1 to A-3-26 (National Archives).

¹⁴Johnson, *The Headwaters District*, 144.

¹⁵Old Dams 2 and 3 were fixed crest, as are new, extant, Dams 2 and 3. Dam 8 had originally been designed for moveable gates, but later was converted to a fixed crest.

¹⁶Contractors were required to insert a header every fourth stone; however, even this method did not completely eliminate problems resulting from the movement of the lock gates.

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were generally utilized to build free-standing structures within a river's channel. The cribs were generally faced with cut stone or planks and covered with coping.

Miter gates provided the necessary seal in the locks. The earliest known canals utilized wooden miter gates. The miter, or angle, faced upstream, where when the water was lowered, the pressure of the upstream water forced the gates together. The gates generally were framed and covered with planks. Balance beams, often with boxes of rocks attached to the land ends, permitted a single lock keeper to operate the gates. The canals of the eighteenth and early nineteenth century, including those of the Pennsylvania Canal, utilized wooden miter gates, with each leaf approximately eight to ten feet long. The shallow draft of such canals, four or five feet, and their 17-foot width, coupled with a low lift of eight to ten feet, resulted in gates that were manageable by the strength of the lock operator.

Later near the middle of the nineteenth century, some locks utilized single-leaf gates that folded down into a pocket at the bottom of the lock. Protruding edges on the lock walls held the gate in place when the water levels were uneven. Like the miter gates, the water pressure against the lock gate helped secure the seal. Occasionally, a single lock would contain both kinds of gates.

When the larger, 110-foot wide locks on the Ohio River began to be designed, the greater width of the chamber could not be spanned by traditional wooden miter gates. Major William E. Merrill designed a single-leaf gate that moved out into the lock on a rail. Because of the pressure against it, Merrill developed a truss that was so wide that it resembled a railroad box car, which eventually became its sobriquet. Although the gates worked, maintenance was difficult; sediment often filled the recess. In addition, the long recess required that the lock be built further into the river, both impeding the river's flow and placing the lock where more debris could accumulate in it. The gates worked well enough that they were used for 40 years on the Ohio River (Johnson 1979: 137-138).

Steel miter gates provided part of the solution. Steel gates could be made larger with less sag than wooden gates. In addition, steel gates warped less than the wooden gates, which were partially submerged and partially dry, with a portion that would be soaked and dried on a daily basis. However, the steel gates did not float, and thus required additional support and force to move them.

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As noted above, the lock operator originally opened and closed the gates by moving a balance beam. As locks and their gates became larger, mechanical means to move the gates were developed. Turn-of-the-century designs included a jointed arm connected to the gate, operated by a large rack and gear. A hand-operated capstan moved the rack against the gear. Such mechanisms permitted lock operators a mechanical advantage to moving a large and heavy gate.¹⁷

Valves also developed during the nineteenth and early twentieth centuries. On the Pennsylvania Canal, valves had been located in the gates, either sliding doors that the operator raised, or shutters that opened with a rod-and-lever arrangement. By the latter portion of the nineteenth century, valves became butterfly-type, a door that rotated around a central axis. The butterfly valves permitted the lock operator to open and close the valves more easily under pressure. By rotating around a central axis, the force of the water helped open one side of the valve, making the operator's task less physically demanding, and reducing wear on the valve mechanism.

By the turn of the century, valves opened and closed by a two-handled crank geared to an arm attached to the valve or its axis. Lock designers utilized both horizontally- and vertically-mounted valves. Horizontally-mounted ones predominated. Triangular supports on the valve connected to an arm that moved up and down. The better mechanical advantage of the triangular supports permitted the operators to open and close the valves under great pressure, even with moderate amounts of debris. Vertically-mounted valves also operated with hand-cranked gears, but the operator rotated the shaft on which the valves rotated. Pressure and debris could make operation difficult.¹⁸

¹⁷Drawings A-13-9 and 13, circa 1906, showed hand-operated capstans driving a rack and gears for old Lock No. 2 (RG-77, Pittsburgh District Office, Plans of Locks and Dams, Allegheny River, Lock & Dam No. 2, National Archives). Old Lock No. 2 would be built with hydraulic power, however. Drawing A-13-8 showed plans for steel miter gates.

¹⁸Drawings A-13-10 and 11, circa 1906, showed hand-cranked horizontally-mounted butterfly valves seven feet, five and three-eighths inches high, and six feet, six inches wide (RG-77, Pittsburgh District Office, Plans of Locks and Dams, Allegheny River, Lock & Dam No. 2, National Archives). A turbine-powered hydraulic system would eventually operate the gates and valves of old Lock No. 2.

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In the latter half of the nineteenth century, power began to be used to open and close gates and valves. The differential in water levels, or head, created by the dam for slackwater provided potential power. In 1876, a water wheel provided mechanical power to operate machinery at Lock No. 3 on the Monongahela River (Johnson 1979: 156).

By the turn of the century, electricity generated by a water-powered turbine and generator at the site became the power to open ever-larger gates and valves. Locks along the Hudson River and those of the Panama Canal (1904-1914) operated with electric motors opening and closing gates and valves, and also supplying motive power for watercraft in the lock (Bennett 1915: 151-152). However, high water would shut down operations, and often damaged the electrical works, however well protected.

By the second decade of the twentieth century, hydraulically-operated gates and valves began to be used. The water turbine operated a hydraulic pump, which then provided power to double-acting pistons that opened and closed gates and valves. The hydraulic system, originally water, but later oil, could be submerged and, at least in theory, still operate. In reality, high water often brought debris that interfered with the gears and connecting rods. However, the hydraulic system did not suffer from submersion, even if it had to be shut down.

Although the hydraulic system operated gates and valves well, hydraulic technologies of the early twentieth century could not move unpowered tows, or groups of barges, in the locks.¹⁹ Electric motors continued to provide power to capstans to move tows. The use of electricity meant that a separate turbine would be required to generate electricity, which would also be used to illuminate the operations.

By the middle of the twentieth century, hybrid technologies appeared. Electric motors began to power the hydraulic pumps, as electric power became more dependable. Eventually, by the 1980's, the electric motor-driven hydraulic pump, operating a single cylinder, was placed in a single unit, called an actuator. Sealed electric lines ran to the actuator. The use of the self-contained actuator eliminated the need for hydraulic lines and large amounts of oil, about 1,200 gallons. The self-contained units provided additional protection against oil spills in a more

¹⁹Today, hydraulically-powered motors, a sort of turbine, can provide efficient rotary power. Such motors were not developed until the 1940's.

