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Contextual Essays on the Monongahela River Navigation System



*LOCKS AND DAMS 2, 3 AND 4
MONONGAHELA RIVER PROJECT*

Contextual Essays on the Monongahela River Navigation System

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FOREWORD

In the first River Act of May 24, 1824, Congress authorized the President and “any of the engineers in the public service which he may deem proper” to improve navigation on the Ohio River. Subsequent legislation led to the Nation’s present 12,000-mile inland navigation system, including 238 lock chambers at 192 navigation facilities maintained by the U.S. Army Corps of Engineers. Of these, the Corps Pittsburgh District operates and maintains 23 navigation locks and dams on the rivers comprising the headwaters of the Ohio River basin.

The majority of the Pittsburgh District navigation projects were constructed over 50 years ago. One project is 105 years old - Monongahela River Locks and Dam 3. In its time, this structure replaced the original 1844 Lock and Dam 3, and is itself scheduled to be decommissioned as the ongoing Locks and Dams 2, 3 and 4, Monongahela River Project nears completion. During the planning process for this “Lower Mon Project,” the Pittsburgh District entered into a Programmatic Agreement with the Advisory Council on Historic Preservation and the Pennsylvania State Historic Preservation Officer for compliance with Section 106 of the of the National Historic Preservation Act of 1966.

One of the Agreement’s stipulations says “In order to provide a historic context for the evaluation of historic properties identified within the project area and to develop a management tool for the development of treatments plans for these historic properties, the Pittsburgh District shall prepare a thematic nomination to the National Register of Historic Places for the locks and dams along the Monongahela River, based upon the surveys conducted pursuant to this Agreement.” The basis for nominating federal properties to the National Register is provided in Section 110(a)(2) of the National Historic Preservation Act, which directs federal agencies to “establish a program to locate, inventory, and nominate to the Secretary [of the Interior] all properties under the agency’s ownership or control by the agency, that appear to qualify for inclusion on the National Register....”

The following **Contextual Essays on the Monongahela River Navigation System** represents part of the District’s effort to provide the historic context for the National Register nomination. It is recognized that this study barely scratches the surface in analyzing the significant contributions of this waterway transportation system. Its interrelationship with the industries of the Pittsburgh region and their influence in the Nation’s development, as well as their influence on world history through two World Wars, leaves much fertile ground for further research by others.

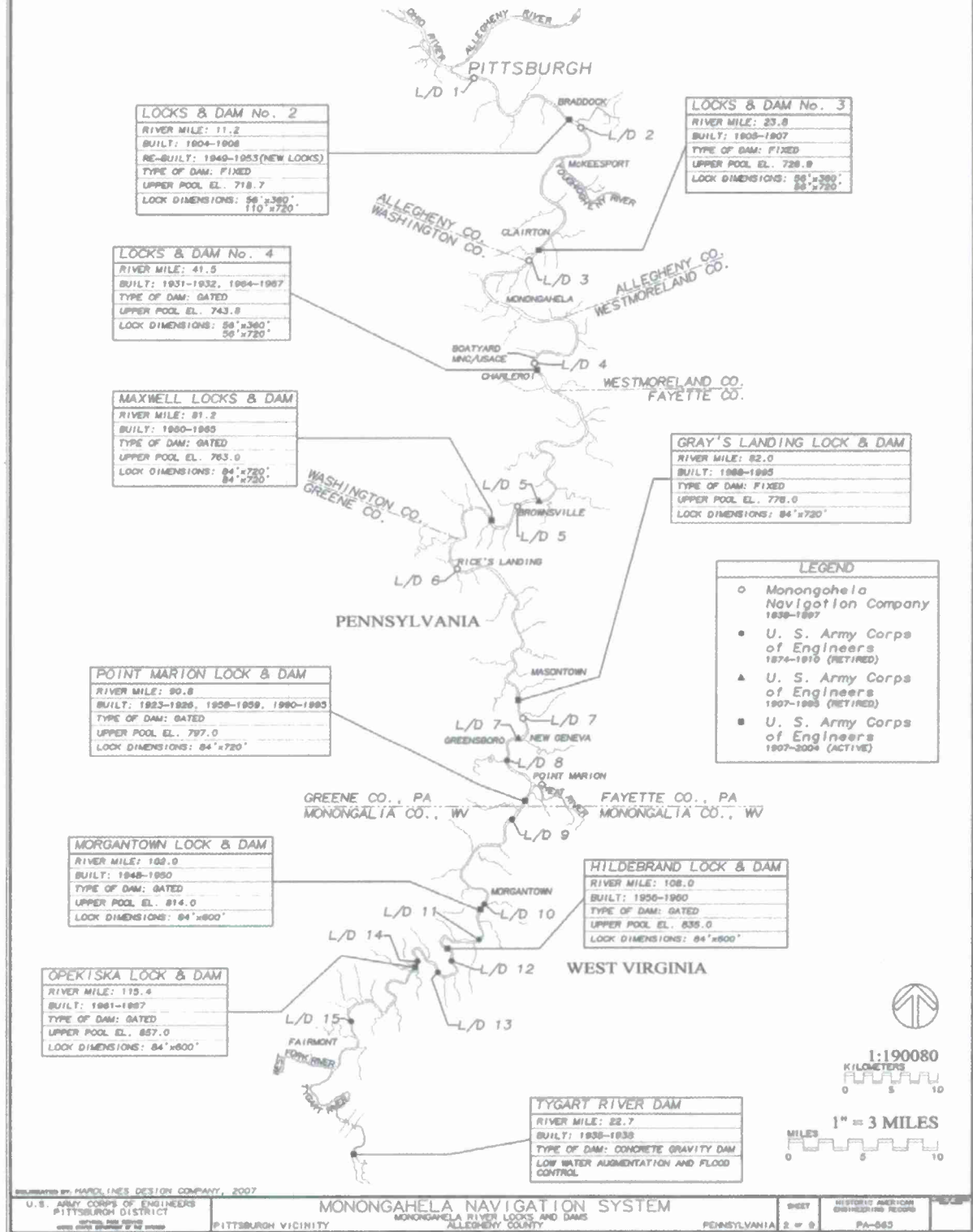
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SYSTEM MAP, 1840-2004



Monongahela River Navigation System



CONTEXTUAL ESSAYS ON THE MONONGAHELA RIVER NAVIGATION SYSTEM

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INTRODUCTION

During the past two decades and under the auspices of the U.S. Army Corps of Engineers and the National Park Service, researchers have thoroughly documented the legislative, construction, and engineering history of the Monongahela River navigation system, as well as the general history of Monongahela Valley industrial development. There seems to be basic agreement on the general history of the region and the development of the river improvements. Any study of value, however, certainly generates new questions and suggests additional research possibilities.

There are several underlying themes and assumptions that seem to be part of every study of the Monongahela River and its navigation system made to date, and this particular research effort was commissioned by the Pittsburgh District of the U.S. Army Corps of Engineers specifically to answer several of those major questions. The resulting information is particularly timely and is relevant to ongoing efforts by the Corps to place some of the navigation structures on the National Register of Historic Places.

There is no argument over the fact that the Monongahela River has played an extremely important role in the development of western Pennsylvania and northern West Virginia, as well as that of the region and the nation as a whole. It carried hundreds of thousands of people to new homes on the frontier, millions of tons of agricultural products and extractive resources to markets and factories throughout the world, and steel, glass, ships, and other goods from western Pennsylvania manufacturers on to the Ohio and Mississippi Rivers and to faraway ports.

The real questions arise, however, when one considers the impact of the locks and dams constructed as part of the Monongahela River navigation system, first by the Monongahela Navigation Company in the 1840s and continued by the Army Corps of Engineers from the end of the nineteenth century to the present. We know who built the "improvements" on the river, how much they cost, how big they were (and are), when they were constructed, and what kinds of machinery was installed.

What we have not really known is what impact this navigation system has had over the years on the people, the communities, and the industries that have used the Monongahela River so heavily and what role it has played, if any, in directing the course of historical events. The three historians who were chosen to contribute essays to this study were charged with investigating the role the Monongahela River navigation system—as it was constituted after 1840—played in four major areas: westward migration in the United States, town building and development, regional coal, coke, iron, and steel industries, and the regional boat-building industry.

The authors of most of the previous studies of the Monongahela River system made the general assumption that the locks and dams constructed on the river by the Monongahela Navigation Company and the Corps of Engineers naturally played a direct role in stimulating

and determining the course of historical movements and the events of everyday life. Many of these authors assumed a direct correlation between the river in its improved state and westward migration routes, the location and development of riverside communities, and the development and success of regional industries.

The historians who conducted this particular research study of the Monongahela River navigation system were not expected to produce another physical documentation of the locks and dams but to take the next step and investigate the actual role the Monongahela River navigation system played after 1840 in the four areas enumerated above. The authors' conclusions, as revealed in their essays on those topics, can be summarized briefly.

Because of its size and topography, the United States was tied to its rivers from the very beginning. Development proceeded from the coasts up the major rivers to the fall lines and, subsequently, along all navigable rivers and streams. Land transportation was difficult, expensive, and slow, and a nation that depended upon the sale of agricultural crops that were ultimately perishable had to get its products to market as expeditiously as possible. As a result, inland areas all depended upon river commerce.

The Monongahela River has its source in the mountains of West Virginia, at the junction of the Tygart and West Fork Rivers south of Fairmont, and flows north into Pennsylvania for 128.7 miles to Pittsburgh, where it joins the Allegheny River to form the Ohio. From its headwaters, the Monongahela winds its way downhill through rugged terrain and a well-defined valley, draining part of what is known as the Allegheny Plateau until it reaches its mouth at Pittsburgh.

The Monongahela is about one-third the length of the Allegheny and was long considered by some to be merely a tributary of a combined Ohio-Allegheny River. The Monongahela, however, has ultimately carried much more traffic through the region as it has tapped the resources of Virginia/West Virginia and southwestern Pennsylvania. The traffic and commercial tonnage carried on western Pennsylvania rivers was, from the beginning, heaviest on the Ohio and Monongahela, and the pressure for organized river improvements was felt much earlier along those more-heavily used rivers, particularly the Monongahela.

It is difficult to overemphasize the importance of the Monongahela River on the flow of emigration to the successive American frontiers between the 1780s and 1830. Between the Revolutionary War and the end of the eighteenth century, Americans headed west from the Atlantic coastal areas in increasingly large numbers, and the Monongahela River was one of the primary routes for emigrants heading west to the Ohio River and the Ohio country beyond the Alleghenies.

In her essay, Dr. Judith Heberling discusses the development of various transportation improvements in the United States during the early-to-mid-nineteenth century. She examines the philosophy behind federal, state, and private funding and how it was applied to the roads, canals, navigation systems, and railroads of the period, including the Monongahela River navigation system. Heberling also describes several of the most important transportation systems of the period and compares and contrasts them to the Monongahela.

The peak of emigration through the Monongahela area had passed long before the Monongahela Navigation Company opened the first of its new locks and dams to navigation in the 1840s. All-water routes, such as the Erie Canal after 1825, offered easier passage to New England emigrants and to European immigrants heading west from the port of New York. From her research considering the impact the Monongahela River navigation system might have had on westward migration after 1840, Dr. Heberling concludes that it primarily influenced local travel patterns.

The locks and dams on the Monongahela were among the first—if not the first—in the country to be designed to carry steamboat traffic, and passengers flocked to the steamboats in the 1830s and 1840s (and to the excursion vessels at the end of the nineteenth century). Steamboats made it possible to travel easily both down and *up* the river for the first time, and people could finally travel in relative comfort and according to published schedules. This meant that they could go to Pittsburgh, Cincinnati, or Morgantown, or any other town along the Monongahela or Ohio River on business or pleasure and return home easily. The navigation system improvements made travel much more dependable.

Dr. John Kudlik investigates the dynamics of the steamboat-building industry that was centered in Monongahela River towns, such as Brownsville, Elizabeth, Belle Vernon, and McKeesport. Although boat-building was an established activity in this area long before the Monongahela Navigation Company began construction in 1838, Kudlik believes that the industry was “one of the leading beneficiaries of the slackwater system and was marked by a well-defined evolution that corresponded with river improvement.” The Monongahela River navigation system was probably the first in the country to have been developed and designed to facilitate steamboat passage on the river.

As boats became larger, heavier, and more elaborate, the Monongahela River builders, working as they did along a very shallow body of water, more and more frequently specialized in hull construction. They then floated the hulls downriver to Pittsburgh where the machinery and superstructures were added. The boat-building industry peaked during the decade preceding the Civil War but was confined largely to communities along the lower stretches of the river since slackwater had not yet been extended to the upper Monongahela River Valley. This increased boat-building activity also coincided with the Monongahela Navigation Company's construction of its first six sets of locks and dams on the river, with No. 6 being located at Rice's Landing, nearly seventy miles from the mouth of the Monongahela at Pittsburgh.

Kudlik also discusses the development of the towboating and barge industry on the Monongahela River at the end of the nineteenth and beginning of the twentieth centuries. Increased barge activity was directly related to the improvement of the river, and both facilitated the regular shipping of huge amounts of coal and other extractive products. Demands for coal iron, steel, sand, and glass largely produced the extraordinarily heavy commercial traffic that has plied the Monongahela River for the past century or more. It is hard to overestimate the importance of this particular river and of its navigational improvement system to the industrialization and prosperity of the United States since the Civil War.

In its *improved* state the river's overall importance was not as a mover of people. The true significance of the Monongahela has been, since the early nineteenth century, as a commercial highway, carrying coal and other extractive and agricultural products between Pittsburgh and Fairmont, West Virginia. For at least 150 years, the Monongahela has been among the world's most heavily used waterways and has carried more tonnage than nearly any other system.

Dr. Ronald Carlisle thoroughly examines the relationship between the Monongahela River slackwater system and the rise of the coal, coke, iron, and steel industries in the Monongahela River Valley. At its most basic level, geology—the presence of an extensive area of bituminous coal—made the industrial growth that took place in this area possible. Carlisle explains this “synergistic industrial expansion” by discussing the ever-increasing demand for coal. Coal was the raw material from which coke was made, and coke was essential for the production of iron (after the phase-out of charcoal) and steel.

The Monongahela River was the critical factor in exploiting the resources of the region. As Dr. Carlisle explains, “The abundant coal reserves of the Monongahela River Valley could never have been commercially exploited on a sufficiently massive scale nor the profits used to finance the industrial expansion of southwestern Pennsylvania had it not been for the transportation possibilities afforded by the Youghiogheny and Monongahela Rivers and for the private and governmental efforts expended to make them navigable year-round.” Coal was king, and coal was the key to the rise of the “Steel City” and the subsequent development of the Monongahela Valley.

Dr. Carlisle has prepared a second essay for this study. In his research on the relationship between the presence of navigation improvements and the establishment and development of riverside communities, he finds that most of the towns that grew up along the Monongahela River were established long before the navigation improvements were begun. He argues that, in some cases, the development of upriver improvements, industries, and communities actually contributed to the decline of older, more established towns in the lower river area.

Carlisle concludes that coal transportation, the railroad, and the demands of the steel industry were the critical factors in spurring the growth and development—or lack of it—of Monongahela Valley communities. Navigation improvements themselves had some positive, as well as negative, influences on riverside cities and towns, but they were rarely direct or controlling factors.

The actual operation of the locks and dams was not labor-intensive, and thus the Monongahela Navigation Company did not employ large numbers of people itself. Carlisle argues, however, that the Monongahela River navigation system affected the communities most profoundly by encouraging the development of other industries—particularly mining, manufacturing, and boat building—that created thousands of jobs for residents of the Monongahela River Valley.

In a final essay, Scott Heberling discusses his inventory of the twenty-seven past and present navigation facilities of the Monongahela River navigation system, built under the aegis of the Monongahela Navigation Company and the U.S. Army Corps of Engineers. He documents their present condition and evaluates their historic integrity. Based on the results of the inventory, Heberling makes recommendations for future study and action.

Without a doubt, the rise of heavy industry and the subsequent demands of coal, coke, iron, and steel producers in western Pennsylvania were the determining factors in the construction, maintenance, and improvements of the Monongahela River navigation system. The river's true significance lies in its almost unsurpassed historic role as a commercial highway. By World War I, according to the U.S. Army Corps of Engineers, the Monongahela's total tonnage was greater than that moved on the Ohio River and Panama Canal. At the end of the twentieth century, some eighty years later, the Monongahela River remains an important shipping link in the inland waterway system of the United States, a niche it has occupied for more than two hundred years.

MONONGAHELA RIVER NAVIGATION IMPROVEMENTS AS A FACTOR IN WESTWARD MOVEMENT

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INTRODUCTION

Americans have always had a passion for movement and mobility—a “fixation” as one geographer has called it (Lewis 1996: 43). Land was a magnet, always holding out the possibility of economic and moral success. As settlers moved inexorably west, they searched for good, cheap transportation, and, after independence, the leaders of the fledgling nation recognized the importance of connecting its various geographic sections. These two needs converged during the first half of the nineteenth century in what historians have called the Transportation Revolution or the development of a vast system of internal improvements. Despite the fact that individual improvement projects were sometimes haphazardly conceived and constructed, technological change proceeded at a dizzying pace, producing engineering feats that astounded the world. Roads, canals, rivers, and railroads were all subjects of innovative transportation solutions.

Economic incentives also played a significant role in the development of America's nineteenth-century internal improvements network. Emigrants moving west needed the manufactured products of the industrializing East. The settled regions wanted the agricultural commodities of the fertile new territories. To satisfy both migrants and merchants, the United States was forced to address its geographical problems and find negotiable, economically viable routes across the Appalachian Mountains. The Monongahela River, as one part of that solution, served as an important link in the settlement and commercial development of the new nation.

GENERAL BACKGROUND CONTEXT

Geography

The Monongahela River has its source in the mountains of West Virginia, at the junction of the Tygart and West Fork Rivers south of Fairmont, and flows north into Pennsylvania for 128.7 miles to Pittsburgh, where it joins the Allegheny River to form the Ohio. From its headwaters, the Monongahela winds its way downhill through rugged terrain and a well-defined valley, draining part of what is known as the Allegheny Plateau, “a wide and choppy sea of considerable local relief” (Wood 1996: 99), until it reaches its mouth at Pittsburgh. The river flows through or touches five Pennsylvania counties during its journey to become part of the Ohio: Greene, Washington, Fayette, Westmoreland, and Allegheny.

The Monongahela is about one-third the length of the Allegheny and was long considered by some to be merely a tributary of a combined Ohio-Allegheny River (Kussart 1938: 1). The Monongahela, however, has ultimately carried much more traffic through the region as it has tapped the resources of Virginia/West Virginia and southwestern Pennsylvania. It was, in its natural state, a more difficult and dangerous river to navigate and was the subject of improvement efforts early in the area’s settlement period.

The Youghiogheny River, the main tributary of the Monongahela, flows into the latter near the present town of McKeesport, and together the two rivers drain the southwestern portion of the state. The headwaters of the Youghiogheny are in the Laurel Highlands of western Pennsylvania. Although the gradient is steep at the upper end, the Youghiogheny River has been navigable generally from about three miles above Connellsville to its end at the Monongahela. The Youghiogheny Valley contained vast deposits of coal and stands of timber and lesser amounts of iron ore and limestone (Gilpin 1975: 37-42).

History

The rivers that converged to create the “forks of the Ohio”—the site of present-day Pittsburgh—played a critical role in the movement of the region’s prehistoric people and of the Indian groups that vied with each other for domination during the contact period. It was, of course, the on-going political struggle between France and Britain (and their Indian allies) for control of the new world empire west of the Allegheny Front during the seventeenth and eighteenth centuries that opened the area to exploration, trade, and settlement. The French, for example, had explored the Allegheny River and its environs long before sending Baron de Longueuil on an extensive expedition in 1739.

Early transportation routes in frontier Pennsylvania during the historic period followed the Indian paths across the mountains and along the rivers. The Raystown and Glades Paths ran east and west from the highlands of the Allegheny Front to the forks of the Ohio; the Frankstown-Venango and Kittanning routes headed northwest from central Pennsylvania and crossed the Allegheny River well north of Pittsburgh on the way to the

Lake Erie (Presque Isle) area. The major north-south route in western Pennsylvania was the Catawba Path that began at the Glades Path north of the Yougiogheny River and extended into southern New York State. The Indian people of the region, of course, also took their canoes up and down the various rivers and navigable creeks, moving people and trade goods over a wide area.

Traders and soldiers were the first white men to penetrate the frontier regions of the state, and the Indian paths and natural water courses were generally sufficient for moving them and their supplies. The primary concern for seventeenth- and early eighteenth-century travelers on the frontier was assuring access to trading posts and military forts. As the Pennsylvania proprietors claimed more and more land in the central and western parts of the colony, and as tensions between the English and French increased in the Ohio Valley during the 1740s, concern grew among settlers and the military over the ability to move men and supplies west to engage the French and their Indian allies and to protect British claims to the western lands.

The first new road was an eighty-mile path—often called Nemacolin's (or Nemocolin's) Path for the Delaware Indian who helped blaze it—opened by the Ohio Company in 1752 as the shortest trade route between the Potomac and the Monongahela (National Park Service 1994a: 18-19). England and France were not the only competitors for western lands; several British colonies, most notably Pennsylvania and Virginia, were also heavily involved in promoting land speculation and the fur trade in the Ohio country. Establishing forts and trading posts on major western rivers, such as the Ohio, Monongahela, Yougiogheny, and Allegheny, was a primary strategy for enforcing claims as the race to the West began.

George Washington followed the old Indian paths, as well as the Ohio Company's route, on his missions from Virginia to the Ohio. Major General Edward Braddock, on his ill-fated expedition to engage the French at Fort Duquesne in 1755, then expanded the Ohio Company's road to move his men, equipment, and supplies from Cumberland, Maryland, northwest along the Monongahela, creating what became known as Braddock's Road.

The Forbes Road, constructed in 1758 to transport British soldiers and military equipment west when General John Forbes finally succeeded in driving the French out of Fort Duquesne, essentially followed the old Raystown Path across the Alleghenies from Philadelphia to Bedford and on to the forks of the Ohio. This road was easily one hundred miles shorter than Braddock's and did not require a difficult river ford. The fact that Forbes's route was built entirely through Pennsylvania was perceived as a victory for Philadelphia's merchants and as a setback for the Virginians—including George Washington—who had land and trade interests in the Ohio Valley.

The French abandonment of Fort Duquesne following Forbes's successful campaign in 1758 effectively signaled the fact that the frontier was now located at the Ohio River. The outcome of the French and Indian War assured prospective settlers that the "Ohio

Territory”—the region beyond the Alleghenies—would be British (National Park Service 1994a: 25-26).

When trouble between the thirteen colonies and England erupted in 1775 creating unrest among the Indian allies of the English up and down the frontier, the Americans occupied the area at the forks of the Ohio and continued to hold this critical strategic position. From there American forces were able to launch offensives and prevent incursions by the Indians, thus ensuring firm American control of the Trans-Allegheny area at the conclusion of hostilities in 1783.

The southwestern Pennsylvania area around Pittsburgh, including the Monongahela River Valley, was first settled between 1769 and 1774, and Indian paths and natural rivers served as adequate transportation for those who had a need to travel. Those who had established homes on the frontier during that period generally fled back east at the outbreak of hostilities with England in 1775. Following the American Revolution, however, settlers began first to trickle and then flood back into the frontier areas of central and western Pennsylvania.

Westmoreland County, which was created from Bedford County in 1773, had a population of 22,700 by 1800; Washington and Greene Counties were actually a part of Virginia until 1781, when they were transferred to Pennsylvania. Westmoreland was later reduced in size, first to create Fayette County in 1783. In 1788 Allegheny was formed from portions of Westmoreland and Washington 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).

Successful campaigns by the new United States Army against the Indians in the Old Northwest Territory (notably, under Generals Harmar, St. Clair, and Wayne) that culminated with the Battle of Fallen Timbers in 1794, opened the flood gates to western settlement in the Ohio country and beyond, including the Lake Erie region of northwestern Pennsylvania. 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 1994a: 28-30).

POLITICAL-ECONOMIC CLIMATE OF INTERNAL IMPROVEMENTS, 1790-1860

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) and in the nation as a whole.

Gallatin's Plan

In the national arena, the first decade of the nineteenth century was also a period of intense interest in internal improvements, with both the Federalists and Democrats of the Early Republic strongly supporting the concept. In 1807 then, Congress authorized Albert Gallatin, the Secretary of the Treasury, to study the subject and produce a report. Gallatin, a Swiss immigrant, financier, western Pennsylvania resident and land developer, and dedicated Jeffersonian, suggested the need for an extensive program of transportation projects planned and funded by the federal government.

Gallatin's 1808 *Report of the Secretary of the Treasury on the Subject of Roads and Canals*, which one economic historian has called "one of the great planning documents in American history" (Goodrich 1960, cited in Shaw 1990: 23), divided the projects into four distinct segments:

1. canals across four coastal necks of land;
2. canals running from the coasts into the interior;
3. interior canals in New York State and around the Great Lakes; and

4. interior roads and canals that would act as links and fill in gaps among the other systems (Richter 1995: 207).

Gallatin himself believed that the projects would benefit the country as a whole and thus should be financed nationally. Many of his fellow Republicans disagreed, however, based upon their reading of the Constitution, and the debate over the proper role of the federal government in internal improvements—complicated by economic fluctuations, sectional tensions, personality conflicts, and a power struggle between the executive and legislative branches—raged until the 1850s.

Although the overall plan of interlocking improvements that Gallatin had envisioned was never realized, the individual components—in most cases built by private or mixed state-private enterprises—were finally completed over the following century. The technology of these subsequent projects was often different—railroads, for example, rather than canals and roads—but all of the transportation improvements were, one way or another, based upon the original 1808 blueprint.

Philosophy

By 1815 roads of all kinds, from narrow, muddy rural roads to sophisticated turnpikes, connected virtually all parts of the state (and the country from Maine to Georgia). The War of 1812 intensified the desire and enthusiasm for a transportation system that could move people, goods, and military supplies effectively from one area to another and convinced many leaders that reliable transportation was critical for national defense (Robinson 1983: 11).

Politics at the local, state, and national level, of course, complicated the process of securing the internal improvements the citizens demanded. Much has been written over the years about the national political battles that raged during the early nineteenth century between the proponents of “strict” and “loose” construction of the Constitution, particularly with regard to the merits of Henry Clay’s and John C. Calhoun’s American System of public improvements with a concern for military security and transportation and for a method of connecting the far-flung parts of the nation.

As George Rogers Taylor, the foremost historian of the Transportation Revolution, has indicated, however, Americans, who have always prided themselves on their interest in practical solutions rather than philosophical theories, were not concerned with the fine points of the role of the government in the nation’s economic affairs.

They believed that economic conditions should constantly improve and that the government had a simple and direct obligation to take any practicable measure to forward such progress. Why should they fear the power of the state? Was it not their own creation in which the people themselves were sovereign? So issues tended to be considered on the basis of simple expediency. Or if theoretical questions were raised, nine times out of ten they dealt with constitutional interpretations having to do with whether a particular activity fell within the powers of the federal or the state government and not whether *any* action by government was theoretically defensible or desirable. (Taylor 1968: 352-353).

Economic regulation had been widespread and accepted throughout the American colonies; after the Revolution this practice continued and, in fact, expanded with the tremendous changes in the economies of the new states following the War of 1812. Because the federal government seemed to be precluded by the Constitution from much direct involvement in economic development, responsibilities for transportation and banking activities, among others, fell to the states.

Enterprise at this level was deemed wholly appropriate by most segments of the population, who actually took for granted the fact that the states would build and pay for—one way or another—most of the transportation improvements that were needed (Taylor 1968: 378-382). On the other hand, the new Republican Party in its first national platform in 1856 declared that Congress had a constitutional right and obligation to fund river and harbor improvements to protect the lives and property of its citizens (Parkman 1983: 105).

Funding

Taylor also points out that the level of state debt during the pre-Civil War period provides an indication of how deeply involved individual states were in promoting internal improvements. He identifies four general periods of that debt development:

1. 1815-1829: gradual growth of state debts
2. 1830-1840: first great debt expansion
3. 1841-1852: collapse and slow revival of state credit
4. 1853-1860: second great debt expansion

(Taylor 1968: 374). The states did not hesitate to underwrite many improvements because between 1815 and 1829 they were practically debt-free, and, until about 1830 they appropriated public money only gradually.

During the 1830s (the canal-building era), however, the Middle Atlantic states accumulated huge public debts by selling state bonds to finance the public improvements. When the boom ended abruptly in 1839 along with state credit/borrowing opportunities, the states found themselves deeply in debt. They also discovered that most of the improvements they owned or in which they held stock would never be profitable enough to pay off the bonds. As a result, they faced the unpleasant reality of levying taxes or defaulting on the debts. Pennsylvania is a prime example of a state that faced this dilemma, and by 1842 it had defaulted on many of its obligations. The executive and legislative branches of the government struggled with the issue of the state debt until prosperity returned and credit and expenditures again expanded in the 1850s (Taylor 1968: 374-376).

Many turnpikes, river improvements, and railroads were organized by vested business and/or political interests to make money, often largely at public expense. The corporation was the organizational form used by every state in building turnpike roads, but Pennsylvania was unique among the New England and Middle Atlantic states in the amount of public money—about one-third of the total—that subsidized the process. Under this model, the

state financed transportation improvements by buying stock in the privately-owned companies and supporting them in many other ways.

This mixture of public and private enterprise was widely accepted as the norm for the first several decades of the nineteenth 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.

Railroads changed the way that transportation companies did business. They were generally chartered by state governments, which granted them many special privileges, such as the right of eminent domain, lottery and banking rights, monopolies, and freedom from state taxation for a certain number of years or up to a particular threshold of earnings. Some states even required other businesses—banks, for example—to purchase railroad stocks before receiving their own charters (Taylor 1968: 88-90).

Economic Change and the Transportation Network

The United States suffered a series of economic displacements between the end of the War of 1812 and the Civil War resulting from internal as well as international factors, such as world pressures on banking practices and the money supply, stock and land speculation, fluctuating prices, and agricultural and manufactured products. The young country developed during this period from a colonial economy based upon the production of agricultural and natural resources into an industrial nation. The Panic of 1819 indicated how sensitive the United States economy could be to European markets, but prosperity returned rapidly, and the decades of the 1820s and 1830s produced steady economic growth, which, in turn stimulated expansion, innovation, and technological development, including intensive canal and railroad construction (Taylor 1968: 337-338).

For many reasons, including feverish speculation, increasingly unwise banking practices, and an unfavorable balance of foreign trade, the United States suffered through a series of economic downturns, beginning with the Panic of 1837, followed by a much more serious crisis in 1839. The period 1839-1843 was one of the severest depressions ever to hit the United States, and it had a disastrous impact on the ability of Pennsylvania to meet its obligations on the State Works.

The return of prosperity in 1844 coincided with a tremendous boom in railroad construction around the country, including in Pennsylvania. By the early 1850s, the new Pennsylvania Railroad had purchased the right-of-way of the Main Line Canal and had consolidated the State Works into a through-system running from Philadelphia to Pittsburgh.

Lines also were built into remote regions of the state to haul natural resources, such as timber, coal, and oil to markets that had previously been inaccessible by water.

In the 1850s also, technological experimentation in the American—and especially Pennsylvania—iron and steel industry began the process by which, after the Civil War, domestic manufacturers could compete with and ultimately out-produce British suppliers of railroad rails and machinery (National Park Service 1994a: 86-90). As one study has concluded, “Western Pennsylvania’s combination of raw materials, strategic geography, well-developed industrial infrastructure and transportation corridors established the region as one of the most important components in the dramatic transformation of the trans-Appalachian West before the Civil War” (National Park Service 1994: 76).

INTERNAL IMPROVEMENTS IN THE MIDDLE ATLANTIC INTERIOR CORRIDOR, 1785-1856

Background

Because of its size and topography, the United States was tied to its rivers from the very beginning. Development proceeded from the coasts up the major rivers to the fall lines and, subsequently, along all navigable rivers and streams. Land transportation was difficult, expensive, and slow, and a nation that depended upon the sale of agricultural crops that were ultimately perishable had to get its products to market as expeditiously as possible. As a result, inland areas all depended upon river commerce.

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).

Pennsylvania's rivers, such as the Ohio, Juniata, and Kiskimineta, flowed east and west through the state, while the Allegheny, Monongahela, Susquehanna, and Youghiogheny took north-south routes (National Park Service 1994a: 42). Shipping and travel began on these rivers before the end of the eighteenth century and increased as settlers moved west in larger numbers between 1790 and 1800. The Kiskimineta, for example, was declared a public highway in 1771, as were the Monongahela in 1792 and 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.

Until the second decade of the nineteenth century in western Pennsylvania, then, the direction of trade was normally east to west by road from the coast across the mountains. Western products were sent downstream by river to the mouth of the Mississippi at the seaport of New Orleans, where they would be loaded on ocean-going vessels bound for the

Atlantic coast. These 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).

Commercial Rivalries

As the population of the United States flowed westward, competition grew among regions, states, and, particularly, cities like Baltimore, Philadelphia, New York, Pittsburgh, Wheeling, and Cincinnati, for control of trade with the interior. The Baltimore-Philadelphia rivalry was especially fierce, and it had a significant impact upon the development of the internal improvement systems of the new nation (Livingood 1947).

The construction of the various turnpikes, the National Road, the Chesapeake and Ohio Canal, Erie Canal, Pennsylvania State Works, and the Baltimore and Ohio and Pennsylvania Railroads, to mention only a few, were strategic elements in efforts to secure commerce for particular areas, while preventing others from doing the same. Envy, competition, and practicality went hand-in-hand on the internal-improvements front.

There was an intense rivalry between Pittsburgh and Wheeling—and, for a time, Brownsville and, later, Cincinnati—for preeminence on the Ohio River system. The newspapers in each area waged relentless public relations and propaganda campaigns, and the legislature was a place of intrigue and constant attempts to fund or promote one region over another (Reiser 1951; Livingood 1947; Ambler 1932: 150-151)). Pennsylvania's financially disastrous State Works was an attempt to compete with New York State and its Erie Canal for the agricultural products moving east out of the new plains and lakes states.

Complicating the inter-city and state competition for internal improvements was an increasing sectionalism in the United States. The National Road, for example, was conceived, at least in part, as a way to link and integrate far-flung sections of the new country and "extend the reach of central authority" (Wood 1996: 109). This was precisely the problem. "The National Road, in effect, had manifest a new set of spatial relationships in the antebellum period. The road divided North from South literally and figuratively, even as it connected East and West literally and figuratively (Wood 1996: 119). Peirce Lewis says, "To Southerners, this was not a 'national' road at all, but merely an expensive project that had been hijacked for the benefit of Northerners but was of no benefit to the South" (Lewis 1996: 17-18).

After 1820 sectional politics prevented consensus on virtually every issue of any importance, including internal improvements and commercial policies. People in the Northeast and the West were interested in increasing trade, often at national expense. Southerners, however, despite the views of their native sons Henry Clay and John C. Calhoun, feared any federal funding for internal improvements. They were afraid that once the national camel had succeeded in getting its nose under the tent, further federal interference in states' rights issues would follow (Wood 1996: 120). Presidential vetoes of

federal funding of internal improvements projects—by Monroe in 1822 (toll collection on the National Road) and Jackson in 1830 (Maysville Road)—made future congressional action on similar issues hopelessly complicated and nearly impossible.

Roads

Pennsylvania Road

Within a few years of independence, the Pennsylvania legislature, concerned about the lack of a good east-west transportation route through the state, set up a lottery to raise money for road construction. It passed its first road-improvement bill in 1785, directing that a highway be constructed from the Carlisle area to Pittsburgh, essentially upgrading the old Forbes Road. By 1787 the route had been planned and confirmed as far as Bedford, and construction was begun. In 1791, the General Assembly passed an Omnibus Act for Internal Improvements that included funding for the road between Bedford and Pittsburgh and followed it with further appropriations over the next two years (Shank 1976: 46-47).

The first turnpike company in the United States was organized in 1792 to build a sixty-two mile road between Philadelphia and Lancaster in eastern Pennsylvania. This road—the Philadelphia-Lancaster Turnpike, or Lancaster Pike—followed the route of an old Indian path that had been widened slightly in the 1750s. The Lancaster Pike was a private stock venture chartered by the state and was constructed using a new technique that prescribed a base of moderate-sized, interlocking stones top-dressed with gravel. The surface proved so smooth, well-drained, and durable that it became an immediate success, generating enough money in tolls to more than offset the extra expense required for its construction. By 1795 the Philadelphia-Lancaster Turnpike was considered the best road in the country. It was also on this thoroughfare that the state of Pennsylvania first instituted the “right-hand side of the road rule” in 1792 (Richter 1995: 566).

After 1803 many other turnpike companies were organized, with subscribers hoping to emulate the success of the Lancaster Pike. By 1804 there was a virtual “turnpike mania” spreading over the state, and by 1820 a link of ten stone-surfaced roads—including the Philadelphia-Lancaster Turnpike—between Philadelphia and Pittsburgh collectively made up what became known as the Pennsylvania Road (Durrenberger 1968: 54; Butko 1996: xxiv-xxv). This route led from Philadelphia through Lancaster, Harrisburg, Shippensburg, and Bedford, where it picked up the Forbes Road/Carlisle-to-Bedford state road, and continued west through Ligonier and Greensburg to Pittsburgh. By 1832 Pennsylvania had 2,400 miles of turnpike roads, more than any other state with the possible exception of New York (Durrenberger 1968: 56; National Park Service 1994a: 36).

As with most of the other transportation routes of the early nineteenth century, there are no reliable traffic figures available for the Pennsylvania Road. Archer B. Hulbert, one of the foremost historians of eastern trails and roads, states that the Pennsylvania Road more than held its own against the Cumberland/National Road to the south in terms of the amount of traffic it carried. He also points out that “almost every important writer who passed over

the mountains went over the Pennsylvania Road” and that this seems to have been the “popular road” to the West (Hulbert 1903: 195-196).

Another early transportation historian, Charles H. Ambler, writes that in 1817 the Bedford-Lancaster Pike alone carried twelve thousand wagons. He quotes a traveler, Henry Bradshaw Fearon, who took the Pennsylvania Road from Chambersburg to Pittsburgh in 1818. On this stretch, Fearon saw

one hundred three wagons together with sixty-three others with families “from the several places following:—twenty from Massachusetts,—ten from the district of Maine,—fourteen from [New] Jersey,—thirteen from Connecticut,—two from Maryland,—one from Pennsylvania,—one from England,—one from Holland,—and one from Ireland.” He also saw about two hundred persons on horseback, twenty on foot, and “one family, with their wagon, returning from Cincinnati, entirely disappointed. . .” (Ambler 1932: 140-141).

The Pennsylvania Road was called the “northern route” or the “State Road” by travelers for whom it was the major highway of westward migration and commerce between the East Coast and the Ohio country. Even after the opening of the National Road and the Pennsylvania and Erie Canals, it was the route of choice for many New Englanders and Middle Atlantic travelers who preferred to travel the most direct road from New York or Philadelphia to Pittsburgh and the Ohio River (Shank 1976: 47). George Swetnam, in his study of Pennsylvania’s transportation history, concludes

Rough as it was, the Pennsylvania Road was a real improvement over the former condition, and until after 1800 carried almost the entire traffic for Pittsburgh, as well as the thousands upon thousands of immigrants going to settle in southwestern Pennsylvania or continue down the Ohio to Kentucky. Archer B. Hulbert, who made an intensive study of the history of America’s highways . . . stated that apparently nine-tenths of the traffic from Philadelphia, Washington, or Baltimore to the Ohio Valley travelled by this road (Swetnam 1968: 13).

Hubert Wilhelm, on the other hand, argues that most of the Middle Atlantic traffic, particularly Pennsylvania’s, followed the National Road to Ohio (Wilhelm 1966: 266-268).

National Road

In 1802 Congress passed “an Act to enable the people of Ohio to form a State government and obtain admission to the Union.” Secretary of the Treasury Albert Gallatin, realizing the need for an efficient system of roads to integrate the various sections of the new nation, insisted upon including in this legislation a mandate for a road from the east coast across Ohio. The Northwest Ordinance had determined that 5 percent of the proceeds from the sale of public lands within the first new state there would be used for the construction of roads, and Gallatin inserted a further provision in the Ohio statehood bill that directed 2 percent of the 5 percent toward the construction of an east-west road, as well as for other roads within the Northwest Territory (Wood 1996: 112; Shank 1976: 48).

The Senate Committee on Internal Improvements then debated the actual route that a road over the Appalachians should take, trying to balance sectional interests and analyze patterns of commerce and travel, as well as the current road-building efforts of the states

across which such a route was likely to run. Since the law mandated that the road must meet the Ohio River at some point in the state of Ohio, and because Ohioans conducted most of their trade with Philadelphia and Baltimore, the Senate committee was able to narrow the choices fairly rapidly. Unfortunately, they were relatively ignorant of topography (Raitz 1996: 47).

[They] thought it expedient to recommend the laying out and making a road from Cumberland, on the northerly bank of the Potomac . . . to the Ohio river, at the most convenient place on the easterly bank of said river, opposite to Steubenville, and the mouth of Grave Creek, which empties into said river, Ohio, a little below Wheeling in Virginia. This route . . . will cross the Monongahela at or near Brownsville, sometimes called Redstone, where the advantage of boating can be taken (quoted in Peyton 1996: 127)

Congress then passed “An Act to Regulate the Laying Out and Making a Road From Cumberland, in the State of Maryland, to the State of Ohio”—familiarily known as the Cumberland Road Act—a bill that gave President Thomas Jefferson wide discretion in appointing commissioners, determining the actual route, and deciding upon construction materials and techniques.

The National Road actually began at Cumberland, Maryland, where it connected with the existing Baltimore Pike to the east. The commissioners let four major considerations direct their work in determining the actual route west of Cumberland:

1. The shortest distance between navigable points on the eastern and western waters;
2. A point on the Monongahela River that maximized the potential of portage to the country within reach of it;
3. A point on the Ohio River most capable of combining river navigation with road transportation, and which considered the potential growth of the lands north and south of that point; and
4. The shortest road with the most benefits. (Peyton 1996: 130)

Congress initially appropriated \$30,000 for construction, but that soon proved to be insufficient since the commissioners estimated the cost of construction at \$6,000 per mile. By 1813, after two years of activity and \$143,786 in federal funding, only about twenty-four miles of the National Road had actually been completed.

The U.S. Army Engineers were not authorized at this point to assist with civil engineering projects and thus played no role in the construction of the National Road east of the Ohio River. The pace of work picked up in 1816, and the final section—to the Ohio River at Wheeling—was completed in 1818 or 1821, depending upon one’s definition of “completed.” The actual cost of construction over the entire length of the road from Cumberland to Wheeling was more than double the original per mile estimate (Peyton 1996: 130-142). The assessment of the National Road by one historian of technology is as follows:

National Road construction successfully overcame the daunting Appalachian Mountain topography. But in so doing, it embodied no new or significant road-building technology, nor spawned any great innovations in road engineering. It generally followed basic and commonly

held practices of the day for creating metal-surfaced [*i.e.* gravel] roads. Although the Road cut transit time considerably, travelers still suffered through a long and bumpy ride in springless wagons. Considering the Road's status as national exemplar, it is ironic that the metaled roadway was neither innovative nor necessarily well-constructed, yet the engineered structures were extraordinary. . . . The stone bridges and culverts carried the Road up and over the water courses that crossed the right-of-way in a manner that defied local geography and allowed the Road to follow a surprisingly straight path to the Ohio Valley. It also marked one of the first mergers in this country of vernacular road-building with finely engineered structures. (Peyton 1996: 142-143)

The western section of the National Road, beginning at the Ohio River, was first surveyed in 1820. In that year Congress agreed to extend it as far as the Mississippi River but appropriated no money until 1825, when it again modified the route; the Road actually terminated at Vandalia, Illinois, in 1850, 591 miles from Cumberland, Maryland, and seventy-some miles short of its destination (Peyton 1996: 130-147; Rose 1996: 160-176).

From the time of its completion east of the Ohio, the National Road suffered from poor construction and overuse. Repairs were necessary almost immediately, but since Congress and the President were involved in continuing arguments over the constitutionality of federal involvement in internal improvements during the 1820s and 1830s, funding was haphazard, and work had to be postponed, sometimes indefinitely. Between 1829 and 1835, the Road required virtually a complete overhaul, and Congress was increasingly reluctant to fund such a massive project. Its solution in the early 1830s was to turn the maintenance and all rights to the Road over to Maryland, Virginia, and Pennsylvania, the individual states through which it passed, thus effectively ending the era of free transportation between east and west when the states established turnpikes on their segments of the National Road (Taylor 1968: 367; Rose 1996: 187).

Despite the fact that turnpike building was very popular for several decades, this type of road did not meet the state's need for cheap transportation, and, for various reasons, turnpikes rarely were profitable. It was the inherent problems of the turnpikes themselves, such as the high costs of keeping the roads in good repair and travelers' aversions to paying tolls, rather than competition from other forms of transportation that really ended the building mania. Roads, in all of their forms, however, continued to be the primary means of transporting good and people across the United States even after the development of alternative forms of transportation (Taylor 1968: 27-28).

It is very difficult to determine how much traffic the National Road actually carried over the various sections during its heyday between 1818 and 1832 and who made up that traffic. Many historians and chroniclers of the Road have made statements like "Great crowds poured onto the National Road as soon as it opened east of the Ohio River" (Peyton 1996: 147) but provide little or no documentation, other than anecdotes, in explanation. Thomas Searight's 1894 book on the National Road describes the endless lines of Conestoga wagons, stagecoaches, and "caravans" of livestock moving back and forth on the highway, as does an 1884 history of Bedford, Fulton, and Somerset Counties (Searight 1894: 16; Waterman, Watkins & Co. 1884: 174-176). No accurate traffic counts exist.

A recent historical geographical study concluded that “the importance assigned by . . . historians to the National Road as an immigrant highway seems exaggerated. . . .” It points out that settlement largely preceded the Road’s arrival and that, based upon an analysis made by a tollgate keeper in 1832, most traffic consisted of livestock being driven to market. “Considering the traffic counts . . . and remembering that settlers did not comprise the sole traffic on the Road, pathways other than the National Road must have carried far more immigrants for the Old Northwest to have grown as it did” (Rose 1996: 177-179). Americans generally were on the move during this period, traveling back and forth constantly on the nation’s roads, rivers, and canals, and there is simply no way of knowing exactly how many people used which route, why they were traveling, or why they chose one route over another.

One frequented pathway was the Pennsylvania Road, and several historians have pointed to the fact that one of the important functions the National Road fulfilled was relieving some of the burden on the northern route by diverting much of the traffic coming out of Baltimore and the southern part of the Middle Atlantic area (Shank 1976: 50; Hulbert 1903: 196). According to George Swetnam’s study of Pennsylvania transportation, the National Road “divided the traffic almost evenly with the Pennsylvania Road” during the period between 1818 and 1852 (Swetnam 1968: 20). Hubert Wilhelm states that the National Road was “*the* factor in the relocation of Pennsylvania settlers” (Wilhelm 1996: 268).

Cultural geographer Joseph S. Wood has summed up the importance of the National Road.

. . . The Road never became functionally all its supporters intended or claimed. The Road became an anachronism, thwarted by constitutional issues and sectional rivalries, and overtaken by technology before Americans completed it. . . . Never at one time was a good road complete and in good repair from Cumberland to Vandalia, but road completion was never the point. In the antebellum period, the Road represented the central government’s power to shape geography, to open wide the Middle West, even as the geographical imbalance between North and South and East and West underlay much of the difficulty and division over the Road’s construction and the larger issue of internal improvements. . . . The National Road was a symbolic highway of America, which both literally and figuratively divided North from South and connected East with the West that became America (Wood 1996: 120-121)

Canals

Erie Canal

In 1817 the New York state legislature passed a bill authorizing the 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. The purpose behind the construction of the Erie Canal was to carry freight—rather than people—back and forth across the state, but it played a major role in the great westward migration across the United States.

The Erie Canal was constructed across the most attractive route between the Atlantic coast and the Old Northwest—from Albany, New York, along the Mohawk Valley to Buffalo on Lake Erie. The highest point was only 650 feet above sea level, and the total length of the original system was 364 miles. Many people had dreamed of a project like this for years, and it started a canal-building craze that had an impact on every section of the nation (Taylor 1968: 32-34).

From its opening in 1825, the Erie Canal was an unqualified success, as traffic increased and revenues rose so fast that tolls financed its rapid completion.

In 1825 tolls on the Erie and Champlain canals totaled over a half a million dollars; the following year, three quarters of a million. Already there was talk of overcrowding and the need for enlargement. Traffic continued to increase, and in 1835, only ten years after the canal's completion, the state of New York ordered the whole work enlarged, the width at the water surface to be increased from 40 to 70 feet and the depth from 4 to 7 feet. This tremendous task of enlargement went forward slowly, not being completed until 1862. But in the meantime, traffic grew and revenues from tolls increased despite financial panics and railroad competition (Taylor 1968: 34).

Despite the fact that the canal commissioners seriously considered banning packet boats on the Erie, it was an important people-mover from its very beginning in 1825. Emigrants bound for the Great Lakes and other parts of the Midwest traveled west to Buffalo on the canal along with vast quantities of freight between 1825 and the early 1850s. Until the railroads reached the West in the period just before the Civil War, no other transportation system could carry passengers or freight at a more reasonable price than the Erie Canal. Traffic and toll statistics are much more numerous and reliable for the Erie Canal than for roads of the period, and the Albany, Buffalo, and Rochester newspapers consistently reported freight tonnage and passenger embarkations on the canal throughout the era (Taylor 1968: 55, 137-138, 142-143, 156, 163-167, 173, 339; Shaw 1966: 271-278).

Pennsylvania Main Line Canal

Whereas in 1816 there were a mere one hundred miles of canals throughout the United States, by the 1820s states and private companies were rushing to cash in on this new transportation craze (Taylor 1968: 34-36). Pennsylvania was no exception, and, despite opposition from turnpike, freighting, and sectional interests and from those who wisely recognized the differences between New York's and Pennsylvania's topographies, the state launched itself into what George Rogers Taylor has called her "canal-building orgy" (Taylor 1968: 43).

Philadelphia merchants had an understandable fear of 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 nineteenth 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, but it did serve as an important transportation artery for at least twenty years (Swetnam 1968: 48).

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 eighty-four locks through which the canal boats had to pass while the Pennsylvania had 174 on its western division alone (Taylor 1968: 43-44). Additionally, the Susquehanna and Juniata Rivers, the two rivers composing 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.

Pennsylvania Canal engineers overcame daunting technological problems with ingenious solutions and amazed the world with their achievements. The Portage Railroad, despite its time-consuming operation, was an innovation at the time and included the first American railroad tunnel. The Pennsylvania Canal, in fact, had the first four transportation tunnels dug in the United States (Swetnam 1968: 48).

Pennsylvania started its building efforts late in the canal era, and it ran into problems when the general economic difficulties of the 1830s made capital scarce and costs high. Sectional rivalries within the state also contributed to the failure of the State Works by tempting the legislature to authorize a series of branch canals that were built simultaneously with the Main Line. These branches drained funds and energy from what should have been the primary focus, the through-route from Philadelphia to Pittsburgh.

Almost from the beginning, Pennsylvania's canals faced competition from railroads. Indeed, the State Works even incorporated railroads into the canal system, using them as the primary link between Philadelphia and Columbia—on the western border of Lancaster County—and at Portage to lift the canal boats across the mountains. Finally, the actual

administration and operation of the canal system promoted graft and corruption, political favoritism, patronage, and inefficiency and did much to turn Pennsylvanians ultimately against public involvement in and financing of transportation improvements.

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. It thus made Pennsylvania part of a broad transportation network and gave its citizens a wider world-view. The Main Line Canal ran from Philadelphia via railroad to Columbia on the Susquehanna River. From there it continued by canal 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. It then turned south to the canal basins at Pittsburgh and ended at the mouth of the Monongahela River after having run through the 810-foot long Grants Hill tunnel between the two rivers. Canal boats then passed through four locks to reach river level so that they could transfer their cargoes to riverboats on the Monongahela (Swetnam 1968: 47-48). Once steamboat technology made it possible to navigate upstream on the western rivers, it was realistic to think of the Monongahela-Allegheny River corridor as extending from Virginia north into New York with an outlet at the Great Lakes through Lake Erie.

Although the consensus is that the Pennsylvania Canal was ultimately a failure, some historians have pointed out its obvious successes. Ronald Shaw, in his book on American canals before the Civil War, says that "traffic was heavy in the 1830s and 1840s and, on some parts of the canal, through the 1850s." On the Allegheny Portage Railroad alone, tonnage nearly tripled in the ten years after 1836, and freight charges dropped from eighteen cents a mile via road to three cents on the Main Line Canal in 1834 (Shaw 1990: 74-75). Catherine Reiser has compiled detailed tables of Main Line Canal receipts and tonnage, the latter divided by categories of products, for the years between 1835 and 1850 (Reiser 1951: 96, 211-224).

Although Reiser does not consider the issue of passenger travel on the canal in her consideration of Pittsburgh's commercial development, Shaw has addressed the subject in his canal-era study.

In the month of April [1837] alone, the collectors at Hollidaysburg and Johnstown reported that these three [packet] lines carried 3,091 passengers going west, for 111,233 passenger miles, and 1,313 passengers traveling east, for 47,320 passenger miles. If more freight came east on the canal, more passengers went west. . . . The fare was \$6 between Philadelphia and Pittsburgh, or two cents a mile. . . . Although most immigrants went west on the Erie Canal, thousands traveled the Mainline, often stopping at hotels in the towns and cities along the way (Shaw 1990: 75).

A movement to sell off much of the state's investments in private corporations was begun as early as the 1840s, and, although it took another decade to accomplish, the State

Works—the Main Line Canal, the Portage Railroad, and the Philadelphia and Columbia Railroad—were finally sold to the Pennsylvania Railroad in 1857 for only a fraction of their actual value (Shaw 1990: 76; Taylor 1968: 382-383).

Chesapeake and Ohio Canal

Another long-planned route across the Appalachians was designed to link tidewater Virginia and Maryland via a canal along the Potomac River to Cumberland, Maryland, then on westward to the Ohio. Although the route was not really practical past Cumberland, many Pennsylvanians saw in it yet another potential threat to their economy. George Washington had been a proponent of such a canal, but it never went beyond the planning stage during his lifetime. The canal fever of the mid-1820s and the commercial threat to Baltimore posed by the incredibly successful Erie Canal, however, prompted an organization called the Chesapeake and Ohio Canal Company to begin actual construction in 1828. The work went slowly, and the company was consistently short of funds.

In 1850, however, the 184-mile route was finally opened to Cumberland. Despite the fact that it faced competition from the Baltimore and Ohio Railroad from the very beginning, the C & O Canal did carry a respectable amount of freight, particularly coal from the Cumberland area, for half a century. It was never financially successful, however, and was never a threat to the routes through Pennsylvania. It also carried very few passengers and was not extended beyond Cumberland (Taylor 1968: 42-43).

Railroads

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, then, 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 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: 102-103).

Baltimore and Ohio Railroad

The contest for regional economic domination continued to influence the development of transportation networks in the United States in the nineteenth century. Baltimore in 1820 was the third largest city in the country with a population of 60,000, and

its leaders recognized that its commercial rivals, particularly New York City and Albany, would secure a tremendous advantage in trade with the interior once the Erie Canal was completed. Baltimore also had an on-going rivalry with Philadelphia and Pittsburgh for control of the Ohio country trade. Baltimore's primary advantage over both New York City and Philadelphia was its shorter distance from the Ohio River.

Many Baltimore merchants were convinced that in order to secure the interior trade advantage they would have to build a canal across the Alleghenies, and, in 1826, a group of stockholders organized the Chesapeake and Ohio Canal Company. At the same time, however, several members of the company realized that a railroad would probably be a better bet, given the technological challenges and costs involved in a trans-mountain canal. In early 1827, then, the state of Maryland chartered the Baltimore and Ohio Railroad. In 1828, the same year in which construction was begun on the Chesapeake and Ohio Canal, work commenced on the railroad line. That same year also, the Pennsylvania legislature gave the B & O a fifteen-year charter to construct its line to Pittsburgh through the southwestern part of the state (Daniels 1997: 9-10; Swetnam 1968: 63).

Within a year and a half, the company had laid enough track to begin paid service runs and had constructed the world's first railroad station (Daniels 1997: 10). The federal government also played a role in the development of the B & O by assigning a number of army engineers to help survey and design the route (National Park Service 1994a: 86). The line reached Washington, D.C. in 1835, Cumberland, Maryland in 1843, and the Ohio River at Wheeling in 1852. It continued laying its tracks westward toward St. Louis and Chicago, gaining access to the latter city in the 1880s.

By 1843 when the Baltimore and Ohio's charter with Pennsylvania expired, the railroad reached only to Cumberland, where it was stopped for three years while its stockholders searched for further funding (Swetnam 1968: 63). Pennsylvania, of course, had its own transportation system to protect at that point, and, as a result, only southwestern Pennsylvania was favorably disposed toward renewing and pursuing the B & O connection. Philadelphians were determined to prevent what they saw as a Baltimore encroachment on their economic turf, and the cities at opposite ends of the Keystone State waged a fierce newspaper and legislative war over the issue (Reiser 1951: 153-154).

By 1845 and 1846, it was obvious that the Main Line Canal could not compete with railroad lines as the commercial link between east and west. As a result, in April of 1846, the legislature approved the Right of Way Bill that permitted the B & O to build to Pittsburgh. At the same time, however, it attached an amendment nullifying that franchise if supporters of a Pennsylvania Railroad could solicit \$3 million in stock subscriptions—with nearly a third on hand in cash—within little more than a year. When they actually accomplished that feat in 1847, the governor announced that the Baltimore and Ohio deal was dead, pleasing both Pittsburgh and Philadelphia by providing commercial connections and face-saving policies (Reiser 1951:155). This move effectively shut the B & O out of the Pennsylvania market—and its lucrative coal and manufacturing trade—for nearly twenty-five years and forced it to take the alternate Wheeling route (National Park Service 1994a: 92).

Pennsylvania Railroad

As has been discussed, Pennsylvania had actually built two of the earliest railroads in the United States as part of its State Works system of improvements in the 1820s and 1830s. The Portage Railroad, between Hollidaysburg and Johnstown, was considered an amazing technological feat in 1834, and it and the Philadelphia and Columbia Railroad in southeastern Pennsylvania were integral parts of the east-west transportation network across the state. By the mid-1840s, however, it was obvious that the system as a whole was obsolete and a financial failure.

The Pennsylvania Railroad was chartered by the state of Pennsylvania on April 13, 1846. Although it was conceived by Captain Samuel D. Karns, a canalboat master from Harrisburg, it was John Edgar Thomson, the railroad's first chief engineer and third president, who created the powerful company that dominated passenger and freight transportation for a century. From the beginning, the Pennsylvania Railroad was involved in a frantic race with the Baltimore and Ohio Railroad to reach the Ohio, the former at Pittsburgh, the latter at Wheeling. The five-year race resulted in a virtual dead heat. The Pennsylvania Railroad, by incorporating the Allegheny Portage and the Philadelphia and Columbia Railroads, was able to offer continuous service between Philadelphia and Pittsburgh in December of 1852. Six weeks later the B & O ran its first train west into Wheeling (Swetnam 1968: 64-65).

Within two years, the Pennsylvania Railroad had replaced its Portage route with two dazzling engineering feats, the Horseshoe Curve west of Altoona, that climbed a thousand feet in twelve miles, and the 3,750 foot long Gallitzin Tunnel, a few miles farther west on the Blair-Cambria County line (Daniels 1997: 23; Swetnam 1968: 65). By 1857, with the sale of the State Works to the Pennsylvania Railroad, the entire route across the state was owned and controlled by one company. It followed up that success by organizing a single system to transport both passengers and freight between Philadelphia and Chicago, thus giving it a decided commercial advantage in the increasingly prosperous American Midwest (Daniels 1997: 23).

New York State Railroads

It was probably inevitable that one or more railroads would be organized in New York State to challenge the near commercial monopoly of the mighty Erie Canal. The first potential rival was the New York and Erie Railroad, chartered in 1833 to connect New York City with Lake Erie. When the Panic of 1837 sent the company into bankruptcy and a fire destroyed its records and property, it abandoned its attempt to cross the state. The Erie was resurrected in 1845 under dynamic new leadership and successfully reached the Great Lakes in 1851. It is credited with being the first line to send a telegraph from one train to another, the first to punch passenger tickets, and the first to encourage newsboys to sell papers and refreshments on board, as well as being the developer of the refrigerator car. The Erie's engineers were also widely admired for their ability to design and build large, structurally sound viaducts over rivers and deep valleys (Daniels 1997: 22-23).

The New York Central Railroad, an arch rival of the Pennsylvania, was the result of a merger between and among various shorter lines that operated near the Erie Canal. For nearly two decades the Canal had successfully blocked the chartering of any railways that it perceived as potential threats. By the early 1850s, however, it no longer had the political power to do so, and, in 1853, the New York Central was formed by combining ten smaller railroad lines (Taylor 1968: 84).

The new railroad followed the same route as the Erie Canal, linking Albany and Buffalo, and thus had to dig no tunnels nor climb any mountains. It had the Erie Canal's monopoly of trade on that route during the winter and established connections with Ohio and with New York City, as well as arrangements with other carriers to serve Detroit and other areas of the Midwest (Daniels 1997: 23-24). The New York Central was a natural rival for the Pennsylvania Railroad in transportation between the East Coast and the interior sections of the United States.

Impact of the Railroads

All of these railroads became voracious consumers of coal, a resource mined in many parts of western Pennsylvania. The increased demand for coal, in turn, produced a demand for improvements in river and rail shipping to get that coal to market. In the antebellum period, the railroads completed the changes begun by the canals in the flow of trade across the mountains. Agricultural products and natural resources could move easily and inexpensively from west to east, directly to Philadelphia and Baltimore, without having to make the circuitous route down the rivers and out to sea to get back to the East Coast.

Railroads offered a number of advantages to passengers and shippers over river and canal systems. First of all, a railroad was normally faster and more dependable and could promise more regular service. It was, in most cases, also more direct in terms of actual route and in being able to offer door-to-door pickup and delivery. Railroads could operate year round, and, as George Rogers Taylor points out, they ultimately triumphed. "Where soundly managed, well located, and built to meet present rather than future traffic needs, they often provided not only the expected advantages to the whole region through which they passed but paid a fair return to those who had put their savings into the venture" (Taylor 1968: 103).

Taylor also notes that, with the exception of the Erie Canal, which for a long time provided cheap fares for poor immigrants, new railroad routes almost immediately "took away from competing waterways most of the passengers and light freight business . . . and most of the western canals rapidly lost the cream of their traffic [heavier and bulkier commodities] to the railroads during the fifties" (Taylor 1968: 165). River traffic also suffered in much the same way. As the railroads reached the Ohio River between 1852 and 1854, the steamboat lines suffered a serious reduction in the number of passengers they carried. Railroads offered more dependable schedules, through-connections, and (by the 1850s) nearly equal comfort (Taylor 1968: 72-73).

During this period before the Civil War, most steamboat lines were also forced to cut their freight rates dramatically to be commercially viable. In this area too, the railroads offered year-around transportation, more dependable scheduling, and smoother transfers from one line to another (Taylor 1968: 72-73). Despite the profound impact the railroads had upon the economy and commerce of the United States, however, they did not put river-shipping interests out of business. In many cases they stimulated each other and worked in partnership to create an efficient system to move people and goods; the rivers could still move some kinds of products more easily and more cheaply than the railroads. Even in 1860 most domestic commerce—measured by total tonnage—moved by water. Trade from west to east expanded so rapidly that all of the available transportation resources were necessary to move products to the northern seaboard markets (Taylor 1968: 166-167).

The nineteenth century, then, 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 1850s, 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: 396-398).

The potential profitability of American industry, agriculture, and western settlement produced a new interest on the part of both political leaders and the population as a whole in funding the internal improvements that were necessary to make it all work. Railroads had to be built across the West, and rivers needed improving to make extensive shipping on them possible and profitable. American business interests had a strong voice in determining government policies through money and access to the men in power, including those at city hall, in state legislatures, in Congress, and even in the White House.

Businessmen had vested interests in moving materials and products, and to do that successfully they needed a modern, efficient transportation system. The philosophical arguments for a more vigorous federal role in funding and building transportation improvements had been increasing, as witnessed in the 1856 national Republican Party platform and in the 1863 waterways convention in Chicago that brought two thousand delegates together to lobby for improvements (Parkman 1983: 105).

MONONGAHELA RIVER CONTEXT, 1790-1860

Settlement Period

In the period between 1769 and 1774, settlers began moving into the Monongahela River Valley, many coming north into the area from Virginia and Maryland. When the American Colonies went to war with Britain in 1775, a good number fled the frontier to wait out the hostilities in the safety of the developed areas to the south and east. With the assurance of American independence and control of the Ohio country, however, settlement began in earnest in the trans-Allegheny region. Several scholars have noted that the "Ohio Valley prior to 1830 was the single most important routeway for Americans moving West because of persistent Spanish control over the South and continued British dominance of the Great Lakes Region (Wilhelm 1996: 264).

The earliest settlers often claimed land along rivers and streams that could provide water power for small industrial operations, such as grist, clover, 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 relatively 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 for river improvement.

The growth rate in the United States as a whole and of the western territories in particular was explosive during the first half of the nineteenth 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 1994a, p. 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.

Economic Growth and Development of Western Pennsylvania

Pittsburgh was always the focus of economic life in western Pennsylvania, and it, in turn, looked south down the Mississippi River for its markets until about 1832 when the system of internal improvements was completed to the point at which it was economically feasible to make routine shipments eastward over the mountains. Because Pennsylvania got a late start in its improvements system, Pittsburgh had the opportunity and the time to develop and consolidate its position as the logical place to buy, sell, ship, and exchange the raw and manufactured goods that were produced in the West.

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 coal, iron ore, timber, grain, glass sand, and wool, in abundance, and it had ready markets for the city's products.

Pittsburgh's industries expanded quickly after 1800 and suffered in the market collapse and retrenchment that followed the end of the War of 1812. The crisis of 1817 and Panic of 1819, although severe in many respects, by no means devastated the manufacturing community in western Pennsylvania. Pittsburghers apparently learned from the experience, weathered the storm, and continued to manufacture the products that were in demand in the West. The economic setbacks of the late 1830s and early 1840s had the same kinds of effects; there were dislocations in the economy as the depression hit certain industries and companies hard. Pittsburgh suffered temporarily, but the business community bounced back, this time on a more solid basis since the financial crisis had rid the economy of its speculative, unstable elements (Reiser 1951: 16-28).

The iron—and, beginning in the 1850s, 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.

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 were kept busy rerolling British rails for use on American railroads. The city's dominance of the late nineteenth- to mid-twentieth-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 1994a: 100).

The rise of Pittsburgh as a manufacturing and commercial center also encouraged settlement as well as the development of markets south along the Monongahela. 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 extend their economic influence throughout all of western Pennsylvania into parts of Ohio, Virginia, and New York State.

River Navigation

In its natural state the Monongahela River could be difficult to navigate, as rapids, narrow channels, sand bars, snags, and boulders were common. The velocity of the current was only two to four miles per hour at best. In the summer low water could make it nearly impossible for boats to travel any distance. Many boatmen considered three feet navigable, 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 on it in its unimproved state, and many people had to wait for the spring freshets to carry them successfully down the Monongahela.

Joshua Gilpin, who made a combined vacation-business trip from Philadelphia to Pittsburgh and back in 1809, described the situation along the Monongahela at Brownsville in his diary:

. . . The river navigation & trade is a great object--at this moment the waters being low little was doing but building boats, which are kept in readiness & accordingly as the waters begin to rise, they are loaded & got ready to depart when sufficiently high--at this time the Banks exhibit an immense scene of bustle & activity; families from the eastern parts of the States arrive here, & purchase boats with which they embark to transport themselves down the Ohio & Mississippi, the rage for doing this was so great a few years ago that 2 to 300 families have embarked in one season, being generally poor they get here as well as they can & encamp on the bank of the river and furnish themselves with a boat--sometimes the scarcity of this article & the tardiness of the winter causes them to remain a considerable time & sometimes numerous families have passed the whole winter in their tents or huts to be ready for the earliest breaking up of the frost & rising of the waters. . . (Walker, ed 1975: 48).

Rafts and Flatboats

Rafts and flatboats carried the bulk of the commerce on western rivers such as the Monongahela from settlement until nearly the middle of the nineteenth century. They were commercially useful only on down-river journeys and were normally broken up and sold as lumber at their destination (Johnson 1974: 22). 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 (Johnson 1974: 24).

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 back 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).

Keelboats

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 between thirty and seventy-five 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). As Leland Johnson describes 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).

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." George Rogers Taylor says 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 Monongahela-Allegheny-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 inland rivers like the Monongahela. 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 shallow rivers. The *Western Engineer*, built in 1819 for military reconnaissance and scientific exploration, drew only nineteen 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 rivers, and he worked on methods to increase steam power and efficiency (Robinson 1983: 7; Taylor 1968: 66; Hunter 1985: 1-30).

Despite the fact that steamboats quickly became familiar sights on interior 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 dominated the Ohio and Mississippi River carrying trade from an early date, and, as a result, flatboats and keelboats—in a generally smaller and lighter form than those used on the large rivers—increasingly shifted their operations onto the Allegheny and Monongahela Rivers where they were thought to be safer (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).

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 nineteenth 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—Elizabeth, Monongahela, Belle Vernon, McKeesport, and California—developed impressive construction operations (National Park Service 1974a: 75).

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 Monongahela River Valley provided raw materials used in constructing oceangoing sail and steam ships (National Park Service 1994a: 75-77).

Passenger Travel on the Monongahela River

As has been noted, between the end of the Revolutionary War and the end of the eighteenth century, Americans headed west from the Atlantic coastal areas in increasingly large numbers. By 1800 there were at least 400,000 people west of the Appalachian Mountains, and southwestern Pennsylvania already had 100,000 of them (National Park Service 1994a: 29, 36). The primary factor in the rapid development of this part of the state, according to James A. Kehl, was its "large-scale dependence upon water transportation." Kehl goes on to say that until 1825 "more people embarked on western waters in the southern counties than in the north because of the direct flow of migration across the mountains from Philadelphia and Baltimore" (Kehl 1956: 24).

The Monongahela was one of the primary river routes for emigrants heading west to the Ohio River and the Ohio country beyond the Alleghenies. One commentator has remarked, "It has been said that in their unimproved condition the Monongahela and Ohio rivers floated the founders of half of the western and southwestern states to their wilderness homes" (Corps of Engineers 1996: 2-3). Because of the seemingly natural route down the Monongahela to its junction with the Allegheny, many people considered the Monongahela effectively a part of the Ohio River for years (Corps of Engineers 1979: 47).

It was Brownsville, on the east side of the Monongahela River in Fayette County—West Brownsville is across the river in Washington County—that served as the primary point of embarkation and the focus of much of the Monongahela River commerce. This town, the fourth-largest urban area in the region, became the center of the important western

Pennsylvania boat-building industry early in the nineteenth century. Gilpin in 1809 thought the view of the river breathtaking.

Brownsville must be 300 feet above the river—on this hill is the upper part of the town which has a very steep descent to the Bank, which is 30 to 50 feet above the river & forms a narrow flat which regularly accompanies it, the river itself having almost the regularity of a vast canal, winding among hills. . . . The river forms a sweep or turn at Brownsville so that both above & below the town at the distance of a few miles it winds round the hills—Brownsville being at the bottom of the curve--has therefore a beautiful sheet of the river in view on each side” (Walker, ed 1975: 45-47).

Once travelers reached Brownsville, they could choose among three different routes to the Ohio.

[They] could continue to Pittsburgh at the confluence of the Allegheny and Monongahela Rivers by either land or water or . . . could bypass the city altogether and follow the National Road some 57 miles to Wheeling, Virginia. This last alternative permitted the traveler to reach the Ohio River 96 water miles below Pittsburgh. Nevertheless, the forks of the Ohio was preferred to Wheeling as an embarkation point because it was nearer Philadelphia and Baltimore (Kehl 1956: 25).

Between the completion of the National Road through the area in 1819 and the coming of the Baltimore and Ohio Railroad to Wheeling in early 1853, stagecoach passengers going to Pittsburgh routinely transferred to steamboats at Brownsville for the trip downriver (Corps of Engineers 1979: 48). According to a nineteenth-century source, National Road stage lines carried 18,000 passengers between the river at Brownsville and Cumberland, Maryland in 1850, fewer than in the three previous years (Waterman, Watkins Co. 1884: 177). Charles H. Ambler says that in the 1820s only one out of ten wagons traveling the National Road bound for the Ohio continued by road to Wheeling; the rest sent their cargoes down the Monongahela to Pittsburgh (Ambler 1932: 138).

Regular steamboat packet (passenger) service was also developed on the river between Brownsville and Pittsburgh during that period, with many companies and boats competing for the business of moving thousands of travelers annually until the coming of the railroads in the 1850s (Ambler 1932: 137-138). According to Leland Johnson, however, “steamboating on the Monongahela did not thrive until after slackwater opened to Brownsville in 1844” (Johnson 1978: 91).

MONONGAHELA RIVER IMPROVEMENTS BEFORE 1844

Improvement Legislation

The traffic and commercial tonnage carried on western Pennsylvania rivers was, from the beginning, heaviest on the Ohio and Monongahela, and the pressure for organized river improvements was felt much earlier along those more-heavily used rivers, particularly the Monongahela. River improvement, like other forms of transportation-related projects, was largely seen as the province 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 benefited 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 (Hill 1957: 44-45). Before 1824 the federal role in navigation had been restricted almost entirely to such activities as building lighthouses and improving harbors (Robinson 1983: 11).

The State of Pennsylvania took an early interest in the Monongahela River, declaring it a public highway in 1782 and beginning navigation improvements ten years later. These first state-funded improvements consisted simply of channel clearing and snag removal, but they coincided with the first great wave of emigration into the Ohio country and the Old Northwest Territory. Thousands of people setting out for new homes in what are now the states of Ohio, Indiana, Illinois, Tennessee, and Kentucky floated down the Monongahela River on their way to Pittsburgh and the Ohio River. When the river was high in the spring, transportation was easy. In the summer when the water level dropped, people had to wait for weeks or sometimes months to launch their flatboats, keelboats, and rafts to start on their way west. They also had to find their way around the private dams and weirs that individuals had erected along the course of the river (Corps of Engineers 1996: 3).

In 1814 and 1815, the Pennsylvania legislature recommended surveys of the Monongahela with an eye to further river improvement, and legislators in southwestern Pennsylvania counties, particularly Fayette, "became preoccupied with bills to improve navigation on the river" (Kehl 1956: 67; Corps of Engineers 1996: 3; Albig 1914: 69). The report recommended a series of sixteen locks and dams that would enable boats to use the river year around, and in 1817 the state chartered the first Monongahela Navigation Company to implement the plan. The legislature appropriated money for stock in the new company, but when the charter expired in 1822 before construction had begun, the General Assembly transferred the funds to channel-dredging and snag-removal projects instead. These continuing improvements facilitated navigation from the mouth at Pittsburgh upriver as far as Morgantown by 1826 (Corps of Engineers 1996: 3).

1824 was 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. This led ultimately to Howard's 1833 survey of the Monongahela. On May 24, 1824, in another 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 (Parkman 1983: 43). The President then assigned the Army engineers this task, thus beginning their involvement in domestic water projects (Hill 1957: 47-52; Corps of Engineers 1979: 11). It was largely the rapid development and subsequent impact of the steamboat on western rivers that led Congress to pass the waterways-improvement legislation as early as 1824 (Corps of Engineers 1979: 7).

Monongahela River Improvements

The success of river clearance on the Ohio and Mississippi led Congress to extend the authorization of the 1824 legislation to survey the Monongahela River (Gannett Fleming 1980: 1). An 1828 survey performed by Edward F. Gay, a Pennsylvania Canal engineer, and funded by the state of Pennsylvania had recommended that 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 under the direction of Dr. William E. Howard, a civil engineer, to investigate the possibility of improving steamboat navigation on that river from Pittsburgh to the intersection of the Cumberland, or National, Road at Brownsville (Gannett Fleming 1980: 2). Again, Howard's recommendation was to construct locks with dams that flatboats could pass over in high water; neither the federal nor state government followed through (Johnson 1978: 91-93; Gannett Fleming 1980: 2).

The State of Pennsylvania curtailed its funding of unrelated river improvements while it concentrated on the construction of the Pennsylvania Main Line Canal. Public interest in river navigation did not diminish, however. On March 31, 1836, the state chartered a private corporation, the second Monongahela Navigation Company, whose purpose was 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 (Corps of Engineers 1939: 4; Ambler 1932: 151).

The Monongahela was, at that time, already carrying a heavy load of commercial traffic because it crossed a formation containing an exceptionally rich bed of bituminous coal. Coal and coke were shipped by river to Pittsburgh and beyond, and these boats too were affected by the seasonal height of the water in the river. Monongahela River sand was also in demand by Pittsburgh-area glass manufacturers who wanted a guaranteed source of this vital reserve (Carlisle 2001: 4-17).

Monongahela River navigation was caught up in the continuing competition for economic supremacy among the cities vying for control of commerce between the Atlantic coast and the Ohio Valley. Merchants in Pittsburgh were afraid that without improvements on the Monongahela, vital commercial traffic would be sent west on the National Road, the

Chesapeake and Ohio Canal, the Baltimore and Ohio Railroad—or possibly even farther north on the Erie Canal. People in Washington, Greene, Fayette, and southern Westmoreland Counties also promoted Monongahela River commerce, as opposed to improvements on the Ohio, construction of the Pennsylvania Main Line Canal, or any other direct, toll-free route that crossed the central or northern part of the state and was thus of no immediate benefit to their area. Their idea of internal improvements involved protecting and enhancing their own interests, and, as a result, they supported the National Road and navigation on the Monongahela and Youghiogheny rivers (Kehl 1956: 70).

The 1836 legislative act that chartered the second Monongahela Navigation Company also provided start-up funding for construction, as well as directions for the acquisition and use of building materials. The legislature's intention was to prevent self-interest and self-dealing on the part of company managers by prohibiting their involvement in direct commercial transactions on or along the river. Tolls were to be set at the same level as those already being collected by the eastern Schuylkill Navigation Company (Carlisle 2001: 24).

W. Milnor Roberts was named chief engineer for the new project in 1837, and the following year he completed another—detailed—survey of the Monongahela that recommended fewer but higher dams and very large locks that would facilitate steamboat navigation on the river. The state legislature approved the plan over the complaints of existing commercial interests, such as mill owners and flatboat/keelboat operators, who feared that the improvements would eliminate or interfere with their business activities (Johnson 1978: 93).

The Monongahela Navigation Company let their contract for the first lock and dam in mid-December of 1837, but construction did not really get under way until the summer of 1839. A few months later, Roberts, as a result of new studies on locks designed for steamboat traffic, recommended relocating and redesigning the first two locks and dams. The company determined, at that point then, to construct all of the locks and dams on the Monongahela to accommodate steamboats.

The nationwide Panic of 1837 affected the Monongahela Navigation Company and its construction project profoundly. Congress ceased funding inland navigation for more than four years—between 1838 and 1842—and, when the Bank of the United States failed, the money promised to internal improvements evaporated (Snyder 1958: 80). The financial crisis affected all transportation projects being constructed or subsidized by state and federal funding, from navigation on the Ohio River to the State Works to the National Road to the Monongahela River.

The financial exigencies of the late 1830s and early 1840s soured the people of Pennsylvania, as well as federal and state legislators, on public funding for internal improvements. The state of Pennsylvania, therefore, determined to sell off its stock in the various transportation companies and projects throughout the Commonwealth. In 1843 a group of local businessmen, under the leadership of James K. Moorhead, purchased the state's shares in the Monongahela Navigation Company at the bargain price of \$3.00 a piece,

creating a privately-held company organized to complete the construction of the river improvements. All of the new stockholders had previous experience in transportation and engineering, and most owned river-related businesses as well (Corps of Engineers 1994: 20-22).

The new owner reorganized the MNC, issued bonds to secure further funding, and repaired the damage that had occurred to first two locks and dams since their opening in 1841 (extending slackwater for eighteen miles upriver). By November of 1844, all of the first four locks and dams were in place and were opened to river traffic of all types. Commercial shipments of coal, sand, and other natural materials increased dramatically (Johnson 1978: 93-97).

The completion of Lock/Dam No. 4 in 1844 made it possible to navigate on five feet of slackwater for nearly sixty miles, as far as Brownsville (Johnson 1978: 97). Financial stability remained a question for several years, but by 1853, the appreciated value of the stock coupled with increased freight revenue made it possible for the company to pay off its remaining debt. Locks Nos. 5 and 6 were completed in 1856, 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, but the most important of the products, without doubt, continued to be coal (Reiser 1951: 62).

By the coming of the Civil War, however, passengers had generally succumbed to the convenience and economy of railroad travel. The Monongahela played an increasingly important role in the commercial and industrial development of western Pennsylvania and of the nation as a whole. It became largely irrelevant, however, in terms of moving people from one place to another.

In 1872, with the passage of the Rivers and Harbors Act of that year, the federal government became directly involved in constructing Locks/Dams Nos. 8 and 9, which were completed by 1889. The system operated under two different authorities between 1879 and 1889, Nos. 1 to 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.

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 nineteenth and early twentieth centuries more tonnage moved on the Monongahela than on any other inland waterway (Robinson 1983: 47).

Route Comparisons

Unlike many other transportation systems and routes created in the nineteenth century, the Monongahela River navigation system has survived and thrived for more than 150 years. It had much in common with the other regional forms of transportation, but it also was different in many ways.

The turnpikes of the early nineteenth century, through their innovations in road-building technology, created the first through-routes between Philadelphia and Pittsburgh, increasing traffic and making it possible for wagons to carry heavier loads. Freight rates fell, and transportation costs overall were reduced by 50 percent (Reiser 1951: 76-77). Before 1830 the turnpikes were normally connected into through-lines, but after that time, they became feeders for other systems, such as river navigation (Durrenberger 1968: 117). Turnpikes, unlike the Monongahela navigation system, were generally not built as investments. Their stockholders expected little return but felt instead that they were making a contribution to public improvements. Freightage on turnpikes, unlike the river, was never highly organized as a system; independent individual teamsters and farmers usually drove the wagons back and forth over the roads (Reiser 1951: 81).

The National Road, which was not a turnpike (no tolls), was a route of tremendous national significance between 1818 and 1835, when it achieved its original purpose of providing access for both people and freight across the Appalachians (Rose 1996: 191; Colten 1996: 194). It made use of current technology, was federally-funded, and expedited travel for westbound commercial traffic, in particular. Its primary contribution was in its access to the Ohio region, both by providing a jumping-off point at Brownsville for travel down the Monongahela to the Ohio and by providing direct access to the Ohio River at Wheeling (Colten 1996: 197).

According to one set of figures, 10 million pounds of cargo were shipped annually in the early 1820s to Wheeling and vicinity; 5,000 wagons actually reached Wheeling, while others certainly unloaded their cargoes at Brownsville or other locations along the road. An estimated 200,000 individuals a year moved along the completed section of the National Road during that period (Colten 1996: 197). Despite the fact that the National Road moved many people along at least part of its route, its main contribution was as a road for driving livestock by established farmers from the region (Rose 1996: 178-179).

By the mid-1830s, the National Road and its technology had basically become obsolete. The country was developing an integrated transportation system that included engineered roadways, cleared river channels, steam-navigation systems, and feeder canals to link the Middle Atlantic states with the Ohio Valley. The Old Northwest and Ohio Valley were already heavily settled by that time. By 1835 the National Road's primary function was carrying the mails; waterways had become the main carriers of trade and passengers, and it was they that had a major impact in shaping regional economies (Colten 1996: 194, 202-203). As the road became obsolete, it also fell into disrepair, and that too influenced travel decisions (Jakle 1996: 233).

The Erie Canal is probably the most-closely related to the Monongahela River navigation system in terms of its impact on regional development in the early-to-mid-nineteenth century. Its primary function was carrying freight, although it ultimately carried hundreds of thousands of passengers as well. It transported more emigrants over the course of its lifetime than any other transportation system except the railroads (Shaw 1966: 272-273). The Erie Canal was much longer than the Monongahela (364 miles vs. 128 miles), and it, unlike the Monongahela navigation system, was constructed at state expense. Like the Monongahela, it was a phenomenal success from the beginning, and its tonnage continued to grow after the Civil War, reaching its peak about 1880 (Taylor 1968: 33-34). Unlike the Monongahela, but like the Pennsylvania Main Line Canal, its primary cargo was agricultural products.

The Erie and the Monongahela both were served on each end by other transportation systems. On the Erie, passengers and freight could connect with Great Lakes transportation on the western end and with the Hudson River and (later) with the railroads on the east. Travelers could make connections with the Monongahela upriver at Brownsville (with the National Road), with the Youghiogeny River at McKeesport, and with the Ohio and Allegheny Rivers and the Pennsylvania Canal at Pittsburgh.

The Pennsylvania Main Line Canal, like the Erie, was built and maintained with state funds, and its primary function was to carry agricultural products to eastern markets and manufactured goods to western ones (Shaw 1990: 230). Traffic was heavy in the 1830s and 1840s—and on some sections even in the 1850s. In the 1840s, the nine packet lines that carried passengers on the Main Line Canal transported three times as many people west than east, but the Erie Canal still carried many more emigrants than did the Pennsylvania (Shaw 1990: 74-75).

The Pennsylvania canal system, unlike the Monongahela, was extensive, complex, and very difficult to administer; some have even called it chaotic. Pennsylvania abandoned its principles of private enterprise in building the Pennsylvania canals, and it did not repeat its mistake when agitation grew for slackwater improvements on the western rivers (Shaw 1990: 211). Passenger traffic declined on the canal in the 1840s, and freight totals followed in the next decade when the railroads reached Pittsburgh and the Ohio (Shaw 1990: 235).

The Pennsylvania Main Line Canal was a losing financial venture, unlike the Monongahela navigation system. The route actually made money, but the state spent too much on upkeep, enlargements, and the branch canal system. The physical nature of the route prevented it from being economical; suppliers gouged the state; the short and uncoordinated operating seasons created confusion and lost revenue, and the state system became a political football (Reiser 1951: 110). As a result, the Pennsylvania Main Line Canal was sold off to its primary—private—competitor, the Pennsylvania Railroad, in 1857 for \$7.5 million, a fraction of its actual value. At that point the canal system showed a net loss of \$57,824,681 (Shaw 1990: 76-78).

Unlike most of the other transportation systems of the period, the Monongahela slackwater navigation system was an immediate success. The Monongahela Navigation Company's annual report for 1845 records that 27,257,870 pounds of freight (exclusive of sand, hoop-poles, wood, staves, posts, boards, timber, bricks, and coal) arrived in Pittsburgh via the Monongahela. That same year 12,961,959 pounds were shipped east from Pittsburgh. The amount of tonnage increased significantly each year after the opening of the first set of locks and dams (Reiser 1951: 62).

According to Reiser, "As an avenue of trade *from Pittsburgh* for agricultural products of other areas, the Monongahela Slackwater was a vital line. . . . The real importance of the Monongahela Valley was not based on agriculture but on mining" (Reiser 1951: 63). That mining was, of course, primarily coal. The Monongahela navigation system thus differed from most of the other transportation routes and systems of the early-to-mid nineteenth century by carrying primarily extractive and manufactured products from the beginning. The freight charges on coal were lower on the Monongahela after the Monongahela Navigation Company built the slackwater system than they were on any other "improved or artificial waterway" (Reiser 1951: 66). Indeed, the Company's annual report for 1846 lists the rate at \$0.8 per ton, while on Pennsylvania, New York, and Virginia canals, it ranged from \$0.20 up to \$0.33 a ton (Reiser 1951: 66).

The Monongahela slackwater system was not a great investment success like the Erie Canal—although it did repay its investors and make a profit—but it certainly 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). Unlike many of the nineteenth-century roads and canals, Monongahela River navigation has never disappeared or been absorbed by a more technologically advanced transportation system.

Canals suffered in comparison with the Monongahela system (and the railroads) in terms of the speed with which boats/freight could move. This speed was necessarily reduced by the number of locks, as well as their capacity. The Monongahela slackwater system was originally designed to accommodate the steamboats then plying the rivers, and the locks were enlarged and replaced over the years in an attempt to keep up with advancing technology. The Pennsylvania Main Line Canal had additional handicaps in the bottlenecks, like the Allegheny Portage Railroad, that were built into the system from the beginning. Canals, because of their inherent problems and inability to respond to technological changes, were in more direct competition with the railroads and were more threatened by them (Taylor 1968: 54-55).

The turnpikes, other roads, and canals generally served as feeders to the river navigation systems, including the Monongahela. The river systems themselves were the main carriers of trade that provided interregional trade and transportation and influenced the development of the regions they served (Colten 1996: 202). It was steamboats that solidified the Monongahela's position as a chief mover of freight and passengers across the region (Colten 1996: 201).

By the end of the nineteenth century, the western Pennsylvania 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 Pittsburgh-area 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. The federal government took over the navigation system in 1897.

By World War I, the Monongahela River had been improved as far upstream as possible, and it was carrying over fifteen million tons of coal annually. Its total commercial tonnage was greater than that moved on the Ohio or through the Panama Canal (Corps of Engineers 1997: 8). At the end of the twentieth century, some eighty years later, the Monongahela River remains an important shipping link in the inland waterway system of the United States, a niche it has occupied for more than two hundred years.

WESTWARD MOVEMENT

There is no question about the fact that the Monongahela River played an important role in moving American settlers west from the eastern seaboard across the Appalachian Mountains into the Ohio Country and the Old Northwest in the years following the end of the French and Indian War, again after the Revolution, and finally, after the opening of the Northwest Territory in 1795.

To historians the term "the Westward Movement" has a specific meaning: the stream (or waves) of people who moved out from the East Coast across the country between the end of the Revolutionary War and the beginning of the Civil War. Using those conflicts as end markers, this migration covered the years between 1783 and 1860, with the period 1795 to 1830 being the time during which most of the movement across the Appalachians took place (White 1991: 183-210; Unruh 1979: 3-27; Billington 1974: 1-11). As will be discussed further, the majority of the people who participated in the "Great Migration" to Oregon in the 1840s and the California Gold Rush of 1849 to the early 1850s, left homes in the Midwest, rather than the East, to move on west (White 1991: 183-210; Unruh 1979: 3-27; Billington 1974: 1-11, 252).

During this period, emigrants moved across the Appalachians (including the Alleghenies) into the Old Northwest Territory, the Great Plains, the southern frontier, across the Rocky Mountains, into the Great Basin and the Sierras, and down to the Pacific Coast. They traveled through the Cumberland Gap, along the National Road, on Zane's Trace, up and down the Monongahela, Ohio, Mississippi, and Missouri Rivers, across the Erie and Pennsylvania canals and the Great Lakes, and along the Santa Fe, Oregon, California, and Mormon Trails. They moved for many reasons, including gold, land, religion, adventure, and pure restlessness (White 1991: 183-210; Unruh 1979: 3-27).

Nature of the Migration

The years between 1795 and 1830 were, according to most historians of the American West, the period of the heaviest movement of settlers out of the east coast states and into the Great Lakes and lower Midwest (White 1991; Horsman 1970; Billington 1974; Faragher 1979; Unruh 1979; Merk 1978; Klose 1964). At the end of the Revolution, settlers moved across the mountains into western Pennsylvania and Virginia, Ohio, Kentucky, and Tennessee. Anthony Wayne's defeat of the Indians in the Northwest Territory, culminating in the Treaty of Greenville in 1795, further opened the flood gates to emigration into that vast area. Many settlers who had already reached the Ohio in the 1780s and 1790s were waiting in the river towns for hostilities in the Northwest Territory to end. With Wayne's victory, they poured out onto the rivers and roads on their way to the Great Lakes region, Ohio, Indiana, and Illinois. They were soon followed by large numbers of people from Pennsylvania, Virginia, and Kentucky (Billington 1974: 252).

Primary routes included the Forbes Road across Pennsylvania to Pittsburgh, from where they spread west, north, and south, and Braddock's Road to the Monongahela River at Brownsville, then down the river to Pittsburgh and the Ohio. Settlers moving out of the South often took the Wilderness Road through the Cumberland Gap into Kentucky, many picking up the Ohio at Louisville or Cincinnati. The main route across Ohio was Zane's Trace, a road that began at Wheeling on the Ohio (Horsman 1970: 73-74; Raitz 1996: 99-101).

Most settlers moving from the Atlantic coast or from the immediate trans-Appalachian areas tended to take the most direct routes possible. Richard White points out that there were "certain regularities" and predictable elements in American migration across the continent. He has discovered that

. . . Native-born migrants. . . tended to move to places located on the same general latitude as the place they had left. Settlers from Mississippi, for example, would move to Texas, not to North Dakota, and settlers from Illinois would be more likely to go to Nebraska than to either Texas or North Dakota. In 1850, 83.4 percent of those living outside their state of birth lived entirely or partially within the latitudes of their state of birth (White 1991: 184).

Emigrants continued to pour out of New England, the Middle Atlantic states, and the upper South until settlement was interrupted again by the outbreak of hostilities with England in 1812. Indian wars flared up intermittently across the Midwest until the Indians were permanently crushed in the Black Hawk War of 1832, but settlement continued steadily across the lakes plains, upper Great Lakes, and prairie territories throughout the first half of the nineteenth century. Ohio, whose population increased dramatically between 1800 and 1810, growing from 45,000 to over 230,000, became a state in 1803; Indiana was added in 1816; Illinois in 1818; Missouri, 1821; and Michigan, 1837 (Horsman 1970: p. 74; Blum et al 1973: 193).

The period between 1824 and 1840 was a time of agricultural hardship in New England—worn out soil and land consolidation during a sheep craze—followed in the 1840s by a similar situation in Pennsylvania and New York. Settlers from both of these regions headed west, with New Englanders in the lead (Billington 1974: 289-291). They were further joined by refugees from the economic and political turmoil affecting Western Europe, particularly Ireland and Germany, during these years.

Migration routes changed somewhat after the completion of the National Road between Cumberland and Wheeling in 1818 and, after 1825, when the Erie Canal finally offered an all-water route from the Hudson River to Lake Erie. The latter route was particularly attractive to New Englanders and to immigrants who landed at the port of New York and made their way west. From Buffalo travelers could book easy and inexpensive passage on a lake steamer to Lake Michigan and the Detroit area. In 1832 the Pennsylvania Main Line Canal made it possible to travel by rail and water across the middle section of the country to make connections at the Ohio.

Hubert Wilhelm and John Jakle have noted the fact that "by the 1830s, the idea of an Ohio River region was diminishing in favor of 'a Middle West emerging to the north of the Ohio River in contrast with the South.' Simultaneously, the Great Lakes and the Erie Canal became the region's principal outlet toward the East" (Wilhelm 1996: 265).

The "vigorous movement," as Nelson Klose has named it, had largely been accomplished by 1840 (Klose 1964: 47). Indeed, by the time the National Road had reached the Ohio in 1818, the peak of emigration through that area had passed. Gregory S. Rose has written, "The National Road mainly followed settlement rather than preceding it because, essentially the Road came too late to dramatically influence settlement in Ohio or to significantly influence settlement in Indiana and Illinois. . . . In many respects, by 1830 the true frontier in the region was in the northern Old Northwest and even beyond the Mississippi River" (Rose 1996: 170-171).