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environmentally-conscious social climate. Valves were operated by sealed, geared electric motors.

Valves became located in lock walls. The valves of the Pennsylvania Canal locks worked in the gates, as noted above. The gate-mounted valves suffered from two primary problems. One, the rapid inrushing water could swamp a boat (see Shank 1981: 78). Second, the placement of the valves within the gates provided a weak structural area. However, the simplicity of the valves within the gates meant that no additional conduits would need to be constructed. In addition, the small size of the earlier locks required less water to be passed through the valves.

The use of slackwater permitted other options to the placement of the valves. By the late nineteenth century, the valves began to be placed in the river walls. The valves were located in short conduits that ran from the river through the wall into the lock. Valves upstream of the dam would fill the lock, and valves downstream would empty it. With mechanization of the valves, more could be used. Valves multiplied from four in the hand-operated days, to 16 with electric or hydraulic power. These valves could also swamp a boat, because water rushed in quickly from one side only.

By the early twentieth century, culverts located within the lock walls, both river and land, began to be used. The culverts ran the length of the lock, with intakes ahead of the upstream gates and outlets below the downstream gates. Outlets into the lock provided the means to adjust the water level of the lock. In each culvert, two large valves controlled the water level. Opening the upper valve filled the lock. Opening the lower valve emptied the lock. The lower valve would be closed when filling, and the upper one closed when emptying. Because the culverts existed in both the land and river walls, water entered the lock more evenly, causing less turbulence on filling.

Culverts also permitted the addition of a second lock along side, on the river wall, of the first lock. When the valves were located in the river walls, the two locks would have to be filled and emptied together. However, the innovation of culverts made each lock independent of the other. In general, culverts were used when a second lock would be built, or anticipated to be built. On the Panama Canal, culverts 18 feet in diameter carried the water to fill and empty the 110-foot-wide, 1000-foot long double locks (Bennett 1915: 118, 151). The two oldest locks on the Allegheny River, Nos. 4 and 5 (1920-1927), have their valves in the river wall. The later

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locks, Nos. 2 and 3, and 6-9 (1928-1938), all have culverts, and had gate pockets for a second lock built into the river walls. They had been built with the potential to add a second lock, as occurred on the Monongahela River system.

The use of water power to operate gate and valve machinery required a building to house the equipment. Locks on the Pennsylvania Canal generally had a lockkeeper's house nearby. If no house stood nearby, a small shelter provided protection from elements. However, when machinery began to be used, housing for it became necessary. By the time of the turbine-powered hydraulic systems, the equipment housing became elaborate. The two-story reinforced-concrete powerhouses of the Allegheny system (1920-1938) provided a substantial and solid base for the turbines, transmissions, hydraulic pumps, electric generators, and other equipment. The powerhouses, also called operations buildings, included an office and sanitary facilities for the lock operators.

The powerhouses contained the equipment for the operation of the lock. In the older locks on the Allegheny River, Nos. 4 and 5, the hydraulic pump and electric generator were both located on the second floor, out of reach of all but the most severe flooding. However, Nos. 2 and 3, and 6-9 all contained duplicate turbines and hydraulic pumps, and the pumps were located on the first floor. However, the electric generator remained on the second floor, leaving the more water-sensitive electrical equipment in a less flood-prone location. The vertically-mounted turbines operated in wells beneath the powerhouse.

The technology utilized on the locks and dams of the Allegheny River developed over the previous century. As barges became larger, larger locks were needed. At each point, the innovations included small steps, rather than a single, all-encompassing change. The enormous cost of construction of slackwater locks and dams made most engineers fairly conservative, drawing on technologies and construction techniques that had been demonstrated to be viable in previous works.²⁰ When radical innovations occurred, like Merrill's boxcar gates, they provided an immediate solution to a problem that had yet to be solved. In Merrill's case, when large steel gates were developed, engineers returned to the old style miter gates, still in use today.

²⁰Many drawings found in RG-77 in the National Archives noted the previous example from which a structure or technology had come.

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Summary

The history of navigation improvements on the Allegheny River, then, are intertwined with the geographical, economic, political, and technological history of the region, the state, and the nation as a whole. The Allegheny River Valley experienced a slower rate of growth and development than did the neighboring western Pennsylvania areas along the Ohio and Monongahela Rivers, and that was reflected in the fact that navigation improvements of the type constructed on the other two rivers came late to the Allegheny. The U.S. Army Corps of Engineers began its active involvement in the Allegheny corridor by clearing a channel and constructing wing-dams and dikes in 1879; between 1893 and 1903, the Corps built the historic lock and dam that initiated the Allegheny slackwater navigation system.

The technology developed as larger locks handled larger barges. Timber-crib construction for both river walls and dams gave way to concrete structures. Valves moved from gates to river walls, then into culverts built into the land and river walls. Gates became steel. Power to move heavy steel gates came from the differential in height of water. Water wheels, then turbines moved gate and valve machinery. Large steel gates were moved by electric or hydraulic systems, powered by water turbines. This technology developed in small increments, as engineers built upon previous examples.

On the Allegheny River, by 1938 there were eight permanent locks and dams in place, and traffic could move safely for seventy-two miles between the river's mouth at Pittsburgh and East Brady in northern Armstrong County. The Allegheny River navigation system has remained virtually the same for sixty years, and today it moves recreation boaters and diesel-powered tugboats pushing barges along the same stretches of river that transported the canoes, rafts, flatboats, keelboats, and steamboats of earlier days.

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Historic Resources of the Allegheny River Navigation System consist of locks, dams, operations buildings, and esplanades at eight sites, Lock and Dam Nos. 2-9. Also extant may be gauging stations, locktender's houses, garages, maintenance buildings, parking areas, recreations facilities, and modern hydroelectric plants. Constructed between 1902 and 1938, the historic resources provided a nine-foot navigable channel for 72 miles from the mouth of the Allegheny at Pittsburgh to beyond East Brady. Built as a concerted plan, Lock and Dams Nos. 2-9 largely remain as originally constructed (historic photos H-1 through 24).

Fixed Crest Concrete Dams

All dams exhibit similar construction, concrete keyed to bedrock, or placed on timber or gravel-filled sheet pilings (historic photos H-5, 8, 13, 17, 21, and 22; Figure 1). All dams are straight, built perpendicular to the flow of the water. The dams are massed concrete, with minimal reinforcing. Dam Nos. 2, 4, 8, and 9 rest on bedrock. No. 3 rests on timber piles, while Nos. 5 and 6 sit on gravel-filled timber cribs, in turn set on timber piles. No. 7 rests on cylindrical sheet piling filled with gravel.