By the 1830s, it was obvious to many Americans that the future of transportation, particularly passenger travel, lay with the railroads. The Baltimore and Ohio was already under construction, and the Pennsylvania State Works incorporated two types of railroads into its Main Line system. By 1850 the Ohio Valley was the center of population in the United States (Wood 1996: 121), and settlement was moving across the "Great American Desert" to the Pacific coast. In the decade leading up to the Civil War, the rivers, as discussed previously, were still extremely important commercial highways throughout the country, but by the end of that conflict—with the exception of the Erie Canal and the Great Lakes—most people no longer traveled long distances by water.

Migration Patterns

Another important factor in the westward movement was Americans' seemingly natural tendency to move frequently. As Richard White has pointed out,

Americans were a restless people, and frequent movements were typical of American society in the nineteenth century, but western movements carried such mobility to extremes. There was a huge population turnover in new settlements throughout the West. . . . All groups shared in this mobility. Immigrant farmers, it now appears, moved as readily as native-born farmers. . . . Only success proved much of an impediment to movement. Usually the wealthiest part of the community tended to stay, whereas the less successful people tended to move on (White 1991: 186).

John Mack Faragher has studied this restlessness in great detail. He found that "most emigrants had moved before." Indeed, in studying people who moved overland to Oregon and California in the 1840s and 1850s, the area that was the focus of migration in mid-century, he found that "the majority had moved at least once, many twice, some three or more times. As one would expect, the number of moves increased with age" (Faragher 1979: 18).

. . . Most men made their moves at the same general points in their lives. Nearly all had moved westward from their parents' homes in their early twenties (46 percent) or had made a similar move westward within the first two years of their marriage (38 percent). Many men moved a second time in their middle thirties; among the men who had been married at least fifteen years by the time of their overland emigration, 80 percent followed their initial move west with a second move, again westward, some ten years later. The combination of these two moves typically took a man from his birthplace on

the east coast first to the Appalachian or Ohio River region and finally to the western frontiers of Illinois, Iowa, or Missouri (Faragher 1979: 18).

Faragher and John Unruh, Jr., in two separate but related studies, found that more people from Missouri moved to the Pacific coast than from any other single state in the union, although a great many New Yorkers went to California in the 1850s (Unruh 1979: 405; Faragher 1979: 189). Faragher's investigations revealed that after Missouri, the migrants' states of origin, in descending order, were Illinois, Iowa, Indiana, Michigan, Arkansas, Wisconsin, and all other states combined (Faragher 1979: 189).

The significance of this information to a study of Monongahela River navigation is in the timing of the westward movement:

1. The largest period of emigration west from the Atlantic coast had ended by 1840.
2. New Yorkers and New Englanders made up the largest group of northern native-born migrants who were still moving out of the eastern seaboard area in the 1830s, 1840s, and 1850s. They generally took the easiest and most direct routes west, which would have led them across New York State (Erie Canal or New York railroads) or no farther south than the middle of Pennsylvania (Pennsylvania Main Line Canal or Pennsylvania Railroad). This would exclude a trip on the Monongahela River.
3. Most of the people moving on to Oregon and California in the 1840s and 1850s left established homes in the *Midwest*. If they had already moved one or more times in their lives and had got beyond the Appalachian Mountains before 1840, they could not logically have taken the Monongahela River route after 1840.
4. Immigration studies have shown that the largest number of immigrants to the United States between 1840 and 1860 entered at the ports of New York and New Orleans, and those who moved to the Great Lakes, lakes plains, or prairie regions normally traveled by way of the Erie Canal or a New York state railroad or up/along the Mississippi and Ohio Rivers (Ambler 1932: 167). Half of the immigrants who entered the United States between 1812 and 1860 came in the 1850s (Taylor 1968: 384).
5. Within eight years of the time the first four locks and dams were opened on the Monongahela in 1844, travelers could take uninterrupted train trips from east to west across the mountains, avoiding roads, rivers, and canals completely.

Local and Regional Travel

Historians have been unable to establish *reliable* traffic counts for each of the east-west routes, let alone how many emigrants—as opposed to business and pleasure travelers—used each road, river, canal, and railroad. We can trace general population flows and settlement patterns for each geographical area over the decades, and we can determine with somewhat more certainty with each advancing year how many bushels of wheat, tons of coal, or numbers of hogs were shipped via the various carriers. We also have figures reported by the Monongahela Navigation Company and the U.S. Army Corps of Engineers that tell us how many people traveled on the river in given years as “through,” “way,” and (after the

1880s) “excursion.” In many cases, however, we must rely upon anecdotal information and deductive reasoning to provide us with a sense of who moved where and why.

There is no doubt that the Monongahela River carried a significant number of emigrants heading west during the years between about 1781 and 1830. As was noted earlier, one study indicated that “in their *unimproved* [italics added] condition the Monongahela and Ohio rivers floated the founders of half of the western and southwestern states to their wilderness homes” (Corps of Engineers 1996: 2-3). The boat building industry along the Monongahela—arks, flatboats, keelboats, and steamboats—also facilitated the movement of people and products to western homes and markets.

It was near the junction of the Youghiogeny and the Monongahela, between McKeesport and Elizabeth (and up the Monongahela at Brownsville), where much of the boat-building and embarkation activity took place. Many emigrants who had crossed Pennsylvania by land took to the river at Brownsville for the journey to Pittsburgh and on to their ultimate destinations (Kudlik 2001: 2-3, 6). Many business travelers also took passage on boats down the Monongahela at this point. Some certainly bought round-trip fares, while others lingered in the city and returned at a later time.

It was the development of steamboats that ultimately provided the impetus for the construction of navigation improvements on the Monongahela River (Taylor 1968: 63; Robinson 1983: 7). Steamboats quickly became all-purpose carriers, transporting passengers, freight, and mail both upstream and down. The Monongahela River navigation system was built to satisfy the needs of the people, communities, and businesses of the Pittsburgh region, so that the river could more effectively, efficiently, and expeditiously move whatever or whoever needed to travel by water back and forth, to and/or from Pittsburgh.

The (second) Monongahela Navigation Company opened the first of its new locks and dams in 1841, and by 1844 the Brownsville and Pittsburgh Packet Company had established the first really successful regular packet service on the river. This company carried newspapers, mail, and about ninety passengers each day (Kudlik 2001: 22). The figures of the Monongahela Navigation Company indicate that in 1844-45, the total number of people who traveled on all of the steamboats (combined) working the Monongahela was 22,726 through-passengers and 20,675 way-passengers (Monongahela Navigation Company 1845: n.p.). By 1848 the numbers had risen to 47,619 through-passengers and 51,739 way-passengers (Monongahela Navigation Company 1848: n.p.)

By the late 1840s, travel time between Baltimore, Philadelphia, or other points east and Pittsburgh had decreased significantly. It was possible to make regular connections via railroad, steamboat, canal, and/or road, and travelers could routinely move back and forth without having to spend months getting back upstream (Kussart 1937: 150-152; Ambler 1932: 184). Ambler says, “As the steamboat improved in design and security it found increasing favor with the traveling public” (Ambler 1932: 166).

As mentioned above, given the lack of reliable nineteenth-century statistics, it is impossible to determine why individuals traveled particular routes (pleasure, business, emigration), whether they made one-way or roundtrips, how long they stayed, which kinds of transportation they used, and how many passengers were on each boat. We have anecdotal statements, general observations, sheer guesses, and many opinions, but we have little concrete evidence.

Although the era of heavy migration to the West had passed by about 1830, immigrants continued to arrive in the United States, and many moved west by one means or another. At the port of New York, for example, 30,000 people entered in 1830; by 1840 it had climbed to almost 63,000. Authorities recorded 192,000 newcomers in 1848 and nearly 300,000 in 1852 (Shaw 1966: 274). During the five years after 1840, more than 300,000 people entered the country through New York, but the city's population grew by only 80,000 during that same period (Shaw 1966: 274).

We do know that traffic on the Monongahela was significant throughout the nineteenth century and that it—both freight and passenger—rose dramatically for awhile after the opening of the Monongahela Navigation Company's locks and dams in the mid-1840s. The Monongahela Navigation Company's annual reports routinely report the numbers of passengers who traveled on the river. We also know that passenger travel on the rivers and canals declined with the appearance of the railroads in the early 1850s (Taylor 1968: 72-73). According to Monongahela Navigation Company reports, however, packet steamboats managed to hold on to regular passengers through the end of the Civil War (Monongahela Navigation Company 1844-1865). The 1865 report lists 24,539 through-passengers and 110,899 who traveled less than the full length.

The extension of the slackwater system on the upper Monongahela in the 1870s, 1880s, and 1890s, stimulated the packet excursion business on the river for a time and kept at least some type of passenger service operating. This travel was pleasure- and leisure-based and appealed primarily to a local audience (Kudlik 2001: 29-30). Monongahela Navigation Company figures from the 1880s and 1890s document the decline in general passenger travel, coupled with peaks in excursion traffic. In 1887, 50,584 people traveled by boat on the Monongahela. John Kudlik gives further details:

In 1890 17,062 people made the direct voyage, while 52,681 way-passengers were carried on local trips, and 11,201 were listed as excursionists. . . . Excursionists increased to 38,619 by 1894, while through-voyagers to Pittsburgh numbered only 12,339, and by 1897 had dropped to 3,643. Apparently this class of service was being lost to the railroads, in spite of almost uninterrupted sailing days permitted by an improved slackwater system (Kudlik 2001: 30).

The figures given reported in the Annual Report of the Chief of Engineers during the same period paint an even more optimistic picture of the increase in packet traffic. According to the Corps of Engineers, 26,885 people traveled on the river in 1886; 98,440 took packets in 1893; 81,550 did so in 1894; 77,050 traveled by steamer in 1895; 54,838 went in 1896. The numbers continued to rise until 1926, but from then on they declined steadily (Corps of Engineers 1886-1935).

It seems clear from the figures that travel patterns on the Monongahela followed the general trends of the nineteenth century. People first moved downstream on flatboats, keelboats, and arks, after having traveled overland by road to reach the river. By the 1820s, steamboats had proved that they could move people and freight easily and safely upstream and down. Passengers flocked to them in the 1830s and 1840s, and traveled much more frequently for both business and pleasure. Those who were moving west to new homes, were happy to be able to travel more comfortably, easily, and quickly on the river steamboats. The railroads with their better connections and more reliable schedules began to take passengers away from the rivers in the 1850s; by the 1870s little passenger service remained on the Monongahela except for pleasure-boat excursions out of Pittsburgh.

There is no doubt that the Monongahela navigation improvements facilitated passenger travel on the river between Pittsburgh and the various communities upriver. The Monongahela Navigation Company's annual statistics indicate, as general as they are, that the pattern of movement overall on the Monongahela tended to change from one-way down-river in the early to mid-1840s to short trips—less than the full length of the river—by the 1860s (Monongahela Navigation Company 1844-1865). We know also that most of the passenger traffic was lost to the railroads during the 1860s, as was the case in most of the country.

One could argue that the movement of people was one of the precipitating factors in the general agitation for the construction of the Monongahela River slackwater system in the 1830s, 1840s, and 1850s. A reading of newspaper editorials and other contemporary sources makes it clear that it was a desire for ease and range of movement in general, specifically steamboat movement back and forth on the river (carrying both passengers and freight), that fueled the desire for the river improvements that began in the 1840s (*Pittsburgh Gazette*, February 20, 1841; *Wheeling Times and Advertiser*, August 10, 1843). Following on the heels of the greatest migration period in American history, the navigation improvements on the Monongahela were expected to facilitate passenger travel on the steamboats that would move through the new locks.

Because people traveled primarily on steamboats from the 1830s until the Civil War, their needs were certainly a factor in the overall planning of river navigation. There had long been a tremendous amount of traffic on the Monongahela, and the Monongahela Navigation Company stockholders were confident that they could make a profit by tapping into that market. By making it possible to travel nearly all year around, upstream and down on regularly-scheduled boats under comfortable conditions, they proved that they were correct. The Monongahela River navigation system also played a role in the national expansion of the United States by moving people, natural resources, and manufactured products to new homes and new markets across the country.

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LOCKS, DAMS, STEAMBOATS AND MONONGAHELA RIVER NAVIGATION

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INTRODUCTION

Steamboats revolutionized nineteenth century transportation on the inland rivers of the United States. In the era before the coming of the railroads, they were instrumental in facilitating the growth of industries, encouraging the migration westward, and promoting the evolution of market commerce in both eastern and frontier society (Puth 1988: 141-142). Along the Monongahela River in Western Pennsylvania a bustling boat industry emerged at a very early stage in the steam revolution. Builders and operators along the shore between Pittsburgh and Brownsville invented many of the basic concepts that accommodated navigation to an often shallow and unpredictable river. As the nineteenth century progressed, steamboats continued to profoundly affect many aspects of the social and economic existence of the Monongahela Valley. The evolution of lock and dam improvement is intimately connected with this story of boat building, river navigation and the settlement and character of the people living along its banks (Wiley 1936: 69-82).

The arrival of steamboats brought prosperity to almost all of the towns along the river. What happened here were local events in a special environment. The wider function of these events was that many of the concepts first applied along the Monongahela for the construction and incorporation of steamboats into trade and commerce, applied equally well to conditions on many other inland waterways. The evolution of a lucrative transportation industry and slackwater system here was a starting point for the successful introduction of steamboats and river improvements into other sections of the United States (Hunter 1949: 206-207).

This section of the report focuses on the impact of locks, dams and slackwater improvements on steamboat construction and operation in the Monongahela Valley. The topic necessitates the investigation of a number of forces at work in nineteenth and twentieth century river history. Among those incorporated here are the historical context for the evolution of steamboat design and operation, the role of market forces in river transportation, and the consequences of private and government engagement in river improvements. No one could possibly deny that the creation of a slackwater system on this river was one of the most useful developments in the transportation history of Western Pennsylvania.

The full effects are best assessed, however, when the starting point is not just the function of locks and dams, but the forces behind their invention and the transformational effects they had on society, business institutions and technological change as a whole (Hunter 1949: 206-207; Haites, Mak and Walton 1975: ix-x). Boat building had a particularly important role in all of this. For over a century it was one of the leading beneficiaries of the slackwater system and was marked by a well-defined evolution that corresponded with river improvement (Wiley 1936: 69). Boat building was a leading Pittsburgh area industry that aided the evolution of transportation not just on the Monongahela River, but on the entire Mississippi-Ohio inland river system.

PRE-LOCK AND DAM/STEAMBOAT ERA IN THE MONONGAHELA VALLEY

Prospects for economic development in the Monongahela Valley looked fairly dim in the decades immediately following the Revolutionary War. Pittsburgh, the primary urban settlement in the area, had experienced some development in specialized occupations and small-scale manufacturing based around available natural resources. But in reality it was still little more than a frontier village (Reiser 1951: vii). Trans-Appalachian migration led to an increase in population. Agrarian settlement expanded upstream along the banks of the Monongahela River, and this resulted in more agricultural surplus reaching the Pittsburgh market. But commercial activity was stagnant, rarely venturing beyond the range of the immediate region. Business transactions were very commonly conducted at the barter-exchange level, as hard currency was very difficult to come by (Reiser 1951: 1-9).

Inability to access wider markets was the determining factor here. High bulk, lower value commodities such as corn, wheat, oats, timber, whiskey, animal and iron products were the regional staple goods. Unfortunately, these items were isolated from eastern population centers by a combination of distance and severe overland transportation difficulties. The cost of moving goods as little as fifty miles or less often exceeded their market sales price (Puth 1988: 137-139). For years the resulting shortage of investment capital and hard currency depressed the local economy to little more than frontier self-sufficiency.

The expansion of western migration into the new Northwest Territories, and the opening of New Orleans-Southern Mississippi Valley trade in the last decade of the eighteenth century widened economic horizons somewhat. But here too, high transportation costs remained the obstacle to development. Since wagon roads were nonexistent or of too poor quality to be of much use, venturing into these new regions focused on natural inland waterways (Puth 1988: 137-139). In the West, and in many part of the East as well, inland shippers preferred travel by water, and made use of any stream or river capable of floating their goods in the right direction (Hunter 1949: 25-27, 353-356).

In Pennsylvania, immigration from the East converged in the country between McKeesport and Brownsville. At the close of the Revolutionary War an increasing tide of emigration arrived overland to Redstone Old Fort (Brownsville) where professionals and amateurs constructed boats for a spring trip down river. The completion of the National Road to this point in 1819 tremendously multiplied this carrying trade, with coaches and wagons bringing huge quantities of freight and passengers from Cumberland, Maryland, to Brownsville.

In a similar fashion, from the late seventeenth century on, the Youghiogheny Valley was a major avenue of emigration from Pennsylvania's eastern counties. That tributary flowed into the Monongahela at the "Forks of the Yough" the stretch between McKeesport and Elizabeth. The area became quite populous in no small part because sawmills, boatyards and

shopkeepers here launched and supplied the requisite river craft for downstream emigrants. For decades, the Brownsville, Elizabeth, McKeesport axis was a centerpiece in westward migration, and the Monongahela became the preferred route for connections to Pittsburgh and on down the Ohio or Mississippi Rivers (*Elizabeth Herald*, September 1, 1900: 1-2).

Pittsburgh was extremely fortunate that the solution to economic isolation flowed right past its doors. The town enjoyed a strategic location at the forks of the Allegheny, Monongahela and Ohio Rivers and was on its way to becoming the preferred river port for westward migration (Cramer 1987: 47). Connecting the East, West and South would prove especially important for the Monongahela and its tributary Youghiogheny Valley. But the requisite river craft were still primitive and the streams on which they floated subject to seasonal weather that made them unpredictable as highways.

More efficient methods of moving immigrants downstream and trade goods both down and upstream became a preoccupation of entrepreneurs living around these rivers. Within a few decades of the 1780s, resident businessmen, farmers, and inventors proved remarkably successful in combining traditional methods of inland water transportation together with new and innovative skills. The result would be a revolution in American transportation technology, which would reach far beyond the confines of Western Pennsylvania (Drago 1967: 6-7, 10-12).

CONDITIONS FOR INLAND RIVER NAVIGATION

Long before Pittsburgh came into existence, the Monongahela River already had a complex history as a transportation highway. Whether prehistoric Indian or Euro-American, navigation had been a prominent feature in the settlement of its valley for centuries. But, travelers had to focus on developing the craft and navigational skills necessary to deal with a river in which water levels constantly changed in depth and volume according to rainfall and other exigencies of nature. Local Native Americans relied upon the Monongahela in spite of its problems for centuries. Their canoes were designed for paddling on and portage over water of no great depth and these boats adequately served the trade and transit needs of their times (Donovan 1966: 16-18).

Time passed, and demands increased. The changing role in later historic times for the Monongahela and its main tributary, the Youghiogheny, was noted by the Pennsylvania State Assembly in 1782. An enactment stated in part that "in so far as they, or each of them, can be made navigable for rafts, boats and canoes within the bounds and limits of this State they hereby are declared to be public highways." The significance of these rivers is recognized here, but implied too are the navigational difficulties (Ellis 1882: 261).

Few parts of the early Monongahela were entirely free from one or another obstruction for any great distance. Early nineteenth-century maps show a river filled with ripples, shoals and bars every few miles or less (Veech 1873: 4-5). Names like Speer's Ripple, Cookstown Shoals, Wood's Bar, and Little Falls were part of the local landscape. A rough count from period maps reveals about seventy of these features by name between Pittsburgh and what is today the Fairmont, West Virginia area (Roberts 1838: A-Q.). These physical characteristics set the framework for navigation. Summer shoals and ripples, often only inches deep, interrupted pools of shallow but more or less navigable water (Cramer 1987: 14-17). In many places the river was so lacking in depth that horses and wagons were walked across it to save ferry tolls. The broad shallows at McKeesport extended above the mouth of the Youghiogheny for a considerable distance and served as a submerged public road for years. As late as the 1830s, steamboats had a very difficult time making passage here and were compelled to anchor ropes on the shore and pull the boat up or down stream by hand (*McKeesport Daily News*, April 3, 1891).

Before the introduction of slackwater, transportation was sometimes halted for months in the summer and autumn when water was low. When freshets finally arrived, trees often fell into the stream from collapsing riverbanks, and sunken trunks presented obstructions that were formidable to remove. Deposits of silt and gravel from tributary streams added to the difficulties. They formed bars across the river that were difficult to sail over and even more problematic to excavate away. Even if some were removed, others would reoccur somewhere else in an endless succession. Reducing their number would have been sensible, but that presented another sort of dilemma. These bars restricted the current

acting as natural dams, and the water they held back, if released in dry seasons, lowered pool depths at the general expense of navigation.

The main Monongahela channel frequently dispersed into smaller secondary flows. Concentrating these into a single channel would have helped, but large scale dredging was beyond the technology of the time. To all this were added the problems winter ice, droughts and other uncontrollable phenomena that periodically depressed transportation activity (U.S. Army Corps of Engineers 1975: 9-15).

Contemporary businessmen and farmers were well aware that an improved river channel would have been of the greatest benefit to their interests. Rivermen were responsible for the earliest attempts at maintaining as clear a channel as was within their power. On occasion state and local politicians responded to the situation. In 1808, the Secretary of the Treasury Albert Gallatin proposed a whole series of transportation improvements to Congress to assist East-West commerce, among them river improvements (Hunter 1949: 190). Unfortunately his proposals were never realized for the early Monongahela Valley. Little could be expected other than the piecemeal improvements that came with mill dams providing slightly deeper pools, stone or timber wing dams chutes concentrating currents through a restricted place, or clearing away rocks and snag hazards as best they could. The focus remained more on inventing and building river craft better suited to the realities of shallow water navigation.

EARLY MONONGAHELA RIVER NAVIGATION

As mentioned, had it not been for Native American canoes, Western Pennsylvania would have probably remained far less inhabited during the prehistoric period. When European fur trappers first entered the scene, canoes were a natural choice for the river. As attempts to control and exploit regional resources increased, traffic in the later eighteenth century demanded craft of greater carrying capacity than canoes but equally able to function in minimal water. Pirogues (larger canoe-type boats) and batteaux (ancestor of barges), both pushed by oars or poles, were commonly used by all sides in the French and Indian War period. Both were shallow-draft craft which functioned well enough for what was required of them in military and trading expeditions (Davis 1994: 5-7).

During these years, progress in river navigation was measured in very slow improvements. Resourceful rivermen were constantly adapting new boat designs to solve the problems inherent in negotiating a difficult river. Early craft were quite heterogeneous and built according to cargo needs. Rafts, canoes, barges, skiffs: common to all of them was the need to increase carrying capacity, and decrease boat draft, if operations were to successfully expand into low water seasons (Davis 1994: 5-8).

As far back as Revolutionary War times, the government sent carpenters to Fort Pitt to construct forty-foot long batteaux in the Monongahela Valley to help secure command of the rivers. About thirty of these barge-like boats were built there for military use on the Ohio River. Period descriptions suggest that the architectural pattern had evolved into flatboats partially covered with protective cabins and guided with sweep oars and steering poles. For decades to come, these shallow-draft flatboats would be one answer to inland river navigational problems. They, more than any other early craft, initiated a vigorous building tradition along the Monongahela River.

During the last third of the eighteenth century, the lower river between Pittsburgh and Brownsville became the busiest center of building activity in the whole Ohio-Mississippi system. Flatboats were low-cost and fairly simple to construct with basic carpentry skills. Design-wise they were little more than rectangular boxes formed from square hardwood timbers. The hulls rose three or four feet above the water. On each of these, deck space was mostly taken up with a roofed cabin. Direction was limited to sweep oars guiding the craft through river currents (Berty n.d.: 1-4).

Although conforming to no rigid size or pattern, several types of flatboats were common by the 1790s. There were "family" or "Kentucky" boats for immigrant-livestock traffic, larger "New Orleans" boats for heavier commerce to the footwaters of the Mississippi, and Monongahela "arks" intended for regional conveyance. The beauty of these river craft was that as a simple, cheap conveyor of goods, they could be tailor-made on the spot to the size of the expected cargo. Such boatyards were initially quite informal in their machinery and labor force (Andrist 1962: 23-32).

There was a tremendous increase in passenger and freight traffic diverted at Brownsville to the Monongahela River. Boat building became a profitable enterprise at many points along the shoreline as the volume of trade and emigration increased. This industry was the third largest in Pittsburgh in 1803 (Reiser 1951: 13). Emigrants often constructed the boats themselves if they could not afford to purchase them. They did not even require expensive nails; wooden dowels usually sufficed. When autumn or spring water stages became high enough, they drifted on one-way trips down river, with from thirty to two-hundred or more tons of freight, depending on capacity.

They were preferred over land transportation, especially since they could be dismantled for lumber at the final destination. There was good building material or cash to be made in their bones. Although sometimes dangerous to control with sweep oars and wholly dependent on high currents, flatboats remained popular with rural people for decades. Flotillas of them steadily encouraged small-scale commerce. In 1787 one hundred and twenty flatboats passed Pittsburgh on the way to the Ohio River; on one busy day in 1796, seventy of them arrived from upstream (Kussart 1937: 16). As late as 1842, there were some 450 steamboats on the western rivers and an estimated 4,500 flatboats of one sort or another still operating (Haites et al 1975: 21-22, 52-53).

By the 1820s, Fredericktown and Rice's Landing had become shipping points for flatboats attempting round trips, after mill dams deepened the water somewhat there. A primitive lock was actually constructed in one dam to facilitate passage. The boats were pushed with poles or drawn by horses for the return trip, but this proved very difficult for such unwieldy watercraft. The character of shipments began to change too with deeper water.

Fayette City was a flatboat-construction center. These craft were required for transporting large quantities of glass from factories there. At various stoneware, iron, millstone, coal, and lumber production sites along the river, boatyards were established to provide "on the spot" transportation of these commodities (Kussart 1937: 34-35). Even the slight increase in depth that came with primitive mill and fish dams was enough to induce an increased commerce in bulk goods.

Biographical histories of the early Monongahela Valley reveal that many families routinely had some male member who acquired a boat individually or in partnership with others and transported goods downriver at some point in their lives (*Historical Magazine of Monongahela* 1908: 207-214). Most were not professional rivermen but simply entrepreneurs. This micro-level trade helped to generate a higher volume transportation system further developing viable markets such as Pittsburgh.

What was needed were craft to transport cargo and passenger traffic upstream more efficiently. This came with keelboats which initiated a new era, as they could be propelled upriver as well as down. It is not known exactly when they were invented, but there is mention of this type by around the 1780s. References are made to their construction in Elizabeth as early as 1788 by ship carpenters imported from Philadelphia (*Elizabeth Herald*,

June 7, 1900). Pointed at bow and stern, they were forty to eighty feet in length, with a shallow keel drawing about two to three feet of water fully loaded.

On the Monongahela keelboats tended to be quite small, six to thirteen tons, before slackwater came to the river. Boats intended for the Ohio River were generally built larger. As on flatboats, goods were stored in an enclosed cabin, but instead of drifting, a keelboat was powered by a crew of eight to twelve men laboring on deck with long poles to push the craft over obstructions downstream or against upstream currents. Navigation was difficult, especially in ascending a stream in strong currents. Dozens of dams built to provide water power for mills provided slackwater pools, but keelboats could have trouble negotiating passage upstream through the swift water moving through the narrow open chutes left in them (Andrist 1962: 23-31).

This class of boat was slow and very labor intensive but represented a considerable improvement over flatboats. It had a reasonably reliable and stable form and in the long run brought a higher degree of professionalism to river transportation than was generally true of flatboating. An increasing number of entrepreneurs established combinations of stores, warehouses, and ferry landings to which people from the countryside brought goods for sale or transport. One such was John McDonald from Peter's Creek, near present day Clairton, Pennsylvania. McDonald, in addition to his retail store, was the first person of whom there is any record who operated an actual keelboat line. His 1786 newspaper advertisements promised "speedy and sure service" once a week between Pittsburgh and Brownsville. Business must have been good; the following year he sold the boat as "it was too small for the use it was intended for" (Kussart 1937: 43). His line was a forerunner of the concept of passenger and freight packets that would further evolve with steamboats and be part of Monongahela Valley life for more than a century to come.

That same year, 1786, the *Pittsburgh Gazette* had newspapers delivered on a weekly basis thirty-five miles up the river. Period newspapers frequently refer to increasing numbers of river craft anchored at the Monongahela wharf. By 1800 they were running as regularly as water allowed and offering different classes of passenger service for the lower river and even attempted limited freight service into the shallow river above Brownsville. In Greenfield, the Farmers' and Mechanics' Commercial Store operated their own boat, which was becoming a fairly common thing to do (Kussart 1937: 49).

There were boatyards in nearly all the larger settlements well before 1800. Water-powered sawmills cutting rich sources of available timber were the centerpieces of a yard. Brownsville, Elizabeth and McKeesport, in particular, made a successful industry of applying them to boat construction. Fayette City builders added keelboats to the huge number of flatboats that continued to take form there. By the later 1780s, West Newton had its own company of boatbuilders and a thriving business supplying them to emigrants using the Youghiogheny River route.

The keelboats and flatboats produced in these and other yards were responsible for a tremendous increase in the volume of commerce centered at Pittsburgh (Reiser 1951: 44-45).

The commercial traffic of the Allegheny, Monongahela and Youghiogheny River valleys made the town a natural depot for all sorts of products. This continued to be encouraged by huge numbers of emigrants continuing passage through western Pennsylvania on the journey west. As headwater port for the Ohio-Mississippi Rivers, Pittsburgh was well on its way to becoming the best known of all inland river towns by the eighteen teens. Here emigrants secured river passage, plus the items required for the trek into the frontier. It was most significant for Monongahela area progress that the Mississippi Valley developed into a market for its agricultural and manufactured goods by the early 1800s. Frontier self-sufficiency was replaced by participation in a complex economy that encouraged manufacturing and attracted river trade in products local residents were able provide (Reiser 1951: 53).

Hard numbers are difficult to come by. A powerful stimulus to commerce was the construction of the National Road from Cumberland, Maryland, to Brownsville. By the time this road had reached Brownsville in 1819, the volume of freight and passenger travel had increased to the point that regular keelboat service was worth the pains required to maintain it. Keelboats were the pioneer packets on the Monongahela River. Different sized boats were built, some as small as five or six tons, so operations could continue unless the river was virtually dry. Their bottoms were somewhat rounded and based on a heavy keel designed to take the pounding of frequently running aground.

Prior to 1831, when river craft were required to be enrolled at the customs house, their comings and goings are difficult to follow. But it has been estimated that 20,000 people and 4,000 freight wagons per year arrived in Brownsville in those days, and most of this traffic transferred to boats for the remainder of the journey to Pittsburgh or beyond (Kussart 1937: 55-57).

Well into the early steamboat era of the 1830s, Pittsburgh newspapers frequently continued to refer to Monongahela keelboats and their captains by name. The *Caleb Harvey* was owned by a captain of the same name from Monongahela; the *Westmoreland* sailed regularly from the Youghiogheny area, and the nine-ton *Rover* was run by several Brownsville businessmen. These names are but a few from a very lengthy list. All were typically rather small, built locally, and much in demand for commercial service. An increasing number arrived from the upper Monongahela with freight from as far away as settlements around Morgantown and the mouth of the Cheat River (Kussart 1937: 55-57).

The water depth here could be a real problem. Iron, wheat, and wool manufacturers of the 1830s from that region were early proponents of upriver lock and dam projects, but it would be decades before that need was addressed. In the meantime shallow-draft river craft remained in high demand. Very large keelboats were built in Pittsburgh, some up to fifty or sixty feet in length, but these were for use down the Ohio River (Andrist 1962: 23-24).

The volume of combined keelboat and flatboat traffic on the Monongahela River prior to the advent of slackwater navigation may be gauged from a document drawn up by the wharfmaster at Pittsburgh in the year 1840. It was compiled at the request of the

Monongahela Navigation Company as a survey of potential traffic through proposed locks and dams. It relates that 686 keel and flatboats with assorted produce, plus 1084 flatboats bearing a range of bulk cargoes such as iron, coal, and bricks, had made use of the Monongahela wharf during the previous year (Kussart 1937: 58). This was not counting steamboats, which were running in large numbers by then, or through traffic that had not landed and proceeded down the Ohio River.

When the Monongahela Navigation Company's lock and dam system was initiated in 1841 on the lower river, the era of keel and flatboats was by no means ended. The tolls paid by these boats were seen by the company as a matter of considerable financial importance. These river craft continued to arrive with consignments of everything imaginable. However, their weight and volume seem to have dramatically increased with the added depth provided with the new slackwater system.

By 1844 Locks and Dams Nos. 3 and 4 provided good navigation up to Brownsville. On December 13 of that year, the *Pittsburgh Gazette* reported the keelboat *Smash* arrived from a brickyard on the Monongahela with four thousand bricks, one thousand bushels of fire clay, over a thousand gallons of stoneware, plus other items. The dimensions of the boat are not known, but clearly it was a far cry from the tiny keelboats of earlier times. The *Henry Clay*, which was considered a bit small by 1840s expectations at ninety feet long and a registered twenty tons (and ran the still-shallow river to New Geneva, Pennsylvania, when able), indicates the extent to which keelboats of increased dimensions continued to operate successfully on the pools of an improved Monongahela River. They remained common on the Youghiogheny River too but were of much smaller tonnage until the river was improved in the 1850s (*McKeesport Daily News*, January 7, 1896).

Long before the development of steamboats, Americans looked to waterways as the logical answer to transportation difficulties. From the pre-steamboat era on down to the Civil War, river craft became the primary carriers of goods and people that contributed to a dramatic fall in the cost of transportation west of the Appalachian Mountains. This was a major factor in the economic growth of the western frontier, encouraging emigration, manufacturing, market growth and agricultural productivity.

For decades in the Monongahela Valley, the skills developed for boat building were employed in perfecting flatboats, keelboats and barges that overcame some of the navigational difficulties associated with bulk commerce. When the steam engine arrived, these same skills were transferred to the perfection of steamboats that also had to operate on rivers that remained largely unimproved for some decades. Fallen Timber Run at the edge of Elizabeth had been the scene of early flatboat launchings. Samuel Walker, who was one of the first to lead the Valley into the steam era, acquired the site, and quickly converted it into a major hull-construction workshop (*Elizabeth Herald*, June 7, 1900).

Steamboat construction and sailing operations expanded rapidly on the Monongahela, but the older river craft did not quickly disappear in the face of progress. The reason was simple and related to the issue of locks and dams. By the 1840s trade along the upper

Monongahela had developed into a matter of some economic significance, but lock and dam improvements did not arrive there for decades. Small steamboats ventured into this stretch of river on as regular a basis as water depth permitted but often with difficulty (Davis 1994: 7-13). Determinants such as fuel, insurance, delays in running ripples and shallows, plus other costs meant that steam transportation savings per payload-ton were reduced.

As late as 1850, merchants in Fairmont, (now West) Virginia, offered cash premiums to any steamer that would initiate communication that far upriver (Kussart 1937: 180). Due to the continuation of shallow water navigation along the upper half of the Monongahela Valley, smaller capacity steamboats were generally the only ones willing to risk the trip. During low water periods none ventured there at all.

Flatboats and keelboats, however, were able to venture in the waters of the upper Monongahela more informally and, especially in the case of flatboats, at lower cost. As late as the 1840s, Monongahela keelboats still arrived in Pittsburgh at the average rate of five or six per day. Steamboats competed easily against these slow, labor intensive boats; on upstream voyages, costs fell to less than ten percent of keelboat rates.

Downstream, however, drifting flatboats still enjoyed genuine cost advantages. Contemporary sources reveal that these "primitive" boats remained viable well into the steam age (Haite et al 1975: 22-23). To flatboats must go the credit for maintaining a segment of the low-cost shallow river trade so important to the financial and manufacturing success of the Pittsburgh region. Flatboatmen remained on the river scene until the 1860s-1870s, by which time locks and dams and railroads finally made them a memory. In a sense, their freight-carrying boats outlived them, evolving into the barges that became so much a part of the steam-tow era (Haite et al 1975: 22-23, 52-53).

INVENTION AND REGIONAL RESOURCES IN MONONGAHELA NAVIGATION

History texts usually refer to Robert Fulton as the inventor of the steamboat. His 1807 Hudson River trip on the *Clermont* from New York City to Albany is seen as heralding the steam age in the United States. The full story is a bit more complex and deeply rooted in the Monongahela River navigation tradition. Fulton's first voyage may have been in the East, but his financial ambitions were set on navigation of the Mississippi River, and activities were soon transferred to the inland waters of the West (Hunter 1949: 5-9, 66-67). His plan was to secure a monopoly on commercial steam navigation rights to operate between Pittsburgh and New Orleans.

Using Fulton's designs and financial backing, the steamboat *New Orleans* took shape in a Pittsburgh boatyard in 1810 under the supervision of Nicholas Roosevelt. It had a design similar to the deep-water sail-supplemented steamer Fulton had built for the Hudson River, but a round-bottomed hull depth of twelve feet was impractical for inland navigation. In 1811, Roosevelt piloted the boat down the Ohio River on a one way trip to New Orleans, where it remained in the deeper water of the lower Mississippi (Hunter 1949: 12, 67).

Of greater historical significance for the western rivers was a lesser-known man, Henry Shreve, a Monongahela River keelboat builder from Brownsville, Pennsylvania. He plied the Mississippi and pioneered the technique of pushing keelboats up that river into unexplored Illinois territory. The experience served him well. Daniel French, also from Brownsville, built a Fulton-type steamer, *Enterprise*, in 1814. Shreve piloted the boat on a difficult round trip to New Orleans and back to Brownsville again. It was a sensational demonstration of the viability of steam to power two-way commerce with the New Orleans market, but, had the rivers not been exceptionally high that year, things might not have gone as well as they did (Drago 1967: 12-15).

Steamboats were in their infancy, and deep-draft Hudson River hull patterns were a poor design for shallow western rivers. Shreve and other Monongahela keelboat builders arrived on the scene with a different sort of knowledge and pioneered the construction of the lighter draft, higher powered boats essential for voyages prior to slackwater improvements. Progress depended on altering the structure and equipment of eastern seagoing vessels to concepts appropriate to western waters (Hunter 1949: 13-14, 75-76, 89-90). The movement was toward a flat-bottomed hull design that would support weight with a minimal draft. The best ideas for western riverboats came out of long-established yards where there were men with years of practical experience who understood the need for shallow watercraft that could skim over river water.

Shreve's next boat, the *Washington*, was a cross between a 136-foot keelboat and a shallow barge-like hull. Engines and boilers were shifted to the main deck, not set below within the hull. A second deck was added above for passengers, and that was topped with a

pilothouse and smokestacks. It was a concept proportioned to be functional, riding on the water rather than plowing into it (Donovan 1966: 49-52).

Daniel French designed high-pressure engines far lighter and more efficient than Fulton's. Shreve improved basic boiler design and placed the boilers horizontally on the main deck, unlike Fulton's vertical placement down in the hull. This became standard on western boats, permitting shallower, flat-bottomed hulls. Likewise, engine pistons and paddlewheel cranks (called pitmans) operated in a horizontal position on the deck. Shreve used two of them, one for each wheel (Drago 1967: 15-17). All early boats were sidewheelers; while a bit wider than the later sternwheel design, they had greater dexterity in turning in a narrow channel by putting one side in reverse, while the other was driven forward.

River steamers were reinvented in the Monongahela Valley. Many refinements would evolve in the future, but they were variations on these core ideas. Plodding progress continued over the years with a multitude of mostly anonymous mechanics, craftsmen and rivermen who slowly improved and maintained inland steamers until the end of their era (Haites et al 1975: 73). It was in the towns of Brownsville and Pittsburgh that these structural and mechanical ideas were first begun to be worked out by a system of trial and error. Without these ideas, steamboats would have had very limited usefulness on western rivers. Henry Shreve's new boat was able to steam 1,500 miles upstream against the Mississippi current in only twenty-four days, a voyage that normally took keelboats four to five months. It was not long before Pennsylvania boats had set the standard for the western rivers and were in high demand for the Ohio and Mississippi freight and passenger trade.

Fulton ultimately failed in his vision of a Mississippi River monopoly for many reasons. One was his inability to retreat from the basic plan of the sailing vessel, a heavy-hull design characteristic of the eastern seaboard (Hunter 1949: 9-11, 13-14). Along the Monongahela, however, innovative changes in construction were encouraged in the atmosphere of an industrial frontier where skilled engineers were few, and makeshift ideas about boats were a way of life quite conducive to experimentation. Decades of flatboat and keelboat construction had produced boatyards and craftsmen who moved into the steam era and used their experience to improve upon steamboat design. Between 1811 and 1816, nine more steamboats were built, each an improvement over the preceding one (Reiser 1951: 31). It seems to have been an especially easy transition for these builders to begin constructing steamboat hulls in Brownsville and Elizabeth (Wiley 1936: 69-70).

The steam engine and the steamboat arrived in Western Pennsylvania almost simultaneously, long preceding improvement of the river. Pittsburgh manufacturers were introducing stationary steam engines to power machinery by 1807, and eight of them were in use in mills and iron factories by 1816. Steam power has long been recognized as a critical part of the Industrial Revolution. Its comparatively early introduction into the Monongahela Valley provides an interesting example of the diffusion of technology into the American West (Fogel and Engerman 1971: 228-237).

Innovations were not ignored if their successful application could compensate for the deficiencies of a frontier setting. For example, a typical backwoods shortage of labor encouraged some Pittsburgh manufacturers to employ steam power, in spite of the initial difficulties of acquiring the equipment. Likewise, traditional river craft had reduced frontier isolation but had to creep along with or against slow currents. Applying steam engines to river transportation was immediately seen as a novel benefit to the speed and volume of commerce.

Much of the inventiveness in pre-steam Monongahela River navigation was inspired by the difficulties of an often shallow and obstructed channel. It is interesting that Henry Shreve not only designed one of the first successful steamboats but, later in the 1830s, a steam-powered snag boat as well. He became extremely involved in the promotion of river improvement (Hunter 1949: 193, 197-203). When steam power began contributing substantially to commercial progress, there were louder demands for improving the waterways. Businessmen in the West saw themselves dominated by one-sided trade with the East. Open rivers meant increased trade to and from Monongahela-Ohio-Mississippi River stations, which brought market diversification and a healthier economic situation for the western territories.

The greatest need in the United States of the early 1800s involved the area of inland commerce. It was fortunate that Pittsburgh and the surrounding area had not only a river location, but also the economic, social and technological atmosphere to encourage steamboat development. Robert Fulton's choice of Pittsburgh as the head of navigation for his transportation dreams had not been based solely on geography. Even at an early date, every facility required for potential steamboat construction, from lumber yards to machine shops, was to be found here. Cramer's *Almanack* states that iron-related industries were already very significant to the local economy in 1803.

Assisted by the material demands of the War of 1812 and westward emigrants, many new manufacturers appeared with enterprises that facilitated the invention and construction of steamboats. They built ropewalks and sawmills and hired boat carpenters. The upper valley of the Monongahela contained huge stands of virgin timber. Some blacksmiths worked in foundries, manufactories that evolved into more sophisticated machine and pattern shops and eventually into rolling mills. All were required for producing boilers and engines (Reiser 1951: 60-61).

The building of machinery for an expanding steamboat industry stimulated the development of metal-working techniques and further accelerated this industrial revolution on the frontier. By 1812 coal was being mined near Pittsburgh in significant quantities, and by 1817 the mineral fueled the processing of five thousand tons of iron (Reiser 1951: 3). Early boatyards were usually situated near these nascent industrial centers, where foundries, shops and mills could be relied on to produce equipment, iron plate, rods and other fittings.

Within the space of only a few years, western commerce changed under the influence of steam and brought a boom to towns already enjoying prosperous trade by flat and

keelboats. The Ohio Valley saw dramatic growth as an emerging industrial region. Settlements were growing more rapidly here than in any other section of the nation. From around one million in 1810, the population west of the Appalachian Mountains reached six million by 1840.

Pittsburgh, Cincinnati, Wheeling, Louisville and numerous other towns blossomed with everything from cotton mills and glass factories to foundries and hardware manufactories. The upper Ohio also blossomed with boatyards, but for many years the Pittsburgh area had the natural and industrial resources to maintain the greatest number of yards actively producing river craft (Reiser 1951: 29-51). By the middle of the nineteenth century, just about every navigable river in the Mississippi Basin had one or more Monongahela-built boats steaming on its waters.

The rise of the West and the rise of steam power went hand in hand. Nowhere was this more evident than in the Monongahela Valley, where steam power provided the impetus for more diversified manufacturing, as well as whole new industries associated with steamboat operations. The lower Monongahela was one of the busiest streams feeding upper Ohio River commerce.

However, on the home waters, opportunities continued to be restricted by navigational difficulties which placed constraints on local trade (Ellis 1882: 261-263). Boats still had to be rather small, and the greatest number of voyages to or from Pittsburgh were concentrated during spring and fall high water seasons. Otherwise the trips could be irregular, infrequent or canceled in the days before lock and dam slackwater. In 1840 the wharfmaster in Pittsburgh reported that there had been two hundred steamboat arrivals from points along the Monongahela, but the average weight of these vessels was only fifty to sixty tons, not much bigger than a large keelboat (Ellis 1882: 261-263).

Success was the mother of invention. Quite a number of steamboats were built on the western rivers within a short time of the successful voyages of the *New Orleans* and the *Washington*. An early Pittsburgh newspaper contained the names of forty steamboats built between the Monongahela and the lower Mississippi from 1812 to 1819 and added that twenty-eight more were under construction (*Elizabeth Herald*, June 7, 1900). Dr. William Howard's 1832 survey of the Monongahela River mentions that sixteen steamboats were built in 1831 at different points along the shores of the lower valley. By mid-century, the region had evolved into a major center of inland-river steamboat construction, followed by Wheeling, Cincinnati, Louisville and later St. Louis. Hundreds were employed in this industry, which grew until it came to produce more than one half of the steamers on the western rivers.

Many boats produced around Pittsburgh went downstream aiming at the Ohio and Mississippi trade, and so it would continue through the nineteenth century. But Monongahela builders were producing vessels for local use as well. Steamboat traffic here was the greatest of any river of its size in the United States (Wiley 1937: 130). For home use, they continually aimed at reducing boat weight while maximizing cargo capacity for the channel

depths available. Size solved some navigation problems, but small boats meant smaller cargoes.

Larger steamboats were built on the Monongahela, like the 175-foot *Mediterranean* at Elizabeth in 1833. Here and in Brownsville, yards became skilled at increasing the length and breadth of boat hulls, at the same time decreasing their depth. The technique was to increase the water plane, distributing weight over a larger surface area. Despite these accomplishments, more often than not just the hulls could be built in Monongahela pools and then floated down to Pittsburgh for completion (Kussart 1937: 62, 94). If the heavier components, such as superstructures, boilers, and engines, had been applied upriver, larger boats would have had too much draft to move downstream under ordinary water conditions.

The *Albion* was a more typical light Monongahela steamer of forty tons. It was built at Brownsville and spent the 1820s sailing between its home port and Pittsburgh. Another was the *Monongahela* built in 1828 and described as running the lower river “. . . whenever the state of the water will admit.” It was the first steamer ever to arrive in Morgantown during high water in 1828 (Kussart 1937: 64-65). An 1830 newspaper expressed the hope that such trips could become more frequent if “. . . a little improvement will afford three feet of water for six (months) of the year” (Kussart 1937: 61). Comments like this are frequent in the journalism of the time.

That same year—1830—the *Pittsburgh Gazette* stated that “the small steamer *Odd Fellow* plies regularly between Brownsville and Pittsburgh, her draught of water is so small that she will probably be able to continue trips during the whole season.” The dimensions of the *Elk*, built in Fayette City in 1831, were typical of these early Monongahela craft at twenty-nine tons, eighty-one feet long, thirteen feet wide and a hold of slightly less than three feet. When water was low, even steamers this small had to be replaced by keelboats, a procedure that raised the cost of transport (Kussart 1937: 65, 67).

The *Pittsburgh Gazette* on January 30, 1835 indicated the Monongahela trade was responsible for a total of 718 steamboat arrivals and departures in Pittsburgh that year. When seasonally unable to run, most of the boats then working there went into the Ohio River trade, to the detriment of local commerce. Smaller tonnage, lighter draft boats picked up some of the activity. Still, in 1835, keelboats running nine or ten months of the year did a total of \$40,000 worth of business on the Monongahela, while steamboats operating barely one-half the year did \$210,000 (Kussart 1937: 70). The speed and lower operating costs of steamboats were sorely missed when low water halted their service in the valley.

Travelers and freight shippers had to put up with irregular service. Low water periods meant doldrums for business, but in the early steam era this was just seen as the nature of things. They suffered further inconvenience from the informality with which early steamboats operated. Each steamer was a private enterprise, a “tramp-steamer,” that was sometimes quite transient, leaving one market for another depending on business circumstances.

A new type of operation came with packet lines that promised to carry passengers and freight on some semblance of a regular schedule. The concept had been known from keelboat days on the Monongahela. Two boats were the minimum for a packet line to function with evenly distributed return service between ports (Eskew 1929: 78-84). Organization was loose, but the Pittsburgh and Brownsville Packet Line was established in 1837 with two steamers, the *Liberty* and the *Shannon*. Its first year was considered a great success as spring water levels permitted three months of uninterrupted scheduled trips.

By 1839 business was brisk on the Monongahela. Six steamboats regularly plied between Pittsburgh and points upstream during a very busy freight and passenger season, three arriving and three departing daily. Still, in the midst of prosperity, the *Pittsburgh Gazette* wrote on April 2, 1839, "Improvement of this river is necessary, before we can derive from it all the advantages which it can furnish." A steamer named *Lebanon* was built that year in Brownsville but at 145 tons was too large to operate locally except when water was practically at flood stage.

The physical character of the river and the natural resources of the Monongahela Valley had a great deal to do with the location and operations of nineteenth century boatyards. These factors also fixed the structural design of steamboats and the conditions of their operations. They operated in shallow water in a semi-frontier area with few or no formal landing facilities. Early in the era, every effort continued to be made to lighten the designs. By the 1840s, external keels disappeared from boat hulls, their support function replaced by a keelson running the inside length of the hull (Watson 1985: 54-63).

A surviving boatbuilders' guide compiled in Freedom, Pennsylvania, in 1845 illustrates the unique lines of these early steamer hulls (Rogers 1845: n.p.). With that change, steamboats became practically flat-bottomed and able to land by running the bow into the mud of a sloping natural shoreline, close enough to reach freight and passengers by gangplanks. Given the frequent fluctuations in water stages, fixed shore positions, such as wharves, were impractical. This proved to be an advantage. Informal landings could be made at just about any village or rural point along the river, and not having to construct landing facilities kept expenses lower.

Nineteenth-century side or sternwheel steamboats had the maneuverability to negotiate landings at minor way points along the Monongahela River. This was referred to as "way business" and was too commercially important to be ignored. From the dawn of the steam era, it was standard practice to pick up or land freight and passengers on the river's edge. Prior to the arrival of railroads, access to this form of transportation was of great value to isolated farms and hamlets in the valley. For boat operators, the value rested in greater carrying volume and on their ability to demand higher rates for flexible service (Watson 1985: 89-112).

This trade required nothing more than a clearing along the shoreline and a prearranged stop signal recognizable to the eye of a river pilot. A boat delivering a blast on the whistle told anyone within hearing distance that freight was being deposited. When

slackwater navigational improvements eventually deepened river pools, hundreds of potential landing sites opened between Morgantown and Pittsburgh. Many of these shoreline locations are identifiable from local histories. Their significance as micro-level commercial sites in the lock/dam/steamboat picture is worthy of more historical recognition than they traditionally receive.

The more formal trade in passengers and freight was referred to as "through traffic." This transpired from fixed points with facilities that ranged from simple to complex. The most complex arrangements included a graded shoreline down to the river's edge (paved in brick in larger cities like Pittsburgh in later years), wharf boats (permanently anchored barges with building structures on them) and warehouses on shore for storage (Watson 1985: 89-112). Wharf boats were introduced in the 1840s but were not common until post-Civil War times. They were usually constructed from the hulls of retired riverboats with a deck cabin added. Packet companies had offices on wharf boats in terminals such as Pittsburgh.

All of this is significant for a number of reasons related to locks and dams. Regularized transportation service offered a measure of predictability to business and commercial exchange in towns anxious to shed their image of "backwoods" unreliability. Likewise, packet service shaped new public expectations about passenger boats meeting departure/arrival times as closely as possible for connections to other boats, stagecoaches, and later on railways. Packet operators came to pride themselves on speed and reliability. Advertisements in local newspapers boasted regular schedules but frequently with the caveat, "water permitting." In 1838 the steamers *Franklin* and *Pike* advertised themselves to be "light and fast, and commencing daily runs for most of the season between Brownsville and Pittsburgh" (Kussart 1937: 73). They must have been disappointed as 1838 saw extremely low water from summer through fall, and the *Pike* was eventually listed as sailing on the Ohio River.

It was difficult to maintain a reliable packet service with sailing conditions varying as they did. Steamboats became less of a novelty and more a part of everyday life. Operators, shippers and travelers were far less tolerant of deficiencies in service. Many little steamers ran the Monongahela with as much regularity as was possible. Water depth, however, did not yet permit the construction of structurally embellished vessels with large numbers of staterooms, elegant cabins and freight capacity. Such appointments would have made them draw entirely too much water for average river conditions. By the 1830s, both the Monongahela Valley business community and its newspaper editors had become more vocal in demanding river improvements designed to extend reliable navigation periods for larger boats.

LOCKS/DAMS AND TWENTIETH-CENTURY STEAM PACKETBOATS

Steamboating on the tributary rivers to the greater Ohio-Mississippi trunk system was often slow in developing. This was not the case on the Monongahela. Here boatyards continued to perfect improvements in the structural design, mechanical equipment and operation of new craft making them much in demand downriver. Add local mineral wealth, nascent industries and the continuing emigration highway through in the valley, and the Monongahela River remained not a tributary but the headwater of Ohio-Mississippi navigation for decades.

Locally too, steamboating grew extensively from the time of its invention, through the 1830s. Service was in demand on the Monongahela, and profits could be excellent, even if limited to high-water periods. Navigational difficulties on an unimproved river curtailed transportation, to the annoyance of many, but these problems did not prevent steam service from expanding within the six or so months of normally usable water.

Entry into the business was comparatively easy. Capital requirements were not huge; it cost about the same to open a quality dry goods store as to build a small steamboat. Financing boats did not require large amounts of eastern capital as railroads later would; river improvements, however, were another question (Haite et al 1975: 42-43). Typically, money was pooled locally by about four to six shareholding partners, often the boat or engine builders, steamboat officers and boat-storekeepers of a single town. This arrangement gave the business a "local feel" in the early days. The river was open and free, with no monopolies barring entry to newcomers. The formation of packet lines was the closest this business got to a consortium fixing allotted sailing days and rates, sharing particular wharf facilities, or other sorts of exclusive agreements (Eskew 1929: 78-84).

The several enduring Monongahela packet lines of the nineteenth century were not organized until the arrival of slackwater navigation. The river always had transient "tramp" steamers (arriving for short-term opportunities from the Ohio or Allegheny Rivers) and a host of independent Monongahela packets as well. There were no barriers to succeeding in this trade other than a highly competitive market. Rivalries existed among the various boats vis-a-vis speed, passenger accommodations and freight rates, but competition was difficult to restrict. Until the arrival of big coal interests, open market forces generally ruled the river (Haite et al 1975: 28-29).

Boatbuilding took off as well, with major yards developing in McKeesport, Webster, Belle Vernon, Monongahela City, Fayette City, California, Brownsville, West Brownsville and a host of lesser sites. Steamboating was increasingly woven into the fabric of urban and rural businesses. The production of supplies and labor for boat construction at one end and the transportation provided by the finished product at the other meant increasing economic productivity.

Nineteenth century sources show that by the 1830s, river improvements were recognized as being critical to regional prosperity. Their absence was seen as retarding the region by increasing the costs of local products and limiting commercial outlets (Veech 1873: 1-10). For a variety of political reasons, the Monongahela River received minimal support from state or federal governments embroiled in debates over the constitutionality of internal improvements (Veech 1873: 1-10). But as commerce increased, so did the clamor for change from disparate local interests.

One indication of public interest was the amount of public money spent by Pittsburgh for river landing improvements. Between 1824 and 1829, only \$2000 had been spent on maintaining the Monongahela wharf, but in 1830-1839 the amount of municipal expenditures increased to \$29,000 (Kussart 1937: 102). This reflected the increase in steamboat traffic and the revenues that it brought to the city. For the most part, however, Monongahela improvement had to rely mostly on private initiative until after the Civil War.

There had been numerous false starts in Pennsylvania in the area of river improvements. In 1808 legislators drafted a bill to protect river-control projects, and the Monongahela Navigation Company was chartered to construct dams on the river, an essential step in the maintenance of a reasonable water depth that would permit year round travel. The company failed in 1822, but local residents, with the assistance of the State Assembly, raised the capital to clear snags and boulders between Pittsburgh and Brownsville.

A state survey of the Monongahela was made in 1828, followed by a federal survey in 1832, which again proposed a system of locks and dams. A convention was held in Brownsville in 1835 and a committee appointed to petition Congress. Another Monongahela Navigation Company was chartered in 1836 for the express purpose of creating a slackwater system to the state line. Efforts focused on improving the river to develop a continuous navigation channel between Brownsville and Pittsburgh (Davis 1994: 10-12).

When the company actually began lock and dam construction in 1840 on the lower Monongahela, information was solicited from the wharfmaster at Pittsburgh about potential steamboat traffic. His report related that eight steamers were regularly running the local trade, carrying 14,916 tons of freight. About this time, small steamers began penetrating the Youghiogheny River, thus adding to the volume of traffic. Newspapers were overjoyed (*McKeesport Daily News*, January 28 and February 1, 1896). The first week of May, forty-two steamboats arrived in Pittsburgh from the Monongahela with huge quantities of flour, glass, coal, wheat, and other commodities.

The spring of 1841 saw high water for longer than usual, and a number of small steamers visited Morgantown, 102 miles upstream from Pittsburgh; one sailed on to the Cheat River ten miles beyond. Then came a dry summer with very little water. What should have been profitable river traffic in passengers and freight downstream to Pittsburgh was instead diverted at Brownsville to the National Road and overland to Wheeling. Intense commercial rivalry existed between the two river towns, and Wheeling joked that the Monongahela Navigation Company's efforts to slackwater the Monongahela were "... a silly

attempt at damming that little creek" (*Pittsburgh Advocate*, August 3, 1841). There were times when water at the Pittsburgh wharf was measured in inches not feet.

The two lower locks and dams on the Monongahela were finally open for use in October 1841. The rivermen were concerned that passage through the lock system would cause delays. Fortunately, at Lock No. 1 it required only eight minutes on the average, and at Lock No. 2, thirteen minutes was considered good time. Far from slowing business down, more steamboats were added to deal with the growing level of river business.

By December of 1841, navigation had improved so much that 138 steamers (and 936 boats of all types, flats, keels, etc.) passed up and downstream through Lock No. 1. One of them, the *Mentor*, was a large new 270-ton craft built for the Ohio River; observers were impressed when it successfully passed through the lock and on to Pittsburgh in good time. The new slackwater system gave a boost to trade as far as the raised water levels reached, which was about twenty-five miles upstream. There was so much business in Pittsburgh that the Monongahela wharf was again extended and improved, but at times the volume of traffic caused hours of delay for boats trying to land (Kussart 1937: 126).

The summer of 1842 was dry. Small packets continued to run as far as Elizabeth, but low water farther up left Brownsville goods piling up with no way to move them. In 1843 the Monongahela had the most prosperous year ever recorded, with large steamers running until yet another dry summer, and a break in Dam No. 1 left only a few small craft able to operate.

By now the benefits of the slackwater system had converted skeptics, and there were cheers when Locks/Dams Nos. 3 and 4 were completed in 1844. It is difficult for us to imagine the impact these pieces of engineering had on people at that time. Slackwater lock and dam systems had been attempted with varying degrees of success on several Ohio tributaries since the 1830s (Wayman n.d.: 271).

What was constructed on the Monongahela River was the first financially successful large-scale navigational improvement project in the United States (Wiley 1936: 166). These locks and dams were the engineering marvels of their day, huge in size compared to canal locks and mill dams, and massive in their accomplishment of raising water levels. Their success was noted throughout America's inland-river system. Locally, slackwater navigation to Brownsville resulted in an immediate increase in profitable business on the river. Steam-packet carrying trade and steamboat construction now entered into their era of fullest development.

Before 1844 scheduled packet service had been attempted but proved too erratic. Now more commodious packets were able to offer fairly dependable service. Passengers happily traded the National Road at Brownsville for comfortable river passage on the *Consul* or the *Josephine*, both 147 feet long, 127 tons, with staterooms and a large dining room. An even larger boat, the 155-foot *Louis McLane* at 149 tons, drew more water than had been considered acceptable for the Monongahela River. It was of sufficient bulk and engine power

to keep a channel open through fifty miles of moderate ice that winter, which only added to the reputation of steam travel.

The Brownsville and Pittsburgh Packet Company was founded in 1844 (*Elizabeth Herald*, June 7, 1900). It and its successor firm would be the leading name in river passenger and freight service for some time. They operated more than twenty large steamers over the span of seventy years. Above McKeesport there was no telegraph service until 1866. These Brownsville packets regularly delivered newspapers and were considered reliable enough to be contracted to deliver daily mail. At the same time, they carried an average of about ninety passengers a day. The eleven steamers regularly employed by all the various lines in 1845 carried an aggregate of 22,726 through passengers and 20,675 way passengers (Monongahela Navigation Company 1845: n.p.).

1846 saw freight service extended and a 20 percent rise in passengers and tri-weekly packet service from Monongahela City. Pittsburgh newspapers lauded slackwater improvement as having done more to advance the region than anything else in recent years (*Pittsburgh Post*, March 18, 1845). By way of land and water, good passenger connection time between Pittsburgh and Baltimore, was now thirty-two hours. During a single week in 1847, 750 travelers ventured from Cumberland, Maryland, to Brownsville via the Monongahela route to Pittsburgh. The Pittsburgh and Brownsville Packet Company advertisements emphasized the comfort of river travel from Brownsville on downstream by steamboat. After hours in a stagecoach or days on a freight wagon, a steamboat must have been considered luxury travel (Kussart 1937: 151).

There was a significant increase in the volume of eastern goods finding their way to western markets through Pittsburgh by this time. Records for 1852 indicate that 8,494,102 pounds of "eastern merchandise" were shipped through the Monongahela slackwater locks (Monongahela Navigation Company 1852: n.p.). The reputation of the city's primary landing site improved when the traditionally muddy wharf was paved for the first time in 1847. In the late winter of 1848, a record thirty steamboats were at the wharf waiting for the ice to breakup to begin regular Monongahela service. Upstream, the Pittsburgh and Brownsville Packet Company had constructed two new boats as large as the locks could take (166 feet) in anticipation of a good year. The *Baltic* and the *Atlantic* weighed in at 188 tons, boasting "no delays on route." Traffic increased to 47,619 through and 51,739 way passengers for all points on the river that year (Monongahela Navigation Company 1848: n.p.).

The boat yards and engine works along the Monongahela reached the height of their reputation and production volume in the 1840s and 1850s. Hundreds of hulls and completed steamers were produced to meet the demand from both local and downriver customers (Wiley 1937: 133-134). Between 1852 and 1856 362 steamboats were built between Brownsville and Pittsburgh, as well as an undetermined number of barges and flatboats. The *Peytona*, built by the Coursin firm in West Elizabeth, was written up in newspapers from the Mississippi to the Monongahela when it sailed from New Orleans to Louisville in a record six days.

Monongahela steamers still set the standard for other inland boatyards to imitate. Larger boats intended for the Ohio and Mississippi Rivers were built once the slackwater system in the valley permitted it. The names of former and newly built Monongahela steamers constantly turned up in newspapers in reference to the excellent service rendered wherever they went (Ellis 1882: 270).

Left out of these achievements were the communities of the upper Monongahela beyond Brownsville. Occasional runs were made in small steamers to Morgantown, natural water permitting. But at mid-century this was irregular, and merchants in Fairmont (then Virginia) were begging steamers to brave the shallows and initiate service. This remained a rare occurrence until slackwater reached that far south. It was common by the 1850s for lower Monongahela boats to have hulls with five-foot depths (Way 1983: various boat entries). Boats attempting to reach the upper river were generally of smaller dimensions, rarely exceeding three-foot depths a situation that limited cargo capacity.

In 1850 steam navigation on the Youghiogheny River began with the completion of a privately-built three-stage lock and dam system (Ellis 1882: 261-263). A new plank road connected Cumberland, Maryland, to West Newton, Pennsylvania, and for a time this town was an important little port enjoying moderate freight and passenger traffic (Veech 1974: 13-14). Like the Monongahela River route to Brownsville, Youghiogheny River passage was connected ultimately by coach and railroad to Baltimore and Philadelphia. Both of these routes initiated an important through traffic that grew to immense proportions by the standards of the time (Wiley 1937: 143). This resulted in an increased volume of traffic into the lower fifteen miles of the Monongahela and an improvement in commerce for Pittsburgh merchants.

In 1851 about eight thousand more passengers traveled downstream by steamboat to the city than in the previous year. The 158-foot sidewheeler *Farmer* was intended to operate from West Newton but proved too large for navigation; a successor, the *Youghiogheny*, at 119 feet and a light 78 tons was more realistic for a low-water boat. This boat carried both passengers and freight very profitably. Another steamer, the McKeesport-built *Thomas Shriver*, double tripped on a daily basis between West Newton and Pittsburgh. One Pittsburgh observer was "astonished at the amount of freight brought to this place within a few days from points up the Monongahela and Youghiogheny Rivers" (*Pittsburgh Post*, February 27, 1852).

Freight tonnage increased dramatically during the first decade the slackwater system was in operation. The Monongahela shore was touched by stretches of productive farmland, and agricultural and livestock products finally had a greater number of outlets. The year 1852 saw 2,879,310 pounds of pork and 181,260 pounds of butter and lard sent downstream to Pittsburgh (Monongahela Navigation Company 1852: n.p.). Towns and villages along the valley also produced a variety of heavy manufactured goods, such as glass, bricks and processed lumber products that could be transported with greater facility. Again for 1852, the Monongahela Valley sent out 5,027,293 feet of cut lumber and 98,361 tons of bricks (Monongahela Navigation Company 1852).

Of great economic significance was eastern merchandise that began to arrive for Pittsburgh consumers (as well as for those living farther down the Ohio and beyond), as well as exports to the west. The hauling of extractive minerals, such as coal, iron ore, salt and stone, had begun in the 1830s. In 1845 steamers and flatboats moved 4,605,185 bushels of coal; five years later the amount had risen to 12,297,967 bushels. In the long run it was coal that steadily provided greater tolls for the Monongahela Navigation Company as the slackwater system served the regional economy.

In 1854 the Youghiogeny dam system was seriously damaged and never successfully repaired. While attempts continued to be made to run that trade with shallow draft craft, for the most part, steamboating ended with a breakdown of the slackwater system on this once-successful route (Veech 1974: 13-14). When repairs were required on Monongahela locks and dams, newspaper editors grumbled, and the public was reminded of the extent to which they were dependent upon the water levels maintained by the Monongahela Navigation Company.

In 1852 an interruption of service at Lock No. 2 required steamers to transfer cargoes and people around the dam from one boat to another for about six weeks. This process was inconvenient, but water levels were maintained. On more than one occasion, thick winter ice closed the river for extended periods, and everything came to a halt. The first three months of 1856 were lost to navigation this way, and they were followed by a low-water summer that made steam passage difficult (Kussart 1937: 246).

The only redeeming event on the Monongahela in 1856 was the improvement of the river with the opening of Locks and Dams Nos. 5 and 6, extending a navigable channel to New Geneva, Pennsylvania, eighty-five miles above Pittsburgh. It would be three decades more before slackwater was extended to Morgantown. Alert for extended business, the Brownsville and Pittsburgh Packet Company had a new steamer, the *Telegraph*, built in California, Pennsylvania, and named for the latest invention suggesting speed (Way 1983: 445). Like most of these packets it generated a handsome profit. By the time this boat was eventually retired in 1866, it had carried 179,309 passengers and paid \$28,612 in tolls at the Monongahela Navigation Company locks over the span of a decade (Way 1983: 445). The Brownsville and Pittsburgh Packet Company had negotiated agreements for carrying through-passengers and cargo, making them an essential link in a transportation chain that connected its packets with stagecoaches on the National Road and with the Baltimore and Ohio Railroad. The latter had reached Cumberland, Maryland, by 1852, and from there, passengers and freight could move on to the eastern seaboard.

The year 1854 was significant for the arrival of rail transportation in the Monongahela Valley. A new Pennsylvania Railroad track and tunnel system was completed connecting Pittsburgh to Philadelphia. While some portion of traditional steamboat business was lost, local carrying within the valley maintained itself for the time being (Ellis 1882: 272-273). But steamboat operators were more anxious than ever to improve service.

In 1853 after years of requests, the Monongahela Navigation Company began to enlarge the existing Lock No. 2 and add a second lock chamber to facilitate more and larger steamer passages. Boat operators hoped this would help them operate more efficiently against emerging railway competition. There were criticisms that the locks were inadequate (Veech 1974: 9-20).

Even an improved navigation system could not completely solve the problems associated with extreme drought and ice. For several months in 1854, the river dried up for lack of rain, and a number of newly-built boats had to be sold for lack of business. This hurt steamboats in their competition with railroads since the latter were unaffected by such seasonal changes. A cursory reading of newspapers for 1854 through 1857 reveals numerous interruptions in river traffic due to the weather. To this was added the one or two months a year that boats were customarily taken out of the water for maintenance.

Steamboat design and machinery weight continued to be perfected as much as possible in the local yards to permit larger boats with very shallow drafts to operate in low water conditions. Monongahela boatyards maintained their reputation for producing strong oak hulls capable of taking a beating on sandbars and ripples anywhere in the inland river system. They were preferred above all others on the newly opening Missouri River which presented extremely difficult navigation conditions requiring strong, light craft. Monongahela boats had superstructures largely constructed of thin pine and poplar to reduce weight (Lass 1962: 107-111). The *Argos*, a sternwheeler of that era which ran locally, drew only eight-and-a-half inches of water, despite its 115-foot length (Way 1983: 28). But occasionally at the Pittsburgh wharf, the river measured less water than that!

During dry summers, the Monongahela slackwater system generally kept steamers afloat at the wharf, but it was often unable to support consistent service farther upriver until nature again elevated the water levels. Low water had a negative impact on a packet line's reputation. Passengers and shipping companies experienced serious inconveniences during periods of interrupted service. One attempt to deal with this problem accidentally initiated a whole new transportation era on the river.

The innovation began with the practice of lashing wooden barges to the port and starboard sides of a steamer as a solution to low water. The idea was to lighten a boat by distributing its cargo over a greater surface area, while at the same time increasing freight capacity (Way 1990: xii). This system worked more easily with sternwheel than sidewheel steamers. During the 1850s, more of the former began to emerge from the boatyards as informal towboating activity increased. The *Dr. Kane*, an example of this type of sternwheeler, was launched in Brownsville to haul emigrants and freight barges from the Monongahela to the upper Mississippi.

By the 1850s, steamboats constructed in Brownsville offered every form of luxurious accommodation, dining, and speed. Newspapers suggest that when water was abundant, river navigation rebounded vigorously from the doldrums. The slackwater system afforded plenty of water during the spring and summer of 1857, allowing steamboats to make regular trips.

There were enormous farm harvests that year in the valley, but by late September there were “. . . no departures, no arrivals, no business, no rain and no prospects of any” (*Pittsburgh Gazette*, September 18, 1857). Freight wagons and railroads carried most of the crop at increased cost to Pittsburgh, while thirty-five steamboats remained anchored at the city wharf for several weeks.

At other times, it was not the Monongahela but the Ohio that was the problem. While the slackwater pools on the Monongahela might be sufficiently full above Lock No. 1, the upper Ohio river level could fall so low that the mouth of the Monongahela had too little water to permit navigation out of Pittsburgh. Under these circumstances, the main wharf became useless, and boats had to land in the vicinity of Lock No. 1.

There were complaints that the city government of Pittsburgh profited from wharfage fees but too infrequently dredged the river leading to the landing (Kussart 1937: 453). This situation could make it nearly impossible for steamboats to approach shore in low water. Not until the Corps of Engineers regularly began dredging in 1910 was the task regularly attended to (Kussart 1937: 722). Prior to construction of the Davis Island Dam on the Ohio in 1885, only a rise in the Allegheny River could back water up into the Monongahela sufficiently to allow navigation to resume.

During the year 1860, with the exception of a short period of January ice, river navigation was not suspended for a single day because of low water. The Brownsville steamer *Gallatin* ran the fifty-five miles and four locks to Pittsburgh in a record five hours. The large, white-painted sidewheel steamers offering splendid accommodations continued to hold their own with passenger traffic in the valley. They were comparatively inexpensive and offered a touch of luxury for ordinary people that rail travel could not match. But, as so often happened, good years were followed by bad. The autumn of 1862 saw water so low few steamers even attempted trips to Pittsburgh (*Pittsburgh Post*, October 1, 1862). Those that did had to land above Lock No.1, discharging passengers and cargo there. All of this meant scarce goods and higher prices in every commodity from the Monongahela Valley.

Local way passenger and freight traffic continued to hold its own through the 1860s. There was as yet no railroad running directly along the Monongahela above McKeesport, a situation that allowed packets to operate without competition in the lower river for a few more years. Steamers remained popular because of the spontaneity with which an accommodating steamboat could respond to a call from the river shore.

In 1865 the Monongahela Navigation Company reported that 24,539 passengers traveled through the length of the river, while 110,899 way passengers commuted shorter distances on it (Monongahela Navigation Company 1865: n.p.). The Company report for 1866 relates that passenger packets were running quite well when nature and slackwater combined to allow regular service. Five steamers did double daily trips connecting Pittsburgh to Brownsville that year. A new packet company, the People's Line, connected New Geneva to Brownsville and Pittsburgh three times a week with two locally constructed boats. Both lines added small, light draft boats to keep on hand to replace the large packets

in low water. The little Brownsville steamer *Active*, which drew only ten inches of water, was described as splendidly furnished for passenger travel to Morgantown (*Commercial*, September 21, 1867).

On the Monongahela, the best years for boat construction were from the initiation of lock and dam slackwater in 1841 through the late 1850s. Combined passenger and freight packet traffic was at a high volume with minimal competition from rail transportation. Rivalries among steamboat lines kept prices fairly low and service as close to scheduled times as possible. New boats were frequently ordered, and newspapers spoke of them in very excited terms. In general, Monongahela packets catered less to affluent travelers than to a more local trade. These boats usually exhibited excellent practical designs, in contrast to Mississippi steamboats which became quite flamboyant in the age of the "Steamboat Gothic" style (DuPae 1995: 39).

Steam calliopes were placed on some of the Monongahela boats for entertainment. People lined the riverbank near the locks and dams to watch rival steamers race full speed to be first to pass through the Monongahela locks (Wiley 1936: 169). Disputes over precedence were common, as the winner could keep well ahead and on schedule. Daily racing between the Pittsburgh and Brownsville Packet Company and the new People's Line packets became so heated and dangerous that a judge forbade the practice in 1868. The two lines eventually consolidated to form the Pittsburgh, Brownsville and Geneva Packet Company (*Elizabeth Herald*, September 1, 1900).

All of this provided novel advertising that helped riverboat travel remain popular despite intermittent seasonal interruptions. Another line of packets between Pittsburgh and Elizabeth operated large side-wheelers on daily round trips from the late 1840s until the early twentieth century. In the 1870s, Elizabeth's Lock No. 3 gate system was improved and passage time quickened. Residents of that town saw the lock as an integral part of the community (Wiley 1936: 131-132). Still other packets ran the Monongahela City-Pittsburgh trade for many years. According to an advertising card dating to about 1918, small boats such as the yacht-sized *Hazel L. Watson* continued this tradition, plying between Lock No. 4, Monessen, Donora and Webster until the First World War.

Over the years, thousands of people were served by these river steamers which operated as well as they did only because of the co-evolution of boat design and slackwater improvements. Beginning in the 1860s, however, the public gradually came to think of railroads as offering more predictable service. Business interests complained that, although steamboats ran passengers cheaply, the high rates charged for freight hurt manufacturers and farmers. Still, as locks and dams improved, traveling times were reduced, and the number of yearly voyages completed by steam packets on the Monongahela increased. This encouraged a variety of small freight-carrying services for which railroads had not yet demonstrated superiority (Haites et al 1975: 120). The barge lines had the advantage of lower freight rates for trunk line quantity shipments, but until railroads completely took over the short-haul trade, steam packets held on to a share of the commerce (Wayman n.d.: 314).

The slackwater system had been a boon since the 1840s. However, it could not manipulate the river against the extremes of weather and the seasonal nature of river navigation. Goods could pile up in storage at town wharves, farms and villages along the shore profiting no one, while boats waited for higher water. When a seasonal freshet finally arrived and conditions improved, large quantities of goods were suddenly dumped on the market, and prices fell. Newspapers frequently complained about this state of fluctuating economic affairs. This was reinforced with the pressures placed on river transportation during the Civil War as Pittsburgh became an arsenal bustling with strategic industries for the Union Army. Many regiments and tons of equipment were shipped through the city by way of the rivers, but the demands of the war years also accelerated the construction of railways.

The completion of each new mile of rail track slowly diverted more trade traditionally carried by the packets. Sections of the Pennsylvania Railroad emerged by fits and starts in western Pennsylvania. The first track connection between Pittsburgh and Philadelphia came in 1852 and had an immediate effect in reducing the Monongahela trade from Brownsville. On the Youghiogheny it was difficult to maintain the privately owned locks and dams that permitted a once-profitable steamboat service on that tributary (Ellis 1882: 270-272). The arrival of the Pittsburgh and Connellsville Railroad in late 1861 ended any further attempts to repair that slackwater system, and river commerce on the Youghiogheny ended. In 1868 once-profitable packet operations on the Allegheny River ceased after the completion of the Allegheny Valley Railroad (Kussart 1938: 265-268).

When in 1870 the Pittsburgh, Virginia and Charleston Railroad was proposed to run along the length of the Monongahela River, the handwriting appeared on the wall, but years would pass before notable changes drove packet steamers from the river. The railroad that ended Youghiogheny navigation actually increased Monongahela River traffic for a time (Ellis 1882: 271). In 1871 McKeesport found itself at the end of the line on a rail system connecting to Cumberland, Maryland. Passengers who traveled by rail to McKeesport could then transfer to steamboats to carry them to Pittsburgh via the Monongahela (Abbott and Harrison 1876: 28-29).

After 1873 the economic climate in the United States delayed the expansion of railroads any farther up the river than Monongahela City. In 1874 the Monongahela Navigation Company reported that freight levels remained good but that the passenger trade was decreasing (Monongahela Navigation Company 1874: n.p.). Faced with this competition, packet boats lowered fares, offered free sleeping cabins, and made special arrangements with lock tenders to give preference to passenger over towboats. A rivalry between railroads and steamboats for the Monongahela trade came with the 1870s. Packet freight tonnage fell by 75 percent during the thirty-year period 1870-1900.

With this state of affairs, there was greater incentive to complete locks and dams on the upper river in order to increase the range of business. The federal government finally became involved with the construction of Lock No. 9 just within the West Virginia line in 1879. But this meant little for slackwater navigation until the Monongahela Navigation

Company completed Lock No. 7 below New Geneva near the mouth of Jacob's Creek five years later in 1884 (Ellis 1882: 267-269).

The slowness of the railroad companies to complete lines on both sides of the river gave the packets a grace period in the later nineteenth century. On the western side, the Pittsburgh, Virginia and Charleston Railroad pushed very slowly up the shore, not reaching West Brownsville until 1881. It was 1888 before a rail line would run the eastern side of the Monongahela south from McKeesport. By 1889 it had reached Belle Vernon, but not until 1903 did it reach Brownsville.

It was critical for river business that the slackwater system be improved into the upper river, but this too happened at a slow pace. The government completed Lock No. 8 in 1889, thus creating the first reliable and continuous navigation channel to Morgantown (Wiley 1937: 210-213). Railroad and other kinds of low bridges were always a problem for Monongahela packets. Since they could not have lofty superstructures like their Mississippi counterparts, they tended to have somewhat lower profiles. Smokestacks were designed to be lowered up to eighty-five degrees and rest on wooden yokes behind the pilot house to allow bridge clearance during high water (DuPae 1995: 39).

One important development that kept the packets sailing on towards the twentieth century was the growth of an excursion business. Beginning in the 1880s, newspapers gave accounts of the pleasures of a day excursion on the upper Monongahela to New Geneva or, conditions permitting, on to Morgantown. This was part of a wider cultural phenomenon that involved middle-class Americans with leisure time taking trips just out of curiosity and enjoyment (Hilton 1976: 130-131). They could escape the smoke and grime of Pittsburgh on a steamboat that served as hotel, restaurant and fishing boat. In 1882 not a single day was lost to low water, and excursion packets had to refuse passengers for lack of space much of the year (Kussart 1937: 493). There were trips for all occasions as Locks Nos. 7, 8 and 9 extended slackwater into some of the most attractive sections of the upper Monongahela into West Virginia. Here expanses of pristine river and magnificent landscapes found tremendous public appeal.

The steamer *Adam Jacobs* was an example of the new excursion-oriented craft. It was a pure Monongahela boat built in the Axton Yards in Brownsville with machinery from the Herbertson shops of the same town (Way 1983: 5). The *Commercial Gazette* on September 16, 1885 described it as 166 feet long, thirty-two foot beam, and requiring only thirty inches to float comfortably. The cabin was finished in hardwoods; electric chandeliers illuminated first class meals accompanied by music, and staterooms were inexpensive. For years this and other boats met with an enthusiastic reception from picnic groups, Sunday schools, rowing clubs, social organizations and lodges, fishing clubs, etc. The *Pittsburgh Telegraph* on November 12, 1885, carried a lengthy account of such an excursion:

No trip for recreation and pleasure can be made out of Pittsburgh so cheap, (\$2.00 with meals) and affording so much enjoyment as one up the Monongahela Valley. While Pittsburgh has been steadily extending her great industrial establishments. . .the opening of additional locks

will give navigation to Geneva and Greensboro. These are becoming quite a resort during the heated summers for hard worked families to enjoy and then return to their homes more benefited than if they had visited some fashionable summer resort in the East.

By this time the lock and dam system was functioning so well that in spite of an unprecedented drought and absence of freshets in 1887, steamers lost not a single sailing day, except a few due to winter ice. Locks Nos. 3 and 4 had second chambers added in the 1880s that were enlarged to 56 by 277 feet, which set a new dimension standard for improvements on the lower river. This, coupled with more consistent water levels, increased steamboat carrying capacity, sailing seasons and overall productivity (Haites et al 1975: 72-73). The records indicate that 50,584 passengers of all sorts were carried that year (Monongahela Navigation Company 1887: n.p.).

The lock and dam system was inseparable from a financial profit. In 1889 the government completed Lock and Dam No. 8. The Pittsburgh, Brownsville and Geneva Packet Company's three boats began regular trips to Morgantown amid general rejoicing in the West Virginia newspapers. Even at that late date when railroads otherwise eroding business, daily through trips by steam packets to Pittsburgh were, for a time, popular again. In 1890 17,062 people made the direct voyage, while 52,681 way-passengers were carried on local trips, and 11,201 were listed as excursionists. Long navigation seasons permitted sailing during much of the 1890s. The number of excursionists increased to 38,619 in 1894, while through-voyagers to Pittsburgh numbered only 12,339. By 1897, however, the total had dropped to 3,643. Apparently this class of service was being lost to the railroads, in spite of almost uninterrupted sailing days permitted by an improved slackwater system (Monongahela Navigation Company 1890-1987: n.p.).

The excursion business continued to evolve, but the packets were no longer locally built. While this class of steamers kept sailing into the twentieth century, the decline of passenger boat building along the Monongahela River happened much earlier for a variety of reasons. One was a decline in locally available timber; sources of virgin oak so long used in the construction of hulls became increasingly scarce in the quantity and dimensions required (Wiley 1936: 82). Likewise, the slow push of railways up along both banks of the Monongahela cut through the traditional boatyard sites or placed too many obstructions along the shores to permit further operations requiring launchways. Some felt that the railroads did this deliberately to ruin the industry and lessen competition for passengers and freight (Wiley 1936: 82).

The locks and dams that had initially promoted steamboat building in the end also hastened the industry's demise in the valley. The inland river operators began to call for larger hulls and boats. By the 1880s, the type of boats in demand became too large for easy passage through the Monongahela slackwater of that era. When the hulls for the huge 250-foot by 49-foot Missouri River steamers *Montana* and *Dacotah* were constructed in the McFall yards in California, Pennsylvania, they had to await a freshet to float their five-and-a-half-foot deep hulls over the dams, as they could not pass through the lock chambers. This

was dangerous to do without injury, and the *Montana* was almost lost in the process at Lock No. 3.

One hundred sixty-eight steamboats and hulls had been built in California over the years; the *Montana* and the *Dacotah* were the last. Less than a month after their launching, the railroad cut its tracks directly through the yard destroying it (Hornbake 1949: 27-28). In Elizabeth the last phase for the old yards came with conversion to building coal barges in the 1870s. They were in high demand and required less quality timber and smaller scale construction operations.

Turn-of-the-century passenger steamboating could still do well. New craft were added to the old lines, and the new Mason Line arrived into the Monongahela's upper pools. Now that the slackwater system was fully operational, larger passenger packets were purchased and smaller ones sold. The *Admiral Dewey*, at 120 feet in length and 137 tons, was only two years old when sold in 1900 as by then too small for the trade (Kussart 1937: 640). That same year the *Francis J. Torrance* arrived from Marietta, Ohio. At \$60,000 it was said to be the grandest boat ever to sail here and the biggest. With a 211-foot length, 667 tons and a 6.4-foot hull depth, it would have been impossible to navigate on the upper pools in earlier years (*Elizabeth Herald*, September 1, 1900).

Locks and Dams Nos. 10 to 15 were completed by 1905, extending navigation to Fairmont, West Virginia. There had never been consistently reliable navigation to the headwaters before, but now small freight boats and larger excursion packets began operating there. The *I.C. Woodward* and the *Columbia* would be the last big packets to run the Monongahela. There were some efforts to begin another new steamboat line, the Pittsburgh and Fairmont Packet Company, in anticipation of business. The Fairmont packets did excellent excursion traffic, partly because Pools 13 and 14 had become a famous destination for camping, hunting and fishing clubs.

However, in the long run, profits were not forthcoming at the anticipated level. Industrialization was polluting the river with acid to the extent that steamers were faced with great expense because of boiler corrosion (Kussart 1937: 741). Gradually, some of the larger boats were sold downriver and not replaced. The *Woodward* continued to run between Pittsburgh and Morgantown until 1912, along with a few smaller packets that alternated between Ohio and Monongahela River excursions out of Pittsburgh. But by this time, the Pennsylvania Railroad had reached the upper pools, and packet navigation of the Monongahela River ceased around 1916. It was no longer a paying proposition. In 1920 there was a brief attempt to revive excursions to Fairmont, but against existing railroad competition the steam packets finally passed into history.

LOCKS/DAMS AND THE MONONGAHELA RIVER COAL TRADE

It was of the utmost significance for the Monongahela Valley that its surrounding hills were filled with conveniently located, high quality natural resources, which could further an industrial evolution. Timber, farmland, iron ore, limestone and rich bituminous coal fields predestined the Pittsburgh area to emerge from its frontier origins into an emporium of western commerce (Reiser 1951: 2-3).

Coal was especially significant. The English garrison at Fort Pitt began mining the seemingly inexhaustible beds of the fuel from Coal Hill (Mount Washington) on the south side of the river. Commercial extraction dates as far back as 1784 when the Penn family sold privileges to this "great seam" (Kussart 1937: 783). The fuel was used not only in processing glass, bricks and iron but was the leading determinant in production sites being located on the south side of the Monongahela River, which was most accessible to coal deposits. As steam-powered manufacturing grew during the War of 1812, coal assumed even greater importance. Some of the earliest roads and river crossing improvements running up to Six Mile Ferry (Streets Run Creek) were predicated on the coal trade (Kussart 1937: 792).

Early mining was little more than primitive pit digging. However, the quantities of fuel extracted were inexpensive and consumed in sufficient quantities to put a smoky canopy over the city quite early in the nineteenth century. In 1834 ninety steam engines consuming 2,165,306 bushels of coal (twenty six bushels equal approximately one ton) powered various Pittsburgh factories and mills (Kussart 1937: 818).

There is mention in 1809 of coal being placed in boats for shipment down the Ohio River to Cincinnati, where it was scarce and in high demand. In 1837 one-half of the coal mined in the lower Monongahela Valley, 1,605,680 bushels, was shipped down the Ohio on flatboats (Harris 1837: 174-175). The implication of these numbers is that a large number of rivermen were primarily concerned with building and operating coal boats. An estimated 3,000 Western Pennsylvania men were engaged in these activities in one way or another (*Pittsburgh Advocate*, January 5, 1838).

Pittsburgh was ideally placed for growth in the steam age. Located at the head of navigation on the Ohio in one direction, and with a valley full of Monongahela coal behind it in the other, the city was poised to develop into a major export as well as a manufacturing center. The iron and rolling mills were increasingly burning mineral fuel, and blast furnaces were not far in the future (Fogel and Engerman 1971: 235). Flat-bottomed current and steering oar-propelled boats hauled loads of fuel from mining villages further upstream when coal supplies closest to Pittsburgh grew thin. From 1828 on, the Street's Run Creek area was mined intensely to supply Pittsburgh's needs. As exploitation increased, wooden slide tipples became a common sight along the river shores. Coal moved down chutes directly onto flatboats or into storage areas by the river awaiting shipment.

The river craft employed were not much different from the flatboats used to transport emigrants and freight in the eighteenth century. Essentially they were large clumsy boxes which any carpenter could put together out of raw lumber. As late as 1844, an eighty-footer could be purchased at Pittsburgh for as little as sixty to seventy-five dollars (Hunter 1949: 54). With minimal change in the arrangement of timber beams and planks, the same yards could produce both passenger or coal boats. The latter were required to be somewhat more substantial to deal with the weight and had higher planking on the sides. Like other flatboats, they were one way craft broken up for their lumber value after completing a trip.

There are numerous references in the early newspapers to coal shipments from the Monongahela River on just about anything that would float. Keelboats were also used in the early days of this trade. The *Pittsburgh Gazette* on February 7, 1789 related an incident in which a keelboat full of coal was lost, and most of the crew drowned. But flatboats carried a greater volume and handled the bulk of the business.

This sort of voyage was not especially extraordinary for valley entrepreneurs from small farmers to full-time coal operators. W. H. Brown, whose descendants later owned a fleet of towboats and barges operating out of Brownsville, began as a small time transporter in the 1830s (*S & D Reflector*, September 1989). Members of the Jones family, who operated a ferry in Pittsburgh, on several occasions sent sons as pilots on coal boats (Kussart 1937: 862). By the 1820s newspapers abound with references to Monongahela coal arriving at the city wharf by river during high water seasons. When water was low, the traffic came to a halt, much to the distress of all classes of people dependant on the fuel (Veech 1974: 4). When it had to be transported overland, the costs went up.

The coal trade had assumed some importance by the 1830s, but it was handicapped by uncertain navigation (Reiser 1951: 60). Still, from early times, the river was definitely the preferred method of cheap and reliable delivery, and tonnage figures increased. One hundred coal-laden flatboats were counted between Pittsburgh and Brownsville during the winter of 1833 awaiting navigable water (*Pittsburgh Gazette*, December 3, 1833). During a freshet in November of 1834, seventy-five flatboats arrived in one week bearing 245,000 bushels. In the days before towboating, packet steamboats attempted to accept as much of this cargo as they could transport on deck in baskets and sacks after accommodating other freight and passengers. But the all-purpose steamboat had relatively little share in the coal hauling business.

The transportation of coal would play a great role in the movement to improve the Monongahela River, but, as was the case with steam packet boats, coal operators would also have to endure drawn out delays and inconveniences before the slackwater system became a reality. The Monongahela River Navigation Company thought of the emerging coal trade as potentially a great source of revenue when their lock and dam system would be completed.

When loaded coal boats were delayed because of low water, it was a financial disaster and a physical disaster as well. If not taken downstream before winter set in, ice frequently destroyed boats and cargoes. In 1837 losses amounted to \$400,000. In 1838 150 flatboats

were stranded for three months waiting for a rise in the Monongahela (Monongahela Navigation Company 1839: 30). In 1840, unable to move due to low water, coal boats were caught in winter ice, and all of them between Brownsville and Pittsburgh were sunk. An unimproved river made the hazards of successfully landing these square ended cumbersome craft a skilled art form.

This situation began to change with the completion of Locks and Dams Nos. 1 and 2. In the first two months of operation in 1841, 1,200,000 bushels of coal went through the new facilities, arriving in Pittsburgh before winter set in. The price of coal went down by about one-half with the increase in shipment and a lowering of insurance costs (Kussart 1937: 871-872). By 1843 Pittsburgh newspapers were praising the lock and dam system as having saved Pittsburgh some \$700,000 in reduced fuel costs, not to mention less anxiety with more regular supplies now reaching the city (*Pittsburgh Post*, September 11, 1843). This certainty of delivery greatly accelerated Pittsburgh manufacturing.

It is clear that the slackwater system immediately altered the entire coal trade by providing reliable water at the loading areas near the mines. Prior to that, the industry was dependent upon uncertain river freshets in the lower pools from which almost all of the coal was mined until after the Civil War era. Since major urban centers from Cincinnati to St. Louis and on to New Orleans looked to the Monongahela Valley as the principal supplier of their coal, river improvements here were essential for reliable delivery on all the inland waterways (Evenson n.d.: 387ff).

By the time Locks and Dams Nos. 3 and 4 were opened in late 1844, coal shipments were moving regularly in ever-increasing quantities, unless the river was frozen. The year 1845 saw 4,605,185 bushels pass through Lock No. 1 into Pittsburgh. The following year shipments doubled (Monongahela Navigation Company 1845, 1846: n.p.). Clearly it was not just the accessibility of coal fields near Pittsburgh that was the issue here. It was the rapid evolution of a transportation system that facilitated shipment. The slackwater system definitely had made it possible for the coal trade to develop with fewer navigation handicaps (Reiser 1951: 63).

Pittsburgh as a manufacturing center enjoyed the luxury of very inexpensive fuel. When Monongahela coal was shipped farther down the Ohio or Mississippi Rivers, transportation costs increased fuel prices, placing downstream manufacturers at a disadvantage (Gould 1889: 497-508). In Pittsburgh coal was four cents a bushel, while in Cincinnati it averaged eleven cents, and in Louisville up to fifteen cents. There is no question that great quantities of coal, cheaply and regularly transported, was at the core of Pittsburgh's early manufacturing development (Reiser 1951: 53-68). Reductions in transportation costs increased demand and provided a buoyant influence on flatboat building. Individually these boats were but a modest capital investment; collectively their construction by the thousands generated a significant income for western Pennsylvania timber and river construction industries in the middle decades of the nineteenth century.

Increased demand led to congestion at the locks. In 1848 No. 1 had a second chamber added; this was replicated in 1854 at Dam No. 2. Deeper slackwater encouraged the building of larger coal flatboats with deeper drafts. Many of these were constructed from Allegheny Valley pine trees in the vicinity of the mouth of the Clarion River or farther north on French Creek to supplement those coming from the Monongahela yards.

Flatboats were built upside down on cradle structures in yards along the riverbank and then flipped into the river. Skilled builders typically launched two a week and up to 750 a year (Way 1990: xiii). By the late 1840s, they averaged one hundred feet in length and twenty-four feet wide and were still steered by sweep oars on the sides and stern. Lengths of up to 150 feet were not uncommon, but the dimensions of the locks limited how large they could emerge from the Monongahela yards. Eventually only the bottoms were built along the Allegheny; the pine siding, caulking and finishing work was completed at the numerous Monongahela boat yards. Most of the larger ones intended for Ohio and Mississippi River service were finished in the Allegheny Valley, as the early Monongahela locks were unable to accommodate them (Kussart 1938: 273-279).

Coalboat pilots as well as boat builders were in very high demand as navigation evolved into a more skilled profession with increased boat size. These cargoes were worth thousands of dollars. Boats were lashed together side-by-side in pairs for greater stability and volume, and the slackwater system now necessitated guiding these traditionally unwieldy flatboats into lock gates, not just into a natural river channel. McKeesport, Brownsville, Point Perry (Braddock) and other towns were proud of family names such as Dravo, Gilmore, Brown, McFeeters, Packer and countless others emerging as a new class of professionals adding much to the regional economy.

Traditional coalboat crews were thought of as a specialized class of workers. When the conversion to steam towboating began, many of these men would bring their river knowledge to the pilothouses and decks of Monongahela steamers, becoming their pilots and crews (Gould 1889: 497-508). McKeesport was one town whose economy depended upon this trade in terms of boat building and the large number of men employed on crews. The vicissitudes of winter ice or low water brought hardship to the community (Abbott and Harrison 1876: 27-32). By the 1860s coal had become one of the most commercially significant aspects life in the Monongahela Valley-Pittsburgh economy (*Pittsburgh Commercial*, October 26, 1869).

The flatboat delivery system continued after the Civil War for economic reasons. Until then a few hundred dollars bought a pair of substantial boats. There were no fuel costs; crews were small (six to twelve); depreciation was not a factor as they were still constructed for one-way trips, and salvage revenue could be subtracted from costs (Haites et al 1975: 165-169). The Monongahela slackwater system lowered insurance costs on this traditionally hazardous work. Thus coal flatboat rates could be consistently lower than steamboat tow rates (Haites et al 1975: 165-169).

The disadvantages were slow travel and less ability to guide the boats than was eventually the case with a steamboat. It was not unusual for 10 to 20 percent of coal flatboats to be lost every year. Nonetheless, this traditional method of coal being floated to market would remain viable and compete with steamboats for many decades. Not until the 1850s, did it gradually fall off. The industrial needs of the Civil War set off a great increase in the coal trade, and steam towboats replaced flatboats as safer and more reliable (Wiley 1937: 181). By the end of the war, the flatboating method of transporting coal was virtually dead. Only ninety-eight of them arrived at the Pittsburgh wharf in 1867.

Steam towing on the Monongahela River was an innovation that initiated an expansion of the bulk-commodities trade. It represented a fundamental reorganization of river transportation and greatly expanded the coal and iron businesses. Before the 1850s, steam towing meant nothing more than lashing one or two flatboats (called "lighters") alongside a standard riverboat to take on additional cargo and lighten the primary hull draft by distributing weight over a greater surface area (Way 1990: xi-xii). The practice was controversial. Navigating this arrangement was not easy, and accidents were frequent. Ordinary passenger packets were not designed for this, and insurance companies charged double rates to discourage the practice (Hunter 1949: 568-569). The *Harlem*, built in 1844 for a Pittsburgh judge who mined coal near Monongahela City, was intended to be used for his coal barges in season and otherwise employed as a packet boat (Way 1990: 91).

In the long run, operators found that passenger service and express freight delivery (which were their primary income) were incompatible with hauling bulk freight. More engine and boiler power were required, along with progressively heavier hull construction as towing loads would become greater. The trade needed steamboats designed for towing, not all-purpose packet-type service, plus new techniques of river navigation so that barges at least as large as their flatboat competition could be handled safely and profitably (Hunter 1949: 569). It required a reinventing of the concept of steam paddlewheelers that would not be equipped for passengers and would not stop for miscellaneous small way freight. This made towboats less expensive to construct and operate (Wayman n.d.: 312).

Until the 1880s, towboats continued to have the round bows of packet steamers. One significant design change was the appearance of square bows fitted with "towing knees" to facilitate pushing the barges. This reflected an alteration of towing style in which the steamer faced up to the barges and no longer was set back in a clustering style that prevailed in earlier times (Way 1990: xiii).

There had been early attempts by Monongahela Valley mine owners to employ towing steamboats as far back as the tiny 25-ton *Davy Crockett* in 1838. The even smaller steamers *Juniata* and *Juniata No. 2* were successful on a small scale in the 1840s, but the concept never spread beyond a few individual mines. Between 1842 and 1844 the towboat *Hope* brought coal into Pittsburgh from Six Mile Ferry, occasionally through winter ice (*Pittsburgh Gazette*, December 25, 1844). Experiments began with more strongly built and powered steamboats. The earliest steam towing of Monongahela coal down the Ohio River was in 1845 on the 28 ton *Walter Forward*, a Pittsburgh built boat which had no passenger deck or

cabin (Way 1990: xii, 236). But it would be some years before such ventures became more common (Gould 1889: 502-503).

There was a demand for coal in Pittsburgh mills, homes and the municipal gas works, and dissatisfaction was growing with fragile flatboats "no stronger than an egg shell and too unsafe to be permanently relied upon" (*Pittsburgh Gazette*, January 25, 1851). A new class of steamboats was being invented in the Monongahela yards. These would be known as pool boats whose sole function was towing barges in the slackwater pools adjoining the coal mines. On a true pool boat the pilothouse was eventually set forward on the second deck rather than on the roof, which was typical for a packet boat. This was to permit them to operate under the low bridges on the Monongahela. Sturdier wooden barges designed to draw less water and not be dismantled after one trip were added to the concept of towing.

Allegheny City became noted for constructing these in the 1850s, as did the older Monongahela yards. By the 1870s, several barge and boat building concerns were economically important for Allegheny City. Among them were Reed's Manchester Docks, Richey, Smith and Company, and Anderson and Potter at Darrah Street (W.P.A. 1941: 63-64). Towboats also brought unfinished hulls from the Allegheny Valley to siding yards at locations along the Monongahela. Riverton (below McKeesport), Dravosburg, West Elizabeth and Monongahela City were among the active sites where higher siding and gunwale planks were applied to complete the containers. These yards were able to produce up to twenty complete transports a week (Way 1990: xiv).

Coal containers evolved through the 19th century. Their main categories included the following:

Coal boats: These were not much different from the old-time current-propelled flatboats, altered to accomodate lockage between Monongahela mines and Pittsburgh. Typically 170 feet by 25 feet, carrying 24,000 bushels, they remained one-way containers sold with the cargo until the last third of the nineteenth century when it became more common to return them upstream for new loads. They cost \$600 in the 1880s.

Barges: These were smaller than coal boats, 130 feet by 25 feet, but sturdy with a life span of up to a decade and always returned to home port. They carried up to 1,300 bushels and cost \$1000 or more in the 1880s. Originally constructed in the Allegheny Valley, they were later built along the Monongahela, of West Virginia lumber brought in by railroads. American Steel and Wire Company built sixty in 1899. By the 1900s steel barges were replacing this category but at a much higher cost.

Flats: Commonly 90 feet by 16 feet, they were a smaller, cheaper form of barge. They cost \$400 in the 1880s.

Model Barges: Up to 200 or more feet by 39 feet, they resembled a huge canal boat or ark covered with hatches and were used mostly from Pittsburgh on down the Ohio River. Gray's Iron Line based near the Point on the Monongahela River used these downriver, towed

by large steamers like the Pittsburgh-built *Ironsides*, which had appointments as elegant as any packet boat (Way 1990: xv - xvi).

The 198-ton, 167 foot-long *Lake Erie No. 3*, built in McKeesport in 1851, was the first really large towboat. Its appearance marked the advent of serious steam propelled coal transportation in the Monongahela Valley (Way 1990: 141). In 1853, J. J. Vandergrift of Pittsburgh became the first captain to place coal flats in front of his steamers, instead of lashing them to the sides in the old fashion (Kussart 1937: 918). It had hitherto been considered impossibly dangerous. By the 1860s, this system of pushing barges in front of the towboats became the accepted method, as it allowed pilots to stop, reverse and change course with greater control.

Locally built pool boats were a common sight on the lower river, many of them operated by individual mine owners. Until the 1860s, it was the more easily controlled, faster sidewheeler steamers that ruled the Monongahela. They would continue to dominate the packet trade to the end. With the incorporation of improvements in boilers, high- pressure engines and other hull design improvements, however, stern-wheelers came to dominate almost all inland-river towboating.

Pittsburgh and the Monongahela Valley were entering into the coal age full swing by the mid-1850s. As a benefit to bulk trade, the lock and dam system was a total success. For the Monongahela Valley it had noticeably increased all settlement, capital and even land values related to coal (Reiser 1951: 67). The bituminous variety from this region was of the best quality and highly sought after throughout the Ohio and Mississippi Valleys. Coal mined above Elizabeth, Pennsylvania, was regularly run to St. Louis, eight to ten barges to a tow. Steamboats began to burn coal that was superior to and cheaper than wood fuel. Ocean going steamships leaving New Orleans preferred to use Pittsburgh coal (Kussart 1937: 926). The *Crescent City* was a large steamer built in Elizabeth in 1854 to regularly haul the fuel, fourteen barges at a time, to the city for which it was named (Way 1990: 49).

The arrival of railroads into the Pittsburgh area impacted the packet boats from the start, but the competition was less felt by towboats. Railroads transported coal but not as cheaply or in the tonnage that barges were able to accommodate. Coal continued to keep river transportation alive through out the remainder of the nineteenth and on into the twentieth centuries. New steamboat construction continued because railroads had not demonstrated any superiority over shipment by water (Haite et al 1975: 120). Hundreds of towboats were constructed in the Monongahela yards that had turned out packet boats for so many years. They kept the yards economically alive.

Many towboats, however, were built all or in part at launch sites near the mines. Coal operators needed small pool boats by the score. The *Hercules*, another McKeesport built craft, was typical of the type at 151 tons, as was the Brownsville built *Tigress*, which went on to become a Civil War ironclad. The *Joseph Fleming* was built in the McFall yard in California, Pennsylvania, in 1864, and the *John Bigley* was launched at Pittsburgh with an iron hull, a first in river towing, in 1870. A complete list of launching sites would run the

entire length of the Monongahela River to Brownsville. Elizabeth was one town which made an immense contribution not only in towboat construction, but in personnel with numerous captains, pilots, engineers, deck hands, female chambermaids and cooks (Wiley 1936: 145). Many other Monongahela River towns offered their citizens to the work force as well.

Many of these pool boats alternated between local and Ohio River service depending on water conditions. W.H. Brown of Brownsville regularly pushed his boats to New Orleans prior to and after the Civil War. Locally, the iron industries were booming at an accelerated rate around Pittsburgh during the war years. Fuel was sent in huge quantities down to the Union Navy fleets on the Mississippi River. In 1861 20,865,772 bushels of coal passed through Lock No. 1; in 1866 it had risen to 42,605,300 (*Monongahela Navigation Company Annual Reports*, 1861-1865). By that year, ninety large mines were active in the Monongahela and Youghiogheny Valleys; railroads carried some of their output, but the river saw most of this coal production (Gould 1889: 504).

These regular shipments would have been impossible without the slackwater improvements that came with the Monongahela Navigation Company lock and dam system. The locks became hard pressed to pass all of the traffic. Mining was confined to the first four pools through the Civil War era; Locks and Dams Nos. 5 and 6 would not share in coal profits for some years in the future (Kussart 1937: 940-941).

The Monongahela Navigation Company profited well from this trade, collecting one dollar per thousand bushels toll. Towboats rather than packet boats now paid the greatest dividends. The Pennsylvania state government levied a tonnage tax in 1864 as a source of revenue, but it so infuriated coal operators that the law was repealed a few years later. These men were becoming extremely powerful by the 1870s and formed the Pittsburgh Coal Exchange to defend their boat fleets against railroad construction, low bridge building, and the Monongahela Navigation Company whose tolls they detested, even though their locks and dams permitted nearly year round navigation.

This new river era was dominated by the towboat and barge. By the 1870s, the river was black with coal barges; 61,409,000 bushels passed through Lock No. 1 into Pittsburgh in 1875 (Monongahela Navigation Company 1875: n.d.). The towing trade was initiated with coal hauling, but soon grain, iron ore, sand, and other products were carried this way as well. The city wharf at Water Street was often covered with every conceivable sort of raw mineral and manufactured commodity piled on it. About 60 percent of the coal produced was consumed locally; the remainder went downriver. Almost all of it had arrived on Monongahela sternwheel steamers.

In 1881 local boating interests were collectively represented by 163 packet and tow boats, 1,500 coal barges, 500 coal boats and 1,000 coal flats; the previous year this flotilla had handled 84,048,350 bushels (Kussart 1937: 947). One local boat, the *Joseph B. Williams*, carried 600,000 bushels to New Orleans in 1881 (Way 1990: 131). Monongahela mines were producing so much coal that Locks Nos. 3 and 4 had to be doubled to deal with the traffic and machinery on all the locks improved to reduce delays.

Another product that was added to river transport was coke for iron and steel manufacturing. As far back as the 1830s, Connellsville ovens began producing coke and boating it down the Youghiogheny River to Monongahela flatboats. More ovens resulted from an increasing business magnified during the Civil War, as coke proved itself in iron production. By 1876 over 3,000 ovens were producing 900,000 tons (Storey n.d.: 115-120).

The railroad eventually gained a monopoly on this transportation, but Monongahela Navigation Company records indicate an immense quantity went through Locks Nos. 1 and 2 as well. In the early twentieth century, coal mining and coke production began to increase on the upper Monongahela River above Brownsville, as Fayette, Westmoreland and Greene Counties entered into the sphere of the big iron and steel interests. This pushed tow and barge traffic to even higher levels on the upper river well into the twentieth century (Gould 1889: 506).

Towing activities on this scale called for change. The Pittsburgh Coal Exchange petitioned Congress endlessly, calling for freedom from tolls and urging the Federal Government to assume control of the slackwater system (*Elizabeth Herald*, September 1, 1900). The argument was that less expensive shipping would further the growth of industry in the valley. Government construction of locks and dams in the upper river was a concession to these interests.

An act of Congress eventually authorized acquisition of the lock and dam properties of the Monongahela Navigation Company on the lower river. When the government assumed control in 1897, it was the requirements of big coal that guided a rebuilding of all the older properties and the addition of appropriate new ones. The then 360 foot by 56 foot dimension standard and the doubling of most of the lock chambers for Nos. 1 through 8 was dictated by the transportation of coal as the primary business of the river. Towboating was by the early twentieth century fairly standardized with pool boats pushing six barges on the average. The inner chamber of Lock No. 3 was eventually doubled to 720 feet to permit unbroken tows to pass through. This became the objective for the river by the 1920s (Wiley 1937: 171).

In 1899 the formation of the Monongahela Consolidated Coal and Coke Company ended competition among the myriad numbers of rival mine operators in the valley. Most of the coal lands between Pittsburgh and the West Virginia border were taken over by the new organization. Headquarters for river operations was at Market and Water Streets in Pittsburgh, which housed a boat-supply store as well as engineering departments and company offices. Consolidated also were their respective river operations consisting of over eighty towboats, 6,000 coal boats and barges, plus wharves, boat yards, marine ways, and like properties. This revolutionized transportation in the areas of efficiency and costs and produced the demands for increasing lock size to avoid breaking up the barge tows.

The coal company came to own saw and lumber mills for boat and barge construction, and they built and repaired towboats on their own marine ways. Every size of boat was built to accommodate the wide variety of river operations. In December 1899, the "Combine" shipped 876 barges and 512 coal boats south from Pittsburgh (Way 1990: xvii-xviii). The

steamer *Sprague* at 1,479 tons and 318 feet was the largest towboat in the world when built in 1902. Such huge towboats were never used on the Monongahela River but were loaded at Pittsburgh with so much coal to be transported downriver that railroads presented no competition. The smaller pool boats were used only on the Monongahela (Wiley 1936: 145). For awhile the "Combine" fleet represented 63 percent of the total marine tonnage on the Mississippi-Ohio system (Wayman n.d.: 314).

In 1916 the Monongahela Coal & Coke Company was succeeded by the Pittsburgh Coal Company, which narrowed operations to the immediate Pittsburgh area. World War I saw barge fleets revive for a time to supplement rail transportation, and vast improvements in canalization of the Ohio led to more traffic on the Monongahela in the nineteen teens and twenties (Wayman n.d.: 314-315). With this development, the wood coal boat days soon came to an end, and many of the older steam towboats were dismantled.

Diesel engine steel-framed towboats and barges became the new standard as modern towboating had its inception during the 1930s. As the Monongahela slackwater improved into the twentieth century, deeper water permitted deeper draft propeller-driven boats. The older sternwheeled craft did not disappear completely until the 1950s. As it had done since the 1840s, improved slackwater lock and dam transportation continued to make Monongahela-Pittsburgh business a national instead of a merely local concern (Reiser 1951: 125).

MONONGAHELA RIVER BOATYARDS IN THE EIGHTEENTH AND NINETEENTH CENTURIES

The major steamboat construction industries were focused in the following communities, at one time or another, during the period of the late eighteenth through the early twentieth century: Pittsburgh, McKeesport, Elizabeth, West Elizabeth, Monongahela, Webster, Lock No. 4, Belle Vernon, California, Brownsville, West Brownsville. On occasion small craft were constructed at other river sites such as Fayette City, Rice's Landing and Fredericktown, but these places were very secondary to the principal sites where larger boatyards existed.

The following sections describe each of these communities with an aim towards pinpointing boatyard sites in Monongahela River communities which played a central role in the evolution of river navigation well on into the 20th century. There is a close relationship between this major Monongahela Valley industry and the communities, social groups and natural, as well as commercial, resources of the region.

Pittsburgh, Pennsylvania

It is not surprising that boat building began in the area while Pittsburgh was still a frontier settlement. French and later English garrisons had been constructed here because of the strategic river placement. In the 1750s sawyers and carpenters were employed by the French at Fort Duquesne. The earliest boats built here were designed for the deeper waters of the Mississippi and Ohio and were not much employed on the shallow river into which they were launched. But so began an industry that would in large measure define the socio-economic evolution of Monongahela navigation (Kussart 1938: 18-33).

There were many small navigation-related yards around and immediately upriver from Pittsburgh. As early as the 1750s, rafts and flatboats ventured from the area as far south as New Orleans. At the close of the Revolutionary War, a flood of emigration started west, and the Monongahela River was the central artery of travel. Arriving from the south along Braddock's Road to Brownsville or from the east along Forbes Road to the Forks of the Youghiogheny at the strip of land between Elizabeth and McKeesport, both streams of emigrants found themselves dependent upon river transportation to continue their western journey through the Monongahela Valley (Cramer 1987: 21-23).

When Robert Fulton wished to move his revolutionary steamboat business from the Hudson into western rivers, he was attracted to Pittsburgh since it already had special facilities for building river craft (*Elizabeth Herald*, June 7, 1900). As travel between Brownsville and Pittsburgh intensified, the availability of natural resources such as oak timber, plus an assortment of small scale industries related to the production of iron products such as nails, led entrepreneurs into boat construction.

From these beginnings, specialized boat building rapidly increased with the development of steamboat technology in the eighteen teens. Boatbuilding was the third largest industry in Pittsburgh in 1803, valued at \$40,000; by 1826 it had risen to \$62,000 (Reiser 1951: 13, 25). Between 1811 and 1836, long before slackwater navigation began, some 252 steamboats were built in Pittsburgh. Carpenters had been brought in from the east coast to work at several sites here and farther upriver from the city.

The construction, equipping and repair of steamboats grew into an important part of the economy of the area. As early as 1840, Pittsburgh was seen as a dominant boatbuilding center. Certain boatyards tended to specialize in machinery production, while others focused on building hulls and superstructures (Wayman n.d.: 156). Formal and semi-formal boatyards produced every type of river craft in a tradition that continued for the next 120 years. One example of many would be the Marine Saw Mill Company at Six Mile Ferry, on the south side of the river at Street's Run, that advertised in 1881, not only boat lumber for sale, but "flat bottom and oil boats" constructed on site as well (original document, author's collection). Such small operations were to be found all along the lowest reaches of the Monongahela River, near the city.

McKeesport, Pennsylvania

Boat building was at the center of the very existence of McKeesport. Flatboat production for the garrison at Fort Pitt began at this site three decades before McKeesport was formally laid out in 1795. Its position at the mouth of the Youghiogheny Valley meant that many travelers relied on finding the flatboats, keelboats and barges they required here for further travel. By the steam era in the 1830s, some of the important early firms were Cook and Fenton, J. and G. Taylor, and Thomas Cunningham. It is said the first drydock for lifting steamers out of the Monongahela for repairs was constructed here in 1836. The steamboat industry began to take off after the river improvements of the 1840s. By 1865 over sixty steamers of ever-increasing tonnage had been built here, among them some of the best and fastest on western waters.

The establishment of Benjamin Coursin's large boatyard in 1849—he would also be associated with the same profession in California, Pennsylvania—gave a great boost to the industry in McKeesport. Thurston's *Monongahela Valley Directory* for 1859/1860 refers to his yard as being located "on the left side of the Youghiogheny," probably at the corner of Wood and First Streets. Many hulls, as well as towboats and coal barges, were constructed here during the Civil War. The most famous were the ironclad Monitor-type ships *Marietta* and *Sandusky*.

The Cock family of Brownsville extended boat-building operations to McKeesport in the 1860s. Hundreds of coal barges were also constructed by the McKeesport Sawmill Company. In the 1890s John Shoup and Company, in Riverton, continued the local tradition of barge construction. The McKeesport Sawmill Company, on the right bank of the Monongahela River, just above the mouth of the Youghiogheny, built 150 coal barges for the Jones and Laughlin Steel Company in 1901 (Abbott and Harrison 1876: 29-33).

Period copies of the local newspaper, the *McKeesport Daily News*, and local histories of the town continually refer to the significance of improved navigation conditions on river craft production, as well as the city economy in general. Prior to slackwater navigation, shallow water barges, skiffs and yawls had dominated boat building in McKeesport. Farmers carried produce to Pittsburgh in them like wagons, using horses instead of oars through the shallow riverbed. Steam traffic was irregular. Boats, often unable to approach land, stopped midstream, and yawls were sent out to retrieve passengers and limited freight. In 1831 the *Little Swan* was forced to have a crewman wade ashore near McKeesport and plant an anchor, while the crew pulled on an attached rope to drag the steamer over a shallow riffle. McKeesport newspapers praised every lock and dam improvement over the years and could scarcely contain their joy when free navigation was opened in 1894 (*McKeesport Daily News*, July 8, 1897).

Elizabeth, Pennsylvania

Boat building was at the core of the very existence of this community. As early as 1788 a Philadelphia newspaper advertised "boat construction of every size six miles above the mouth of the Yough" (Elizabeth, PA). Stephen Bayard was the yardmaster at that time. This major keelboat yard was active between 1788 and 1831 and was rebuilt many times. At the close of the nineteenth century, the site was still marked by a large shed on Water Street, just below the railroad on Mill Street. In the year 1800, the Monongahela Company was formed to build a 200-ton schooner the *Monongahela Farmer*. It was one of the first craft built at what was called the upper yard, where in the century to follow hundreds of steamboats would be constructed. There was a large boat yard centered around a sawmill constructed near a natural stream that ran into the Monongahela (*Elizabeth Herald*, September 1, 1900).

Isaac Harris's *Directory* for the year 1836 mentions three steamboat yards in Elizabeth with one hundred town residents actively engaged in related employment. Six blacksmith shops were turning out the nails and bolts necessary for boat construction by the 1830s. An 1844 publication mentions that between 1826 and that year "a larger number of valuable steam vessels were (built) here than any other place in the United States."

A large steam-powered sawmill was built in 1832 by the boat building firm of Walker and Evans. Thurston's *Directory* of 1859 mentions the upper yard as being run by a Colonel Ekin who built nine boats there that year. This was the high tide of the steamboat industry in Elizabeth with sometimes a dozen or more hulls under construction at one time in all the yards. About 1860 the yard and mill were bought by William Latta (Thurston 1888: 6). The upper yard was the oldest and the main center for construction activities. It changed hands several times finally ceasing operations in 1870. The sawmill was still standing as a ruin in 1900. The site has been further transformed by the Pennsylvania Fish and Boat Commission's Elizabeth Borough public boat access in the area of Upper Mill Street.

Another boat construction site at Elizabeth (1850s) was located in a natural ravine at the river's edge, at the foot of Plum Street. As was most often the case, a steam-powered

sawmill was the focal point of the yard. This site was active in the 1850s-1860s but was destroyed by the construction of the original Elizabeth bridge. About the middle of the nineteenth century, Samuel Walker also operated a short-lived "middle yard" between Bayard and Walnut Streets running toward the river (*Elizabeth Herald*, September 1, 1900).

At the lower end of the town (downstream) was located "the commons," a low area at the mouth of Fallen Timber Run. A steam sawmill was constructed near where the Second Avenue bridge later crossed the run. This was the initial center of operations (1860s) for S.P. and I.N. Large, who built coal barges and steamboat hulls. This was taken over by the firm of Weigel Brothers in 1887. By 1896 the boat yard had been moved slightly downstream, where it became the Elizabeth Marine Ways, the River Division of the Monongahela River Coal and Coke Company. Weigel Brothers retained the controlling interest.

This location evolved into a major operation for boat and barge repair, as well as towboat building. The yard was equipped with the most modern machinery available at the time, especially the specialized equipment required for forming timber into the unusual shapes required in steamboat framing. After several name changes, the parent company to the river division became the Consolidated Coal Company in 1899. By then it had taken over the boats, barges and mines formerly operated by many small coal companies. Operations continue to this day. The present Marine Way operates as a department within the River Division, maintaining and servicing river equipment belonging to the Consol Company. At the peak period about the beginning of this century, the company owned about 100 steamboats and hundreds of barges. This required large-scale facilities for river craft repair and construction. A number of original photographs of boat building and repair on the Marine Way docks survive.

There were, at one time, fourteen docks each 272-feet long, passing up over the yard in a succession of three terraces, each capable of holding one large or two small steamboats. The establishment was capable of having three to six boats on dry docks at the same time. A series of cradles and sprocket wheels provided enormous pulling power. Cradles ran down to the river pulling boats up or down by chains. Hulls as long as 280 feet could be accommodated. For many years, however, the locks below the yard were only 220 feet long, which fixed the maximum size of boats that were seen on the ways (Consolidation Coal Company 1977: 9-10).

Today the Marine Way property encompasses six acres of land, with about 1000 feet of river frontage. Boat building ceased here, but the original marine railway, storehouses, machine shops and assorted other buildings survive and are still put to use in towboat and barge repair operations. The marine railway now consists of four sets of track about 150 feet long running down into the river. Much of the original equipment, such as shafting, foundations and underwater cribbing, piling and launchways, are still in use. Some equipment dates to the original marine rail system of the 1890s. A warehouse on the property contains many of the original wooden patterns for molding gears and sprocket wheels for the railway machinery.

The capacity of the marinc railway was 400 tons on four cradles. This yard had one of the easiest grades (1 ½ inches per foot) of any inland waterway, which made it far casier for building and overhauling river craft. It is the sole survivor of what were once six building yards and launch skids of the old coal combine around Elizabeth (Consolidation Coal Company 1977: 9-10).

Elizabeth has been called "the mother house" of boat builders in the Monongahela Valley. Subsequent yards at California, Belle Vernon, Monongahela City and West Elizabeth werc offshoots of operations here. Elizabeth was the training ground for many noted steamboat construction men. A total of about 196 steamboats were built in Elizabeth prior to 1870.

West Elizabeth, Pennsylvania

West Elizabeth was laid out in 1833, and it was not long before a boat yard was established there around a sawmill built by Joseph Walton, west of Border Street. This was near one of two ferry landing sites: one at the foot of Border Street, the other, downstream near the foot of Market and Ferry Streets. The latter served as the town's main steamboat landing. Harris's 1837 *Directory* does not directly mention West Elizabeth, but flat boats were definitely being built there by then. A Gilbert Stephens owned a yard that built mostly flatboats until the subsequent owner, Corwin, Irwin and Company, began building steamboats about 1843. This later became the Isaac Hammitt Yard until operations ceased in 1852.

The upper end of town was always the boat building area. Until the mid-1880s, West Elizabeth was in the center of coal mining and shipping activities. Barges were built and repaired at the siding yards and, as in Elizabeth, numerous men were employed in river-related trades. As mining moved upstream into the more distant pools, West Elizabeth lost some of its former significance, but river coal remained a very important industry there well into the twentieth century (*Elizabeth Herald*, June 7, 1900; see also Ellis 1882: 266-267).

Webster, Pennsylvania

Not much is known about boat building operations here, but Webster is an old Monongahela Valley town with a genuine river history. Much of this history was integrated with that of the Gilmore family. Captain John Gilmore and his brothers were involved in the coal business around Rostraver Township well before the Civil War. He owned a great deal of coal land; the Wildcat Mine, near the lower end of present day Donora was opened in 1863. Ten years later a tract of coal was opened along with coke ovens in the town of Webster. The many steamboats and barges required to haul all of this were collectively known as the Gilmore Linc. In the 1870s, Webster had a sawmill near the river shore at the corner of Water and Anderson Streets, owned by a J. Hopkins. It cannot be said with certainty that boat hulls or barges were produced here, but there is an oral tradition among some of the older residents of the town that they were. There was also a steamboat landing in use for many years (well into the twentieth century) at the foot of Mechanic Street.

Monongahela City, Pennsylvania

Joseph Parkinson was the first settler in the Monongahela City area, opening among other things a mill and a ferry service (the latter operating from the mouth of Pigeon Creek) in the 1780s or 1790s. He was the first to build flatboats and keelboats here. Keelboats, until they were displaced by steamboats, always landed at Pigeon Creek, which was both convenient and a safe harbor for these small craft. Steamboats, when they came to dominate the Monongahela River, never used this as a landing place. Pilots and captains first landed at the Chess Street wharf at the mouth of Ferry Street (now 4th Street). At some point in the 1840s or 1850s, the town moved the wharf to the mouth of Washington Street (now 2nd Street) (*Historical Magazine of Monongahela* 1908: 207-211).

More sophisticated boat building began here in the late 1820s or early 1830s with the activities of a business entrepreneur named William Mills. Neither the location of his yard nor the names of boats and hulls constructed have been preserved. By 1849 William McFall and Company produced a number of steamboats here until he relocated to California, Pennsylvania. In 1856 George Cunningham relocated to Monongahela from Elizabeth and, in partnership with Isaac Coursin, opened a boatyard at the mouth of Pigeon Creek. The fact that a sawmill was already operating here suggests that this had been the site of the earlier boat building. VanVoorhis's *History of Old and New Monongahela* mentions that before the Civil War boat building went on here for a number of years until the yard was dismantled. It would seem that they produced only hulls and not completed boats.

Thurston's *Directory* states that by 1859-1860 a larger-size boatyard was to be found in Monongahela operated by Mr. W. McClure (Thurston 1859: 115). William Latta was the foreman, a name quite famous in Elizabeth boat building. During the Civil War, a number of steamers that found their way into government service as tinclad warships were built here. The most famous was the *Argosy*. Several boats of that name were built here during the war.

In 1865 the Monongahela City Dry Dock Company was set up. It changed hands a number of times but was still operating in the 1880s under the name Monongahela City Steam Docks. Steam towboats and barges were built and repaired here at the end of Brown Street (now 5th Street). Although 1880s maps of Monongahela City clearly depict barges under construction on the yard's marine ways, alterations of the shoreline have removed all traces of these construction sites. During the nineteenth century, forty-four known steamboats were built in Monongahela. As late as 1910, the small firm of J.S. Hudson was still producing some smaller river craft and barges here.

Belle Vernon, Pennsylvania

Boat building was a key element in the industrial economy of early Belle Vernon. The Speers and Gaskill boatyard began operations sometime around the mid-1820s in conjunction with the construction of a water-powered sawmill on Speers' Run, near the lower end of Water Street. Here flatboats, keelboats and a few early steamboats were produced. Most of this site, in the vicinity of the area beneath the present Interstate 70 Bridge, was

washed away in an 1844 flood. By that year, however, the yard had already been moved upriver to the mouth of 3rd Street (where 3rd and Water Streets now intersect; the latter did not extend that far then). A new sawmill had been constructed here with a stone foundation in 1833.

Quite a few steamboats were built by Speers and Gaskill prior to the suspension of operations in 1847. About 1851 a reorganized firm, Speers and Latta, resumed activities. In 1853 yet another larger sawmill was erected just below the confluence of Speers Run and the Monongahela River. Boat building was resumed here. The sawmill at the old yard at Third Street burned in 1880.

Speers and Latta continued building boats through the Civil War. Speers's sons entered into partnership, building many steamboats, boat hulls and wooden barges. In 1876 this sawmill burned; it was rebuilt and one final boat, the *Katie Stockdale*, was produced. Bankruptcy ended this business, and with it, Belle Vernon's half century of boat construction tradition came to an end. A planing mill and lumber business continued on the same site. It presently is occupied by the Matt Canestrall Coal Company.

Water Street was gradually extended eastward, parallel to the river as far as 5th Street, in nineteenth century Belle Vernon. However, when the original town lots were laid out, the river shore front between it and the river was reserved for the original proprietors. Townspeople were effectively cut off from all wharfing privileges. The Speers family retained this ownership for decades. They established a wharf at the end of 2nd Street which functioned as the landing site for boat traffic until 1850. In 1853 the wharf was moved to the mouth of 3rd Street after the boat yard left that site. The town wharf was moved yet again in 1857 to a newly graded shore at Second Street. It remained in the hands of the Speers family until 1877.

The arrival of the P. & L.E. Railroad tracks between Water Street and the riverbank resulted in a radical alteration of what remained of the original topography of the shore area. The area beneath the railroad bridge at the end of 2nd Street is the last functional remnant of the wharf landing area. All told, seventy-nine steamboats were built in Belle Vernon (*Valley Independent*, May 5, 1973).

California, Pennsylvania

The original 1849 land grants that gave rise to California, Pennsylvania, indicate that town lots 23-25 were set aside for a sawmill. These lots extended to the Monongahela River giving direct access for shipping and receiving timber. This mill was purchased in 1851 by William McFall and others, who erected a boat and barge construction business in conjunction with the sawmill. This boat yard was extended to include lots 28, at the corner of Green Street, 31-32 on both sides of Porcupine Alley, and parallel to these lots also lots 43-35. Eventually sixteen town lots in all formed the boat construction area. This encompassed the land bordering on the south by Porcupine Alley, the west by Second Street, the north by Wood Street, plus the river front from Porcupine Alley to Plum Alley.

In 1853 the yard was sold to Benjamin Coursin, a boat builder from Elizabeth, Pennsylvania. It was quite successful but changed hands several times. George Eberman and William McFall purchased it and supervised operations from 1870 until 1879. During these years, business averaged \$40,000 per annum and sometimes went as high as \$80,000. As many as forty to sixty or more men were employed here. Records suggest that over its twenty-eight year history the California boat yard produced mostly hulls for steamboats and wooden barges. They were constructed of locally cut oak floated to the saw mill landing. This privilege of landing log rafts along the shore was incorporated in deeds each time the yard changed owners (Folmar 1994: 11).

There were in the 1870s at least five buildings on the property housing a blacksmith shop, tin and copper smithing, as well as offices and the sawmill. Some steamboats were completed at California; more typically it was just the hulls. These were floated downstream to yards in Pittsburgh, Elizabeth, or Belle Vernon, or upstream to Brownville for their engines, boilers and superstructure finishing. Between 1851 and 1857, sixty-four boat hulls were constructed; by 1879 an estimated 168 had been finished here. One hundred forty of these hulls are known by the steamboats' subsequent names. Most were sternwheel packets; about fifteen were towboats. Close to two hundred barges were built during those years. During its lifetime, the value of all construction in the yard has been placed at \$750,000.

River craft produced here had an excellent reputation, not only in the three-rivers area, but all over America's inland rivers and as far away as Brazil. By 1870 there were four launch ways, two north and two south of the yard's central sawmill. The average production was about twelve hulls per year. By 1879 the Pennsylvania, Virginia and Charleston Railroad had advanced up the valley to California, demanding and receiving a right-of-way through the center of the boat yard (Ellis 1882: 272-274). A municipal park was created between the former railroad depot and the river in the 1980s. The gradual slope that once led to the river shore was filled in and is now a steep embankment with a drop of thirty feet to the shoreline. Nothing remains of the original terrain on which the boatyard stood (*Monongahela Valley Review*, July 1994).

Brownsville and West Brownsville, Pennsylvania

As in other river towns, the evolution of boat building was significant in the economic growth of the Brownsville area. The first mention of boat building around here is a reference to flatboats in 1777-1778, constructed for General George Rogers Clark's expedition bound for western waters. Subsequent emigrants for the western territories converged on Fort Redstone (Brownsville), building flatboats and rafts for voyages down the Monongahela and Ohio Rivers. The *Pittsburgh Gazette* (November 24, 1787) informs that 120 such craft from Brownsville passed downriver that year on their way west. Commercial traffic in items such as farm goods, millstones, etc. was significant as well. An early boat construction area was at the end of Hill Street, operated by the firm of Chalfant and Carter. Many skilled artisans and laborers were employed in this trade.

In 1811 Daniel French formed the "Monongahela and Ohio Steamboat Company," which in 1814 built a small sternwheeler at the mouth of Dunlap's Creek. This was the steamer *Enterprise*, later chartered by the government during the War of 1812 to carry supplies to New Orleans. It was the first steamer to make a round trip from the Monongahela to the mouth of the Mississippi.

In 1829 John S. Pringle opened a boatyard in Brownsville near the site of present Lock No. 5. He was quite successful and expanded to larger operations in West Brownsville in 1843. In this new yard, immediately above the old inter-county covered bridge, 546 boats were built by 1877. There were two launchways with a sawmill in between them. The Pringle yards had an excellent reputation for boats with durability and mechanical excellence. Boatmen and companies were continually traveling here from all over the Mississippi-Ohio-Missouri River system to commission boats to be constructed. Pringle was known to have a steamboat built from scratch in twenty-six working days, with an average of eleven completed boats and boat hulls produced each year (*Pittsburgh Commercial Journal*, August 11, 1857). After his retirement, his son J.D.S. Pringle and son-in-law Andrew Axton took over the firm, which by 1885 came to be known as Axton and Son. The last boat launched from this yard was in 1896. That year Axton purchased a new site at the lower end of West Brownsville. Here steam towboats, as well as barges, continued to be produced until 1912 (Hart 1904: 12-13, 56-57).

Thurston's *Monongahela Valley Directory* for 1859-186 (p.38) is very informative about Brownsville's river past. Information is given about West Brownsville's other boatyard, Cock and Williams. Founded in 1846 and located on the riverbank, about one-fourth of a mile below the old covered bridge, this yard produced 125 or more steamboats and hulls before ceasing operations in 1877.

In its heyday, something on the order of a thousand wooden boats of all sizes and descriptions were constructed from locally-harvested oak and pine. When those sources ran low, lumber was towed to the Brownsville yards in rafts from the Cheat River and the Allegheny River Valley. The combined production of the Cock and Pringle yards averaged up to twenty-five launchings each year. There were others involved in the boat building industry here. For example, Miller and Coffin built three boats in 1825 at an unknown site.

Brownsville boat building history has left very few traces. The Pringle operation was situated along almost a quarter-mile of land between Main Street and the river front, immediately south of the (present-day) inter-county Brownsville Highway Bridge. The Cock Yard was located north of the present Brownsville High-Level Bridge, between Middle Street and the river front, roughly at the end of Virgin Alley and Penn Street as they intersect with Middle Street. This area was later extensively used by a lumber company as well as the coal railway and barge loading activities associated with the Beaumont Mines.

The story of Brownsville boat building would be incomplete without mention of the machine shops where steam engines, boilers and iron foundry castings of every description were on hand or made to order for the boatyards. These establishments were well known

throughout the inland water systems for the skill and workmanship of their mechanics. Many of the steamboats built in yards along the Monongahela Valley received their machinery from Brownsville. This is also why the boatyards here were able to generate boats ready to sail.

Thurston's *Directory* describes the Vulcan Iron and Machine Works operated by J. Snowden and Sons. This firm was first established in 1824 on Market and Water Streets in Brownsville at the boat landing. It was one of the most complete iron and machine works in the United States, occupying nearly an acre of ground with forges, rolling mills, pattern shops and boiler yards, and a work force of over one hundred. The plant was located near the present West Penn Power Company building on present day Market Street (Hart 1904: 12-13, 56-57).

In 1837 John Herbertson first became associated with what came to be known as Herbertson's Foundry, located on Water Street near the old inter-county bridge. This firm had an excellent reputation and continued in operation until 1917. Some of these buildings survive, but the rivershore fronts of both of these nineteenth century engine/boiler works were destroyed by railway embankments. Some 291 steamboats, complete or in part, were constructed in Brownsville and West Brownsville. While California and Elizabeth produced only boat hulls, for the most part, Brownsville, like Pittsburgh, was fully-equipped with established businesses for upper deck and cabin construction, boiler and engine works, ship chandlers, and the like. Thus many, if not most, of the hulls produced here were fully completed into steamboats here in Brownsville (Wiley 1937: 133).

COMMERCIAL FLEETS AND CONSTRUCTION YARDS ALONG THE MONONGAHELA RIVER IN THE TWENTIETH CENTURY

Towing Fleets

Consolidation Coal Company - River Division

One of oldest continuing river operations on the Monongahela River, Consol moves a huge amount of tonnage with its fleet of diesel towboats to markets such as utility companies. In the 1970s, the company had six boats and close to three hundred standard barges in their fleet. The River Division of Consol has had an interest in lock and dam navigational improvements over the years and traditionally was quick to point out the relationship between river inadequacies and the economy of the Monongahela-Ohio Valleys. The Marine Ways Division (see previous section under Elizabeth) services their fleet of boats and barges on drydocks with everything from emergency repairs to annual overhauls. During an average year in the 1970s, 370 craft were docked and another 150 were repaired afloat.

Across the river, nearly 3500 feet of West Elizabeth's river frontage came to be associated with Landings Nos. 1 and 2 of the Consolidation Coal Company River Division. This West Elizabeth operation began in late 1954, when the landing facilities from Dravosburg and the Pittsburgh Point area were consolidated here on seven acres of land, immediately below Lock No. 3. The principal reason for consolidating the landings here was the rechambering of Lock No. 2 in 1954 permitting lockages of fifteen barges at a time in its 110 x 720 foot chamber. Fuel storage tanks were built as well as landing houseboats and eighteen 26-foot diameter mooring cells at the river's edge. This location provides an ideally-situated hub for boat operations and crew changes. There is a great deal of towboat and barge activity here, as well as storage for fuel, supplies and equipment associated with boats, barges and wharf landings. As many as seventy to eighty barges and 90,000 tons of cargo can be accommodated at one time (Consolidation Coal Company 1977: 11-13).

Towboats of Captain Charles T. Campbell

Charles Campbell foresaw the concept of modern barge lines in river transportation. For decades it has been common to see towboats of the Coal City Towing/Barge Line fleet pushing barges along the rivers of the Pittsburgh district. They operated as "switch-boats" out of Pittsburgh during the big steel mill era. Large barges arriving from the South to destinations such as Neville Island, Dravosburg, etc. had Campbell towboats finish delivering the loads to local customers in the Tri-State area. Along the Monongahela River, his towboats assembled barges of steel products, building southbound tows for line-haul towboats of firms such as Union Barge Line, Mississippi Valley Barge, etc.

By the 1980s, they operated over the years some fifty-four steam and diesel boats. An outline of Campbell's history on the Monongahela River runs from a few initial steamboats through a sequence of incorporated titles:

- Reliable Towing Company (1917-1930)
- Water Transportation Company (1920 - 1926)
- Union Barge Line (1924, later sold to the Dravo interests)
- The Ohio River Company (1926)
- Campbell Transportation Company (1931 - 1941)
- Coal City Towing Company (1935 - 1964)
- Campbell Barge Line Inc. (1951 - 1987)
- Campbell Transportation Company (1987+)

Hillman Towboats

This yard was founded in 1891 by Captain W. Harry Brown and Sons, a coal operator with a large fleet of steam towboats (1837-1899), "Brown's Line." They towed Monongahela Valley coal to the South until acquired by the Coal Combine (1899-1916). Their Alicia Ways were located just south of Brownsville on a forty-three acre site at river mile 57 from Pittsburgh. The Hillman Coal and Coke Company took them over and began shipment of their coal by barge down the Monongahela and Ohio Rivers in 1917 to the LaBelle Steel Company plant in Steubenville. Hillman coal was mined along the upper Monongahela River at their Alida Mines, Black Diamond Mine, etc. (Mace 1944: 308-309).

The Hillman Barge Construction Company (renamed HBC Barge Inc. in 1981) was founded in 1945, and a total of twenty-three steam and motor vessels flew the Hillman banner. After years of pushing coal to the electric power plants along the Monongahela and other area rivers, Hillman ended the river transportation portion of their business—as a large-scale division—in 1966, although they retained some boats. Mon River Towing Company, owned by Guttman Group of Belle Vernon, Pennsylvania, which had a modern fleet of new towboats built at Hillman's shipyard, took over the contract towing once done by the Hillman boats on the Monongahela (Wayman 1971: 311- 323).

This firm also developed a fine reputation for hopper barge construction. In the 1980s, they developed a new welding method called "Steelfuse" that replaced older welding types. Between 1945 and 1984, some forty-six diesel towboats were constructed or substantially refurbished at this facility. In 1989, Hillman Barge Company was acquired by new owners from Dallas, Texas, a group which owns numerous shipyards throughout the Mississippi Valley (Mace, 1944: 308).

Ohio Barge Line

Shortly before World War II, the Ohio Barge Line was established at Dravosburg as a wholly owned subsidiary of Carnegie-Illinois / United States Steel Corporation to serve their

long-haul towing trade to the South with barge loads of finished steel products from the Monongahela Valley mills. Return trips to the Monongahela consisted of tows of basic raw materials of scrap iron, sulfur, iron ore, oil and coal for the United States Steel mills. In addition to the original name, the Ohio Barge Line was known as Mon Valley Transportation (1976) and, out of Pittsburgh, the River and Gulf Transportation Company (1978) and A & G Transportation Company (1978). About twenty-four towboats have been operated by all of these companies since 1941. The major decline of steel in the Monongahela Valley mill districts brought an end to this line in 1984 after forty-three years of service towing "Big Steel's" payloads to southern marketplaces as far as New Orleans.

Union Barge Line et al

For many years, the Union Barge Line Corporation with central offices in Pittsburgh and Brownsville, as well as many subsidiary points in the Ohio and Mississippi Valleys, served to connect Monongahela River industries to the inland water ways. This was accomplished through direct voyages with their own towing fleet and special arrangements with connecting carriers. Between 1924 and 1973, they operated a total of twenty-five towboats. All of the barge lines associated with these operations were subsidiaries of the Dravo Corporation of Pittsburgh. Other barge lines (possessing on-shore marine facilities connected to their river operations) which functioned through the parent Dravo Corporation were as follows:

- Cardinal Carriers (1967 - 1984) with 6 boats
- Union Mechling (1973 - 1979) with 22 boats
- Dravo Mechling Corp. (1989 - 1988) with 1 boat
- Sea West Partners Inc. (1981 - 1988) with 8 boats

After sixty-four years in the barge line business on the Monongahela, Ohio, and Mississippi, the Dravo Corporation sold all of its varied marine holdings in 1988. This followed a period of depression in the inland rivers industry that was coupled with a severe drought in the Mississippi Valley, during which time the river nearly dried up.

Crucible Steel Company

In 1910 Crucible Steel began extensively towing coal from the company mines along the Monongahela River at Crucible, Pennsylvania, to their ovens and various mill works at Midland, Pennsylvania, in Beaver County. Over a period of fifty-one years of operation, their fleet of eight steam and oil-powered diesel vessels included some of the most famous towboats that ever ran the Monongahela River in the days of steel. Among the most renowned was the 175- foot steel-hulled steamer *W.P. Snyder*, built in 1918 at the James Rees and Sons yards in Pittsburgh. It continued pushing tows until 1955. After its work years were over, the *Snyder* became a floating museum on the Muskingum River in Marietta, Ohio, one of the last of the old paddlewheel coal towboats to survive.

Jones and Laughlin Steel Corporation

Jones & Laughlin began towing operations on the Monongahela River with its own boats as early as the Civil War years, hauling coal and other basic materials to their mills in the Monongahela Valley. In the early 1900s, they expanded their mills down the Ohio River to Aliquippa, Pennsylvania. The Vesta Coal Company was established as the center for mining and barge towing operations. Floreffe, Pennsylvania, was home to the company repair and service marine ways. Jones & Laughlin boats connected the Monongahela Valley to midwest and southern ports for decades. Locally, their Pittsburgh marine division pushed Jones & Laughlin barges between the mines and steel mills in the valley.

Over the space of 118 years in the river transportation business, some thirty-eight steam and diesel towboats connected this corporation's varied interests and industrial sites. Jones & Laughlin sold its towboats and barges to Mon River Towing of Belle Vernon, Pennsylvania, in 1983 at the time when the end was near for the old Pittsburgh district mills in the Monongahela Valley (Mace 1944: 308, Wayman 1971: 311-323).

From Carnegie Steel Company to United States Steel Corporation

The River Transportation Department of "Big Steel" commenced operations on the Monongahela and Ohio Rivers in 1917 with the River Transportation Service of the Carnegie Steel Company. Its primary purpose was the towing of coal and coke to Carnegie steel mills located in Homestead, Rankin, Braddock, Duquesne, Clairton, and McKeesport in the Monongahela Valley. The coal came originally from H.C. Frick's mines along the upper pools of the Monongahela River in Fayette, Greene, and Washington Counties, where loads of bituminous coal filled empty barges at the company tipples. An early company publication pointed out that the slackwater system as it existed by the nineteen-teens was the primary reason why regular and economic movement of large quantities of these materials was possible. There were continual additions to their river transportation facilities with towing and barge capacity evolving into one of the largest of its kind in the United States (Carnegie-Illinois Steel Corporation, *Weekly Bulletin*, Sept. 10, 1938).

In 1922 the Carnegie River Service extended the movement of finished steel products from the Monongahela Valley downstream to western and southern markets. Until 1929 these sailings were dependent upon natural water stages south of Pittsburgh. The completion that year of nine-foot canalization programs in the Ohio River allowed regular towing the year round. This significantly increased the river traffic from the Monongahela as the primary industrial tributary. There was extensive river shipment of finished and semi-finished steel as well as other raw materials and products among the various company plants in the Pittsburgh district.

The central river terminal of the Carnegie/U.S. Steel Companies was opened at Munhall in 1924. Much larger towboats were necessary as well as heavier, covered cargo barges. The facility for hull building was at the barge yard of American Bridge Company in

Ambridge, on the Ohio River. By the 1930s, 1557 steamboat hulls and barges had been launched from these ways. They were then taken to the marine ways at Coal Valley on the Monongahela, where they were equipped with a superstructure, engines and other fittings. The ways here, 195 feet long and 210 feet wide, were the largest on the Monongahela River.

In the 1930s, the Company fleet consisted of forty-two open-top and twenty-eight covered cargo barges. The slackwater at this point permitted 175- foot barges to haul 850 tons of cargo with a 8.5 foot draft. The Carnegie-Illinois Company towed finished steel products downriver until the subsidiary Ohio Barge Line was formed in 1941 (Carnegie Steel Company River Service 1934: 1-12). The sequence of incorporated names and related tow fleet information is as follows:

- Carnegie Steel Company (1917-1985), twenty-four steam & gas towboats
- Carnegie-Illinois Steel Corporation (1928-1951), fourteen steam and motor vessel boats
- United States Steel Corporation (1951-1985), twelve steam and motor vessel towboats
- USX Corporation River Docks Department, Clairton, Pennsylvania (1985+)

After sixty-eight years of towing from mines to the hot mills on the Monongahela, the Carnegie/U.S. Steel fleet came to an end in 1985. Their boats had been among the most familiar towing barges on the fifty-nine mile trip to and from the Robena coal processing plant in Green County to coke oven batteries located in Clairton, Pennsylvania.

Mon River Towing, Inc.

Mon River Towing Inc. was founded by the Guttman Oil Company in 1960. They operated as distributors of gasoline, oil and heating fuel along the Monongahela from their tanks located in Speers, Pennsylvania. Petroleum products came up the Monongahela from Ohio River tank farms, and this new barge towing company began hauling tanker barges in a new trade. When the Hillman Company ended their role in the coal trade, Guttman acquired their contracts continuing to push coal to the electric power plants in the Pittsburgh district. Hillman Barge and Construction Company in Brownsville built ten modern towboats for the Mon River Towing fleet (Wayman 1971: 311-323).

When Jones & Laughlin Steel discontinued their river fleet in 1983, Guttman bought all of their boats and barges and the marine ways and continued to push coal from Jones & Laughlin/ LTV mines on the Monongahela to the coke ovens in Hazelwood, Pennsylvania. From 1960 through the 1990s their fleet of towboats has numbered over thirty vessels.

The Sand and Gravel Fleets

Dravo Corporation has been dredging sand and gravel from local rivers for eighty years for consumers in the Pittsburgh market area. Since 1919 they have had about twenty steam and motor vessels functioning in this trade. Likewise, Iron City Sand and Gravel Corporation

has long been in this business, with its landing on the Monongahela River at the foot of South 22nd Street, South Side, near the old Brady Street Bridge. The firm was originally founded in 1873 under a different name. Its current incorporation dates from 1892. They have owned and operated many sand digger, dredge and steam and diesel tow boats over the years; the number currently stands at over twenty river craft.

The McCrary-Rodgers Company once operated from the Manchester Landing on the Monongahela. It operated as Rodgers Sand Company between 1920 and 1953. The company's most respected member and towboat captain, William B. Rodgers (1851-1925), was a lifetime advocate for river improvements. During the firm's fifty-four year history (under two different names), fifteen—mostly steam—towboats and dredges operated on the Monongahela River.

Another river fleet that operated extensively on the Monongahela, and in 1960 moved its main landing from the Northside of Pittsburgh to Glenfield on the Mon, was Crain Brothers, Inc. This firm has been a river towing company and contractor in the Pittsburgh area since 1943 and has built bridge piers, riverside docks and boat terminals along the Monongahela and other district rivers. They also engage in sand and gravel dredging and extensive marine salvage work and repair. About 1970 they moved their main landing to Beaver County, but for years their various river craft (over thirty have been employed) were a working part of regular Monongahela River lock and dam traffic.

Captain Richard J. Hiernaux, who also worked for the U.S. Army Corps of Engineers, Pittsburgh District, and was master of several Corps steamboats, had a towboat fleet operating out of Charleroi, Pennsylvania, between 1928 and 1941. He operated four successive steamers during his time. The business evolved into Marine Sales and Service, Inc. in 1959, also in Charleroi, which operated eleven motor towboats until 1974. This, in turn, was succeeded by Hancy Barge Line, Inc. in the same city, which finally merged with Campbell Barge Lines (see above) in 1987. All together, over the years and under its various configurations, this firm placed twenty-two towboats on the Monongahela River.

Farther upriver at Point Marion, Pennsylvania, the McClain Sand Company operated in the 1920s; at Red House, West Virginia, the firm of Stephen D. Leach was active in the 1930s. Both of these operations had but a few boats each (City Directories, 1920s-1960).

U.S. Army Corps of Engineers Fleet and Electric Powerplant Towboats

These two final categories ran river fleets regularly on the Monongahela River, although not in the numbers of the above-mentioned commercial-industrial firms. Over the years, the U.S. Army Corps of Engineers, Pittsburgh District, has operated a varied river fleet of dredges, derrickboats, snagboats and towboats. These provided tri-state area rivers with perpetual service, keeping the river basins open for navigation. This has been an important part of Monongahela River history since 1897. That year the Corps purchased the steamer *Slackwater*. Its previous owner had been the Monongahela River Navigation Company, which used it to service Company-owned locks and dams since 1884.

This was the first of many craft used by the Corps in area rivers. Between 1897 and the 1990s, over thirty steam, gasoline and diesel boats constituted the ongoing fleet. Dredge-boats varied in design for the rivers where they were to be used, *i.e.* dippers, ladder-style, pipeline dredges, bucket-types, etc. Snagboats with bow derricks for the removal of obstructions in the navigation channels were also employed as dredges on bar, shoal and rock obstructions. These craft are essential to maintain the 9-foot channel currently prescribed in the pools behind the dams on the Monongahela River. It might be mentioned that the navigation charts published and updated by the Corps are obviously vital to local river traffic.

Electric powerplants became extremely large consumers of Monongahela coal in the valley region. Unobstructed river operations are vital for fuel supplies to arrive on a timely basis at important facilities, such as Monongahela Power Company, West Penn Power Company, and Pennsylvania Power Company, and others. The use of hopper-barges has eliminated the need for coal supplies to be transferred from the river to expensive stockpiling areas on shore. Harbor boats shift these barges to unloading docks and reassemble the empty barges back into tows for the return voyage to the upriver mines. Tugboats remain the main vessels that make up the power company fleets.

(Some data in the last section was edited from a file on twentieth-century river transportation compiled by the late Captain James T. Swartzwelder of Pittsburgh, Pennsylvania. His unpublished notebook *Towboat Log - Inland Barge and Fleet Record* contains data on Mississippi, Ohio, and Monongahela River commercial river operations. Captain Swartzwelder's sources for this compilation were numerous company pamphlets, trade publications, inland shipping records and company logs. The original typed notebook is in this author's collection.)

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**THE INFLUENCE OF THE MONONGAHELA RIVER
NAVIGATION SYSTEM ON THE DEVELOPMENT OF THE
COAL, COKE, IRON, AND STEEL INDUSTRIES OF THE
MONONGAHELA RIVER VALLEY**

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INTRODUCTION

The Monongahela River originates at the junction of the West Fork and Tygart Rivers about one mile south of Fairmont, West Virginia. Varying in width along its course from 420 to 900 feet, it flows northward from that point a distance of 128 miles to Pittsburgh where it unites with the Allegheny River to form the Ohio River (Figure 1). The most important tributary of the Monongahela River, the Youghiogheny River, flows northwest through the heart of the Connellsville Coke District in Fayette and Westmoreland counties and joins the Monongahela at McKeesport, Pennsylvania. About eighty miles of the Monongahela River's length pass through lands rich in coal.

Coal lies at the heart of understanding the history of the Monongahela River Valley's industrial development, but for it to be useful, coal must be mined and transported to mills, power plants, and homes. From the late eighteenth century through the present, the Monongahela River has been the chief corridor for the transportation of both coal and coke. Like the string of a necklace, the river strung together the individual "pearls"—chiefly coal, coke, iron, and steel—that made the Monongahela River Valley world famous. To understand this industrial history, therefore, one must understand and appreciate the navigation of the river.

Settlement of the Monongahela and Youghiogheny River Valleys was well underway by the late eighteenth and early nineteenth centuries. Originating as a military and trading center, Pittsburgh's vital location at the head of the Ohio River and its rapidly growing population soon allowed it to develop into a major commercial and industrial center and a destination for the agricultural produce of the early Monongahela River Valley. In the absence of well-developed overland transportation routes, the Monongahela itself became the most important corridor of travel and commerce in early southwestern Pennsylvania. So important were the rivers that the Pennsylvania legislature declared the Monongahela and Youghiogheny to be "public highways" as early as 1782. In 1814 the state assembly authorized the governor to appoint three reviewers to examine the length of the river to determine the best locations for locks, dams, and navigation improvements (Albig 1914: 69).

Many of the Monongahela River Valley's early towns, such as Redstone Old Fort (current Brownsville) and Wilson's Port (later New Geneva at the mouth of Georges Creek) were established along its banks or near the mouths of its tributary streams to take advantage of the water as a source of transportation. As these early population centers developed, mills were built along the river to harness the waterpower.

The Monongahela's riverbanks and places near them also became the sites for early industrial enterprises, such as the James O'Hara and Isaac Craig glassworks in Pittsburgh, and Albert Gallatin's glassworks upriver at New Geneva, both of which began production in 1798. Boat building, too, became another common feature along the Monongahela's banks

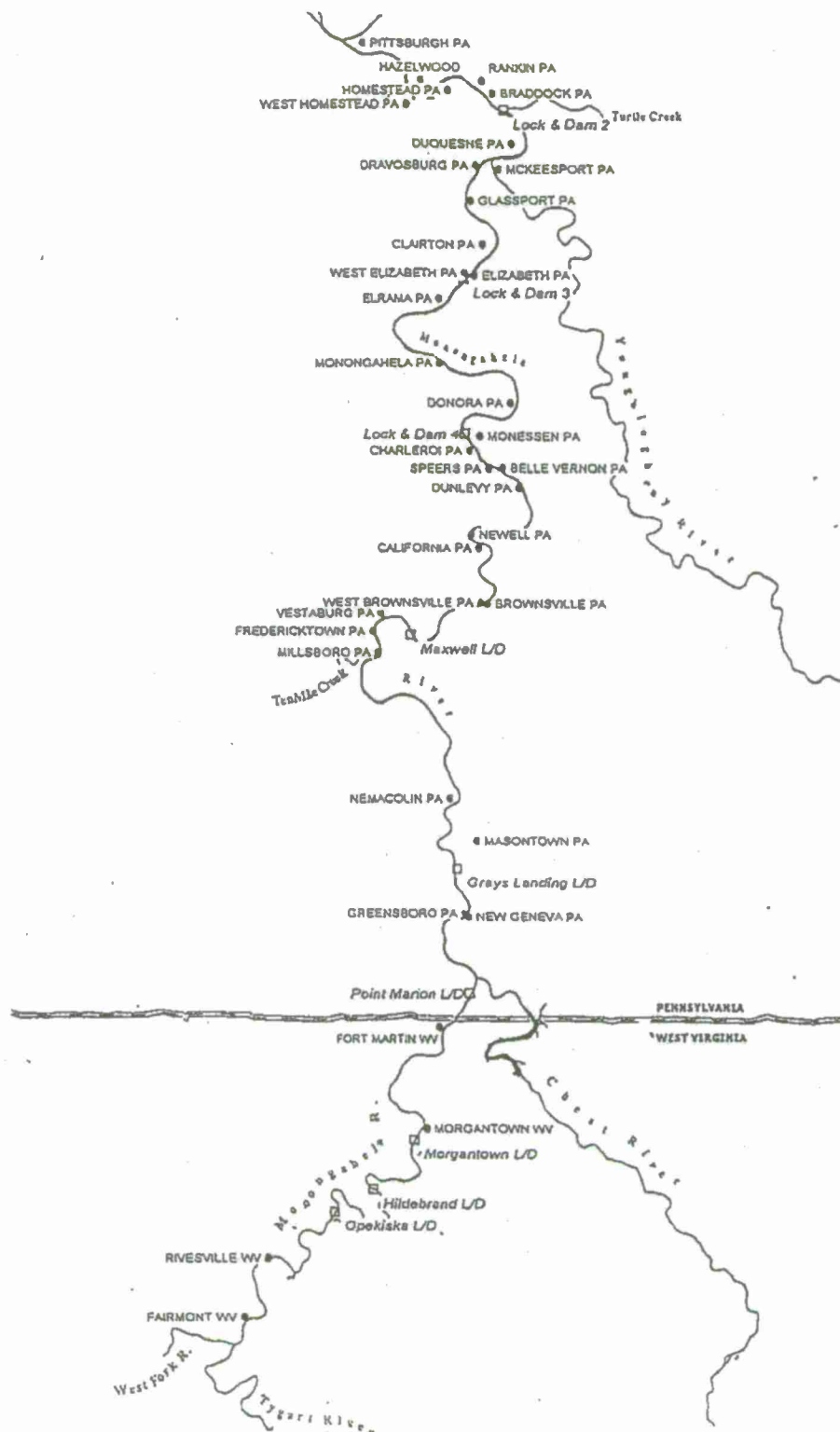


Figure 1. The Monongahela River Valley in southwestern Pennsylvania and adjoining Monongalia and Marion counties, West Virginia. From Parker (1999: xiv).

by 1800.¹ McKeesport, Webster, Belle Vernon, Monongahela City, Fayette City, California, Brownsville, and West Brownsville were important boat-building sites before the industrial revolution of the nineteenth century transformed the valley. It was the third largest business in Pittsburgh by 1803 after iron making and textile production (Reiser 1951: 14).

Boat-building relied upon the timber cut primarily during the winter months from the Monongahela River Valley's virgin forests. In the spring, lumbermen capitalized on the river's natural but short-lived rise to float large "booms" or rafts of this timber down-river to Pittsburgh and other river valley towns where sawmills also had become a common component of the valley's landscape (Carlisle 1995).

Although the natural river was essential to travel and trade from western Pennsylvania's earliest days, it also could be fickle. Early newspaper accounts reflect just how closely the pace of business and even the social life of towns at the time revolved around the water level in the Monongahela. Too much water, too little water, or ice often halted river traffic for weeks or months at a time. River improvements therefore became important at an early date, but they proved essential to the industrial transformation of the Monongahela River Valley that began in the decades preceding the Civil War and accelerated greatly from that time until the 1930s. Few records have been preserved, however, to document the increasing volume of commerce on the early Monongahela except for the occasional traveler's comment or merchant's record (Albig 1914: 66).

This industrial growth—first in coal, then in coke, then iron, then steel—was made possible at its most basic level by the presence of the extensive bituminous coal deposits in the Monongahela River Valley and especially by the Connellsville Coke District to the east that is bisected by the Youghiogeny River. The degree to which synergistic industrial expansion energized itself and created ever greater demands for coal resists easy explanation or reduction to neat "feed back" schematics, but some attempt is required.

Coal burned in home fireplaces or stoves provided a direct source of both heat and light. The same was true for stores and the new industrial workshops. Long before natural gas was exploited, coal-gas was extracted and piped to homes, stores, and businesses. This promoted urban growth, created more demand for coal, and lengthened the industrial work day. Longer hours spent on the job required still more coal for heat, light, and the steam power needed to run the new machines of the industrial workplace.

By the 1830s, steam engines were being adapted to many old and new uses. They powered grist- and sawmills, industrial shops, water pumps for new municipal waterworks, steamboats and railroads to name a few uses. Wood most frequently supplied the energy to generate steam, but with the rapid disappearance of the country's virgin forests, coal took on

¹The schooner *Monongahela Farmer* was built by "certain farmers" at Elizabeth on the Monongahela River in 1800 and was launched in 1801 for trade at New Orleans. The cargo, loaded at Elizabeth and Pittsburgh, included (among other things) 721 barrels of flour, 500 barrels of whiskey, 4,000 deer skins, 2,000 bear skins, and large amounts of flax, hemp, and guns plus ammunition for the eight-man crew (Albig 1914: 70).

greater importance as a source of heat to make steam. The adaptation of the steam engine to river craft enabled larger tows of coal boats and barges to be assembled to meet the growing demand. With diminishing supplies of wood charcoal available, coal also soon became essential to the production of coke as an alternative to charcoal in the iron and, later in the century, the steel industries. The establishment and expansion of railroads spurred further growth in the iron and steel through increased demand for iron and steel rails.

The abundant coal reserves of the Monongahela River Valley could never have been commercially exploited on a sufficiently massive scale nor the profits used to finance the industrial expansion of southwestern Pennsylvania had it not been for the transportation possibilities afforded by the Youghiogheny and Monongahela Rivers and for the private and governmental efforts expended to make them navigable year-round. Railroad lines eventually were built to transport coal from the inland portions of the Connellsville Coke District, but they were relatively slow to spread up the Monongahela River Valley and never could carry the enormous volume of mineral freight that was supported by the navigable river. In 1928, near southwestern Pennsylvania's industrial apogee, the Monongahela River carried 27,412,143 tons of freight—more than any other single inland river of the United States—of which 85.1 percent consisted of coal and coke (Bureau of Railway Economics 1930: 101; 102, Table 17).

Coal, and its highly productive “twin,” coke, therefore lie at the heart of understanding the “industrial synergy” that transformed the nineteenth and twentieth-century Monongahela River Valley into an interconnected and industrial juggernaut without parallel in the world. Henry Clay Frick, one of the paramount industrialists of the period, was fond of reminding people that “coke’s the thing they can’t make steel without.” But coal is the thing you can’t make coke without, and neither of them could have been exploited so successfully and on such a massive scale without a navigable river to transport them. Moreover, most of the coal and coke freight on the Monongahela was carried but a short distance (an average of 41.4 miles in 1928). This reflects the fact that the river valley was not only the leading national producer of coal and coke but that its industrial mills were also the chief consumers of those products.

RIVER NAVIGATION AND THE DEVELOPMENT OF THE MONONGAHELA RIVER VALLEY COAL INDUSTRY

The Economic Geology of Monongahela River Valley Coal

Pittsburgh and the Monongahela River Valley are blessed with vast deposits of bituminous coal. In the present-day Hill District, Schenley Heights, Mt. Washington, Hazelwood, and Squirrel Hill neighborhoods of Pittsburgh, for example, Late Cenozoic Era uplift and subsequent erosion exposed, rich, near-surface deposits of the thick and economically important Pittsburgh Coal seam used by the city's early occupants (Figure 2; Heyman 1970; Dodge 1985).

South and southeast of Pittsburgh, the bituminous coal fields found in the Monongahela River counties of Westmoreland, Washington, Greene, and Fayette and adjoining counties of West Virginia are part of the northernmost extension of the northeast-to-southwest trending Appalachian or Eastern Coal Region, one of seven major coal regions of the United States. This coal region covers some 55,076 square miles over nine states from Pennsylvania to Alabama and Georgia. It extends some 900 miles in length and 30-180 miles in width (Figure 3). It is responsible for about 90 percent of the current coal production in the United States. In 1925 the Appalachian Coal Region produced 92 percent of the nation's coal; Pennsylvania's portion of the region alone produced 34.5 percent of this amount. Little wonder, then, that in 1925 the U.S. Coal Commission recognized that the Appalachian Coal Region was

the greatest store-house of highrank coal in the United States, if not the world. This nearby and almost inexhaustible supply of high-grade fuel has been the foundation of the development of the blast furnaces the great iron and steel mills, and the countless manufacturing enterprises of the eastern States (quoted in Mulrooney 1989: 12).

The Main Bituminous Field in the western and southwestern part of Pennsylvania represents one of four major deposit of bituminous coal in the Commonwealth and forms the northernmost extension of the Appalachian Coal Region (Figure 4). Bituminous coal deposits underlie about 14,200 square miles of Pennsylvania, about one-third of its entire area. The geological strata represented in the Main Bituminous Field of Pennsylvania include some forty-two different coal seams, but only a few are of economic importance.

Historically, the Pittsburgh seam, which lies closest to ground surface, has produced about 80 percent of the bituminous coal mined in southwestern Pennsylvania. The Pittsburgh coal seam measures five to fourteen feet in thickness and extends over an area of some 5,729 square miles in four states. It has been called "the world's most valuable single mineral deposit," and the economic value of the 54 billion tons of coal it was estimated to contain following the Civil War was said to exceed the total worth of the California gold fields over 1,000 years (DiCiccio 1996b: 12, 13).

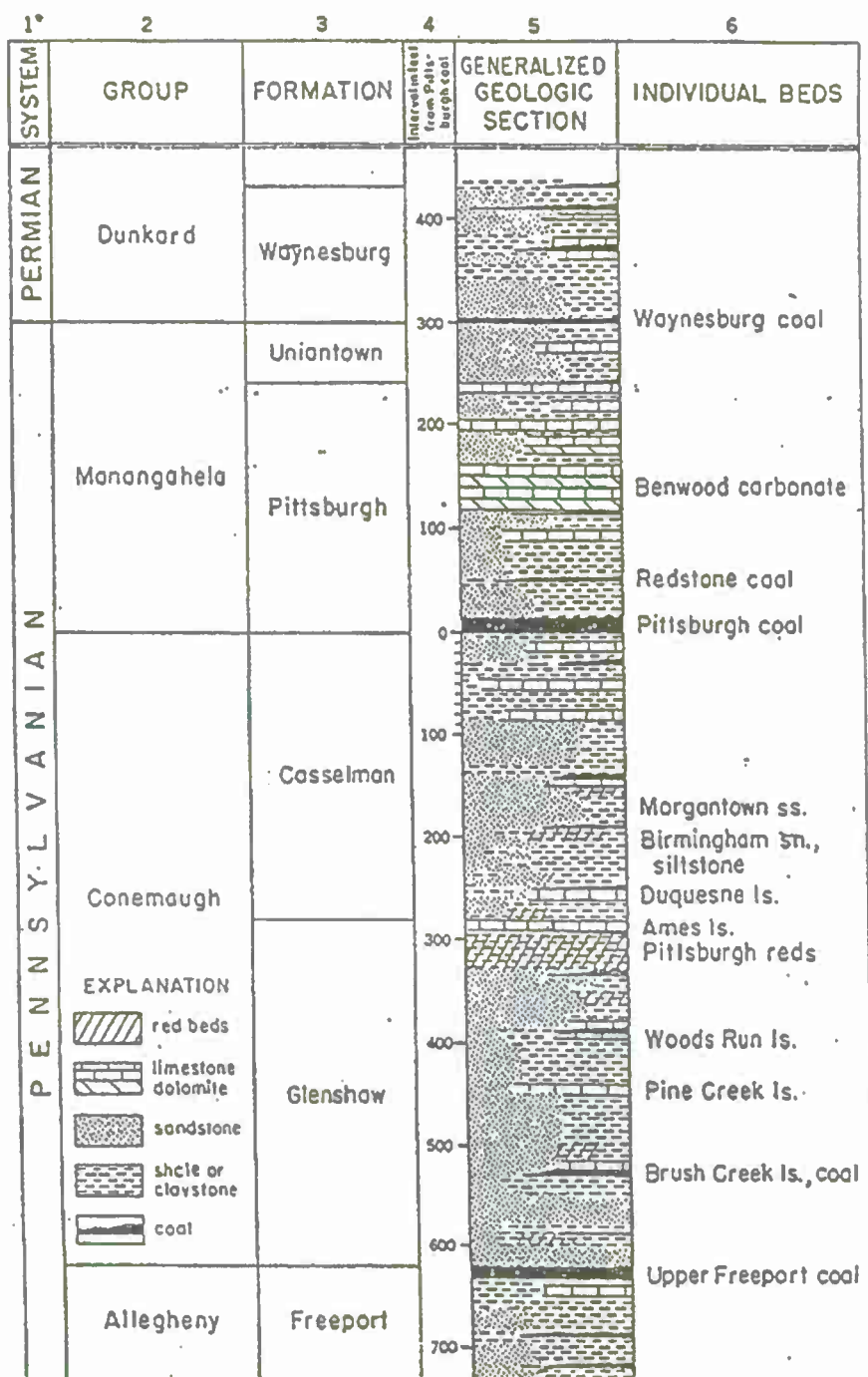


Figure 2. General stratigraphic section for rocks in the Pittsburgh, Pennsylvania, area. The location of the Pittsburgh Coal seam is shown. From Wagner (1970: 46, Figure 25).

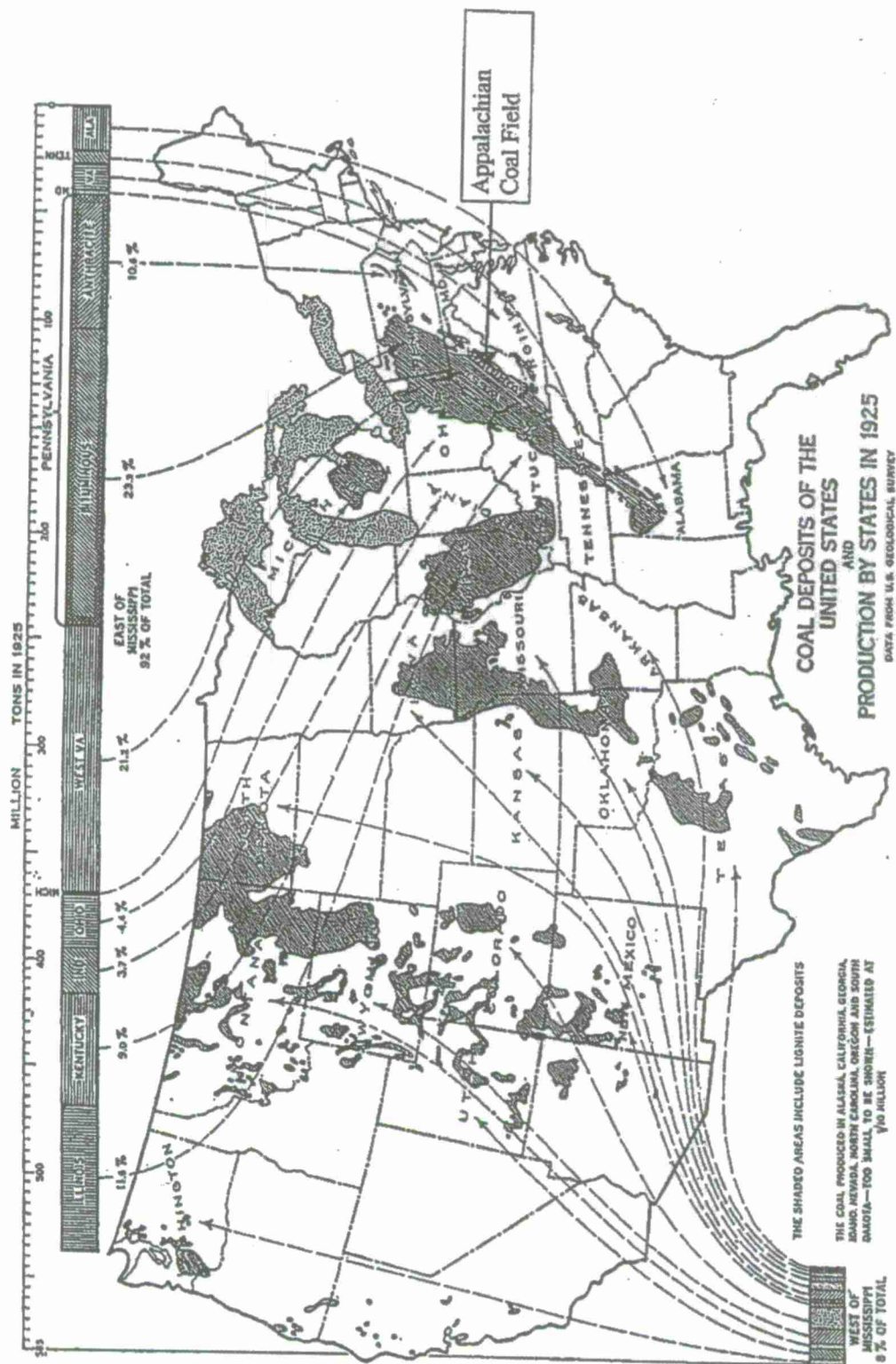


Figure 3. Major coal deposits of the United States. The location of the Appalachian Coal Field is shown. After Mulrooney (1989: 13, Figure 2-1).

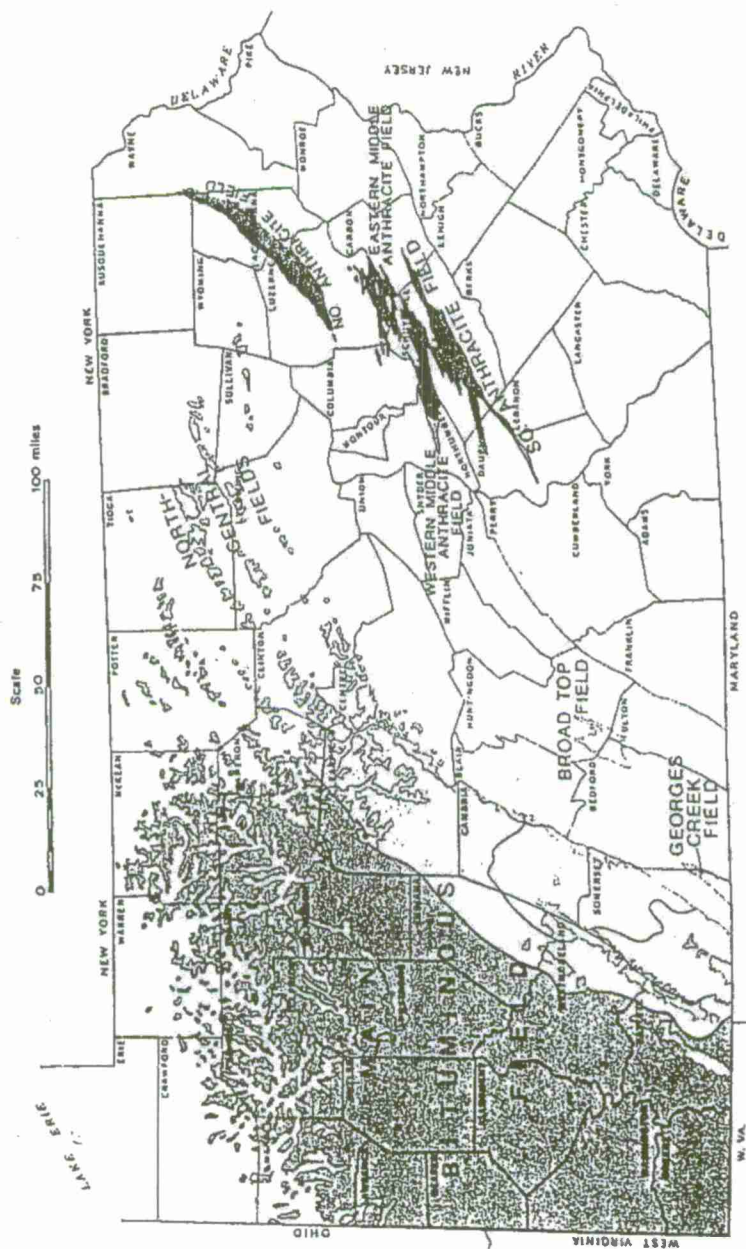


Figure 4. Bituminous and anthracite coal fields in Pennsylvania. The Main Bituminous Field extends throughout the Monongahela and Youghiogheny River Valleys in the southwestern corner of the Commonwealth. From DiCiccio (1996b: 10).

Its uses were (and remain) multiple. It was as useful at home as in stores and industrial workplaces. It fired the furnaces of early Pittsburgh glassmakers and the retorts of early salt makers. Its combination of high carbon content (57-65 percent), relatively low percentage of volatile materials (30-35 percent) and low ash and sulfur (4 to 14 percent and less than 1 percent, respectively), however, also make the Pittsburgh coal ideal for making coke, essentially "baked coal" (Enman 1962: 63). Coke became vital first to iron production and later to steel making.

Early American iron making used wood charcoal as the predominant source of carbon and as a fuel that was combined in an iron furnace with iron ore and limestone. The great expanses of early America's virgin forests supplied this charcoal, but the process used up enormous numbers of trees. Eventually, it became far too costly to transport the wood or charcoal to the iron furnaces.

Experimentation with coke produced from the enormous quantities of bituminous coal available in the Monongahela River Valley led to coke's use as an alternative iron-making fuel and carbon source. The adoption of the technology of coke-smelted iron sparked the beginnings of that industry in the Monongahela River Valley. Further, since steel requires coke as one of its essential ingredients, coke also contributed to the Monongahela River Valley's subsequent growth into the steel producing capital of the world between 1875 and the end of the Second World War.

Another fortuitous part of the economic geology of the Monongahela River Valley was the location of the Connellsville Coke District just to the east of the Monongahela River and within the valley of the tributary Youghiogheny River. The Connellsville Coke District in Fayette and Westmoreland counties, Pennsylvania, consists entirely of coal from the Pittsburgh seam. It is widely regarded as the finest coking coal in the world (Figure 5).

Extensive mining of the Pittsburgh seam for coal and coke production during the nineteenth and twentieth centuries excavated perhaps half of the area's original reserves. Pennsylvania was the leading bituminous coal producing state in the country and was responsible for upwards of 30 percent of all coal mined in the country between 1840 and 1930. By 1970 Pennsylvania mines had produced over 18 billion tons of bituminous coal as well as 10.75 billion tons of anthracite coal, the latter from mines in the northeastern part of the Commonwealth.

Due to the extensive earlier mining in Fayette and Westmoreland counties, the focus of present-day bituminous coal mining in the Monongahela River Valley has shifted to Washington and Greene counties, Pennsylvania, and to the adjoining coal fields of West Virginia in the valley's upper reaches. This is the current origin of most of the bituminous coal that continues to be transported down the river in large tows of barges. Although Pennsylvania's coal production has dropped about 30 percent from the levels attained during World War II, it still ranks fifth among states in overall coal production. Washington and

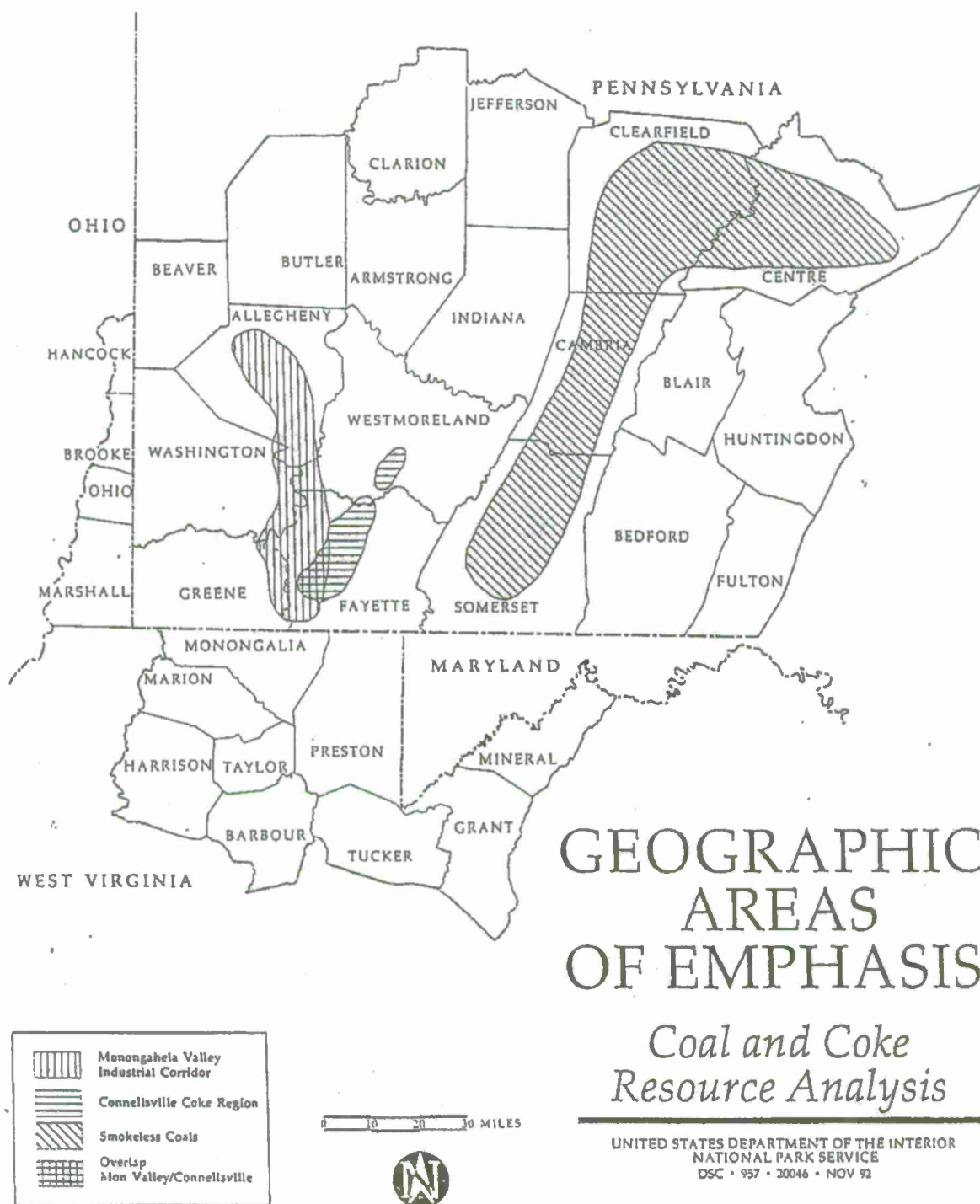


Figure 5. Location of the Monongahela River Valley industrial corridor and the adjacent Connellsville Coke District in southwestern Pennsylvania in relationship to the smokeless coal fields in the central and northeastern portions of the Commonwealth. From NPS (1992: 69).

Greene counties contribute about 28 percent of all the coal mined in Pennsylvania (Jones and Jones 1994: 17).

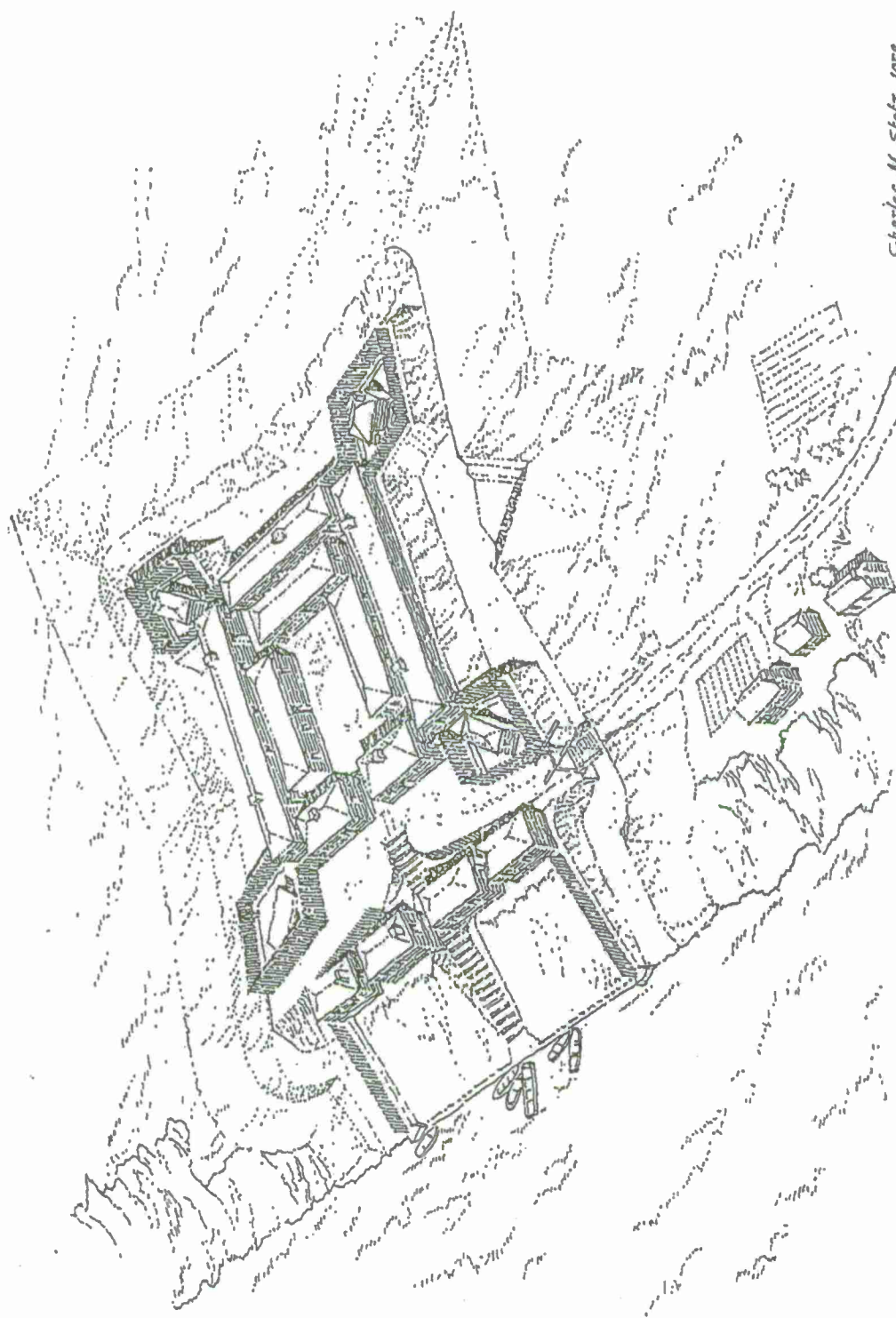
Mining, Transportation, and Use of Monongahela River Valley Coal Before the First River Navigation Improvements

Early travelers through eighteenth-century western Pennsylvania made occasional references to outcrops of coal, but its uses remained limited to the fireplace. John Pattin, a trader, noted in 1752 that he had observed “sea coal” along the Kiskiminetas River near Saltsburg, Pennsylvania. Adam Stephen (who went on to have a distinguished military career in the American Revolution) wrote to a friend in London of his observations of coal near present-day Brownsville in 1754. During James Burd’s construction of a road near Redstone Old Fort (Brownsville) in 1759 he recorded in his journal that the bottom of Coal Run was “paved” with fine coal and that “...the hill on the south is a rock of the finest coal I ever saw.” He also wrote that he burned about a bushel of it in his fire (Eavenson 1942: 23). This is one of the earliest known accounts of the use of coal in the Monongahela River Valley.

Adam Stephen also recorded that a coal mine had been opened on Coal Hill for the use of the garrison at Fort Pitt. Captain Thomas Hutchins saw the same mine during his visit to the post in 1761. Major Edward Ward of Fort Pitt was then in charge of the mine. This mine was located on the south side of the Monongahela River between the current Fort Pitt bridge and the Smithfield Street bridge, possibly just west of the Duquesne Incline. It tapped the Pittsburgh Seam of coal near the crest of Mt. Washington. The Quaker James Kenny recorded that mined coal was put into bags and tumbled down the side of the hill to the river, where it was transported across the Monongahela River to the fort in a flatboat. The troops at the fort used it both as fireplace fuel and to heat water or food in kettles. Coal also was reduced by the soldiers to make tar for caulking boats and for waterproofing.

The coal mined from Mount Washington by the troops of Mercer’s Fort and Fort Pitt provides the earliest known evidence of coal transportation on the Monongahela River, even though it was being transported across, not along the river. This was not the only such mine in the area, however. Kenny also recorded that he had visited a “French lime kiln and coal mine” about 1.25 miles from the Monongahela on a branch of Saw Mill Run. This entry suggests that the French may have begun mining some coal for use at Fort Duquesne during their occupation of the post between 1754 and 1758.

The coal mine located in the Pittsburgh Seam of Mt. Washington was opened in 1758 or 1759 by Colonel Hugh Mercer, who was then completing a fortification that has come to be called Mercer’s Fort (Figure 6). This post was situated along the Monongahela River outside the ruins of Fort Duquesne. It was an important but short-lived fortification (1758-1759) that preceded the construction of Fort Pitt between September 3, 1759 and 1761. During the construction of the smaller outpost, Mercer also identified sources of both limestone and coal. In addition to tumbling the coal mined from Mount Washington down



Charles M. Stotz 1958

Figure 6. Reconstruction of the appearance of Fort Mercer (1758-1759) along the Monongahela River. Troops from this post under Colonel Hugh Mercer's command began to mine coal from Coal Hill on the south side of the river. From Stotz (1958: 147).

the hillside in bags, Mercer also constructed horse paths so that the coal could be transported from the mine to the river in pack trains (Stotz 1958: 151).