The dams that rest on pilings or cribs and pilings required additional mass to secure them to the bottom of the river. Dam No. 3 utilizes a similar downstream slope, approximately 1:1, as Dam No. 2 (which rests on bedrock). However, No. 3 exhibits a relatively long apron, resting on timber piles to provide additional mass to counteract the force of the water.

Dam No. 5 rests on gravel-filled timber cribbing, which is in turn situated on timber piles. However, the downstream slope of the dam is much less, approximately 4:1. This gentler slope provides additional mass to secure the dam. Dam No. 6 exhibits a similar foundation, and, thus, a similar slope.

Dam No. 7, as noted above, rests on cylindrical sheet piling. It has a gentler slope than the dams keyed to bedrock, but steeper than Nos. 5 and 6, at approximately 2:1. Dam No. 7 also has a longer concrete apron, and gravel and rip rap, supported by sheet piling downstream to help secure the structure. Additional rip rap extends further downstream, beyond the rip-rap supported by sheet piling.

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Dam No. 8, keyed to bedrock, exhibits pockets placed regularly across the face of the dam, approximately 100 feet apart. These pockets had been built to receive piers holding moveable gates. Originally, the dam was designed to have moveable gates, which would increase the head by three feet. However, in 1938, an additional three-foot concrete cap was added, making it a fixed crest dam. The additional cap was pinned to the former crest with steel rods. At present, no plans exist to add moveable gates; the lock already has water higher in its chamber than any of the other Allegheny River locks.

Of the dams situated on bedrock, Nos. 2, 4, 8, and 9, the first three use a *keyway*, a trench or channel cut in the bedrock approximately five feet wide and three feet deep, to anchor the dam to the rock. The keyway of Nos. 2 and 4 were cut by workers using standard caissons, wood and steel boxes lowered to the river bed, then pumped full of air to drive out the water. No. 8 utilized poured concrete caissons, which were then filled to become the foundation of the dam. No. 9 used the concrete caissons, but no keyway was excavated. The higher head of the pool of No. 9, 22 feet, required such a mass of concrete that no keyway was required to anchor the dam to the bedrock. Mass alone provided the anchor for No. 9.

Cofferdams provided most of the water-free environment for dam construction. The caissons were used only for keyway excavation and preparation of the bedrock. Otherwise, cofferdams were constructed. The cofferdam for No. 4 consisted of timber cribs filled with gravel, faced on the outside with vertical timber planks and packed on both sides with gravel, silt, and clay, also called box dams. The cofferdam of No. 4, constructed first of the group, utilized timber crib technology that had been standard for the nineteenth and early twentieth centuries.

The other cofferdams for Nos. 2, 3, 5, 6, 7, 8, and 9 consisted of sheet piling driven into the sand of the river's bed. The sheet pilings were long, narrow, flat slabs of steel, with lips on both vertical edges. The lips made the pilings interlock, providing a seal. They were driven into the river bed one at a time. At Nos. 2, 3, and 9, the sheets were formed into large, 40-foot diameter cylinders, which were then filled with gravel. These cylinders, also called circular cells, were placed against one another to form a long chain, encompassing the area to be pumped dry. Often wood planks would be bolted horizontally to the individual slabs to provide additional strength. Developed in the first decade of the twentieth century, sheet pilings required less labor to construct than timber cribs.

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At Nos. 5, 6, 7, and 8, a combination of the two types of technology was used. At these cofferdams, the steel sheet pilings were formed into parallel lines, 20 feet apart. The two parallel lines were held together with steel rods, and filled with sand and gravel. The combination of the steel sheet pilings with the box construction provided a stable cofferdam when the water was relatively shallow.

Generally, construction began on the lock and, across the river, the abutment of the dam (historic photos H-17 and 24). After completion of the lock, dam construction began. The dam was constructed in sections, and within the sections, portions were left with only the foundation. The dam thus exhibited a crenelated-type of surface, so that the river could flow through the crenels (historic photos H-20 and 24). The use of crenels kept the level of the water lower behind the cofferdams. When the dam was completed and the cofferdam removed, the crenels were filled, using small, localized cofferdams. The sequence of construction, with lock first, then the dam, permitted limited commerce to continue during construction.

Locks

The locks consist of river and land walls and steel miter gates. The concrete river and land walls remain nearly identical for Lock Nos. 2-3 and 6-9. Built on bedrock or timber pilings, the steel-armored walls hold the gates and valves. The river walls extend 600 to 800 feet long and are uniformly 25 feet wide. The land walls run from 1200 to 1600 feet long; they are all ten feet wide at the top, stepped in from 20 feet wide at the foundation. Those not built on bedrock rest on timber piles (historic photo H-16). An esplanade, concrete-paved fill, extends from the top of the land wall to the river bank.

The guide and guard walls extend beyond the lock gates up and downstream on both the river and land sides, respectively. The ends of the guide and guard walls are monolithic, but behind the monoliths, the walls sit on relieving arches, molded in concrete (historic photo H-18). Lock No. 9 departs from this pattern with piers, on which sit the guide walls (historic photo H-22). Some of the guard walls have been extended with concrete or with gravel-filled, concrete-capped cylindrical sheet piling. All of these locks were built with the potential to add a second lock, as presently exist on the Monongahela and Ohio Rivers. The gate pockets on the river side of the river walls remain.

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The land and river walls of Lock Nos. 2-3 and 6-9 feature eight-foot-wide and ten-foot-high tunnels or culverts to carry the water that fills and empties the locks. Intakes for the culverts, also eight by ten feet, are situated in the guide walls (historic photo H-15). Inside the lock, eight openings, four feet square, in both the river and land walls, convey water to fill the lock. An additional eight openings in the river and land walls empty the lock. Downstream of the lower lock gate, the water exits through four openings in each wall.

The water in the culverts is regulated by four large horizontally-mounted butterfly valves. Two valves, one in the river wall and one in the land wall, control the flow of water into the lock. The other two valves control the flow out of the lock.

In both the land and river walls of Lock Nos. 2-3 and 6-9, tunnels exist for maintenance and repair operations (Figure 2). The tunnels contain electric and hydraulic lines and some machinery access. Generally dry, the tunnels have a gutter along one side to carry away excess moisture. Pits provide access to other machinery, covered with metal grating or sheets.