The British troops and officers at Fort Pitt would have been familiar with the use of coal. Britain's own coal industry was producing some 2,200,000 tons as early as 1660 and about 2,500,000 tons by 1770. The fireplaces, stores, and industries of London alone consumed about 850,000 tons of coal at the start of the American Revolution (DiCiccio 1996b: 47). In the first half of the nineteenth century, immigrant English and Welsh miners provided a core of skill and experience in the fledgling American coal mines.

The Fort Pitt coal mine also was the site of an early underground mine fire, perhaps the first in the country (Edmunds and Koppe 1970: 2, 15). Presbyterian ministers Charles Beatty and Reverend Duffield visited Fort Pitt in 1766. Beatty described the nearby coal mine but noted that nearly a year before their visit the mine accidentally had been set ablaze by a small fire the miners kept near their work area. This mine fire was still burning in 1820, when the *Pittsburgh Gazette* described it as "like a volcano" (DiCiccio 1996b: 15).

Through two treaties concluded at Fort Stanwix, New York, in 1768 and 1784, title to Indian lands south of the Ohio River and in the present state of Ohio were secured. An additional treaty was concluded at Fort McIntosh on the Ohio River at present Beaver, Pennsylvania, in January 1785. Thomas and Richard Penn, the proprietors of the Pennsylvania colony, purchased the land of western Pennsylvania from the Iroquois Nation for an amount now equal to about \$10,000. In 1769 the lieutenant governor of the colony, John Penn, ordered John Lukens to make a survey of about 5,000 acres of coal lands in this region. This included the area near Fort Pitt and the Mt. Washington coal mine. After the American Revolution, the Penns sold off property lots in this large tract. For £30 purchasers of lots could secure the rights to mine the "Great Seam" of the Pittsburgh Coal on their new property (Harper 1931: 532).

By the end of the eighteenth century, the Monongahela River Valley at Pittsburgh was one of only two main bituminous coal-producing areas in the country. The other was near Richmond in the James River Valley of Virginia. The latter location then provided much of the bituminous coal used by such East Coast cities as Philadelphia, New York, and Boston until the development of railroad lines in the nineteenth century made west to east transportation of western Pennsylvania bituminous coal both technically possible and economically profitable.

Most late eighteenth-century landowners in western Pennsylvania envisioned only a limited use for the coal beneath their feet. Some deeds allowed property owners to mine coal on their own land for family use in perpetuity and without additional charge (Majumdar and Miller 1983: 33). On the eve of the industrial revolution few people understood the mineral's multifaceted utility or foresaw the great amount of money that would be made from its extraction in the next two centuries. Connellsville-area tavern owner Cornelius Woodruff was an exception. He inscribed the following in one of his books about 1800:

For those who will come after us, will find vast and undeveloped mines of material for men to work upon, treasure of untold wealth that now are hid from us....It will give employment to millions, not only to war, but peaceful occupation and the wants of life....Some great invention will be made to carry on commerce and communication in this to-be-great country" (Swetnam 1951: 228)

As Hugh Mercer's soldiers had discovered in the late 1750s, the early settlers of Pittsburgh also found they could obtain small quantities of coal for heating (often called "home coal") with relatively little labor or expense as the Pittsburgh seam has frequent exposures in the hillsides above the Monongahela River. Small drift mines, dug horizontally into these exposures, could be mined by one or two individuals. Mt. Washington or "Coal Hill," where Mercer's mine was located, became the site of many other small coal mines during Pittsburgh's early days.

In some cases, coal mined from the Pittsburgh Seam could be loaded directly from the mouth of the mine into waiting boats by dumping the coal through a simple wooden chute or tippie (Figure 7). Other areas of Pittsburgh on the north side of the Monongahela River also were mined at an early date. Just when coal from the Schenley Heights area was first used is not known, but a Pittsburgh brewery was burning coal from these deposits by 1795 (Eavenson 1942). That same year, a Mr. Mossman began to mine coal from what today is Herron Hill. He transported it to Pittsburgh in wagons and sold it to a number of early businesses (Harper 1931: 532).

As the population in the largely agricultural Monongahela River Valley counties of Fayette, Washington, and Westmoreland south of Pittsburgh grew during the late eighteenth and early nineteenth centuries, other exposures of bituminous coal were identified and began to be mined. By 1790 the population of Allegheny, Washington, Fayette and Westmoreland counties had grown to about 65,000 people spread over about 3,400 square miles. At first, most of the coal production for the population of this area was for local use, and coal was transported only short distances in wagons. Other coal mining, however, came to be directed toward the production of a cash commodity that was offered for sale at Pittsburgh.

Given the rudimentary development of roads at the time, the Monongahela River became the principal route of longer distance coal transportation from early mines in the Youghiogheny and Monongahela River Valleys to Pittsburgh. As settlement pushed down the Ohio River into Ohio, Kentucky, and beyond, Pittsburgh became the "wholesale and outfitting point for the Old Northwest" (Raitz and Ulack with Leinbach 1984: 95). Other rapidly growing river towns located outside the rich Appalachian Coal Region, such as Cincinnati and St. Louis, developed as new urban markets for the exceptional bituminous coal reserves of the Youghiogheny and Monongahela River Valleys. The exploitation of these early coal reserves, together with diversification of manufacturing, the establishment of small towns, better and more roads, and agricultural specialization played important roles in the commercialization of an otherwise overwhelmingly agricultural early American economy.

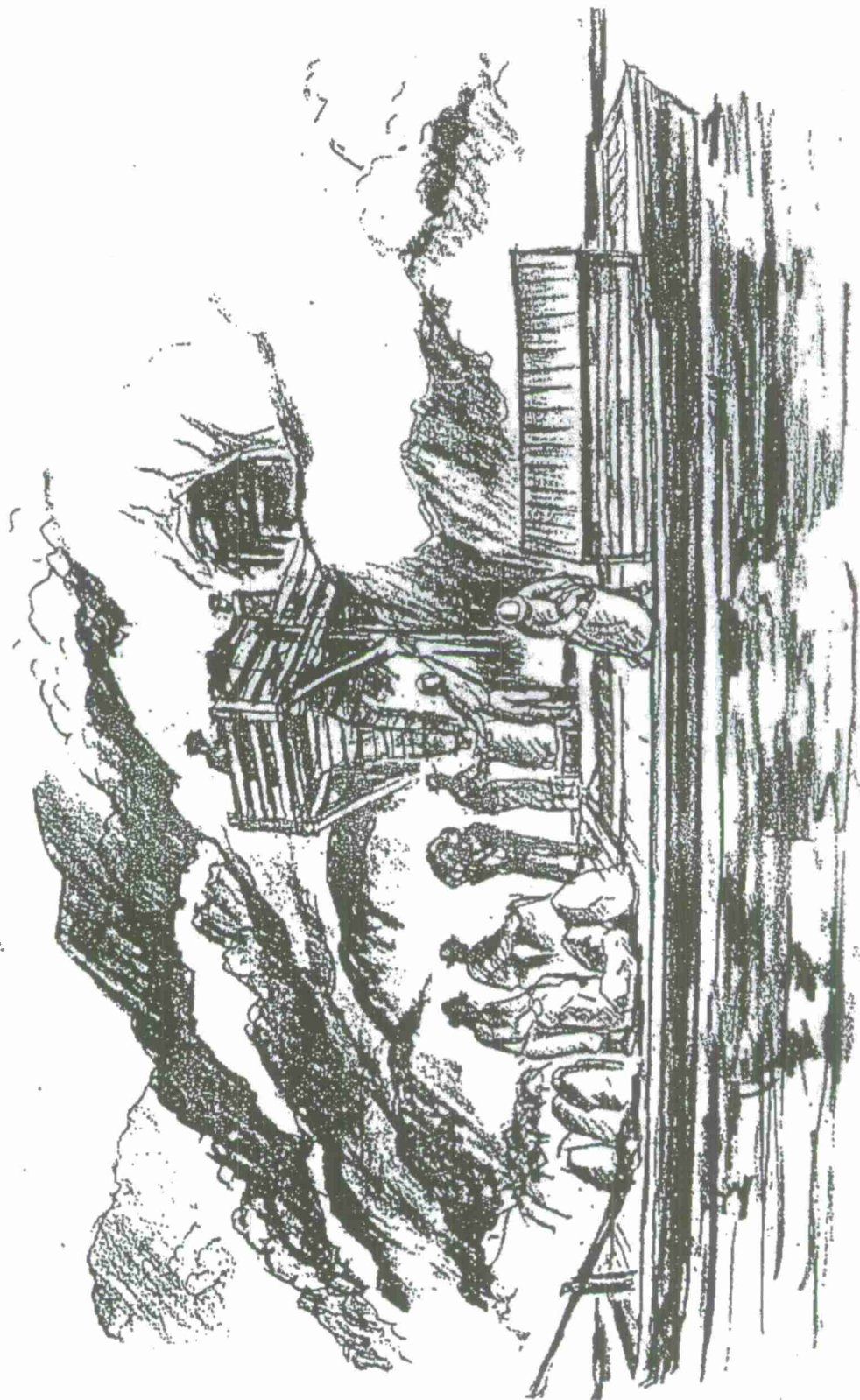


Figure 7. Bagging and loading coal from a drift mine along the river directly into a coal barge. From DiCiccio (1996b: 15).

Early newspaper accounts document some transportation of coal on the Monongahela River near Pittsburgh before 1800, long before any concerted efforts were made to improve navigation on the natural river. These accounts also show the danger that was inherent in the coal boatman's life. A *Pittsburgh Gazette* article dated February 7, 1789 reported that a large keelboat owned by John McDonald of Pittsburgh and "laden with coal" had sunk in the frigid river and that four of its crew had drowned. McDonald himself escaped only with great difficulty. Fifty years later, such dangerous conditions had not improved. In mid-January 1839, for example, a sudden rise in the river at Pittsburgh broke up an ice jam. The ice crashed into fourteen coal barges tied up above the mouth of Saw Mill Run sinking all of them. The cargo proved a complete loss (*Daily Advocate and Advertiser* January 15, 1839).

The first documented coal shipment from Pittsburgh for other than local use occurred in 1803, when a company of French merchants shipped 350 tons of coal as ballast on a ship called the *Louisiana*. The coal was taken down the Ohio and Mississippi rivers to New Orleans and was shipped from there along the coast to Philadelphia, where it sold at a price of \$9-\$10 per ton.

Some people were beginning to realize the utility of coal mining, transportation, and sale in the Monongahela and Ohio River Valleys by the beginning of the nineteenth century. In comparison to wood, however, coal everywhere remained under-utilized at this time, even in southwestern Pennsylvania. Wood was ubiquitous and more easily collected. It was the fuel of choice in the Monongahela River Valley as throughout the country for domestic lighting, heating, and cooking. As long as it was readily available, wood also fueled the steam engines being introduced by commercial and industrial enterprises. It also provided the charcoal used in early iron making (Binder 1974: 1-2).

Before 1800 commercial ventures in the Pittsburgh area were largely speculative undertakings often financed by established Philadelphia trading companies eager to exploit the lucrative fur trade with interior Native American populations (Reiser 1951: 3). After 1800, however, population growth and increased settlement in southwestern Pennsylvania combined with the area's abundant deposits of natural resources stimulated the development of locally-financed commercial and early industrial enterprises. As stands of native trees disappeared and the cost of wood increased, bituminous coal soon proved to be an economical alternative to wood for many Pittsburgh industries. Nowhere was this more apparent than in the early Pittsburgh glass industry.

In 1797 James O'Hara and Isaac Craig established Pittsburgh's first glasshouse on the south bank of the Monongahela River opposite the Point. Several months earlier, the New Geneva Glassworks owned by Albert Gallatin had opened farther up the Monongahela River at New Geneva, Pennsylvania. These were the earliest glasshouses in western Pennsylvania, among the earliest in the country, and both were located on or very near the Monongahela River.

Whereas Gallatin's glass furnaces were fired with wood, the O'Hara-Craig plant used coal from Coal Hill. This was the first glasshouse in the country to use coal for fuel (Innes

1976: 9). O'Hara and Craig purchased two lots of coal lands on Coal Hill to insure themselves a steady supply. In a letter to Edward Ensell in New York in 1801, Craig commented that

Materials are very conveniently procured and the Glass Works situate on the bank of a navigable river so near an extensive coal mine that one old Horse is able to haul more than one hundred bushels of Coal per day from the Coal pit to the Glass house (quoted by Innes 1976: 12).

In 1810 the O'Hara-Craig glasshouse and the houses occupied by their foremen and workers formed a small village at the foot of Coal Hill, which was still supplying the fuel used in their glassmaking operation (Innes 1976: 15). Coal was a cheap and readily available fuel for homes throughout Pittsburgh. In 1807 a bushel of it cost about five cents, and a \$2.00 load of forty bushels was enough to keep two fireplaces in a home operating for a month (Harper 1931: 532).

In addition to ease of coal procurement, the O'Hara-Craig glass plant's location adjacent to the Monongahela River also facilitated the economical river transportation of the raw materials needed to produce glass. Barrels of potash came from the wood ashes that were abundant everywhere, and a source of fine sand for silica eventually was discovered on the Youghiogeny River near the mouth of Jacob's Creek. The latter could be brought downstream to the glasshouse by boat. What they could not find locally was a satisfactory clay for crucibles.

The location of both the Gallatin and O'Hara-Craig glasshouses on or near the Monongahela River also exemplifies the significant role that the river played in the transportation and merchandising of the finished but fragile product, which could not withstand the rough handling of long distance overland transportation. The rapid spread of settlement down the Ohio River and up the Allegheny River into the Northwest Territory created new and growing markets that were anxious to receive the holloware and window glass these factories produced. Most of Pittsburgh's early glass was shipped west and south by river. Comparatively little was shipped east. The manufacturers often consigned a shipment to boat masters who turned over their cargoes to down-river agents for sale to consumers in riverside towns. The most frequent problem that delayed the delivery of orders was the condition of the river.

Given the importance of the river in the transportation of raw materials and the transportation and sale of finished glass products, it is not surprising that the navigability of rivers was a matter of direct and immediate economic concern to Pittsburgh glass makers. For that reason, many of them, including William Eichbaum, Benjamin and Thomas Bakewell, and Morgan Robertson, became stockholders and/or managers of the Monongahela Navigation Company, which before the Civil War began to address the problem of navigation on the Monongahela River (Innes 1976: 17; Veech 1873: 27, 28). Interest in river navigation might even extend to several generations of these glass-making families. For example, Neville B. Craig, son of early glassmaker Isaac Craig and a prominent Pittsburgh historian

and newspaperman, was elected a manager of the company eighteen times, beginning in 1846 (Veech 1873: 28).

Southwestern Pennsylvania bituminous coal had the twin virtues of being both cheap and plentiful. The high cost of transporting it overland was significantly reduced by river shipping even though the natural river could be treacherous and unpredictable. It was difficult to steer the early coal boats, barges, arks, French Creek boats, flatboats, and keelboats in the rapid current of the untamed river (Figure 8). In the absence of navigation controls on the river, a coal boat could easily be swept away from its moorings and sink. Five or six men were required to steer a single boat, and the resulting higher labor costs drove up the market price.

The river also froze over for long periods during the winter months, just when demand for coal for heating was at its highest. This could temporarily force up the price of coal at Pittsburgh or other river markets. Alternatively, if a number of loaded coal boats became marooned by the ice at one of these towns, a local glut of coal might be produced and the owners would have to sell their coal at or below cost or face potential economic ruin through the loss of their boats and cargo in a sudden thaw.

Low water in the natural river also proved daunting to the efficient transportation of heavy products like coal. River water levels in the summer and early autumn months were usually quite low, and river traffic often came to a halt for weeks or longer at a time. Coal was therefore usually mined in the winter. It might be stored in piles along the riverbank, then loaded into boats just before the few weeks each spring when river freshets provided enough water to float the heavily laden coal barges down river. The water level usually rose later in the fall, and this time of year was a busy one for getting coal to city markets before the onset of winter. All the river coal merchants had to make use of this spring rise, and since each coal boat might require five to as many as eight men to control it, the spring departure of the coal boats took on the air of a festive occasion.

A variety of boats was used in the early coal trade in western Pennsylvania, but most of the larger mines that developed in the Monongahela Valley adapted "French Creek boats" to ship their coal. This boat type had been developed in the valley of French Creek (a tributary of the Allegheny River north of Pittsburgh) and was used to transport iron, lumber, salt, and agricultural products to Pittsburgh. Early coal merchants purchased the boats and raised their sides to six to seven feet so that they would hold more coal. The boats ranged from sixty-eight to seventy-nine feet in length, were about sixteen feet wide and four to five feet in height. Each boat, once modified, could hold 140-260 tons of coal. Pairs of them were sometimes lashed together, creating the forerunner of the coal barge tows so often seen on the Monongahela even today. Once the coal had been delivered downstream, it was easier to break up the boats and to sell them for scrap lumber than it was to pole them all the way back up the river against the current. Most early boatmen either walked back home or worked their way back on the river.



Figure 8. A flatboat and two keelboats on the river. Flatboats, keelboats, barges, arks, and French Creek boats all were used to transport coal on the Monongahela and Ohio rivers in the early days of coal mining. From Buck and Buck (1939: 249).

In addition to the French Creek boats, barges and keelboats were also being used for coal transportation by 1810, and a small but growing river business in the delivery of western Pennsylvania bituminous coal to Ohio River towns had been established by the time of the War of 1812. In 1814 there were perhaps forty to fifty coal pits in operation on both sides of the Monongahela River at Pittsburgh. One miner was capable of digging perhaps 100 bushels of coal per day from these pits. The city was then consuming some 40,000 tons of coal per year, according to Zadok Cramer, the author of *The Navigator*, a popular guide to the Ohio River intended for the enlightenment of settlers that went through many different editions. Cramer reported that the price of coal had increased from six to twelve cents a bushel. By this time coal also had had an impact on early Pittsburgh's industrial growth. Cramer reported that three manufacturing establishments in the city were using coal-fired steam engines in 1814; three years later, the number had increased to eight.

Despite the national economic downturn that followed the end of the war, the first shipments of coal on a regular basis down the Ohio River from Pittsburgh began in 1817. In that year, a boat piloted by Tom Jones carried coal to Maysville, Kentucky. James and Robert Watson also were regularly shipping Monongahela River Valley coal to Cincinnati, Maysville, and St. Louis, and New Orleans by this time. The 457-mile river trip from Pittsburgh to Cincinnati took about five days to complete.

Louis Sweeney also began mining Pittsburgh coal for down-river trade about this time. His mine was located at what was called "O'Hara's burning pit" on the south side of the Monongahela (Harper 1931: 533). Other early Pittsburgh coal owners and merchants in the Monongahela River Valley at this time included George Ledlie, Herron & Peterson, Colonel William L. Miller, D. Bushnell, Fawcett & Brothers, John Gill, and William H. Brown, but little more is known about their operations (DiCiccio 1996b: 18).

Although coal was becoming a valuable commodity in Pittsburgh's economy by the eighteen teens, it was still only one of many products carried on the rivers. The March 14, 1823 *Pittsburgh Gazette and Manufacturing and Mercantile Advertiser*, for example, noted the departure of a thirty-ton flatboat loaded with coal and destined for Cincinnati. It was, however, only one of ten steamboats, flatboats, and keelboats bound for Cincinnati, St. Louis, Nashville, Louisville, and Natchez that left Pittsburgh between March 8 and March 13, and the only one that carried coal.

By 1825 Pittsburgh was being supplied by coal from the Walton Pool No. 1 and the Castle Shannon mines, in addition to the mines in Pittsburgh itself. There were at least ten such mines on Coal Hill alone in 1837, and they were then producing over 200,000 tons of coal per year, up from about 146,000 tons in 1832. However, this was insufficient to meet the needs of the city alone, whose homes, stores, and industries were by then consuming some 275,000 tons of coal annually. This local demand stimulated the opening of other mines up the Monongahela River and elsewhere in the Pittsburgh area. Although a great deal of coal was shipped down the Ohio River to other towns, the rapidly growing city of Pittsburgh itself became the most immediate market for Monongahela and Youghiogheny River Valley coal (Table 1). Towns farther down the Ohio River received progressively

smaller—though still significant—amounts of southwestern Pennsylvania coal. The records for Pittsburgh coal shipped to the port of New Orleans are especially well preserved and reflect dramatic growth over a forty-five-year period from a mere sixty tons in 1816 to 151,000 tons in 1861—an increase of more than 2,516 times. Growth such as this would have been impossible had it not been for the ability to transport coal on a Monongahela, Ohio, and Mississippi river system that was navigable at least seasonally each year.

Table 1

Tons of Pennsylvania Bituminous Coal Received at Pittsburgh, Cincinnati, Louisville, and New Orleans, 1816-1861

| Year | Pittsburgh | Cincinnati | Louisville | New Orleans |
|------|------------------------|----------------|------------|-------------|
| 1816 | -- | -- | -- | 60 |
| 1828 | 40,000 (est.) | -- | -- | -- |
| 1830 | -- | -- | -- | 420 |
| 1833 | 246,619 | -- | -- | 2,192 |
| 1835 | -- | -- | -- | 4,734 |
| 1836 | -- | -- | -- | 7,143 |
| 1837 | 452,160 (est.) | -- | -- | 5,133 |
| 1838 | -- | -- | -- | 9,440 |
| 1839 | -- | -- | -- | 8,576 |
| 1840 | -- | -- | -- | 6,141 |
| 1841 | -- | -- | 3,200 | 8,764 |
| 1842 | 510,400 (est.) | -- | -- | 4,756 |
| 1843 | -- | -- | 24,520 | 7,385 |
| 1844 | -- | -- | -- | 4,520 |
| 1845 | -- | -- | -- | 14,020 |
| 1846 | 760,000 (announced) | -- | -- | 15,374 |
| 1847 | -- | -- | -- | 22,990 |
| 1848 | -- | -- | -- | 19,400 |
| 1849 | -- | -- | -- | 23,250 |
| 1850 | -- | -- | -- | 29,650 |
| 1851 | -- | -- | -- | 4,000 |
| 1852 | -- | -- | 101,862 | 82,910 |
| 1853 | -- | 320,000 (est.) | -- | 45,660 |
| 1854 | -- | 410,000 (est.) | -- | 54,550 |
| 1855 | -- | 300,000 (est.) | -- | 111,800 |
| 1856 | 2,151,286 | -- | -- | 19,200 |
| 1857 | -- | 580,000 (est.) | -- | 61,970 |
| 1858 | -- | 600,000 (est.) | -- | 67,700 |
| 1859 | -- | 493,320 (est.) | -- | 96,500 |
| 1860 | -- | 700,000 (est.) | 240,000 | 168,500 |
| 1861 | -- | -- | -- | 151,000 |

Compiled or calculated from data in Binder (1974: Appendix, Tables J, K, L, and M). Data available for Cincinnati beginning in 1853 through 1856 and from 1857 through 1861 is actually for 1853-54, 1854-55, 1855-56, 1857-58, 1858-59, 1859-60, and 1860-61, respectively. "Est." refers to an estimated tonnage received at the indicated city.

Money made from Pittsburgh's early coal mining businesses also helped to fund some of the city's early land development schemes. For example, William Arthurs (1784-1857), after whom the Arthursville neighborhood in the Hill District derives its name, once operated a coal mine and was treasurer of the Pittsburgh and Coal Hill Turnpike Company (Carlisle et al. 1991: 1.5, 2.20). By the 1830s, he had become involved in land development and sold off many Hill District lots to new arrivals, including a number of African Americans. Arthursville soon developed into the center of African-American residential and institutional life in the early Hill. As was true of early Welsh residents in the nearby Minersville area (Herron Hill), some of the African-American men who lived in the Hill may have found employment in the numerous coal pits that operated there.

By the 1840s, western Pennsylvania bituminous coal was becoming a critical and essential economic factor in the continued growth and industrial development of towns and cities from Pittsburgh to New Orleans. It was being used to light and heat homes and businesses, fueled the steam engines that propelled industries to new levels of production and output, and had begun to make inroads into the charcoal iron industry. The demand for ever-larger amounts of this cheap and readily available fuel continued to increase with the meteoric rise in the nation's western population.

There were perhaps thirty-five to forty mines operating in the Monongahela River Valley about 1837. Washington County alone had twenty-seven coal mines in operation in 1840, and Allegheny County was the leading single producer of bituminous coal in the country. In that year, the coal industry employed 1,294 people in southwestern Pennsylvania and extracted some 350,000 tons of coal—about 72 percent of the Commonwealth's total employment in the coal industry and 75 percent of its overall coal production (Bureau of the Census 1840). Railroads were still in their infancy and long-distance overland transportation was uneconomical and impractical. Coal transportation by river was the only effective means of meeting the nation's growing demand.

River navigation, however, was unpredictable. Periods of low water or freezing temperatures could halt coal deliveries for weeks or months while high water could sink the unwieldy coal boats. The volume of river commerce had developed about as far as it could given the status of navigation on the natural Monongahela River. New navigation measures were now required for economic growth to continue.

The Monongahela Navigation Company and the Coal Trade, ca. 1840-1870

The utility of locks and dams to improve navigation on the Monongahela River and thereby to increase the volume of trade that its towns and villages might enjoy was recognized at an early time. Owners of early grist mills and sawmills built the first dams on the river. These privately constructed and maintained improvements harnessed waterpower to operate mills, but the dams also blocked heavier or larger boats from moving up or down the river. As long as the river traffic consisted of small numbers of lighter craft, such obstacles could be overcome, but early mill dams posed a more serious problem for the efficient transportation of heavy loads, such as sand and coal.

Pennsylvania eventually regulated these improvements by requiring the mill dams to be no more than 4.5 feet high. This allowed smaller keelboats and flatboats to go over the dam during periods of high water. Owners also had to provide a chute at the side of their dam so that boats could by-pass it during periods of low water. The wool and cotton carding firm of Gillespie and Clarke constructed the first lock on the Monongahela River at Brownsville about 1807. The firm also operated a grist mill and sawmill here. Colonel Henry Heaton constructed another lock farther up the river at East Millsboro, and a third private lock was erected at Parkinsons Mills, what today is Monongahela City.

These private dams were necessary to pioneer life, but their benefits were primarily local. Any economic difficulties experienced by just one owner could delay or prevent repairs to his lock and dam. This could tie up river commerce for others who relied on the river to transport agricultural produce, coal, timber, livestock, and manufactured goods. Legislative efforts to remedy the problem began as early as 1814 with the passage of an act to survey the river and to assess the number of mill dams constructed on it. The state incorporated the Monongahela Navigation Company (hereafter, MNC) in 1817 for the purpose of building a slackwater navigation system on the river. Debates over the proper role of the federal government in funding such internal improvements and the economic panic of 1817 resulted in inaction, however, and the company's charter was revoked in 1822.

In 1827 a Pennsylvania Canal engineer, Edward F. Gay, was retained by the Commonwealth of Pennsylvania to survey the Monongahela River and to recommend navigation improvements. Gay's 1828 report proposed a system of nine locks and seven dams extending some eighty-nine miles up-river to the state border with (West) Virginia. He chose the locations of his proposed locks and dams with an eye not only toward improving river navigation but also to preserving the economically important and by now numerous mill dams that had been constructed along the length of the river.

Gay's report generated no immediate state action, but in July 1832 the federal government authorized another study of the river from Pittsburgh to Brownsville, this one by William E. Howard. Support for federal involvement in surveying the river came from businessmen in the Brownsville area, including mill owner Clarke, glassmaker George Hogg, and industrialist Jacob Bowman, all of whom also stood to benefit personally from improvements to river navigation. Howard's 1833 study, unlike Gay's, specifically considered how to improve steamboat navigation on the Monongahela. Construction of these river craft had by this time advanced to the point that they were becoming a significant factor in river commerce. Howard's report also addressed the economic potential of the coal resources that outcropped all along the river if this valuable mineral could be efficiently extracted and transported to market. By Howard's time, the widespread adoption of steam power had greatly reduce the need for mill dams on the river; only Heaton's dam at East Millsboro and one at Monongahela City then remained.

Gay's and Howard's surveys increased the engineering knowledge and mapping of the Monongahela River, but the federal government declined to participate in the river's improvement and in 1835 passed responsibility for any navigation improvements back to

Pennsylvania. In 1836 Pennsylvania re-incorporated the MNC and charged it with carrying out the construction of navigation locks and dams on the river from Pittsburgh to the (West) Virginia state line. The re-incorporation provided that tolls on the new navigation system would match those collected by eastern Pennsylvania's Schuylkill Navigation Company.

The act of re-incorporation attempted to guard against conflicts of interest. It specified that managers of the MNC could not also engage in river commerce or the construction of docks and warehouses. Nevertheless, Brownsville and Pittsburgh businessmen were at the helm of the MNC from its first days. James Clarke of the Gillespie and Clarke mill in Brownsville, became the MNC's first president (1837 to 1840). Prominent glassmakers Thomas Bakewell and George Hogg were elected as two of the company's first ten managers. Bakewell served a total of twenty-five terms as a manager of the company and was its president from October 1840 to October 1841. In 1838 another glassmaker, William Eichbaum, was elected and continued to serve as a manager for many years thereafter. He also was president of the MNC from October 1841 to January 1844.

After its re-incorporation, the MNC conducted another survey of the river under the direction of William Milnor Roberts, their chief engineer, from July to September 1838. In December contracts were awarded for construction of the company's first two locks and dams. Construction of Lock and Dam A, as it was originally called, was planned for a sandbar known as "McClurg's Bar," about two miles up the Monongahela River from Pittsburgh. The location was subsequently moved downstream to a point about one mile from Pittsburgh. The construction contract was awarded to a company owned by James K. and J.B. Moorhead. (James K. Moorhead, later known affectionately as "Old Slackwater," subsequently became president of the MNC in 1846.)

A number of technological and economic developments propelled the MNC's agenda. First, the rapid evolution of steam power and its adaptation to river craft allowed larger steam-powered boats to be constructed on the Monongahela and gave new impetus to this widespread valley business. The MNC's lock and dam system was among the first in the United States to take steamboat size into consideration in determining the dimensions of their locks.

Milnor Roberts studied the lock sizes under consideration for other projects in Kentucky and Ohio and the locks of the Louisville and Portland Canal at the Falls of the Ohio River. He settled on a size of 180 feet by 50 feet for the Monongahela River locks. Second, the adoption of steam power also stimulated the use of coal for fuel, and this increased the demand for the efficient extraction and transport of Monongahela River Valley coal as well as sand that was used in the valley's prominent glass making industry.

A third MNC consideration was the opening of the Pennsylvania Canal at Pittsburgh in 1831 and the completion of an outlet lock on the Monongahela that held the added promise of transporting Monongahela Valley coal by canal boat to eastern Pennsylvania. High freight rates, small canal boats, narrow locks, and competition from anthracite coal producers in eastern Pennsylvania and other coal producers in Virginia, Maryland, and Great Britain,

however, worked against the economics of shipping western Pennsylvania bituminous coal eastward on the canal. Between 1832 and 1880, annual canal shipments of coal eastward never exceeded the 29, 234 tons achieved in 1854 (DiCiccio 1996b: 34).

Finally, the opening of the National Road from Cumberland, Maryland, through Brownsville to Wheeling on the Ohio River in 1818 inspired a mixture of both fear and hope. Pittsburgh merchants, especially, were worried that trade and passengers who might otherwise travel down the river to their town would be diverted to Wheeling. They also hoped that efficient and comfortable river transportation might lure passengers from Wheeling to Pittsburgh and from Pittsburgh to Brownsville, where overland connections to the East could then be established.

The national economic depression that began in 1837 brought work on the MNC's new lock and dam system to a halt. With the failure of the United States Bank, a payment of \$50,000 from Pennsylvania to the MNC was not realized, and engineer Roberts left for work in St. Louis (though he later returned). These economic problems had immediate consequence for the river's coal commerce. It was determined that in 1837 alone, ice-bound boats cost the industry \$40,000, and in October of the next year, boats loaded with about 30,000 tons of coal had waited three months for enough water in the river to continue downstream (Albig 1914: 71).

In 1843 a group of businessmen led by James K. Moorhead purchased a majority interest in the depressed shares of MNC stock. Pittsburgh business and financial interests were well-represented in the group of new owners. Glassmakers continued to be prominent stockholders and managers, but so too were members of the city's cotton and textile industry (a significant Pittsburgh business during the ante-bellum period) and its financial community.

Despite the economic troubles that began in 1837, between 1841 and 1856, the MNC constructed and opened Locks and Dams Nos. 1 through 6 on the Monongahela River providing a navigation pool as far upriver as New Geneva/Greensboro (Gannett Fleming, Corddry, and Carpenter, Inc. 1980: 4). When Locks and Dams Nos. 1 and 2 opened in 1844, slackwater was created up the river to Monongahela City, some eighteen miles above Pittsburgh, and in a two-month period, 936 steamboats, flatboats, and keelboats passed through Lock No. 1 at Pittsburgh. Lock and Dam No. 3 two miles south of Elizabeth, and Lock and Dam No. 4, below Belle Vernon and stretching across the river between the future site of Monessen and North Charleroi (first called "Lock Four"), 41.3 miles above Pittsburgh, also opened in 1844.

Although brick and glass were important components of the river freight that passed through these locks, coal was the river's most important commodity from the navigation system's earliest days. The opening of just these first four locks of the navigation system significantly spurred the exploitation of coal from mines in the lower and middle stretches of the river. This is apparent from the figures presented in Table 2. Some 30,686 tons of coal passed through Lock No. 1 to Pittsburgh in 1844, all of it extracted from Allegheny County mines that could take advantage of the navigation available in Pool No. 1, formed between

Locks and Dams Nos. 1 and 2. No coal was contributed to this total by mines farther upriver.²

In 1845, the first full year of the operation of Locks and Dams Nos. 1-4, the amount of coal shipped down river to Pittsburgh climbed to 184,207 tons. The contributions of the four navigation pools to this total were not equal, however. In general, the largest amounts of coal came from the mines closer to Pittsburgh. Pool No. 1, for example, contributed 101,115 tons of coal or about 55 percent of all the coal that passed through the navigation system's locks and dams in 1845. Considerably less coal, about 53,144 tons (29 percent) came through Lock and Dam No. 2. Mines located in the vicinity of Pools No. 3 and 4 showed still smaller contributions to the total tonnage, only 6.8 and 9.4 percent, respectively.

Coal shipments increased by 126,949 tons in 1846 to 311,156 tons, a 69 percent increase over 1845 levels. As a result of production increases stimulated by construction of the locks and dams, by 1847 mines in the vicinity of Pool No. 2 were out-producing the older mines in Pool No. 1 by 32,422 tons. In succeeding years, mines in the Pool No. 2 stretch of the river between Turtle Creek and Elizabeth, dominated coal production in the river valley.

In the fifteen years between 1845 and 1860, the amount of coal shipped down the Monongahela (and after 1852, the Youghiogeny) rivers, according to Monongahela Navigation Company records, increased about seven times (see Table 2). Through-passenger travel also increased and reached a peak of some 48,000 in 1848 (Albig 1914: 72). Access to slackwater navigation throughout most of what in 1856 was the main coal-producing section of the Monongahela River Valley played a major role in achieving this significant increase in coal transportation. The opening of the two locks and dams above Brownsville that year brought slackwater navigation to within seven miles of the (West) Virginia border (Albig 1914: 72). By 1860 nearly half of the bituminous coal mined in the United States came from Pennsylvania mines (Binder 1974: 3). The Commonwealth's coal industry had grown to be its largest in the number of employees, second in the amount of invested capital, and fourth in the value of product (Bomberger and Sisson 1991: 8).

The amount of Monongahela River Valley coal delivered at Pittsburgh in the fifteen years between 1845 and 1860 shows a generally steady annual increase from 184,200 tons to 1,517,909 tons (see Table 2). The only shortfall during this period was recorded in 1856, due to severe winter weather (see below). It was widely recognized that such steady and dramatic increases would have been impossible were it not for the construction of the Monongahela Navigation Company's locks and dams and for the resultant extension of navigation pools up the river.

²In 1840, before the opening of the MNC's navigation facilities, the Monongahela River wharfmaster at Pittsburgh, Thomas McFadden, recorded that 1,048 flatboats loaded with coal, brick, etc. had passed through Pittsburgh, but the total tonnage carried was unknown (Albig 1914: 72).

Table 2
Coal Shipments Down the Monongahela River to Pittsburgh, 1844-1872

| Year | Tons |
|------|-----------|
| 1844 | 30,686 |
| 1845 | 184,207 |
| 1846 | 311,156 |
| 1847 | 385,805 |
| 1848 | 392,774 |
| 1849 | 398,340 |
| 1850 | 491,918 |
| 1851 | 490,850 |
| 1852 | 585,233 |
| 1853 | 628,654 |
| 1854 | 693,278 |
| 1855 | 889,360 |
| 1856 | 353,364 |
| 1857 | 1,158,939 |
| 1858 | 1,027,866 |
| 1859 | 1,131,467 |
| 1860 | 1,517,909 |
| 1861 | 832,229 |
| 1862 | 743,358 |
| 1863 | 1,057,770 |
| 1864 | 1,402,837 |
| 1865 | 1,580,912 |
| 1866 | 1,704,616 |
| 1867 | 1,202,908 |
| 1868 | 1,812,040 |
| 1869 | 2,100,504 |
| 1870 | 2,303,856 |
| 1871 | 1,920,852 |
| 1872 | 2,168,352 |

Information for 1845-1860 from Binder (1974: Appendix, Table N) based on data contained in Wall (1884) and Saward (1887-1888). Data for 1844 and 1861-1872 calculated from Veech (1873: 23). NOTE: Tonnage figures for 1852 through 1860 represent combined coal tonnage on both the Monongahela and Youghiogheny rivers. One ton (2,000 lbs.) of coal equaled approximately 25 bushels, and one barrel of coal contained about 2.5 bushels.

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While the development of the Monongahela Navigation Company's locks and dams stimulated growth in the transportation of both passengers and freight, seasonal or episodic rises and falls in the river sometimes damaged the company's locks and dams and interrupted

river commerce and travel. In mid-July 1843, for example, a sudden rise in the river created a breach in Dam No. 1 and disrupted travel between Dams No. 1 and No. 2. Repairs to these private structures were, of course, accomplished at the company's expense, and the company could not always afford them. Even a small amount of damage could have a disproportionately large effect on river traffic (*Daily Advocate and Advertiser* July 18 and 19, 1843). Ice jams combined with floods caused the most damage to the company's works.³

Since much of the bituminous coal that was transported on the river was actually consumed in Pittsburgh, operation of the MNC's navigation system had the immediate effect of keeping the coal supply high and its price correspondingly low for Pittsburgh residents, businesses, and industries. Since coal was used for everything from home heating to the production of power for large industrial concerns, even a small increase in its price could have a direct effect on the city's economy. On January 21, 1856, for example, the *Pittsburgh Morning Post* estimated that the city's total coal annual usage then ran to about 10 million bushels (400,000 tons), in fact, a considerable under-estimate (see Table 1); thus, the paper reasoned, an increase in price of only one cent per bushel could cost Pittsburghers an additional \$100,000. The truth was worse. When the river froze and caused a two-week interruption in Pittsburgh's coal deliveries in mid-January 1856, local coal prices did temporarily rise, but by three to four cents per bushel.

The same *Pittsburgh Morning Post* article estimated that some 16 million bushels (640,000 tons) of coal were shipped down the Ohio River in 1856. The success of the navigation improvements on the Monongahela River led the editorial voice of the paper to demand the same improvements for the Ohio. "Were that river improved by dams and locks, as the Monongahela is," wrote the paper's editors, "the coal trade would soon swell to a magnitude that would make what is now appear but 'the day of small things' in the comparison."

During the first two years of the navigation system's operation tolls nearly doubled, but accumulated debt and interest from the company's earlier years and maintenance costs on the locks and dams continued to create economic problems for the MNC. Compared to other river navigation systems, tolls for coal were very cheap at \$2.91 per forty tons. Fees were four times that amount on the Schuylkill Navigation Company's system in eastern Pennsylvania. Despite the reasonable tolls on the Monongahela, coal operators still complained about what they saw as the high cost of using the MNC's facilities.

³Pittsburgh newspapers often pointed out the necessity of completing the Monongahela Navigation Company's locks and dams as a way to further the city's commerce and passenger travel. Navigation improvements were editorially linked with the positive aspects of urban development. On May 19, 1843, for example, the *Daily Advocate and Advertiser* recorded that four days before the steamboat *Oella* had landed at Pittsburgh with ninety-three passengers aboard, thirty of whom had embarked at Cumberland, Maryland. The same announcement warned city residents, however, that the river would soon be too low for further travel and that "...the interests of our great city require the completion of ...[the navigation improvement]... as speedily as possible."

They also wanted the dams on the river lowered to 4.5 feet from 8 feet so that they could float their barges directly over the dams at times of high water and avoid paying the MNC toll altogether. The dams were not lowered, but the MNC did further reduce its tolls to \$2.46 per forty tons. The toll reduction further stimulated the exploitation of coal and increased river traffic but also yielded less income that the MNC could devote toward lock and dam maintenance or to upriver expansion of the navigation system.

Despite such difficulties, by 1847 the company had begun to pay off its bond issues, and revenues were good. In 1852 the share price of the company had climbed twenty-five times from its original price of \$3.00 to \$75.00. Coal and coke were responsible for most of the navigation system's revenue and for its brighter economic prospects.

Experiments with coal towing on the Monongahela River began in 1845, the year after the MNC had extended the navigable pool of the Monongahela River upriver as far as Brownsville. Access to the improved navigation facilities adjacent to the coal-rich middle- and lower-river valley immediately enabled larger, more heavily laden coal boats and barges to be used. It also stimulated the rapid evolution of a new form of transportation, coal boat towing (Figure 9).

"Towing" is actually not an accurate term, for the coal barges were not pulled along as the term suggests but were pushed by a steamboat. Initially the barges were lashed to either side of the steamboat. In 1851 the steamboat was placed at the rear of the barges, a position that allowed larger tows to be assembled and increased their maneuverability (Bissell 1952: 119).

By the 1880s, a coal "tow" might consist of a steam towboat and as many as ten to fourteen coal boats, barges, or flatboats and from one to four fuel boats that supplied the steamer during the voyage. All the boats were placed in front of the steam-powered towboat except for two boats placed on either side of it. The boats were all lashed together and made up a unit perhaps 350 feet long and 150 feet wide. Such a flotilla could carry some 24,000 tons of coal, representing the mineral extract from as many as seven acres of coal lands. Tows of such large size would not have been feasible in the absence of river navigation facilities that provided the channel depth needed to float so wide and heavy a load and that also cut the river current so that the tow could be controlled.

The first coal tows were more modest in size. Daniel Bushnell utilized a small sternwheel boat called the *Walter Forward* for this purpose in 1845. His first trip was a run to Cincinnati with three flatboats, each loaded with eighty tons of coal, or 240 tons in all, a remarkably small payload considering the mammoth sizes of the river tows that developed before the end of the nineteenth century. The *Walter Forward* continued to be used for coal towing until 1860, when she sank on the Tradewater River of Kentucky.

Judge Thomas Baird also began towing coal barges to Hanging Rock, Ohio, from Pittsburgh in 1845. Baird used two barges and a side wheel steamboat called the *Harlem*,

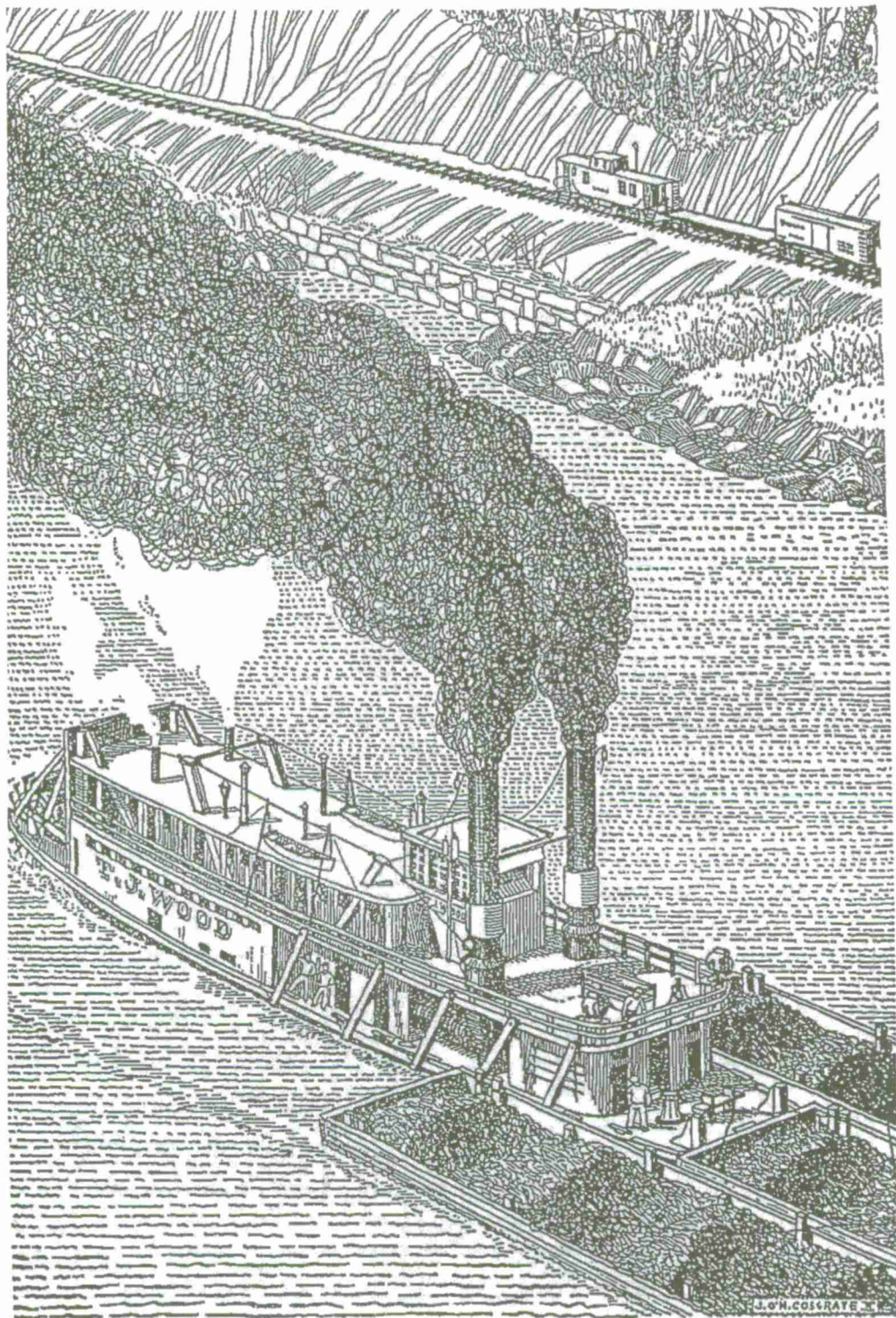


Figure 9. A coal tow with the steamboat *T.J. Wood* on the Monongahela River. From Bissell (1952: 117, Figure 7).

and on his return trip, he loaded the barges with pig iron that was sold to the iron mills in Pittsburgh (Harper 1931: 534).

The year 1849 marked an extension of Pittsburgh's river trade. In that year, Hugh Smith began towing coal to markets farther down the Ohio River using a steamboat called *Lake Erie*. Daniel Bushnell, the same man credited with beginning the practice of coal towing in 1845, built the *Black Diamond* in 1849 in partnership with James G. Gray and N. J. Bigley. Bushnell is also credited with developing the modern system of barge towing about 1851 that placed the coal barges in front of the steamboat. The four loads that the *Black Diamond* carried to Cincinnati using this method proved a great success, and the system quickly became the industry standard. Bushnell later extended his market to New Orleans, but the steamboat *Crescent City* is said to have made the first such tow from Pittsburgh in 1854. Three coal boats and a barge of coke were delivered in sixteen days. The return trip carried freight and required forty days (Bissell 1952: 119).

For some men, experience in the early Monongahela River coal trade proved a stepping stone to industrial wealth. For example, William Hughey Brown, born in Westmoreland County in 1815, began floating coal down the Monongahela River to the iron furnaces in Pittsburgh in 1845 or 1846. In 1848 he formed a partnership with Alexander Miller and George Black, the owners of the Kensington Iron Works and a number of coke ovens. Together, the men purchased a coal mine in the second navigation pool of the Monongahela at Nine Mile Run. Most of their coal trade went to manufacturers in Pittsburgh, but they also sold surplus coal to Cincinnati and Louisville.

In 1854-1855 William Hughey Brown purchased Bushnell's steamboat *Walter Forward*, and in 1856 he acquired a one-half interest in another river steamer, *Tempest*. He later added the steamers *W.H.B.*, *Bee*, *Collier*, and *Shark*. In 1858 he added the steamer *General Larimer* to his fleet and extended his coal towing business to New Orleans. Brown created the first large coal tows on the river. His first shipment south consisted of a tow of twelve boats loaded with 9,200 tons of coal. Two steamers, *General Larimer* and *Grampus*, propelled the flotilla, one steamer poised on each side of the coal boats. The shipment was under the leadership of Brown's son, Captain Samuel S. Brown.

The great economic success of this large flotilla set a new standard for subsequent shipments of Monongahela River Valley coal down the Ohio and Mississippi River system. It also brought a larger number of southern river towns into Pittsburgh's economic sphere prior to the Civil War. During the war, Brown had contracts with the U.S. Government to supply coal to Pittsburgh, Memphis, and Cairo, and he also began to supply St. Louis with coal for the coal gas works at that city. After W.H. Brown's death in 1875, his estate was estimated at some \$6,000,000 (Bissell 1952: 148). W.H. Brown Sons, continued to be operated by his heirs for over twenty years. It was sold to Pittsburgh Consolidated Coal and Coke Company when that company was established in 1899.

In 1859 Pittsburgher George Thurston published a directory of the Monongahela River Valley (Thurston 1859). As part of his directory, Thurston included an inventory of

coal businesses throughout the Monongahela and Youghiogheny Valleys. This work provides a valuable snapshot of the state of coal mining here just prior to the Civil War.

Thurston listed approximately fifty coal mining operations for the Monongahela River Valley although three of the mines listed were not then in operation and four others had just opened. The great majority of these coal works were found in the first three navigation pools of the river. Only one, the firm of N.B. Rigdon, was located above Brownsville in the fifth navigation pool of the river. Collectively, these mines extracted 1,021,040 to 1,084,700 tons of coal per year and directly employed between 1,759 and 1,831 men. The number of employees per mine varied from as few as six to a maximum of 125. The total value of the mine improvements in 1859 amounted to \$628,700.

Annual coal production among the Monongahela River Valley mines in 1859 varied widely from several thousands of tons to 60,000 tons. The largest producer was J.F. and F.S. Dravo, located in the second navigation pool about one-half mile above McKeesport. Dravo produced 60,000 tons of coal yearly for sale in Louisville and New Orleans. The firm employed between 100 and 125 men and had improvements valued at \$20,000.

Another large coal producer was the firm of Henning and Redman in the first navigation pool of the river opposite Braddock's Field (Braddock, Pennsylvania). This firm produced 56,000 tons of coal and employed seventy-five men. Another major mining firm in the first navigation pool was Horner and Hyett, which opened four miles above Pittsburgh in 1852. This firm produced 50,000 tons annually, employed 100 men, and had improvements valued at \$32,000. In addition the firm owned forty-one coal barges valued at \$28,700 and one steam tow, the *Gutherie*, valued at \$15,000. This was one of six coal firms on the Monongahela that owned its own steam towboat in 1859. Most firms seem to have made their own runs to destinations down the Ohio River, but other mines sold their coal to merchants who then transported it to market.

To judge from Thurston's information, Pittsburgh's down-river coal markets were well-developed by 1859. Four Monongahela River mines supplied coal to Cincinnati; five supplied Louisville; one supplied Nashville; another supplied coal for Memphis; no fewer than eight firms sold coal in the New Orleans market. At least one of the New Orleans suppliers, McCloskey Cosgrove & Company with mines at Port Perry and a new one at Bellwood, actually had an office in New Orleans and sold coal exclusively in that city.

Mines that sold coal to Pittsburgh in 1859 included the firm owned by Robert Forsythe in the fourth navigation pool three miles down river from Brownsville. Forsythe served the Pittsburgh market exclusively. The Hodgens coal works nineteen miles above Pittsburgh produced 36,000 tons of coal per year for the city. Logan & Dohrman, located five miles down river from Monongahela City, mined 40,000 tons of coal a year that they sold in Pittsburgh, Cincinnati, Louisville, and New Orleans.

The construction of navigation improvements on the Youghiogheny River in the early 1850s also stimulated the opening of coal works in that area. Thurston's directory listed

some fourteen coal works on this river in 1859. Collective production was considerably below that of mines on the Monongahela River but still accounted for some 224,496 tons of coal per year. Between 665 and 730 men were employed at these works, whose improvements were collectively valued between \$217,000 and \$220,000.

The smallest annual production among the Youghiogheny River Valley mines was that of S.B. and C.P. Markle, located three miles below West Newton. They produced 2,498 to 3,744 tons of coal per year and transported it on the Pittsburgh and Connellsville Railroad to a West Newton paper mill that the firm also operated.

The largest output of Youghiogheny River coal in 1859 was the 48,000 tons extracted by the Pittsburgh & Youghiogheny Coal Company seven miles above McKeesport. This firm, which opened in 1856, also owned twenty-seven coal barges worth \$20,000 and a steam towboat called the *Alps* valued at \$25,000. The firm employed 150 men, the largest number that worked at any single coal works on either the Monongahela or Youghiogheny in 1859. Most of the Youghiogheny River coal firms sold their coal to Louisville and New Orleans, but the Pittsburgh & Youghiogheny Coal Company served the Cincinnati and Pittsburgh markets.

Cincinnati and Louisville illustrate the impact that the ample supplies of relatively cheap southwestern Pennsylvania bituminous coal had on the development of river towns before the Civil War. In 1840 Cincinnati consumed about 100,000 tons of coal per year, perhaps half of which was used for domestic heating and cooking. Just eighteen years later, however, coal consumption in Cincinnati had increased to 600,000 tons per year. This need was supplied not only by southwestern Pennsylvania but also by the newer Peach Orchard mines along the Big Sandy River and the Pomeroy coal of Ohio. Nevertheless, southwestern Pennsylvania bituminous still filled most of the city's demand.

The importance of the Pittsburgh coal supply that floated with regularity down the Ohio River to the "Queen City" was brought into sharp relief during the harsh winter of 1856-1857 mentioned above. This was a widespread event. Baltimore's harbor became blocked with ice, and Savannah, Georgia, recorded temperature in the teens. Floods followed by drought characterized the Ohio River Valley from spring through the summer and into the fall of 1856. As winter set in, ice jams halted boat traffic throughout the Midwest. Coal deliveries from Pittsburgh were stopped. An emergency coal committee was set up to ration supplies, but prices for coal in Cincinnati, whose population had increased to more than 196,000, rose to thirty cents a bushel or more—two to three times the normal price.

The Cincinnati Relief Committee was established to raise money to purchase coal that could be shipped to the city by rail. The *Pittsburgh Gazette* reminded its readers of the assistance that Cincinnati had rendered following the disastrous Pittsburgh fire of 1845 and appealed for emergency donations of cash. A total of \$4,000 was raised, and some coal was shipped to Cincinnati on the Pittsburgh, Fort Wayne and Chicago Railroad.

Due to the dominance that the river enjoyed in transporting coal, however, the railroad line was ill-equipped for the task. It had too few freight cars, and its rates were excessive. It was estimated that 30,000 families in Cincinnati would require 8,400 tons of coal per week to survive the winter (560 lbs. of coal per family per week). The average railroad freight car of the day, however, carried just ten tons, and a standard train consisted of perhaps ten cars. The eight or nine trains of coal required to meet Cincinnati's most basic needs were simply beyond the limits of what was then possible, and the relief effort failed until a thaw permitted the resumption of coal deliveries by river.

Louisville, which also had been supplied with Pennsylvania coal by river shipment, turned to Illinois for replacement during the winter of 1856-1857, but the amount of coal that could be brought in on the Jeffersonville Railroad was too small. The price of coal for domestic use in Louisville doubled to about twenty-two cents per bushel in January 1857.

The freeze of 1856-1857 brought home the importance of river navigation to the citizens of Ohio River Valley towns and also demonstrated the extent to which they had become dependent upon southwestern Pennsylvania coal. As a result, Pittsburgh found ready political support for improvement of navigation on the Ohio River among the residents, commercial interests, and industries of Cincinnati (Binder 1974: 25-26).

Between 1844 and 1872, some 30,997,244 tons of coal and coke passed through the MNC's lock system, an average of 1,068,871 tons per year or, at 4,000 tons of coal to the acre, the equivalent of about 267 acres of the Monongahela River Valley floated down the river and through the MNC's locks annually for twenty-nine consecutive years. The coal and coke traffic was the economic mainstay of the system. The MNC collected a total of \$1,253,041.37 in coal and coke freight fees during this period in contrast to only \$424,646.35 in passenger tolls. Revenues from all other freight categories combined totaled just \$1,080,666.25. Of the \$2,758,353.97 the company collected in tolls between 1845 and 1872, fully 45 percent came from coal and coke alone (Veech 1873: 23-25).

The Monongahela and Youghiogheny River Valley coal mines provided expanding employment opportunities for new immigrants. George Thurston counted 2,424 to 2,561 coal miners at work here in 1859. By 1868 the number is estimated to have grown to some 7,000, and there were 120 steamboats working the Monongahela River coal trade (Bissell 1952: 148).

1870 was the greatest single year for coal and coke traffic through the MNC's locks between 1845 and 1872. In that one year, 2,303,856 tons of coal and coke passed down the river between Pool No. 5 (upriver from Denbo) and Pittsburgh. The contribution of each navigation pool of the river to this total was not equal, however. Mines in just the second river pool, roughly between the mouth of Turtle Creek and Elizabeth, Pennsylvania, were responsible for 266,704 more tons of coal and coke than were the other four operating river pools combined. This was the greatest single year of production for Pool No. 2 mines between 1845 and 1872.

In contrast upriver mines in Pool No. 5 between Denbo and Rice's Landing were responsible for a mere 800 tons of coal/coke moving through the MNC locks in 1870. This figure was down from a high of 4,036 tons reached in 1866. After Pool No. 2, coal and coke freight in 1870 was next highest in Pool No. 3, but this amount was less than one-third that originating in Pool No. 2. This was followed in decreasing order by Pool No. 1, Pool No. 4, and Pool No. 5.

The MNC's revenues from the coal and coke trade increased steadily between 1845 and 1860 (with the exception of 1856, an exceptionally cold winter when ice shut down river traffic for a lengthy period). From \$5,283.79 in coal traffic fees collected in 1845, the MNC garnered \$52,082.17 in 1860. The tolls dropped from this plateau in the first three years of the Civil War but then climbed dramatically in 1864 (\$61,384.29) and 1865 (\$69,628.48) due in part to the increased demand for coal and coke as part of the Union war effort. By 1869 revenues realized from the coal and coke trade on the Monongahela River exceeded \$100,000 for the first time since the opening of the navigation system.

The coal trade volume generated by mines in the vicinity of the lower four locks of the navigation system grew so rapidly that the MNC constructed second locks at each of them, moving progressively upriver to service the major coal producing areas of the river. A second lock was added at Lock No. 1 in 1848, at Lock No. 2 in 1854, at Lock No. 3 in 1884, and at Lock No. 4 in 1886. The second locks were also larger than the 50-foot wide by 158-foot long original locks. The two additional locks at Locks No. 1 and 2 each measured 56 feet by 216 feet while the new locks built at Locks No. 3 and 4 were larger still, measuring 56 feet by 277 feet. When the second lock was built at Lock No. 1 in 1848, it was reputed to be the largest in the country (Wilcy 1937: 151).

The use of doubled locks and an increase in the width and length of the new locks in the middle and lower sections of the river resulted overwhelmingly from the need to handle a greater volume of larger coal barges and wider coal barge tows. Before the construction of the larger locks, it was necessary to disassemble a tow to lock through, a time-consuming process that slowed down the pace of the river coal traffic.

Another measure of the importance of the coal trade between Locks and Dams Nos. 1 and 4 is that the MNC constructed second locks at Lock Nos. 1 and 2 two years before the state legislature required the company to take the next step of extending the navigation system above Brownsville by constructing Lock and Dam No. 5 at Denbo and Lock and Dam No. 6 at Rice's Landing (1856). Both of these new locks were of the old dimensions, however, 50 by 158 feet. The decision to use the smaller lock dimensions increased the volume of steamboat passenger traffic on the upper reaches of the river, but also reflected the more rudimentary development of coal lands here before the Civil War.

The statistics of coal and coke transportation through the MNC locks help to explain why the company was slow to extend the navigation system toward the West Virginia state line. As long as mines in the middle and lower stretches of the river remained so productive

and profitable for the company, there was little incentive for the MNC to take on additional construction and maintenance debt for a diminishing return on tolls.

Development and Decline of a National Coal Industry, ca. 1870-1950

Coal shipments down the Monongahela River slowed during the first two years of the Civil War but then increased steadily from 1863 through 1865 as the war effort exerted new demands on southwestern Pennsylvania coal producers for increased production. Production peaked the year after the war ended (1866) and then retreated in 1867 as demand slowed. From 1868 through 1870, however, coal shipments on the Monongahela again increased steadily, breaking 2,000,000 tons for the first time in 1869. Some 2,168,352 tons of coal were shipped out on the river in 1872. The MNC took in \$115,609.20 in coal and coke revenues that year. Gross receipts for coal and coke had reached an all-time high of \$118,705.68 in 1870, but the 1872 tolls represented fully 59 percent of the company's total receipts that year, 5 percent more than in 1870 (see Veech 1873: 25).

The MNC also spent a large amount of the money they collected on improvements and repairs, especially on the locks and dams between Brownsville and Pittsburgh, where the most lucrative and productive coal mines of the time were found. The company's upkeep of the navigation system played an important role in the success of the southwestern Pennsylvania coal trade.

The increased demand for southwestern Pennsylvania bituminous coal in the decades following the Civil War resulted from its diverse uses and the relative ease with which large amounts of it could be transported by river. The rapidly growing populations of Ohio and Mississippi River towns required more coal for domestic use. The coal gas plants established in these towns also needed more coal for illumination of homes, offices, and industrial plants.

Cincinnati was an especially valued customer for southwestern Pennsylvania coal and received about 45 percent of that region's down-river shipments in 1865. As the southern economy was rebuilt after the Civil War, western Pennsylvania coal fueled the steam engines that ran southern cotton gins and fired the boilers of sugar refiners. Western migration also opened up new markets for coal. As steamboats conquered the Missouri River, southwestern Pennsylvania coal found its way inland as far as Montana. The construction of greater numbers of ever-larger steamboats greatly increased the demand for coal to fuel their own boilers.

Coke also came into wider use in the manufacture of iron after the war and would be indispensable for the growth of the steel industry yet to come. The expansion of existing railroad lines, the establishment of new rail lines, and the development of improved firebox technology increased the number of coal-fired steam engines in service and generated further demand for coal.

Rail lines also posed a potential threat to the river trade in coal and coke, but river navigation offered such a significant economy of scale, especially in the transportation of

coal, that early railroads could not match it. This was especially true given the high rail freight rates of the time, the correspondingly very low tolls for river transportation, the comparatively small capacity of railroad freight cars, and the eventual development of steel river barges capable of carrying even larger loads than their wooden predecessors.

The railroad did enjoy some significant advantages over water transportation, primarily speed and its ability to travel in nearly all kinds of weather. Railroads also could be constructed in places where streams or rivers did not occur naturally. They therefore could transport goods and passengers to and from otherwise hard-to-reach places. The Baltimore and Ohio Railroad, for example, the first major line built in the United States, was chartered in 1828 by Baltimore merchants who did not enjoy the luxury of a good water route to markets in the West.

American railroads built before 1850 usually sought termini at navigable rivers, as these were then the major corridors of trade and travel. The B&O's eventual connection with the Ohio River at Wheeling (West) Virginia via a route south of Pittsburgh on January 1, 1853 is an example (even though politics also influenced the Wheeling's choice as a terminus). The B&O also tried to construct a direct line from Cumberland, Maryland, to Pittsburgh in the 1850s, but this attempt failed in the national depression of the late 1850s. Eventually, the B&O did obtain a railroad connection to Pittsburgh but did so by purchasing other rail lines.

Another example of the construction of early rail lines to river termini is the Pennsylvania Railroad, chief competitor of the B&O. This road was completed to Pittsburgh in late 1852. In the second half of the nineteenth century railroads began to knit together areas of the country that were not on major rivers.

Railroads proved to be effective competitors against most canals for both passengers and freight traffic. Navigable rivers, however, remained effective competition for the railroads, especially in the transportation of heavy bulk goods, such as coal, sand and gravel, coke, iron, and steel. The matter was never as simple as "railroad vs. water" however. Railroad construction actually contributed to the development of new markets for western Pennsylvania coal increasing its production and the amount of coal transported by river.

The B&O began experiments to burn bituminous coal in its own locomotives in 1837, and cheap bituminous coal began to gain favor with the company over more expensive anthracite coal about 1840-1841. By about 1860, most of the important rail lines had switched or were in the process of switching from wood and anthracite to bituminous coal. The expanding railroad lines of the country became one of the best markets for southwestern Pennsylvania bituminous coal and remained so from the Civil War to the appearance of the diesel locomotive in the 1930s (DiCiccio 1996b: 34).

By the middle of the nineteenth century, rail construction had begun to reduce the natural impediment of the Allegheny Mountains to the transportation of western Pennsylvania gas coals to eastern Pennsylvania's urban markets. These were new markets

for this coal that were not served by river transportation. With the construction of the new rail lines, Westmoreland County, Pennsylvania, gas coal began to make its way east to Philadelphia and New York after 1856, where it was used in some fifty-eight gas coal plants that illuminated these cities (Baer 1981: 8; DiCiccio 1996b: 35).

Construction of some railroads also increased the amount of coal freight traffic on rivers by making the exploitation of deposits inland from the rivers feasible for the first time. Exploitation of the Connellsville Coke District in Fayette and Westmoreland counties, Pennsylvania, during the last quarter of the nineteenth century, for example, would not have been possible without the construction of rail lines into the fields. Connellsville coal was not suitable for long-distance rail shipment as it tended to break into small pieces (Jardini 1992: 5). However, the coal could be hauled a relatively short distance by rail to the river and then loaded into barges for the longer trip down river.

The transfer of coal, sand, and gravel between land and river modes of transportation stimulated the development of riverside docks, tipples, derricks, and terminal warehouses. In 1892, for example, six riverside coal tipples were built in the fourth navigation pool of the river and one in the third navigation pool. In 1893 another tipple was constructed in the third navigation pool, another in the fourth pool, and two in the fifth pool. These developments are indications of the increasing importance of mining in the upper navigation pools of the river by that time (U.S. Army Corps of Engineers, *Annual Report of the Chief of Engineers* 1893: 2492).

As coke became more integrated into the production of iron and steel, rail lines were built directly to the batteries of beehive coke ovens located throughout the fields. Unlike, coal, coke did not crush under its own weight in the rail cars, and railroads became indispensable in the development of integrated mining and coking operations. Between 1870 and 1879, forty integrated mining and coking facilities were developed in the Connellsville Coke District. By the mid-1880s, the Pennsylvania Railroad, the Baltimore and Ohio, and the Pittsburgh and Lake Erie Railroad all had constructed lines into the district (Jardini 1992: 5, 7).

In the late nineteenth century, the railroad companies became essential in the opening of the "Klondike region," as the southern part of the Connellsville Coke District was called. As the major customers for coal, many railroad companies were instrumental in opening new mines to assure themselves of a steady supply of steam coal. The Rochester and Pittsburgh Coal Company and the Pennsylvania Coal and Coke Company, for example, were both railroad-owned coal mining enterprises of the late nineteenth century. By 1909 railroad companies controlled about a quarter of the nation's coal production. Their "captive mines," so called because they produced coal strictly for the use of their owners, accounted for 21.4 percent of Pennsylvania coal in 1913 and 24 percent by 1919 (DiCiccio 1996b: 63, 102).

As American industry and population grew, so too did the pace of rail growth. From about 3,000 miles of track in the country in 1840, over 30,000 miles had been established by 1860, and some 254,000 miles by 1910. Spending for the construction of early rail lines soon

eclipsed the amount of money that had been spent on the earlier construction of canals in the 1820s and 1830s. By 1860 Americans had expended about \$188,000,000 on canals but \$1,100,000,000 on railroads (Blackford and Kerr 1990: 88). Water transportation, however, remained the most cost-effective means of getting large amounts of coal to distant markets.

It is important to stress that the navigation facilities the MNC provided on the Monongahela River were not matched on the Ohio River in the 1860s and 1870s. In fact, canalization of the Ohio River was not completed until October 1929 (Engineers' Society of Western Pennsylvania 1930: 152). Before river navigation facilities were constructed on the Ohio, tows of coal barges that passed relatively quickly down the Monongahela might need to tie up at Pittsburgh for days or weeks until the water level in the Ohio rose far enough to float the coal barges down river. A prolonged period of low water on the Ohio could cost the coal owners substantial sums. Men had to be kept on hand to watch the moored boats, to check for leaks, and to be ready to disembark almost on an instant's notice once "coal boat water" had risen (Bissell 1952: 155).

As coal production increased in the stretch of the Monongahela between Brownsville and Pittsburgh during the 1870s the mines there began to play out, and the attention of the coal operators turned to the upper stretches of the river. Between 1856 and the MNC's construction of Lock and Dam No. 7 at Jacob's Creek in 1883, Greensboro and New Geneva in Greene and Fayette counties, respectively, marked the head of navigation on the Monongahela.

The coal lands between Brownsville and these towns had contributed relatively little to the overall river trade in coal. Coal operators nevertheless continued to buy up coal rights in the upper stretches of the river into West Virginia. They also began to organize themselves politically to demand an end to tolls for the use of the river. They formed the Pittsburgh Coal Exchange in the 1860s, but incorporated in 1891 for the purpose of securing free use of the rivers and improved navigation, measures that would contribute significantly to the country's further industrialization and, of course, their own profits.

The coal operators of Pittsburgh and Brownsville felt justified in these demands by the development of toll-free transportation on the Upper Monongahela River in West Virginia and on the federally constructed Kanawha River navigation system. Coal in the Kanawha River Valley could be shipped without charge to the Ohio below Pittsburgh and from there to towns on the Mississippi. These were Pittsburgh's traditional markets, and her businessmen feared that the river transportation tolls they had to pay would now make them noncompetitive with these new suppliers. The arguments of the Pittsburgh coal interests received the backing of other Pittsburgh businessmen who also saw a potential loss of revenue for their city in the opening of the new coal fields in West Virginia, Kentucky, and Tennessee. They, too, now supported a greater role for the federal government in the construction and maintenance of locks and dams on the Upper Monongahela and for the removal of river tolls.

The passage of the Rivers and Harbors Act of 1871 initiated the federal government's role in improving the nation's inland navigation system. This resulted in a survey of the Upper Monongahela by Charles Reichspfonn, E. A. Chase, and J.F. Wilson. Their 1872 report recommended the construction of three additional locks and dams. The River and Harbors Act of 1872 appropriated money for federal construction of Lock and Dam No. 9 in West Virginia. Lock No. 9 was completed in 1876, but the dam was not finished until 1879. However, since the MNC had not constructed Lock and Dam No. 7 and Lock and Dam No. 8 also remained to be built (by the federal government), the utility of Lock and Dam No. 9 was severely limited until these two intervening navigation facilities opened in 1883 and 1889, respectively. It was not until the completion of Lock and Dam No. 8 in 1889, therefore, that the Monongahela River was fully navigable between Pittsburgh and Morgantown, West Virginia. The navigation system was administered by both the federal government and the MNC, and the MNC continued to levy tolls for use of its locks.

Political pressure continued to be applied by the coal owners and other business interests for the federal government to operate the Monongahela River navigation system as a "free river." To be sure, the industrial development of the United States was demanding ever-larger quantities of both anthracite and bituminous coal. Between 1870 and 1880, bituminous coal alone grew from providing 13.8 percent to 26.7 percent of the nation's total energy supply. Wood, historically the nation's great energy source dropped from 73.2 percent to 57 percent during the same period. Between 1870 and 1880, the country's production of bituminous coal grew 148 percent, from 20,471,000 tons to 50,757,000 tons (DiCiccio 1996b: 31).

Coal economics and the national market therefore supported the political demands of the western Pennsylvania coal producers for improved transportation at lower cost. In no uncertain terms, the English political economist William Stanley Jevons (1835-1882) verbalized the economic importance that coal had assumed for the American economy during a trip he made to Pittsburgh in 1882:

Coal in truth stands not beside but entirely above all other commodities. It is the material energy of the country—the universal aid—the factor in everything we do. With coal almost any feat is possible; without it we are thrown back into the laborious poverty of early times (quoted from DiCiccio 1996b: 61).

Between 1883 and 1897, the MNC and the federal government engaged in a protracted legal dispute and condemnation proceeding that eventually brought the entire MNC system under federal control. The matter reached the Supreme Court in 1893, but in July 1897, the federal government took over the ownership and control of the MNC's facilities. From this time on, tolls ceased to be charged for freight transportation on the Monongahela River. This was almost wholly due to the influence of coal and other industrial interests, not to the demands of passenger traffic. Packet traffic on the river did increase substantially between 1886 and 1893 (from 26,885 passengers in 1886 to 98,440 in 1893) but then declined to 81,550 in 1894, 77,050 in 1895, and to 54,838 in 1896 (U.S. Army Corps of Engineers, *Annual Report of the Chief of Engineers* 1895: 2399; 1896: 2137; 1897: 2406).

Although these figures are evidence that the Monongahela River was quickly becoming a river devoted substantially to industrial commerce, packet traffic also continued to be important. This was due in large part to the slow pace of railroad growth up the river valley, the proliferation of coal company and other industrial towns and the concomitant increase in the population of the Monongahela River Valley, and the development of river excursion tours. River excursions gave urban industrial workers a brief respite from long days of labor, often in the dark and cramped surroundings of mills. Packet boats continued to be given priority of passage over barges at locks, and six river packet lines operated between Pittsburgh and Morgantown before the construction of railroad lines to the latter city.

In 1900 nearly one million steamboat passengers passed through Pittsburgh, and a new daily service from Pittsburgh to Morgantown was inaugurated in 1904. River packet traffic decline peaked in 1926 when the river carried 1,293,033 passengers. By 1932 the river's passenger traffic had fallen to 297,182 passengers (U.S. Army Corps of Engineers, *Annual Report of the Chief of Engineers* 1933: 677). In 1935 a mere twenty excursion passengers passed through Lock No. 4 in contrast to the 692 that had passed through the same lock in 1888 (U.S. Army Corps of Engineers, *Annual Report of the Chief of Engineers* 1994: 40-41).

Between 1897 and 1903, the federal government extended the reach of the Monongahela navigation system by constructing Locks and Dams Nos. 10 through 15 and by improving existing river facilities. The new locks and dams lengthened the navigation system twenty-eight river miles up the Monongahela from Morgantown to four miles above Fairmont, West Virginia. By 1903, the date of the completion of these new facilities, the Monongahela was navigable over a total distance from Fairmont to Pittsburgh of 131 river miles (Gannett, Fleming, Corddry & Carpenter, Inc. 1980: 15). Such improvements were not misplaced. Pennsylvania produced a full 66 percent of the country's coal in 1880. In 1897 bituminous coal first surpassed anthracite coal as the Commonwealth's principal mineral product.

During these years, thousands of immigrant European workers also arrived in the coal fields of Fayette, Washington, and Greene counties to live in the Monongahela River Valley's new coal towns established by the coal companies to provide worker housing. It was also during the last decade of the nineteenth century that labor disputes and disagreements over the treatment of these miners and the conditions of work led to the formation of the United Mine Workers union in 1890. The development of new coal fields decreased Pennsylvania's contribution to the nation's coal supply after 1900, but as late as 1902 the Commonwealth was still supplying 50 percent of the country's coal.

The MNC's older navigation facilities also were upgraded between 1902 and 1916. At Locks Nos. 1-8, the federal government constructed second lock chambers, and the locks were increased to 56 feet in width by 360 feet in length. These improvements accommodated the increased coal production from mines in the upper part of the river, the larger sizes of the coal barges and tows then in use, and the country's seemingly insatiable demand for coal. Between 1880 and 1920, for example, national production of bituminous coal increased more

than ten times, from 50,757 tons to 568,667 tons, while Pennsylvania's employment in the coal industry jumped from 33,391 to 184,168 during the same period (DiCiccio 1996b: 62, 63).

Iron and steel river-traffic in the lower part of the river also benefited greatly from these lock improvements. With the elimination of tolls, the construction of new locks and dams and improvement to existing facilities, river freight traffic grew significantly. The total tonnage of coal and coke carried on the river in 1896 (the year before the federal government assumed control of the navigation system) was 5,713,594 tons. By 1903, however, 30,815,164 tons of coal alone were being transported on the river, and this figure had grown to 42,196,087 tons by 1918 (U.S. Army Corps of Engineers, *Annual Report of the Chief of Engineers* 1897: 2406 and 1903: 1665; 1919: 3071).

The opening of the by-product coke ovens at the Monongahela River town of Clairton, Pennsylvania, in 1919 provided another major boost to coal traffic on the river. The plant originally contained 640 coke ovens with a daily capacity of 10,500 tons of coal. Between 1924 and 1928, 714 additional ovens arranged in ten batteries were built. The plant was then the largest producer of by-product coke in the nation at a time when Pittsburgh was the largest coke-producing district in the country. The plant was supplied daily by 1,000-ton barges of coal shipped from the Connellsville Coke District.

By-product coke technology, unlike the older beehive coking process, could use coal of inferior quality to make adequate coke. Thus coal mined in the upper reaches of the Monongahela River Valley outside the Connellsville Coke District could now be used successfully in steel manufacture. By-product coke technology, therefore, further stimulated the opening of new coal mines in the upper river valley. Speculators and coal and steel companies had purchased much of the Pittsburgh Coal lands in Greene County by 1907, and even as early as 1900 some 2,033 coke ovens had been constructed there (DiCiccio 1996b: 79, 80, 84).

Coal production in the Monongahela River Valley during the latter nineteenth century was increased not only by the improvement of the river navigation facilities but also by internal reorganization of the coal industry. The national growth of the coal industry yielded economic opportunity but also produced increased competition. For example, there were some 140 coal companies of small to medium size operating in the Monongahela River Valley during the 1890s. Competition among them and with newer mines in West Virginia, Kentucky, and Tennessee resulted in over-production and price reductions that pushed the market price of coal below the cost of production.

One response to this problem was consolidation within the coal industry. In June 1899, the Monongahela River Consolidated Coal and Coke Company, usually called "the Combine," was formed out of an amalgamation of smaller coal companies. The Combine soon owned most of the productive coal lands on both sides of the Monongahela River. Its Washington, Alice, Snowhill, and Anchor, mines were all located on the Pittsburgh, McKeesport, and Youghioghenny Railroad. About twenty-five of the Combine's fifty mines were equipped with river tipples where coal was directly loaded into the company's river

barges. These river tipples also served as important transfer points where coal shipped by rail from inland mines was loaded into barges. The Combine also maintained boat yards at Elizabeth and Monongahela City for repairs to its barges and river tugs.

Although some independent coal companies held out and did not join the Combine, the economics and scale of the company's operation soon proved successful. In 1900 it shipped over 24,000,000 tons of coal, and six years later, its assets stood at \$45,500,000. By 1908 the Combine's river operations included 3,500 coal barges, eighty steamboats, and fourteen docks. The company owned its own dock and ocean-going tugboat in New Orleans, a favorite down-river market for Monongahela River Valley coal from early in the nineteenth century.

The Pittsburgh Coal Company also was formed in 1899 out of an amalgamation of smaller Monongahela River Valley companies. Organized in Pittsburgh, Pittsburgh Coal, like "the Combine" also owned mines, boats, barges, docks, and railroad lines, the great majority of which were located in Allegheny, Westmoreland, and Fayette counties. Its early board of directors included some of Pittsburgh's most important industrialists and financiers, among whom were Andrew W. Mellon, Henry R. Rea, Henry W. Oliver, and Henry Clay Frick. By 1900 it was the largest coal company in the nation, and three years later acquired majority stock ownership of "the Combine." The two companies formally merged in 1916. By 1920 Pittsburgh Coal's seventy mines in Pennsylvania, Ohio, Illinois, and Kentucky produced some 30,000,000 tons of coal. Sixty of the company's mines and 152,745 acres of untapped coal lands were in southwestern Pennsylvania (DiCiccio 1996b: 104).

The late nineteenth and early twentieth centuries were also the heyday of the truly enormous riverboats designed to push the equally impressive coal tows of the day. One of the most famous of these riverboats was the *Sprague*, built for the Combine by the Iowa Iron works but outfitted in Pittsburgh. It was capable of pushing at least fifty-six barges loaded with some 1,400,000 tons of coal.⁴ In 1904 the American Bridge Company at Ambridge, Pennsylvania, on the Upper Ohio River constructed the first steel coal barge. This barge design utilized sloping steel plates to extend the cargo space and made a number of other technological improvements that modernized the water transport of coal (Engineers' Society of Western Pennsylvania 1930: 170-171).

Between 1905 and the outbreak of the First World War in 1914, the Monongahela River never carried less than the 24,677,800 tons of coal recorded in 1908. The demands of wartime production created an even greater market for coal. In 1915 the Monongahela traffic in coal was 32,198,900 tons. The figures dipped a little in 1916 but then rose to 35,467,730

⁴The *Sprague* was sold to the Aluminum Ore Company of St. Louis in 1917, but during Pittsburgh's bicentennial in 1958, it was towed upriver and moored during the summer's celebrations along the lower Allegheny River at the Point. No one, including this author, failed to be impressed by its size. For twenty-five cents, I could spend as much time exploring her as I wanted to spend, and I spent every day on her that I could. The view from the wheel house with its six-foot or eight-foot diameter wheel was beyond description. With the intervening improvements that had been made to the Ohio River's navigation system and the resultant rise in its pool level, the boat was almost too big to pass under the bridges, even with its smokestacks lowered. Some years later, the *Sprague* was destroyed in a fire, a sad end to a magnificent riverboat.

tons in 1917 and to 42,196,087 tons in 1918, the last year of the war (U.S. Army Corps of Engineers, *Annual Report of the Chief of Engineers* 1909: 1764; 1916: 2843; 1918: 2987; 1919: 3071).

The iron and steel mills of the Monongahela River Valley produced vast quantities of arms and munitions during World War I. Together with the iron and steel industries, the coal industry of the valley helped boost the total amount of freight carried on the Monongahela during the war to world-class levels. During the war, bituminous coal produced 69.5 percent of the country's total energy supply, a percentage that has never been equaled since (DiCiccio 1996b: 137).

More freight per mile was carried on this one river than on the Great Lakes or Suez Canal or in the major ports of New York, Hamburg, London, and Marseilles combined. It carried more freight per day than the rest of the Ohio River system or the Mississippi River system. Only the tremendous trade in iron ore that passed through the St. Mary's Falls Canal at Sault Ste. Marie ever surpassed the freight tonnage carried on the Monongahela. Due to the demands of the war effort, the length of one lock chamber at Lock No. 3 was doubled in size to 720 feet (U.S. Army Corps of Engineers 1994: 51, 52).

By the time that Pittsburgh Coal bought a controlling interest in the Combine to form Pittsburgh Coal Company, Inc., a number of mines in the Connellsville Coke District of southwestern Pennsylvania already had "played out" and were closing. A period of mine closures in the district began about 1910 and continued to about 1931. Of the 115 mines identified by DiCiccio (1996a: 537-539) in the coke district that closed between 1878 and 1957, 72, or 62 percent of them closed between 1910 and 1931. Many new mines continued to open, however, in order to meet the war effort's needs. Some 3,103 new coal mines opened throughout the country between 1910 and 1920, and the cost of coal per ton increased from \$1.34 per ton in 1916 to a high of \$3.75 in 1920 before dropping to \$2.89 in 1921. Much of this price increase was due to inflation (roughly 50 percent nationally between 1917 and 1919).

Pennsylvania remained the country's leading bituminous coal producer during this time despite the opening of many new mines in other states. Pennsylvania mines produced 42 percent of the country's bituminous coal between 1912 and 1916 and 36 percent from 1917 to 1921. 1918 was Pennsylvania's peak production year for both bituminous and anthracite coal. In that year, 276,600,000 tons of coal were mined by 329,904 Pennsylvania miners. Of that amount, 177,217,294 tons were bituminous coal, which represented 30.8 percent of the nation's total production. Bituminous coal employed 181,678 Pennsylvania miners in 1918 (DiCiccio 1996b: 137).

The high national inflation rate brought about by wartime over-production led to demands for unionization in the country's industrial workforce, better pay, and a reduced work week. In 1917 a worker in one of the country's steel plants could expect to put in an average of 68.7 hours of work a week. An unskilled laborer in such a plant might take home

about \$1,400 in pay a year, some \$175.00 below the minimum subsistence level calculated for a family of five.

A general strike of U.S. Steel workers was called for September 1919, and the United Mine Workers of America (UMWA) voted to join them. The steel strike of 1919 was severely repressed by the steel companies during the remainder of 1919. Negotiations with the Wilson administration led the UMWA president, John L. Lewis to call for an end to the strike in November, but many miners refused, and the nation's coal production dropped 75 percent. In the middle of December, a new agreement was signed with the UMWA that gave miners pay increases ranging from 20 to 34 percent. The UMWA controlled almost 51 percent of the nation's coal miners in 1920, and the union continued to secure improved working conditions, improved mine safety, and better wages for miners under Lewis' long period of leadership from 1919 to 1960.

What such labor agreements could not forestall, however, were the economic consequences of certain weaknesses inherent in the mining business that in hindsight were apparent even before the pivotal 1919 strikes. These included the vast over-expansion of mining between 1890 and 1920 and a decrease in the need for coal especially following the development of more efficient steam locomotives followed by the introduction of diesel-powered locomotives and the further development of oil, natural gas, and hydro-electricity as new fuel sources.

Iron and steel production also became more efficient in their use of coal and coke. In 1860 a ton of iron required 1.6 tons of coke, but by 1920, only one ton of coke was required. This number dropped to just 0.9 of a ton by 1940 (Fritz and Veenstra 1935: 4). The growth of by-product coke production over the older and less efficient beehive production method also decreased the demand for coal. Beehive ovens produced 40 percent of the country's coke in 1920 but just 6 percent in 1930 and just 5 percent in 1940. Beehive coke production in 1944 stood at just 34 percent of its production in 1920 while by-product coke production more than doubled during the same period.

By 1914 bituminous coal provided 56.9 percent of the country's fuel supply, while the national use of oil, both domestic and a small amount of imported oil, had grown to 21.6 percent of the total energy supply. Natural gas and water then contributed only 5.2 percent each to the country's energy needs. Within the nation's oil industry, gasoline overtook kerosene production by 1920, thanks largely to the proliferation of the automobile.

On the national scene, the decade from 1920 to 1930 was the most turbulent and troubling one for coal since the beginnings of the industry. The problems were especially hard on Pennsylvania as the Commonwealth employed more miners than any other state at the start of the decade. Severe competition and the opening of new mines drew far more men into the industry than it could support and pushed production way beyond demand. Employment reached a peak in 1923, when more than 862,00 men and boys worked in the nation's mines. Price-cut wars and competition from newly opened non-union mines in the South drove down coal prices and drove many mines out of business. Increasing demand for

cleaner coal required owners to invest in new coal washing equipment, plants, and labor, additional costs in a time of retrenchment.

To reduce their own losses, owners cut the wages of miners severely; layoffs were common. With greater frequency, management also began to turn to mechanization of the mining process to reduce costs. As labor was the chief cost in coal production most mechanization attempts were directed at lowering this expense. By the 1920s, coal often was mined with the aid of machines that undercut the bedded mineral, although miners still usually loaded it by hand into coal cars. In most mines, mechanical loaders and continuous mining machines did not come into use until after the Second World War.

The 1920s was also a time of retrenchment among mine owners. Fewer but larger companies came to own more and more of the nation's coal resources. Of the 1,300 coal operators in Pennsylvania in 1930, just 100 of them produced 80 percent of the Commonwealth's coal output. Pittsburgh Coal Company was the largest mine employer in Pennsylvania at the time, and H. C. Frick Coke Company was the state's largest coal producer. In addition to these challenges to the supremacy of coal, the widespread Depression that began in 1929 added only new misery and a further drop in coal prices to \$1.78 per ton.

The retrenchment in the coal industry during the 1920s also resulted in numerous strikes, those in 1922 and 1927 being the most severe. The resolution of the 1919 coal strike had increased the wages of union coal miners significantly, and the union fought to retain these advances in the face of a diminished coal market. Company owners strove to hang on to whatever profits their mines could produce by reducing wages and by using non-union or "scab" labor. The coal union, United Mine Workers of America (UMWA), was under severe attack during the entire decade as the number of miners dwindled, wages were cut, mines closed, and the use of non-union labor grew. In 1925 Pittsburgh Coal Company, then the largest coal company in the world and controlled by the Pittsburgh-based Mellon banking family, abrogated the use of union labor in any of its mines. The 1927 strike all but shut down bituminous coal mining in western Pennsylvania and involved perhaps 100,000 miners in all. The conclusion of the decade found the UMWA in a severely weakened position. In 1920 union membership stood at a high of 373,800 members, but by 1930, that figure had dropped 45 percent to 205,100.

The price, labor, and management problems of Pennsylvania 1920's bituminous coal industry are reflected in Monongahela River freight statistics. From the staggering 42,196,087 tons of coal transported on the river in 1918, river commerce in the mineral had declined to 20,717,535 tons by 1920, a drop of 51 percent. Declines continued during the next two years to 13,846,233 tons in 1921 and to a low of 11,608,146 tons in 1922. In general, river coal shipments then increased to about 20,000,000 tons per year throughout the remainder of the decade (U.S. Army Corps of Engineers, *Annual Reports of the Chief of Engineers* 1921-1930).

Although growth of the coal industry had peaked by the early 1920s, the impressive freight tonnage carried on the Monongahela during and immediately following the First World War led Congress to authorize further improvements to the navigation facilities through the River and Harbor Act of 1922. Among the authorized improvements were the extension of the guard and guide walls at Locks and Dams Nos. 1-6, the lengthening of the land chamber at Locks No. 3 (opened August 1924), and construction of a new lock chamber at Locks No. 4. Reconstruction of Locks and Dams Nos. 7 and 8 was intended to improve navigation in the upper portion of the river in Pennsylvania and to deepen the navigation pool by dredging to provide a low-water depth of 9 feet. Construction of these two new facilities also eliminated the need for Lock and Dam No. 9. New Lock and Dam No. 8, located near Point Marion and 3.5 miles upriver from the old lock and dam location, went into service in October 1925. New lock and Dam No. 7, 2.5 miles upriver from the old facility, opened the following month.

The great increase in the length of one of the Lock No. 3 chambers was the direct result of the coal trade. Most of the movement of coal on the Monongahela River by this time was "down-bound" trade. This terminology means that coal originating at mines up the river terminated farther down the same river. Specifically, most coal at this time was transported in barges from the Frick mines near navigation pools 4-6 and was shipped to the Clairton coke plant through Locks No. 3. It was the need for coal to make coke and coke's use to the iron and steel plants on the Monongahela River that was the generator of the enormous river trade in bituminous coal (Tomer 1939: 44).

Conditions in the American coal fields worsened following the 1929 stock market crash, and these bleak years persisted into the early 1930s. The industry nearly collapsed altogether in 1932 when the average price of a ton of coal dropped to \$1.31. Some 2,500 independently owned bituminous mines in Pennsylvania went out of business between 1920 and 1935. Unemployment in the coal-producing regions of southwestern Pennsylvania approached 40 percent in 1934 (Coode 1986: 103-104). Coal tonnage on the Monongahela River dropped precipitously. In 1931, for example, only 12,313,523 tons passed down the river (U.S. Army Corps of Engineers, *Annual Report of the Chief of Engineers* 1932: 721-722), a decline of 8,408,042 tons over 1930's total.

The nadir of coal transportation on the Monongahela River in the first half of the twentieth century came in 1932, however, as the economic effects of the Depression continued to worsen. In that year, only 7,086,148 tons of coal were shipped, a figure not seen since the 1890s (U.S. Army Corps of Engineers, *Annual Report of the Chief of Engineers* 1933: 677-678). 1932 was, in fact, a low point for the value of all river shipping on the Monongahela. The total value of goods shipped on the river that year was just \$51,578,027, whereas as recently as 1928 it had stood at \$170,974,558 (U.S. Army Corps of Engineers, *Annual Report of the Chief of Engineers* 1933: 677).

In an effort to stimulate the economy, Congress passed Franklin D. Roosevelt's National Industrial Recovery Act (NIRA) in June 1933. NIRA was administered by the National Recovery Administration (NRA) and gave the federal government broad powers and

authority to set wage and price levels, establish production goals, and to monitor working conditions, including the length of the work week. One of the many industry and work codes the NRA devised was the Bituminous Coal Code, the first major attempt of the federal government to regulate the coal industry. The U.S. Supreme Court ruled the NIRA unconstitutional in May 1935 and reached the same conclusion regarding the Bituminous Coal Conservation Act of 1935 in 1936. However, the court let stand the Guffey-Vinson Bituminous Coal Act of 1937 that reasserted many of the same provisions of the earlier acts and established codes of fair competition within the coal industry.

The UMWA also reasserted itself after 1933 and began a long drive not only to recapture its lost membership but also to expand union membership and union authority. Although the NIRA was ultimately struck down, passage of the bill had spurred the revitalization of unions. UMWA memberships quadrupled within a few months of the bill's passage, and the union soon became the most powerful and largest of American unions. Only the so-called "captive mines" that produced coal solely for the railroad and steel companies who owned them remained outside the unionizing grasp of the UMWA (DiCiccio 1996b: 185, 186).

Trade union memberships throughout the country in general grew remarkably after 1933. The year 1937 also saw the formation of a new national union, the Congress of Industrial Organizations (CIO), formed in Pittsburgh after a dispute with the far older American Federation of Labor (AFL). From about 3,300,000 members in 1930, union memberships in the United States stood at 8,200,000 by 1939 and had ballooned to 13,600,000 by the end of World War II (Peterson 1945: 43).

In general the lot of the American coal miner improved substantially during the mid to late 1930s. The UMWA not only was successful in obtaining the right to unionize but through collective bargaining agreements also greatly improved wages and working conditions and reinstated the eight-hour working day. The average annual wage of an American miner in 1932 stood at just \$677, a figure that increased 77 percent by 1935 to \$1,196 and to \$1,235 by 1941.

New Deal efforts to counteract the effects of the Depression at the national level had an immediate and positive impact on Monongahela River coal freight figures. The numbers began to rebound in 1933 (10,090,236 tons) and reached a decade high of 21,491,626 tons in 1937 before declining 41 percent in 1938 (U.S. Army Corps of Engineers, *Annual Report of the Chief of Engineers* 1934: 703-704; 1938: 843-844; 1939: 887-888).

Southwestern Pennsylvania steel companies, many with plants in the Monongahela River Valley, were the primary owners of "captive mines" in the 1930s. Steel owners had always opposed the unionization of their miners just as they had opposed the formation of unions within their own steel plants after the violent 1892 strike in Homestead, Pennsylvania, had broken the union. By the 1930s, however, the steel companies were employing a more beneficent approach in their dealings with miners. This included the establishment of model mining towns, like Muse, Bobtown, Richeyville, Vestaburg, Slickville, Daisytown, and

others that offered miners decent company housing, fair prices at the company-owned store, good wages, recreational activities, and other "perks" in exchange for a policy of non-unionization.