The concrete river and land walls of Lock Nos. 4 and 5 exhibit different construction. At these locks, the valves, all located in the river wall, fill and empty the lock directly from the river through circular, four-foot diameter, openings, each controlled by a single vertically-mounted butterfly valve. Eight valves, located upstream of the dam, fill the locks, and eight below the dam empty them.

The intake and discharge through the river walls would make the addition of a second lock unlikely (and costly). These river walls slope at approximately 1:1 to the water, and have no gate pockets on the river side. Pits provide access to the hydraulic valve machinery. No tunnels exist in either the land or river walls of Lock Nos. 4 and 5.

The guide and guard walls of Lock Nos. 4 and 5 rest on stone and gravel-filled timber cribs, rather than concrete arches or piers (historic photo H-10).

The land walls of Old Lock Nos. 2 and 3 remain extant. No other part of the lock, dam, operations buildings, or other facilities presently exist.

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The steel miter gates at Lock Nos. 2-9 exhibit nearly identical features. All are horizontally-framed with diagonal bracing. All are operated by large hydraulic pistons; Lock Nos. 2-3 and 5-9 have large gears and jointed connecting rods pushed from a stationary piston, while the hydraulic piston of Lock No. 4 pivots to follow the gate. All have walkways and sensors to monitor the status of the gate, open or closed. All close against concrete sills. All have ion anodes to inhibit rust. The gates all have bubblers that retard ice formation. The steel miter gates last approximately 25 years before replacement or renovation.

Operations Buildings

The reinforced concrete powerhouses, also called operations buildings, retain many original features. The two-story, flat rubber-roofed buildings house the machinery that operates the locks' gates, valves, and other equipment. Lock Nos. 4-5 have a smaller, 15 by 60-foot Modernistic-style powerhouse, with a rounded upstream end. A simple strip cornice and a narrow overhang above the first story windows provide a horizontal decoration. The powerhouses of Nos. 4-5 originally had fireplaces with mantles; some remain, but unused.

Lock Nos. 2-3 and 6-9 have a larger, 25 by 65-foot Beaux Arts-style structure, all of which originally sported faux-quoins at the corners (Figure 3). A complex cornice with a pediment on the ends provided a modest classical statement for the powerhouses of Nos. 2-3 and 6-9. All powerhouses have been targeted (circa 1987-91), and some windows replaced. All powerhouses also have an office for lock personnel.

The powerhouses of Lock Nos. 2-3 and 6-9 contain machinery that operates the gates, valves, and other equipment. Originally all of these powerhouses had three water-powered turbines. Three separate intakes and penstocks, the latter six-foot-diameter concrete pipes, lead to the forebays and turbines (historic photo H-23). The vertically-mounted turbines are 26 to 27.5 inches in diameter. Shutters control the flow of water through the turbine, and thus its speed.

Two of the three turbines operate hydraulic pumps, which in turn operate the pistons (cylinders) that open and close the gates and valves. The two sets of turbines and hydraulic pumps provide redundancy in the event of equipment failure, maintenance and repair, or high water. A third hydraulic pump was originally powered by steam from a boiler, now by an air

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compressor. The turbines attached to the hydraulic pumps also powered an air compressor and a water pump for general maintenance.

Each of the two turbines drives its own hydraulic pump through a transmission. The turbine runs at 61 revolutions per minute (rpm), and the transmission increases this to 200 rpm for the hydraulic pump. Even though each turbine has its own transmission and hydraulic pump, they can be connected together, with one turbine running the other's transmission and pump. In the event of high water, which could reduce the head (and reduce the amount of power available), both turbines can be hooked together to power one pump.

The hydraulic system operates at approximately 250 pounds per square inch (psi). The operator opens the shutters that lead from the penstock to the forebay. The shutters are adjusted so that the turbine runs the hydraulic pump to create 250 psi. Once the proper pressure has been reached, the hydraulic pump and turbine cannot overcome the pressure, and they cease moving. When hydraulic pressure is used to open gates and valves, the pressure drops, and the turbine and its pump begin to operate again. The relatively low speed of the machinery gives it an audible low rumble, unlike the generally high-pitched whine of modern machinery.

The use of hydraulic systems to operate the gates and valves provides a mechanism that does not suffer from being submerged. The hydraulic lines are one to two-inch steel pipe. Two sets of lines run under the lock at different sites to the river wall hydraulic cylinders (Figure 4). Because the hydraulic system both pushes the cylinders open, then pushes them closed, the oil does not circulate, but moves back and forth in the same area. The system uses about 1,200 gallons of oil, about which 175 are in reserve.

Oil pressure relief valves, also called automatic bypasses, exist at Lock Nos. 3 and 5-9. These valves consist of a piston attached to weights. As the oil pressure rises, the piston pushes the weights up, and eventually, the excess oil flows out of the pressure system and into the reserve tank. The weights, usually four in number, bolted together in halves, provide the means to keep the oil pressure in the system at 250 psi. Of the two that do not have the weighted valves, No. 2 has a modern valve, while No. 4, without a hydraulic system, does not need such a valve.

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The third turbine powered an electric generator that operated the capstans, used for moving tows (barges) that had to be separated from their towboat because of their length. A rope, approximately 1.5 inches in diameter, running from the capstan would be secured to the barge. Then the direct-current (DC) motor would be engaged, and the capstan would wind in the rope, pulling the barge forward. The operators unwind the rope at the same time, so that only three or four loops actually remain on the capstan at any one time. This sequence of simultaneous winding and unwinding prevents the accumulation of rope on the capstan. The barge is pulled with enough velocity, that as the bow of the barge passes the capstan, the rope can be removed from the barge, and the DC motor turned off. The barge then continues out of the lock chamber, to be secured along the guide wall. The gates are then closed and the water returned to the level of the rest of the tow.

The use of the lock's propulsion to move tows through permits more rapid movement of towboats and their barges. Uncoupling and recoupling a tow is a time-consuming operation. If the towboats were required to move the separated tows through the lock, the time would double. Presently, the time required to lock through a double tow (that must be separated) is approximately an hour. Because the locks fill or empty within about seven minutes, most of the time required becomes the procedure for coupling and uncoupling the tows. Without the lock's propulsion system, the time required for a double tow could be two hours.

Heavy cables, ropes, or chains secure the tows to one another, and to the towboat. These fasteners are heavy and thus difficult to handle. Cable or chain tighteners must be winched tight. A single standard coal barge, approximately 175 feet long and 26 feet wide, can contain a maximum of 1,500 tons of coal. Two would be coupled together, and locked through, making a maximum of 3,000 tons. The considerable weight of two tows requires that the cables, ropes, and chains be well-secured. The considerable weight also means that failure of a fastener, or a mistake by the towboats's workers, could result in a serious accident. As a result, the workers and lock operators take great care locking through a double (or triple) tow.

Originally, the electric generator also operated the lights. Only Lock No. 2 retains its generator and third turbine. No. 3 retains its capstans, but they operate with electricity from the local power company. No. 4 also retains its capstans, but they utilize an electric-powered rail-guided *mule*, a small, cable-driven wheeled vehicle with mooring pins, to lock through double

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tows. Lock Nos. 5-7 have the same rail tow haulage system. Lock No. 8 utilizes an air-compressor-driven winch.

All locks retain an electric-motor-powered cable winch, circa 1980, which had been intended to replace the capstans. However, the operation of the winch and the stiffness of the cable resulted in a system that proved both cumbersome and dangerous to use. As a result, lock operators returned to the capstan system. Eventually, the rail-guided mule provided the propulsion to move tows that must be disconnected from their towboat because of their length.

Lock Nos. 4-7 also have a free-moving rail-guided mule on the upper land lock wall. This mule provides stability to the disconnected tows as they are being moved out of the lock by the powered mule. The free-wheeling mule prevents the bow of the tows from being pulled by the river's current toward the dam. As the bow of the disconnected tow emerges from the lock into the pool upstream of the dam, high water can result in strong currents that catch the bow, and begin to sweep the tow into the river toward the dam. The free-wheeling mule stabilizes the bow of the tow, preventing a potentially dangerous situation.

Lock Nos. 4-5 originally featured two water-powered turbines. One turbine operated a single hydraulic pump, while the other supplied power for the electric generator. At No. 5, the second turbine that powered the generator has been removed. However, at No. 4, all turbines have been removed, and the powerhouse now holds vast electrical switching equipment. Each gate at Lock No. 4 has an electrically-operated hydraulic piston (cylinder), while the valves operate with electric motors and sets of gears.

Electricity for lights and other equipment at Lock Nos. 2-9 is presently supplied by the local power company. Each lock now has a back-up diesel-powered electric generator. All locks have an electric-powered air compressor. The compressor is a recently-added unit, circa 1970. All locks originally had a diesel or gasoline-powered back-up generator. The original units have all been replaced; most of the existing ones date to about 1980.

Repairs to the concrete decks of the land and river walls have occurred. The walls of the locks remain as built, except for Lock No. 4. At No. 4, the outer layer of concrete was blasted

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and chiseled away, and prefabricated concrete plates were bolted and glued to the old concrete. The rest of the locks retain their old concrete, some with fairly significant spalling.

EXISTING ORIGINAL EQUIPMENT OF ALLEGHENY RIVER LOCKS

Lock	Turbine-powered Hydraulic System	Turbine-powered Electric Generator	Turbine-powered Air Compressor	Turbine-powered Water Pump	Capstans	Air-operated Hydraulic Pump	Oil Pressure Relief Valve
Lock 2	yes	yes	no	yes	yes	yes	no
Lock 3	yes	no	no	no	yes	yes	yes
Lock 4	no	no	no	no	yes	no	no
Lock 5	yes	no	no	no	no	yes	yes
Lock 6	yes	no	no	yes	no	yes	yes
Lock 7	yes	no	yes	yes	no	yes	yes
Lock 8	yes	no	yes	yes	no	yes	yes
Lock 9	yes	no	yes	yes	no	yes	yes

Esplanade

The esplanade is concrete-paved fill between the land wall and the river bank. The esplanade covers the penstocks that carry water to the turbines. The esplanade serves as a work and parking area for the lock operators. All esplanades have a landing area for helicopters in case of emergency. Most esplanades have been repaired to fix spalling, buckling, or cracking of the large concrete squares that form the pavement.

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Gauging Stations

Lock Nos. 2, 3, 7, and 9 feature gauging stations situated at the extreme upstream end of the land (guide) wall. The stations are housed in a small concrete-and-steel structure built into the terminus of the land wall. These stations permit the accurate daily measure of the river's height and flow. All four stations were constructed at the time of the lock wall at which they sit.

Locktender's Houses

Locktender's Houses remain on the site of Lock Nos. 4 and 6 under Corps ownership. Locktender's Houses remain off-site at Lock Nos. 2, 3, 8, and 9, and are privately owned. The houses at Lock No. 5 have been demolished, and no Locktender's Houses were built at No. 7, due to its proximity to the town of Kittanning. The styles of the houses vary from the Prairie-influenced foursquares of No. 2, to the Colonial Revival of No. 3, to the more vernacular styles of the remainder. The Locktender's Houses are presently the subject of a separate study.

Garages, Maintenance Buildings, and Parking Areas

Lock Nos. 2, 3, 4, 5, and 6 have modern concrete buildings utilized as garages and maintenance buildings (also called workshops). These buildings range from 24 x 24 feet to 80 x 40 feet. Parking areas exist adjacent to all locks. Some parking areas are situated on the esplanade, others near to the maintenance buildings.

Recreation Facilities

Recreation facilities exist adjacent to Lock Nos. 2 and 6. At Lock No. 2, the facility includes the land wall of Old Lock No. 2. There, a fishing and picnic area, along with a parking area have been provided for the public. At Lock No. 6, a picnic table stands adjacent to a small public parking area.

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Hydroelectric Plants

At Lock and Dam Nos. 5-6 and 8-9, modern hydroelectric facilities stand. These facilities were constructed at the opposite end of the dams from the locks. Constructed in the period 1988-1990, these facilities are owned and operated by private interests.