Such paternalistic policies, however, did not prevent violence and a wildcat strike among the miners of the H.C. Frick Coke Company mines in the summer and fall of 1933. Violence was particularly severe in Grindstone, Maxwell, Star Junction, and Colonial Number 1 in Fayette County. These strikes and the concomitant attempts to organize the workers in southwestern Pennsylvania's captive mines failed, and both the mines and the steel mills remained un-unionized on the eve of World War II. Finally, in the wake of the Japanese attack on Pearl Harbor and the start of the war, the National Defense Mobilization Board granted union status to miners in the captive mines. With this development the steel companies capitulated and also permitted steel workers to form labor unions.

To a large degree, the Monongahela River navigation improvements resulting from the 1922 Congressional act responded to the needs of the river's coal traffic and reflected the larger sizes of the coal barges then in use and the dominance of coal in the river's commerce. By 1935 more than 98 percent of the traffic passing through Lock No. 5 consisted of coal carried by an average of fifty-six barges per day. Most of this coal, about 96 percent of it, was destined for use by one or another of the steel mills in the lower part of the Monongahela River Valley. The large power plants of Duquesne Light and West Penn Power and the once vital coke plant of the Clairton Coke works, all located along the river, were other significant customers for Monongahela River Valley bituminous coal during these years.

Improvements at Locks and Dam No. 4 required further consideration under the River and Harbor Act of 1930 and passage of a joint resolution of the Senate and House in January 1931. A new Locks and Dam No. 4 complex was constructed 0.6 miles upriver from the old site. The new 56-foot by 720-foot land-side lock chamber here opened in May 1932, and the smaller (56-foot by 360-foot) river-side lock opened in fiscal year 1933. The old Dam No. 4 was also removed at that time.

All of the improvements, originally called for in the 1920 River and Harbor Act, were completed by the end of fiscal year 1935 (Gannett, Fleming, Corrdry, and Carpenter, Inc. 1980: 30-32). This sustained program of modernization reflected the national importance Congress attached to maintaining and furthering successful navigation and commerce on the Monongahela River. Reconstruction of the Emsworth Dams on the Upper Ohio River below Pittsburgh in 1938 raised the pool level in the Lower Monongahela River sufficiently that Lock and Dam No. 1 was no longer needed, and it was subsequently demolished.

The perennial problem of an insufficient amount of water in the river during periods of seasonal draw-down also was addressed during the 1930s by the construction of several lakes and reservoirs. These included Tygart Dam at Grafton, West Virginia (1938), the Lynn Lake Reservoir on the Cheat River, and two reservoirs on the Youghiogheny River.

Navigation improvements could not reverse the declining importance of coal to the nation's energy supply, however. Between 1930 and 1940, coal declined from 55 percent to 48 percent of that supply. Although the downward trend slowed somewhat during the Second World War, by 1950 coal was providing just 39 percent of the nation's energy (DiCiccio 1996b: 151).

Changes in the ways that coke was produced between 1920 and 1940 also affected coal river traffic on the Monongahela. Since by-product coke ovens were usually built near the steel mills, shipping of coke from the older and increasingly obsolete beehive coke ovens of the Connellsville Coke District slowed appreciably. Unprocessed southwestern Pennsylvania coal rather than coke was now hauled in river barges to the Clairton coke works near Pittsburgh.

Other than normal upkeep and maintenance, little new work was done on the Monongahela River locks and dams during World War II. A 1942 survey did recommend reconstruction of Locks and Dam No. 2, now the first navigation facility on the river above Pittsburgh, including the construction of one lock measuring 110 feet by 720 feet and another chamber of 56 feet by 360 feet. This construction work was undertaken between 1949 and 1953.

The years during and immediately following the Second World War saw a number of significant changes in the American coal industry. War production quotients increased the demand for coal, and both coal production and coal prices rose throughout the war. The price of coal increased from \$2.19 per ton in 1941 to \$3.06 by 1945, and annual production increased by 63,000,000 tons during the same period (DiCiccio 1996b: 196). During the war years, however, coal shipments on the Monongahela River never exceeded the 28,495,717 tons achieved in 1942, a pale reflection of the highs achieved during World War I (U.S. Army Corps of Engineers, *Annual Report of the Chief of Engineers* 1943: 767-768).

Strip mines, first used for anthracite mining in eastern Pennsylvania, became much more widespread in southwestern Pennsylvania in the late 1940s and 1950s. Mechanical coal mining increased throughout this period and greatly cut the need for mine labor. Continuous mining machines greatly increased mine productivity while long wall mining, a highly mechanized and productive extraction method, also was introduced.

The switch to alternative fuel sources, especially natural gas, further reduced the demand for coal and the number of miners required. Even though the remaining miners were now better paid than ever, the number of miners decreased steadily from the period of the revitalization of the UMWA in 1933 into the post-war period and beyond. There were some 170,000 miners in Pennsylvania in 1950, but by the 1980s, this figure had dropped to about 26,000.

In the early post-war period, the attention of Congress and the U.S. Army Corps of Engineers turned to making improvements to navigation facilities in the upper reaches of the Monongahela River. In 1947 the Congressional Committee on Public Works requested the

Chief of Engineers to study the matter. The resulting report recommended replacement of Locks and Dams Nos. 12 through 15 with two new complexes with larger lock chambers. The report also recommended dredging to create a wider river channel and the construction of movable crest gates on Dam No. 8 to increase the depth of the navigation pool behind the dam by four feet. This work was finally completed in 1959.

In 1948 the Chief of Engineers' report also commented on the actual and expected increases in coal production on the Monongahela River in the vicinity of Locks and Dams Nos. 10 and 11. By the late 1940s, then, all of the existing Upper Monongahela River navigation facilities from Locks and Dam No. 10 through 15 were determined to be inadequate to the needs of the contemporary coal business as well as other commercial interests in that segment of the river.

Coal shipment figures for the Monongahela River in the post-war period justified the decision to upgrade the navigation facilities. Although tonnage figures dropped somewhat in 1945 and 1946 over those achieved during the war, some 27,278,150 tons of coal were shipped on the Monongahela River in 1947. In the period between 1948 and 1951, the total shipment figures ranged from a low of 20,445,886 tons (1949) to a high of 26,144,039 tons in 1951 (U.S. Army Corps of Engineers, *Annual Report of the Chief of Engineers* 1949: 817; 1950: 910; 191: 972; 1952: 1019-1020).

Construction of the new Morgantown Lock and Dam, which replaced Locks and Dams Nos. 10 and 11, began in September 1948. The new lock, which measured 84 feet by 600 feet, began operation in June 1950, and the project as a whole was completed in December of that year. The 600-foot length of the new lock conformed in size to the locks in use on the Ohio River and reflected the growing importance of coal production on the Upper Monongahela.

The Hildebrand Lock and Dam complex at 107.7 river miles above Pittsburgh was constructed between 1956 and 1959 and replaced Locks and Dams Nos. 12 and 13. The Opekiska Lock and Dam, at 115.1 miles above Pittsburgh, was constructed between 1961 and 1967 and replaced old Locks and Dams Nos. 14 and 15. The Maxwell Locks and Dam in the Middle Monongahela River at 61.3 river miles above Pittsburgh were constructed between 1963 and 1965 with the subsequent removal of old Locks and Dam No. 6 by 1967. Nine locks and dams now maintained the navigation of the river between Pittsburgh and Fairmont.

With the completion of the Opekiska facility and the corresponding widening and deepening of the river channel, a minimum channel depth of nine feet, minimum width of 250 feet, and total lift of 147 feet was maintained throughout the river system (Gannett, Fleming, Corddry, and Carpenter, Inc. 1980: 33-40). The development of the steel, chemical, and sand and gravel industries in the Monongahela River Valley played important roles in stimulating the Corps's program of navigation improvements. The growth of the bituminous coal industry in the upper reaches of the river and the need to get coal to Pittsburgh's coke plants and steel mills, however, was critical to the nearly continuous improvement of locks and dams on the Monongahela before and immediately after World War II.

Subsequent changes in the steel industry, especially the installation of electric steel-making furnaces, reduced the need for metallurgical coal and coke. Railroad demands for coal also diminished not only with the proliferation of the diesel engine but with the decline of the nation's railroad system following the war. By 1981 the single greatest users of southwestern Pennsylvania bituminous coal were the coal-fired electricity generating plants that supplied power to a growing and increasingly suburban population.

After the opening of the first known mine on the river opposite Pittsburgh about 1760, the transportation of coal developed throughout the nineteenth and first half of the twentieth centuries into the largest and most valuable single commercial product carried on the Monongahela River. During the first half of the nineteenth century, coal was needed primarily for domestic, commercial, and industrial heating and illumination. With the disappearance of much of the eastern half of the country's stands of virgin timber and technological advancements in science and metallurgy, coal also became indispensable to iron and, later, steel production.

The growth of coal mining also paralleled the technological evolution of steam power and the expansion of the railroad as a means of both passenger and freight transportation and as a mechanism of national expansion, especially in the full bloom of the industrial revolution that followed the Civil War. On a par with nowhere else in the world except perhaps Germany's Ruhr Valley, the Monongahela River was the connecting link between coal/coke and iron/steel that vastly increased the industrial synergy of southwestern Pennsylvania.

Early coal and other businessmen from Pittsburgh to Brownsville played the lead in the formation of the Monongahela Navigation Company, a private firm that succeeded in opening six locks and dams in the most important industrial and mining stretch of the river between 1841 and 1856. The construction and maintenance of the Monongahela River navigation system was a significant factor in the industrial development of Pittsburgh during the second half of the nineteenth century.

The production of armor plate, munitions, and materiel required of Pittsburgh's iron and steel mills during the Spanish-American War and World War I greatly increased the need for additional southwestern Pennsylvania bituminous coal, and the most economical means of transporting this valued mineral was by river barge. The national demand for southwestern Pennsylvania bituminous began to drop after World War I as new mines opened in other parts of the country and as petroleum, electricity, and natural gas became more important fuels. Coal was still necessary for coke production, however. River shipments of coal, especially from the H. C. Frick Coke Company mines up the Monongahela River in the Connellsville Coke District to the Clairton by-product coke ovens accounted for a large portion of the coal trade on the river after the coke plant opened in 1919.

Over-production and over-expansion in coal industry employment from 1900 to 1920 brought a decade of labor disputes, falling coal prices, and fierce competition capped by the Depression that befell the nation after October 29, 1929. The 1930s were largely years of

economic rejuvenation and redefinition marked by the direct intervention of the federal government into matters of labor, production, and management. Coal production never regained the over-blown numbers of the century's first two decades, but government efforts to stimulate the economy left southwestern Pennsylvania's coal industry in a good position to support the nation's war effort from 1941 to 1945 and its economic expansion of the 1950s.

THE RIVER NAVIGATION SYSTEM AND THE DEVELOPMENT OF THE MONONGAHELA RIVER VALLEY COKE, IRON, AND STEEL INDUSTRIES

Early Iron Production

The production of iron requires three essential ingredients: iron ore, a carbonaceous flux to remove the slag formed in the iron-making process, and a fuel (Eggert 1994: 1). From the early days of the American iron industry until the mid-nineteenth century charcoal provided most of the fuel for iron making. An early Pennsylvania blast furnace might produce two tons of iron per day and consume in the process the charcoal made from one acre of hardwood forest. An early charcoal-fueled blast furnace often had a refinery forge nearby. Water power often was harnessed to operate the bellows at the forge, where air was injected to remove some of the impurities in the iron. The forge also might be equipped with a tilt hammer operated by water power. The tilt hammer was used to beat impurities out of the pig iron and produce malleable wrought iron. Charcoal for a large iron-making operation could consume the wood from some 700 acres of trees (Figures 10-13).

Pennsylvania played a pivotal role in the development of the early American iron industry. The first iron in the state was produced on Manatawney Creek near Pottstown, Berks County in 1716. Between 1717 and 1776, Pennsylvania saw the construction of at least twenty-one blast furnaces, forty-five forges, four bloomeries, three slitting mills, two plate mills, a wire mill, and even six furnaces for the early production of steel. In order to be near a steady supply of charcoal, most of the early blast furnaces were located in rural areas. These industrial developments catapulted Pennsylvania to the front rank in iron production in England's North American colonies by 1750 (DiCiccio 1996b: 23). Pennsylvania's early iron industry was located in the eastern and central counties of the state. Iron making in western Pennsylvania began only near the end of the eighteenth century. As the American population spread from east to west so too did Pennsylvania's iron industry move west across the Allegheny Mountains.

The Monongahela River Valley Coke and Iron Industries

The use of coke in the production of American iron and steel achieved its zenith in the Monongahela and Youghiogheny River Valleys of southwestern Pennsylvania in the second half of the nineteenth and the first half of the twentieth centuries. The first known production of this mineral fuel, however, occurred in late sixteenth-century England, when the process of making coke by baking coal in a covered pit was known as "charking." The process was analogous to producing charcoal from wood by controlling the combustion of the material to produce a high-carbon content fuel.

Some attempts were made in seventeenth-century England to create a coke that was useful for iron-making, but these experiments came to little. The English iron master Abraham Darby is usually credited with producing the first iron smelted with coke at Colebrookdale on England's Severn River in either 1709 or 1713. The rising prices of charcoal that accompanied the disappearance of the hardwood forests led other English iron

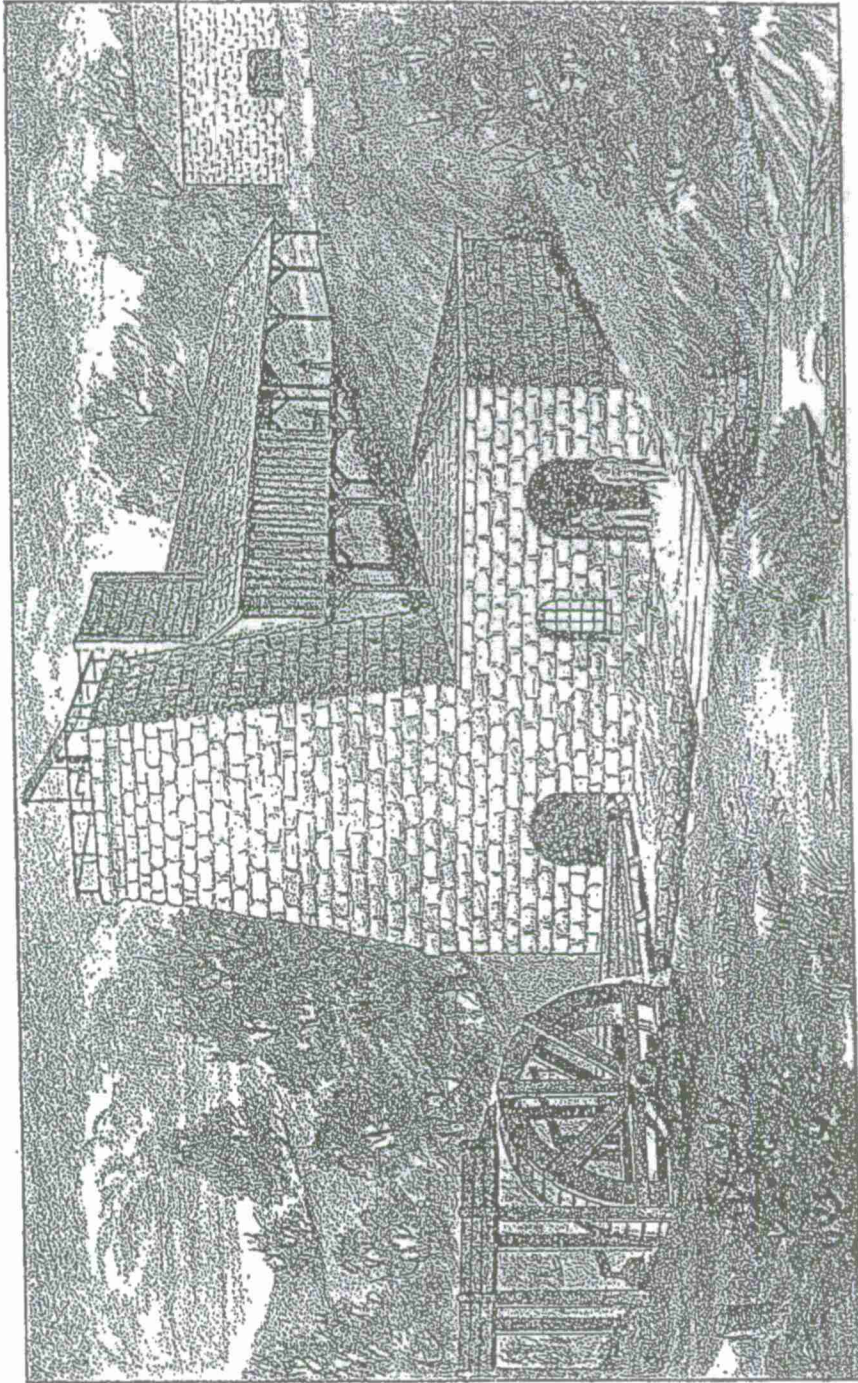


Figure 10. Exterior of a typical charcoal-fired cold blast iron furnace. The charge of iron ore, limestone, and charcoal is dumped into the top of the blast furnace (center) from the covered charging floor and is heated from the bottom using a water-powered bellows that blows cold air into the furnace, raising the temperature. A small casting house stands at the right of the furnace. In the background is the charcoal house. From Buck and Buck (1939: 301).

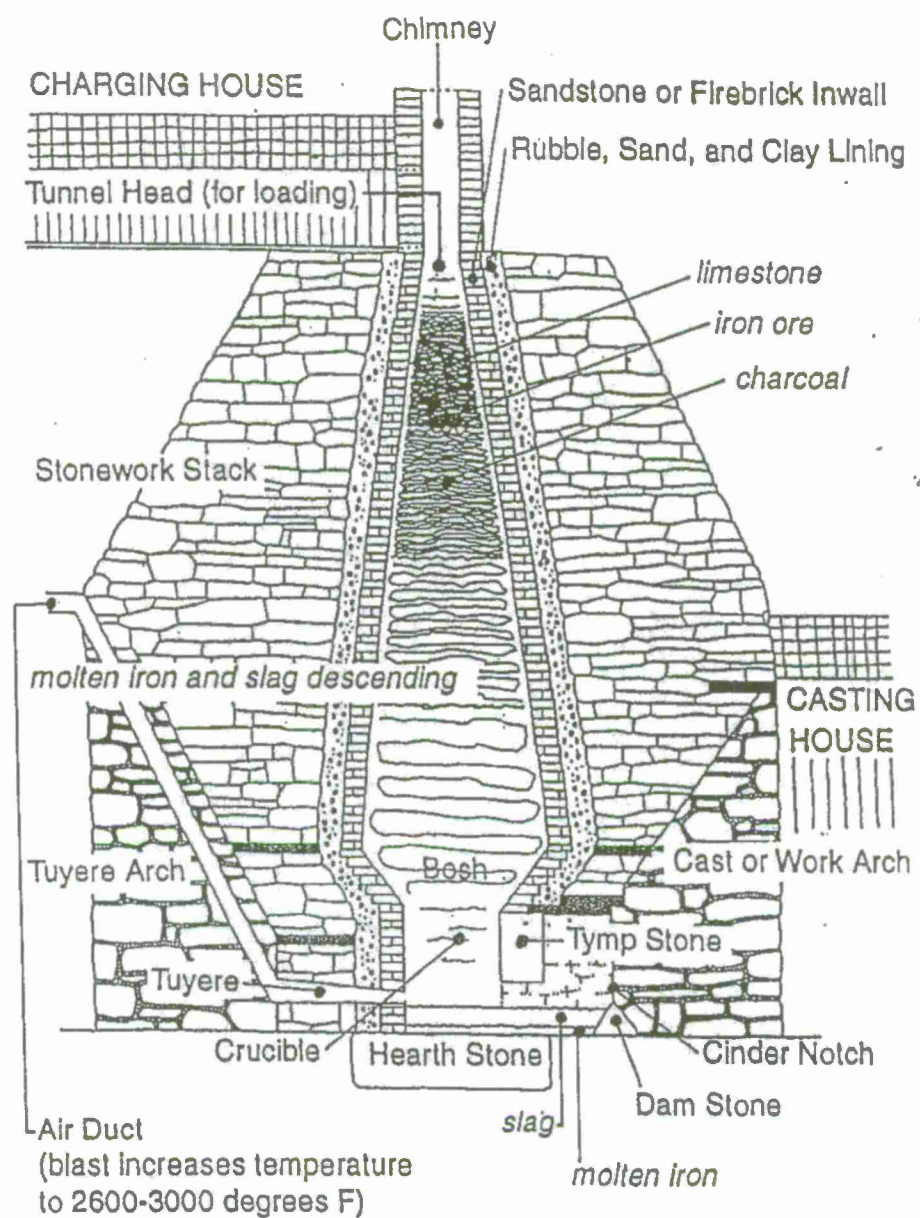


Figure 11. Schematic diagram showing the operation of a charcoal-fueled cold blast iron furnace. From Eggert (1994: 7, Figure 2).

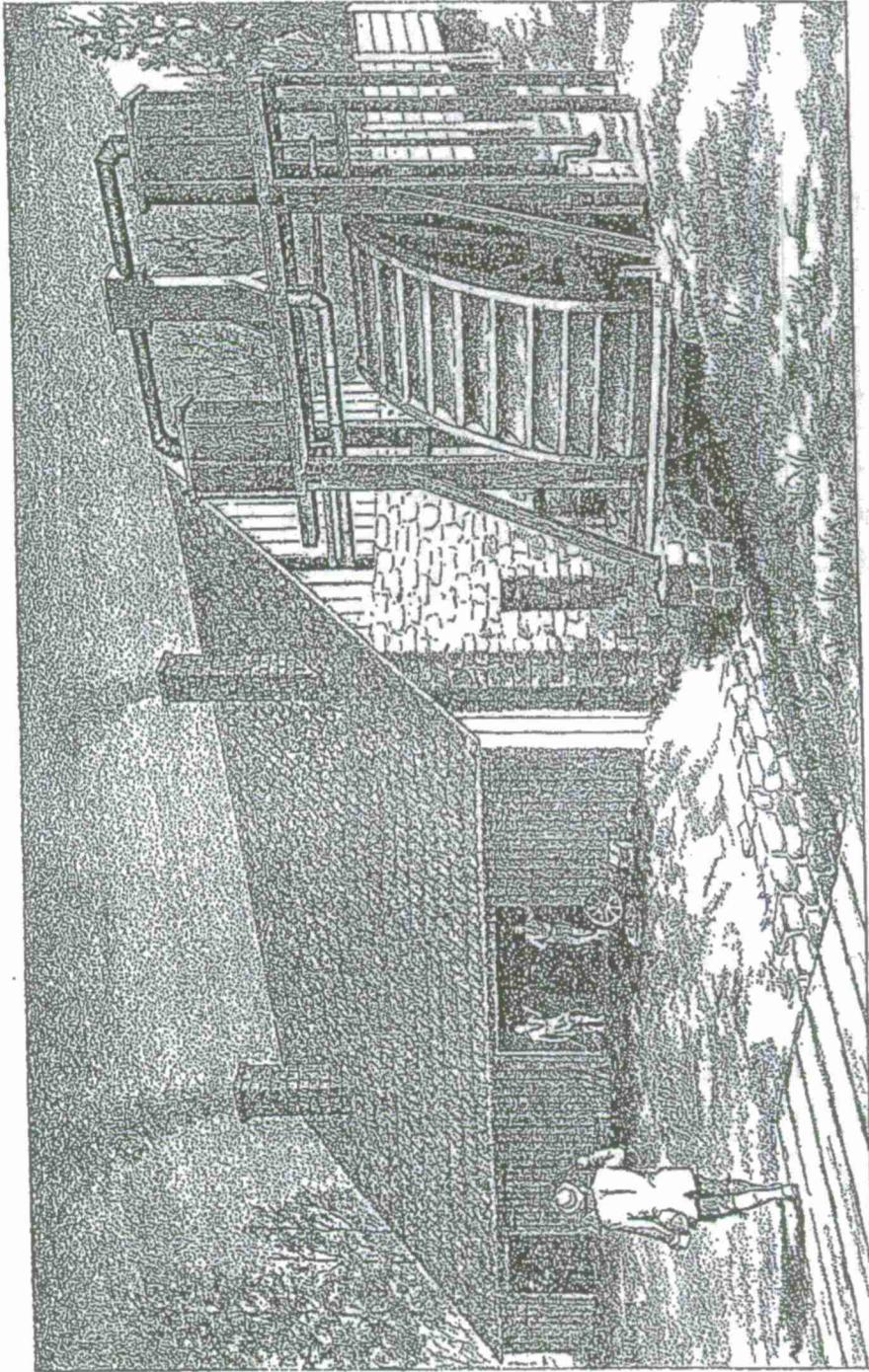


Figure 12. A water-powered iron forge. Cams on the water wheel operate two tub bellows suspended above it. The bellows provide air to heat the forge. The central shaft of the water wheel (in this case a breast wheel in which water from the sluice aimed at the center of the wheel) also operates cams that drive a tilt hammer. From Buck and Buck (1939: 302).

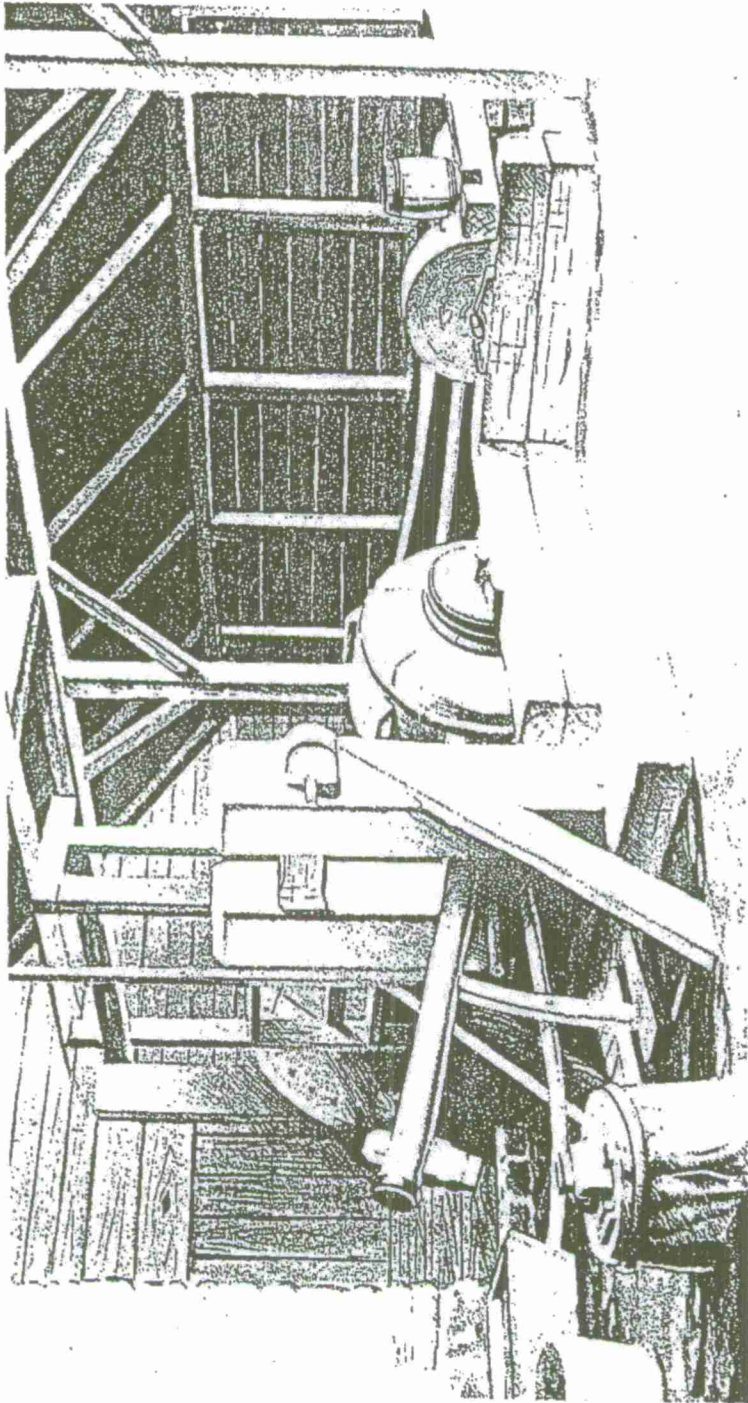


Figure 13. A tilt hammer in an iron forge. The exterior water wheel provides rotary motion to the central shaft of the hammer, which is raised and lowered by a series of cams attached to the large hub in the center of the picture. The speed of the hammer could be regulated by the speed of the water wheel. A grindstone, also operated by the water wheel and a belt, is shown at right. From Buck and Buck (1939: between 304 and 305).

makers to experiment with coke in the production of iron, and coke-smelted iron became common there after 1760. Most early English coking was done in open pits, but the first English coke produced in an oven was made in 1763 (Bining 1973: 60-61). By 1806 coke fueled 162 of England's 173 iron blast furnaces.

Despite the English example of coke's utility in iron making, the seemingly inexhaustible supply of trees in North America, poorly developed transportation systems, custom, prejudices against the use of anthracite, and the difficulty of finding a suitable coking coal all kept charcoal as the American iron maker's fuel of choice until at least the early nineteenth century. Even then, most American iron producers stubbornly clung to their traditional fuel as long as possible, even in the face of the rising charcoal prices that accompanied the progressive decline of the American hardwood forests.

By the 1830s, charcoal prices were rising. A bushel of charcoal then cost about five cents, and it required about 200 bushels to produce a ton of pig iron, or a charcoal cost of about \$10.00 per ton. Anthracite coal in eastern Pennsylvania, on the other hand, then cost \$2.50 per ton or less and required just two tons to produce a ton of iron (Binder 1974: 65). Thus, anthracite coal offered an immediate and increasingly compelling economic advantage of about 50 percent over charcoal in the production of eastern Pennsylvania iron.

The bituminous coal found in southwestern Pennsylvania had been used for heating Pittsburgh-area homes and businesses since at least the 1760s (see *River Navigation and the Development of the Monongahela River Valley Coal Industry*). It also was used in the Monongahela River Valley's iron forges and mills to reheat pig iron, but for a variety of reasons little use of bituminous coal or coke was made in early iron making.

At the time, it was difficult to identify specific bituminous coal that had the correct coke-making properties. There also were technological problems in coke production, lack of knowledge about the correct blast of air needed in the iron furnaces of the day, individual prejudices in favor of the continued use of charcoal iron, and the generally low-level of business organization among coal companies (Binder 1974: 76). Impurities, especially sulfur, in bituminous coal were also a hindrance to its direct use in iron making and to the production of acceptable coke.

Just where coke was first produced in the United States is a matter of some disagreement. While some authorities argue for the Allegheny Furnace in Pennsylvania's Blair County in 1811 (Ellis 1882: 242); others credit Colonel Isaac Meason of Fayette County in 1818 or the Bear Furnace in Armstrong County in 1818 or 1819 (Heald 1990: 10; Bomberger et al. 1991: 34). In their review of western Pennsylvania stone blast furnaces, Myron B. Sharp and William H. Thomas (1966: 51) claim that the first American iron produced with coke was made in 1803 by the Oliphant family at the Springhill Furnace in Springhill Township, Fayette County. Since it appears that the Oliphants did not purchase this furnace until 1833, however, this claim must be considered with caution. In 1836, however, the Oliphants' Fairchance Furnace near Uniontown, Pennsylvania, did produce

about 100 tons of bituminous coke pig iron. The resulting product was poor, however, and the furnace soon returned to charcoal iron production (Binder 1974: 79).

Whether the first use of coke occurred in 1803, 1811, or 1818-19, the process itself was definitely derived from then-current British technology. John Beal, an immigrant English iron founder, for example, placed an advertisement in the *Pittsburgh Mercury* on May 27, 1813 in which he offered to share his knowledge of iron production using coke fuel. It is not known, however, if any iron masters in western Pennsylvania took Beal up on his offer (Binder 1974: 77-78).

Isaac Meason's Plumsock rolling mill was located just east of Brownsville and opened in 1815. (The Plumsock forge had opened in 1794; Eggert 1994: 32.) Meason's Welsh iron founder at the Plumsock works, Thomas Lewis, employed three men to produce coke in open ricks from Redstone Seam coal deposits. The coke was used for puddling the iron worked at the mill, and Meason proudly advertised its use in the *Pittsburgh Gazette* in June 1818.

In puddling, pig iron produced in a charcoal-fired blast furnace was reheated to yield wrought iron, which then was worked by rolling it out into sheets and cutting it to shape, producing iron bars, ingots, or other useful finished or semi-finished forms (Figure 14). Cut nails were a typical product of the slitting mills, but bars and rods were furnished to country blacksmiths or to other metal fabricators for shaping into the finished products useful on an expanding western frontier. The Redstone Seam coke Lewis used at Plumsock was high in sulfur, however, and it was soon judged to be unsatisfactory. Lewis and Meason soon returned to charcoal fuel for their puddling process (DiCiccio 1996b: 27).

Coke was used in small amounts early in the nineteenth century by some urban coal gas plants, such as the large coal-gas works in Philadelphia's. It was largely limited, however, to heating the retorts in which the coal gas was produced or as a heating fuel in the company's office. Small amounts of coke also were sold on the open market for domestic consumption, but for the most part, it was a product without an American market and remained so until its utility in iron production eventually was realized (Binder 1974: 32).

The first use of coke to make pig iron in the United States took place in western Pennsylvania at the Bear Creek Furnace south of Parker in Armstrong County in 1819. The same Thomas Lewis who had worked for Isaac Meason was also involved here. This furnace was constructed explicitly to use coke for making iron and was therefore somewhat larger in size than the typical charcoal furnace of its day. Unfortunately, the cold air blast used at the furnace did not produce good results, and its owners reverted to charcoal after having produced just a few tons of coke iron (Binder 1974: 78; DiCiccio 1996b: 27).

Inevitably confronted with diminishing forests and rising charcoal prices, Pennsylvania iron makers began searching in earnest for a charcoal replacement during the 1820s. It was not until the mid-1830s, however, that the search accelerated (Bining 1973: 59). The state's General Assembly passed an act in 1836 to encourage iron making with coal

or coke and in 1835 formed the first Geological Survey of Pennsylvania to identify deposits of coal suitable for making coke. In 1831 and 1832, Philadelphia's Franklin Institute offered a gold medal to anyone who could produce twenty tons of good iron using coke or coal as a fuel (Binder 1974: 63). Nicholas Biddle's Bank of Philadelphia offered a \$5,000 reward to anyone who could keep a blast furnace going continuously for three months using either coal or coke.

The Pennsylvania Society for the Promotion of Internal Improvements sent William Strickland to Great Britain in 1825 to study the coking technology then in use there and its use in iron making. Strickland's report encouraged some additional experimentation in Pennsylvania. The first successful attempt to use coke in iron production occurred at the Mary Ann Furnace, Huntingdon County, Pennsylvania, in 1835.

In 1835 or 1836, Fidelio H. Oliphant produced 100 tons of coke iron using blue lump iron ore at his Fairchance Furnace near Uniontown in Fayette County. Oliphant exhibited some examples of this iron at Philadelphia's Franklin Institute. The purpose of the exhibition was to attract eastern money to support the development of western Pennsylvania's iron industry (Albert 1882: 403-404). The iron was judged to be of poor quality, however, and the Oliphants soon returned to charcoal iron production. In 1839 the Lonaconing Furnace, built by the Georges Creek Coal Company near Frostburg, Maryland, was producing seventy tons of bituminous coke iron of good quality per week (Binder 1974: 79, 80).

The first production of coke in a beehive oven (Figure 15) seems to have occurred within the current limits of Connellsville, Fayette County, Pennsylvania, in 1833. Here an Englishman named Nichols, whom Isaac Meason had employed since the 1790s, supervised the erection of a twelve-foot diameter stone and brick coke oven on property owned by Lester LeRoy Norton. In 1831 Norton had built a small foundry next to his textile mill on Connell Run.

Apparently, Nichols had made some earlier but unsuccessful attempts to use coke in iron making at Meason's Union (Dunbar) Furnace during the 1790s. In his subsequent beehive oven experiments with coke, Nichols obtained Pittsburgh Seam bituminous coal from the Plummer Mine near the confluence of Mounts Creek and the Youghiogheny River just north of Connellsville. He produced coke both in the stone oven and in open ricks on the ground, the latter being the traditional way in which coke had been produced in England.

The beehive coke that resulted from this early attempt was loaded into boats and floated down the Youghiogheny River to McKeesport, then up the Monongahela River to Brownsville. Here it was transferred to wagons and hauled to Colonel Meason's Plumsock iron mill. This is the first known instance of the river transportation of bituminous coke produced in the forerunner of the beehive oven for which southwestern Pennsylvania became famous in the second half of the nineteenth century (Billinger 1954: 37; DiCiccio 1996b: 28).

Coke also was made at an early date in the Hill District neighborhood of Pittsburgh, specifically in what used to be called Minersville, today's Herron Hill. Herron Hill is named

after the Herron family, who were prominent coal merchants in the city. Although few details are known, the Cokain Coke ovens in the Hill District are mentioned in city directories as early as the 1830s. These ovens, which may have employed African-American as well as white workers, supplied coke to early iron factories in the city (Brown et al. 1994: 131).

About 1835 an attempt to use coke to augment or replace charcoal was made at Trevor and McClurg's Mt. Hope Furnace near Champion in Westmoreland County, built about 1810 (Sharp and Thomas 1966: 83). Nicholas Biddle's award, however, went to the Pioneer Furnace in Pottsville, Pennsylvania, erected earlier by Burd Patterson. Patterson's iron master, Benjamin Perry, brought in the first successful blast of iron using anthracite coal here in October 1839. The furnace produced twenty-eight tons of anthracite pig iron each week for more than three months (Binder 1974: 64-65).

However, anthracite coal, common in eastern Pennsylvania, was problematic for early iron production. The fuel burned at a much higher temperature than charcoal, and these temperatures could not be attained or sustained easily using the "cold blast" technology commonly found at early furnaces (see Figures 10 and 11). In this technology, a cold blast of air was introduced into the blast furnace from one or a pair of water-operated bellows.

A solution to the cold blast problem was developed in Scotland and England in the late 1820s when a system to interject pre-heated air, so-called "hot blast," into the bottom of the blast furnace was perfected. The hot blast provided air several hundred degrees hotter than the cold blast bellows and allowed anthracite to be used more commonly in iron production. Adoption of this technology increased British iron production and further lowered the cost of British iron imported into the United States. This had a dampening effect on the development of the native iron industry and led American iron masters to demand high tariffs on imported iron.

Hot blast technology was used in Perry's first production of anthracite iron at the Pioneer Furnace and also was incorporated into the operation of the Fairchance Furnace in Fayette County, Pennsylvania, long before the technique became widespread. John Hayden constructed this furnace about 1803 or 1804. One cold day, Hayden built a fire under the 150-foot long pipe that carried the cold blast to his furnace. The technique worked well and allowed the iron-making process to continue during cold weather, but Hayden seems not to have patented or further developed his hot blast technique (Sharp and Thomas 1966: 46).

The development of the British iron industry coupled with the national economic problems of 1837-1842 hindered the technological maturation and expansion of American iron producers. Nevertheless, some Pennsylvania ironmasters persisted. Frederick Geissenhainer obtained an U.S. patent for anthracite iron production in 1833 and three years later constructed the Lucy Furnace in eastern Pennsylvania where the first successful use of anthracite in American hot blast iron production was made.

Geissenhainer died shortly thereafter, but two other Pennsylvania iron makers, Josiah White and Erskine Hazzard, had experimented with the use of anthracite coal since the 1820s. They later imported knowledgeable talent from Wales and opened the Catasauqua Furnace near Allentown, Pennsylvania, for their Lehigh Crane Iron Company in 1840. The furnace continued to produce fifty to sixty tons of anthracite iron per week until it closed in 1879.

The success that Geissenhainer, White, and Hazzard demonstrated and the abundance of anthracite in eastern Pennsylvania made this the fuel of choice in most eastern Pennsylvania iron furnaces by 1859. Anthracite-fueled iron furnaces were larger than their charcoal-fired predecessors, and their adoption by furnaces located along the Lehigh, Susquehanna, and Schuylkill River Valleys pushed Pennsylvania to the fore in American iron production. By 1850 some 370 anthracite furnaces were producing 600,000 tons of iron annually, twelve times the production just forty years earlier (DiCiccio 1996b: 25-26).

While the early chapters in the history of iron production in Pennsylvania unfolded in the eastern end of the state, western and southwestern Pennsylvania also played an important, though somewhat later, role. Pittsburgh eventually came to be regarded as the iron and steel-making capital of the world; however, its earliest importance to the iron industry was rolling, shaping and fabricating iron and iron products, not its manufacture.

An early attempt to produce iron in the Pittsburgh area did take place at the Shadyside Furnace. This opened in 1792 under George Anshutz, William Amberson, and Francis Beelen, but their enterprise was short-lived and was by no means the earliest iron furnace in western Pennsylvania. That distinction belongs to the Alliance Furnace, a blast furnace and forge complex on Jacobs Creek, a tributary of the Youghiogheny River in Fayette County. William Turnbull, John Holker, and Peter Marmie erected this furnace, which went into blast in 1789. Shot for the six-pound artillery pieces carried by General Anthony Wayne's troops in their expedition against the Ohio Indians was made at the Alliance Furnace in 1792 (Sharp and Thomas 1966: 43).

Fayette County took the lead in the early southwestern Pennsylvania iron production and manufacturing industries. Between 1789 and 1800, the county saw the construction of eight blast furnaces, eight iron forges, a bloomery, and a slitting mill. Most of these early industrial developments were situated on tributaries of the Youghiogheny or Monongahela rivers.

The earliest forges in Fayette County included the one built by Isaac Meason as part of his Union Furnaces on Dunbar Creek near Connellsville. (Union Furnace No. 1 was built in 1790 or 1791. Union Furnace 2 was built nearby in 1793.) The Pine Grove Forge of T. Lewis was built on Pine Grove Run, also in 1790. John Hayden and John Nicholson constructed Hayden's Bloomery on Georges Creek, a tributary of the Monongahela River, in 1792. Hayden, one of the most important names in early Fayette County industry, also was responsible for the Fairfield Furnace and Forge in Georges Township in 1797.

In 1794 Jeremiah Pears, another important name in Fayette County industrial history, erected the Plumsock Forge in Menallen Township. Pears also built the first slitting mill in the county at his forge prior to 1800 and erected the Redstone Furnace on Redstone Creek in 1797. John Oliphant's Sylvan Forge on Georges Creek was built in 1796, while Reuben Mochabee's (or Mochbee) Hampton Forge on Laurel Run was put up the following year. The Little Falls Forge was constructed on Arnolds Run in 1800 while the Youghioghenny Forge (also known as Lamb's Forge) was built on the Youghioghenny River some time before 1800 (information abstracted from Bining 1973: Appendix A, pp. 171-176).

The banks of the Cheat River, a tributary of the Monongahela, in today's West Virginia were also the location of an early iron industry supported by capitalists in Wheeling. This industry lasted from the 1790s until the discovery of iron ore in the Lake Superior area in the 1840s made it uneconomical for iron-making to continue in the Cheat River Valley. The Cheat River iron industry did supply munitions and weapons for the War of 1812, and iron was probably shipped down the Monongahela River for processing in the early mills of Pittsburgh (NPS 1991: 20).

The center of Monongahela River Valley iron manufacturing shifted downstream to areas closer to Pittsburgh during the second half of the nineteenth century, but some of the early Fayette County blast furnaces remained in production. The Redstone and Springhill Furnaces, both founded prior to 1800, stayed in production until 1870. The Union Furnace No. 2, built in 1793, continued to produce iron until 1930 under the name of the Dunbar Furnace, adopted in 1844. Sharp and Thomas (1966: 52) record that the Dunbar Furnace also was a site of an early by-product coke-making operation but do not give a date for this technological development.

Twelve additional blast furnaces were erected in Fayette County after 1800. The end-dates of production are known for ten of these furnaces. Seven of them had gone out of blast by 1840 or before (six of these during the national economic downturn of the late 1830s). One other was defunct by 1860, another by 1873, and the tenth was out of blast by 1887 (data extracted from Sharp and Thomas 1966: 43-53).

The Westmoreland County economy in 1850 remained heavily devoted to supplying the needs of a traditional agricultural economy. Of the nearly 600 businesses included in the manufacturing schedules for the census that year 153 of them involved the processing or production of wood, and 125 others worked with leather. The third largest category of businesses was metal-working with 116 establishments. Most of the last were blacksmiths (79), and a number of others made thrashing machines, agricultural implements, and edge tools. Iron manufacturing was still represented, however. Six iron furnaces were in blast that year, three of which were located in Fairfield Township. Two other furnaces were in Ligonier Township, and a sixth was in Loyalhanna Township. The industrial portion of the county's economy also included three foundries, three foundry and plow factories, six machine shops, and four machinists. There also were twelve coal mines in operation (U.S. Bureau of the Census 1850; Muller et al. 1994: 1).

It was necessary to build the early iron works on streams because water power was used to operate the bellows found at both furnaces and forges (see Figures 10, 12, and 13). Data on the early transportation and sale of iron are slim, but it is also likely that the rivers were used to transport the heavy pig and wrought iron to blacksmiths, boat builders, and other iron-working businesses along the river all the way to Pittsburgh. By the time the census of 1810 was compiled, Fayette County had ten blast furnaces, one air furnace, eight forges, three rolling and slitting mills, one steel furnace, and five trip hammers in operation (DiCiccio 1996b: 27). Within sixty miles of Pittsburgh, some 4,000 tons of bar iron, 18,000 tons of pig iron, and 400 tons of flat iron was produced annually at the time (A. Warner and Company 1889a: 601).

Detailed information on the early metal-working industries of Pittsburgh is scarce, but area blacksmiths, like George M'Gunegle fashioned a great many products that were useful in the predominantly agricultural economy of the period. In 1789 M'Gunegle advertised in the *Pittsburgh Gazette* that he made

. . . locks, keys, and hinges of all sorts, pipe and square tomahawks, scalping knives, boxes and pins for vizes, grates. . . andirons, shovels, tongs, pokers, chaffing dishes, bread toasters, ladles, skimmers, flesh forks, and skewers. . . razors, scissors, and pen knives. . . bed screws, and branding irons. . . and does several other pieces of business in the White Smith line too tedious to mention (quoted from Buck and Buck 1939: 303-304).

Samuel Black also had established a nail factory at Washington, Pennsylvania, by 1789, and a Mercersburg nail factory east of the Allegheny Mountains advertised its products for sale in the *Pittsburgh Gazette*. By 1797 a water-powered cut nail factory had been established in the Pittsburgh area and two cut nail factories were in operation in the town before 1800 (Buck and Buck 1939: 305).

By comparison with Fayette County, Pittsburgh and Allegheny County lagged in iron production and even in metal processing in the early nineteenth century. In 1800 Pittsburgh business was dominated by commercial rather than industrial concerns. The town then had sixty-three shops, twenty-three of which were general stores. Industrial development at that time, though slight, did include a brewery, two glasshouses, paper mill, various oil-, grist-, fulling- and sawmills as well as ironworks, powder works, and salt works (Reiser 1951: 9).

Industrial growth over the next several years must have been swift. Zadok Cramer's *Almanac* of 1804 (citing figures for 1803) reported that Pittsburgh then produced: \$12,800 worth of tin ware, \$19,800 worth of bar iron, axes, plows, hoes, etc., \$16,128 worth of cut and hammered nails, \$2,800 worth of brass, and-irons, and still-faucets, \$1,000 worth of cutlery, augers, chisels, hackles, and planing bits, and \$1,500 worth of scythes and sickles, a total of \$54,028 annual production among a total of Pittsburgh manufactured articles valued at approximately \$350,000 (A. Warner and Company 1889a: 598-600).⁵ The pig iron came

⁵Somewhat different figures are given by Catherine Reiser (1951: 14), who lists the value of iron production in Pittsburgh in 1803 at \$56,548. The \$358,908 figure includes manufactured and "country goods" for Allegheny County. Reiser (1951: 14, note 10) gives the figure for Pittsburgh alone as \$266,403.

from furnaces outside the city, but even at this early date iron working was the single largest business in Pittsburgh.

The Pittsburgh iron industry enjoyed a period of comparatively rapid growth in the early nineteenth century. This was due in part to the ample supplies of pig and wrought iron available from blast furnaces up the Monongahela River, primarily in Fayette County but also in Westmoreland County (sixteen furnaces built between 1794 and 1854), and Greene County (one furnace built before 1800). In 1807 Cramer recorded one foundry in the city (McClurg's), three nail factories, and three copper and tin factories. In 1809 a steam engine was assembled in Pittsburgh for the first time, and by 1814 the town had three steam engine factories.

In 1810 an iron-grinding mill was mentioned along with McClurg's Foundry, a white-metal button factory, several ironmongeries and nail factories, and six copper and tin factories. That same year, William Eichbaum, who also was prominent in the early Pittsburgh glass industry, set up the first wire manufactory in Pittsburgh. By the time the 1810 census was compiled, the value of Pittsburgh's iron production had grown to \$94,890 (Reiser 951: 15). The census recorded thirty-four naileries, twenty-eight gun factories, twenty-six cutlers, two plane factories, and two mills that ground flatirons in operation in western Pennsylvania (Buck and Buck 1939: 305-306).

Joseph McClurg's Pittsburgh foundry had been built in 1803 or 1804 and cast hollow wares, utensils, plows, and cannonballs. McClurg built a cannon foundry in Pittsburgh and supplied Perry's Lake Erie fleet during the War of 1812 (Thurston 1888: 139). The War of 1812 spurred iron production in Pittsburgh and in the American iron industry in general as it temporarily cut off Britain as a source of relatively cheap iron and iron products.

In 1812, the first year of the war, Pittsburgh had a flat-iron mill, two foundries, six nail works, and ten silversmiths, copper, tin, and brass factories. The very next year, there were three foundries, and edge-tool factory, a steam-powered factory for making shovels, scythes, etc., a lock factory, two steam engine and boiler works, and a steel factory plus the rolling and slitting mill established by Christopher Cowan, the first such in Pittsburgh. War production greatly accelerated the iron industry in Pittsburgh. The value of the city's iron products in 1815 was estimated at \$764,200, slightly more than eight times the amount produced just five years earlier.

In the eighth edition to *The Navigator*, his guide to the navigation of the Monongahela, Allegheny, and Ohio Rivers and to the developments on them, Zadok Cramer presented a "snapshot" of the forges, furnaces, and other industrial developments on the Monongahela and Youghiogheny rivers and their tributaries about 1813. Even at this early date, there were some iron works located on the headwaters of the Monongahela River in what was then Randolph County, Virginia.

Cramer's report showed just how active local entrepreneurs were in developing new industrial pursuits. In some cases, these were incorporated with traditional water-powered grist/sawmill complexes that served the still-dominant agricultural economy.

While industrial development eluded early McKeesport, there were a number of significant industrial enterprises located on the Youghiogheny River and its tributaries above the town. For example, the firm of Mochbee and Werts was erecting a forge in 1813-14 near the mouth of Indian Creek, a Youghiogheny River tributary. The Fountain Furnace (1809) and the Mt. Hope Furnace (1813), erected by Trevor and Rodgers and Trevor and Sheave, respectively, and the St. John's Furnace (ca.1808) were all sited on Indian Creek. The Mt. Hope Furnace, Cramer reported, was then producing about twenty-one tons of pig iron per week. Cramer mentioned Meason's forge about one mile above Connellsville on the Youghiogheny. The firm of Huston & Taylor was then erecting a rolling and slitting mill on Dunbar Creek, a tributary of the Youghiogheny River also about one mile above Connellsville.

Connellsville and the town of New Haven on the opposite side of the river then contained an air foundry as well as a rolling and slitting mill in addition to two gristmills and a fulling mill. The firm of Baldwin, Norton, and Mears also was building a cotton factory near the town at the time. One-quarter of a mile below Connellsville was the Gibsons' rolling and slitting mill, gristmill and a tilt hammer. One mile below the town, the Gibsons also had erected a forge, gristmill, and sawmill. Seven miles below Connellsville, at the Little Falls of the Youghiogheny, was another Gibson complex consisting of a forge, iron furnace, gristmill, sawmill, and tilt hammer. The firm of McClurg and Barnes was then building a new iron furnace on Jacobs Creek, which enters the Youghiogheny River about ten miles below Connellsville (Cramer 1814: 17, 40).

Bridgeport, then a separate small town near Brownsville, had a "wire weaver" in operation by at least 1814, although most of the town's businesses were oriented toward a non-industrial economy. Brownsville itself, already was a well-developed village of about 120 houses in 1810. Among its businesses, metal-working represented a substantial component by 1814. There were two tin and copper factories, two nail-making factories, one scythe and sickle maker, blacksmiths and silversmiths, a foundry "on an extensive scale," a mill saw manufactory, and the Morris Truman & Company steel factory, which went into full operation in 1811 (Cramer 1814: 42).

Not all Monongahela River towns were early participants in the early metals industries. Located at the junction of the Monongahela and Youghiogheny rivers, McKeesport's eventual development of heavy industry was nowhere in evidence in 1814. David McKee had occupied the swampy site perhaps as early as 1755, and a survey warrant was granted to him on April 3, 1769. Adjoining survey warrants were given to Robert and Thomas McKee several days later. The town site of McKeesport was not laid out, however, until 1795 (A. Warner and Company 1889a: 723-725). In 1814 McKeesport was the site of a boatyard, tanyard, several mercantile interests, and a brewery (Cramer 1814: 44). The first

coal pit was opened in 1830, and early McKeesport's economy revolved primarily around the river trade in that mineral (A. Warner and Company 1889a: 731-733).

A national economic recession began after the end of the War of 1812. The value of Pittsburgh manufactured goods dropped by about 14 percent overall. The value of its iron production dropped to \$525,616 in 1817. Though this was a severe decline from the levels of 1815, iron was still the dominant product of Pittsburgh manufacturers. The recession continued into 1819 when a period of general business retrenchment in Pittsburgh dropped the total value of the city's iron production to \$166,500.

By 1821 the manufacturing industry of the city was reviving, and by 1826 the value of its iron products exceeded one million dollars for the first time (\$1,155,094). Iron then accounted for more than 50 percent of Pittsburgh's product value and greatly increased its lead as the single most important business in the town. Its next closest competitor, textiles, accounted for only \$288,032 that year (Reiser 1951: 15, 19, 21-24).

It is also important to point out that early western Pennsylvania iron making was not confined to the Monongahela and Youghiogheny River Valleys. Iron furnaces situated on or adjacent to the Allegheny River in Armstrong County northeast of Pittsburgh also became important suppliers to metal-working factories there. The Allegheny River and its tributaries were essential for the transport of this iron to Pittsburgh factories.

A total of nineteen furnaces were constructed at twelve different establishments in Armstrong County between 1818 and 1859. Twelve of these furnaces were built during the decade between 1840 and 1850. At least three of the Armstrong County furnaces continued to produce iron after the Civil War. One of these, the Stewardson Furnace, which had been built originally to use coke as a fuel, survived in production until 1880.

Several of the early Armstrong County furnaces had technological significance in the history of iron production. County iron masters experimented with cold and hot blast charcoal as well as coke and raw bituminous coal for fuel. The Bear Creek Furnace south of Parker was the first to open in the county (1818). It was built originally to use coke rather than charcoal as fuel, but the blast produced was too weak and the furnace was soon converted to charcoal. The owners also experimented with iron production using raw bituminous coal for fuel. In 1832 the Bear Creek Furnace was reputed to have been the largest in the country with production hovering around forty tons of pig iron per week (Sharp and Thomas 1966: 7-8). A tramway was constructed at the furnace to transfer the heavy iron pigs from the production site to boats on the Allegheny River where they were then transported to the iron mills in Pittsburgh.

Among the important Armstrong County iron-making complexes established before the Civil War none was more significant than the Great Western Iron Works at Brady's Bend. Four furnaces were built here between 1840 and 1846 together with forges and rolling mills. Great Western Furnace No. 1 (1840) was built as a hot blast coke-fueled furnace, one of the earliest successful uses of coke in iron making. The second furnace, also coke-fueled, was

built in 1841, and each of these two furnaces was capable of producing 100 tons of iron per week, a far cry from the forty tons per week the Bear Creek Furnace was turning out less than a decade before.

The furnaces in Pennsylvania's central counties also supplied early Pittsburgh factories with iron. Indeed, prior to the opening of the Alliance Furnace in 1789, all iron shaped by southwestern Pennsylvania blacksmiths was brought over the mountains from such furnaces. The first American-produced bar iron brought to Pittsburgh came from Bedford Furnace nearly 200 miles overland on the backs of pack animals (Eggert 1994: 36). The iron masters who owned these furnaces used both overland and water transportation to get their pig iron to market. Iron was carried in wagons or by horses and mules on the old Frankstown Path (later, road) to the Conemaugh River. The load then was transferred to boats and taken down the Conemaugh, Kiskiminetas, and Allegheny rivers to Pittsburgh (Buck and Buck 1939: 306; Eggert 1994: 36).

There are no consistent records of these shipments, but newspaper accounts afford some insight. On May 19, 1818, for example, the *Pittsburgh Gazette* reported that between the fifth and tenth days of that month no fewer than fifty-nine flatboats, each of twenty to forty tons "burthen" and loaded with bar-iron and Philadelphia store goods had passed down the Conemaugh River to Pittsburgh. On March 19, 1824 the *Pittsburgh Gazette* reported that during the previous week \$100,000 worth of bar and pig iron, salt, flour, and other merchandise had been delivered to Pittsburgh on the Allegheny River, and weekly shipments of some 500 tons of pig iron on the Allegheny River to Pittsburgh factories also were reported.

The development of the Pittsburgh-area steamboat industry and the establishment of regular steamboat service in the late 1830s also facilitated the area's iron industry and its shipment on the rivers. One of the earliest steamboats to ply the Allegheny River for both passenger and freight trade was the *New Castle*. It was owned by Venango County iron manufacturers, and by April 1837 it already had made three successful trips on the Allegheny River to and from Franklin, Pennsylvania. The early success of this vessel in the river trade inspired Congress to pass legislation calling for the first navigation survey of the Allegheny River.

Much of the iron ware produced in Pittsburgh's factories was used locally, but it was also shipped down the Ohio River where the advancing frontier provided a ready market. The March 14, 1823 *Pittsburgh Gazette and Manufacturing and Mercantile Advertiser*, for example, announced the departure from Pittsburgh of two ninety-five-ton flatboats loaded with iron and nails and bound for Louisville. A ninety-ton keelboat bound for Nashville carried nails as well as other merchandise. These three boats were part of the ten steamboats, flatboats, and keelboats that left Pittsburgh for Cincinnati, St. Louis, Nashville, Louisville, and Natchez from March 8-13 that year.

The growth of Pittsburgh's iron business between 1826 and 1836 is not well documented, but the overall trend was positive. In 1825 there were eight foundries and seven

rolling mills in town. Three years later, there were nine foundries and eight rolling mills. In 1831 twelve iron foundries could be found. By 1836 the value of Pittsburgh's iron products stood at \$6,290,000, which represented about 40 percent of the town's overall business. The following year, however, saw another national recession that lasted into the early 1840s. In 1839 Pittsburgh iron production was valued at just \$4,946,400 (Reiser 1951: 27). Few business inventories were made during the 1840s, but it seems to have been another era of economic rebuilding for Pittsburgh iron. The recovery was drawn out, however, and by 1850 the value of Pittsburgh's iron production had recovered only to the levels previously reached in 1836. Nevertheless, iron products retained its lead among Pittsburgh manufactures.

The advance of iron production using coke was so slow that by the 1840s, Pennsylvania had just four coke-fired iron blast furnaces in operation, all at the Western Iron Works on the Allegheny River at Brady's Bend some forty miles upriver from Pittsburgh. Most Pittsburgh rolling mills refused to use the "red-short" coke iron produced at Brady's Bend, so the company also had to erect its own rolling mill (Binder 1974: 80).

The coal of the Connellsville Coke District was discovered during the 1840s, although economic difficulties in the American iron industry between 1846 and 1850 put off the true beginning of its exploitation until the 1850s. An early attempt to produce coke here took place in the Youghiogheny River Valley near what later was known as Sedgwick Station, a few miles south of Connellsville. Here, William Turner, Sr., Provance McCormick, and James Campbell hired John Taylor to build two small coke ovens on his farm in the summer of 1841. The beehive ovens held only sixty-five bushels of coal, and the first attempts to produce acceptable coke were disappointing. After some experimentation, however, Taylor succeeded, and he continued to produce small batches of coke into the spring of 1842.

These early industrialists saved the coke they produced until they had enough to fill a ninety-foot long coal boat, which they floated down the Youghiogheny and Monongahela rivers, continuing down the Ohio River to Cincinnati in search of a purchaser. The men provided samples in sacks to potential customers but with little initial success as too few iron manufacturers were then equipped with the furnaces or the know-how to use coke effectively. They finally sold their coke to a Mr. Greenwood, a foundryman and wine merchant, at 6 ¼ cents per bushel, half in cash and half in scrap iron trade. This is the first known example of the marketing of Connellsville Coke District coke by river.

In the fall of 1842, Mordecai Cochran and his nephews took over the interests of these coke pioneers and continued to successfully produce coke in Taylor's ovens. At the same time, Richard Brookins began to mine coal on the opposite side of the Youghiogheny River from Taylor's farm and soon constructed five beehive coke ovens there. In 1844 coal operator Colonel A. M. Hill purchased the Dickerson Farm and built seven beehive coke ovens with a capacity of about ninety bushels. Thus by 1841-44, the industry for which the Connellsville Coke District soon became world-famous was underway (Albert 1882: 403-404). Still, the Connellsville area had just four coke ovens in operation by 1850.

Comparison of Iron Transportation on the Monongahela Navigation System and the Pennsylvania Canal

The completion of the Pennsylvania Canal westward across the state to Pittsburgh in the early 1830s proved an important contribution to the continuing evolution of the town's iron industry. Although it was often beset by the same problems that cursed river transportation (low or frozen water), the canal offered another means and another route for transporting commercial and industrial products both to and from Pittsburgh. Its east-west orientation firmly tied Pittsburgh and Philadelphia together economically and gave iron makers in eastern and central Pennsylvania a more efficient way of getting their pig iron to the iron factories in Pittsburgh.

The records maintained by canal officials and the later records kept by the Monongahela Navigation Company are the earliest reliable figures for iron shipments on these two respective water transportation systems. These figures can be compared to show the relative amounts of iron and iron products that were being shipped to and from Pittsburgh before the Civil War and prior to the arrival of the first railroads (Table 3).

Table 3
Total Tons of Iron and Iron Products Shipped to and from Pittsburgh on the Monongahela River and Pennsylvania Canal, 1845-1850

| Iron Shipped Up the Monongahela River from Pittsburgh | Iron Shipped Down the Monongahela River to Pittsburgh | Iron Shipped East from Pittsburgh on the Pennsylvania Canal | Iron Shipped West to Pittsburgh on the Pennsylvania Canal |
|---|---|---|---|
| 8,322 | 9,517 | 10,924 | 106,985 |

Compiled from data presented in Reiser (1951: Appendix II: 207 and Appendix III: 217-220). Original figures given in pounds and converted to tons by dividing by 2,000 and rounding to the nearest whole ton. Figures include both pig iron and manufactured iron products.

The figures in Table 3 compare the amount of iron moving on the two water systems for the five-year period from 1845 to 1850. By this time, the canal across Pennsylvania was well established as a transportation route. It had been in operation to Pittsburgh since the early 1830s. Similarly, by 1844 the Monongahela Navigation Company had completed Locks and Dams Nos. 1-4, creating a navigable pool in the most populous and industrialized section of the river from Pittsburgh to Brownsville.

Examination of these figures suggests several immediate trends. First, the iron traffic on both the Monongahela and the canal was a two-way affair. Iron did not move either to *or* from Pittsburgh. It moved to *and* from Pittsburgh. Pittsburgh was both a manufacturer of iron implements and a retailer of items produced in its own factories and factories in the East. Some Pittsburgh iron products were shipped eastward to Philadelphia while others were sold locally or sent down the Ohio to a rapidly growing western population.

A second observation from Table 3 is that the volume of iron moving up and down the Monongahela River was, generally speaking, more equal than the volume of iron that was

shipped on the canal, where the volume moving west was on the order of ten times the amount moving east from Pittsburgh during this five-year period. Table 3 makes it abundantly clear that during this five-year period the volume of iron and iron products carried west to Pittsburgh on the canal from the older, more established iron furnaces and forges in the central and eastern parts of the Commonwealth greatly exceeded the combined volume of iron moving east from Pittsburgh plus the total up and down-river volume of the iron trade on the Monongahela River. Coal and other extractive products were the “kings” on the Monongahela River Navigation System, but most iron and iron products came to and went from Pittsburgh on the Pennsylvania Canal during this period.⁶

Not as apparent from the Table 3 figures is another fact. The volume of the iron trade on the canal between 1845 and 1850 was accelerating. The 106,986 tons of iron carried east to west during these five years represented about 51 percent of the canal’s total east to west iron volume during the fifteen years between 1835 and 1850 (210,775 tons). Similarly the 10,924 tons sent west to east on the canal from 1845 to 1850 represented about 54 percent of the 1835-1850 west-to-east volume (20,302 tons). It therefore appears that the opening of the Monongahela Navigation System’s first four locks by 1844 had no negative effect on the canal’s iron transportation business.

Coke-Iron Manufacture in the 1850s and the Civil War

Prior to the Civil War, the Pennsylvania iron industry, like that of the country as a whole, was characterized by technological conservatism and the retention of traditional forms of business organization (Paskoff 1983: 132-133). The conservatism of most iron businessmen was bred largely by the financial uncertainties of a market that was largely beyond their control. National economic downturns such as that following the War of 1812, the one from 1837-1842, and again in 1857, could spell instant financial ruin for those who had over-expanded or over-invested in new technology. Moreover, there was no mass market that demanded increased production from the iron industry prior to the boom in railroad building after the Civil War. Increased consumer demand for iron products generated by a larger population was met by developing new rather than larger firms and by the extension of traditional iron-making techniques, so there was little incentive to increase iron production by adopting new technologies.

Protective tariffs helped to prop up the American iron industry in the first half of the nineteenth century, but the implementation of technological improvements—especially the development of coke-smelted iron, and the resulting economies of scale—allowed English iron producers to exploit the emerging American market for iron railroad rails in the 1830s and 1840s. Foreign competition and generally falling prices of iron products helped to repress the development of the native American industry.

⁶During the same five-year period, for example, 53,855,058 tons of coal moved through the Monongahela Navigation System’s locks on the Monongahela River. See Reiser (1951: 67).

Some Pennsylvania iron producers did adopt new technologies, of course, including coke smelting, the use of hot blast and anthracite furnaces, and the integrated corporate (rather than individual ownership or partnerships) form of business organization during these decades, but these were in a minority. Most iron firms, however, persisted with old technologies (e.g., charcoal furnaces), staid levels of production, and simple business organization forms.

This picture began to change about 1850 and was accelerated by the production demands of the Civil War and the expansion of the American railroad system in the 1860s (Paskoff 1983: 134). The great quantities of iron demanded by the railroads for rails and boiler plate conferred economic advantage on iron manufacturers who could assure their customers of an uninterrupted supply of relatively low-cost iron products. This change in the emphasis in the iron market from production for household, commercial, and small-scale industry to large-scale industrial production of specialized products brought about fundamental changes in the organization and operation of the iron industry.

These changes included the concentration of greater amounts of capital in fewer hands, the implementation of labor- and cost-saving technologies, the integration of all facets of industrial production from the production of iron through the fabrication of finished product, the expansion of the labor force, control of production costs, and the development of complex forms of corporate management. In short, by the end of the Civil War the stage had been set for the emergence of the large integrated industrial firms epitomized by the Monongahela River Valley steel mills of the late nineteenth and first half of the twentieth centuries.

Cheap imports from Great Britain remained a primary hindrance to the development of the native American iron industry. This situation also began to change rapidly in the early 1850s. In 1849 not a single coke blast furnace was operating in Pennsylvania, yet by 1856 there were twenty-one, and state-wide production then stood at nearly 40,000 tons of iron annually, about half the annual production of charcoal iron in Pennsylvania at the time (Binder 1974: 81).

It was discovered that the coal of the Connellsville Coke District possessed special attributes that made it ideal in coke production. It was soft and porous and easily mined. It was also relatively free of sulfur and required little processing (such as washing) before it was coked (Albert 1882: 405). It had a hard metallic ring to it and a lustrous silver color. It also retained its physical strength after processing so that it withstood the physical crushing forces when dumped into a blast furnace together with limestone and iron ore.

Regular production of coke in Fayette County began as early as 1841. The lingering economic downturn that had begun in 1837, however, delayed the appreciation of its utility until the 1850s, when the mass American market began to turn from a largely agricultural economy to an industrial economy that demanded more and better iron for castings, boiler plate, locomotives, and steam engines as well as greater quantities of iron rails.

Coke and bituminous coal could also be used in the iron puddling furnaces that were growing in number by the middle of the nineteenth century (see Figure 14). Pig iron, which resulted from the manufacture of iron in a blast furnace, contained a large amount of carbon and other impurities. Although it could be cast into various useful shapes, it was brittle and could neither be bent nor forged.

Wrought iron was the malleable form of iron. Traditionally it was made from iron ore in a bloomery, where impurities were beaten out of a lump of heated iron ore either by hand or with the aid of a water-powered trip hammer and a blast of air from a bellows. After blast furnaces were developed, pig iron could also be reheated and converted into wrought iron in a refining forge. Bloomeries and refining forges were slow, costly, and labor-intensive. They produced relatively small quantities of wrought iron and also required a pure fuel, such as charcoal, since the iron and the fuel were in direct contact with each other in the forge. A fuel with its own impurities would only add other impurities to the iron. After the beginning of the nineteenth century, rolling mills were developed to roll the wrought iron from forges into flat sheets, rods, and plates.

The puddling furnace was a major improvement over the refining forge since the pig iron and the fuel were in two separate hearths within the furnace. Only the heat and gases from the burning fuel came into contact with the pig iron. Puddling furnaces also operated at a sufficiently high temperature to allow wrought iron to be made without needing to beat or hammer the iron. This saved labor, fuel, and time, and lowered the cost of iron production. Coke or coal (bituminous or anthracite) could also be used as the fuel.

Rolling mills were often built as part of an iron-making complex that included the new puddling furnaces. As the wrought iron in the puddling furnace became purer, its melting temperature rose, and remaining impurities had to be squeezed out of the iron in the rolling mill. This produced what was called "muck bar," that was then further rolled out into various bar, sheet, plate, and other shapes.

The development of the puddling furnace and rolling mill complex had great importance for the rapidly developing American railroad industry. In 1844 construction began on twenty-six puddling furnaces and two trains of rolls at Danville in eastern Pennsylvania. The mill complex opened in October 1845 and produced the first "T" rail made in the country. The Danville plant remained the largest railroad rail mill in the country for some years thereafter, turning out some 20,000 tons of rails each year (Eggert 1994: 57).

By 1849 112 forges still remained in Pennsylvania, but the seventy-nine rolling mills at that time were gradually replacing them. Western Pennsylvania took the lead over older iron-producing firms in the eastern end of the state when it came to construction of rolling mills. Allegheny, Armstrong, Fayette, Lawrence, and Venango counties in western Pennsylvania had twenty-three rolling mills (but only three of the old forges) in operation in 1849, but these western Pennsylvania rolling mills employed about 45 percent of all the state's rolling mill workers and produced nearly half the state's output of rolled iron. Cut iron nails were the chief product of western Pennsylvania's rolling mills.

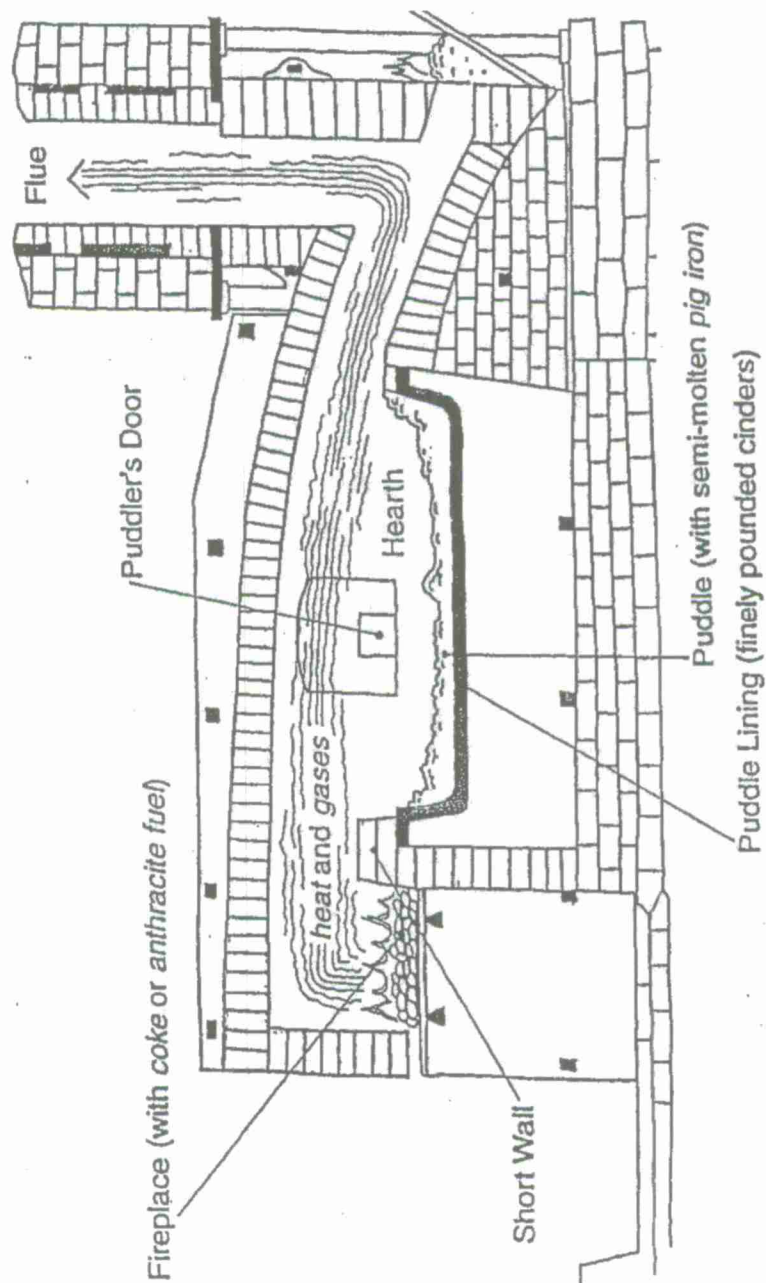


Figure 14. Schematic of the operation of an iron puddling furnace. Separation of the fuel from the iron in puddling furnaces opened the way to the increased use of coke and coal in the iron business, improved the quality of the iron produced, and increased production. From Eggert (1994: 48, Figure 9).

Efficient production and reduced transportation costs made western Pennsylvania iron products less expensive in the growing American West than iron wares from the eastern end of the state. The Allegheny, Monongahela, and Ohio rivers also afforded cheap inland transportation. Western Pennsylvania iron products were marketed both locally and down the Ohio and Mississippi rivers and were readily absorbed by the rapidly increasing western population. Pittsburgh-area nails were used to build thousands of new homes, office, and other buildings in the West and South. In terms of wrought iron production, the more efficient Pennsylvania puddling furnaces and rolling mills were producing 80 percent of the state's wrought iron by 1849. This figure grew to 90 percent by 1856. In 1860 national production of rolled iron reached 500,000 tons per year from 250 rolling mills (Eggert 1994: 5, 11-12, 14, 48-50).

The development of the puddling furnace increased the immediate utility of coke (and in eastern Pennsylvania, for anthracite coal) for processing iron in the first half of the nineteenth century. Its use in iron manufacture, however, grew only gradually in the inherently conservative American iron business after the 1840s (Figure 15). Coke's physical strength also allowed it to be shipped by railroad car without it disintegrating into dust. Since the main field of the Connellsville Coke District lay east of the Monongahela River, rail lines soon were extended into the coal field to carry the coke to blast furnaces (Figure 16). The two increasingly great advantages of coke-produced iron were its cheapness compared to charcoal-iron (about one-third the cost in the mid-1850s) and the fact that far less coke than charcoal was required to produce a ton of iron.

By mid-century Pittsburgh mills were obtaining basic iron from many sources, from furnaces on or near the Monongahela and Allegheny rivers, from the charcoal iron furnaces of the Juniata Valley and even from Tennessee (Figure 17). Even at this date, coke-produced iron offered a significant cost advantage. Charcoal iron then cost about \$30.00 per ton, about \$5.00 more per ton than anthracite-produced iron from eastern Pennsylvania. Small amounts of coke-produced iron and even some made with raw bituminous "block" or "splint" coal as a fuel (primarily in the Mahoning and Shenango River Valleys) ranged in price from \$17.00-\$18.00 per ton and were obtained from furnaces in Lawrence, Mercer, Beaver, Fayette, and Cambria counties (Binder 1974: 83). In comparison to anthracite, more coke was required to produce one ton of iron, but the coke was far cheaper. In the mid-1850s, a ton of coke-iron could be produced for half the cost (or less) of a ton of anthracite iron (Eggert 1994: 62).

The number of Pittsburgh iron manufacturing firms continued to increase during the 1850s. It truly had become the "Iron City" by 1850, when its iron factories employed over 5,000 men. At mid-century—two years before the first railroad was completed to the city—Pittsburgh already was the site of thirty large foundries and thirteen rolling mills. The rolling mills alone were capitalized at approximately \$5,000,000. Each year they turned 60,000 tons of pig iron into some \$4,000,000 worth of nails, bar iron, and other iron products. The foundries were then capitalized at about \$2,000,000, consumed 20,000 tons of pig iron annually and produced stoves, grates, hollow ware, plow castings, tea kettles, irons, weights, and other merchandise "from steam engines to tacks" valued at about \$2,000,000.

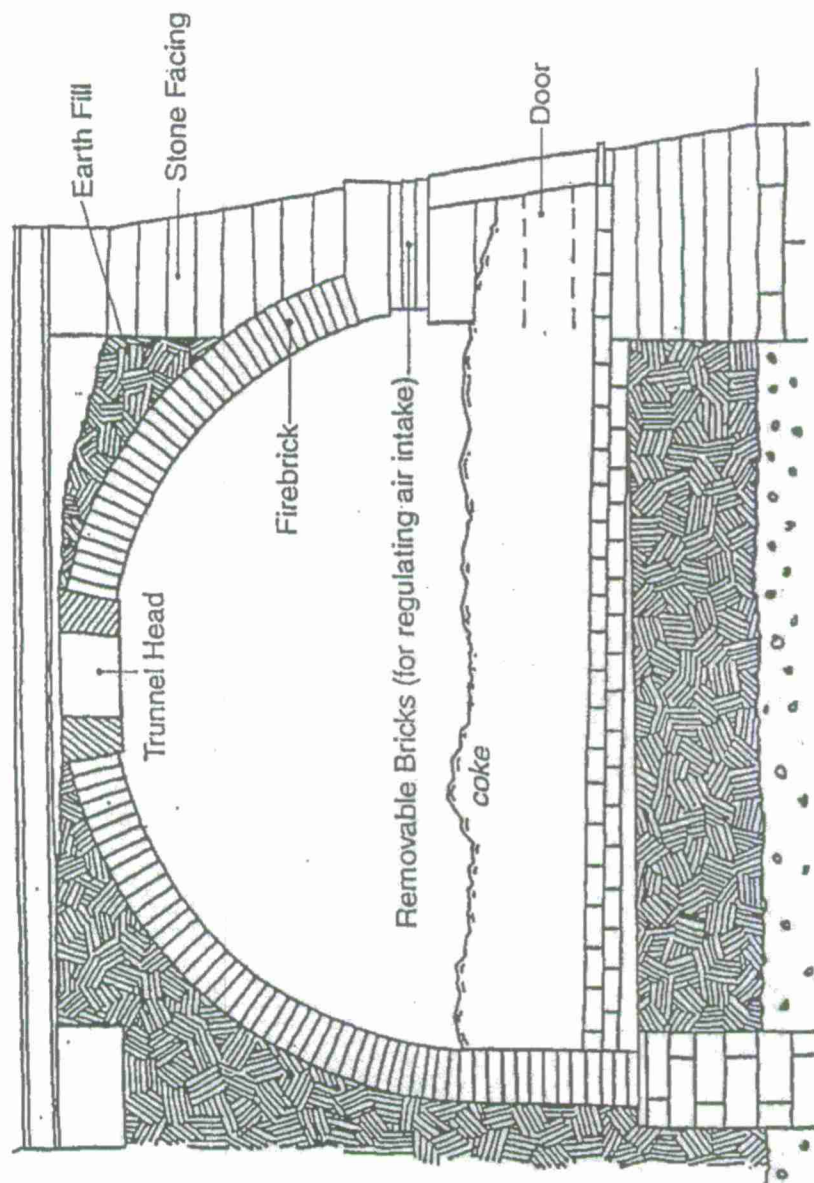


Figure 15. Schematic diagram of the operation of a beehive coke oven. From Eggert (1994: 60, Figure 13).

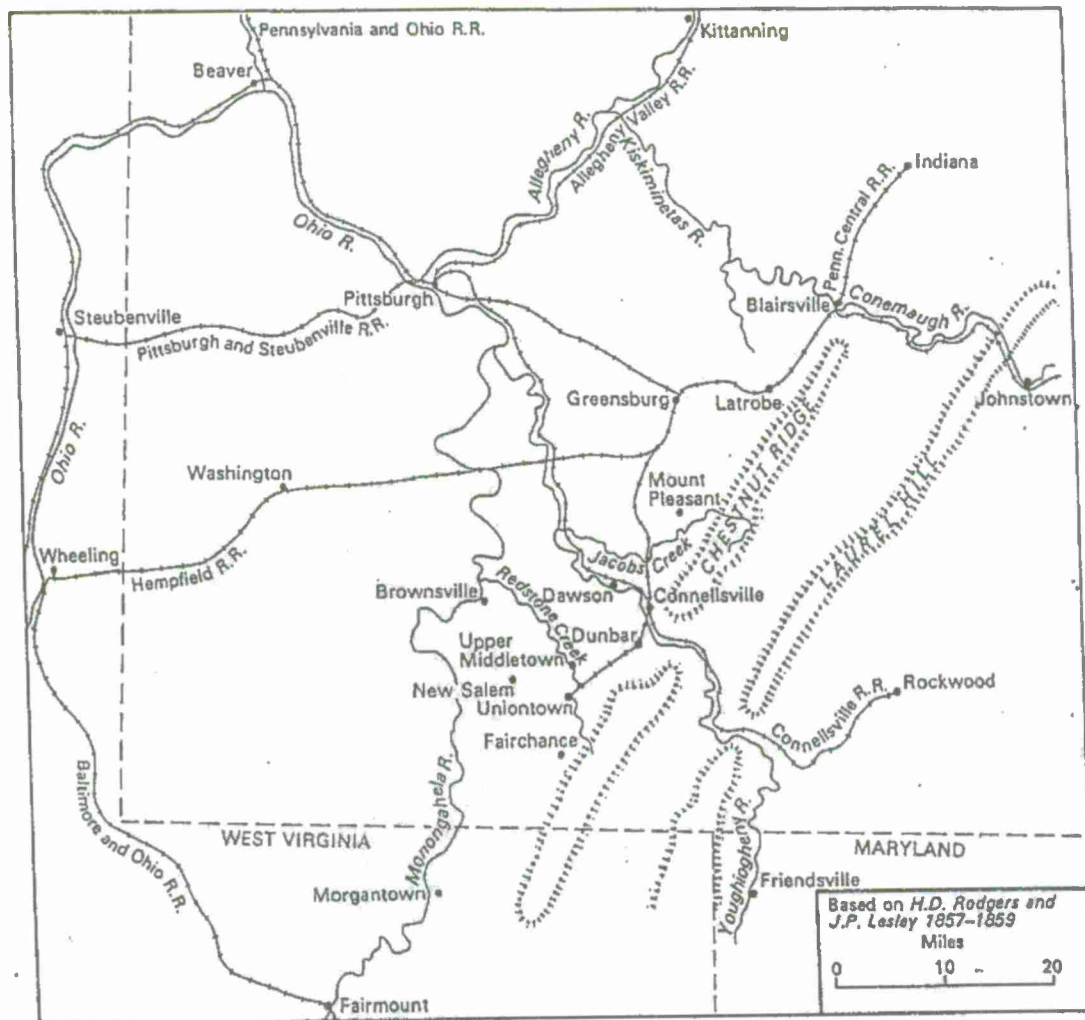


Figure 16. Distribution of railroad lines in southwestern Pennsylvania in 1858. Note that by this date the Connellsville Coke District, in the area roughly between Chestnut Ridge and the Monongahela River already was being served by several railroad lines that carried coke and iron to mills in Pittsburgh. The Clinton Furnace, the first nineteenth-century blast furnace in Pittsburgh, did not open until 1859. From Warren (1973: 37).

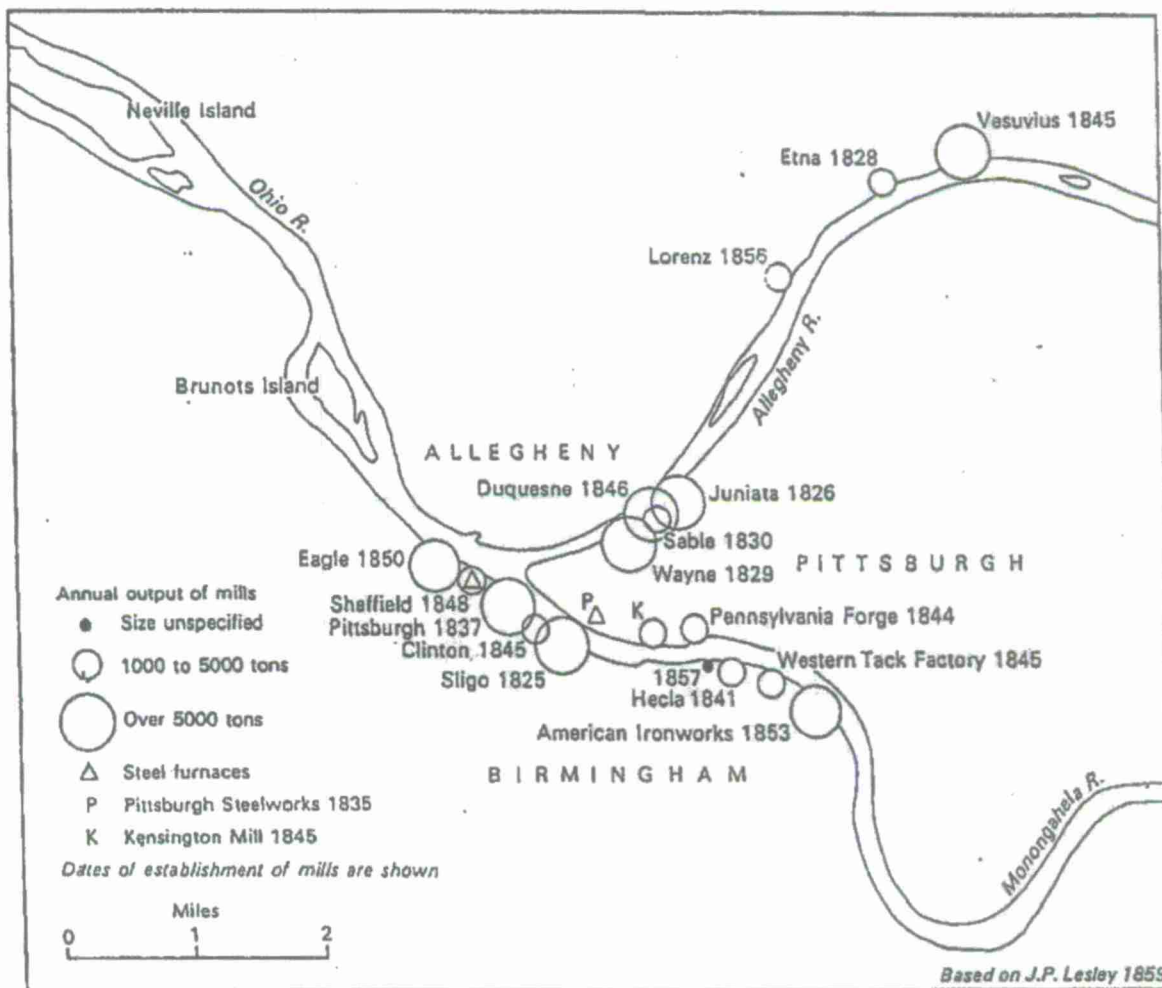


Figure 17. Rolling mills and steel furnaces in Pittsburgh in 1858. Note the clustering of these mills along the Monongahela and Allegheny rivers where iron products could be shipped by river and rail. From Warren (1973: 34).

Thus by 1850, iron and iron products provided occupations for perhaps 5,500 Pittsburgh workers and produced \$6,300,000 worth of products annually. As it had done since the earliest records were maintained in 1803, iron continued to lead all other individual Pittsburgh industries in the value of its products. A start also had been made in the production of cast, shear, and blister steel (Reiser 1951: 191-192).

The opening of the Pennsylvania Railroad to Pittsburgh in 1852 was significant but only indirectly as far as the transportation of coke was concerned. The railroad's completion did allow iron ore to be shipped to Pittsburgh, however, from Cambria and Huntingdon counties and therefore increased the possibilities of the city as an iron making, not just an iron working center. Penetration of the Pennsylvania line into the heart of western Pennsylvania's bituminous coal country also increased the railroad's own consumption of bituminous coal in its locomotives. In 1854 the company was spending \$3,000 more per year for coal than for wood to fire its boilers (Binder 1974: 127).

The direct connection that the Pennsylvania Railroad established between Pittsburgh and Philadelphia markets was extremely important in a number of ways. For example, it allowed the prompt shipment of Pittsburgh-area agricultural produce to eastern parts of the state. Unlike the earlier Pennsylvania Canal, the railroad allowed this trade to go on almost regardless of weather and water conditions. Freight rates for agricultural produce were higher than those for coal. One barrel of flour shipped by rail from Pittsburgh to Philadelphia about 1858 cost \$1.00 in freight charges, whereas a short ton of coal cost only \$4.70 to ship by rail.

Coal itself became a major commodity on the railroad and could be shipped out of Pittsburgh in any season of the year. The Pennsylvania Railroad was hauling 300,000 tons of coal a year by 1858; 200,000 tons of this was shipped from Pittsburgh east while another 100,000 tons was consumed in Pittsburgh itself (Binder 1974: 160). By 1880 the Westmoreland Coal Company of Philadelphia, with mines located in Westmoreland County, was shipping 943,117 tons of coal from western Pennsylvania to east coast urban markets. Ironically, the arrival of the railroad in Pittsburgh, the absence of rail construction up the Monongahela River Valley, and the emergence of coal as the country's principal fuel only increased the Monongahela River trade in this mineral.

Of much greater immediate importance for coke was the construction in 1855 of the Pittsburgh and Connellsville Railroad's line paralleling the northeast bank of the Monongahela and the east bank of the Youghiogheny River from Pittsburgh to Connellsville and then to Rockwood. This route led directly through the heart of the Connellsville Coke District. Branches of this line soon were completed to Uniontown and Mt. Pleasant opening other sections of the coke district to the possibilities of exploitation.

Probably due in no small part to the efficient transportation afforded by the Monongahela Navigation Company's system of locks and dams, no railroad had been constructed up the banks of that river by the mid 1850s, and only one, the Hempfield

Railroad line from the Ohio River at Wheeling, (West) Virginia, through Washington, Pennsylvania, crossed the Monongahela above McKeesport (Warren 1973: 37-38).

The American iron industry faced a brief set-back with the Panic of 1857. It soon recovered with new-found momentum, but the country was still importing from England about half of the iron rails used by its rapidly expanding railroad lines. In 1860, on the eve of the Civil War, American coke iron still had not surpassed charcoal iron or anthracite iron production in Pennsylvania.⁷ Nationally, coal- and coke-produced iron together accounted for only 10 percent of the nation's iron production in 1859. Still, by 1860 there were seventy coke ovens in the Connellsville Coke District with thirty others under construction (Warren 1973: 38). In that year, iron ranked first among Pennsylvania's industries in the amount of invested capital, second in the value of products, and third in the number of employees (Bomberger and Sisson 1991: 8).

The production of Pennsylvania iron received a major boost in 1857 when John Fritz developed the "three-high" rolling mill at the Cambria Iron Works in eastern Pennsylvania. This process was used to produce iron rails by a continuous rolling process that dramatically cut the cost of American-made iron rails from \$160 to \$28 per ton while increasing output some 400 percent. Fritz's process remained the industry standard until the development of the steel rail at the end of the Civil War (Eggert 1994: 52). The increased production and lower cost of American rails allowed the American iron industry to compete successfully with the British iron industry for the increasingly lucrative railroad business. Cheap iron rails could now be produced in the United States at the same time that demand for them was reaching a fever pitch by the burgeoning American railroad industry.

A major contribution to the Pittsburgh iron industry came in 1859 when Graff, Bennett and Company (John Graff and James I. Bennett) constructed its Clinton Furnace on the south bank of the Monongahela River opposite Pittsburgh (near today's Station Square, the former Pittsburgh and Lake Erie Railroad terminal). This was the first iron blast furnace to be built in Pittsburgh since the abortive attempt at the Shadyside Furnace in 1792. During the first three months of its operation, the Clinton Furnace used coke made from coal available near the furnace itself. This proved unsatisfactory, however, as the coal contained too many impurities.

In the spring of 1860, coke from the Connellsville Coke District was brought to the furnace either on the Baltimore & Ohio Railroad (Binder 1974: 83) or in river barges (DiCiccio 1996b: 39). The Connellsville coke proved to be excellent for the production of iron. The Clinton Furnace was constructed next to the earlier Clinton rolling mill. The furnace had an annual capacity of some 12,000 tons of iron. This iron-making complex, however, was just one of a number of Pittsburgh rolling mills and small steel factories that had come to line the banks of that river and the Allegheny since the 1820s (see Figure 17).

⁷However, 57 percent of American iron production in 1860 came from furnaces fueled by anthracite or a combination of anthracite and coke. National iron production then stood at five times the level of 1830 (Eggert 1994: 58).

The Clinton Furnace marked a major turning point in the history of the Pittsburgh and western Pennsylvania iron industry. After 1860 Pittsburgh would be known not only as an iron products and processing center but as a manufacturing location. Coke, which heretofore had been used in small quantities for re-heating iron in forges and bloomeries, would henceforth be needed in vast quantities for the production of pig iron. Graff, Bennett and Company's experiment proved the reliability of Connellsville coke for this purpose and also demonstrated that Monongahela River Valley coke could be economically transported to Pittsburgh by rail or river and combined there with iron ore to manufacture pig iron.⁸ The raw iron could then be processed on the spot into ingots or finished products and shipped either east or west by rail or down the Ohio River. As a result of this centralization of iron making in urban settings, rural iron making in southwestern Pennsylvania declined rapidly after 1860. By 1880 Pittsburgh was producing 80 percent of all the iron manufactured in the seven counties surrounding the city, including the old iron centers in Fayette County to the south and Armstrong County to the north.

The Civil War's demand for armaments greatly accelerated the growth of the American iron industry and of coke iron especially. The evolution of coke-produced iron increased Pennsylvania coal consumption 250,000 tons in the five years leading up to the war, and a great amount of this came from the Connellsville Coal District, principally by rail but also by river. Pittsburgh's iron factories became the armorers of the Union during the war. Some twenty coke-using blast furnaces, each with a capacity of 8-15,000 tons, were built in the Pittsburgh area between 1861 and 1867. In 1864, the last full year of the war, American iron production increased to 263,000 tons; 112,000 tons of that amount was coke-produced iron. At the end of the war, national iron production dropped by 18 percent overall. Significantly, anthracite iron production dropped 30 percent at this time while coke-iron production fell only 10.2 percent (Warren 1973: 38).

Coke and Iron in the Late Nineteenth and Twentieth Centuries

The growth of the southwestern Pennsylvania coke industry after the Civil War was so great that while in 1870 one train per day was judged sufficient to transport the entire coke production of the Connellsville Coke District, by the early 1880s, the output of just one coke works in the district required sixty rail cars per day (Figures 18-20). Pennsylvania was then producing about 84 percent of the country's supply of coke, overwhelmingly from Fayette and Westmoreland counties.

It was estimated that there were then some 1700 rail cars involved exclusively in coke transportation throughout the district (Albert 1882: 406). The Main Line of the Baltimore and Ohio Railroad, for example, served 485 coke ovens at this time. The Mount Pleasant Branch of the B&O, which served the H. C. Frick Coke Company ovens among others, hauled coke from 2,430 ovens, and other B&O branch lines brought the total number of ovens served by that railroad to 3,846. Various branches of the Pennsylvania Railroad,

⁸Coke manufacture was concentrated in Mifflin Township of Allegheny County and in Tyrone Township in Fayette County in 1860. Four of the thirteen Mifflin Township mines had coking operations (Bureau of the Census 1860).

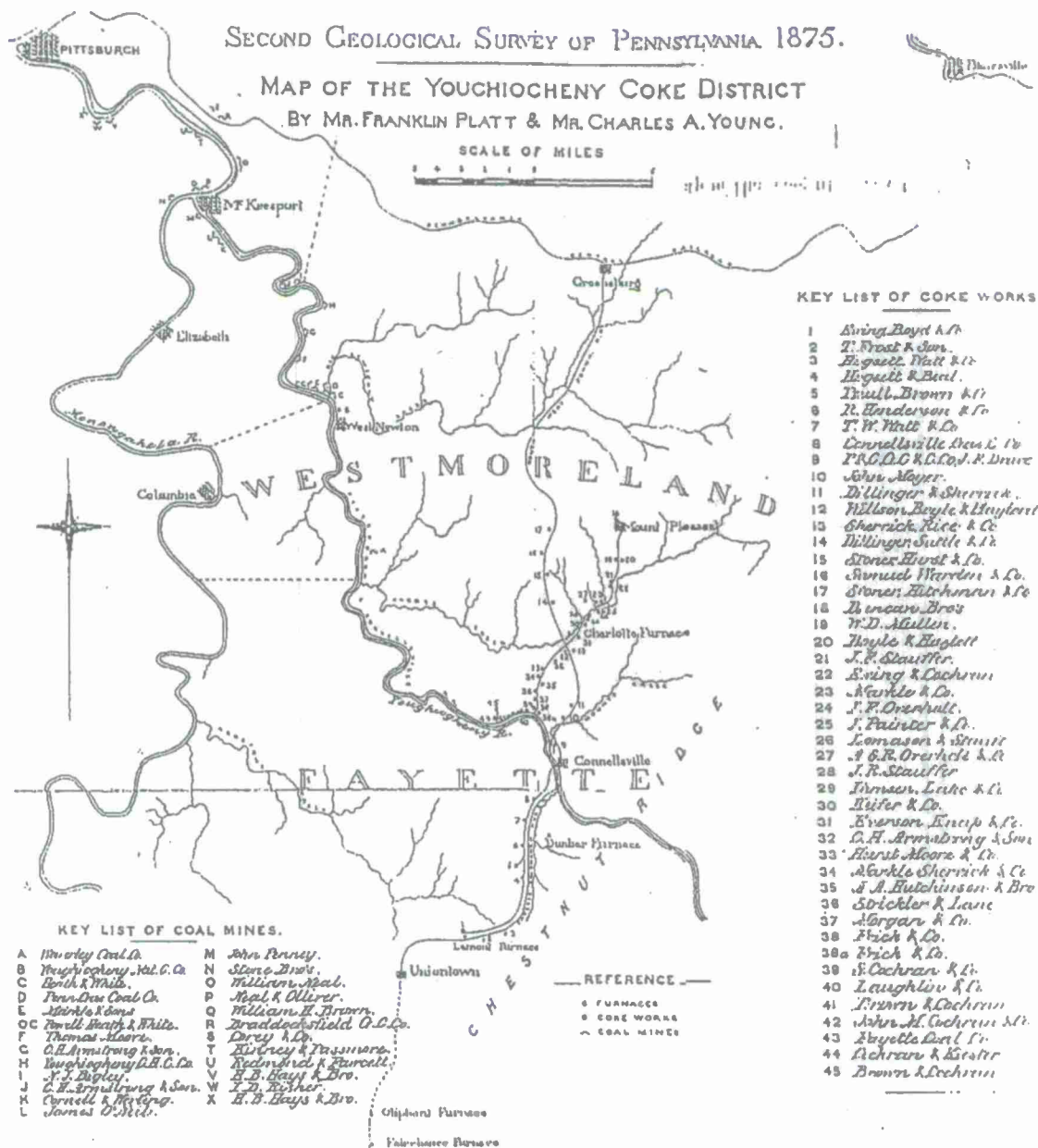


Figure 18. Coal mines and coke works in southwestern Pennsylvania in 1875. Although this was still relatively early in the development of the Connellsville Coke District, the proliferation of coke works is apparent. From Stevenson (1876).

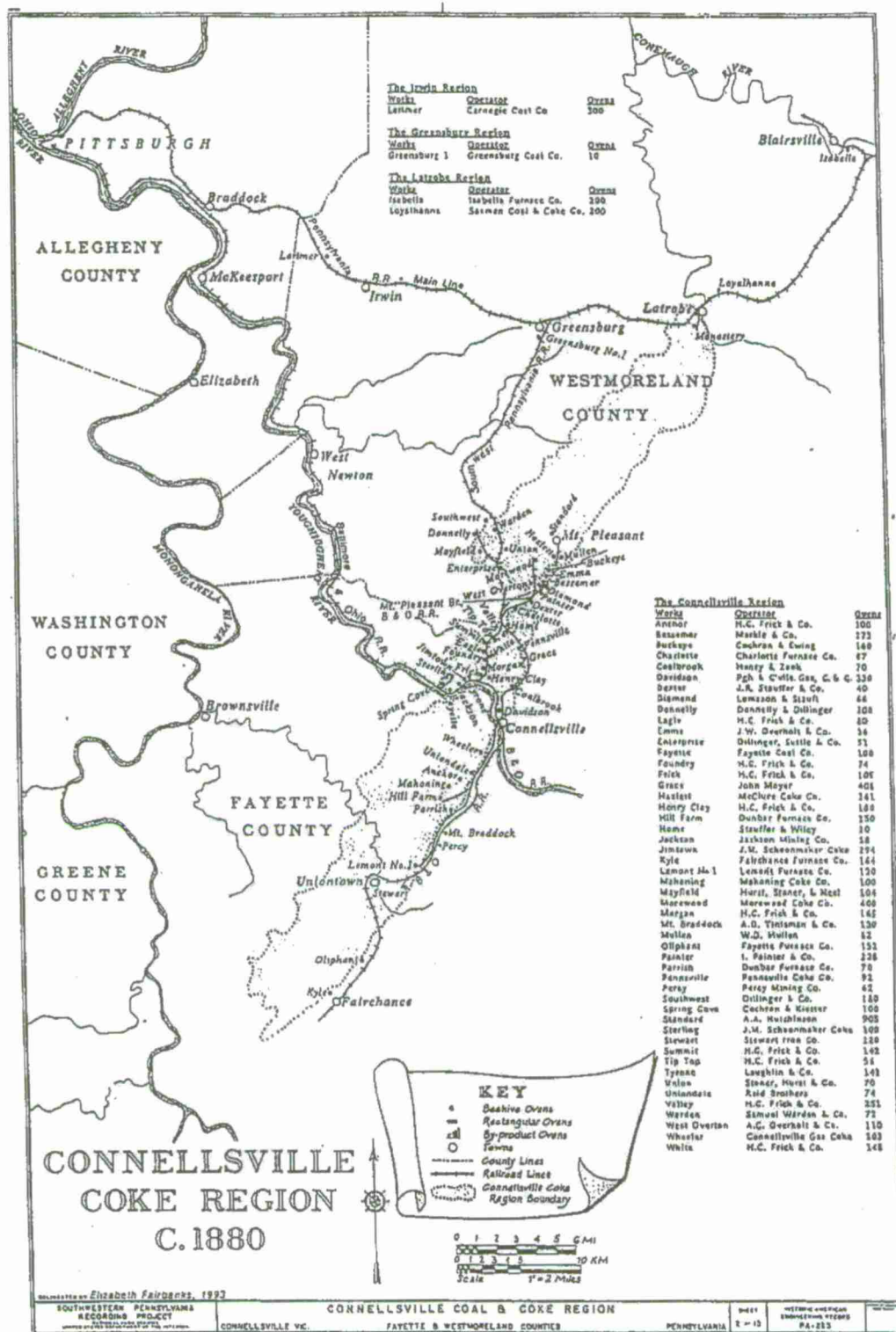


Figure 19. Development of the Connellsville Coke District by 1880. Drawn by the Historic American Engineering Record (HAER) and reproduced from DiCiccio (1996b: 71).

including the Southwestern Railroad (extended to Scottdale in 1872), served 4,245 coke ovens in the early 1880s (Albert 1882: 406-407, 409). All of these railroads as well as Monongahela River barges carried coke from the Connellsville area to the new iron-making center of the valley just upriver from Pittsburgh.

Railroads were essential to the exploitation of the Connellsville Coke District not only because the district was east of the Monongahela River but also because railroad cars had been integrated into the beehive coke-making process. Coal was dumped into the top of a battery of ovens built next to each other in long banks and "cooked" to reduce the coal to coke. When the process was complete, workers stationed in front of the coke batteries reached into each oven with long rods to pull the coke out, where it was transferred immediately into waiting railroad cars for transportation directly to blast furnaces.

Chief among the coke industrialists of Fayette and Westmoreland counties was Henry Clay Frick, born December 19, 1849 in West Overton, Westmoreland County. With a friend and a cousin, Frick formed Overholt, Frick, and Company in 1871 and began supplying beehive oven coke to Pittsburgh-area iron and steel mills from what started out as 123 acres of coal lands near Broad Ford, Pennsylvania.

Frick got in on the "ground floor" of the coke business. In 1870, the year before he began his firm, there were perhaps twenty-five coke ovens in the whole Connellsville area. By 1872 Overholt, Frick and Company had constructed about 200 coke ovens. During the economic downturn of 1873 that drove many of his competitors out of business, Frick borrowed \$10,000 from the Pittsburgh banking firm of Thomas Mellon & Sons, constructed more ovens, and bought out some of his rivals.

Frick's timing was perfect, as the Edgar Thomson steel works, begun in 1873 by Carnegie, McCandless & Company⁹ on 106 acres of ground along the Monongahela River at Braddock, Pennsylvania, had begun production of steel rails in 1875. With the growing demand for steel rails and the seemingly insatiable demand of the mill's Bessemer converters for coke, the Carnegie Brothers Steel Company of Andrew and Thomas Carnegie soon became Frick's best customers. As Frick was fond of saying, "coke's the thing they can't make steel without."

By the age of thirty-one, less than a decade after entering the coke business, Henry Clay Frick was a millionaire. He bought out his own partners in 1876, and the firm emerged

⁹This was a predecessor firm to the Edgar Thomson Steel Company, formed in 1874, and was succeeded by the Carnegie Brothers & Company, Ltd., formed in 1881. In addition to the Edgar Thomson works, to the west of Braddock Borough was the Chess, Cooke & Company nail mill (1887) that had previously been in Pittsburgh, Miller Forge Company's Duquesne Forge, a ten-pot glass factory, the Owen Sheeky & Company tannery, the Braddock Wire Company (which came to the area from St. Louis in 1885-86), the Carrie Furnace Company's eighty-foot high Carrie Blast Furnace, blown in on February 29, 1884, with an annual capacity of 50,000 tons. Finally, Union Switch and Signal Company's works and a then-abandoned car shop completed the industrial landscape of Braddock's environs ca. 1889 (A. Warner and Company 1889b: 125-126).

in 1882 as H.C. Frick Coke Company, the most important of the coke firms operating in southwestern Pennsylvania. By the 1880s, his company was shipping nearly 100 railroad carloads of coke a day to Pittsburgh mills, primarily the Edgar Thomson works. Frick became chairman of Carnegie Brothers Steel Company in 1889 but maintained his own coke firm as a separate corporation. The enormous wealth that coke brought to Frick enabled him to develop "Clayton," a lavish estate on South Homewood Avenue in Pittsburgh's East End and to pursue a lifelong passion for art collecting. In 1905 the Fricks moved to New York City, first to a Vanderbilt mansion and then to a new estate on Fifth Avenue at East 70th Street where Frick died in 1919.

In 1876 some 3,260 coke ovens could be found in the Connellsville area. By May 1879, that number had grown to 4,114, and by the early 1880s, there were some 8,091 beehive ovens in the Connellsville Coke District. In addition to this number, there were about 1,000 other ovens on the fringes of the coke district proper. Thus, by the early 1880s, there were perhaps 10,000 coke ovens in operation in and about the Connellsville Coke District (see Figures 18 and 19). Production averaged about 8.5 tons of coke per oven per week or, in aggregate, about 85,000 tons of coke per week for all the ovens then in operation. To put this production into some perspective, it was estimated that it would have required a single train of 250,000 cars extending almost 2,000 miles to carry the yearly output of the Connellsville Coke District (Albert 1882: 407), and this was during the early years of the district's industrial output.

The rapid growth and geographic spread of American railroads in the 1850s, 1860s, and 1870s created a need for hundreds of miles of affordable iron rails, and this need was met by the American anthracite and coke-iron industries. In thirty years, total American railroad miles more than trebled from just 30,000 in 1850 to 94,000 by 1880. It comes as a surprise today, but in 1849, only about 5 percent of all rails used in constructing American railroads actually were made in this country. The remainder were imported from Britain, whose iron industry had long since adopted coke as its principal fuel.

Pennsylvania saw the establishment of a number of rail-producing mills during the 1850s, including the Bethlehem Iron Company in Bethlehem, the Cambria Iron Works in Johnstown, and Jones and Laughlin in Pittsburgh. Four coke-fueled blast furnaces were constructed at the Cambria Iron Works. Together with the Great Western Iron Company on the Allegheny River at Brady's Bend, the Cambria works turned out about 15 percent of all the iron rails made in the United States between 1850 and 1860. The Cambria mill was the first to employ the "three-high mill" for rail production in 1857, but the technology quickly spread to other iron mills (Temin 1964: 114). By the mid-1850s, new American iron mills tended to be constructed west of the Allegheny Mountains and marked the movement of the epicenter in the American iron industry from the old iron-making centers in the East (Temin 1964: 119).

By 1860 the percentage of American-made rails had increased to about 32 percent, and by the end of the Civil War, to about 55 percent. In the 1870s and 1880s, the percentage actually dropped back to about 50 percent due largely to the development of steel rails. The

increase in American coke-iron production over these years lowered the cost of rails to the railroads. These lower costs in turn stimulated the construction of more railroad lines which increased the demand for still more iron rails, locomotives, railroad car wheels, iron bridges, and other metal products. The increased demand for iron products naturally required still larger supplies of coke as well as more coal, which more of the locomotives were now burning in preference to wood.

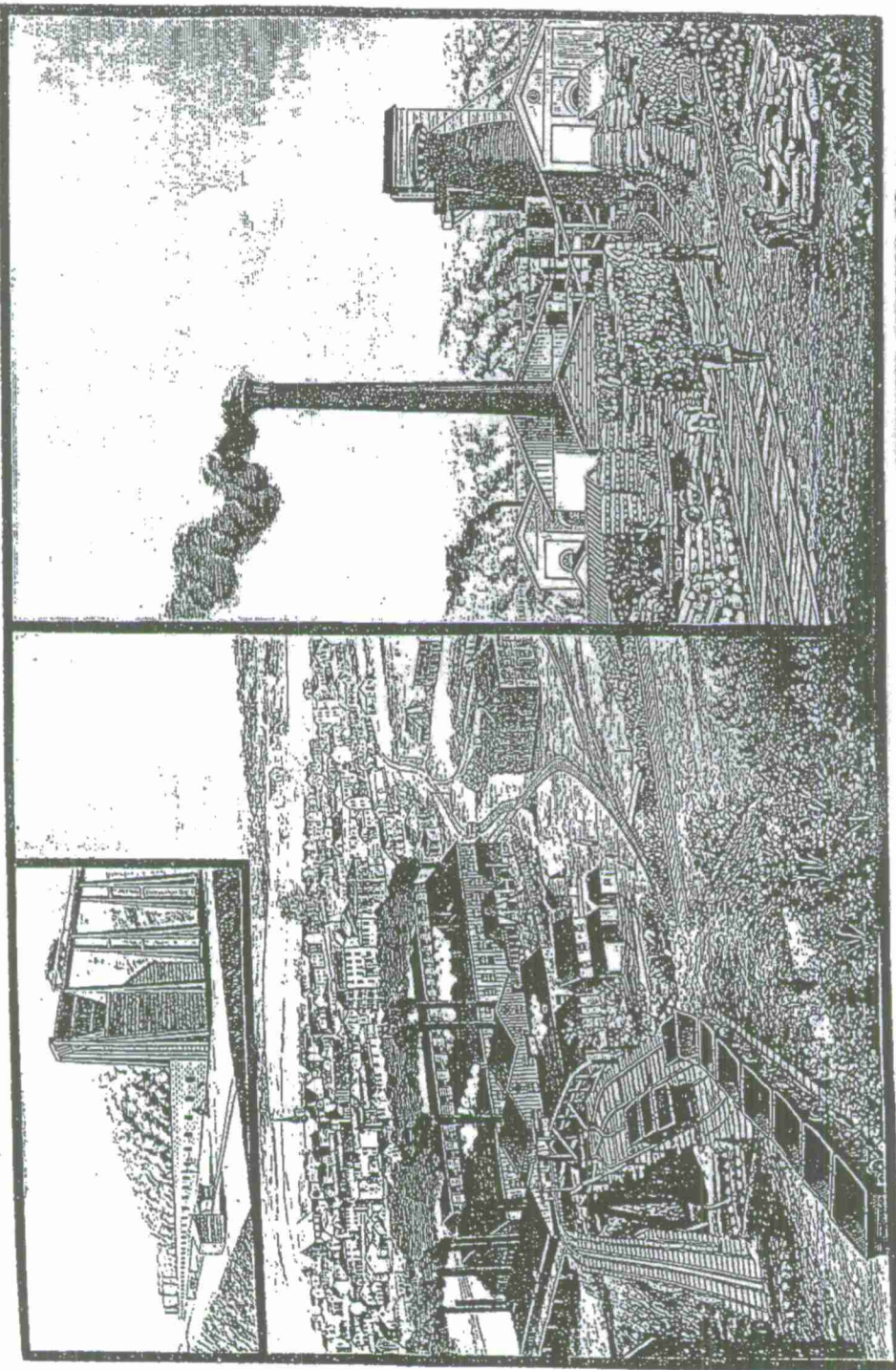
As the percentage of coke-produced iron increased, charcoal iron, the traditional favorite of many an American iron master, declined steadily. By 1866 it accounted for only about one-quarter of all American iron production. Although coke-iron grew in popularity in western Pennsylvania due to the proximity of the Connellsville Coke District, anthracite-fueled iron production remained dominant in the older more well-established mills in the eastern end of the state where anthracite coal was readily available. In fact, anthracite-iron continued to lead coke-iron production in Pennsylvania until the 1880s. Ninety of the 158 anthracite-fueled blast furnaces in the country in 1880 were in Pennsylvania, yet twenty years later, coke had almost entirely replaced anthracite in iron production. The old anthracite-using firms in eastern Pennsylvania had discovered that it was cheaper to bring coke from western Pennsylvania by rail and that coke-produced iron yielded a superior product (DiCiccio 1996b: 68).

Many iron manufacturers in Pittsburgh were separate business enterprises from similar ventures up the Monongahela and Youghiogheny river valleys, but some Pittsburgh iron producers found it useful to establish their rolling mills in the heart of the coke field rather than bringing the coke down-river to the mill. Everson, Preston & Company, for example, began a rolling mill in Pittsburgh in 1842, and it is a good example of the corporate integration that occurred in iron production and processing after the Civil War.

In 1872 a descendant firm, Everson, Graff & Company (later, Everson, Macrum & Company) established a rolling mill in Scottdale, Westmoreland County, shortly before the Southwestern Branch of the Pennsylvania Railroad reached the town that year (Figure 21). The firm purchased land for the construction of the mill, the construction of thirty houses for their workers, and for the erection of a store and began operations in 1873.

In 1872 Peter, Catherine, and Jacob Loucks had laid out the site of Scottdale in farm lands on both sides of the railroad's right-of-way. As the railroad was the premise for the town, the Loucks found it appropriate to name their creation after the railroad's president, Thomas A. Scott. However, the iron mill site, workers' houses, furnace, and store actually formed the nucleus around which the town subsequently developed. Annual mill production in 1873, its first year in operation, was 3,000 tons of sheet iron and 8,000 tons of muck-bar. A foundry was added to the Scottdale plant in 1875 and produced various castings that were used both by the Scottdale and Pittsburgh plants.

Two hundred workers were employed at the Scottdale mill works in 1882. Iron was supplied by the company's Charlotte Furnace, also built in 1873. The furnace, constructed on the former site of the Fountain Mill, employed seventy-five workers and produced thirty-



CHARLOTTE FURNACE CO.
(View looking South.)

SCOTTSDALE ROLLING-MILL.
EVENSON, MACRUM & CO.
(View looking North.)

Coke Ovens, Charlotte Furnace Co.
(Looking East.)

Figure 21. The iron rolling mill, coke ovens, and blast furnace of Everson, Macrum & Company in Scottsdale, Westmoreland County, Pennsylvania. From Albert (1882: between 682 and 683).

five tons of iron per day to start but later increased production to fifty-five to sixty tons. The company owned 112 acres of coal lands on Jacob's Creek that employed fifty miners. The mines produced 50,000 tons of coal per year for the company's fifty coke ovens and for other industrial operations.

The company also constructed its own railroad, the Greenlick Narrow Gauge Railroad, to connect its ore mines and furnace with the Mount Pleasant Branch of the B&O Railroad. The B&O branch provided a way of getting finished iron from the foundry and rolling mill to markets in Pittsburgh and beyond and also brought additional iron ore to the furnace from such diverse sources as Blair County, Pennsylvania, and Lake Superior.

Mills such as the one Everson, Macrum & Company began in Scottdale also spawned auxiliary and support businesses. A former employee at the company's iron furnace, T. C. Kenney, became a partner in the Hill and Kenney machine shop and brass and iron foundry at Scottdale, which specialized in the manufacture and repair of coke-making equipment (Albert 1882: 409-410; 682-683).

The Age of Steel

Steel is made using iron, and it is often erroneously assumed that it was a later development that replaced iron in the latter nineteenth century. Steel is iron in which the carbon has been first removed and then carefully added back in, sometimes with alloys. It has been known for centuries, but due to the difficulty of controlling the carbon content was made for centuries only in small quantities (Figures 22-26).

Early steel was produced by several processes. One was called cementation or blister steel. This was made by heating iron bars in powdered charcoal to a red heat and then allowing them to cool. In the process, the bars absorbed some of the charcoal, and a rather inconsistent form of steel was produced.

Shear steel was another type of early steel made by a process similar to that used for blister steel; however, it employed repeated heatings of the iron bars coupled with pounding to distribute the carbon more evenly throughout the metal. Early scissors used in the textile industry and other blades were made from this type of steel and gave it the name "shear" steel.

Still a third process for making early steel was the crucible method in which small batches of steel were melted in a small pot or crucible. This method, initially developed in mid-eighteenth-century England, was used to produce cutlery and blade tools and weapons (Bining 1954: 20-21).

In the early nineteenth century, most of the steel used in western Pennsylvania was imported from England, but blister steel was being made in Somerset County by 1803. On June 2, 1803, William M'Dermott informed the public that he had removed his blister steel

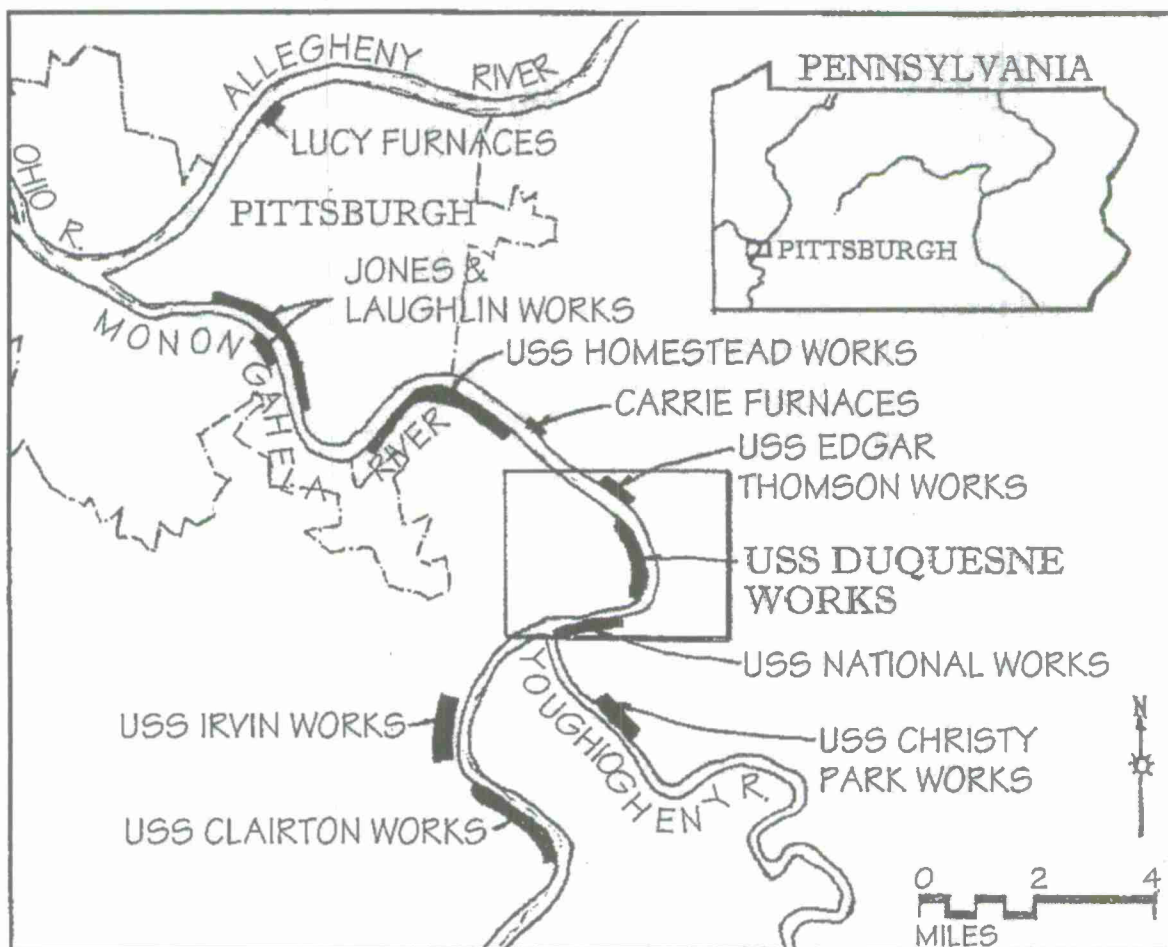
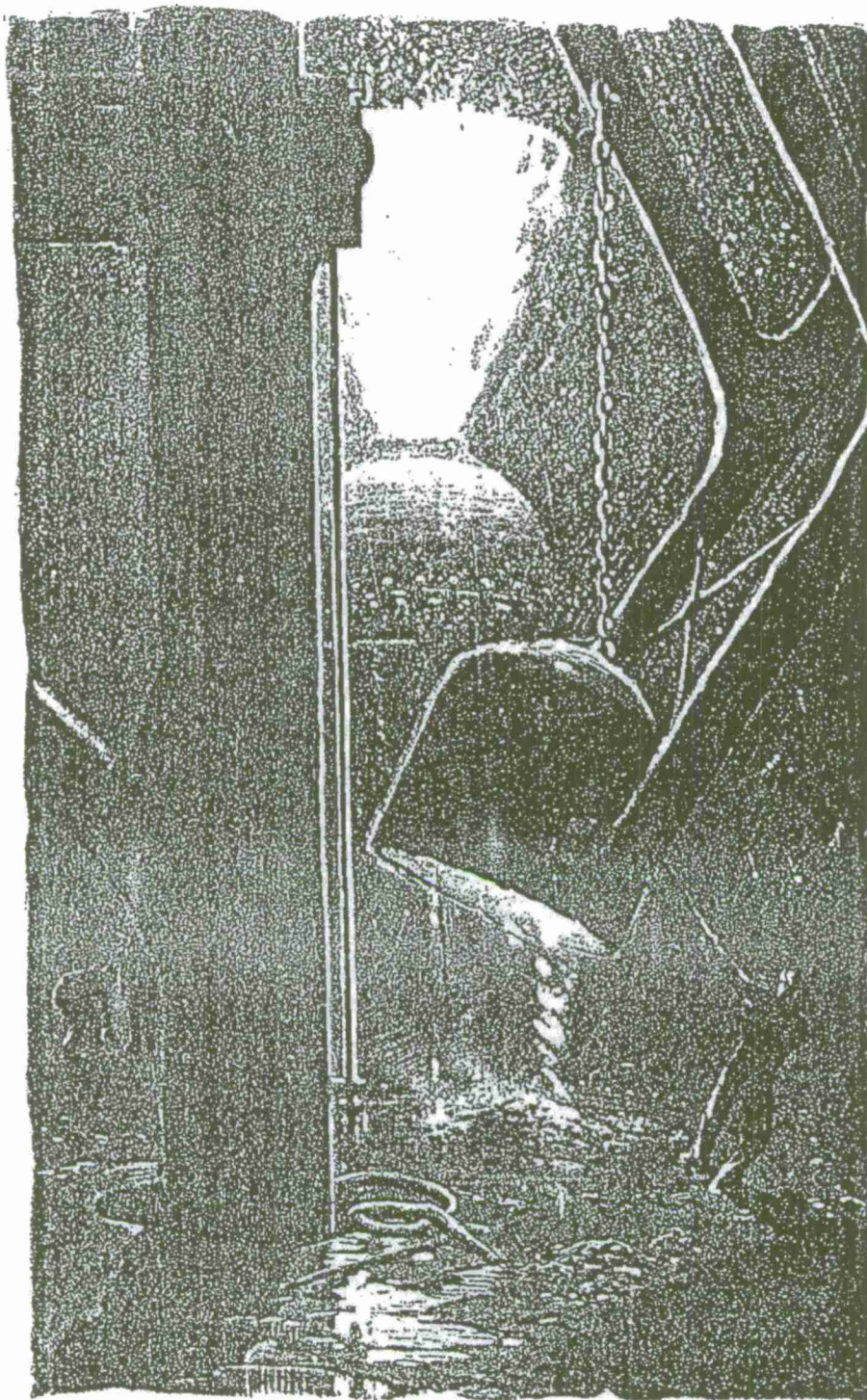


Figure 22. Iron and steel sites in the lower Monongahela River Valley in 1990. From Sabadasz (1992: 94, Figure 1). Drawing by Christopher Marston, Historic American Engineering Survey (HAER).



Courtesy of R. S. McClure Co.

Copyright by the R. S. McClure Co.

Figure 23. A Bessemer converter with air being blasted through the molten metal. From Bridge (1991: between 146 and 147).

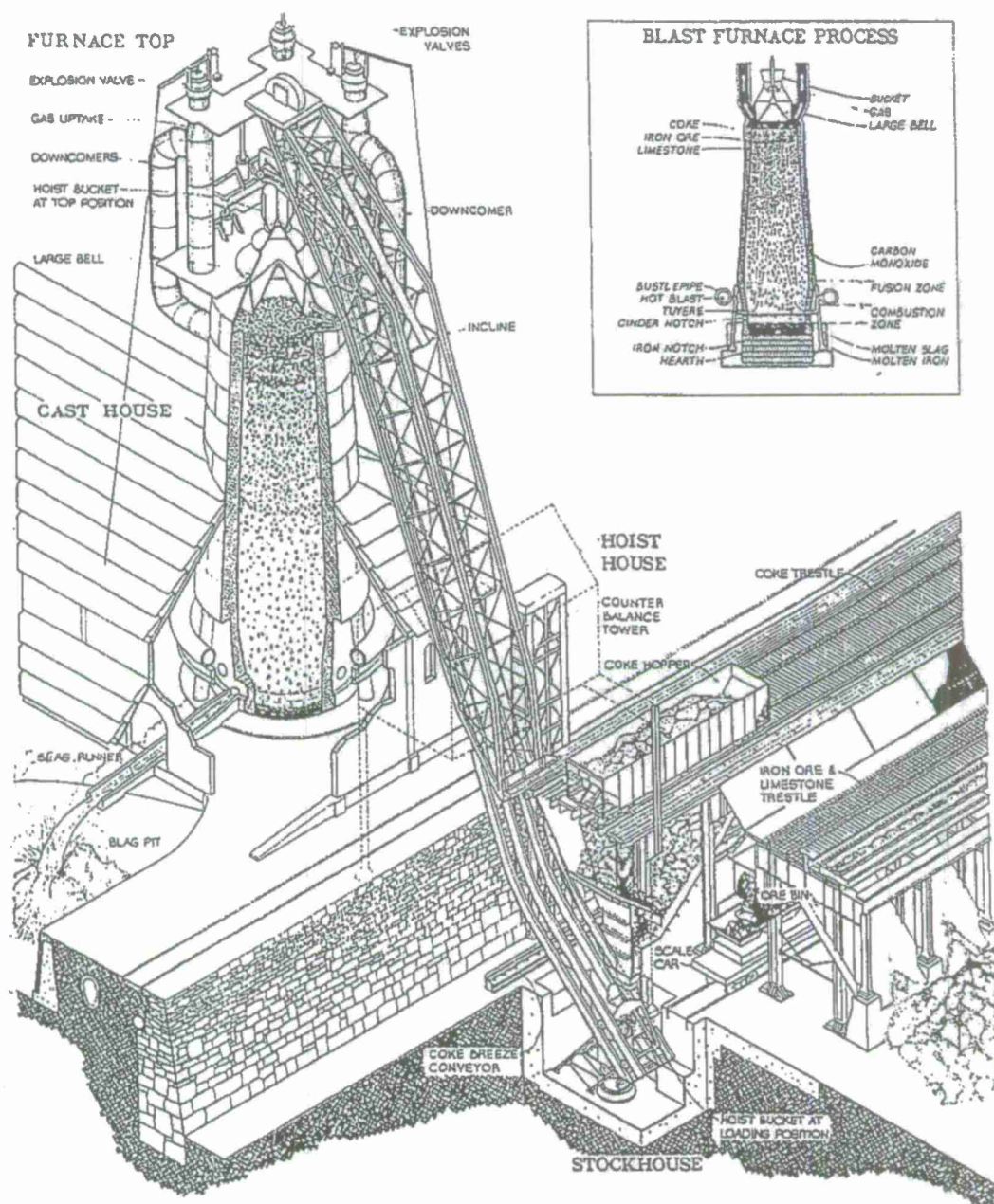


Figure 24. Isometric of Blast Furnace No. 1 at the Duquesne Works, Pittsburgh, in 1990. Drawing by Christopher Marston, Historic American Engineering Survey (HAER). Reproduced from Sabadasz (1992: 100, Figure 7).

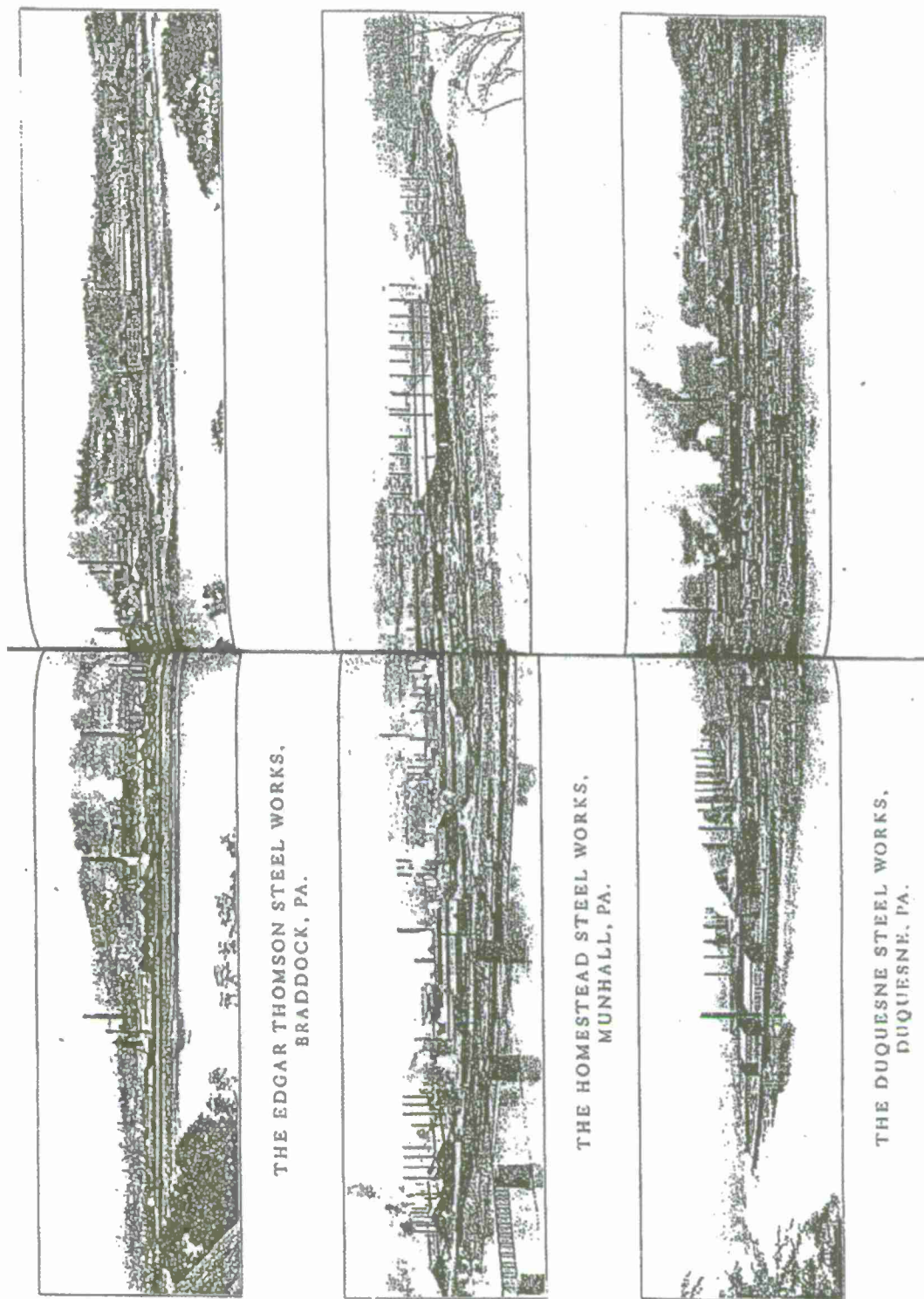


Figure 25. The three steel plants of the Carnegie Steel Corporation near Pittsburgh on the Monongahela River, Edgar Thomson, Homestead, and Duquesne. From Bridge (1991: between 146 and 147).

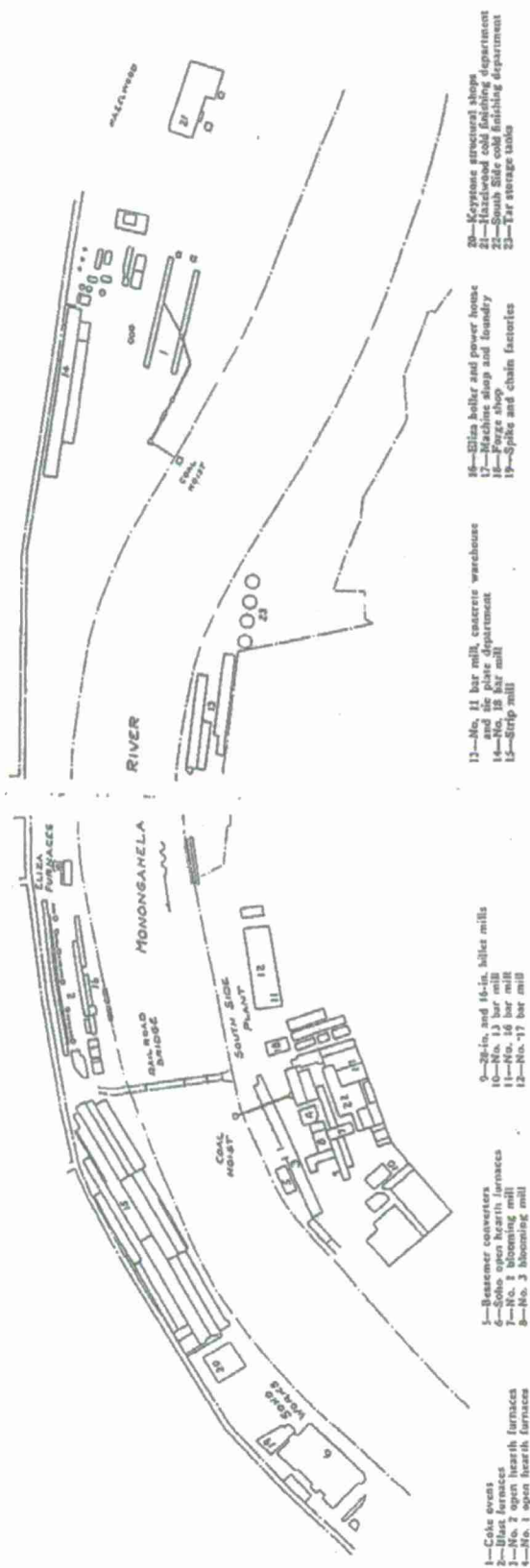


Figure 26. Layout of the Jones and Laughlin Steel plant at Pittsburgh in the early 1940s. From Longenecker (1941: 8-9).

manufactory from his Somerset County house to Bedford, where he intended to carry on his business in all of its various branches (Buck and Buck 939: 306).

According to the 1810 census, the Brownsville Steel Factory operated by Morris Truman and Company produced one and three-quarters tons of steel that year that was valued at \$467.00. The company produced edged tools in addition to basic blister steel (Buck and Buck 19139: 306). What seems like a very low output reflects how rare and difficult early steel was to produce in quantity.

Pittsburgh was the location of a number of important crucible steel mills. In 1859 the firm of Hussey, Howe, and Wells took over Pittsburgh's first crucible steel making operation, Blair & Company. Another important maker of crucible steel in Pittsburgh was the Park brothers' Black Diamond Steel Company (1862), which was built just above Andrew Carnegie's Union Iron Mills on the Allegheny River in Pittsburgh's Lawrenceville neighborhood.

A third important crucible steel maker in early Pittsburgh was the Sheffield Steel works, established in 1848. Crescent Steel, founded in 1867, became one of the city's most successful such steel making concerns (Ingham 1991: 40-42). By 1860 there were thirteen steel mills in the United States; nine of these were in Pennsylvania, and six of the nine were in Allegheny County. This single county was responsible for perhaps 10 percent of all the bar, sheet, and railroad iron produced in the country at that time (Keyes et al. 1991: 10).

What changed following the invention and implementation of the Bessemer process was a marked increase in the amount of steel that could be produced. The process involved blowing air through a charge of molten iron under pressure to remove its carbon impurities. The process was invented in 1856, but Henry Bessemer did not receive a U.S. patent on his process until 1865. Pittsburgh-born William Kelly developed a similar steel-making process almost simultaneously at the Suwanee Furnace in Kentucky. Bessemer and Kelly resolved the disputes over their processes and patents in 1866, which opened the way for the development of large-scale production of steel in the United States (Temin 1964: 127).

Adoption of the Bessemer/Kelly process was slow in coming, however. Three Pennsylvania plants—the Pennsylvania Steel Company in Steelton, the Freedom Iron and Steel works at Lewistown, and the Cambria Iron Company in Johnstown—were early producers of Bessemer steel, but widespread adoption of the technique did not arrive until the 1880s (Bining 1954: 21).

One of the most important consequences of the adoption of the Bessemer process for mass steel production was the related development of the steel rail. Steel rails could carry more weight than iron rails without deforming and therefore lasted much longer. Steel rails allowed larger railroad cars and engines to be built that carried greater freight loads. The older iron rails also could be torn up and recycled as scrap to produce the new steel rails, and this provided an additional incentive for the expanding railroad companies to adopt steel

rails. In 1867 the Cambria Iron and Steel Company at Johnstown, Pennsylvania, produced its first steel rails from ingots turned out by the Pennsylvania Steel Company.

In the 1880s, the invention of a mechanical rising and falling table allowed the Bessemer process to be used in combination with the three-high mill (invented in 1857 by John Fritz) for the production of steel rails. Carnegie Steel Company's Edgar Thomson works on the Monongahela River at Braddock, Pennsylvania, had an integrated production line for the manufacture of Bessemer steel rails in operation by 1888 (Ingham 1991: 36). At its production peak later in the nineteenth century, this mill could produce 3,000 tons of finished steel per day, roughly the equivalent of the annual production of a Pittsburgh-area iron puddling mill in the 1830s (Ingham 1991: 48).

The European Siemens-Martin open-hearth process for making steel was first employed in the United States at Cooper, Hewitt and Company's New Jersey Iron and Steel works in Trenton, New Jersey, in 1868, but the process did not gain wide use here until after 1885 (Temin 1964: 140). This process, an evolution of the older iron puddling furnace concept, required more time than the Bessemer process but produced a generally superior product as its contents could be monitored more carefully. Open-hearth furnaces could also accept a larger percentage of scrap iron in their charge than Bessemer furnaces, which lowered production costs to some extent (Temin 1964: 145). Fewer than 1,500 tons of open-hearth steel were produced in the United States in 1870, but the process gradually grew in acceptance, and by 1908 it had become the dominant steel-making process in the country. Between 1902 and 1906, the open-hearth furnaces in Pittsburgh had evolved to the point where they could produce a ton of steel forty-three cents cheaper than could be produced by the Bessemer process (Temin 1964: 143, Table 6.1).

Like the Bessemer furnace, the open-hearth furnace required a large amount of water during the steel-making process. This and the water requirements of coke plants provided another reason to locate the modern steel mills and by-product coke plants on or near major rivers. A 150-ton open-hearth furnace, for example, required approximately 2,800,000 gallons of water to cool its doors, frames, and burners during every twenty-four-hour period (Committee on Physical Chemistry of Steelmaking 1944: 18). Large amounts of water also were needed to quench the hot eoke as it was pushed out of the ovens and to cool the by-product eoke oven gas (Lankford et al. 1985: 346).

The development of the Bessemer and open-hearth methods of steel production placed a premium on the efficient and orderly procurement and transportation of raw materials to the steel mill, round-the-clock production of steel and steel products, and efficient transportation of those products to customers. Industrialists like Andrew Carnegie developed an approach to the vertical integration of steel making that emphasized tight control over all the steps (and therefore the cost) in the manufacturing process from raw materials to the distribution of finished product. With the opening of the great Mesabi iron ore range of Minnesota in 1890, Carnegie Steel Company, the predecessor to U.S. Steel Corporation (formed in 1901) even ventured into the operation of its own fleet of Great Lakes

“tin stacker” ore boats with red-painted hulls and silver smokestacks.¹⁰ The Pittsburgh Steamship Company, as it was officially called, eventually came to number 112 ships and barges, more ships than the U.S. Navy had at the time (Miller 1999: 12-13).

The integrated process that controlled all phases of steel making from ore to finished product and the speed at which steel could now be produced also required rethinking the organization and layout of industrial space. Blast furnaces increased in size, number, and the output of pig iron, which consequently enabled steel production also to grow to prodigious size. By 1890 the Edgar Thomson Works, originally supplied with pig iron from Carnegie’s Lucy Furnaces situated on the Allegheny River, had nine blast furnaces of its own, each of which was producing 330 tons of iron per day (Sabadasz 1992: 97).

Instead of blast furnaces and rolling mills being spread out along the Monongahela River Valley, as they often had been in the early years of the iron industry, a premium was now placed on erecting each of the elements in the steel-making and finishing process—blast furnace, coke oven, Bessemer furnace, rolling and other types of mills—close to one another so that transfer time among them was not wasted. Steel mill operations became much larger in size and industrial complexity. The physical layout of mills was rationalized so that raw materials “came in” one end and steel “came out” the other. The lower Monongahela River was transformed into an industrialized corridor of large steel mills and the smaller industrial businesses that supported them. The amount of iron and steel produced in Allegheny County mills increased from 757,273 tons in 1880 to 8,203,715 tons in 1900 when the Carnegie Steel Company, the area’s single most important producer, controlled 25-35 percent of the nation’s steel production (Keyes et al. 1991: 11).

Carnegie and his associates, perhaps more visibly than any other industrialists of their time, instituted tight controls over production costs, implemented new technological advances as they were developed, and pushed both workers and blast furnace to their limits, a process aptly called “hard driving.” Twelve-hour shifts six days per week were the norm for workers in a Carnegie-owned mill.

Carnegie also expanded his company’s capabilities and capacities and simultaneously reduced competition by acquiring rival firms. In 1883, for example, he bought the Pittsburgh Bessemer Steel Company’s works at Homestead, Pennsylvania, and converted it from a rail mill to a producer of a relatively new product line, structural steel. Four years after its acquisition by Carnegie the Homestead plant’s two Bessemer converters were producing 19,572 tons of ingots per month and as much as 915 tons in a single day (Ingham 1991: 66).

¹⁰A major drawback to the use of the Bessemer steel making process was the high phosphorous content of most iron ores then in use. The ores of the Mesabi range, however, and other ore deposits discovered earlier in Michigan were free of phosphorous. As Carnegie determined, the combination of phosphorous-free ores and the Bessemer process made modern steel making on a very large scale possible. The Edgar Thomson steel works on the Monongahela River was built soon after Carnegie had traveled to England in 1872 to see the Bessemer process in operation. Carnegie, who already was established in the Pittsburgh iron industry, soon made the switch to steel making and never looked back. Another Pittsburgh industrialist and Carnegie associate, Henry W. Oliver, was closely allied with Carnegie in the exploitation of the Great Lakes iron ore deposits.

Carnegie added the Duquesne Steel Company, located about five miles up the Monongahela from Homestead, about half the distance to McKeesport, in 1889 and just three years after the Bessemer mill had been built. Duquesne was a fully modern steel plant and was equipped for continuous casting of steel rails, an advanced and then unheard-of technology in the United States though it had been implemented in England. Continuous casting was a vital technological change in steel manufacture as it allowed ingots to be pressed into shapes without the costly and time-consuming necessity of re-heating them (Ingham 1991: 69).

By building the Edgar Thomson works and acquiring Homestead and Duquesne, in the few short years between the mid-1870s and 1889 Carnegie assembled an industrial juggernaut that quickly turned the Lower Monongahela River Valley into the steel making capital of the country. In 1892, the year of the mill workers' revolt at Carnegie's Homestead mill, American steel production surpassed that of iron for the first time (Sisson 1992: 79).

By the early twentieth century, virtually all of the Lower Monongahela River flood plain above Pittsburgh had been affected by industrialization and the construction and expansion of steel mills. Jones and Laughlin's blast furnaces, rolling mills, wharves, train yards and worker housing occupied large tracts on both sides of the river nearest Pittsburgh. Upriver were the Homestead, Edgar Thomson, and Duquesne works of United States Steel, the first one billion dollar company, formed in 1901 by financier J. P. Morgan with the former Carnegie Steel Company at its core. Farther upriver, other mills were found at McKeesport, Donora, and Monessen, and many other towns (Keyes et al. 1991: 9; Magda 1985). To the west, the lack of additional land in the Monongahela River Valley had forced industrial entrepreneurs to develop other areas such as McKees Rocks on the Ohio and Mansfield (later re-named Carnegie) on Chartiers Creek into densely populated "industrial suburbs" (Couvares 1984: 81).

The late nineteenth-century expansion and mechanization of large-scale steel making as exemplified by the Carnegie Steel Company had other consequences. First and foremost, it undercut the traditional expertise required of individual workers. In distinction to the highly skilled work force in iron mills and crucible steel works, far fewer skilled (and unionized) workers were needed in the new Bessemer steel plants. More semi-skilled and unskilled, lower-paid labor now sufficed, and the lower wages these men (typically, recent immigrants from Eastern Europe) received helped to keep steel prices low and therefore affordable for a wider range of consumers, primarily the railroads.

The Competition Between the Railroads and Water Transportation

Prior to the passage of the Federal Control Act of 1918, there was little incentive for the coordination of rail and inland river transportation. Indeed, rail and water competition in the second half of the nineteenth century was fierce and usually involved rate cuts on the part of the railroads. The expansion of the American railroad system after the Civil War had a great and adverse impact on the amount of freight carried on the Mississippi River system, to cite one example. Rail freight carried to New Orleans in 1873 amounted to just 464,000 tons,

while in 1887 rail traffic had grown some 500 percent to 2,091,000 tons. The value of freight received by river at New Orleans during this same period dropped from \$144,000,000 in 1873 to \$59,300,000. Receipts for freight shipped by rail and canal in 1887, on the other hand, amounted to \$105,000,000 (U.S. Department of Commerce 1923: 40).

Although hard figures are difficult to come by, the estimated value of river commerce on the Ohio River also declined, for the most part, during the railroads' period of great expansion. Among ten cities on the river between Pittsburgh, Pennsylvania, and Cairo, Illinois, only Louisville, Kentucky, had a greater estimated value of its river trade in 1886 than in 1869. Pittsburgh's value in river trade declined from an (over-estimated) \$150,000,000 in 1869 to \$64,750,000 in 1886 (U.S. Department of Commerce 1923: 44).

The water-rail competition played itself out in a number of ways. Both cut-throat competition and a modicum of cooperation were emphasized at various times. As an example of cut-throat competition and arm twisting, the Cullom Committee on interstate commerce found in 1886 that the New York Central Railway had coerced other railroads connecting with it into declining freight transfer connections with the Erie Canal. In other cases, the railroads responded to potential competition from water carriers by setting up their own water routes.

Water-rail connections were absolutely essential to the operation of the Great Lakes commerce in iron ore and wheat (moving east) and coal (moving west). The railroad companies, however, came to dominate the ownership of the passenger and freight traffic on the Great Lakes, as the Windom Select Committee determined as early as 1874. A similar situation prevailed in the early twentieth century. In yet other cases, a measure of cooperation between water carriers and railroads prevailed. By 1908, for example, the Inland Waterways Commission determined that many of the Pittsburgh-based boat lines then operating on the Ohio and Mississippi River systems had worked out pro-rated freight schedule agreements with connecting railroad lines (U.S. Department of Commerce 1923: 9).

Water commerce interests were successful in getting the Mann-Elkins Act passed in 1910. It stipulated that once a railroad carrier had reduced its rates between two points in order to compete with water transportation it was then not permitted to raise those rates again unless it could show that the increase was the result of factors other than the elimination of water competition.

The federal government also began to play a much larger role in regulating the competition between water and rail carriers. After 1912, for example, the Interstate Commerce Commission had the authority to establish the rules, routes, and maximum through-rate charges for freight moving by combined water and rail routes. The Commission also obtained jurisdiction over the establishment of rail-water transfer terminals. This was important to the water carriers in their growth along the flat river valleys because the railroads often had obtained title to waterfront property and had prevented the construction of water docking facilities (U.S. Department of Commerce 1923:8-10).

The Federal Control Act of 1918 established what eventually became known as the Division of Inland Waterways within the Railroad Administration. This division was charged with working out the problems of connecting rail and water transport, establishing rail and water transportation through-routes, and determining fair transportation rates. This legislation as well as the Transportation Act of 1920 and the Interstate Commerce Act attempted to "...break down the legislative wall hitherto built up between the transportation service by water and the transportation service by rail..." (Bureau of Railway Economics 1930: 74).

By the 1920s and 1930s, the Monongahela River occupied a unique position among the country's rivers due to the wealth of mineral and industrial businesses erected along its course and to the program of lock and dam construction and maintenance that had turned the river into a veritable "industrial canal." The volume of freight carried on the nation's railroads doubled between 1906 and 1929, but the freight tonnage carried on the Monongahela River then exceeded that of any other single river in the country.

In 1922 the federal government set up the Federal Barge Line to stimulate the development of commerce carried on the Mississippi River and also allocated \$42,000,000 for navigation improvements on the Ohio River (Hogan 1971: 1367). Increased freight commerce on the Monongahela and the completion of the federal government's 981-mile long \$118,000,000 Ohio River navigation system from Pittsburgh to Cairo, Illinois (opened on October 11, 1929), resulted in a 55 percent increase in river freight commerce in the Upper Ohio River drainage between 1925 and 1929 (Engineer's Society of Western Pennsylvania 1930: 153).

The Monongahela was one of the few rivers in the country that showed an increase in the amount of freight carried in the face of railroad competition. Between 1892 and 1920, river traffic on the Monongahela increased from 4,163,304 short tons to 24,264,354 tons (U.S. Department of Commerce 1923: 45). Coal and coke made up the great bulk of this traffic (85 percent of total river tonnage in 1928), but many of the iron and steel companies also constructed docks and their own barges to move their raw materials and finished products.

The tonnage carried on Pittsburgh's rivers more than doubled between 1913 and 1926 (from 18,000,000 tons to 36,343,668 tons; Harper 1931: 679). Still, iron, steel, and other metals transported on the river between 1924 and 1928 made up just 7.6 percent of the amount contributed by coal and coke (Tables 4 and 5; Bureau of Railway Economics 1930: 102, Table 17). After coal and coke, sand and gravel contributed the most to the area's river commerce. In 1931, Pittsburgh's water-borne commerce was larger than that of the Panama Canal's (Harper 1931: 679).

In stark contrast to the Monongahela River, by 1920 the Allegheny River was no longer considered to be a significant carrier of commerce. In 1921 the Allegheny carried only about 25 percent of the tonnage of sand, gravel, coal, and metal products that was transported on the Monongahela (U.S. Department of Commerce 1923: 45).

Table 4
Total Tons of Coke Transported on the Monongahela River for 10-Year Periods, 1901-1951

| Years | Tons |
|-----------|-----------|
| 1901-1910 | 397,306 |
| 1911-1920 | 2,796,185 |
| 1921-1930 | 7,756,265 |
| 1931-1940 | 7,410,624 |
| 1941-1950 | 6,463,075 |

Source: Compiled from U.S. Army Corps of Engineers Annual Reports, 1902-1951. Earlier shipping records do not separate coke from coal. Record-keeping for coke shipments from 1901-1916 is inconsistent. No records were identified for 1904, 1915, and 1919.

Table 5
Total Tons of Metals and Metal Products Transported on the Monongahela River 1885-1951

| Years | Tons |
|-----------|------------|
| 1885-1896 | 461,095 |
| 1901-1910 | 1,226,493 |
| 1911-1920 | 1,888,949 |
| 1921-1930 | 8,677,337 |
| 1931-1940 | 8,374,249 |
| 1941-1950 | 13,349,125 |

Source: Compiled from U.S. Army Corps of Engineers Annual Reports, 1902-1951. Figures from 1897-1900 annual reports not identified. No figures available for 1904, 1907, 1913, and 1919.

Not apparent from the gross figures given in Table 5 is the fact that steel rails accounted for most of the river tonnage in metals between 1885 and 1902. Steel rails transported by river ranged from a low of 10,688 tons in 1888 to a high of 91,930 tons in 1902. As a percentage of metal and metal products moved by river transport, steel rails then fell off sharply. In 1918 only 307 tons of them were moved by riverboat, according to figures in the U.S. Army Corps of Engineers Annual Reports.

In contrast, relatively small amounts of iron ore were transported by river between 1885 and 1890. In 1885 16,846 tons are reported. This figure grew slightly in the next two years and then began to drop to 2,335 tons in 1890. Only minor amounts of pig iron are recorded for the years 1885-1891. The drop in the tons of steel rails that were carried by water transportation after 1902 was offset by an increase in the category of "other iron products." In 1902 this unspecified category contributed 43,952 tons to the river's commerce, but the next year, the figure had climbed to 100,643 tons.

In 1920 535,597 tons of steel products worth \$41,368,560 were moved on the Monongahela River. In 1928 an all-time high of 1,774,024 tons were carried before the numbers began to retreat somewhat during the 1930s. The 1,000,000-ton mark was exceeded again in 1939 and persisted throughout the first four years of the Second World War. Between 1941 and 1945, some 6,703,094 tons of steel and steel products were transported on

the Monongahela River. These figures declined somewhat in 1946 and 1947, but climbed again to over 1,000,000 tons annually every year from 1948 through 1951.

The "Pittsburgh Plus" Pricing System and Its Effect on Water Transportation

Pittsburgh and Monongahela River Valley industrial firms showed renewed interest in river shipping during the 1920s due to the demise of a price basis system known as "Pittsburgh Plus." Under this system the price of a commodity, say, a ton of steel, was based on the price in Pittsburgh plus an average freight rate. National Tube Company, located in McKeesport, for example, priced its tubing F.O.B. ("free on board") Pittsburgh in 1900.

Different segments of the iron and steel industry adopted "Pittsburgh Plus" at different times. Before the 1870s, prices were usually determined F.O.B. at the mill at which they were produced. For structural steel, Pittsburgh Plus pricing was adopted in the mid-1880s. Steel billets went on the system in 1896, and after 1900 Carnegie Steel Company priced its sheet products under the system. Makers of steel bar used the pricing system after 1902, nail makers after 1904. 1907 saw a panic in the American steel industry as well as severe problems with congestion and delays in the nation's railroad system. After 1907 the American steel industry as a whole entered a period of relative cooperation rather than the intense competition of previous years and generally followed the price lead of U.S. Steel Company, most of whose mills were in Pittsburgh.

Under Pittsburgh Plus, a steel consumer in the Midwest would pay the same price for steel as another consumer much closer to the point of manufacture. Similarly, the Midwest consumer would pay the Pittsburgh price for steel manufactured, say, in Chicago plus the freight rate as though the product had come from Pittsburgh—"phantom freight" as it was called. This pricing system developed as a way of keeping older, more established eastern industries competitive with newer plants in the growing population centers of the Midwest and West. The phantom freight rates also supplied additional capital to help finance the construction of the newer and more costly mills, or at least that was one justification.

The pricing system also meant, however, that some customers were overpaying for shipment by railroad. Under such a noncompetitive system, there was little incentive on the part of the iron and steel industry to utilize water transportation over railroads since there was no real industry competition to keep freight prices low. Thus, the lower transportation costs that river transportation offered were factored out, and most iron and steel freight moved by the faster and more direct rail routes from the 1880s to the early 1920s even though rail freight rates were rising during the early twentieth century. The cost to ship one ton of steel from Pittsburgh to Chicago in the period 1907-1911 was \$3.30. This rose to \$4.30 by late 1917 and to \$7.60 in August 1920 (Warren 1973: 199).

There is little doubt that Pittsburgh Plus continued to give Pittsburgh and Upper Ohio River Valley producers in general a competitive advantage over distant producers for some years. In cases where Pittsburgh prices were not applied, steel railroad mills, for example, Pittsburgh-area mills quickly lost the market to more advantageously situated rail mills

farther west. Allegheny County mills produced 21.4 percent of the steel rails in the nation in 1906, for example, but only 12.4 percent in 1914. For other finished steel products, where Pittsburgh Plus was applied, these same mills produced 29.9 percent of the national average in 1907 and 24 percent in 1914—a decline but much less than for steel rails (Warren 1973: 197, Table 68).

Naturally, many consumers opposed the Pittsburgh Plus system, especially distant consumers who otherwise could buy locally-produced steel more cheaply. Rival or start-up producers also balked at charging Pittsburgh prices when they might gain additional business by offering local consumers a better price. Steel prices were lowest to Pittsburgh-area consumers, but as rail freight rates continued to grow, so did the burden of paying Pittsburgh prices for a consumer distant from that city.

In 1920 a Pittsburgh-area steel fabricator could purchase steel for \$7.60 per ton less than his rival in Chicago. The difference was in the freight cost. Pittsburgh steel itself then actually cost more than an equivalent amount made in the more modern and efficient Chicago plants. The Pittsburgh Plus system thus made Pittsburgh businesses competitive for contracts in the Midwest, but it greatly increased the cost of buildings, ships, farm tractors, and anything else made of steel in the Midwest.

Opposition to Pittsburgh Plus pricing evolved in the early 1920s largely out of the great growth that occurred in Midwestern industry during World War I. The “Western Association of Rolled Steel Consumers for the Abolition of Pittsburgh Plus” was formed in January 1919. At first, the association only sought the restoration of Chicago as the price basing point for the Midwest, which had been imposed as a temporary measure by the War Industries Board in 1918.

The Federal Trade Commission initially refused to get involved in the dispute, but in September 1920, rail freight rates increased 40 percent and added fuel to the association’s resolve to dismantle Pittsburgh Plus. Finally, the Federal Trade Commission ordered U.S. Steel Corporation to abandon Pittsburgh Plus in July 1924. It was replaced by a multiple-point price basing system.

The combination of the sharp rail freight price increases and the dismantling of Pittsburgh Plus encouraged steel producers to look to water transportation as a way of competing with more advantageously positioned steel mills. The American Rolling Mill Company of Middletown, Ohio, published a tract (American Rolling Mill Company 1923) on the benefits offered by water transportation while reminding its readers of the inadequacy of the nation’s railroad lines—a “lack of balance between our producing and our distributing agencies” as they put it (American Rolling Mill Company 1923: 11).

To the authors of this tract, the waterways were simply indispensable to the nation’s business. By their reckoning, and given what they considered to be the inadequate state of rail service at the time, the country’s waterways had carried some 256,496,113 tons of freight

in 1920, the equivalent of some 8,550,000 rail car loads. In their eyes, every ton of steel shipped by boat was one less ton likely to be delayed on a railroad siding.

Before the Federal Trade Commission's ruling, Jones and Laughlin initiated a trial river shipment of steel from Pittsburgh to New Orleans in October 1921, an event regarded at the time as

... an historic event throughout the Ohio and Mississippi Valleys. The tow was hailed by river men, merchants, manufacturers and newspapers as "The Steel Argosy," and predictions were made that it would usher in a new transportation era as far as the steel industry is concerned (Harper 1931: 681).

Company customers in Parkersburg, Huntington, Louisville, Evansville, Cairo, and St. Louis were thereafter supplied by river shipments. In the early 1930s, J&L had eight steamboats in its fleet plus 227 barges of various sorts.¹¹ J&L constructed major warehouses at Memphis and Cincinnati in 1924 and 1926. Both of these terminals were equipped with cranes to transfer the loads of steel from water to rail. The Memphis warehouse handled seamless and welded pipe that was transferred to rail for shipment to Texas and Oklahoma oil fields. It also received other finished steel products by river that were then shipped by rail throughout the Southwest.

The process of shipping steel by river barge from mills along the Monongahela River was greatly facilitated by the Corps of Engineers' completion of the lock and dam system on the Ohio River, a project that began in 1879. By the middle of 1929—the year that the Corps finished the Ohio River work—two J&L barge tows a month—about 20,000 tons of steel—were being sent down the river, and the company reckoned several years later that it was saving \$2.00 to \$3.00 per ton shipping steel by river rather than by rail. J&L was generally regarded at the time as having taken the lead among Pittsburgh-area steel firms in river shipping. In 1928 J&L even undertook an experimental tow of steel from Pittsburgh to Minneapolis, Minnesota. The section of the trip from Cairo, Illinois, to Minneapolis was completed by the Inland Waterways Corporation, a barge line operated by the federal government.

U.S. Steel began to ship steel by river in 1922 (Warren 1973: 204). In 1923 it was building a waterway terminal at Munhall, Pennsylvania, on the Union Railroad Company line (which it owned) where its steel products were to be concentrated for loading onto barges (American Rolling Mill Company 1923: 77). This terminal had a gantry crane with a double hoist of fifteen tons capacity, a magnet, and chutes for transferring cement from railroad cars to river barges. A company terminal at Duquesne, Pennsylvania, was equipped with five electric locomotive cranes, each with a capacity of five tons. In addition to Clairton,

¹¹These included three wooden barges, 198 open steel barges, ten closed steel barges, two tank barges, two car ferries and twelve barges of other kinds, not specified. U.S. Steel and J&L had the largest industrial fleets on the river at the time. Other companies that had their own river fleets included Crucible Fuel Company, Hillman Transportation Company, Pittsburgh Coal Company, Pittsburgh Plate Glass company, Union Barge Line, and Wheeling Steel Company. In all, these firms plus U.S. Steel and J&L operated 48 towboats and 1,007 steel and wooden barges. See Engineers' Society of Western Pennsylvania (1930: 163).

Munhall, and Duquesne, the company also maintained river terminals at Bessemer, Pennsylvania, at its blast furnace locations in Pittsburgh and Etna, at a warehouse on the north side of the Ohio River at Pittsburgh and at Bellaire and Mingo Junction in Ohio.

U.S. Steel also operated a number of river dock facilities that handled coal shipments from the company's Monongahela River mines. The H.C. Frick Coke Company's Colonial Dock forty-eight miles up the river from Pittsburgh, for example, was equipped with a conveyor belt system that brought coal excavated from mines six miles inland the company's waiting barges. This dock facility then had the longest operating conveyor belt system in the world.

In a little over eleven years, U.S. Steel built up the largest fleet of Pittsburgh-area river boats and barges and probably carried the greatest tonnage of any of its steel producers. Originally U.S. Steel developed the river fleet to carry coal to the company's by-product coke ovens situated on the Monongahela River at Clairton. This was then the largest by-product coke plant in the world, producing about 30,000 tons per day in the early 1930s. Situated along the river at the Clairton plant were four double hoists (each equipped with two six-ton grab buckets) for unloading the barges onto conveyor belts that carried coal to the coking ovens. Clairton also had equipment that was used to pump acid out of barges and for pumping creosote and tar (recovered in the by-product coking process) into barges for subsequent shipment to customers.

River craft also were used to move coke, steel plate, bars, ingots, pig iron, molds, scrap metal, stirring rods, and blast furnace flue dust among various U.S. Steel Company mills situated on the Monongahela, Allegheny, and Ohio rivers (e.g., to the American Bridge Company plant at Ambridge, Pennsylvania, and to plants at Bellaire and Mingo Junction, Ohio). Barges also transported materials to water-rail terminals where they were shipped by train to other U.S. Steel facilities. A monthly Pittsburgh-to-New Orleans tow was in operation in the early 1930s while daily boat trips were made from the company's captive coal mines up the Monongahela to the Clairton coke plant and the steel plant at Duquesne, Pennsylvania, also on the Monongahela River. The company also established a major presence in Houston, Texas, with the construction of a major terminal. A single river tow from Pittsburgh to New Orleans in the late 1920s and early 1930s might involve thirteen to seventeen barges loaded with 12,000-14,000 tons of steel. The trip took thirteen to twenty days to complete (Engineers' Society of Western Pennsylvania (1930: 164).

In the early 1930s, U.S. Steel's river fleet included fourteen steamboats and four motorized towboats. Two of the steamboats, the *City of Pittsburgh* and the *Monongahela*, were used for long-distance hauling down the Ohio and Mississippi rivers. Others steamers in the fleet at that time included *W.H. Clingerman*, *W.G. Clyde*, *A.O. Ackard*, *H.D. Williams*, *Donora*, *Allegheny*, *Youghiogeny*, *William Whigham*, *Edgar Thomson*, *Clairton*, *Isthmian*, and *Homestead*. The company's fleet also had 449 barges. Among these were twenty-six cargo barges and two barges for carrying acid (Harper 1931: 679-681).

Another valley steel plant, Pittsburgh Steel, with its major plant at Monessen on the Monongahela River, was shipping about 40,000 tons of steel per year by river in 1925-1926, and the company acquired its own barges and warehouses in St. Louis and Memphis. Pittsburgh Steel was an integrated independent steel producer that had begun operations in Monessen, thirty miles upriver from Pittsburgh, in 1901. Part of its attempt to stay competitive in the 1920s was to make its steel tubing available to the growing oil and natural gas industries in Texas and Oklahoma, an objective for which its new seamless tube mill at Allenport on the Monongahela River was aptly suited (Workman 1996: 51).

The company constructed its own wharves at both the Allenport and Monessen mills in 1919. The Monessen wharf was set up specifically to receive river shipments of raw materials, especially coal and coke, while the Allenport wharf was constructed for shipping out seamless tubing. The warehouse in Memphis on the Mississippi River was used to store the seamless tubing delivered by barge from Allenport. To further increase its advantage in the southern oil and gas industries, Pittsburgh Steel opened regional offices in Houston, Texas, and Tulsa, Oklahoma (Workman 1996: 52).

Some of the other Pittsburgh steel companies acquired their own barge fleets; other plants used independent river haulers. Even steel mills located some distance from the Monongahela began to incorporate river transport into their delivery schedules. In 1928 Bethlehem Steel Company's Cambria plant, for example, shipped 800 tons of steel by railroad a distance of fifty miles to Glassport on the Monongahela and then transferred the load to the river barges of the American Barge line to complete the trip to consumers in Louisville, Kentucky (Warren 1973: 204; Engineers' Society of Western Pennsylvania 1930: 174).

The marked increase in the amount of river commerce moving on the Monongahela and Ohio rivers in the 1920s and 1930s inspired businessmen near other rivers to seek federal assistance for slackwater navigation systems. A delegation from the Kiskiminetas and Conemaugh River Improvement Association, for example, was dispatched to Washington to seek federal help for navigation improvements on those rivers, and in the early 1930s, more than 400 businessmen in the Youghiogheny River Valley sought the aid of the War Department to rebuild the Youghiogheny River navigation system a distance of fifteen miles from McKeesport (at the junction of the Youghiogheny and Monongahela rivers) to West Newton (Engineers' Society of Western Pennsylvania 1930: 174).

One of the major problems confronting industries on the Monongahela at the time was the absence of freight terminals that could handle different types of river freight. Private companies constructed riverside terminals for specific types of freight, but there were no multi-use terminal facilities. In addition, there were no contractual provisions for the interchange of freight between rail and water in the Pittsburgh area even though the physical connections between these transportation modes were adequate (American Rolling Mill Company 1923: 77, 79). In the early 1930s, it was estimated that the river transport of steel and steel products resulted in an annual savings to Pittsburgh-area producers of about

\$20,000,000 over rail transportation (Engineers' Society of Western Pennsylvania 1930: 166).

Two events in the 1920s, the demise of Pittsburgh Plus pricing and the completion of the lock and dam system on the Ohio River, therefore came together to provide a major boost to the inland transport of Upper Ohio River steel and steel products by river. Water transportation provided an economy of scale that lowered steel freight charges and made Pittsburgh products cheaper at the same time that the Ohio river lock and dam system made year-round shipments on the Ohio river possible. These advantages were short-lived, however, and the business of Pittsburgh-area steel firms generally declined during the 1930s.

River shipping helped only with southern markets and with near-river markets in the Midwest. Generally, it did not make Pittsburgh steel products more competitive in the East or in markets in the Far West. For example, in 1920, (while Pittsburgh Plus was still in effect) Allegheny County steel producers manufactured 20.6 percent of the nation's finished rolled iron and steel. Yet, in 1930, (after the demise of Pittsburgh Plus and the completion of the Ohio River navigation system) they were responsible for just 14.9 percent of this market (Warren 1973: 205, Table 75). Much of Pittsburgh steel's business went to Chicago and Midwest firms who operated more modern and efficient plants and were closer to the major steel consumers, especially the growing Detroit automobile industry.

Although Pittsburgh steel producers generally emerged from the Depression in as good a condition as those in other areas of the country, the construction of new steel plants in those areas had a detrimental effect on Pittsburgh's steel markets. In 1935 steel production capacity in the seventy-five miles surrounding Pittsburgh was probably three times the demand for its product. The problem was eased temporarily by the needs of war production during the Second World War but began to return at the conclusion of the conflict and was exacerbated by increasing rail freight rates in the post-war period. Each increase in rail shipping rates further restricted the geographical sphere in which Pittsburgh-area steel firms were competitive.

Economic recession in 1954 only emphasized just how far behind other steel-producing areas Pittsburgh now lagged. In reaction to the increased rail rates, Pittsburgh-area steel firms again increased the amount of steel they shipped by water and also developed short-haul transportation by truck. By 1955 U.S. Steel shipments of finished steel by rail amounted to just 4.9 tons per year while truck shipments had increased to 13.4 tons. Some steel companies attempted to overcome Pittsburgh's competitive disadvantage by other means, such as product specialization or by shipping semi-finished products to mills closer to the consumer for final finishing (Warren 1973: 210-212).

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APPENDIX

¹The schooner *Monongahela Farmer* was built by "certain farmers" at Elizabeth on the Monongahela River in 1800 and was launched in 1801 for trade at New Orleans. The cargo, loaded at Elizabeth and Pittsburgh, included (among other things) 721 barrels of flour, 500 barrels of whiskey, 4,000 deer skins, 2,000 bear skins, and large amounts of flax, hemp, and guns plus ammunition for the eight-man crew (Albig 1914: 70).

¹In 1840, before the opening of the MNC's navigation facilities, the Monongahela River wharfmaster at Pittsburgh, Thomas McFadden, recorded that 1,048 flatboats loaded with coal, brick, etc. had passed through Pittsburgh, but the total tonnage carried was unknown (Albig 1914: 72).

¹Pittsburgh newspapers often pointed out the necessity of completing the Monongahela Navigation Company's locks and dams as a way to further the city's commerce and passenger travel. Navigation improvements were editorially linked with the positive aspects of urban development. On May 19, 1843, for example, the *Daily Advocate and Advertiser* recorded that four days before the steamboat *Oella* had landed at Pittsburgh with ninety-three passengers aboard, thirty of whom had embarked at Cumberland, Maryland. The same announcement warned city residents, however, that the river would soon be too low for further travel and that "...the interests of our great city require the completion of ...[the navigation improvement]... as speedily as possible."

¹The *Sprague* was sold to the Aluminum Ore Company of St. Louis in 1917, but during Pittsburgh's bicentennial in 1958, it was towed upriver and moored during the summer's celebrations along the lower Allegheny River at the Point. No one, including this author, failed to be impressed by its size. For twenty-five cents, I could spend as much time exploring her as I wanted to spend, and I spent every day on her that I could. The view from the wheel house with its six-foot or eight-foot diameter wheel was beyond description. With the intervening improvements that had been made to the Ohio River's navigation system and the resultant rise in its pool level, the boat was almost too big to pass under the bridges, even with its smokestacks lowered. Some years later, the *Sprague* was destroyed in a fire, a sad end to a magnificent riverboat.

¹Somewhat different figures are given by Catherine Reiser (1951: 14), who lists the value of iron production in Pittsburgh in 1803 at \$56,548. The \$358,908 figure includes manufactured and "country goods" for Allegheny County. Reiser (1951: 14, note 10) gives the figure for Pittsburgh alone as \$266,403.

¹During the same five-year period, for example, 53,855,058 tons of coal moved through the Monongahela Navigation System's locks on the Monongahela River. See Reiser (1951: 67).

¹However, 57 percent of American iron production in 1860 came from furnaces fueled by anthracite or a combination of anthracite and coke. National iron production then stood at five times the level of 1830 (Eggert 1994: 58).

¹Coke manufacture was concentrated in Mifflin Township of Allegheny County and in Tyrone Township in Fayette County in 1860. Four of the thirteen Mifflin Township mines had coking operations (Bureau of the Census 1860).

¹This was a predecessor firm to the Edgar Thomson Steel Company, formed in 1874, and was succeeded by the Carnegie Brothers & Company, Ltd., formed in 1881. In addition to the Edgar Thomson works, to the west of Braddock Borough was the Chess, Cooke & Company nail mill (1887) that had previously been in Pittsburgh, Miller Forge Company's Duquesne Forge, a ten-pot glass factory, the Owen Sheekey & Company tannery, the Braddock Wire Company (which came to the area from St. Louis in 1885-86), the Carrie Furnace Company's eighty-foot high Carrie Blast Furnace, blown in on February 29, 1884, with an annual capacity of 50,000 tons. Finally, Union Switch and Signal Company's works and a then-abandoned car shop completed the industrial landscape of Braddock's environs ca. 1889 (A. Warner and Company 1889b: 125-126).

¹A major drawback to the use of the Bessemer steel making process was the high phosphorous content of most iron ores then in use. The ores of the Mesabi range, however, and other ore deposits discovered earlier in Michigan were free of phosphorous. As Carnegie determined, the combination of phosphorous-free ores and the Bessemer process made modern steel making on a very large scale possible. The Edgar Thomson steel works on the Monongahela River was built soon after Carnegie had traveled to England in 1872 to see the Bessemer process in operation. Carnegie, who already was established in the Pittsburgh iron industry, soon made the switch to steel making and never looked back. Another Pittsburgh industrialist and Carnegie associate, Henry W. Oliver, was closely allied with Carnegie in the exploitation of the Great Lakes iron ore deposits.

¹These included three wooden barges, 198 open steel barges, ten closed steel barges, two tank barges, two car ferries and twelve barges of other kinds, not specified. U.S. Steel and J&L had the largest industrial fleets on the river at the time. Other companies that had their own river fleets included Crucible Fuel Company, Hillman Transportation Company, Pittsburgh Coal Company, Pittsburgh Plate Glass company, Union Barge Line, and Wheeling Steel Company. In all, these firms plus U.S. Steel and J&L operated 48 towboats and 1,007 steel and wooden barges. See Engineers' Society of Western Pennsylvania (1930: 163).

THE MONONGAHELA RIVER NAVIGATION SYSTEM AND RIVERSIDE COMMUNITIES

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INTRODUCTION

This report examines some of the relationships between the development of the navigation system on the Monongahela River in West Virginia and Pennsylvania and the origin and subsequent development of riverside communities and towns. To place the potential significance of the Monongahela River navigation system for community development into perspective, some historical precursors for American river navigation systems in Europe, specifically in England, are first summarized as these earlier engineering accomplishments stood as examples to men of the eighteenth century enlightenment of what might be achieved by the imposition of order on untamed natural rivers. The construction sequence of locks and dams on the Monongahela River by the Monongahela Navigation Company and later by the U.S. Army Corps of Engineers is then discussed, and early towns and communities along the river are summarized with respect to the progression of the navigation system up-river from Pittsburgh to just below Fairmont, West Virginia. The report concludes with a discussion of some of the potential historical relationships that have developed between the navigation system and the towns past which the Monongahela River flows.

River Navigation Systems and Towns in England: Precursors to Navigation Systems on American Rivers

When the subscribers and managers of the Monongahela Navigation Company opened their first two locks and dams on the lowest ten miles of the Monongahela River in 1841 they were following in the footsteps of similar river navigation improvement projects in England that had roots in medieval times.

The most well-documented works of early river navigation engineering in England date from 1760 to the 1830s; however, earlier examples are known from the seventeenth and even sixteenth centuries. These early works are significant because constructing them helped to form a body of practical, applied knowledge about rivers and the techniques that could be used to manage and to improve them for the benefit of commerce and transportation. Taken up by the later great English civil engineers such as Smeaton, Brindley, Jessop, Rennie, and Telford after 1760, a tradition of English river navigation and canal construction also formed an important corpus of information and knowledge that was essential in carrying out similar projects in England's recently independent North American colonies after 1783.

England's primary interest in developing navigation capabilities on her rivers was ease and economy in the transportation of freight. Before the development of railroads, the primary mode of freight and passenger transportation was the horse. Employed directly in carrying goods, one horse might carry 500 pounds of merchandise. Pulling a barge on a river bank, however, that same horse might pull thirty tons, and on a slackwater canal, perhaps fifty tons (Skempton 1996: I: 26, Table I). The cost of transporting goods by water could amount to one-fourth to one-half the cost of land transport, so the improvement of inland

river transportation could be of immediate economic benefit to the manufacturing towns that had grown up along the river banks.

Blessed with a natural abundance of inland rivers, the merchants of England's principal towns and cities made early use of economical water transport to move their goods to markets. By 1600, however, few of the country's 700 miles of navigable inland rivers had been improved. Most were open, natural rivers. The Thames was navigable by ocean-going vessels as far up the river from the estuary as London Bridge, and one could travel by barge from the bridge up to Windsor. From Windsor on up the river to the university town of Oxford, however, was a more difficult trip. By the sixteenth century some twenty-one mill dams (weirs in English terminology) had been constructed in this segment of the river alone, and river craft had to pass through a series of flash locks built along the sides of the rivers at the mill dams.

Flash locks, in fact, were a much more ancient form of river navigation improvement. They are known to have been built on the Thames before 1294 and probably date as early as 1200, when river navigation from London to Oxford was established. The flash lock, or stanch, was a simple affair consisting of a chamber and a vertical moveable gate that could be raised with a pulley or windlass. It had a triple function. With the gate lowered, it allowed water to build up and created something of a navigational pool behind the dam and lock. Then, too, the water could be suddenly released by raising the gate. This "flash" of water could run the wheel of the river mill or might provide enough water to carry a barge downstream over some otherwise impassable shoals and perhaps as far as the next mill dam and flash lock.

These early locks primarily were constructed for the benefit of the miller, not the river barge. During the milling season, a boat might have to wait at the lock for several days and pay the miller a toll before it could pass (Skempton 1996: I: 27).

More sophisticated pound locks, similar to their modern descendants, were in use in Lombardy by the mid-fifteenth century. Leonardo da Vinci used them in his construction of the Milan Canal in 1497. The earliest pound locks in England were employed on a lateral cut made next to the River Exe in 1564-1567 that was known as the Exeter Canal. The importance of the canal to the city of Exeter is apparent from the fact that its engineer and contractor, John Trew, was employed directly by the city.

A second English lock was constructed on the River Lea in 1571-1574, and a survey of the Thames was made between Oxford and Maidenhead in 1585. These examples and the one from Exeter show that river navigation improvements and canal construction were being pursued in England at least as early as the second half of the sixteenth century. Three seventy-five-foot by twenty-foot pound locks were built on the Thames between 1624 and 1635. These were followed by other locks on the Warwick Avon River, built between 1635 and 1639, and a series of ten turf-sided locks on the River Wey, built from 1651-1653. By 1760 the use of locks on English rivers was widespread. Some 700 miles of rivers had been improved by various forms of engineering, and the experience gained was important for the

subsequent flush of canal building that served England's industrial revolution. By 1815 nearly 1,600 miles of rivers had been engineered or improved, and few English towns outside the Midlands were unserved by some form of engineered water transport (Skempton 1996: I: 33-34; VII: 24).

English towns and cities considered river navigation important, even vital, to their prosperity. This is reflected in the lengths to which some of them went to obtain river navigation improvements. The city of York, for example, originally received its coal from two sources, by road from collieries at West Riding some twenty miles away, but principally from the Tyneside coal fields 200 miles away. The Tyneside coal was loaded into barges and transported down-river, then transferred to a coastal sailing ship to the River Humber, loaded again onto barges and taken up the River Ouse to York. Each transfer of course added to the cost, but it was still apparently economical enough to bring in coal from Tyneside rather to increase the amount bought overland from West Riding.

Other English cities sought political help and lobbied for redress of their navigation problems. Sheffield used to send its products twenty miles overland before they could be loaded onto barges working the Idle and Trent rivers to the Humber River, a cumbersome process that put Sheffield's products at a competitive disadvantage with other towns. To obtain relief, Sheffield began a long Parliamentary campaign at the end of the seventeenth century for improvements to its own Don River.

The clothiers of the city of Leeds also petitioned for river improvements on the Aire and Calder since originally they had to transport their goods sixteen miles overland before they could load them onto river barges. In 1699 navigation on the River Aire was extended twenty-three miles to Leeds. The tributary Calder River was also improved thirteen miles to the town of Wakefield. The importance of urban interests in demanding and creating these river improvements is indicated by the fact that the proprietors named in the navigation legislation included nine members of the City of Leeds corporation (one of whom was the mayor) as well as nine gentlemen of Wakefield (Skempton 1996: VII: 31).

Improvements to the Wey River in the mid-seventeenth century also significantly helped the timber merchants of the town of Guilford, and the 1677 Warwick Avon improvements from the Severn River up to Stratford similarly were significant for Bristol's sugar and wine merchants (Skempton 1996: I: 28-29).

As the populations of English cities grew, so did the demands for improvement of their rivers. This was necessary not only to enable merchants and manufacturers to get their products to market at a competitive price but also to insure the predictable and timely arrival of the coal, timber, and food necessary to support a growing urban population increasingly dependent on purchased goods produced in the surrounding hinterlands. Consequently, between 1620 and 1760, some 600 miles of England's rivers received navigation improvements. Most of the work in the seventeenth century was located in the south of England and involved improvements necessary to transport coal and agricultural produce more efficiently.

The Wild Monongahela

Even near the end of the eighteenth century, long before any systematic improvements had been made to the river, people and goods were moving actively on the Monongahela and Ohio rivers. In 1787, for example, 120 flatboats passed Pittsburgh on their way down the Ohio, and on one day alone in 1796, seventy flatboats arrived in Pittsburgh from points upstream (Kussart 1937: 16).

Before the construction of navigation locks and dams on the Monongahela River, and especially in the years before the development of railroad lines, the transportation of perishable and heavy commodities in western Pennsylvania was hampered by difficult terrain and by distance from eastern markets. In the late eighteenth century, many of the settlers moving across the mountains from eastern population centers into western Pennsylvania, Ohio, and Kentucky came overland to the area near Brownsville on the Monongahela River.

Brownsville, first known as Redstone Old Fort, began as a supply center and fortification for the Ohio Company in the 1750s. Brownsville's importance as a trading center was enhanced by the extension of the National Road (modern Route 40) through the town from Cumberland, Maryland, in 1819. Downstream river commerce and travel from the Upper Monongahela River Valley often was off-loaded at Brownsville where it continued west to Wheeling on the National Road bypassing Pittsburgh entirely. This produced commercial rivalry between Pittsburgh and Brownsville and later between Pittsburgh and Wheeling.

The Youghiogheny River is a tributary of the Monongahela that enters it between the present-day towns of McKeesport and Elizabeth. Its valley also was an important locus of early settlement in western Pennsylvania. The significance of the Monongahela and Youghiogheny rivers was recognized officially as early as 1782, when the state legislature declared them to be "public highways" (Kudlik 2001: 4). Settlements in the "Forks of the Yough" area between these two towns soon developed into primary centers of early boat building. Boat builders here supplied businesses serving the western trade and pioneers who needed river craft to continue their journeys into the American interior.

The McKeesport-Elizabeth-Brownsville section of the Monongahela River therefore developed its early concentration in boat building before the advent of river navigation improvements. The subsequent construction of locks and dams, however, significantly furthered and sustained this early interest in boat building. During the last third of the eighteenth century, the stretch of the Monongahela River between Pittsburgh and Brownsville became the busiest boat building center on the Ohio-Mississippi River system. Many of the boatyards in these communities either developed around earlier sawmills that supplied the boat builders or fostered the development of such mills. John McDonald, a resident on Peter's Creek near today's Clairton, was the first person known to have operated his own keelboat line (1786), which provided service between Pittsburgh and Brownsville (Kudlik 2001: 12-13). The *Pittsburgh Gazette* also was having its papers delivered up the

Monongahela River to Gasting's Ferry, some thirty-five miles in 1786 (*Pittsburgh Gazette*, September 2, 1786).

The Farmers' and Mechanics' Commercial Store operated their own boat in Greenfield by about 1800, and nearly all the large river communities had boatyards in operation by his time (Kudlik 2001: 13). Major boat-building towns came to include McKeesport, Webster, Belle Vernon, Monongahela City, Fayette City, California, Brownsville, and West Brownsville among others (Kudlik 2001: 19). As early as 1803, boat building had become Pittsburgh's third largest industry ranking only behind iron and textiles in economic importance (Reiser 1951: 14).

The seasonal draw-down of water in the Monongahela River and the number of shoals and ripples in its shallow stretches created long-standing impediments to river navigation. Colonel John May's 1789 account of a trading expedition from Boston to the Ohio country and back, for example, is one of the earliest and most vivid accounts of the navigation problems that a traveler might encounter on the natural river:

Wednesday, 17th [June]. Rose at 3 ½, not wholly satisfied in my own mind but that the boat might go down the river at all. I want to be at least 12 miles lower down the river than now. I procured two experienced men to survey the ripples, & report. At 8 they returned, & pronounced them impassable. So here we are, laid up, Lord knows how long. I was afraid we might be caught in this way, but we could not get ready to move sooner (May 1921: 127).

As John May discovered, the river shallows at the ripples were often the biggest threats. Low water in the river generally, was even shallower near the ripples, and the rock bottoms could easily cause damage to a boat. Ripples also were numerous on the Monongahela River. A rough count of the number of ripples on an 1838 map of the river valley shows that there were about seventy such impediments to river travel between Pittsburgh and Fairmont (West) Virginia (Kudlik 2001: 4). A broad, shallow area in the Monongahela River above the mouth of the Youghiogheny River at McKeesport was such a well-known feature of the early river that it served as a "submerged public road for years" (Kudlik 2001: 4). Even in the 1830s, steamboats had a difficult time passing this sandbar, and such obstacles long hindered improvement in river navigation for both passengers and commerce.

The bedrock underlying the river's ripples did provide a firm foundation for the construction of river mill dams, however, and engineering surveys for the location of navigational dams often favored these locations. The Monongahela Navigation Company originally planned to erect dams at sixteen ripple sites on the river (U.S. Army Corps of Engineers 1994: 12-13). At some times of the year, it was possible to ford the river on foot or on horseback at the sandbars and ripples, and these areas often were developed as ferries at an early date.

Not surprisingly, footpaths and trails led to these natural fords, and the areas on either side of the river often became the sites of early communities. The Warrior's Branch of the

Catawba Path, for example, from present-day Smithfield to Moundsville, West Virginia, crossed the Monongahela River either at the mouth of George's or Dunkard Creek in Fayette County (Wallace 1971: 184-185). The eighteenth-century Monongahela River settlement of New Geneva is located at the mouth of George's Creek. The old Mingo Path from Cumberland, Maryland, to Wheeling crossed the Monongahela River at Redstone Old Fort (which developed from an outpost of the Ohio Company into present-day Brownsville) and blazed the trail for the later National Road (Wallace 1971: 100).

The problems engendered by ripples and sandbars were only exacerbated by seasonally low water in the river. Low water was usually a problem in the summer and fall, and river traffic often came to a complete standstill at such times. During the winter, ice, too, often caused a cessation in river travel, often lasting from December until March (*Pittsburgh Gazette* March 22, 1788). In the spring, on the other hand, too much water was often the problem, and floods could wash away river mills, boats, bridges, docks, and other improvements.