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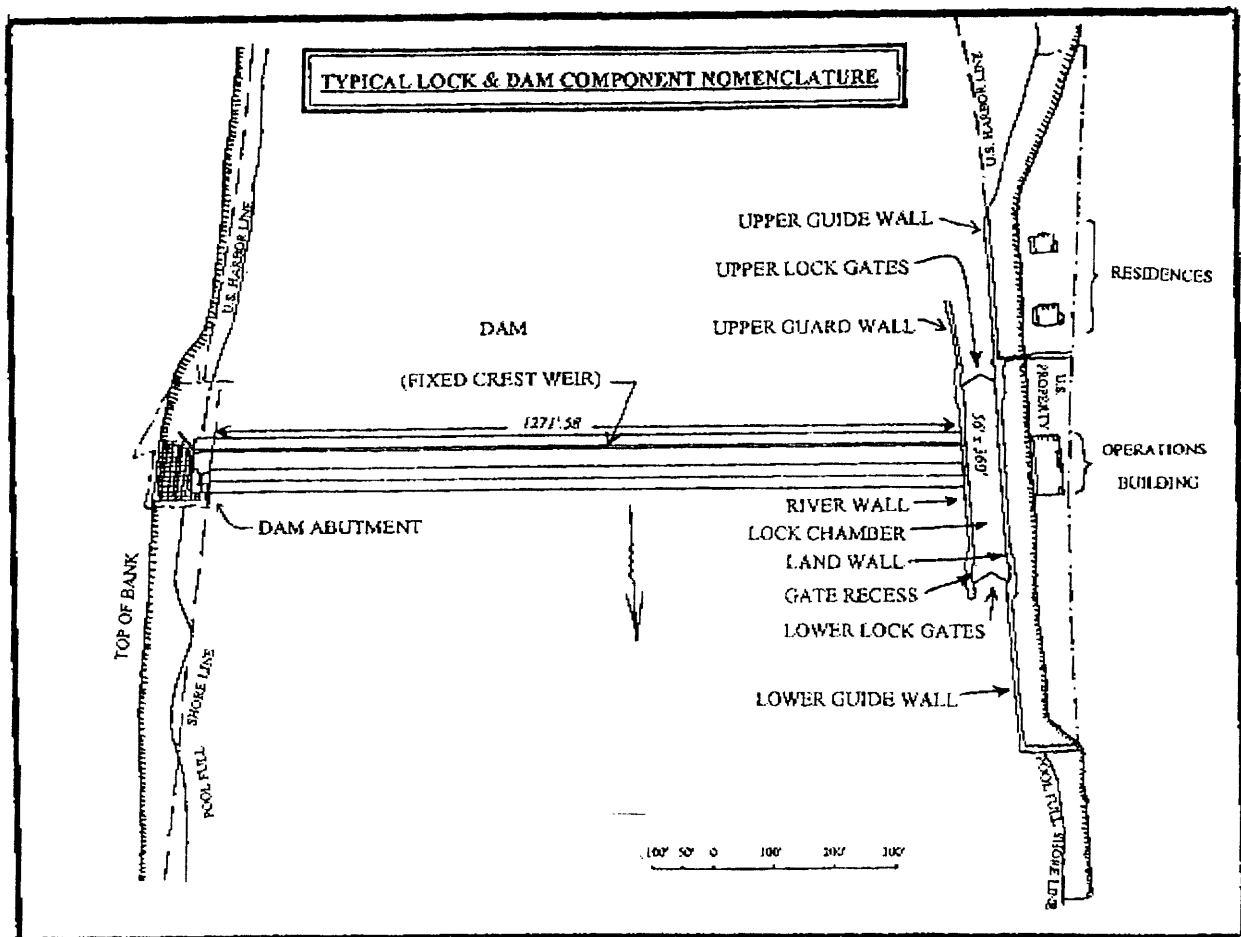
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FIGURE 1



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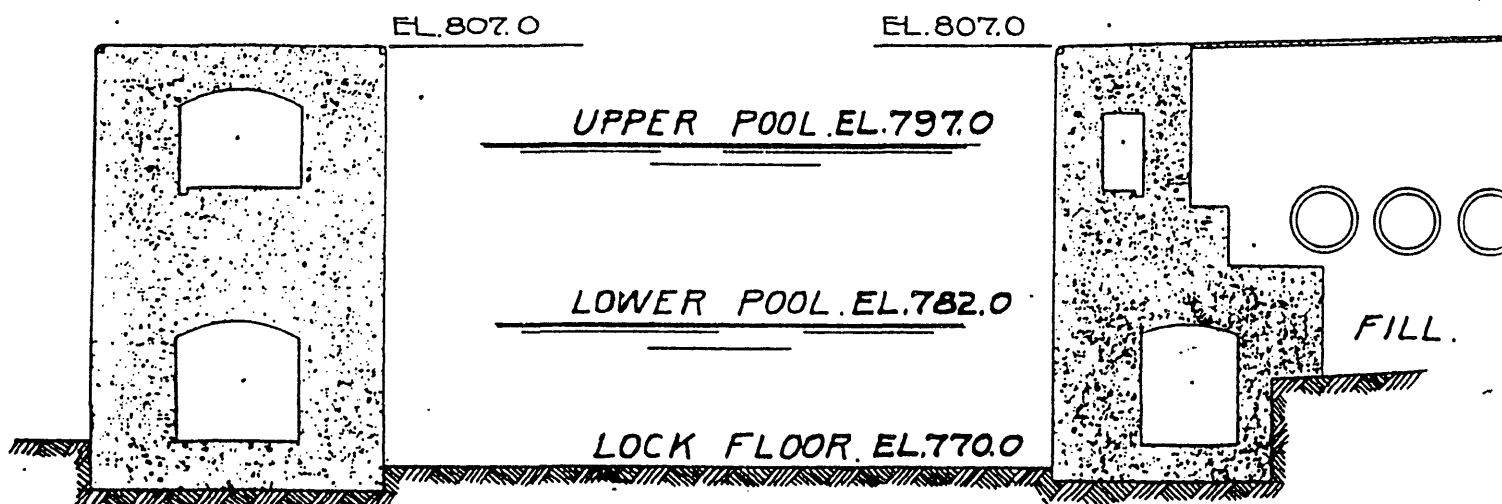
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FIGURE 2