Early Pittsburgh recognized the importance of its rivers to commercial success, but what was lacking was a means of paying for needed river improvements. In 1798 a state-approved lottery was set up to help pay for the construction of "piers to defend the Banks of the Rivers Allegheny and Monongahela within the Borough of Pittsburgh" (*Pittsburgh Gazette* July 21, 1798). The managers of the lottery included many of Pittsburgh's prominent social, political, and businessmen, including Presley Neville; his brother-in-law, Isaac Craig; John Scull; Nathaniel Bedford; George Shiras; Nathaniel Irish; and others.

Seasonal fluctuations in river level made the construction of fixed wharves on the Monongahela River impracticable; however, this led to the creation of informal landings, where boats could and would stop if signaled (Kudlik 2001: 17). Thus, virtually any sandy beach along the river's bank might become the site for a home or business that could have access, when river conditions were right, to boat transportation. This proved an asset to community development along the river and helped to keep transportation costs low since money did not need to be invested in the construction and maintenance of elaborate wharf facilities even though boat operators might charge a premium for such flexible service.

The need for improved navigation of the Monongahela River was only accentuated by the development of the steam engine early in the nineteenth century. Stationary steam engines were being used to operate machinery in Pittsburgh as early as 1807, and eight of them were employed in the town's mills and iron factories by 1816 (Kudlik 2001: 13). The author's examination of Fayette County newspapers shows that advertisements for steam engines to run various mills were making their appearance about 1814. The use of steam-powered sawmills and gristmills on the upper river greatly increased the amount of lumber and grain products that could be shipped down the river to market.

Steam engines also contributed to an expanded and renewed riverside boat manufacturing business as steamboat construction began to take root in the earlier boat building communities of the Monongahela River Valley. One of the first to engage in the

construction of steamboat hulls on the Monongahela River was Samuel Walker, who began his business along Fallen Timber Run near the old boat-building center of Elizabeth (Kudlik 2001: 10). Regular steamboat connections between Pittsburgh and Brownsville were established by at least 1834 and were touted by *The Daily Pittsburgh Gazette* (April 5, 1834).

The experience of Monongahela River boat builders with the demands of low-water navigation on that river led them to pioneer the technology of constructing light but strong hulled steamboats with flatter bottoms. These boats went on to become indispensable to the successful early navigation of the nation's other unimproved western rivers. Monongahela River Valley-built steamers came to set the standard for such boats and were in much demand throughout the Ohio and Mississippi River systems. Pittsburgh became the natural center for the construction of these boats, but so too did smaller upriver communities like Elizabeth and Brownsville, where the long-established boat-building businesses and allied industries continued to attract many skilled and semi-skilled artisans. William Howard's 1832 survey of the Monongahela River recorded that sixteen steamboats had been built in 1831 at various places along the banks of the lower river. Eventually, the valley came to produce nearly half of all the steamers working on the western rivers of the country (Kudlik 2001: 15).

Innovative steamboat design, small size, and the right water conditions allowed the first steamboat to reach Morgantown, (West) Virginia, on the Upper Monongahela as early as 1828, thirteen years before the first locks and dams opened on the lower reaches of the river. The feat was accomplished by the *Monongahela*, built at Brownsville. Such trips were infrequent, however, and dependent on the water level being high enough to make navigation of the upper river possible. Only three feet of water for six months out of the year would do it, but sometimes even that was difficult to come by. Regular navigation of the upper reaches of the Monongahela River to Morgantown was not attained until 1889. Consequently, any direct effect that the Monongahela River navigation system as a whole might have had on the development of new upriver communities was diminished.

By the 1830s, an increasing number of keelboats were arriving in Pittsburgh from farther up the Monongahela River and developing communities near Morgantown and the mouth of the Cheat River. It also has been estimated that in the 1830s some 20,000 people and 4,000 freight wagons annually arrived at Brownsville from the East where they transferred to river craft for the trip downstream to Pittsburgh and beyond. As these upstream Monongahela River communities continued to grow during the nineteenth century in population and in the number and diversity of their manufactures and agricultural produce, their residents became avid supporters of river navigation improvements that would enable them to get their products to the evolving downstream population center at Pittsburgh and farther down the Ohio and Mississippi rivers.

The growing population and industrial prowess of Pittsburgh made it important as a destination market, but the arrival of the Pennsylvania Canal also made it important as a trans-shipment point for Monongahela River Valley farmers and coal producers. The Pittsburgh wharf master drew up a document in 1840 as a type of survey of potential river traffic that might pass through the locks and dams then being proposed by the Monongahela

River Navigation Company. The document showed that in 1839, 686 keelboats loaded with produce and 1,084 flatboats loaded variously with iron, coal, and bricks had used the Monongahela wharf at Pittsburgh. This enumeration did not include the steamboats that were, by that date, using the river in increasingly large numbers. (Kussart 1937: 15).

The lack of river navigation facilities still limited business in the river valley's towns. After the National Road was constructed through Brownsville and on to Wheeling on the Ohio River, some Pittsburgh business interests in the 1820s resisted the construction of river navigation improvements fearing that anything that promoted Brownsville would hurt Pittsburgh. The editors of the *Pittsburgh Gazette* tried to change this parochial view:

Heretofore the members from this northwestern district of the state vote against the establishment of a seat at that place, and so they did against the passage of the law for improving the navigation of the Monongahela river. It is time for us to examine whether such a policy is not selfish in us, & contrary to our interests. If the improvement of the Monongahela from Brownsville to this place, was such as to admit the transportation of merchandize at all seasons, and thereby divert that portion of Western commerce which now passes the channel of the National Road to Wheeling, down the river by our City—Then it is impolitic in us to throw any obstacles in the way of the prosperity of Brownsville: our interests are connected. (*Pittsburgh Gazette*, January 18, 1822).

Despite the early opposition of some in Pittsburgh to constructing navigation improvements on the Monongahela River, upriver businesses continued to evolve. Boat builders at Elizabeth and Brownsville, for example, became adept at designing larger steamboats with shallow drafts, such as the 175-foot long *Mediterranean* built at Elizabeth in 1833 (Kudlik 2001: 16). This was the exception, however. In most cases, Monongahela River boatyards were restricted to producing the hulls of riverboats, which then had to be towed down river to Pittsburgh for completion. Even after locks were added to the river, their small size proved a limiting factor for the upriver construction of the increasingly larger steamboats then in demand. This deterred the growth of boat-building companies and their communities beyond a certain size. Pittsburgh's direct access to the Ohio River, however, made it a logical place for the construction of larger, complete steamboats. Of 378 steamboats running on "the western and southern waters" in 1839, 130 had been built in Pittsburgh (*Daily Advocate and Advertiser*, May 7, 1839).

In the days before the construction of the first locks and dams on the river, the Pittsburgh and Brownsville Packet Line was established (1837) and operated two steamboats, but regular, uninterrupted trips between the two ends of the line usually could occur for only three months in the spring of that year. By 1839 six steamboats regularly connected Pittsburgh with points up the Monongahela River, but the schedule was interrupted often by unfavorable water levels (Kudlik 2001: 17). Monongahela River businessmen and newspaper editors became more vocal in their demands for river improvements during the 1830s and linked these improvements directly to the future growth of Pittsburgh. The *Pittsburgh Gazette* April 2, 1839 stated, "Improvement of this river is necessary, before we can derive from it all the advantages which it can furnish."

A RIVER CONTROLLED: THE EVOLUTION OF NATIONAL INLAND RIVER NAVIGATION POLICY AND THE CONSTRUCTION OF THE MONONGAHELA RIVER NAVIGATION SYSTEM

In addition to their function as avenues of trade and commerce, rivers were significant in eighteenth-century North America for the ways in which they helped to define the most desirable and important land. As part of the grant that the Ohio Company received in 1747 from George II, for example, the company received 60,000 acres located on the Potomac River and on the branches of the Youghiogheny and Monongahela rivers and 4,000 acres at the "Three Forks" of the Youghiogheny (Thomas 1994: 19).

In a land where roads, where they existed at all, usually were little more than crude trails, rivers formed the most natural means of transportation for both humans and for goods. They and their tributary streams provided a source of power for water-driven mills, drinking water for humans and stock, and were permanent (though often meandering) landscape features from which the location of deeds might be reckoned.

As the journal he kept of his 1784 trip to visit his western lands on the Ohio River makes clear, George Washington displayed enormous interest in the development of navigation on the Potomac River system, and he was convinced of the importance of establishing connections between the new nation's eastern and western rivers as a means of developing the new nation's interior lands. Washington, like most men of his times, regarded the improvement of rivers as inseparable from the goals of both national and personal progress and prosperity.

Beyond the recognition of the fundamental importance of American rivers as avenues of trade and transportation was the evolution of the concept of their free use. This concept developed in the post-Revolutionary period out of attempts to stem sectional and commercial rivalries, especially on the rapidly growing western frontier beyond the Allegheny Mountains. Regional divisiveness, sectionalism, and trade rivalry were some of the legacies of the Articles of Confederation that threatened the nation's unity that the federal government hoped to overcome under the new Constitution in 1789.

Free use of the western rivers, that is, without toll or duty, was so important to commerce that provision for it had been incorporated into the Northwest Ordinance of 1787 that established the governance of the Northwest Territory. Article IV of the Ordinance identified the navigable waters of the Mississippi and St. Lawrence drainages as "common highways and forever free." On August 7, 1789, the first Congress, as one of its initial acts, adopted the provisions of the Ordinance without change. This act established the legal framework for the inland navigation policy of the United States. This first Congress also directed the U.S. Treasury to take over the costs of maintaining lighthouses, buoys, beacons, and public piers that had been erected by the old colonial governments. It thus directly

defined a role for the new federal government in the maintenance and management of navigation facilities (Hull and Hull 1967: 10).

So important was the guarantee of the free use of the rivers in the early years of the country that Thomas Jefferson's acquisition of the Louisiana Territory from France in 1803 was motivated in part by his desire to insure the unchallenged use of the Mississippi for western settlers, lest they be persuaded to switch their political allegiances to Spain or France in order to secure that right for themselves (Hull and Hull 1967: 5-7). In 1806 Jefferson expressed the hope that the new nation would develop its rivers, build roads, and construct canals—all of which he considered essential not only for economic progress but to insure political cohesion as well.

The policy of the Jefferson administration soon found voice in the report of Secretary of the Treasury, Albert Gallatin (himself an early resident and entrepreneur of the Monongahela River Valley). Gallatin's 1808 *Report on Roads and Canals* announced a broad plan of internal improvements to be undertaken at the expense and direction of the federal government. Although interrupted by the War of 1812, the place of the federal government in inland navigation and other improvements was reaffirmed by the Madison administration and received congressional support from Daniel Webster, Henry Clay, and John C. Calhoun.

In 1818 the House of Representatives passed a resolution that formally expressed Congress' power to appropriate money for roads and canal construction and to improve inland waters. Two years later, Congress appropriated funds for the survey of the Mississippi and Ohio rivers and their tributaries. In 1824 Congress passed the first bill providing for river improvements and in 1826 the first of many "rivers and harbors" acts. Internal improvements continued to find favor with the Monroe and John Quincy Adams administrations; in fact President Adams himself turned over the first shovel of dirt that inaugurated the construction of the Chesapeake and Ohio Canal in 1828 (Hull and Hull 1967: 14).

Although federal involvement and sponsorship of internal improvements continued under the administration of Andrew Jackson, the interest that individual states were showing in navigation improvements—either directly or through chartered companies—made it increasingly difficult for the federal government to coordinate the planning and construction of these improvements. Federal participation in the internal improvement program of the 1820s and 1830s collapsed in the face of competing state and local interests.

Without funding from the federal government, however, states were forced to borrow from the international bond markets. National financial troubles in 1837-1839 and declining revenues and traffic contributed to a high rate of state default on these loans. By 1844, shortly after the Monongahela Navigation Company had opened its locks and dams on the Monongahela River between Pittsburgh and Brownsville, \$60,000,000 worth of state bonds were in default nationally (Hull and Hull 1967:17). A major criticism of state and privately funded or chartered endeavors such as the Monongahela River navigation system

established by the Monongahela Navigation Company was that they tended to improve only those areas of rivers that were the most immediately profitable for stockholders.

With the construction of turnpikes and canals largely in the hands of states or state-chartered private corporations by the 1820s (Pennsylvania's investment in constructing turnpikes and roads during this period ceased in 1836), the federal government began to further internal improvements by giving assistance to the nation's fledgling railroad companies, often in the form of grants of large amounts of land for rights-of-way. The effect of the construction of many miles of railroad lines helped to drive down the costs of shipping dramatically but placed canals and turnpikes at an increasing disadvantage. Freight charges on the Erie Canal, for example, dropped from \$1.12 per ton in 1839 to \$1.06 in 1850, and \$0.12 in 1882 (Hull and Hull 1967: 23).

The New York and Pennsylvania Canals

The most famous of the state-sponsored improvements was New York's Erie Canal, which opened in November 1825 and kicked off a round of competitive canal building in Pennsylvania. Construction of the Pennsylvania Canal was motivated principally by the concerns of urban merchants eager to exploit the rapidly developing western markets. Between 1800 and 1820, for example, the American population west of the Appalachians had grown five times and stood at about 2,000,000 people. Kentucky, Ohio, Indiana, and Illinois had all become states, and Missouri entered the Union in 1821 (Thomas 1994: 36).

Businessmen in Philadelphia and Pittsburgh were fearful of losing business with the western markets to New York merchants via the Erie Canal. Philadelphia merchants were also worried that Pittsburgh might establish a canal connection with New York, thereby circumventing Philadelphia as both a market and as a source of goods. They were also distressed that a New York connection to markets in Pittsburgh might further enhance the trading position of Baltimore. Much of Pittsburgh's trade as well as that of communities farther up the Monongahela River already was focused on Baltimore, an orientation that was strengthened by the westward progress of the National Road (U.S. Route 40) from Cumberland, Maryland, in the eighteen teens.

For her part, Pittsburgh was still reeling from the loss of business that occurred when the National Road had been routed south of the town, crossing the Monongahela River at Brownsville and proceeding west through Washington in Washington County, Pennsylvania, and then through Wheeling, (West) Virginia on the Ohio River. A turnpike also was constructed from Bedford to the National Road at Washington, Pennsylvania, between 1821 and 1831, potentially further decreasing the significance of Pittsburgh as a regional transportation and commercial hub (Thomas 1994: 36). But Wheeling was seen as the biggest threat to Pittsburgh, and the town's newspapers missed few opportunities to denounce their rival at every turn—exactly the sort of sectionalism and rivalry that the federal government had feared. A canal across Pennsylvania was therefore in the interests of both Philadelphia and Pittsburgh businesses.

Together with road building the canal building frenzy of the 1820s and 1830s was "the first great modification of the American landscape" (Carlisle 1994: 5). The Pennsylvania Canal was built across the rugged landscape of the Commonwealth in an amazingly short amount of time given the simple technologies of the day. It also integrated two early railroad lines into its operation. The canal reached Pittsburgh in 1829, and through connections from Pittsburgh to Philadelphia were available by 1834 (Carlisle et al. 1994: 35.) Pittsburgh business interests also moved aggressively to establish trading connections with Ohio via other canals.

The canal-building movement of the 1820s and 1830s was therefore largely an urban phenomenon that was advocated and utilized by urban commercial interests who saw themselves in competition with merchants and manufacturers in other towns and cities. The canal route approached Pittsburgh and the City of Allegheny (on the opposite side of the Allegheny River) from the northeast. The rich farm crops and mineral wealth of the Monongahela River Valley south of Pittsburgh had access to the canal through an outlet lock on the Monongahela. The arrival of the Pennsylvania Canal in Pittsburgh therefore also added to the demand by Pittsburgh and Brownsville businesses for improvement of navigation on the Monongahela River as new markets both on the East Coast and west into Ohio now were opening up. Brownsville area residents held a convention in 1835 to petition Congress for the improvement of navigation on the Monongahela River.

The advent of slackwater canal navigation to Pittsburgh therefore pre-dated the development of the first major navigation improvements on the Monongahela River by the Monongahela Navigation Company, which was chartered in 1828 and incorporated in 1836. The company's history was somewhat older, however. It was originally incorporated in 1817, but the company failed in 1822 (U.S. Army Corps of Engineers 1994: 12). The best that could be accomplished at the time was that some local residents, with some state assistance, raised money to clear river snags and river debris in the important stretch of the river between Brownsville and Pittsburgh.

Pennsylvania was heavily involved in the company's financial re-structuring from the outset. The Commonwealth owned \$30,000 worth of the company's stock whereas private investors had put up just \$18,360. The state legislature also inserted clauses into the charters of some banks that they would provide financial assistance to the company (Tarr 1989: 255, note 18).

The Monongahela Navigation Company

Some years before the Monongahela Navigation Company was re-incorporated, the Pennsylvania legislature had sponsored engineer Edward Gay's survey of the river to determine the feasibility of improving its navigation. Gay's report recommended the construction of a series of locks and dams between Pittsburgh and New Geneva to establish a navigable channel the length of the river. Gay's survey favored the locations of shoals, sandbars, and ripples as the location of dams, but his planning also preserved many of the river mill dams already built at such places (U.S. Army Corps of Engineers 1994: 13).

Initial legislative action on navigation of the Ohio River was taken with the passage of Public Law 1399 on May 24, 1824, the provisions of which were extended to the Monongahela River in 1832. This resulted in another survey of the Pittsburgh to Brownsville section of the Monongahela River in 1833 by a federal civil engineer, William E. Howard. Howard also recommended the construction of locks and dams in this segment of the river, where connections to the National Road were available at Brownsville.

Since it was occupied with the construction of its statewide canal system, Pennsylvania failed to take up Gay's and Howard's recommendations, but the private Monongahela Navigation Company did, opening its first two locks and dams at Pittsburgh (Lock and Dam No. 1) and at Braddock's Lower Ripple (Lock and Dam No. 2) some ten miles upstream from Pittsburgh, in 1841. The year before, eight steamboats were running the local river traffic and carrying 14,916 tons of freight annually.

In the spring of 1841, high water allowed a small number of steamboats to penetrate the upper reaches of the river as far as Morgantown, 102 miles upriver from Pittsburgh. One of these boats actually continued on the Cheat River an additional ten miles, but such travel remained unusual, episodic, and restricted to fairly small boats. Passage through Lock No. 1 required only eight minutes and thirteen minutes were required at Lock No. 2 (Kudlik 2001: 20-21). The new locks and dams increased river trade as far upstream as the improvements exerted their influence on the navigational pool of the river, about twenty-five miles.

The river could still be fickle, however. The summer of 1842 was dry, and although small packet boats could continue the run upriver as far as Elizabeth, Brownsville merchants were stuck with accumulating piles of goods with no way to move them. High water, and with it prosperity, returned in 1843 until the summer when a break in Dam No. 1 created more problems.

Locks and Dams Nos. 3 and 4, built at fourteen to fifteen-mile intervals farther up the river (two miles above Elizabeth and at North Charleroi, respectively) opened in 1844. By that year, slackwater navigation was possible between Pittsburgh and Brownsville. These locks and dams now permitted the shipment of much larger consignments of goods and the use of larger vessels with deeper drafts. On December 13, 1844, for example, the *Pittsburgh Gazette* recorded the arrival of the keelboat *Smash* loaded with 4,000 bricks, 1,000 bushels of fire clay, more than 1,000 gallons of stoneware, and other items from towns up the river.

Improved river travel also was important for the timely dissemination of news and information as well as "eastern merchandise" previously either unavailable in the Monongahela River Valley or very expensive to ship overland. Telegraph connections upriver above McKeesport did not arrive until 1866, and Pittsburgh newspapers relied on the river packet boats to get their papers up the river (Kudlik 2001: 22). Not surprisingly, *The Pittsburgh Post* (March 18 1845) extolled the virtues of the river navigation improvements as having done more than anything else in recent years to advance the fortunes of the region. The Monongahela Navigation Company's Annual Report for 1852 reported the shipment of

nearly eight and one-half million pounds of "eastern merchandise" through their locks and dams (Monongahela Navigation Company 1852).

The accomplishment of the Monongahela Navigation Company in opening up the Monongahela River to slackwater transportation as far as Brownsville in 1844 and the significance of that achievement to the economic well-being of Pittsburgh received formal recognition from one of Pittsburgh's earliest historians, Neville B. Craig. Craig's *A History of Pittsburgh*, first published in 1851, extolled the value of both the Monongahela River navigation improvements and those on the Youghiogheny River. Significantly, Craig's assessment of those improvements suggests that by the mid-nineteenth century some Pittsburghers at least were beginning to think on a regional rather than on a local scale when it came to transportation developments.

In his widely read book, the first real history of Pittsburgh, Craig wrote that the potential importance of the Youghiogheny River's new locks and dams to Pittsburgh would be multiplied by the completion of another transportation project, a plank road linking West Newton (on the Youghiogheny) to the Baltimore & Ohio Railroad at Cumberland, Maryland (Craig 1917: 277-278). This was a far cry from the sort of petty jealousies over transportation projects and access that had marked, for example, the rivalry between Pittsburgh and Brownsville or Pittsburgh and Wheeling earlier in the century.

The opening of slackwater navigation between Pittsburgh and Brownsville in 1844 stimulated the development of river transportation companies and riverside facilities. The Brownsville and Pittsburgh Packet Company was founded the same year (Wiley 1937: 166), and in 1847 the Pittsburgh wharf was paved for the first time to facilitate the loading and unloading of an increasing number of river passengers and greater volumes of river commerce. It is also probably no coincidence that trade on the National Road between Brownsville and Wheeling began to diminish not long after river travel between these two termini became possible with some predictability.

River travel was faster, more comfortable, and less expensive than long-distance overland travel. Monongahela River packet boats were now being built to a larger size to accommodate this trade and to take better advantage of the river's navigation improvements. During one week in 1847, 750 travelers arrived at Brownsville from Cumberland, Maryland, where they embarked on the Monongahela River for Pittsburgh. (Kussart 1937: 151). Above Brownsville, however, only smaller craft (such as the ninety-foot long twenty-ton *Henry Clay*) continued to ply the shallow and unpredictable upper reaches of the river (Kudlik 2001: 10).

After the opening of the river navigation improvements to Brownsville, business was good. Demand for coal both in Pittsburgh and farther down the river was so great that second and larger lock chambers were added to Locks Nos. 1 and 2 in 1848 and 1854, respectively. Monongahela River boat-building yards reached their peak of production during the 1840s and 1850s, but this prosperity was restricted to those areas of the river served by the Monongahela Navigation Company's locks and dams.

Communities upriver from Brownsville were left largely out of the prosperous times until additional locks and dams were constructed. In 1850 occasional steamer runs still were being made to Morgantown (as they had since 1828), but Fairmont was seldom reached. Merchants there pleaded for boats to come upriver, but until new locks and dams were constructed, such an attempt could be made only in seasons of high water and by small boats.

The Monongahela Navigation Company's lock activities on the Monongahela River also spurred the private construction of navigation locks and dams on the Youghiogheny River, which opened in 1850 (Ellis 1882: 261-263). These locks and dams gave passengers in Pittsburgh an option of traveling to and from Baltimore and Philadelphia either by the earlier Monongahela River route to Brownsville and then overland on the National Road or via the Youghiogheny River Valley and then by road and railroad connections to the East.

The Youghiogheny improvements greatly benefited Pittsburgh's merchants. In 1851 some 8,000 additional passengers traveled down the Monongahela River by steamboat than had made the trip just the previous year. On February 27, 1852 the *Pittsburgh Post* extolled the astonishing amount of freight that had come down the river from towns on the Monongahela and Youghiogheny rivers.

A new plank road was opened between Cumberland, Maryland, and West Newton, Pennsylvania, on the Youghiogheny that increased both passenger and freight traffic through the town, which was connected with Pittsburgh by a twice-daily steamboat packet, the McKeesport-built steamboat *Thomas Shriver*. When the Youghiogheny locks and dams were damaged in 1854 and not repaired, towns, mills, and the steamboat trade on that river suffered.

The opening of the Monongahela River locks and dams provided greater outlets for local agricultural produce, livestock products, as well as a diverse array of goods manufactured in upriver communities. In 1852, 2,879,310 pounds of pork, 181,260 pounds of butter, 5,027,293 feet of lumber, and 98,361 tons of bricks were shipped through the river's locks and dams (Monongahela Navigation Company, *Annual Report*, 1852). Coal extracted from the rich upriver seams became an increasingly important product for the Monongahela River navigation system as industrialization of the Pittsburgh area proceeded. In 1845, for example, 177,122 tons of coal passed through the Monongahela Navigation Company's locks and dams, a number that increased to 472,999 tons just five years later.

Despite the improvements provided by the Monongahela Navigation Company's locks and dams, river traffic and the success or failure of urban merchants and manufacturers in the 1850s was still very much controlled by the weather and the amount of water in the river. A new Pennsylvania Railroad track reached Pittsburgh in 1854 connecting the town directly to Philadelphia. The same year was beset by the lack of rain. The Monongahela River dried up for months and goods could not be moved to or from the towns along the river.

The first three months of 1856, on the other hand, were lost to ice, which was followed by a summer of unusually low water. The growing season of 1857 produced a bumper crop of agricultural produce in the Monongahela River Valley, but by the time of the autumn harvest, water levels in the river had fallen precipitously. "...No departures, no arrivals, no business, no rain and no prospects of any" was the way the *Pittsburgh Gazette* summed up the miserable situation on September 18, 1857.

The first Pennsylvania Railroad Company (incorporated 1846) connection to Pittsburgh arrived on December 10, 1852 and initiated a decades-long railroad-building era throughout the Commonwealth. The railroad also immediately reduced the amount of river trade between Pittsburgh and Brownsville. The Philadelphia and Westmoreland Coal Company of Philadelphia (with an office in Irwin, Westmoreland County) began to ship coal for the Philadelphia gas works east from Westmoreland County on the Pennsylvania Railroad in 1856. This inaugurated a new and important market for Monongahela River Valley coal—the fifty-eight coal-gas plants of Philadelphia and New York, who used the gas to illuminate their streets and buildings (DiCiccio 1996: 35-36).

The construction of the Pittsburgh and Connellsville Railroad in late 1861 stemmed any attempt to repair the navigation improvements that had been built on the Youghiogheny River just a few years earlier. Ironically, the closure of the Youghiogheny locks and dams system initially and temporarily increased the amount of traffic moving on the Monongahela River. In 1870 the Pittsburgh, Virginia, and Charleston Railroad proposed the construction of a rail line to run the entire length of the Monongahela River Valley, but this was years in developing. The initial effect of the railroads on river shipping was felt on passenger travel and short distance freight trips, but the river for a time maintained an "economy of scale" over the railroads for the long distance shipment of bulk commodities. Nevertheless, river freight tonnage fell 75 percent between 1870 and the turn of the century as rail competition increased.

Many of the same problems that traditionally beset river navigation—ice, low water, breaks in dams—also affected east-west transportation on the Pennsylvania Canal, and by the 1860s, the railroad had effectively spelled the doom of the canal. It is likely that Monongahela River navigation might have suffered some irreversible blows from railroad competition in the 1860s had the country not been caught up in the throes of the Civil War and had the progress of a rail line up the Monongahela River Valley from Pittsburgh not been slowed by the subsequent national economic turmoil of the 1870s.

By this time, the railroad had arrived at McKeesport (which also received a direct rail line from Cumberland, Maryland, in 1871), but further progress up the Monongahela River Valley beyond this town did not come until 1888 (Kudlik 2001: 28-29). Belle Vernon received service from this line in 1889, but it was not extended to Brownsville until 1903. The slow growth of rail connections up the Monongahela River Valley even allowed the opening of a new, thrice weekly steamboat packet line to New Geneva/Greensboro in 1866, towns the railroads did not reach for almost a half-century more.

Navigation Improvements Above Brownsville

Construction, operation, and maintenance of four locks and dams between 1838 (when contracts for Locks and Dams Nos. 1 and 2 were awarded) and 1844 placed a severe financial burden on the Monongahela Navigation Company, and construction of additional improvements was halted temporarily. In early 1854, however, the state legislature required the Monongahela Navigation Company to let contracts for Locks and Dams Nos. 5 and 6 by 1855 and to complete the navigation system to the state line by 1857. Lock and Dam No. 5 was built at Denbo, about two miles upriver from Brownsville, and Lock and Dam No. 6 was built at Rice's Landing about ten miles above the Denbo lock and dam. Both of these navigation improvements opened in 1856. Year-round slackwater navigation of the Monongahela River was therefore possible by 1856 as far up the river as the stoneware pottery-making river towns of New Geneva in Fayette County and Greensboro on the opposite side of the Monongahela River in Greene County (Gannett, Fleming, Corddry, and Carpenter, Inc. 1980: 3-4).

In 1857 the state legislature stepped back from its requirement that the Monongahela Navigation Company complete construction of Lock and Dam No. 7, which would have extended navigation as far up the river as the (West) Virginia state line. Matters remained stalled at this point until well after the Civil War. From 1856 until 1883, the date that Lock and Dam No. 7 was finally opened, therefore, New Geneva and Greensboro remained at the head of navigation on the Monongahela River. During this twenty-seven-year period, neither the federal government, the state of Virginia, nor the Monongahela Navigation Company made any navigation improvements to the upper portion of the river in what became West Virginia in 1863.

An increasing amount of the nation's freight and passenger traffic was being moved on rails by the 1860s, but with decreasing competition, the railroads raised their freight rates, often to exorbitant levels. To counteract this, Congress passed a series of Rivers and Harbors Acts beginning in the 1870s that brought the federal government into the role of improving the nation's inland waterways.

In passing the River and Harbor Act in March 1871, Congress authorized the Secretary of War to conduct additional surveys of the upper Monongahela River from New Geneva/Greensboro to Morgantown, West Virginia. The survey was conducted in August of that year by civil engineers Charles Reichspfonn, E.A. Chase, and J.F. Wilson (Gannett, Fleming, Corddry, and Carpenter, Inc. 1980: 5). Their 1872 report advised the construction of three locks and dams on this upper portion of the river, and they recommended that the dams be built so as to provide at least six feet of water over the sills of the locks when the river was at its seasonal low. This recommendation was based on the earlier experience of the Monongahela Navigation Company with four-foot navigation depths that had proven too low to float the larger boats that were then being built.

The Monongahela Navigation Company objected to the idea that they should be required to build three locks on the upper river but proposed a counter-offer to construct one

much larger lock and dam complex. Federal review of the company's proposal and recommendations from the report of engineer W.E. Merrill concluded that the Monongahela Navigation Company should build Locks and Dams Nos. 7 and 8 but that the federal government should then reimburse the company for their costs and assume operation of the improvements in the stretch of the river above the proposed Lock and Dam No. 7 (Gannett, Fleming, Corddry, and Carpenter, Inc. 1980: 6-7).

The River and Harbor Act of 1872 appropriated \$25,000 for improvement of the Monongahela River by the construction of Lock and Dam No. 9 in West Virginia. Originally this lock and dam were scheduled to be erected at Collin's Ripple but they were subsequently moved to Hoard's Rocks, 3.5 miles downstream where a more solid bedrock foundation extending all the way across the river was available to support the dam. Lock No. 9 opened in 1876, but the dam itself was not completed until 1879. These were the first navigation improvements constructed by the federal government on the Monongahela River, and they marked the emergence of direct federal involvement in the construction and management of navigation improvements on the river. Obviously, since neither Locks and Dam Nos. 7 and 8 had yet been constructed, the effects of the opening of Lock and Dam No. 9 were strictly local. It would still be many years before large boats or tows could lock through to or from West Virginia (Gannett, Fleming, Corddry, and Carpenter, Inc. 1980: 6-7).

In 1880 and 1881, Congress appropriated funds for the construction of Lock and Dam No. 8 at the mouth of Dunkard's Creek in Pennsylvania, about two miles below the mouth of the Cheat River. Congress also provided, however, that no funds could be expended on the project until the Monongahela Navigation Company had constructed Lock and Dam No. 7 at Jacob's Creek. Assurances to that effect were obtained from the company, and federal construction of Lock and Dam No. 8 proceeded.

The lock and dam did not open to river traffic, however, until November 1889. In the interim, the Monongahela Navigation Company had built Lock and Dam No. 7 at Jacob's Creek in Pennsylvania, which opened for navigation in 1883. This disconnected sequence of construction meant that between 1883 and 1889, the Monongahela River was navigable from Pittsburgh only up as far as Point Marion near the Pennsylvania/West Virginia border. Only after the opening of the federally constructed Lock and Dam No. 8 in 1889 was the river fully navigable between Pittsburgh and Morgantown. The cost of navigation on the river was not yet free, however. The Monongahela Navigation Company levied tolls on river traffic using their facilities.

The River and Harbor Act of 1884 reasserted that river navigation owned or operated by the federal government should be free of duties and tolls, a proposition with roots in the nation's earliest days. With the prospects of free river navigation and a corresponding drop in their own transportation costs, the large coal interests active in the Monongahela River Valley in the 1880s began to press the federal government to takeover control of the entire Monongahela River navigation system—this just a year after the Monongahela Navigation Company had opened Lock and Dam No. 7 and the prospects of completing the navigation system into the coal-rich lands of West Virginia loomed in the foreseeable future.

In 1888 the federal government offered to purchase Lock and Dam No. 7 from the Monongahela Navigation Company, but the offer was refused. The company contested subsequent attempts by the government to obtain the property through eminent domain. Finally, in 1897 the Supreme Court affirmed the right of the Government to obtain the company's locks and dams. This year therefore marked the onset of open and free navigation between Pittsburgh and Morgantown (Gannett, Fleming, Corddry, and Carpenter, Inc. 1980: 11-12).

As early as 1875 Congress had begun to investigate the possibility of extending the navigation system upriver from Morgantown to Fairmont, West Virginia, near the headwaters of the Monongahela River. The government's report at that time recommended construction of six additional locks and dams between these two towns. These six locks and dams would have created navigable water not only on the Upper Monongahela but also on the tributary West Fork River, thereby further providing free river navigation down the Monongahela for companies mining the rich coal fields of the area.

Work began on the upper locks and dams in 1897 but proceeded with difficulty. By 1900 work had started only on Lock and Dam No. 10 and on Lock No. 11. The upper six locks and dams finally were completed and opened in January 1904, extending slackwater navigation up the river an additional twenty-eight miles from Morgantown to four miles above Fairmont, West Virginia. The project that the Monongahela Navigation Company had begun with the opening of Locks and Dams Nos. 1 and 2 in 1841 was, therefore, completed 131 miles upriver a few miles above Fairmont, West Virginia, sixty-three years later (Gannett, Fleming, Corddry, and Carpenter, Inc. 1980: 12-15).

The opening of the locks and dams on the Upper Monongahela River from 1899-1904 facilitated the recreational use of the river by an urban middle class population whose lives had become increasingly regulated by the tempo and schedules of the heavy industries now found in the lower reaches of the river nearer Pittsburgh. The pristine upper reaches of the Monongahela River offered an opportunity for short-term escape from the industrial pall.

The Pittsburgh, Brownsville, and Geneva Packet Company's three boats began to make regular trips from Pittsburgh to Morgantown during the 1890s. Some 17,062 people made the through trip in 1890 while 11,201 undertook the trip as excursionists. The number of through-trips declined in succeeding years while the number of excursion trips actually increased. In 1894 the number of through trips numbered only 12,339 and 3,643 such trips were reported in 1897. Excursionists in 1894, on the other hand, numbered 38,619. By the turn of the century, larger boats were being successfully used on the upper river, and the new Mason Line began to offer service there as well. The large river packet boats the *I.C. Woodward* and the *Columbia* now plied the upper reaches of the river, and there was an effort to begin a new Pittsburgh and Fairmont Packet Company.

With the opening of the locks and dams in West Virginia in 1904 navigation pools Nos. 13 and 14 between Morgantown and Fairmont became tourist destinations for camping, fishing, and relaxation. The *I.C. Woodward* continued to run until 1912, by which time the

Pennsylvania Railroad had established connections in the upper river valley. As a result, packet travel declined, and the last of the river packet boats ceased running about 1916 (Kudlik 2001: 31).

The federal government's policy of continuing to improve the nation's inland navigation system has continued throughout the twentieth century and has had broad political support. In 1908, for example, four years after the Monongahela River navigation system had been completed between Pittsburgh, Pennsylvania, and Fairmont, West Virginia, President Theodore Roosevelt, responding to complaints about the lack of progress in inland river navigation improvements and the inadequacy of the country's transportation system, sent a special message to Congress in which he exhorted them to meet these demands without delay.

River traffic on the Monongahela increased significantly in the early twentieth century. By 1935 more tonnage was being shipped on the Monongahela River than through the Panama Canal, and in 1937 the Monongahela River carried slightly more tonnage annually than did the Ohio River (Tomer 1935: 3). The Corps of Engineers continued to make improvements to the Monongahela River's locks and dams in the 1920s and 1930s (see Gannett, Fleming, Corddry, and Carpenter, Inc. 1980: 16-35). The reconstruction of the Emsworth Dam with a raised pool on the Ohio River in the late 1930s made Monongahela Lock and Dam No. 1 and Allegheny Lock and Dam No. 1 unnecessary, and they were removed in 1938.

Little construction or reconstruction of navigation facilities on the Monongahela River was carried out during World War II. The Corps did survey the river from its mouth to Lock and Dam No. 15 in 1942, however, and in 1943 developed plans for the reconstruction of Locks and Dam No. 2. Due to the war, plans and specifications were not finalized until 1945. The project was bid in 1946, but all of the bids were rejected, and additional planning was begun to develop a less costly undertaking (Gannett, Fleming, Corddry, and Carpenter, Inc. 1980: 35-36).

The new plans were completed in 1948 and called for an increase in the size of the land-side lock chamber to 110 feet by 720 feet. Plans for building a new 56-foot by 360-foot river lock chamber at Lock and Dam No. 2 were also completed in 1948, and a construction contract for that lock was awarded. The river lock was completed in 1951. The larger land-side lock chamber was begun in 1951 and completed in 1953 (Gannett, Fleming, Corddry, and Carpenter, Inc. 1980: 35-36).

The late 1940s and early 1950s also saw Corps planning for new lock and dam construction in the upper Monongahela River. Increased coal mining and other river traffic in this segment of the river and the forty-five year age of Locks Nos. 10 and 11 led the Corps to recommend their replacement with a single lock and dam at Morgantown, West Virginia. The lock was to have a usable length of 84 feet by 600 feet (a length selected to conform to the standard Ohio River lock size). Work on this complex began in 1948, and the

Morgantown Lock and Dam was completed in December 1950 (Gannett, Fleming, Corddry, and Carpenter, Inc. 1980: 36-37).

In 1947 the Corps also recommended the replacement of Locks and Dams Nos. 12-15 in the Upper Monongahela River Valley with two new locks and dam complexes. The increased industrial river traffic in the upper sections of the river also resulted in Corps recommendations for the construction of a navigable river channel 9 feet deep and 300 feet wide extending up the Monongahela River from Lock and Dam No. 8. Construction of a 2.1-mile long channel measuring 9 feet deep by 200 feet wide also was proposed for the tributary Tygart River at this time. Congress accepted these recommendations in 1950 (the cut-off date for this study), but construction of these new navigation improvements was not begun until 1956 (Gannett, Fleming, Corddry, and Carpenter, Inc. 1980: 37-38).

MONONGAHELA RIVER COMMUNITIES

Early Towns on the Monongahela River

In his 1802 edition of *The Ohio and Mississippi Navigator*, Zadok Cramer mentions ten towns or communities along the Monongahela River between Morgantown and Pittsburgh. These included Morgantown, New Geneva, Fredericktown, Bridgeport, Brownsville, Williamsport, Elizabethtown, McKeesport, and Pittsburgh. Cramer described the Morgantown of this period as a "flourishing" town of about sixty dwellings. The town long pre-dated the arrival of slackwater navigation in 1889, however. It was founded in 1785 by Zacquell Morgan. An even earlier settlement there by Thomas Decker and others dated to 1758, but the settlement was attacked by Native Americans with great loss of life.

Construction of a state road from Winchester through Romney to Morgantown, Virginia, was authorized as early as 1786, and a wagon is reported to have been driven from Alexandria, Virginia, to Morgantown in 1796. Morgantown got its first post office in 1794 (Callahan 1912: 12), but a post road from Pittsburgh was established by the *Pittsburgh Gazette* in 1793 to deliver its newspaper by rider to Morgantown's inhabitants (Callahan 1923: 139). By 1859 Morgantown's population had grown to 1,700-1,800 inhabitants, so it had become a sizable town even without the benefits of river navigation improvements. Steamboat travel to Morgantown was initiated during periods of high water beginning in the 1820s even without benefit of locks and dams.

Fairmont (formerly called Middletown) in Marion County, West Virginia, was established in 1819. Steamboat traffic up the Monongahela River from Pittsburgh began to reach Fairmont about 1850 and with some regularity during periods of high water after 1854 (Callahan 1912: 13-14). The urgent need for slackwater transportation connections in the Upper Monongahela River Valley was ameliorated by the arrival from the East of the Baltimore and Ohio Railroad in Fairmont on June 23, 1852 (Callahan 1912: 44).

To Zadok Cramer, New Geneva was a "thriving town, a place of much business," famous for the glass-making business begun by Albert Gallatin and as a place where "Kentucky boats" were made, according to Cramer. On the opposite side of the river was Greensburgh (Greensboro), which he described as "a small village." Fredericktown and Bridgeport were small but pleasantly situated towns. Brownsville or Redstone, its older name, was an important and well-known town even in 1802. It then had about ninety homes and a population that Cramer estimated at 500.

In addition to a number of merchant grist mills, there was a paper mill near the town on Redstone Creek. Williamsport (earlier Parkinson's Mills and now Monongahela City) was, in 1802, a well-situated town growing in business and with excellent land transportation connections to Philadelphia; Washington, Pennsylvania; and Wheeling. Cramer recognized Elizabethtown (Elizabeth) as the source of many river craft. Another well-positioned town

for commerce in 1802 was McKeesport, which had been laid out in 1794 by John McKee. Cramer singled out its boat-building business and predicted that the town probably "would rise to considerable importance."

Zadok Cramer's eighth edition of *The Navigator* (1814) lists the same towns (with the addition of Clarksburg, Virginia), but the descriptions suggest that business in many, if not most, had developed in size and composition in the intervening years. He observed that Gallatin's glass making business had moved (1807) from New Geneva across the river to Greensboro. Fredericktown contained two mercantile stores and a public library. A large brewery, distillery, and tan yard were found within a short distance. Bridgeport consisted of some fifty-six dwellings in 1814 and was then separated from Brownsville by a chain bridge erected over Dunlap's Creek. It was a prosperous little community that contained several stores, an earthenware pottery, tan yard, a wire weaver, card maker, hatters, a boat yard, and a market house. Glass making began in 1811.

Brownsville in 1810, according to Cramer, contained about 120 houses, mostly wood but some of stone and others of brick. It was by far the most well-developed town on the river with the exception of Pittsburgh and contained eighteen stores, a market house, two tanyards, an Episcopal church, a rope walk, two boat yards, two tin and copper manufactories, two nail factories, a printing office that issued a weekly paper, a post office, warehouse, a scythe and sickle maker, blacksmiths, silversmiths, tailors, shoemakers, saddlers, etc. The Morris Truman & Company steel manufactory had begun operations in 1811. There also was a foundry in operation and a mill saw manufactory. A large steam-powered cotton manufactory was being erected at the time. Brownsville also had a water-powered grist and saw mill "turned by the water of the river" where wool and cotton carding machines also had been installed. The latter mill was erected by Gillespie and Clark, who had placed a dam across the Monongahela River. Of interest is Cramer's (1814: 43) observation that this dam originally was equipped with a chute built into the dam that allowed boats to pass both up and down the river; however, the chute had been replaced by "a lock canal."

Boat building in the area of Brownsville (Redstone) dates to 1777-78 and therefore pre-dates construction of the Monongahela River navigation system. Some 120 river craft built at Brownsville are mentioned passing by Pittsburgh on their way down the Ohio River in 1787 (*Pittsburgh Gazette* Nov. 24, 1787). The steamer *Enterprise* was built by Daniel French at the mouth of Dunlap's Creek as early as 1814. It carried supplies to troops at New Orleans and was the first steamer to make the round trip from the Monongahela to the mouth of the Mississippi and back (Kudlik 2001: 85). John Pringle's Brownsville boat yard opened in 1829. Pringle was successful enough that he opened another boat yard in West Brownsville on the west side of the river in 1843, where 546 boats were constructed by 1877.

The Cock and Williams boat yard (1846-1877) was another of West Brownsville's successful boat businesses. The establishment of both the Pringle and the Cock and Williams yards at West Brownsville may have been stimulated by the extension of slackwater to Brownsville through the opening of Lock and Dam No. 4 in 1844, although the availability of

local lumber as well as steam engines, boilers, iron castings, and other materials at Brownsville undoubtedly also played large roles in the decision.

The Vulcan Iron and Machine Works began business at the Brownsville boat landing in 1824. Equipped with rolling mills, pattern shops, forges, and boiler-making facilities, it was one of the largest and most famous shops of its day (Kudlik 2001: 51). Steamboats continued to be built in West Brownsville as late as 1912 (Kudlik 2001: 50).

Williamsport (Monongahela City) on the left bank of the Monongahela River was the site of the building of "Kentucky, New Orleans boats, and keels" in 1814. A glass works was also being built at the time, and Parkinson's mill was still to be found on the right side of the river. The initial settlements were made here in the late eighteenth century when Joseph Parkinson operated a mill and a ferry service from the mouth of Pigeon Creek. Parkinson also soon embarked on the construction of flatboats and keelboats for the Monongahela River trade. Additional boat construction began at Monongahela City in the 1820s or early 1830s, again, prior to the construction of the river's locks and dams.

Steamboat builder George Cunningham's relocation from Elizabeth to Monongahela City in 1856 (Kudlik 2001: 47) may have been due in part to the opening of Lock and Dam No. 5 at Denbo and the extension of slackwater from Brownsville to Rice's Landing that same year. Thus the progressive opening of the upper reaches of the Monongahela River, while good for the economic development of towns there, also could bring business loss to the older boat building towns down the river. Furthermore, Cunningham's Monongahela City yard is said to have produced only boat hulls, not complete craft (Kudlik 2001: 47).

This is a good example of how, even as more of the upper river was being slackwatered and opened to navigation, technological change on the lower river did not keep pace. Lower locks on the river were not enlarged to provide for the upriver construction of the larger, complete steamboats then being developed, and this no doubt put a brake on community economic growth. In fact, Lock No. 3 was not enlarged until 1884, and Lock No. 4 in 1886, years after the demand for larger boats had begun (Gannett Fleming Corddry and Carpenter 1980). By 1910 only a few small river craft were still being produced by one firm at Monongahela City.

"Elizabethtown," Zadok Cramer noted in 1814, was still the site of boat building, but, Cramer's assessment in 1814 was that "The town does not thrive much." In this evaluation, too, he seems to have been wide of the mark. Elizabeth had become the principal location for the construction of boats and other river craft in the Monongahela River Valley at an early date. Pittsburgh businessman Stephan Bayard was building keelboats at Elizabeth as early as 1788 using ship's carpenters brought from Philadelphia (Kudlik 2001: 7). The men who got their start here often went on to establish boat yards on the opposite side of the river at West Elizabeth and farther up the river at California, Belle Vernon, and Monongahela City. Hundreds of steamboats and other river craft continued to be built there throughout the nineteenth century. Perhaps 196 steamboats alone had been built before 1870 (Kudlik 2001: 46). Three steamboat yards were in operation at Elizabeth by 1836 and directly employed

100 town residents. In addition, sawyers and blacksmiths turned out other valuable products that also were vital to the boatyards. By 1859 more than twelve boat hulls might be under construction at any one time in Elizabeth's yards.

Boat building in Elizabeth gradually diminished in the nineteenth century, but the Monongahela River Coal Company, later the Consolidated Coal Company, established its Marine Ways Division, where boats were repaired and refitted, at Elizabeth in 1896. This business continues to the present day, but for many years, the size of the locks down-river from Elizabeth set the limit for the sizes of boats that could be serviced there (Kudlik 2001: 45). Thus, although the construction of the river navigation system greatly benefited Elizabeth by establishing a stable pool level that promoted boat building and repair, subsequent delays in lock maintenance and enlargement eventually limited that business and hindered the town's economic development.

The town of West Elizabeth dates to 1833 and pre-dates the establishment of the Monongahela River navigation system. Like the town of Elizabeth on the east side of the river, boat building and lumbering became important early industries in West Elizabeth, where community development also was promoted by the presence of two ferry landings. Steamboats began to be built at West Elizabeth about 1843, before the opening of the first locks and dams on the river. The town was important in the early stages of coal production and shipping on the river but lost some of this significance as new coal deposits farther up the river valley were opened. As the opening of these new coal deposits was facilitated by the construction of additional locks and dams that allowed coal to be brought down-river in ever larger barges, it can be argued that the elaboration of the river navigation system was detrimental to some older downstream communities.

Changes to the Monongahela River navigation system in the mid-1950s had a profoundly beneficial effect on West Elizabeth but was not without consequence for other riverside towns and cities. In 1954 about seven acres of West Elizabeth's river frontage below Lock No. 3 was taken over by Consolidated Coal Company's River Division. The coal company specifically developed their West Elizabeth facilities after the enlargement of downstream Lock No. 2 (also in 1954) that increased the lock size to 110 feet in width by 720 feet in length, permitting some fifteen coal barges at a time to pass through the lock. West Elizabeth's gain, however, came at the expense of Dravosburg and Pittsburgh as Consol's landing facilities there were abandoned in favor of the new West Elizabeth facilities (Kudlik 2001: 52).

Zadok Cramer apparently had changed his mind about McKeesport's fortunes between 1802 and 1814, too, as he described it as a "small and dull village" with two stores, a large brewery, a tanyard, and a boat yard, where "Boats may sometimes be procured..." Actually, Cramer's assessment of McKeesport may have been a little premature. The importance of the Monongahela River to this town dates well before its laying out in 1794. Flatboats were being built here for the garrison at downstream Fort Pitt some thirty years before this date (Kudlik 2001: 43).

The importance of water transportation to the economic growth and development of early McKeesport was multiplied by its position at the confluence of the Monongahela River and the Youghiogheny, where many early mills and other early enterprises were located and where another navigation system of locks and dams eventually was built in the nineteenth century. McKeesport is said to have been the site of the first Monongahela River drydock for lifting steamboats out of the river, constructed in 1836 (Kudlik 2001: 43). Boat building in McKeesport received another boost from the construction of the Benjamin Coursin boatyard on the Youghiogheny River in 1849 and during the Civil War, his yard turned out many boat hulls as well as two Monitor-style ironclads, the *Marietta* and *Sandusky*.

As this example shows, the presence of the Monongahela River and the Monongahela River navigation system's locks and dams could facilitate both the continuation of an established business and the technological innovation necessary to extend that business into new arenas, specifically the construction of ironclads. Like newspapers in Pittsburgh, the *McKeesport Daily News* was quick to point out the contribution of the improved navigation system to the vitality and economic vigor of the town, especially the increased production of different types and larger sizes of river craft that the improvements allowed. The newspaper was especially effusive in 1894 after the river's navigation system was taken over by the federal government and boats could travel free of the Monongahela Navigation Company's charges (Kudlik 2001: 44).

McKeesport's Benjamin Coursin later built another yard at the Monongahela River town of California, Pennsylvania, so boat-building contributed not only to private wealth formation but offered successful entrepreneurs like Coursin the opportunity to enlarge their enterprises to other Monongahela River towns, thereby also contributing to community development and economic growth. Nor was Coursin alone. The Cock family of Brownsville, another important boat-building center on the Monongahela River also expanded its operations to McKeesport in the 1860s (Kudlik 2001: 43).

Zadok Cramer's account of the Monongahela River in 1814 named no settlements between McKeesport and Pittsburgh, although he did mention that a "town" (unnamed, but probably the town later known as Port Perry, established in 1790) had been laid out just above the mouth of Turtle Creek "a few years ago" but that it had "not progressed." This stretch of the Monongahela River was still most famous as the site of "Braddock's Fields," the location of the defeat of forces under Major General Edward Braddock by the French and their Indian allies in July 1755 and as the assembly point of the "Whiskey Boys" during the Whiskey Insurrection in 1794. Thus, it is clear that town formation was well underway along the Monongahela River long before the construction of the navigational improvements to the river by the Monongahela Navigation Company. It is also worth pointing out that all of these towns still exist today, although their relative fortunes have ebbed and flowed.

Pittsburgh, advantageously situated where the Monongahela and Allegheny rivers join to form the Ohio River, developed as the principal town and market for smaller towns in the Monongahela River drainage. Virgin stands of oak and pine, early iron furnaces and rolling

and slitting mills that produced needed nails and spikes all helped to develop boat production into a major Pittsburgh industry by early in the nineteenth century.

In 1803 boat building was the third largest industry in the town, with assets of some \$40,000. It was exceeded in importance at that time only by the value of the city's iron and textile (at this time, primarily linen) industries, both of which also relied upon river navigation for the distribution of their products (Reiser 1951: 13, 14). Glass making, which would grow into another of the primary industries of the town and of the Monongahela River Valley, was in 1803 a relatively small component of Pittsburgh's economy but one for which the river was an important asset given the difficulties of overland transport of this fragile commodity.

Although the boat-building industry in early Pittsburgh and up the Monongahela River to Brownsville was greatly facilitated by the Monongahela Navigation Company's eventual construction of locks and dams, boat building was going on in the Monongahela River Valley long before the earliest dams and locks were built. Between 1811 and 1836, for example, well before the appearance of the first locks on the lower river, some 252 steamboats had been built in Pittsburgh. By 1840, before the first locks and dams opened, Pittsburgh had become a major boat-building center (Kudlik 2001: 43).

Population growth and economic development in Pittsburgh and in adjacent industrial communities up the Monongahela during the second half of the nineteenth century were the result of many factors, and although the Monongahela River navigation system played a role, its exact contribution is difficult to estimate. Between 1860 and 1900, the population of Allegheny County increased from 179,000 to 775,000 (Couvares 1984: 32, Table 3; 81, Table 4). A large percentage of this growth took place in the city, but the populations of adjacent Monongahela River Valley industrial towns also increased greatly during this period due to the construction of huge steel plants in Braddock, Duquesne, McKeesport, Monongahela City, Monessen, and other river towns.

The river and its excellent system of locks and dams contributed significantly to the choice of these towns as the sites of new plants, but so too did the railroad lines, as well as an ever increasing supply of immigrant labor. The railroads and the river together connected the industrial process of steel making together and allowed all of the essential materials to come together at one place. They then allowed the finished products to be shipped out at competitive prices.

Several other towns on the Monongahela River pre-date the development of the Monongahela River navigation system as centers of boat building and allied businesses. Boat building began at Belle Vernon, for example, in the mid-1820s together with a water-powered sawmill and continued until about 1876. Some seventy-nine steamboats in all were built in Belle Vernon (Kudlik 2001: 48). Fayette City also became an early center of flatboat building, primarily to serve the glass manufacturing businesses that developed there. Boat building was also carried out almost on an impromptu basis near pottery, lumber, iron, coal, and other early industries adjacent to the river.

The town of California was laid out in 1849, five years after slackwater had reached as far up the river as Brownsville. By 1851 boat builder William McFall had relocated from Monongahela City up the river to California. The boat yard at California soon grew to cover sixteen town lots (Kudlik 2001: 48). McFall's move to California was no doubt influenced by the extension of slackwater that resulted from the opening of Lock and Dam No. 4 at present-day North Charleroi in 1844, and in this way the Monongahela River navigation system may have promoted community growth in California at the expense of Monongahela City.

McFall sold his California boat yard to Benjamin Coursin from Elizabeth in 1853, but the firm changed hands several times thereafter. Although the yard was quite successful financially, the size of the downstream locks and the failure of the Monongahela Navigation Company to enlarge them limited California boat production mostly to steamboat hulls and to wooden barges that could make it through the river's lower locks or could be floated over their dams.

As in other boat-building towns along the river, California's economy was helped not only by boat construction but also by the demand for related skilled and unskilled labor—blacksmiths, laborers, coppersmiths, sawyers, carpenters, caulkers, etc. Boat building in California was ended by the arrival of the Pennsylvania, Virginia, and Charleston Railroad, who laid their track through the middle of the town boat yard in 1879, effectively cutting off unimpeded access to the river (Kudlik 2001: 49).

The year 1859 saw the publication of George Thurston's *Directory of the Monongahela and Youghiogheny Valleys* (Thurston 1859). Thurston's Directory gives an excellent picture of how town and community development on the Monongahela River had proceeded just three years after slackwater navigation had been extended as far up the river as New Geneva/Greensboro by the construction of Locks and Dams Nos. 5 and 6, opened in 1856. In contrast to the ten towns listed by Zadok Cramer in 1814, Thurston lists some twenty-one towns or communities (not including a few ferry crossings) between Pittsburgh and Point Marion in Pennsylvania, as well as two additional towns in (West) Virginia between Morgantown and the Pennsylvania line, Granville and Hamilton (Table).

Nine of the towns that Cramer had listed earlier were still enumerated in 1859. The tenth, Bridgeport, was being listed with Brownsville in 1859. Thus the fourteen additional towns mentioned by Thurston represented essentially "new" communities added to and not replacing older ones. (This probably is not an absolutely accurate count as Cramer seems to have missed or excluded some of the river communities established in his day. Belle Vernon, for example, had been established by 1813 yet is not included in Cramer's list of towns.)

The extension of slackwater up the river as far as Greensboro/New Geneva by 1856 greatly benefited the growth of businesses in these riverside communities. For example, the stoneware pottery businesses for which both of these communities became nationally famous in the second half of the nineteenth century depended upon the river for the transportation of

Table
Monongahela River Communities Included in George Thurston's *Directory of the Monongahela
and Youghiogheny River Valleys*, 1859, from Morgantown, (West) Virginia Downstream to
Pittsburgh

Morgantown*
Granville
Hamilton
Point Marion
Greensboro*
New Geneva*
Gray's Distillery
Davidson's Ferry
Port Fremont
Rice's Landing
Millsboro
Fredericktown*
Brownsville*
California
Greenfield
Albany
Fayette City
Belle Vernon
Monongahela City*
Elizabeth*
McKeesport*
Saltsburg
Port Perry
Pittsburgh*

* Towns also listed in Zadok Cramer's *The Navigator* in 1814

heavy but fragile output from their kilns. In the absence of effective rail connections (which did not reach New Geneva until the early twentieth century), slackwater river transportation was essential.

Until the demise of the business about the time of the First World War, New Geneva and Greensboro pottery was marketed widely throughout the Ohio and Mississippi River Valleys. Pittsburgh was a frequent local market for the potters themselves, but the wares

were distributed widely beyond that city, reaching as far south as New Orleans. These regional pottery production centers ultimately fell prey to competition from newer pottery-production centers situated closer to inland markets, to the growth of the American bottling industry, and, after 1906, to increased governmental bottling and packaging regulations.

Until the expansion of the river navigation system and the opening of coal mines in the upper reaches of the river, towns upriver from New Geneva/Greensboro tended to remain small, with rudimentary agricultural economies oriented to local markets. According to Thurston's (1859: 17) directory, for example, Point Marion was only a small settlement of ten to twelve houses clustered at a ferry crossing of the river.

Granville was another agricultural village of about 150 people located two miles down the river from Morgantown. Hamilton was a settlement of about fifty people four miles down-river from Morgantown. Granville's major product was sorghum, which when processed into molasses (a process that was to begin in 1859 according to Thurston's account) would have traveled well to down-river market towns if the navigation system was extended to this portion of the river valley. The occupations compiled for various towns in Thurston's 1859 Monongahela River Valley directory paints an unambiguous picture that industry, mining, ship-building, and economic development/expansion beyond the agricultural baseline paralleled the extension of the navigation system up the river.

The economic potential of Morgantown, the principal population center in the Upper Monongahela River Valley (population in 1859 of 1,700-1,800 inhabitants; Thurston 1859: 2), for example, remained underdeveloped in the absence of river transportation and navigation facilities. By 1859 the population there had raised \$25,000 toward the construction of one of two additional river dams needed to extend the navigation system to the town, but an additional appropriation of \$30,000-\$40,000 from the State of Virginia was still lacking to fund the other dam.

Morgantown had been settled as early as 1758 and later was connected by overland routes to the Baltimore and Ohio Railroad at Fairmont, but extensions of both the navigation system and railroad to the town were interpreted in the mid-nineteenth century as important steps toward securing its economic future:

The slack-water being completed, it will need but twenty miles of Railroad to connect the slack-water navigation with the Baltimore and Ohio Railroad—which being done, Morgantown would at once rise into importance as a shipping point; and, from the easy access to the east or west, would present itself from its transportation advantages, and its minerals and forests as an extremely eligible [sic] site for manufacturing various articles (Thurston 1859: 2).

As things stood in 1859, however, Morgantown had little manufacturing or mining in distinction to smaller down-river towns that were directly on the navigation system, like Greensboro, New Geneva, Brownsville, or Rice's Landing. David, Frank, and James Thompson were Morgantown's only potters, and Samuel Dunning was the sole person in the town to list his occupation as "coal digger" (Thurston 1859). In distinction, Greensboro, with

perhaps only 500 inhabitants (about one-third the population of Morgantown) had several operating potteries in 1859, about ten potters, two glassblowers, and at least one glass cutter. New Geneva, on the opposite bank of the river, with about 400 occupants in 1859, listed some ten persons engaged in the glass business, four coal diggers and miners, two foundries, and a pottery. [Thurston (1859: 23) reported, however, that the number of castings done in New Geneva was then "very light," the glass house was idle, and the pottery "does but a limited amount of burning."]

Rice's Landing, located at Lock and Dam No. 6 of the Monongahela River Navigation Company's system, was an even smaller town than New Geneva, consisting of about 300 inhabitants in 1859. Although settled in the late eighteenth century, the town's prosperity in the mid-nineteenth century was tied directly to its position at the head of the river navigation system. The navigation system had allowed Rice's Landing to develop into a redistribution point for goods brought by river to all of the interior communities in Greene County. It contained two commission houses, a dry goods store, a grocery, distillery, and a grist- and sawmill in addition to one foundry.

Only a few names appear throughout Thurston's (1859) directory of those who actually worked at the navigation system's locks. Rice's Landing resident Thomas McQuade was the lock keeper at Lock No. 6, and Captain B.L. Wood filed that role at Lock No. 2 at Port Perry. A cursory reading of this directory might lead to the erroneous conclusion that the navigation system—as represented by the number of people employed at the locks—was economically relatively unimportant. Although the locks required relatively few people to operate them, Thurston's directory still may not identify all of them.

The true significance of the navigation system to the economy of the riverside communities is reflected indirectly in Thurston's directory by the number and diversity of mining and manufacturing jobs in those communities and by the number of people employed in one or another aspect of boat-building, not by the number of people directly employed at the locks. Brownsville, for example, had numerous glassblowers and glass cutters; steamboatmen and rivermen; coal diggers, miners, and merchants; steamboat captains and clerks; ship's carpenters; potters; founders; plus others whose livelihoods were tied to the rivers and indirectly to the navigation system and to the numerous benefits it provided.

The navigation system and the river commerce it supported provided employment possibilities for many men in Brownsville, including a number of its early African-American residents. Thurston's directory (Thurston 1859) lists Samuel L. Baldsden, William Bolden, and Jacob Jones¹ as "steamboatmen" while the occupation of Phillip Drew, Goen Fairfax, Charles Morsett, and William Cyrus is recorded as "boatman." A number of Brownsville African-Americans also were employed in the early coal industry. James E. Bradley and William Carpenter are listed as "coal diggers." Matthew Little was an African-American coal hauler, and William Little's occupation is given as "coal miner."²

¹ Jones is listed under Brownsville, but the entry gives his residence as Monongahela City.

² The notation "(col.)" for "colored" is given following each of these men's names in Thurston's directory. No African Americans are identified in the directory for towns up-river from Brownsville.

Coal Patches and Industrial Towns

The Importance of Coal and Coke

Coal was among the earliest commodities shipped on the Monongahela River, and the coal trade came to dominate the river's commercial traffic, especially from the 1880s through World War I. Shipments of the mineral were numerous even before the construction of the first navigation improvements on the river, but river conditions directly affected whether coal was plentiful and cheap or scarce and expensive. The uncertainty of navigation on the unimproved Monongahela River at various times of the year could result in too much coal being delivered at some times (which depressed local prices) and not enough at others (which increased local prices). As more and more businesses became dependent on steam-generated power, coal and its predictable delivery had a greater direct impact on urban life.

So important was coal that its arrival at the Pittsburgh wharf often was announced in Pittsburgh's early newspapers. The Street's Run Creek area along the Monongahela River was being mined intensively by 1828 to meet the town's own demands. Pittsburgh's population stood at about 30,000 people in 1833. This population required some 140,000 tons of coal annually for domestic consumption and perhaps 40,000 additional tons for stores and public buildings. Its ninety steam engines consumed some 90,000 tons of coal each year (Binder 1974: 22, 43).

Through-shipments of coal beyond Pittsburgh also were important to Pittsburgh's economy even before navigation improvements were introduced to the Monongahela River in 1841. Shipments of southwestern Pennsylvania bituminous coal to the East Coast via New Orleans began as early as 1803. Cincinnati, Louisville, Maysville (Kentucky), St. Louis, and New Orleans all were early recipients of bituminous coal from western Pennsylvania, regular shipments of which began about 1817 (DiCiccio 1996: 31). About 5,000 southwestern Pennsylvania men were engaged in bituminous coal mining by 1860 (DiCiccio 1996: 31).

The potential damage to coal barges trapped by low water on an unimproved Monongahela River could be financially disastrous. Such losses totaled \$400,000 in 1837 alone (Kudlik 2001: 57). In 1840 low water in the river during the autumn stranded the coal barges in the river stretch between Brownsville and Pittsburgh, and the ice that formed that winter destroyed all of them.

By 1843 the Pittsburgh papers were singing the praises of the Monongahela Navigation Company's system, saying that it already had saved the city \$700,000 in fuel costs. The navigation system also spurred industrial development in Pittsburgh and farther down the Ohio River as businessmen were able to predict their future operating costs for power and heat with greater reliability. Since so much Monongahela River Valley coal was shipped down the Ohio to other cities, the effects of the navigation system extended well beyond the valley itself.

This benefited Pittsburgh businesses in another way. Since industries down river from Pittsburgh relied so heavily on Monongahela River Valley coal, their costs for coal compared to Pittsburgh's were higher; thus, Pittsburgh industries were placed at a competitive advantage with regard to cost of production even though the inland transportation cost of finished goods from Pittsburgh was higher than for cities closer to the growing population of the West.

The opening of slackwater navigation between Brownsville and Pittsburgh had an immediate impact on the coal industry in the Monongahela River Valley. In 1845, the year after Locks and Dams Nos. 3 and 4 opened, about 177,122 tons of coal entered Lock No. 1 at Pittsburgh, and the shipments doubled the following year (Monongahela Navigation Company *Annual Reports*, 1845-1846). River traffic was large enough that a second chamber was added to Lock No. 1 in 1848, and a second chamber was added to Lock No. 2 in 1854. The early coal mines of the Monongahela River Valley tended to be located near the river; later in the century, new coal mines and their associated company towns and coal patches were opened as rail connections were extended inland (Keyes 1991: 69).

In one form or another, coal transportation underlay the development of many Monongahela River Valley businesses that offered employment to the residents of riverside communities and spurred the growth of their populations. Enduring local family names like Dravo, McFeeters, Packer, Gilmore, and Brown became synonymous with the prosperous coal business of the river (Kudlik 2001: 35). The W.H. Brown firm of Brownsville later owned towboats and barges, but it began as a small coal shipper (Kudlik 2001: 33). The coal business also contributed to occupation specialization. Coal barge pilots, coal boat crews, and coal boat builders all developed craft specializations within their communities, and the merits of one town's practitioners with respect to those in other river towns was a source of both speculation and local pride.

By 1850 the Monongahela River navigation improvements of the Monongahela Navigation Company were an unqualified success where coal was concerned. The navigation system both directly and indirectly had increased the population, capital, and land values of the lower part of the valley from Brownsville to Pittsburgh (Reiser 1951: 67).

The Civil War greatly increased the demand for Monongahela River Valley coal and made the Monongahela River navigation system vital to the Union's war effort. Most railroad locomotives by this time were burning bituminous coal, a fact that helped to increase demand for it (DiCiccio 1996: 35). Coal mining was restricted to the first four pools of the Monongahela River during the war (Kudlik 2001: 39). Between 1861 and 1866, the amount of coal that passed through Lock No. 1, for example, more than doubled from 802,530 tons to 1,638,665 tons (Monongahela Navigation Company, *Annual Reports*, 1861-1865). In 1859 there were about sixty small coal mining operations concentrated in the Monongahela and Youghiogheny river valleys in Allegheny, Washington, Fayette, and Westmoreland counties (DiCiccio 1996: 32). By 1866 ninety large mines were operating here (Kudlik 2001: 67), and in 1875, 2,361,885 tons of coal passed down-river and through Lock No. 1 at Pittsburgh.

The establishment of the numerous small coal towns, or patches, as they are called, along both banks of the Monongahela River in Washington, Fayette, and Greene counties, Pennsylvania, owe their existence first to the presence nearby of bituminous coal and second to the river, along the banks of which coal tipples could be easily built and barges filled. The Monongahela River navigation system therefore contributed to the formation of these small coal towns indirectly by facilitating the coal companies' profitable extraction and transport of this valuable mineral. "The western coal trade was not created by the Monongahela Navigation Company, but slack water river improvements were responsible for greatly increasing the volume of the coal trade" (DiCiccio 1996: 32).

Most of the coal production in the Monongahela River Valley was taken over in 1899 by the Monongahela Consolidated Coal and Coke Company, the parent of the later (1916) Pittsburgh Coal Company. The effect of reducing the number of competing smaller coal producers scattered throughout the valley was literally to consolidate not only the production of coal but to provide greater efficiency in its shipment as well. The headquarters of the new firm was located at Pittsburgh and added a considerable number of executive and skilled engineering jobs to that city's work force, in addition to working-class jobs repairing and refitting the now-huge numbers of coal boats, barges, and towboats owned and operated by the company. The River Division of Consolidated Coal Company has long expressed interest in maintaining and improving the quality of the Monongahela River navigation system and has linked the welfare of that system not only to their own business but to the economic well-being of the Monongahela River Valley as a whole (Kudlik 2001: 52).

The amount of coal shipped down the Monongahela River continued to increase as new mines in the upper reaches of the valley were opened in the late nineteenth and early twentieth centuries. Coal business interests came to have a powerful voice in the conditions of river navigation. Always opposed to the toll charges imposed by the Monongahela Navigation Company, the Pittsburgh Coal Exchange lobbied Congress for the federal government to take over the Monongahela River navigation system and to extend the system into coal-rich West Virginia. As noted earlier, the federal government finally assumed control over the Monongahela River navigation system's locks and dams through eminent domain in 1897 and subsequently constructed Locks and Dams Nos. 8-15 on the upper river.

The earliest record of settlement at Webster in Rostraver Township, Westmoreland County, dates to 1841, when Matthew Beazel obtained a deed for lot number forty-seven (West 1990: 1). Economically, however, the town received a boost about 1873 from the development of the Monongahela River coal and coke industries. Town growth also was promoted by the presence of a steamboat landing that persisted well into the twentieth century (Kudlik 2001: 46). The development of the coal and coke industries in Webster was promoted by the proximity of the Monongahela River and the availability of the navigation system that allowed shipping of these bulk products down river.

The era of coal towing soon broadened out to include other products as well: gravel and sand, iron and steel, coke, grain, iron ore, cement, stone, limestone, foodstuffs, textiles, and petrochemicals. Coal, sand and gravel, and iron and steel always stood out clearly from

the others. In the first three decades of the twentieth century, coal and coke taken together accounted for about twenty times the tonnage of either iron and steel or sand and gravel even though coal shipments on the river dropped sharply between 1929 and 1932 (Tomer 1939: 39; 40, Figure 10).

Coke hauling on the Youghiogheny and Monongahela rivers had begun in the Connellsville area in the 1830s. A successful "trial run" of coke for iron making was conducted at Graff, Bennett and Company's Clinton Furnace along the Monongahela River at Pittsburgh in 1860, and the coke was brought down the Monongahela River to the furnace from Connellsville in barges (DiCiccio 1996: 39). The 147-square mile Connellsville coke district of Fayette and Westmoreland counties became the largest coke-producing area in the country during the 1860s. Spurred by the growth in the iron and steel industries required by the Civil War, some 3,000 coke ovens were producing 900,000 tons annually by 1876, and, although the railroads eventually came to dominate this business, large volumes of coke also were being barged down the Monongahela River (Kudlik 2001: 40).

The River Transportation Department of the old Carnegie Steel Company, which became U.S. Steel in 1900, towed coal and coke to the company's Monongahela River plants, originally from Henry Clay Frick's coal and coke operations up the river in the Connellsville district. Towing and barge facilities for this business evolved into one of the largest of its kind in the country, and company publications in the early twentieth century acknowledged the importance of the river navigation system to the success of their ventures. A good deal of the down-river coal business was in transporting coal to the large coke batteries at Clairton on the west bank of the Monongahela River. Although coke originally moved only down the river, by 1936 it also was moving up the river from the Ohio (Tomer 1939: 47). The American Barge Line operated a public terminal at Glassport just down the river from Clairton in the 1930s. It was the only public terminal on the river where a direct transfer could be made between river and rail transportation (Tomer 1939: 31).

Iron and Steel

The transportation of steel and its raw materials, for which Monongahela River towns such as Homestead, Braddock, Rankin, Duquesne, McKeesport, Clairton, and Monessen became nationally and even internationally famous in the second half of the nineteenth and early twentieth centuries, was facilitated by the presence of the Monongahela River navigation system. By allowing efficient and relatively inexpensive transportation for the heavy industries located in the river valley, the Monongahela River navigation system also indirectly supported the population and economic well-being of these and other industrial communities. Utilization of the Monongahela River for the shipment of iron and steel started in World War I as an auxiliary to the rail lines. Increased freight rates after the war led several mills to look to river transport as a less expensive mode of transportation for some limited steel products to distant customers. They also began to ship scrap, pig iron, and molds from blast furnace to the mills by river (Tomer 1939: 47).

In 1922 the Carnegie River Service expanded its services and began to tow finished steel products down the Ohio/Mississippi River systems as far as New Orleans and opened its major river terminal at the Monongahela River town of Munhall between Homestead and Braddock, in 1924. River service for the steel industry was enhanced further by the U.S. Army Corps of Engineers completion of its nine-foot canalization of the Ohio in 1929. By 1934 finished steel products could be shipped directly by river from Pittsburgh down the Mississippi and to the Carnegie-Illinois Steel Company's warehouse in Texas via the Intercoastal Canal (Tomer 1939: 49). Under a series of ownerships, this river transportation service continued throughout the critical days of World War II ceasing operation in 1985 (Kudlik 2001: 55-56).

Industrial Towns

The extension of railroad lines and the construction of steel mills, especially, along the Lower Monongahela River created whole new industrial communities like Homestead and Monessen during the last twenty years of the nineteenth century. The land on which such communities developed remained rural until the 1870s but was eyed by industrial developers who needed large, flat, open spaces for the construction of mills and worker housing and plenty of river water for industrial processing.

The banks of the Monongahela River between Pittsburgh and the Allegheny County line were ideal for such expansion. The McClure and West farms occupied the later town and steel mill sites at Homestead as late as 1870. The Homestead Bank and Life Insurance Company bought both farms with the intention of developing housing on them, but it was not until 1872 that residents could travel to Pittsburgh on a direct rail connection, the Pittsburgh, Virginia, and Charleston line, which reached Homestead in 1872.

Although accessibility to the Monongahela River navigation system certainly would have been important, the establishment of the community here and in the other industrial towns along the Monongahela River between Charleroi/Monessen and Pittsburgh was linked more directly to the arrival of the railroad and to the demands of heavy industry, especially steel. Homestead's first church, for example, always a sign that community growth is underway, dates to 1874, and the Bryce and Highbie glass factory, the town's first industry, to 1878. Homestead's steel industry got underway only in 1881 with the opening of the Kloman mill that was taken over five years later by Carnegie Steel Company (Byington 1974: 4-5). The major steel works at Duquesne arrived in 1889, then up the river to McKeesport, and to the integrated works at Clairton, which produced semi-finished steel for the new Crucible Steel Company. Continuing up the Monongahela River, the Donora works of American Steel and Wire Company went into operation in 1905 (Warren 1973: 134).

Monessen and Charleroi are even younger than Homestead. Although it grew rapidly, even exponentially, in the first three decades of the twentieth century, in 1893 the site of Monessen had eight farmhouses, two barns, and a schoolhouse grouped along a narrow unpaved road. Its development did not get underway until 1894 when the land was purchased for industrial development by the East Side Land Company, headed by James Schoonmaker,

vice-president and general manager of the Pittsburgh and Lake Erie Railroad Company. The development company selected the 211-acre tract because of its proximity to Pittsburgh, cheap supplies of coal, coke, and gas, water, and both river and rail transportation. Pittsburgh Steel Company began its works at Monessen in 1902.

Charleroi dates to 1890, even though Robert McKean had purchased 220 acres of farmland at the site of the later town by 1865 (Martinet 1990: 1). The Charleroi Land Company purchased nearly 456 acres of land between Lock Four (North Charleroi) and Speers after its charter was obtained in 1889. They laid out 1,025 lots on the property and advertised them for sale in area newspapers on March 4, 1890. They also constructed an eleven-acre plate glass company in the town, Charleroi Plate Glass, which became the important business of the town.

Lock Four, which was named after the nearby lock on the Monongahela River, is now often known as North Charleroi although the official name is still Lock Four. North Charleroi was the name given to the post office established there in 1951. The railroad station stop at Lock Four was officially called West Monessen (Martinet 1990: 12-14). It began in 1885 as a part of Fallowfield Township but was granted a separate charter from Washington County in 1894. Without doubt, the presence of the Monongahela River navigation system was an important consideration in the formation (and even the naming) of some of these late nineteenth and early twentieth-century industrial communities, but it was one of many (Magda 1985: 3-5).

OVERVIEW

Although boat building and manufacturing were early developments on the Monongahela River and Upper Ohio River, the lack of safe navigation due to river snags, sandbars, and rock ripples, and the unpredictable and seasonal fluctuations in the depth of water in the rivers continued to restrain trade emanating from Monongahela River communities well into the nineteenth century. This situation became worse the farther upstream one went from Pittsburgh, where lack of navigational improvements impeded population and economic growth as well as community development. While Monongahela River communities were innovative in adopting and improving new boat designs and eventually in adapting steam power to them, the construction of large, complete boats remained difficult except near Pittsburgh itself. Most steamboats built for the Monongahela River trade in 1840, for example, averaged only fifty to sixty tons, about the size of a large keelboat.

By the 1830s, growth in Monongahela River Valley commerce had led to wide recognition that improvement of navigation facilities on the Monongahela River was necessary to further community and regional prosperity. Pittsburgh's earlier commercial competition with Brownsville, exacerbated by the routing of the National road through the latter town in the eighteen teens, had delayed serious attempts by Pittsburgh business interests to improve the river. By the late 1820s or early 1830s, this outlook seems to have been replaced by a greater regional identity that brought the two towns into closer cooperation with each other.

As the frontier advanced westward, Pittsburgh's and Brownsville's competitor towns were now increasingly the growing urban centers farther down the Ohio and Mississippi rivers. The continued absence of effective river navigation facilities now was seen as a deterrent to the growth of the region's economy in several ways: by raising the cost of transportation to and from upriver communities and by limiting the markets available for the sale of Monongahela River Valley products. The opening of the Pennsylvania Canal in Pittsburgh afforded a greater potential market for Monongahela River Valley products and underscored the importance of improving river navigation. At the same time, there was great debate over the respective roles of private corporations, and the federal and state governments in paying for such improvements.

Town development along the Monongahela River (and elsewhere) was well underway before the construction of the Monongahela Navigation Company's navigation improvements in the 1840s. Nine towns had been established in Fayette County by 1796, and there were then eight in Washington County. Town development took place both on rivers and away from rivers.

At least ten towns of some size had been established on the river from Morgantown to Pittsburgh by the beginning of the nineteenth century. Although river navigation

improvements generally facilitated the growth of such towns, the origins of these towns lie more with the availability of water (either directly on the river or at the mouth of a tributary stream), the presence of broad, flat, and fertile floodplains where abundant crops could be grown, the early development of river mills and dams, the presence of roads or at least trails, but especially with the entrepreneurial vision of town proprietors. These individuals, frequently mill owners or men with other business interests, secured property where they wished to begin a town, surveyed it into lots, and then offered the lots for sale to potential buyers (Harper 1991: 83-85). In the late nineteenth century, the development of the lower Monongahela River Valley's industrial towns such as Charleroi and Monessen had a similar origin, although the proprietors in these cases were usually development companies rather than individuals.

Early towns in western Pennsylvania in general served as important centers of local trade and attracted skilled artisans in various trades and crafts. From the late eighteenth century through the early twentieth century, for example, the Monongahela River and the towns along its banks attracted artisans skilled in the construction of river craft. Boat building (and its necessary companions, saw mills and nail factories) developed at many riverside towns, including Pittsburgh, McKeesport, Elizabeth and West Elizabeth, Monongahela City, Webster, North Charleroi (originally known as Lock No. 4), Belle Vernon, California, Brownsville, and West Brownsville. In addition Fayette City, Rice's Landing, and Fredericktown also produced boats from time to time, but at a much lower level of production.

Town and population growth in the Monongahela River Valley was stimulated greatly by the evolution of the coal and coke industries. Coal was mined in small quantities near the river beginning in the late eighteenth century. National demand for it increased, however, as the region felt the full impact of the Industrial Revolution. New markets led to the opening of the Upper Monongahela River Valley coal fields and to the demand both for larger coal barges and locks to accommodate the large-scale exploitation of this valuable mineral. In 1859 there were already some sixty-five coal works active in the Monongahela and Youghiogheny valleys (Thurston 1859: 253-266).

Industrial coal mining in the later nineteenth and early twentieth centuries required the establishment of coal patches and towns near the mines to accommodate workers and their families, and this is the origin of many of the coal towns that dot the Monongahela River banks, especially in Washington, Fayette, and Greene counties. The further growth and development of the river towns in the mid- and Upper Monongahela River Valley may have been hurt more by the slow progress of rail connections up the valley from Pittsburgh during the nineteenth century than they were stimulated by the presence of the river's locks and dams.

In some respects, the failure to upgrade the size of the original locks built on the Monongahela River proved a hindrance to community growth. After the 1880s, passenger steamboats in demand for the nation's inland rivers were too large to be built in the Monongahela River Valley. The hulls were simply too big to get through the existing river

locks. The McFall yards at California, Pennsylvania, for example, produced their last passenger boat hulls for the *Montana* and *Dacotah*, destined for use on the Missouri River. Since the 250-foot long hulls were too big to get through the downstream locks, they had to wait for a freshet to float them over the dams, and the *Montana* was nearly lost in the process (Kudlik 2001: 52). Shortly thereafter, the railroad put its tracks through the middle of the McFall yards, putting an end to boat building there. In another old boat-building town, Elizabeth, established boat yards began to restrict their output to coal barges during the 1870s.

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INVENTORY OF PAST AND PRESENT COMPONENTS OF THE MONONGAHELA RIVER NAVIGATION SYSTEM IN PENNSYLVANIA AND WEST VIRGINIA

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INTRODUCTION

The Monongahela River Navigation System consists of a series of dams, locks, and slackwater pools designed to facilitate navigation of the Monongahela River between its mouth at Pittsburgh, Pennsylvania, and river mile 124.2 near Fairmont, West Virginia (Figure 1). Although the first locks and dams on the river were privately built and operated, the system was acquired by the federal government in 1897 and has been operated by the Pittsburgh District of the U.S. Army Corps of Engineers ever since. The present navigation system consists of nine sets of locks and dams, the oldest of which was constructed in 1905-1907, and the most recent in 1993-1996. Six of the operating facilities are located in Pennsylvania and three in West Virginia. Extant remains of earlier, abandoned components of the system also survive at various locations along the river.

Since the end of World War II, the federal government has been working to modernize the navigation facilities on the middle and upper river. Completion of the Grays Landing Lock and Dam in 1996 was the final stage of this post-war modernization program. The six operational facilities on the middle and upper river (Maxwell, Grays Landing, Point Marion, Morgantown, Hildebrand, and Opekiska) all were constructed after 1945. The Pittsburgh District is now proceeding with plans to modernize its facilities on the lower river, as authorized by Congress in the Water Resources Development Act of 1992. These are the oldest operational components of the system. Dam No. 2 at Braddock and Locks and Dam No. 3 at Elizabeth were constructed in 1905 and Locks No. 4 at Charleroi in 1932. The "Lower Mon Project" would eliminate Locks and Dam No. 3, replace the fixed crest dam at No. 2 with a gated dam, and replace the locks at No. 4 with wider structures. The pool behind Dam No. 2 will be raised by five feet, and the pool between Nos. 3 and 4 will be lowered 3.2 feet (COE 1996: 1).

Under the provisions of Section 106 of the National Historic Preservation Act of 1966, as amended, the effects of this federal undertaking on significant historic properties must be taken into account. In 1992 the Pittsburgh District executed a Programmatic Agreement with the Advisory Council on Historic Preservation and the Pennsylvania State Historic Preservation Office (PA SHPO), stipulating that the Corps would prepare a thematic nomination to the National Register of Historic Places for the Monongahela River Navigation System (COE 1996: 1). Since that time, the Pittsburgh District has performed a number of studies designed to gather information in support of the National Register nomination (e.g., COE 1994, 1996; Gundy *et al* 1996; Hardlines 1998; McVarish 1999). In 1998 the Pittsburgh District requested Heberling Associates, Inc. (HAI) to prepare a Multiple Property Nomination for the Monongahela River Navigation System, including individual nomination forms for Locks and Dams Nos. 2 and 4. This work was to be performed under an Indefinite Quantities Agreement (Contract DACW59-96-D-0004) with Gannett Fleming, Inc., to whom HAI is serving as cultural resources subconsultant.

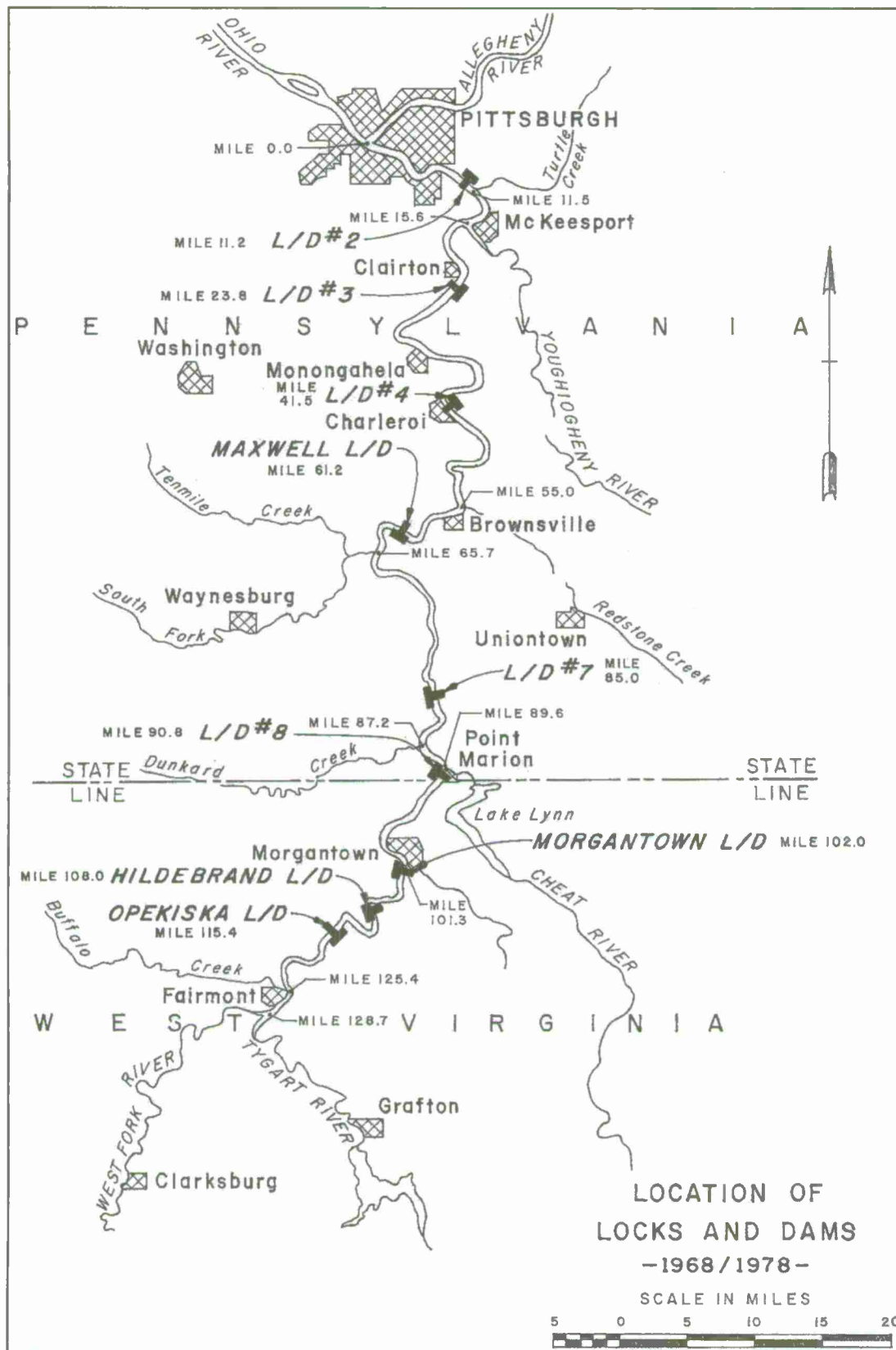


Figure 1

Prior to preparing the Multiple Property Nomination, it was necessary to undertake a comprehensive inventory of all past and present navigation facilities along the length of the Monongahela River in Pennsylvania and West Virginia. The inventory included background research, review of previous studies, and field survey and was completed in 1998-2000. All twenty-seven operational and abandoned navigation facilities were visited and documented. The results of the inventory are presented in this report.

RESEARCH DESIGN AND METHODOLOGY

The goal of the project was to inventory all past and present Monongahela River navigation facilities in Pennsylvania and West Virginia in order to gather information to be used in preparing the Multiple Property Nomination for the Monongahela River Navigation System. The inventory was completed in 1998-1999 by Scott D. Heberling and Douglas Dinsmore of Heberling Associates, Inc. and included background research, review of previous studies, and extensive field survey. It was designed to expand on a previous photographic inventory undertaken by Christine Davis Consultants, Inc. in 1994 as part of a contextual overview of the navigation system (see below). Although that project was not completed, the documentation compiled at that time provided a good point of departure for the present study.

Background research was completed by Scott D. Heberling, Douglas Dinsmore, and Judith A. Heberling on an ongoing basis throughout the project. Information about the navigation system was drawn from numerous sources, including research conducted in 1996 for the *National Register Eligibility Evaluation, Monongahela River Locks and Dams 2, 3 and 4*, prepared by the U.S. Army Corps of Engineers, Pittsburgh District (COE 1996). Much of the technological information was derived from various recent studies completed by the Pittsburgh District, especially the *Monongahela River Navigation System Historical Engineering Evaluation*, prepared for the Pittsburgh District by Douglas C. McVarish of John Milner Associates, Inc. (McVarish 1999). The McVarish study provides a detailed account of the construction history and technological characteristics of the past and present navigation facilities on the Monongahela River and was invaluable for completing the inventory.

General historical information concerning the development of the system was derived from Gannett Fleming Corddry and Carpenter, Inc.'s *History of Navigation Improvements on the Monongahela River* (1980), and Leland Johnson's *The Headwaters District: A History of the Pittsburgh District, U.S. Army Corps of Engineers* (1979). Other very useful sources included the Pittsburgh District's *Draft Historic Contextual Overview of the Locks and Dams on the Monongahela River* (1994), prepared by Christine Davis Consultants, Inc.; *Thematic Study of Civil Works Residences for U.S. Army Corps of Engineers Pittsburgh District* (1998), prepared by Hardlines, Inc.; and a 1994 recordation of Lock and Dam No. 7 by the Historic American Engineering Record (HABS/HAER 1994). *An Overview of Historical Research on the Monongahela River Navigation System* (Carlisle 1997), previously commissioned by the Pittsburgh District, was a useful bibliographic finding aid.

Information also was gathered from primary documents, including Annual Reports of the U.S. Army Corps of Engineers officer in charge of the Monongahela River, on file at the Pittsburgh District. Other documents in the Pittsburgh District's files and archives were reviewed, as were related documents from local and regional repositories, including the Historical Society of Western Pennsylvania and the Carnegie Library of Pittsburgh. Early twentieth century Sanborn fire insurance maps, examined at the Carnegie Library, provided

information about the spatial configuration and appearance of facilities in urban areas, such as Brownsville (COE No. 5) and North Charleroi (MNC/COE Boatyard). The District's extensive collection of historic photographs documenting the construction and alteration of each of its facilities is an extraordinarily valuable research tool which was extremely useful in compiling the inventory. Numerous historic photographs from that collection were used in preparing the National Register nomination forms for Locks and Dams Nos. 2 and 4.

Record Group 77 (Records of the U.S. Army Corps of Engineers) at the National Archives Cartographic and Architectural Branch in College Park, Maryland contains many historic maps, photographs, and other documents pertaining to the early Monongahela River navigation facilities operated by the Monongahela Navigation Company and the Corps of Engineers. A 1947 promotional publication by the Dravo Corporation provided information concerning several Monongahela locks and dams that had been constructed by that company in the first half of the twentieth century (Dravo Corporation 1947). Land and tax records were examined at the Washington, Greene, and Fayette County (PA) courthouses in order to clarify the ownership histories of certain properties that were believed to have a possible association with the navigation system.

All twenty-seven operational and abandoned navigation facilities were visited as part of the field survey, most of them on more than one occasion. Although Tygart Dam near Grafton, West Virginia, is considered part of the Monongahela River Navigation System, the District's scope-of-work stipulated that it was not to be studied in detail, and thus it was not visited. The nine operational navigation facilities were documented through 35mm black-and-white photography, but detailed maps were not drawn since the Pittsburgh District maintains current maps of all of its present facilities.

In most cases, Corps employees were interviewed for information on current operations and recent modifications. At Morgantown Lock and Dam, the staff lent the investigators a number of excellent color photographs of the facility that were taken during and after its construction in the mid-twentieth century. At each abandoned facility, the present use, condition, and integrity of the property were recorded, and any surviving navigation-related features were documented through detailed mapping and 35mm black-and-white photography. One abandoned facility (MNC No. 7 near Greensboro, PA) is now completely inaccessible by road, and there were landowner problems at another (COE No. 11, at Uffington, WV); these were documented from the opposite bank of the river. All of the others were examined on foot.

Pennsylvania and West Virginia historic inventory forms were completed for all properties and were submitted to the appropriate State Historic Preservation Offices. The information in the present report is a summary of the contents of the state inventory forms, which were prepared in 1999-2000. The comprehensive photographic documentation of the system is being submitted to the Pittsburgh District separately and will become part of the District's files.