TYPICAL SECTION LAND AND RIVER WALLS.
SCALE 1"=16' 1

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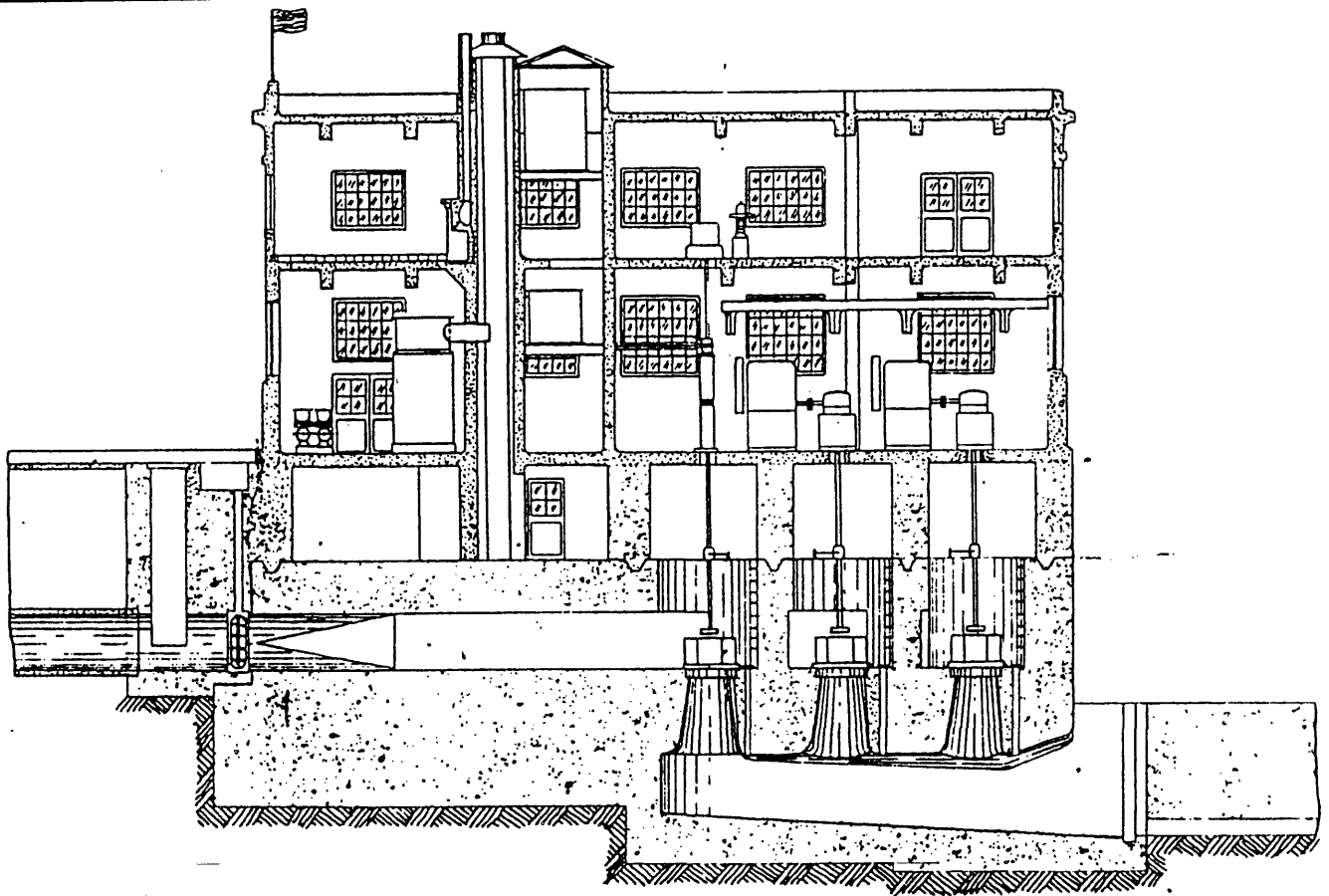
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FIGURE 3



**SECTION THROUGH ϕ OF POWERHOUSE
SCALE 1"=16'**

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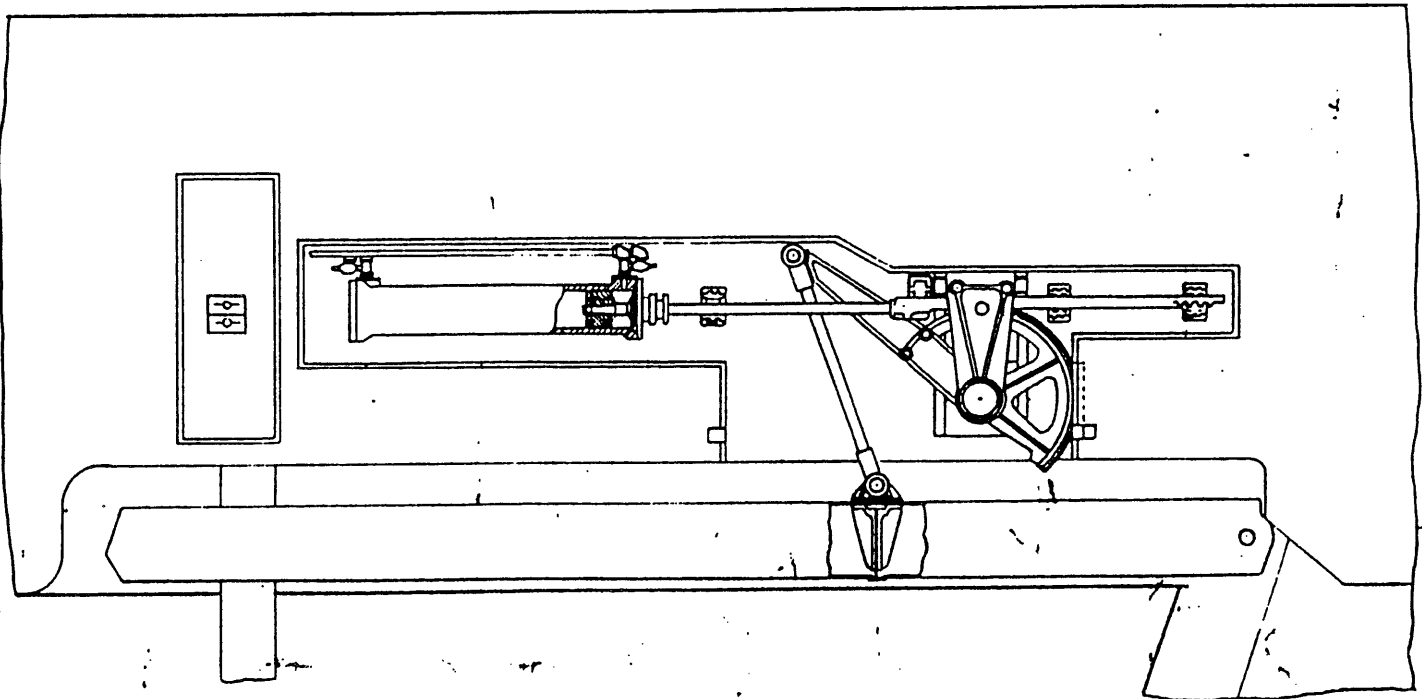
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FIGURE 4



**GATE OPERATING MACHINERY.
SCALE 3/16" = 1'-0"**

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Historic Resources of the Allegheny River Navigation System, 1739-1948

The historic resources of the Allegheny River Navigation System, 1739-1948, as defined under the property types of locks, dams, operations buildings, esplanades, gauging stations, and locktender's houses, should be considered to be eligible for the National Register of Historic Places under Criterion A, for their contribution to the long-term maritime and transportation history. The extant resources, Lock and Dam Nos. 2-9 (Lock and Dam No. 1, Herrs Island Lock and Dam, was removed in 1938), illustrate the turn-of-the-century response to the continuing importance of the river as a transportation corridor. The historic resources are also significant under Criterion C as representative examples of early-twentieth-century slackwater engineering and construction. The extant resources represent the practical use of building materials and mechanical equipment available during their period of construction.

Historical Significance

The Allegheny River corridor became important early in its recorded history. The French saw it as a means of linking their disparate North American colonies, stretched between the Mississippi and St. Lawrence Rivers. The English perceived the Allegheny, Monongahela, and Ohio Rivers as the natural sequence of their trans-Appalachian colonies.

As European settlement proceeded, the Allegheny River corridor became a major conduit of timber, both logs and finished products. The vast forests of the Allegheny plateau provided lumber for most of the nineteenth century to the growing towns and industries in the Ohio Valley. Other products also moved along the river, including ores, sand, aggregate, and coal.

The nineteenth-century development of the Pittsburgh area as the predominant industrial center in North America continued the use of the Allegheny River corridor. Although timber resources eventually became depleted, the industrial development continued to spread along the corridor, prompting increasing action by the Corps of Engineers. Beginning with snag and boulder clearing in 1879, with the subsequent construction of wing dams, the Corps began to improve the corridor for more extensive navigation.

Improvements to navigation continued, in the form of locks and dams to create a deep channel for barge and towboat traffic. Beginning with Herr's Island Lock and Dam, slackwater navigation ran 17 miles to Natrona by 1908. However, considerable additional locks and dams

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had been already been offered. Proposed by Major Charles F. Powell in 1898, the additional locks and dams on the Allegheny River were conceived as a unit to provide a navigable channel to Bradys Bend, 70 miles from the mouth of the Allegheny River at Pittsburgh. Their construction, from 1920 through 1938, continued and increased the use of the river as a maritime and transportation corridor. Following the reconstruction of the Emsworth Lock and Dam on the Ohio River, the pool was raised, eliminating the need for Lock and Dam No. 1, the Herr's Island Lock and Dam, and it was removed. Subsequently, Lock and Dam Nos. 2 and 3 were replaced, leaving the system as it remains today.

The construction of the locks and dams on the Allegheny River permitted steel, glass, concrete, brick, and petroleum industries to operate along the Allegheny, and move their products to Pittsburgh, Cincinnati, and New Orleans. Coal from the Monongahela and Ohio Rivers could be brought by barge to the industries located along the Allegheny. Industries along the Allegheny River developed or expanded in New Kensington, Natrona, Freeport, Ford City, Kittanning, Templeton, and East Brady. The populations of these towns grew accordingly, as workers moved into new housing developments near to the industries. Lock and Dam Nos. 2-9 provided inexpensive transportation of bulk commodities to the Allegheny River corridor, previously unavailable because of the naturally shallow channel. The Locks and Dams opened the lower Allegheny River to commerce that included the port of New Orleans.

Historic resources under Criterion A aided or contributed to the use of the Allegheny River as a transportation corridor in the period 1739-1948.

Engineering and Architectural Significance

The historic resources of the Allegheny River Navigation System are also significant under Criterion C, as representative examples of navigation engineering and construction. The resources embody the attributes that demonstrate the utilization of knowledge and materials of the period of construction. The resources of the Allegheny River Navigation System represent a unique period in lock and dam construction, a use of a water-turbine powered hydraulic system. Thus, the historic resources contain evidence of their contribution to the body of navigation engineering and construction within the Allegheny River corridor.

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The continued repair and rebuilding of functioning navigational structures also remains a defining aspect of the engineering and construction. As older structures and machinery wears or becomes unable to meet present needs, the continued upgrading and repair demonstrates adaptation to changing technologies, materials, and environmental awareness. The resource must be evaluated as a unit relating to slackwater navigation in the Allegheny River corridor.

Period of Significance

The period of significance, 1739-1948, encompasses major phases of transportation history in the Allegheny River corridor more than 50 years old. From the first recorded use of the Allegheny River as a transportation corridor in 1739, continuing through the function of the corridor 50 years ago, reflects the development of transportation use and structures, buildings, and landscapes in navigation history as defined in this nomination.

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The nominated resources must be located within the Allegheny River corridor, including the river and its immediate environs. They must be associated with aiding and developing transportation on the river or in its immediate environs during the period 1739-1948. Resources should include characteristics described in Section F-2 herein.

In assessing the significance of the resources within the defined property types, Criteria A and C are interdependent. Use to aid or develop navigation within the Allegheny River corridor both includes transportation history in addition to engineering and construction.

Criterion A

Area of Significance: Maritime and Navigation History

To be eligible for registration under Criterion A, a property must have contributed to the navigational development and use of the Allegheny River corridor. The property must retain the characteristics of that development and use, specifically providing aid to further navigation on the Allegheny River.

Criterion C

Area of Significance: Engineering and Construction

To be eligible for nomination under Criterion C, the property must include a structure that represents the distinctive characteristics of a type, period, or method of engineering and construction relating to the historic context "Allegheny River Navigation System, 1739-1948." In particular, properties must represent the characteristics of engineering and construction methods and techniques applied to the knowledge and materials of the period of construction. A property must exhibit characteristics of engineering and construction that illustrate its place in the development of the Allegheny River as a transportation corridor.

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Integrity

- Location: The significant structures, buildings, and landscape features of the property must retain historic location.
- Design: The design of the structures, buildings, and surrounding area should exhibit an organization pattern characteristic of the use of the property as an aid to the development of the Allegheny River as a transportation corridor.
- Setting: The physical environment surrounding a property provides a unique setting. Because the Allegheny River developed as a transportation corridor, industrial, commercial, and residential development may or may not be present.
- Materials: A property must exhibit integrity of materials in the construction of the structures and buildings. Cases of alteration or reconstruction should be evaluated as to the impact on the ability to identify the original materials used. When evaluating locks and dams, the ongoing function of the structure and buildings as aids to river navigation should be considered when assessing integrity of materials.
- Workmanship: Integrity of workmanship should be evident on a property. It should illustrate the soundness and durability of construction methods and materials, as well as aesthetic qualities that typify the heritage of the builder.
- Feeling: Integrity of feeling gives a property its own sense of time and place. Each property should evoke its own feeling of its connection with the past as well as its place in the overall history of the Allegheny River corridor.
- Association: A property should have integrity of association, the relationship between the place and its function within the transportation history of the Allegheny River corridor.

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