This report was prepared in May 2000 and revised in January 2001. The historical background section was written by Judith A. Heberling and Scott D. Heberling, and Scott Heberling was the author of the other sections. The technological information presented here is based primarily on the *Monongahela River Navigation System Historical Engineering Evaluation*, by Douglas C. McVarish of John Milner Associates, Inc. (McVarish 1999).

MONONGAHELA RIVER NAVIGATION SYSTEM: AN OVERVIEW

Historical Background

Because of its size and topography, the United States was tied to its rivers from the very beginning. Development proceeded from the coasts up the major rivers to the fall lines and, subsequently, along all navigable rivers and streams. Land transportation was difficult, expensive, and slow, and a nation that depended upon the sale of agricultural crops that were ultimately perishable had to get its products to market as expeditiously as possible. As a result, inland areas all depended upon river commerce.

The traffic and commercial tonnage carried on western Pennsylvania rivers was always heaviest on the Ohio and Monongahela, and the pressure for improvements was felt much earlier along those more-heavily used rivers, particularly the shallow Monongahela. River improvement, like other forms of transportation-related projects, was largely seen as the province 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 benefited a *national* rather than a *local* constituency. The line between the two often was blurred, and in 1823 James Monroe, a strict constitutional constructionist, declared that federal involvement in "national" internal improvements was legitimate so long as the actual control over the contractors remained in state hands. Before 1824 the federal role in navigation was restricted almost entirely to such activities as building lighthouses and improving harbors.

The State of Pennsylvania took an early interest in the Monongahela River, declaring it a public highway in 1782 and beginning navigation improvements ten years later. In its natural state, the Monongahela could be extremely difficult to navigate, as rapids, narrow channels, sand bars, snags, and boulders were common hazards. The velocity of the current was only two to four miles per hour at best. In the summer, low water could make it nearly impossible for boats to travel any distance. Many boatmen considered three feet to be navigable, but the river was rarely that deep over its full length. Only shallow-draft vessels, such as canoes, rafts, flatboats, and keelboats, could normally be used on it in its unimproved state, and many people had to wait for the spring freshets to carry them successfully down the Monongahela.

The first state-funded improvements on the Monongahela River consisted simply of channel clearing and snag removal, but they coincided with the first great wave of emigration into the Ohio country and the old Northwest Territory. Thousands of people setting out for new homes in what are now the states of Ohio, Indiana, Illinois, Tennessee, and Kentucky floated down the Monongahela River on their way to Pittsburgh and the Ohio River. In the spring, when the river was high, transportation was easy. In the summer when the water level dropped, people had to wait for weeks or sometimes months to launch their flatboats,

keelboats, and rafts to start on their way west. They also had to find their way around the many private dams and weirs that individuals had erected along the course of the river.

In 1814 and 1815, the Pennsylvania legislature recommended surveys of the Monongahela with an eye to further river improvement, and legislators in southwestern Pennsylvania counties, particularly Fayette, seemingly could introduce bills on only one subject—the improvement of river navigation. The report recommended a series of sixteen locks and dams that would enable boats to use the river the year around, and in 1817 the state chartered the (first) Monongahela Navigation Company to implement the plan. The legislature appropriated money for stock in the new company, but when the charter expired in 1822 before construction had begun, the General Assembly transferred the funds to channel-dredging and snag-removal projects instead. These continuing improvements facilitated navigation from the mouth of the Monongahela at Pittsburgh upriver as far as Morgantown by 1826 (COE 1996: 3).

1824 was 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. It was largely the rapid development and subsequent impact of the steamboat on western rivers that led Congress to pass the waterways improvement legislation as early as 1824.

Americans had 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 Robert Fulton and John Stevens proved that steamboats had a commercial future. The advantage of steamboats was that they could move back upstream under their own power and could carry a full load of both passengers and cargo. The new vessels were adopted enthusiastically, and the period between 1815 and 1860 was “the golden age of the river steamboat.”

Steamboats were the driving force behind the industrial development of the Monongahela-Allegheny-Ohio-Mississippi Valleys during the forty-five years preceding the Civil War. 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.

While steamboats quickly became familiar sights on western rivers, they did not threaten the flatboat industry and, in fact, actually encouraged it. Boatmen could now return 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 Pittsburgh region entered the boat-building business early in the nineteenth 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—Elizabeth, Monongahela, Belle Vernon, McKeesport, and California—developed impressive construction operations (Kudlik 2001, this volume).

The success of early river improvements on the Ohio and Mississippi led Congress to extend the authorization of its 1824 survey legislation to the Monongahela River. In 1828 a state-funded survey of the Monongahela had been performed by Edward F. Gay, a Pennsylvania Canal engineer, who recommended construction of a series of ten stone masonry locks and eight timber-crib dams to canalize the river from Pittsburgh to [West] Virginia. Gay proposed that a four-foot deep channel be maintained over the entire distance and recommended that the locks should measure 26 feet wide by 120 feet long. He estimated that the project would cost \$300,000.

Gay preferred river improvements to the other alternative—a canal—due to lower construction and maintenance costs. The river's gradual gradient in the lower and middle valley (a fall of only seventy-five feet over a distance of eighty-nine miles) would require relatively few locks (COE 1994: 13). Gay selected potential locations for locks and dams based on the existence of shoals, sand bars, and rock outcrops, so that little or no excavation into the riverbed would be necessary. Because he wanted to preserve existing mill sites wherever possible, he carefully considered the implications of raising the pool level at each location. The availability of stone, lime, and other construction materials was taken into account as well (COE 1994: 13).

A second survey—this one federally-funded—was conducted in 1833 under the direction of Dr. William Howard of the Army Corps of Engineers to investigate the possibility of improving steamboat navigation on the Monongahela River between Pittsburgh and Brownsville. Like Gay, Howard rejected the concept of a canal and instead recommended the construction of a series of locks with dams that flatboats could pass over in high water. He recommended eight potential sites for locks, only three of which had been on Gay's list. Again most were located at existing shoals, sand bars, and ripples in the river. Howard estimated that the project would cost \$213,286.

Neither the federal government nor Pennsylvania was anxious to finance the improvements recommend by Gay and Howard (COE 1994: 15-16; COE 1996: 4). The State of Pennsylvania curtailed its funding of unrelated river improvements while it concentrated on the construction of the Pennsylvania Main Line Canal. However, public interest in river navigation did not diminish, and on March 31, 1836, the state chartered a private corporation, the (second) Monongahela Navigation Company, whose purpose was 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 heavy commercial traffic because it crossed a formation containing an exceptionally rich bed of bituminous coal. Coal and coke were shipped by river to Pittsburgh and beyond, and these boats too were affected by the seasonal height of the water in the river (Kudlik 2001, this volume). Monongahela River sand was also in demand by Pittsburgh-area glass manufacturers who wanted a guaranteed source of this vital reserve (COE 1994: 17).

Monongahela River navigation was caught up in the continuing competition for economic supremacy among the cities vying for control of commerce between the Atlantic coast and the Ohio Valley. Merchants in Pittsburgh were afraid that without improvements on the Monongahela, vital commercial traffic would be sent west on the National Road, the Chesapeake and Ohio Canal, the Baltimore and Ohio Railroad—or possibly even farther north on the Erie Canal. People in Washington, Greene, Fayette, and southern Westmoreland Counties also promoted Monongahela River commerce over improvements on the Ohio, construction of the Pennsylvania State Works, or any other direct, toll-free route that crossed the central or northern part of the state and was thus of no immediate benefit to their area. Their idea of internal improvements involved protecting and enhancing their own interests, and, as a result, they supported the National Road and navigation on the Monongahela and Youghiogheny Rivers (Kehl 1956: 70).

The legislative act that chartered the Monongahela Navigation Company also provided start-up funding for construction, as well as directions for the acquisition and use of building materials. The legislature's intention was to prevent self-interest and self-dealing on the part of company managers by prohibiting their involvement in direct commercial transactions on or along the river. Tolls were to be set at the same level as those already being collected by the Schuylkill Navigation Company in eastern Pennsylvania.

W. Milnor Roberts, a nationally-known canal engineer, was named chief engineer for the new project in 1837. The following year, Roberts completed another, more detailed, survey of the Monongahela that recommended fewer but higher dams and very large locks that would facilitate steamboat navigation on the river. Roberts's 50-foot by 190-foot locks were equal to the largest in the world, far bigger than the locks on the recently-completed Pennsylvania Canal. All of the dams were to be eight feet high. As in the previous surveys, the proposed lock sites were at existing shoals and deep ripples in the river, where navigation was difficult for much of the year and where little excavation would be necessary. The state legislature approved Roberts's plan over the complaints of existing commercial interests, such as mill owners and flatboat/keelboat operators, who feared that the improvements would eliminate or interfere with their business activities (COE 1994: 18-19; COE 1996: 4).

The Monongahela Navigation Company let the contract for the first two locks and dams (at Pittsburgh and Braddock's Lower Ripple at the mouth of Turtle Creek) in mid-December of 1837, but construction did not really get under way until the summer of 1839. A few months later, Roberts, as a result of new studies on locks designed for steamboat traffic, recommended relocating and redesigning the first two facilities. The Monongahela system was one of the first in the United States to be designed specifically for steamboats (COE 1994: 19).

The nationwide Panic of 1837 profoundly affected the Monongahela Navigation Company and its construction project. Congress ceased funding inland navigation for more than four years—between 1838 and 1842—and, when the Bank of the United States failed, the money promised to internal improvements evaporated. The financial crisis affected all transportation projects being constructed or subsidized by state and federal funding, from navigation on the Ohio River to the State Works to the National Road to the Monongahela River. When the MNC ran out of funds in 1841, Roberts left the Monongahela River project, and was replaced as chief engineer by Sylvanus Lothrop (COE 1994: 20; COE 1996: 4).

The financial exigencies of the late 1830s and early 1840s soured the people of Pennsylvania, as well as federal and state legislators, on public funding for internal improvements. The State of Pennsylvania determined to sell its stock in various transportation companies and projects across the Commonwealth. In 1843 a group of local businessmen under the leadership of James K. Moorhead purchased the state's shares in the Monongahela Navigation Company at the bargain price of \$3.00 each, creating a privately-held company organized to complete the construction of the river improvements. All of the new stockholders had previous experience in transportation and engineering, and most owned river-related businesses. Moorhead, who was known by the nickname of "Old Slackwater," previously had been a contractor on the Pennsylvania Canal, and the MNC had awarded him the contract for Monongahela Locks Nos. 1 and 2 (COE 1994: 20-22; Johnson 1979: 93).

The new owners reorganized the Monongahela Navigation Company, issued bonds to secure further funding, and repaired the damage that had occurred to the first two locks and dams since their opening in 1841 (extending slackwater for eighteen miles upriver). By November 1844, the first four locks and dams were in place and were opened to river traffic

of all types. Commercial shipments of coal, sand, and other natural materials increased dramatically. Over 30,600 tons of coal passed through Lock No. 1 in 1844, all of it mined along Pool No. 1. By the following year, the first full year that all four locks were in operation, the total reached 184,207 tons; the greatest amount originated along Pool No. 1, with smaller amounts from the upper three pools (Carlisle 2000, this volume). In Pittsburgh, the price of coal was cut in half, providing an immediate benefit to local industries (Kudlik 2001, this volume).

The completion of Locks and Dams Nos. 3 and 4, near Elizabeth and Belle Vernon, made it possible to navigate on five feet of slackwater for nearly sixty miles, as far as Brownsville. Each of the locks was 50 feet wide by 190 feet long (with a usable length of 158 feet), large enough to accommodate the rafts and steamboats then in use. Although the Monongahela Navigation Company's financial stability remained a question for several years, by 1853 the appreciated value of the stock coupled with growing freight revenue made it possible for the company to pay off its remaining debt. Steadily-increasing coal traffic induced the MNC to add an additional, larger lock, 56 feet wide by 250 feet long (216 feet of usable length), at both Nos. 1 and 2. These were completed in 1848 and 1854, respectively. Boat operators hoped that these larger locks would enable them to compete more effectively against the emerging competition from railroads (Kudlik 2001, this volume).

In 1856 as coal mines continued to be opened farther upriver, the MNC completed Locks Nos. 5 and 6 at Denbo and Rice's Landing, extending slackwater navigation to New Geneva, eight-five miles above Pittsburgh. The amount of traffic and commercial tonnage on the Monongahela continued to increase, but the MNC, again in debt, petitioned the Commonwealth to postpone the construction on Lock and Dam No. 7, a plea that was granted in 1857.

Five general types of goods were shipped on this slackwater navigation system: agricultural products, extractive resources, manufactured goods, livestock, and eastern merchandise, but the most important of the products, without doubt, continued to be coal (Reiser 1951: 62; Carlisle 2001, this volume). The coal trade provided the fuel for Pittsburgh's furnaces, foundries, and mills that produced munitions and armament during the Civil War. In addition, Monongahela Valley coal powered the boats that the Union used to keep the Mississippi River open for travel and shipping during the war and also was consumed in vast quantities by the railroads (COE 1994: 25-29; Gannett Fleming Corddry and Carpenter 1980: 2-5; Gundy *et al* 1996: 58-59; Johnson 1979: 107).

Through the 1860s, no railroads were constructed in the Monongahela Valley above McKeesport, so virtually all coal and other freight was moved by boat or barge. Through the rest of the nineteenth century, railroad construction proceeded only very slowly along the Monongahela, to the benefit of the boat and barge operators (Kudlik 2001, this volume). The slow progress of railroads through the valley was a testament to the success of the slackwater system and the efficiency with which barges could transport metal and raw materials produced near the river (COE 1994: 28).

The system transformed the coal industry overnight by providing navigable water at the loading areas near the mines. Shipping costs were slashed, and consumers were ensured a reliable supply of coal that was no longer dependent on river conditions. There would be no more calamities like that which occurred in 1840, when all of the coal boats between Brownsville and Pittsburgh were trapped by low water in the autumn and destroyed by winter ice. Furthermore, convenient access to large quantities of extremely cheap coal gave Pittsburgh manufacturers a huge competitive advantage over downriver rivals, who also relied on Monongahela Valley coal, but at inflated prices. It has been said that "it was these great quantities of coal, cheaply and regularly transported, that was at the core of Pittsburgh's early manufacturing development" (Kudlik 2001, this volume). Between 1844 and 1872, nearly 31 million tons of coal passed through the locks of the Monongahela Navigation Company. This was 1,068,871 tons per year or, at 4,000 tons of coal to the acre, "the equivalent of about 267 acres of the Monongahela River Valley floated down the river and through the MNC's locks annually for 29 consecutive years" (Carlisle 2001, this volume). Every coal barge that passed through a lock represented a toll paid to the MNC, whose revenues increased steadily over this period.

The slackwater system also had a tremendous impact on the boatbuilding industry in the lower Monongahela valley. The huge increase in river commerce that occurred after construction of the locks and dams on the lower river led to an intensification of boatbuilding activity at a host of towns. Hundreds of hulls and completed vessels were constructed at local boatyards for both local and downriver customers, including large vessels destined for the Ohio and Mississippi rivers. During 1852-1856, 362 steamboats were built between Brownsville and Pittsburgh, as well as even larger numbers of barges and flatboats (Kudlik 2001, this volume).

The success of the Monongahela system led to the construction of a private system of two locks and dams on the Youghiogheny River in 1848-1850, creating four feet of slackwater as far upriver as West Newton. Although this system was heavily used, contributing to the economic development of both the Youghiogheny and lower Monongahela valleys, the Yough is a very different river from the Mon, and the Youghiogheny Navigation Company could not recover sufficient tolls to repair frequent damage caused by ice jams and the swift Youghiogheny current. As a result, the system was often in disrepair. It was offered for sale in 1861, but there were no buyers. The dams were not rebuilt after they were severely damaged by an ice-flood in 1867, effectively ending the brief period of steamboat navigation on that river (COE 1994: 30-31; Johnson 1979: 99-100; Kudlik 2001, this volume).

Following the Civil War, mining and business interests in Morgantown and Fairmont, West Virginia, called for extending slackwater navigation on the upper Monongahela River. In 1871 federal legislation provided funds for surveys of the upper river. The MNC, however, held only a Pennsylvania charter, and private funds for the upriver venture could not be raised. Federal funding was obviously necessary, and the government and the Monongahela Navigation Company negotiated a solution by which the Corps of Engineers constructed Locks and Dams Nos. 8 and 9, and the MNC, No. 7. Lock and Dam No. 9

became operational in 1879, followed by No. 8 ten years later. MNC Lock and Dam No. 7 was placed into service in 1884. These three upper locks and dams provided slackwater as far as Morgantown, with the entire river from Pool No. 7 into West Virginia under federal control. Lock No. 8, where the valves and gates were powered by turbines, was the first facility on the Monongahela River that was not operated by hand (COE 1994: 27, 34; DiCicco 1996: 32-33; Gannett Fleming Corddry and Carpenter 1980: 5; Johnson 1979: 128-129).

Lock and Dam No. 9, at Hoards Rocks, West Virginia, was notable because it was the first facility on the river to be constructed directly by the Corps of Engineers, rather than the Monongahela Navigation Company. It also incorporated several technological innovations, including the use of culverts in the lock walls to fill and empty the chamber, instead of valves or wickets in the gates. It also marked the first use of Stoney valves in this country (McVarish 1999: 92).

The demand for coal increased dramatically as industrial enterprises of all kinds in Pittsburgh and the surrounding area, as well as in other cities along the Ohio, Mississippi, and Missouri Rivers, multiplied. The development of mild steel production by 1875, using Bessemer and open-hearth methods, required large amounts of coke made from Monongahela Valley coal, much of it from the Connellsville area. Vast quantities of coal were carried downriver by barges. By the late nineteenth century, the Monongahela was carrying more tonnage than any other inland river in the United States, despite its relatively short length. This continued to be the case in 1928, when 85.1 percent of the freight shipped on the river was coal and coke. Most of this coal and coke was carried only a short distance (an average of 41.4 miles in 1928), underscoring the fact that the Monongahela Valley was not only the country's leading producer of coal and coke but also the principal consumer (Carlisle 2001, this volume).

To meet the demands imposed by increasing river commerce, the MNC added second locks to Nos. 3 and 4 in 1884 and 1886, respectively. Like the second locks at Nos. 1 and 2, the new locks at Nos. 3 and 4 were 56 feet wide, but the length was increased to 277 feet. At the time of its construction, the new lock at No. 3 was the largest in the United States. Minor modifications were made to Lock No. 5 to extend its usable length by six feet (COE 1994: 28-29; COE 1996: 7; DiCicco 1996: 41; Gannett Fleming Corddry and Carpenter 1980: 5-8; Gundy *et al* 1996: 47-48; Johnson 1979: 128).

Almost from the beginning of the Monongahela River Navigation System, boat operators and coal companies had resented the payment of tolls to the MNC, and after the U.S. Army Corps of Engineers began constructing its own locks on the upper river, there was increasing agitation for the federal government to take over the entire system and operate it for free. In 1884, Congress authorized the U.S. Army Corps of Engineers to purchase all or part of the locks and dams of the MNC, but the company was unwilling to sell. Even the sale of Lock No. 7 was out of the question. When the Corps initiated condemnation proceedings to acquire the MNC's properties, the MNC fought the condemnation all the way to the Supreme Court. In the largest condemnation suit in American history prior to 1900, the

Court decided in favor of the federal government, and, in 1897, after a decade of litigation and payment of just under \$4 million to the Monongahela Navigation Company, the Corps of Engineers assumed control over MNC property. This created a single free navigation system between Pittsburgh and Morgantown, West Virginia (COE 1994: 32-33; Gannett Fleming Corddry and Carpenter 1980: 11-12; Johnson 1979: 141-143).

Acquisition of the Monongahela Navigation System presented significant challenges to the Corps of Engineers. A previous study by the Pittsburgh District (COE 1996: 7) has noted, "despite the navigation system's increasingly heavy usage and importance...it essentially remained a nineteenth century steamboat project patched up to handle twentieth century barge-tow commerce. The system of locks and dams at that time was fundamentally as planned by the MNC in the 1840s, at or near the original sites, with improvements limited to rebuilding or reinforcing dams, and enlarging locks."

After acquiring the system from the MNC, the Corps immediately began an ambitious plan of expansion and renovation. Between 1897 and 1903, six new lock-and-dam facilities (Nos. 10-15) were constructed on the upper river, extending slackwater navigation to the headwaters of the Monongahela near Fairmont, West Virginia. Each facility had a single 56-foot by 182-foot lock chamber, a concrete fixed-crest dam, and a similar complement of support buildings. These and all subsequent structures differed from the earlier facilities in that concrete was the primary structural material. Only a few years earlier, concrete had first been used for river lock construction in Kentucky (COE 1996: 6; Gannett Fleming Corddry and Carpenter 1980: 12-15).

By the time that the federal government acquired the system, several of the MNC's older facilities had become seriously deteriorated. In addition the small locks were inadequate to handle the large tows that had become common on the river. Over the next twenty years, the Corps of Engineers repaired or replaced most of the facilities on the lower and middle sections of the river. Locks and Dam No. 2 was the first facility to be recommended for replacement, and in 1906 was completely reconstructed at a new location downriver. Locks and Dams Nos. 3 and 5 were also relocated, with construction completed in 1907 and 1909, respectively. Each of these facilities had two locks, measuring 56 feet wide by 360 feet long.

In 1909-1915, both locks at No. 1 were reconstructed to the same dimensions, followed by the locks at No. 4 in 1912-1917. A second lock was added at No. 6 in 1915, and the support facilities were modernized (Gannett Fleming Corddry and Carpenter 1980: 17-27). By World War I, all of the locks on the lower river had been rebuilt to the new standard dimensions of 56 feet by 360 feet. The Pittsburgh District also installed movable crests (Betwa wickets and Chittenden drums) on the lower dams during this period, but their performance was unsatisfactory, and they were replaced with concrete fixed-crests in 1921 (COE 1996: 6; McVarish 1999).

After the war, the Corps planned additional changes to the system. No. 4 was rebuilt at a new location in 1932. Locks and Dams Nos. 7 and 8 also were rebuilt at new locations,

each with a higher lift, resulting in the elimination of Lock and Dam No. 9. The closing of No. 9 became the first of a series of consolidations by which a higher lift was used to reduce the number of locks and dams. By these changes, the Corps hoped to speed transit time on the river and reduce labor and maintenance costs in lock operations. Each of the new locks was 360 feet long, the current Monongahela standard (Gannett Fleming Corrdry and Carpenter 1980: 23-27).

The next consolidation occurred in 1938, when the Emsworth Dam on the Ohio River was replaced with a gated structure, raising the upper Ohio pool by seven feet. The deeper pool extended into both the Monongahela and Allegheny rivers, eliminating the need for both Monongahela Locks and Dam No. 1 and Allegheny Lock and Dam No. 1. Monongahela No. 1 at Pittsburgh was closed that year (Gannett Fleming Corrdry and Carpenter 1980: 35; McVarish 1999: 18). Also in 1938, the Pittsburgh District constructed a reservoir on the Tygart River in West Virginia (Tygart Dam) to augment the flow on the upper Monongahela River during periods of drought.

After World War II, the Corps of Engineers initiated its second major improvement program, this time focusing on the navigation facilities on the middle and upper river. Many of the facilities then in operation had been constructed in the early twentieth century and were now obsolete. The first to be closed (in 1946) were the Corps' repair shops and boatyard at North Charleroi, which were consolidated with the Ohio River repair shops on Neville Island (COE 1996: 7).

Locks and Dams Nos. 10-15 in West Virginia all were replaced over the next two decades. The new Morgantown Lock and Dam was completed in 1950, replacing Nos. 10 and 11. Hildebrand Lock and Dam was constructed in 1956-1960, permitting the removal of Nos. 12 and 13. Opekiska Lock and Dam was placed into service in 1964, replacing Nos. 14 and 15. On the middle river, Nos. 5 and 6 (at Brownsville and Rice's Landing) were replaced by a single new facility, Maxwell Locks and Dam. At Lock and Dam No. 8, a new lock chamber, 84 feet wide and 600 feet long, replaced the old one; the new complex was renamed Point Marion and opened in 1994. Grays Landing Lock and Dam was completed in 1996, eliminating the need for No. 7 near Greensboro.

The Corps' present plans to modernize the locks and dams on the lower river (the "Lower Mon Project") represent the final stage of its post-war modernization and consolidation program. The project will replace the existing fixed-crest dam at No. 2 (to be renamed Braddock Locks and Dam) with a new gated dam, raising Pool No. 2 by five feet. Locks and Dam No. 3 at Elizabeth will be removed. Locks No. 4 will be replaced by larger chambers, and the facility will be renamed Charleroi Locks and Dam. Along the Monongahela River, the minimum depth over the sills will be eleven feet after the planned construction is completed. Eight lock and dam facilities will provide slackwater the length of the Monongahela, where fifteen once were needed. All will have been constructed after World War II.

In Pennsylvania the coal trade continues to drive the renovation and construction of the Monongahela River locks and dams. The 30 million tons of coal hauled annually on the river constitute the largest and most important commodity on the lower section. The shipping of West Virginia coal with its higher sulfur content, has declined dramatically, however, leaving the upper Monongahela locks and dams with comparatively little industrial traffic.

Technological Overview¹

According to McVarish (1999: 89), the general principles of lock and dam operation have changed little since the Monongahela River Navigation System was initially constructed, but what has changed over time are the lock and dam materials, construction techniques, size, and technology. He considers the evolution of the Monongahela River navigation structures to have occurred in three phases: the Monongahela Navigation Company operation (1840-1890), the early Corps of Engineers operation (1879-1945), and the post-war Corps of Engineers operation (1945-present).

Monongahela Navigation Company Locks and Dams (1840-1890)

The earliest navigational structures on the Monongahela River were constructed using hand-operated derricks and simple earthen dike cofferdams (Jansen 1948: 26). These cofferdams provided the dry conditions that were needed for construction of the locks and dams. Later a central cutoff wall of wood sheeting was installed to make the dams more watertight, and the dike was covered with riprap to prevent scour (McVarish 1999: 102).

The early Monongahela Navigation Company river dams (Nos. 1-6, all built in the 1840s and 1850s) varied in length from 600 feet to 1,100 feet, with the length decreasing as one moved upstream. All were timber cribs filled with stone and gravel, faced with thick timber planks to prevent damage from water-borne debris. The cribs were constructed of large logs laid in alternate courses crossing each other at right angles, forming open cribs of seven to nine feet each. The walls were built up perpendicularly from the bed of the river to near the water level, at which point they sloped up to the crest. The mass of the stone-filled cribs helped to secure the dams in place, but a double course of vertical sheet piling also was used to anchor them to the river bottom (MNC 1840: 31).

The first locks were constructed of smooth-dressed cut stone set in hydraulic cement founded either on wood or on gravel and sand, with floors of heavy longitudinal timbers covered with heavy planking. They had chambers 190 feet long and 50 feet wide, large enough to pass the relatively small boats currently being built along the river. Like the dams, the guidewalls and guardwalls above and below the locks were constructed of stone-filled timber cribs. The miter gates were constructed of white oak, with 12-inch white oak sills. Originally the gates were opened on rollers that moved along a semi-circular track in the floor

¹This section is based mainly on the *Monongahela River Navigation System Historical Engineering Evaluation* prepared by John Milner Associates for the Pittsburgh District (McVarish 1999: 89-101).

of the lock, powered by submarine chains. There were serious problems with this system because the rollers were often entangled with drift, logs, snags, and other debris, that interfered with the movement of the gates. The MNC soon reconstructed the gates so that they were suspended from posts on the lock walls, using a design patented by Henry McCarty, assistant to John Sanders of the Pittsburgh Engineer Office. This allowed the gates to swing open and closed like house doors (Johnson 1979: 97).

Initially the gates were opened and closed by hand by means of chains wound on hand-powered capstans located on top of the lock walls. In 1876 Superintendent George W. Lutes devised a new system to take advantage of the current passing over the dam at Lock No. 3. He installed a waterwheel which operated a system of drums, shafting, clutches, and gearing and allowed the automated opening of a lock gate in thirty seconds, an eighth of the time it took by hand (Johnson 1979: 156). The MNC subsequently installed this system in Locks and Dams Nos. 1 through 4.

In later years, lock chambers were filled through valves in the head bay, and emptied by wickets at the bottom of the lower gates (HAER 1994). The wickets originally were made of cast iron and later of steel. They were operated with a rack and gear mechanism connected to the wickets by chains.

MNC Lock and Dam No. 7, the last to be privately built (1882-1883), incorporated essentially the same technology as Nos. 1-6, with a stone-filled timber crib dam and a 50-foot by 195-foot lock. The lock chamber was constructed of dressed cut stone and had wooden miter gates that were opened and closed with six hand-powered winches. Hand-operated butterfly valves and wickets in the gates filled and emptied the chamber.

Early U.S. Army Corps of Engineers Locks and Dams (1879-1945)

After the U.S. Army Corps of Engineers assumed control of the Monongahela Navigation System, significant improvements were made in lock and dam technology. Notable features of the first Corps-built lock and dam on the river, No. 9 (completed in 1879), included the only stone masonry dam on the river, the first use of culverts through the lock walls rather than valves or wickets in lock gates for filling and emptying the lock chamber, and the first use in the United States of British-designed Stoney valves to open and close the culverts (McVarish 1999: 92). Except for No. 9, concrete was used for all of the new dams constructed by the Corps during this period, a major departure from the earlier crib dams built by the Monongahela Navigation Company.

New innovations were adopted to automate lock operation. By the end of the nineteenth century, miter gates were operated by steam power, except in the river wall of the river chamber, where power was derived from a waterwheel placed in the dam. The waterwheel provided power for a system of drums, shafting, clutches, and gearing that operated the gates. After the turn-of-the-century, electricity generated by a water-powered turbine and generator became the power to open ever-larger gates and valves. During the 1910s and 1920s, water turbines were installed at all of the lower locks and dams, replacing the steam plants.

The Corps embarked on a major expansion of the system at the turn-of-the-century, extending navigation upriver to Fairmont, West Virginia, and reconstructing or replacing many of the older locks and dams on the lower river. Lock and Dams Nos. 10-15 in West Virginia, constructed between 1897 and 1903, were all very similar. All featured fixed-crest concrete dams and had a single lock measuring 56 feet wide and 182 feet long, with six filling valves below the upper miter sill and emptying valves in the lock walls beyond the lower miter sill. The original timber miter gates were later replaced by steel gates. In contrast to the locks on the lower Monongahela, the valves and gates at locks on the upper river were manually operated until World War II.

At about the same time, the Corps began to rebuild the original Monongahela Navigation Company locks and dams on the lower river. The new and reconstructed locks on the lower Monongahela featured much larger chambers (56 feet wide by 360 feet long) to accommodate the larger boats and tows then in use on the river. The older dams were capped with concrete, and the new ones were constructed entirely of concrete. Timber or concrete aprons were added on the downstream side. On the lower river, there were experiments with movable crests (Chittenden drum and Betwa wicket), soon abandoned in favor of raised, fixed concrete weirs. The new locks (Nos. 2, 3 and 5) all had steel miter gates, with culverts and cylindrical or butterfly valves to fill and empty the chambers. The valves could be operated by compressed air or by hand.

Compressed air was the motive power of all of the older lower locks during their last period of operation. The plant consisted of a water turbine connected by bevel-gears to an air-compressor. Air was piped from the reservoirs to the engines operating the valves and gates. It was said that one stroke of the cylinder could open or close a miter gate in forty seconds. The hydraulic cylinder connected to the rack spar machinery consisting of gears, racks, and pinions that operated the lock gates (Stickle 1919: 699). Except for No. 8, which was powered by turbines, all of the upper locks continued to be operated by hand.

Concrete was used for all of the new locks and dams built in the 1920s and 1930s, and butterfly valves and lock gates were now constructed of steel rather than iron and wood. The old manual and compressed air systems that formerly had been used to operate the gates and valves were replaced by gravity-fed hydraulic systems. McVarish describes the hydraulic system at No. 7, which was typical: "water that entered through penstocks turned the spinning vertical wicket turbines that powered the Aldrich hydraulic pump. Oil ran into the hydraulic pumping system, which controlled the gears that opened or closed the butterfly valve to fill or empty the chamber. When the proper water level was attained, the hydraulic cylinder gears operated the lock gate mechanisms to open or close the lock gates" (McVarish 1999: 94).

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

the operations. Turbines already existed at some of the locks. In the 1920s, water turbines were added to Locks No. 5, 7, and 8 (COE 1996: 7).

In the dry summer months, it was not uncommon for a lack of water in the river to interfere with navigation. In an effort to resolve this problem, flashboards were installed on the dams of the lower river. These were vertical boards secured by iron pins in holes in the tops of dams, designed to raise the pool level. In June 1898, the U.S. Engineer Office in Pittsburgh specified that flashboards of sufficient height to raise the pools from twelve to thirty inches were to be installed at Dams No. 1-5. Unfortunately flashboards had significant disadvantages; not only did the boards have to be installed and removed by hand, but, in addition, the boring of numerous holes into the tops of dams for flashboards tended to weaken the dams. It soon became obvious that either the dams had to be raised or the locks lowered. The Corps began to experiment with movable crest dams on the lower and middle river although flashboards remained in use at Dam No. 7. At the turn-of-the-century, Dams Nos. 1 and 5 were equipped with Betwa wickets and Dams Nos. 2 and 3 with Chittenden drums. However, the performance of these movable crest dams was not satisfactory, and in 1921 they were replaced by fixed concrete dam tops (McVarish 1999: 97-98).

Post-World War II Locks and Dams (1945-present)

While the three operational locks and dam complexes on the lower river date in part to the first third of the twentieth century, the six upper lock and dam complexes all were constructed after World War II. The first of these, Morgantown Lock and Dam, opened in 1950, while the most recent, Grays Landing and Point Marion, were completed in the mid-1990s. The technology of most of the modern facilities is similar. All but one use two Tainter valves to fill and two Tainter valves to empty the lock chamber(s), while Morgantown uses butterfly valves. The gates and valves are hydraulically operated.

With one exception, all of the Monongahela River dams constructed after World War II are of the gated, non-navigable type. At the nine operational facilities, Dams No. 2, No. 3 and Grays Landing are fixed concrete weirs, while the remaining dams (Dam No. 4, Maxwell, Point Marion, Morgantown, Hildebrand, and Opekiska) are gated movable structures. By the mid-twentieth century, several different types of movable dam gates had been developed to control the depth of navigational pools, including the roller gate, the Sidney gate, the vertical lift gate, and the Tainter gate. The Monongahela River dams all use Tainter gates, which are less expensive to install than the other types. A combination of submersible and non-submersible gates are used. Tainter gates are the most common gate type used at the Corps' recently-constructed navigational dams (McVarish 1999: 99-100).

The three upper river locks (Morgantown, Hildebrand, Opekiska) incorporate several recent engineering innovations. These include the use of an emergency bulkheading system to dewater selected areas and facilitate inspection and repair of the locks and movable dam gates, and the use of package hydraulic plants for operation of the miter gate and valve machinery. Package hydraulic systems were used at both Grays Landing and Point Marion. A separate system is provided for each gate leaf and each valve, eliminating the need for

hydraulic pumps in the operations building and an extensive network of piping in the culverts. The package hydraulic systems are not only cheaper to construct, but a hydraulic system failure will not cause the entire lock to fail (McVarish 1999: 100).

All locks on the Monongahela River are now operated by an electric-hydraulic system. At these locks, electric power is obtained from the outside power grid and is distributed from electrical panels located in the operations building. This electricity provides the power necessary to operate hydraulic pumps, also generally located in the operations building. The pumps force oil through a series of pipes to the lock gate and valve mechanisms. These mechanisms are operated by means of a hydraulic piston (McVarish 1999).

Support Complexes

Each lock and dam facility required support buildings. These included locktenders' houses, workshops, powerhouses, boiler and engine houses, and lock offices, all of which were necessary for the lock's daily operations. The number and types of buildings that were needed and their physical arrangement at the site, varied according to the construction date of the lock, the builder (MNC or Corps of Engineers), and the technology employed. Support complexes at Monongahela River navigation facilities evolved in response to technological innovations adopted at the locks and dams, and this evolution occurred in four principal phases, corresponding roughly to the three technological phases discussed above.

Monongahela Navigation Company Locks and Dams (1840-1890)

Similar topographic settings were selected for all of the Monongahela Navigation Company's early navigational facilities on the lower and middle sections of the Monongahela River in Pennsylvania (MNC Locks and Dams Nos. 1-7). All of the sites were at existing shoals or ripples, where there was a solid foundation for the dam and where shallow water posed special hazards for river traffic. At each location, the facility occupied a narrow terrace between steep mountain slopes and the river. Similar sites were chosen for the later dams built by the U.S. Army Corps of Engineers in both Pennsylvania and West Virginia.

Support complexes at the Monongahela Navigation Company locks and dams (MNC Nos. 1-7) were not built according to standard specifications. The arrangement of structures varied considerably, according to constraints imposed by terrain and property lines. These complexes tended to include a large number and variety of structures. There sometimes were buildings on the middle lock wall, including an office, engine house and one or more sheds. On the bank adjacent to the lock were one or two brick or frame houses for the collector and locktenders, together with some or all of the following: carpenter shop, blacksmith shop, coal shed, stable, tool shed, warehouse, ice house, wash house, poultry house, and lock office. No MNC-era support structures are known to have survived, although a house at the site of MNC No. 5 is possibly associated with the navigation system.

Early U.S. Army Corps of Engineers Locks and Dams (1879-1904)

The facilities constructed by the U.S. Army Corps of Engineers, beginning at Lock and Dam No. 9 at Hoards Rock, West Virginia in 1874-1879, were more standardized. Each generation of Corps facilities embodied certain general common characteristics. The earliest of the Corps' Monongahela River lock complexes included Original No. 8 in Pennsylvania (built 1882-1889), and Nos. 9-15 in West Virginia. Except for No. 9 (built 1874-1879), all of the West Virginia complexes were constructed within a very short time span (1897-1904), according to standard plans. The original buildings at No. 9 were destroyed by a flood in 1888, and replacements were built in 1893. As a result, the support structures at all seven early West Virginia facilities share a basic similarity of design. Except for No. 8, which had a timber-crib dam like the MNC facilities, and No. 9, which had a solid masonry dam, all of the early Corps locks and dams used concrete as the primary structural material, an important technological advance. Each facility contained a single 56-foot by 182-foot lock chamber, a concrete fixed-crest dam, and a similar complement of support buildings.

Because Locks and Dams Nos. 9-15 all were hand-operated until World War II, none of these facilities had powerhouses. Instead, hand-operated capstans, levers, and winches were used to open and close the gates and fill the chambers. Most of the facilities were in remote locations, so a full complement of support structures was needed. These invariably included two houses for the lockmaster and lockman, a carpenter shop, blacksmith shop, coal house, office, storehouse, and one or more privies. There was little variation in their physical layout. The site plans of Nos. 10, 13, and 14 were identical, and those for Nos. 11 and 12 were the reverse of Nos. 10, 13, and 14. The plans of Nos. 9 and 15 were slightly different from the others, but the minor variations are less important than the overall consistency of design that is characteristic of these facilities.

At each location, there were two locktenders' houses so that the lock could be manned around-the-clock. The two houses were virtually identical but built on reverse plans. Although the houses at Nos. 9 and 10 were distinctive because of their date (No. 9) or location (No. 10), those at Nos. 11-15 all were built on the same plan by the same contractor. Only those at Nos. 9, 10, 12 (one house) and 13 are extant. The Queen Anne-style structures at No. 10 were the most architecturally-distinctive locktenders' houses to be constructed at any of the Monongahela River locks and dams, probably because of their highly-visible location at Morgantown. The others were comfortable but architecturally-undistinguished vernacular structures with little ornamentation and few amenities. A more detailed discussion of the locktenders' houses at the Monongahela River facilities is presented in a recent study of civil works housing constructed by the Pittsburgh District (Hardlines 1998).

The lock office and a storehouse typically stood between the two houses and seem to have been identical at each facility. The office was a small one-story frame building with lap siding and a steep hipped roof; a curved bay window on the river elevation overlooking the esplanade allowed the lockmaster to monitor locking operations. The nearby storehouse was a small one-story gabled structure with multiple doors. In West Virginia, the office has

survived only at Nos. 12 and 13; the former is completely unaltered, but the latter has been modified. A similar office survives at COE Original Lock and Dam No. 8 in Pennsylvania but is in ruinous condition. Extant storehouses are located at Nos. 9, 11, 12, and 13; all are unmodified and in fair condition.

At a rear corner of the property was a row of three utilitarian buildings: the two-story carpenter shop, the one-story blacksmith shop, and a coal house. All were simple frame buildings with lap siding and gable roofs. The carpenter shop at No. 9 was different from the others in that it was only one-story in height; this may be due to its slightly earlier date. Unmodified carpenter shops have survived at Nos. 9 and 12, while extant shops at Nos. 10, 11, and 13 have been altered. Blacksmith shops survive in unaltered form at Nos. 9, 10, and 12, but those at Nos. 11 and 13 have been modified. Intact coal houses survive at Nos. 9 and 12, and privies at Nos. 9 and 10. All of the support structures were grouped on a level platform situated above the esplanade, which was accessed by several flights of stone or concrete steps. The esplanade generally was paved with concrete, although brick or stone occasionally was used.

Middle-Period U.S. Army Corps of Engineers Locks and Dams (1904-1930)

The second generation of Corps facilities date to the first period of modernization on the lower and middle river between 1904 and 1930. These include COE Nos. 1-3, COE Original No. 4, and COE Nos. 5-8. Locks and dams constructed or modernized during this period had fewer buildings, usually two brick or frame houses for the lockmaster and lockman, a power house, an office, and a warehouse. The concrete and brick powerhouses were of standard design, distinguished by a bow front overlooking the locks and esplanade. Some were two stories in height; others were one story, and they could be located on either of the lock walls. Complexes on the lower river had two 56-foot by 360-foot concrete locks, while those above No. 6 had a single lock of the same dimensions. Except for a few short-lived experiments with movable-crest dams, fixed-crest concrete dams were standard. Timber or concrete aprons were added on the downstream side. The new locks (Nos. 2, 3, and 5) all had steel miter gates, with culverts and cylindrical or butterfly valves to fill and empty the chambers.

A variety of original structures have survived at the second generation facilities, including powerhouses at Original No. 4 and No. 7, and locktenders' houses at Nos. 5 and 6. COE New No. 4 was built in 1931-1933, at the end of this period. It included no houses (the Pittsburgh District built no locktenders' houses on the Monongahela River after 1927) but had two powerhouses and an operations/administration building. Because of the types and arrangement of buildings that were present, it can be considered a transitional facility between those of the second and third generations. Examples of support structures built during this period survive at several facilities in Pennsylvania and West Virginia, both operational complexes and abandoned ones.

Post-World War II Locks and Dams (after 1945)

The third generation facilities date to the Corps' second major modernization program, beginning after World War II. They include the facilities at Maxwell, Grays Landing, Point Marion, Morgantown, Hildebrand, and Opekiska, all of which have large locks (84-foot by 720-foot chambers at the Pennsylvania facilities, and 84-foot by 600-foot chambers in West Virginia) and few support buildings. The older lock complexes that have been modernized since World War II, such as COE No. 2 at Braddock, share these characteristics. Associated structures at these facilities typically include only an operations/administration building and a service/maintenance building. These tend to be architecturally undistinguished box-like structures of concrete block construction faced with stucco or brick.

RESULTS

The Monongahela River Navigation System consists of twenty-seven individual properties located along the length of the river (seventeen in Pennsylvania and ten in West Virginia), including both functioning facilities and remnants of abandoned locks and dams (Table 1). Five of the nine functioning facilities are modern, less than fifty years old, while the other four were constructed in the first half of the twentieth century. Of the remaining eighteen properties, seventeen are portions of earlier, abandoned locks and dams, ranging from barely-visible land walls (even this is absent in one case) to lock walls and esplanades with extant buildings. The final property is the former MNC/Corps of Engineers repair facility and boatyard in North Charleroi, Pennsylvania. Tygart Dam Reservoir in West Virginia is also considered part of the system since it was constructed in 1938 to augment flow in the upper river during periods of drought. Other than the boatyard and reservoir, which are functionally distinct from the others, the components of the Monongahela River Navigation System share certain defining physical characteristics. The following types of structures are found in various combinations at nearly all sites:

Reinforced concrete **dams** impound the river at the lock. Only the operating properties have dams, since those at abandoned facilities were removed to eliminate potential navigation hazards. The dams are reinforced concrete set on timber or steel piles. At the nine operational facilities, the dams at No. 2, No. 3, and Grays Landing are fixed concrete weirs, while those at No. 4, Maxwell, Point Marion, Morgantown, Hildebrand, and Opekiska are gated movable structures. Gated dams better regulate the flow of water in the navigation pools upstream of the dam.

Cut stone or concrete **land walls** occur in nearly every property. The land wall formed the land side of the inner lock. Constructed of cut stone or concrete resting on wooden stone-filled cribs or anchored to bedrock, the land walls stand adjacent to the riverbank. Most remnants still exhibit gate pockets and anchors, but others have been covered with fill or capped with concrete for use as a wharf.

Concrete **river walls** occur at all nine operating properties, and at one abandoned facility (MNC/COE No. 4). The river walls form the river side of the locks. For properties with double locks, a middle wall situated between the river and land walls is common to both lock chambers. River walls often contain duplicate controls for the gates and valves and conduits and hatchways for servicing them.

All operating locks have steel **miter gates**, which are lock gates consisting of a pair of symmetrical leaves, movable about a vertical axis, shutting against each other at one end and against the miter-sills at the bottom, and abutting the hollow quoins at the other end. The gates were originally constructed of wood, but steel provided a lower maintenance alternative. The steel gates are horizontally framed with a steel plate skin.

TABLE 1a: MONONGAHELA RIVER NAVIGATION SYSTEM IN PENNSYLVANIA

| PROPERTY | LOCATION (lock, M.M.) | CONSTRUCTION AND CLOSURE DATES | BUILT BY | DESCRIPTION | NAT. REG. ELIGIBILITY |
|--|--------------------------|---|------------------------|--|--------------------------|
| MNC/COE L/D No. 1 | RB, 1.9 | 1838-1851; 1909-1912; closed 1938 | MNC; rebuilt by COE | land wall and dam abutment remain | Yes |
| COE L/D No. 2 | RB, 11.2 | 1904-1906 | COE | operational; locks rebuilt in 1949-53 | Yes |
| MNC L/D No. 2 | RB, 11.8 | 1838-1854; closed 1906 | MNC | no visible remains | No |
| COE L/D No. 3 | RB, 23.8 | 1905-1907 | COE | operational | Yes |
| MNC L/D No. 3 | RB, 25.0 | 1840-1844; 1883-1884; closed 1907 | MNC | land wall remains | Yes |
| MNC/COE L/D No. 4 | LB, 41.2 | 1840-1844; closed 1933 | MNC; rebuilt by COE | two locks, powerhouse, esplanade remain | Yes |
| MNC/COE Boatyard | LB, 41.4 | 1880s; closed 1946 | MNC | brick office/warehouse, repair shops remain | Yes |
| COE New L/D No. 4 | RB, 11.8 | 1931-1933 | COE | operational; new gated dam in 1964-67 | Yes |
| COE L/D No. 5 | RB, 56.5 | 1907-1910; closed 1966 | COE | land wall, esplanade, two houses remain | Yes |
| MNC L/D No. 5 | LB, 82.3 | 1854-1856; closed 1909 | MNC | land wall remains | Yes |
| Maxwell L/D | RB, 61.2 | 1960-1965 | COE | operational | No (age) |
| MNC/COE L/D No. 6 | LB, 68.3 | 1854-1856; 1913-1915; closed 1967 | MNC; rebuilt by COE | land wall, esplanade, two houses remain | Yes |
| Grays Landing L/D | RB, 82.0 | 1988-1996 | COE | operational | No (age) |
| MNC L/D No. 7 | LB, 82.3 | 1882-1883; closed 1925 | MNC | land wall, foundations remain | Yes |
| COE L/D No. 7 | LB, 85.0 | 1923-1926; closed 1994 | COE | land wall, esplanade, powerhouse remain | Yes |
| COE Original L/D No. 8 | RB, 87.1 | 1882-1889; closed 1925 | COE | land wall, esplanade, office remain | Yes |
| COE New L/D No. 8/ Point Marion L/D | LB, 90.8 | 1923-1926; 1958-1959; 1994-1996 | COE | operational; dam rebuilt 1958-59; new lock and operations building in 1994-1996 | No (age) |

TABLE 1b: MONONGAHELA RIVER NAVIGATION SYSTEM IN WEST VIRGINIA

| PROPERTY | LOCATION (lock, M.M.) | CONSTRUCTION AND CLOSURE DATES | BUILT BY | DESCRIPTION | NAT. REG. ELIGIBILITY |
|-------------------|--------------------------|--------------------------------------|----------|---|--------------------------|
| COE L/D No. 9 | RB, 92.4 | 1874-1879; closed 1926 | COE | land wall, esplanade, two houses, carpenter shop, blacksmith shop, storehouse, privy remain | Yes |
| COE L/D No. 10 | LB, 101.5 | 1897-1903; closed 1950 | COE | land wall, esplanade, two houses, carpenter shop, blacksmith shop remain | Yes |
| Morgantown L/D | LB, 102.0 | 1948-1950 | COE | operational | Yes |
| COE L/D No. 11 | RB, 104.1 | 1901-1903; closed 1950 | COE | land wall, esplanade, carpenter shop, blacksmith shop, storehouse remain | Yes |
| Hildebrand L/D | LB, 108.2 | 1956-1960 | COE | operational | No (age) |
| COE L/D No. 12 | LB, 109.1 | 1901-1903; closed 1960 | COE | one house, office, carpenter shop, blacksmith shop, coal house, storehouse remain; land wall and esplanade are submerged | Yes |
| COE L/D No. 13 | LB, 111.6 | 1901-1903; closed 1960 | COE | land wall, esplanade, two houses, office, carpenter shop, blacksmith shop, storehouse remain | Yes |
| COE L/D No. 14 | LB, 115.0 | 1901-1903 closed 1967 | COE | land wall, esplanade remain | Yes |
| Opekiska L/D | RB, 115.4 | 1961-1967 | COE | operational | No (age) |
| COE L/D No. 15 | LB, 124.2 | 1901-1903; closed 1967 | COE | land wall, esplanade remain | Yes |

Guardwalls extend upward and downstream from the river wall of the lock and prevent traffic from straying into the dam. **Guidewalls** extend upstream and downstream from the land wall of the lock and prevent traffic from running aground on the riverbank. **Bulkheads** are of two general types. Lock bulkheads are designed to de-water portions of the lock to permit inspection and repair, while dam bulkheads permit de-watering in the vicinity of the movable dam gates for the same purpose.

A paved or gravel-covered **esplanade**, placed on fill between the land wall and the river bank, occurs in many properties. The esplanade provides a work area for the locktenders and maintenance personnel. Gate and valve controls and tunnels and hatches leading to them are also part of the esplanade. At many locks, the esplanade also covers penstocks, that once carried water to the turbines that were used to drive hydraulic pumps that opened and closed gates and valves. Esplanades often have small control shelters near the lock gates to protect the operators and equipment.

Reinforced concrete or brick **powerhouses** occur at all operating properties and at two abandoned facilities (MNC/COE No. 4, COE No. 7). The powerhouses originally housed steam engines or turbines to provide the power to open and close gates and valves. They were also used as operations buildings, with an office for the lockmaster. The modern properties all have separate **operations buildings**. At facilities constructed in the early twentieth century, the lock **office** was a small frame structure always in a central location overlooking the esplanade.

Workshops, constructed of reinforced concrete, brick, or wood, provided an area for routine repairs. Larger repairs required specialized crews and equipment. In the past, the workshops were generally stand-alone structures, but modern lock and dam complexes usually include them within the operations or maintenance buildings.

Frame, brick, or tile **locktenders' houses** were built for the lock employees and their families. The early MNC facilities generally had only one dwelling for the collector. Facilities built or upgraded by the U.S. Army Corps of Engineers between 1879 and 1927 generally had a pair of houses for the lockmaster and lockman, identical but built on reverse plans. Due to a change in Corps policy, the Pittsburgh District built no houses on the Monongahela River after 1927. None of the facilities constructed after that date have houses, and those at older facilities began to be sold as excess government property or were demolished.

MNC/COE Locks and Dam No. 1
Right Bank at River Mile 1.9
Pittsburgh, Pennsylvania
Abandoned, Public Ownership

The original facilities at Locks and Dam No. 1 were constructed by the Monongahela Navigation Company between 1838 and 1841. This site was located in Pittsburgh's Sixth Ward, 1.9 miles above the mouth of the river. The complex originally consisted of a stone-

filled timber-crib dam, a single stone lock chamber, and several support buildings. Due to increasing river traffic, the MNC added a second, larger lock chamber in 1848-1851. Both locks were completely reconstructed in 1909-1912.

The original dam was a timber-crib, fixed-weir structure, 1,022 feet long, about 60 feet wide, and 18-45 feet high. The pool behind the dam was 9.25 miles long, and it had an elevation of 707.4 feet. Like the dam, the guidewalls were stone-filled timber cribs. In 1910-1912, a concrete top was added to the timber structure and a flat timber apron constructed on the downstream side. In 1920 the experimental movable-crest Betwa-wicket dam was replaced with a fixed-crest concrete dam; the timber apron had already been replaced by concrete in 1915.

The original (river chamber) lock was 50 feet wide by 158 feet long, and the second (land chamber) lock was 56 feet wide by 216 feet long. Their lift was 4.4 feet at normal pool. The lock walls were constructed of heavy blocks of dressed cut stone laid in hydraulic cement, founded on timbers that rested in gravel. The locks were floored with heavy timbers and planks. The lock originally had sluices in the walls and floor for filling and emptying the locks, but these were later replaced with wickets that were operated by a rack and gear mechanism. The gates originally were opened and closed using railways, rollers, sheaves, chains, and crabs, but by 1844 they were operated using chains wound on capstans. This manual system later was replaced by an automated arrangement of drums, shafting, clutches, and gearing, all powered by a waterwheel in the dam. The system was altered further to combine steam power and a waterwheel. Reconstruction of the locks in 1909-1912 increased the dimensions of each chamber to the current Monongahela standard of 56 by 360 feet. During the final operating period, all of the lower lock gates were powered by compressed air.

The Monongahela Navigation Company's property at its Locks and Dam No. 1 included a 0.4-acre strip of land between Second Avenue and the river, containing various support buildings. When the federal government acquired the property in 1897, there were a frame office, a frame engine house, and a frame shelter house on the middle wall, and three brick houses, a frame boiler shed, a stable, a tool house, and two sheds on the esplanade. Several new buildings were constructed at the site during the next two decades. A frame warehouse was added in 1899, and a paint-storage shed in 1903. A new brick powerhouse was constructed on the middle wall in 1910 when the locks were reconstructed. This structure was typical of the powerhouses built by the Corps of Engineers at its Monongahela River facilities between 1910 and 1925: the brick structure measured 48 by 53 feet, with an eight-foot radius two-story bow.

In 1917 the Corps constructed two new houses at No. 1, different from any other locktenders houses built on the Monongahela River before or after. In a major departure from the vernacular four-square houses constructed at other facilities during the preceding decade, the new houses at No. 1 were large Tudor Revival structures, brick on the first floor and half-timbered on the second floor. The houses at No. 1 were unusually elaborate, both inside and out. Though unique in the Monongahela system, they were similar to a style of

locktenders' house that was built at numerous Ohio River dams by both the Pittsburgh and Wheeling Districts (Hardlines 1998: 56-58). While simple vernacular houses may have been considered appropriate for rural locations on the Monongahela River, the Corps may have desired a more costly and formal style for its Pittsburgh facility; it should be noted that the locktenders' houses constructed a decade earlier at Lock and Dam No. 10 in the urban center of Morgantown, West Virginia, were elaborate Queen Anne-style structures that were also unique in the Monongahela system.

Locks and Dams No. 1 were closed in 1938 upon completion of the new Emsworth Dam on the Ohio River, which raised the upper Ohio pool by seven feet. Only the south abutment of the dam and the land wall of the land chamber were extant in 1999. The former is now part of a riverside park, and the latter now functions as a retaining wall for Second Avenue, with concrete slopes extending from the roadway to the top of the land wall. The sites of the houses and other landward structures at Locks and Dam No. 1 are sealed under highway fill and concrete.

The site has suffered a serious loss of integrity through the removal or obliteration of most navigation-related features and subsequent grading and filling associated with highway construction on the right bank of the river. The site is barely identifiable as an historic navigation facility. Although the extant remains (concrete land wall and south abutment of dam) should be considered an eligible component of the Monongahela River Navigation System, the boundaries should encompass only the footprint of these walls and should not include the entire property formerly belonging to the Monongahela Navigation Company and the federal government.

COE Locks and Dam No. 2
Right Bank at River Mile 11.2
Braddock, Pennsylvania
Operational, Federal Ownership

Locks and Dam No. 2 were built by the U.S. Army Corps of Engineers in 1904-1906 to replace the original Locks and Dam No. 2, located 3,200 feet upriver. Modifications were made to the dam in 1921 and 1950, but it retains its original appearance as an overflow weir and effectively illustrates early twentieth century dam technology. The original locks were replaced in 1953, and none of the original support buildings have survived. All of the existing support buildings post-date 1950. In its present configuration, the complex consists of a fixed-crest concrete dam, 720-foot lock chamber, 360-foot lock chamber, concrete land and river walls, floodway bulkhead, concrete esplanade, two operations buildings, and a maintenance building.

The 748-foot long dam was constructed in 1904-1906 as a movable-crest Chittenden-drum-weir dam, consisting of twenty unreinforced concrete sections with ten movable drums. A pier in mid-river divided the dam into two equal sections and contained the water-powered machinery controlling the movable crest. In 1921 a fixed concrete top replaced the deteriorated movable crest. This created a permanent three-foot increase in the pool. In 1950

the dam was shortened to its current length to accommodate a larger lock chamber, and the central pier was removed.

The original locks, constructed in 1904-1905, both measured 56 feet wide by 360 feet long, the standard dimensions for the Monongahela locks built during this period. Their lift at normal pool was 7.85 feet. The original capstan and windlass engines were replaced with new lock gate machinery in 1917. The vertical butterfly valves used to fill and empty the chambers originally were operated by hand, but compressed air generated by a turbine began to be used in 1908. In 1921 new valves were installed in the bottom sector of all of the lock gates.

Both locks were replaced in 1949-1953. The dimensions of the river chamber remained the same, at 56 by 360 feet, while the land chamber was increased to 110 by 720 feet, making it the nation's largest inland river lock chamber. In the reconstruction, butterfly filling and emptying valves were installed, with manual control levers located on the middle wall. The gate machinery consists of a hydraulic-powered rack and sector gear mechanism that is now the norm in Monongahela River locks. Gate controls are located in shelters on the middle wall. Water enters and exits the lock through wall culverts, and there are intake and discharge ports on the land wall, river wall, and middle wall. Floodway bulkhead piers, bulkheads, and machinery were installed in 1951.

The facility originally had a two-story powerhouse, built in 1906-1907. This building followed the same plan as the existing structure at Locks and Dam No. 3, but the structure at No. 2 is no longer standing. Two brick four-square houses for the lockmaster and lockman (1908-1909), a brick warehouse (1912) and a storage building (1912) have also been removed. In 1953 a new operations building was constructed on the site of the old powerhouse. It houses the offices, conference room, and locker room. A metal shell maintenance facility and a trailer are lined up beside it on the esplanade. An additional operations building on the central lock wall contains the electrical and hydraulic machinery. The capstans, used for pulling tows separated from their tugs through the locks, are hydraulically-powered and operated by foot controls.

Locks and Dam No. 2 continues to perform as an integral unit of the Monongahela River Navigation System. Over the years, modifications have been made to ensure structural integrity and adapt to modern towing configurations, including complete replacement of the locks and all support structures. However, the dam remains largely as it was reconstructed in 1921, retaining its historic appearance as an overflow weir. With the exception of the Grays Landing Lock and Dam, all of the post-World War II modernization projects on the Monongahela River have incorporated gated dams, which are visually and functionally distinct from overflow weirs. The concrete fixed-crest Dam No. 2 retains integrity and illustrates early twentieth century dam technology. Although the present locks are replacements, they are at the same site and serve the same function as the original structures. The dam, locks, and support buildings together compose a complete and functioning navigation facility which illustrates the evolution of lock and dam technology in the twentieth century. Locks and Dam No. 2 contribute to the significance of the Monongahela River

Navigation System, and are eligible for inclusion in the National Register under Criteria A and C. The boundary of the historic resource includes the entire federally-owned property, which encompasses the land containing the existing locks, dam and esplanade, and all of the land historically associated with Locks and Dam No. 2.

MNC Locks and Dam No. 2
Right Bank at River Mile 11.8
Port Perry, Pennsylvania
Abandoned, Private Ownership

The original navigation facilities at Port Perry (Braddock's Lower Ripple) were constructed by the Monongahela Navigation Company between 1838 and 1841. This site was just above the mouth of Turtle Creek, and about ten miles above Lock and Dam No. 1 at Pittsburgh. The complex originally consisted of a stone-filled timber-crib dam, a single stone lock chamber, and several support buildings. A second lock chamber was added in 1848-1854.

The original dam was a timber-crib, fixed-weir structure, 916 feet long, about 60 feet wide, and 20-30 feet high. Like the dam, the guidewalls were stone-filled timber cribs. The dam was later reconstructed as a fixed-crest concrete dam on piles founded on gravel.

The original (river chamber) lock was 50 feet wide by 160 feet long, and the second (land chamber) lock was 56 feet wide by 216 feet long. Their lift was 7.85 feet at normal pool. The lock walls were constructed of heavy blocks of dressed cut stone laid in hydraulic cement, founded on timbers that rested in gravel. The locks were floored with heavy timbers and planks. The lock originally had sluices in the walls and floor for filling and emptying the locks, but these were later replaced with wickets that were operated by a system of rods and levers. The gates originally were opened and closed by chains wound on hand-powered capstans, but this manual system later was replaced by an automated arrangement of drums, shafting, clutches, and gearing, all powered by a waterwheel in the dam. In 1887 the system was altered further to combine steam power, a turbine, and a waterwheel.

The Monongahela Navigation Company's property at its Locks and Dam No. 2 included a strip of land between Water Street and the river and an adjacent 50 foot by 150 foot lot of land bounded by Water, Washington, and First streets. Associated buildings were located on the middle and land walls of the locks and on the adjacent lot. Over the course of its existence, the complex included: an engine and boiler house on the middle wall; a second boiler and engine house on the land wall; two dwellings, an office, stables, shelter house, coal house, warehouse, storehouse, and five sheds. All of the buildings were wood-framed, with the exception of one brick house.

The original Locks and Dam No. 2 were closed and removed in 1906, when the Corps of Engineers' new Locks and Dam No. 2 were placed into operation. During the next few decades, the site of the original navigation facility and the rest of the town of Port Perry were completely obliterated by the construction of multiple railroad tracks. By the 1940s, only one

house remained in Port Perry. Tracks now fill the entire terrace between the steep mountainside and the river. It is possible that some visible rubble stonework at the site may be associated with the former navigation facility, but it also may be part of the later railroad grade. There are no documented visible remains of MNC Locks and Dam No. 2, and the site is no longer identifiable as an historic navigation facility. Because of its lack of integrity and the absence of visible remains, the site of MNC Locks and Dam No. 2 is not eligible for the National Register.

COE Locks and Dam No. 3
Right Bank at River Mile 23.8
Elizabeth, Pennsylvania
Operational, Federal Ownership

Locks and Dam No. 3 is located near the borough of Elizabeth, Pennsylvania, at river mile 23.8. It was built by the U.S. Army Corps of Engineers in 1905-1907 to replace the original Locks and Dam No. 3 (built between 1840 and 1844) at Watson's Run, located about 1.2 miles upriver from the present site. In its present configuration, the complex consists of a fixed-crest concrete dam, 720-foot lock chamber, 360-foot lock chamber, concrete land and river walls, middle wall operations building, land wall office and maintenance building, and a concrete esplanade.

The 684.4-foot long concrete dam was completed in 1908. Like Dam No. 2, Dam No. 3 originally had a 3-foot high movable Chittenden-drum crest, with a pier in mid-river that contained the water-powered machinery controlling the movable crest. In 1921 a fixed concrete top replaced the deteriorated movable crest, but it is reported that some of the original machinery still exists within the extant central pier. The guardwalls originally consisted of 10-foot wide concrete caps on timber cribs, but now consist of circular steel sheet piling cells.

The two locks were built in 1905-1907 and measured 56 feet wide by 360 feet long, the standard dimensions for the Corps' Monongahela locks built on the lower river during this period. The chamber walls were constructed of concrete founded on rock, with a lift at normal pool of 8.2 feet. The land chamber originally was divided into two smaller chambers by an internal set of gates, like the river lock at No. 5. In dry seasons, the internal gates were used to reduce the amount of water required to lock single vessels or small tows. In 1922-1924, the land chamber was lengthened to 720 feet, and it is believed that the internal gates were removed at that time. The steel miter gates originally were operated by capstans and compressed air engines. The cylindrical and butterfly valves used to fill and empty the river and land chambers were operated by compressed air generated by a turbine. In 1921 new valves were installed in the bottom sector of all of the lock gates, and five filling ports were placed in the river wall.

The concrete in the structures had become seriously deteriorated by the late 1930s, and the Corps of Engineers undertook a major resurfacing project in 1939-1940. By 1978 continued deterioration necessitated another major rehabilitation project. Although the river

chamber's dimensions remained the same (56 by 360 feet), an auxiliary set of gates was added and the river wall was extended, allowing the river lock to function temporarily as a 56 by 751 foot chamber. It remains usable today, but since the land chamber empties into the downstream extension of the river chamber, both cannot be used simultaneously. In addition to the river lock modifications, the 1978 renovations included extending the upper guard-wall, renovating gate and valve operating machinery, refacing and resurfacing lock walls, changing the operating system from air to hydraulic, and renewing the electrical system. Currently, the miter gates are operated by a hydraulic-powered rack-and-sector mechanism connected to the gate leaves by sector arms, strut pins, and strut tubes; this mechanism is now the norm in all Monongahela River locks.

The original landwall powerhouse was a two-story structure with a hipped roof. Although substantially altered, part of the structure survives and now serves as an office and maintenance facility. Other original buildings included an operations building on the middle wall and a one-story frame warehouse on the land wall, since removed. The operations building survives in altered form. In 1906-1907, the Corps built two brick four-square locktenders' houses on the hill overlooking the locks and dam. Similar but not identical to the extant houses at COE No. 5, the houses at No. 3 were removed in the 1970s, when that portion of the federal property was sold. In 1911 a new one-story brick powerhouse was built on the river wall. It was typical of the Monongahela River powerhouses built between 1910 and 1930, with a flat roof and an upriver end resembling a rounded ship's bow. It has not survived.

Locks and Dam No. 3 continue to perform as an integral unit of the Monongahela River Navigation System. The dam retains its original appearance as an overflow weir, with a historic modification, the 1921 removal of the Chittenden drum weirs and their replacement with a concrete cap. The locks have been repaired and altered over the years, but retain their 56-foot width, which distinguishes Locks No. 3 (and No. 4) from all of the other operational navigation structures on the river. With the 1907/1921 dam, they possess integrity of feeling and association with the historic system, as well as integrity of location, design, setting, and materials. The dam, locks, and support buildings together compose a complete and functioning navigation facility which illustrates the evolution of lock and dam technology in the twentieth century. The boundary of the historic resource includes the present federally-owned property, containing the existing locks, dam, and esplanade.

MNC Locks and Dam No. 3
Right Bank at River Mile 25.0
Watson's Run, Pennsylvania
Abandoned, Private Ownership

The original navigation facilities at Watson's Run were constructed by the Monongahela Navigation Company between 1840 and 1844. This site was two miles above the town of Elizabeth and about twenty-three miles above Lock and Dam No. 1 at Pittsburgh. The complex originally consisted of a stone-filled timber dam, a single stone lock chamber, and several support buildings. A second lock chamber was added in 1883-1884.

The dam was a timber-crib, fixed-weir structure, 687.5 feet long, about 60 feet wide, and 20-35 feet high. The guidewalls also were stone-filled timber cribs. The original (river chamber) lock was 50 feet wide by 158 feet long, and the second (land chamber) lock was 56 feet wide by 277 feet long. When it was completed in 1884, the land chamber was the largest lock on the Monongahela River. The lift of the locks was 7.44 feet at normal pool. The lock walls were constructed of heavy blocks of dressed cut stone laid in hydraulic cement, founded on timbers and concrete that rested in gravel and sand. The locks were floored with heavy timbers and planks. The mechanisms used for filling and emptying the lock chambers and operating the gates were the same as at the other MNC locks.

The MNC's property at its Locks and Dam No. 3 included an irregularly-shaped lot of land between the river and the tracks of the Pittsburgh, McKeesport & Youghioghney Railroad, and two smaller lots between the railroad and S.R. 2001. Associated buildings on the large lot included: a two-story brick house with a frame addition for the lockmaster, with an adjacent frame coal/ice/bake house; a two-story frame office with a bay window overlooking the locks; frame carpenter, blacksmith and paint shops; a frame stable; and a frame shed. A small railroad station and a stable stood on MNC property between the railroad and S.R. 2001. None of these buildings are extant.

There is no evidence that the Corps of Engineers constructed new houses or other major structures after it acquired the property from the MNC in 1897. Instead, plans began to be made almost immediately to replace Locks and Dams No. 3 with a new facility 1.2 miles downriver. In the meantime, it is likely that the old MNC structures were used by Corps employees. The original Locks and Dam No. 3 were closed and removed in 1907, when the Corps of Engineers' new Locks and Dam No. 3 were placed into operation.

In the twentieth century, the site became an industrial facility producing concrete products, and this function continues today. The site was graded to provide a level parking and storage area, and new buildings were erected. The only visible remains of the earlier MNC facility are the stone landwall and some stone steps at the riverbank. There is no public access. The property has suffered a serious loss of integrity and is only marginally identifiable as an historic navigation facility. Although the stone land wall should be considered an eligible component of the National Register-eligible Monongahela River Navigation System, the boundaries should encompass only the footprint of the wall, and should not include the entire former Monongahela Navigation Company property.

MNC/COE Locks and Dam No. 4
Left Bank at River Mile 41.2
North Charleroi (Frey's Shoals), Pennsylvania
Abandoned, Private Ownership

This facility is located at North Charleroi (formerly Lock Four), Pennsylvania, at River Mile 41.2. The original lock and dam were built by the Monongahela Navigation Company in 1840-1844, extending slackwater navigation to Brownsville. The complex originally consisted of a stone-filled timber-crib dam, a single stone lock chamber, and

several support buildings. A second lock chamber was added in 1885-1886. Both locks were reconstructed by the U.S. Army Corps of Engineers in 1912-1917.

The dam was a timber-crib, fixed-weir structure, 608 feet long, about 56 feet wide, and 20 feet high. Like the dam, the guidewalls were stone-filled timber cribs. After the federal government acquired the Monongahela River Navigation System in 1897, the Corps of Engineers rebuilt the guide cribs (1898), lengthened the dam by 100 feet and constructed a new sloped concrete abutment (1904), and lengthened both the guide- and guardwalls (1922).

The original (river chamber) lock, opened to navigation in 1844, was 50 by 160 feet long. The land chamber was built in 1885-1886 and measured 56 by 226 feet. In 1912-1917, the Corps of Engineers reconstructed both locks to dimensions of 56 by 360 feet, the standard dimensions for the Monongahela locks built during this period. They had a lift of 11.15 feet at normal pool. The physical characteristics of the locks and the mechanisms used to operate the valves and gates were typical of all the MNC facilities. When the locks were reconstructed in 1912-1917, butterfly and cylindrical valves were installed. The butterfly valves were operated by a sector gear mechanism and rack mechanism powered by a compressed air piston, and the cylindrical valves were powered by a compressed air cylinder. The butterfly valves could also be operated by hand, if necessary. In 1921 new valves were installed in the bottom sector of all lock gates.

The MNC property included eleven acres of land on the left bank of the river, and four acres on the right bank. The property on the left bank included two separate lots, one at the locks and the other at the MNC boatyard just upriver. In 1887 the buildings at the two sites included one frame office, one frame cement house, one frame blacksmith shop, one frame coal house, one frame ice house, one brick house for the collector, five new frame houses for other lock employees, and one frame carpenter shop (U.S. Congress, House, *Ex. Doc. No. 112*, 49th Congress, 2nd sess., 1887: 22). Of these, the five new frame houses and either the carpenter shop or the cement house were located at the boatyard, while the others were at the lock. The office was a small one-story structure situated in a central location overlooking the locks and esplanade. The blacksmith shop stood just to the north, also near the locks. At the rear of the property, adjacent to the tracks of the Pittsburgh, Virginia & Charleston Railroad, which bisected the MNC property, were several utilitarian buildings (poultry house, warehouse, and icehouse). The collector's brick house was located to the south of the other buildings, at the upper end of the complex. It was similar to the collectors' houses built by the MNC at its other locks, two stories in height with a frame rear wing.

After the federal government acquired the property, most of the MNC buildings were removed. In 1902-1904, the collector's house was replaced on the same site by a new two-story wood-framed hipped-roof house. This house was identical to the locktenders' houses that the Pittsburgh District currently was constructing at its new upper river locks (Nos. 11-15) in West Virginia. In 1939 it was occupied by the clerk for the lock and boatyard. In 1902-1904, a new office was constructed at the lower end of the complex, identical to the offices built at Monongahela Locks Nos. 8-15 during that period: a small one-story structure with a steeply-pitched hipped roof, dormers, and a bay window overlooking the locks.

In 1919 two Craftsman-style bungalows were constructed at the upper end of the property, one for the lockmaster, and the other for the boatyard superintendent. These houses, the only ones of this type to be constructed by the Pittsburgh District, were based on a 1917 design developed by the Corps. They were one-and-one-half stories in height, with a low-pitched gable roof, external cladding of stucco and wood shingles, a gable-roofed front porch, and the flowing floor plan characteristic of the Craftsman style (Hardlines 1998: 59-61). When the locks were reconstructed in 1912-1917, a two-story brick powerhouse was constructed on the middle wall. This structure was typical of Monongahela powerhouse architecture during that period, with a rounded bow end and a flat asphalt roof. The powerhouse at No. 4 was identical to the one at No. 6 built at the same time.

The facility at North Charleroi was closed in 1933 following completion of the Corps' new Locks and Dam No. 4 just upriver. The dam was removed, but the lock walls were left in place, contrary to the standard practice of removing all navigational hazards at abandoned facilities. The property was sold as excess government property and has been owned by an oil company in recent years. All landward buildings were removed, and the site now contains a two-story concrete block office/boiler house, a refueling shed, and a number of large fuel storage tanks. The land wall, middle wall, and river wall still survive, but in very deteriorated condition. The shell of the powerhouse also survives, but it is vacant and deteriorated, with many broken windows. The site is surrounded by a chain-link fence, and public access is not permitted. The adjacent site of the MNC collector's house and the later Corps clerk's house is vacant, although a poured concrete retaining wall dating to the period of Corps ownership still bounds the lot.

Despite the loss of many features, important components of Locks and Dam No. 4 have survived, and the site is still easily recognizable as an historic navigation facility. All three walls of the two early twentieth century locks are extant, as is the associated powerhouse. This is the only abandoned facility on the Monongahela River to retain its middle and river walls or middle wall powerhouse. By helping to illustrate the evolution of lock and dam technology in the early twentieth century, these structures are important components of the National Register-eligible Monongahela River Navigation System. Unfortunately, the landward portion of the former MNC/Corps property has suffered a severe loss of integrity through the removal of all navigation-related structures and their replacement by intrusive fuel storage tanks and modern oil company buildings. Because the landward portion of the site lacks integrity, the boundaries of the National Register property should include only the land wall, the lock chambers, and the powerhouse.

MNC/COE Boatyard
Left Bank at River Mile 41.4
North Charleroi, Pennsylvania
Abandoned, Private Ownership

The site of the Monongahela River Navigation System's former repair facility and boatyard is located at North Charleroi (formerly Lock Four), Pennsylvania. This facility was responsible for the maintenance of boats, locks, and other equipment throughout the system. The original buildings were constructed by the Monongahela Navigation Company in the mid-1880s, and the federal government greatly expanded the scope of the operation after it assumed control of the navigation system in 1897. As part of the Corps' post-World War II modernization and consolidation program for the system, the functions of the North Charleroi facility were consolidated with those of the Corps' Ohio River repair shops on Neville Island. In 1949 the land and buildings were sold as excess government property. The facility is currently owned and operated by the Channel Holdings Corporation as a manufacturing plant.

The present facility includes most of the property historically associated with the boatyard, as well as two additional parcels on Seventh Street. It consists of a large lot on the east side of Monongahela Avenue between Fifth and Seventh Streets, an adjacent riverfront parcel north of Fifth Street, and a small lot at the southwest corner of Monongahela Avenue and Fifth Street. The property at 624 Monongahela Avenue, which contains a house formerly owned by the federal government and used as boatyard employee housing, is now privately-owned.

Existing structures on the site include three large industrial buildings and four smaller ones. One large structure and all four smaller ones are remnants of the federal boatyard, while the others are recent additions. The major historic building is a brick office and warehouse fronting on Monongahela Avenue, built between 1925 and 1944. It consists of a two-story section (office) and a one-story section (warehouse). Attached to the south end of the warehouse is a large new industrial building that now dominates the streetscape. Two small industrial buildings are located at the southeast corner of the property near the riverbank; both were built between 1925 and 1944. During the Corps era, the larger structure functioned as a paint shop, and the smaller as an oil house. At the northwest corner of the property is a modern industrial structure that occupies the former site of a two-story frame warehouse shown on historic maps. Two small frame buildings stand on the lot at Monongahela and Fifth: the former boatyard office and a former carpenter shop/garage. Both date to the early twentieth century.

During the Corps era, gantry cranes and storage sheds were located on the parcel north of Fifth Street. A rail line connected the boatyard complex with the Corps' Locks No. 4, several blocks north. This area is vacant and unused today. A high concrete retaining wall bounds the main complex on the east. At the base of this wall, is a rocky beach along the edge of the river. During the late Corps era, there were a number of racks used to store lock gates and boats. All that remain today are several concrete footers. There is no trace of the incline formerly used to launch boats into the river.

The final property historically associated with the boatyard is a small lot at 624 Monongahela Avenue. It was owned by the federal government between 1903 and 1937, and contains a two-story frame house once used house boatyard employees. Now privately owned, the house retains integrity.

Despite the loss of many buildings and features from the period when it served as a boatyard and repair facility for the Monongahela River Navigation System, the site still contains notable remnants of that complex. Surviving historic structures include the circa 1930s brick office and warehouse building, the paint shop and oil house; the early twentieth century garage and office structures; and the circa 1891 employees' house at 624 Monongahela Avenue. The retaining wall and remnants of the storage racks along the river also survive. While historic buildings have been removed, and modern buildings added, enough of the early twentieth century complex remains to convey a sense of historic land use and functional relationships among buildings and features.

The boatyard is still linked to nearby Locks No. 4 by a strip of open land along the riverbank, just as it was throughout the historic era. In addition, there is continuity of use between the site's historic and current functions. The boatyard is an important component of the navigation system, and represents a unique property type not found elsewhere in the system. It retains integrity of location, setting, design, materials, workmanship, feeling and association and is eligible for the National Register under Criteria A and C. The boundaries correspond to the historic boundaries of the boatyard complex, together with the house and lot at 624 Monongahela Avenue and the lot containing the early twentieth century office and carpenter shop/garage.

**COE New Locks and Dam No. 4
Right Bank at River Mile 41.5
Monesson Vicinity, Pennsylvania
Operational, Federal Ownership**

COE New Locks and Dam No. 4 is located on the right bank of the Monongahela River at river mile 41.5, across from the borough of Charleroi. It was built by the U.S. Army Corps of Engineers in 1931-1933 to replace the original Locks and Dam No. 4, located about 0.6 mile upriver from the present site. Pool No. 4 is 19.7 miles in length and has an elevation of 743.5 feet. In its present configuration, the complex consists of a gated dam with concrete piers and steel Tainter gates, two lock chambers, concrete land and river walls, a land wall powerhouse, an operations/administrative building, and a concrete esplanade.

The original 551-foot long dam, a fixed-crest weir, was constructed of concrete founded on piles in gravel. In 1964-1967, the dam was replaced in order to raise the pool by six feet and eliminate COE Lock No. 5. The replacement dam is a gated concrete spillway structure adjacent to the upstream side of the original dam and consists of pier monoliths, piers, gate sill monoliths, and a service bridge. The lowered crest of the original dam now serves as a stilling basin and apron for the new gated dam. Two non-overflow Tainter gates

are located in the interior bays of the dam, and there are three movable-crest Tainter gates of the Sidney design in the two bays adjacent to the locks and in the end bay adjacent to the abutment.

Both locks were constructed in 1931-1933. The river chamber measures 56 by 360 feet and the land chamber 56 by 720 feet; they have a 16.6-ft lift at normal pool. The locks have concrete gravity-section walls founded on piles in gravel. The land chamber has butterfly valves supplemented by electric wickets in the bottom of the gates, with control levers located on the lock walls. The miter gates are operated by a hydraulic-powered rack-and-sector mechanism connected to the gate leaves by sector arms, strut pins, and strut tubes; this mechanism is now the norm in all Monongahela River locks.

The land wall powerhouse is a two-story rectangular building with a flat asphalt roof. The foundation, walls, and floors are concrete. The interior of the powerhouse was modified in 1963, and today it serves as a combination powerhouse and maintenance building. Another powerhouse originally was constructed on the river wall with a vertical-shaft turbine beneath it, but this building is no longer extant. An original two-story concrete operations/administration building, built in the same style as the powerhouse, is located on the middle wall; it received a new platform in 1974 but otherwise is essentially unchanged from its original appearance. The original concrete esplanade also is intact. There were no locktenders' houses at this site.

Locks and Dam No. 4 continues to perform as an integral unit of the Monongahela River Navigation System. The two locks have been repaired over the years, but they retain their original dimensions and appearance. The narrow 56-foot width of both lock chambers distinguishes Locks No. 4 (and No. 3) from all of the other extant navigation structures on the river. The middle wall operations building and land wall powerhouse are original structures which have undergone few exterior alterations. The gated dam is a 1967 replacement which is quite different from the original concrete fixed-crest dam, but it is located adjacent to the site of the original dam and fulfills the same function; it possesses integrity of feeling and association with the historic system, as well as integrity of location, design, and setting. The dam, locks, and support buildings together compose a complete and functioning navigation facility that illustrates the evolution of lock-and-dam technology in the twentieth century. Therefore, COE New Locks and Dam No. 4 is an eligible component of the Monongahela River Navigation System. The boundaries include the entire federally-owned property consisting of a linear tract between the Pittsburgh and Lake Erie Railroad and the Monongahela River. Additionally, a small area on the opposite bank includes the abutment of the dam.

**COE Locks and Dam No. 5
Right Bank at River Mile 56.5
Brownsville, Pennsylvania
Abandoned, Public/Private Ownership**

The U.S. Army Corps of Engineers constructed Locks and Dam No. 5 at Brownsville, Pennsylvania, in 1907-1910 to replace the deteriorated MNC Lock and Dam No. 5 at Denbo, 1.8 miles upriver. COE No. 5 consisted of a concrete dam, two lock chambers, an esplanade, concrete powerhouse, office, warehouse, and two brick houses for the lockmaster and lockman.

The concrete dam was founded on crib-pile and was 555 feet long. It was originally built with a movable Bctwa wicket top, like that at Dam No. 1, which could temporarily raise the height of the dam by three feet. In 1921 the deteriorated movable-crest was replaced with a concrete top, as was done at Dams Nos. 1-3. Dam No. 5 was anchored by a massive stone abutment on the left bank of the river, 265.5 feet long, 47 feet high, and 21.5 feet wide at the base.

The concrete lock chambers were both 56 by 360 feet long, had a lift of 12.4 feet at normal pool, and were filled and emptied using steel cylindrical and butterfly valves. These valves could be operated by compressed air or by hand. The river lock originally was divided into two smaller chambers by an internal set of gates, like the land chamber at No. 3. In dry seasons, this reduced the amount of water required to lock single vessels or small tows. In 1921 new valves were installed in the bottom sector of all of the lock gates.

The 1909 powerhouse was a one-story concrete structure located on the river wall over the turbine wells. Measuring 12 feet wide by 60 feet long, it was typical of the Monongahela

River powerhouses built in the early twentieth century, with a flat roof and an upriver end resembling a rounded ship's bow. The powerhouse was replaced by a new operations building in 1941. Other support structures included a lockmaster's office on the middle wall, probably similar to the one at COE No. 3, and a warehouse on the esplanade. Today the only remnant of any of these structures is the poured concrete foundation of the warehouse.

In 1911 two brick four-square houses were built for the lockmaster and lockman. They still survive and are located at 602 and 610 Water Street, across the Monongahela Railroad tracks from the rest of the complex. As was standard Corps practice at its Monongahela facilities, the houses are mirror images of each other, built on reverse plans. According to the detailed survey information on these houses provided in a previous study (Hardlines 1998), they represent one of three different four-square house designs constructed by the Pittsburgh District in the early twentieth century. The same design was employed at Allegheny Lock No. 2 and Monongahela Locks and Dams No. 2. Those at Monongahela No. 5 and Allegheny No. 2 are the only surviving pairs. After the abandonment of Locks and Dam No. 5, the locktenders' houses were sold; both are now privately owned and used as single

family rental units. The Hardlines study recommended that they are eligible for the National Register under Criteria A and C, and they were included in a National Register nomination prepared by the Pittsburgh District.

COE Locks and Dam No. 5 was closed in 1966 after a new gated dam was constructed at Locks and Dam No. 4, raising Pool No. 4 by six feet. At the same time, the new Maxwell facility at river mile 61.2 was completed, and Locks and Dams Nos. 5 and 6 at Brownsville and Rice's Landing were eliminated. The dam and most of the lock at No. 5 were removed at that time, but the land wall, esplanade, and one control shelter are extant and accessible to the public. The poured concrete foundation of the former warehouse is also visible. The esplanade and other features are overgrown with vegetation and are deteriorating. Their condition is notably poorer than when they were last documented in 1994.

Despite the loss of many features, important components of Locks and Dam No. 5 have survived, and the site is still easily recognizable as an historic navigation facility. The concrete land wall, esplanade, warehouse foundation, dam abutment, and one control shelter all are extant, as well as the two intact locktenders' houses on the other side of the railroad tracks. There are no modern intrusions to detract from the setting. As a group, the remains represent a good—albeit incomplete—example of an early twentieth century Corps-built lock and dam complex and help to illustrate the evolution of lock and dam technology during that period. For this reason, the property is eligible for the National Register as part of the Monongahela River Navigation System. Because the site retains its integrity of setting and design, the boundaries of COE Locks and Dam No. 5 should correspond to the legal boundaries of the former federally-owned property, including the associated houses, which are now privately owned.

MNC Lock and Dam No. 5
Left Bank at River Mile 58.3
Denbo, Pennsylvania
Abandoned, Private Ownership

The site of MNC Lock and Dam No. 5, built by the Monongahela Navigation Company in 1854-1856, is located near the village of Denbo, about 2.5 miles upriver from the town of Brownsville, Pennsylvania. The complex originally consisted of a stone-filled timber-crib dam, a single stone lock chamber, and several support buildings.

The 20-30-foot high crib dam was founded on gravel and was 620 feet long. This dam was a segment of a circle with the convex side upward. Like the dam, the 118-foot long lower guidewall and 108-ft long upper guardwall were stone-filled timber cribs. The pool behind MNC Lock and Dam No. 5 was 9.75 miles in length and 746.41 feet in elevation. The lock chamber was 50 feet wide by 158 feet long and had a lift of 10.93 feet at low water. The lock's length later was extended by six feet (the maximum extension possible without lengthening the lock walls) in order to better accommodate the longer coal barges then in use.

The physical characteristics of the lock and the mechanisms used for operating the valves and gates were the same as described for the other MNC locks. In addition to the lock, dam, and walls, the complex included a frame office, a frame collector's dwelling, a stable and carpenter's shop, a corncrib, a shed, and a privy. All of the buildings stood on a one-acre lot adjacent to the lock (U.S. Congress, House, *Ex. Doc. No. 112*, 49th Congress, 2nd sess., 1887: 22). MNC Lock and Dam No. 5 was closed in 1909 when the U.S. Army Corps of Engineers constructed a new Lock and Dam No. 5 a few miles downriver at Brownsville. A series of industries subsequently occupied the site, which is now used as a concrete products manufacturing facility, with little visible evidence of its original use. A portion of the stone land wall is the only extant feature that can be definitely associated with MNC Lock and Dam No. 5.

A previous survey identified the building currently used as the concrete company office as the MNC collector's house (Hardlines 1998:36-37), but this has not been verified; the building's location seems to be the same as that of the collector's house shown on a 1897 plan, but the configuration is different. Deed research was of no assistance in determining the original function or construction date of the building. In any event, it has lost integrity through the application of asbestos siding and alteration or blocking of many window and door openings.

The site of MNC Lock and Dam No. 5 has suffered a serious loss of integrity through the removal or obliteration of most navigation-related features, grading and filling associated with its conversion to a concrete manufacturing facility, and the addition of numerous modern buildings and sheds. The site is only marginally identifiable as an historic navigation facility. Although the stone landwall should be considered a contributing element of the National Register-eligible Monongahela River Navigation System, the boundaries should encompass only the footprint of the wall, and should not include the entire one-acre property formerly owned by the Monongahela Navigation Company and federal government.

Maxwell Lock and Dam
Right Bank at River Mile 61.2
Maxwell, Pennsylvania
Operational, Federal Ownership

Maxwell Locks and Dam are located on the right bank of the Monongahela River at river mile 61.2, near the town of Maxwell, Pennsylvania. The facility was constructed by the U.S. Army Corps of Engineers between 1960 and 1965 to replace Lock and Dam No. 5 at Brownsville, 4.7 miles downriver. The Maxwell facility consists of a gated dam, two lock chambers with steel miter gates, an operations building, an office, a maintenance building, and a concrete esplanade.

The 460-foot dam is constructed of concrete and steel and founded on rock with a five-gated concrete spillway, a downstream stilling basin with baffles and end sill, piers, an abutment, and a service bridge. The dam piers support the crest gates and the service bridge and are founded on the lock river wall and the abutment. There are five welded structural

steel crest gates, two double leaf radial submergible gates, and three standard radial non-submergible gates. The Maxwell Pool's normal level is 763.0 feet, and its length is 20.8 miles.

Both lock chambers measure 84 feet wide by 720 feet long and have a lift of 19.5 feet at the normal pool. The locks have concrete gravity-section walls founded on rock, and the chamber floors are founded on bedrock. They have four reversed welded structural steel Tainter valves for filling and emptying the chambers with intake ports on the middle and river walls. The steel miter gates have hydraulically operated machinery that includes a cylinder, piston, piston rod, rack, sector gear, sector arm, and strut on each. The closed constant-pressure hydraulic system uses oil as its medium. In 1963 emergency bulkheads, a bulkhead hoist, and a lifting beam were fabricated and installed on the lock.

A two-story brick and concrete operations building is located on the middle wall. The upper story has a protruding window bay on both the river and land sides, providing excellent views of the two locks. A one-story office building and one-story maintenance building stand on an elevation overlooking the concrete esplanade, which is accessed by two flights of concrete steps. Both are utilitarian box-type concrete structures with flat roofs, similar to their counterparts at the other modern lock and dam facilities on the Monongahela River.

Built between 1960 and 1965, the Maxwell Locks and Dam facility does not meet the fifty-year National Register age requirement. It is not an eligible component of the Monongahela River Navigation System.

MNC/COE Locks and Dam No. 6
Left Bank at River Mile 68.3
Rice's Landing, Pennsylvania
Abandoned, Federal Ownership

The Monongahela Navigation Company's Lock and Dam 6 was located in the village of Rice's Landing, Pennsylvania, 68.3 miles from the mouth of the Monongahela River at Pittsburgh. It was constructed between 1854 and 1856 and was placed into service in November 1856.

The original dam was 626 feet long and was built of stone-filled timber cribs founded on gravel. It formed a segment of a circle with its convex side facing upward. At fourteen feet, it and No. 5 were the highest of all of the Monongahela Navigation Company dams. The pool behind MNC Dam No. 6 was 14.07 miles in length and 760.15 feet in elevation.

The lock chamber originally was 50 feet wide and had a usable length of 158 feet, but in 1900 it was extended by six feet (the maximum extension possible without lengthening the lock walls) in order to better accommodate the longer coal barges then in use. Its lift was 13.3 feet at low water. The walls were made of cut masonry blocks laid in hydraulic cement and founded on rock, and the floors were constructed of heavy timbers and planks. As was the case for all of the MNC locks, sluices in the walls and floor were used originally to fill

and empty the lock chamber, but at a later point they were replaced by gate wickets. The gates and wickets were all operated by eight hand-powered winches until the system was converted to use compressed air as the motive power. A water turbine provided the power to operate the air compressor.

Support structures for the MNC lock and dam included a frame house for the collector, an office, stable, wash house, coal house, bake oven, and water closet, all situated on a rectangular lot between Main Street and the river. The office was located at the upper end of the lock, while the other buildings were grouped together at the top of the bank above the lock.

MNC Lock and Dam No. 6 was acquired by the federal government in 1897, together with the other Monongahela Navigation Company properties. A few repairs and improvements were made to the existing facilities over the next few years, including extension of the lock walls by six feet, extension of the fender and mooring crib, and construction of a deflecting dike. In 1913-1915, U.S. Army Corps of Engineers constructed a second lock on the river side of the existing lock and repaired the dam. The new lock measured 56 feet by 360 feet with an 8-ft depth on the sills, the same dimensions as the other new locks on the lower river. In 1921-1922, the land lock chamber was rebuilt with the same dimensions. The locks were filled and emptied with butterfly and cylindrical valves. In 1920 the dam was reconstructed, and in 1940 the upper guard wall was replaced.

Other Corps-period structures at Locks and Dam No. 6 included an esplanade, powerhouse, control shelters, an office, blacksmith shop, carpenter shop, tool house, and two houses for the lockmaster and lockman. Of these only the esplanade and houses (1922-1923) are extant. The houses were studied in detail during a previous survey of civil works housing built by the Pittsburgh District (Hardlines 1998). The houses at No. 6 were based on the same plans used at Monongahela Nos. 7 and 8 and Allegheny Nos. 4, 5 and 6. Constructed of tile veneered with brick, the houses at No. 6 are two-story bungalows with three rooms on each floor. They are essentially unaltered from their original appearance and are among the very few locktenders' houses in the Pittsburgh District to retain their architectural integrity. Hardlines recommended that the two houses are eligible for the National Register under Criteria A and C, an assessment confirmed by the present survey. The powerhouse was a two-story brick structure exhibiting the typical Monongahela bow-end design of the period. It was identical to the extant powerhouse at MNC/COE No. 4.

Locks and Dam No. 6 was closed in 1967 when the Maxwell Locks and Dam was opened for navigation. Most of the structures were removed at that time, and the site is now used as a public park and boat launch. The U.S. Army Corps of Engineers leases the property (including the houses) to the community of Rice's Landing. Unlike most other abandoned Monongahela River lock complexes, the site is well-maintained and continues to be an integral part of the community. The extant structures, including the two houses, the concrete esplanade, and the concrete landwall, are currently listed in the National Register as contributing resources in the Rice's Landing Historic District, listed in 1992.

Despite the loss of the dam and most of the lock, the extant remains otherwise have retained strong integrity and are easily recognizable as an early twentieth century lock and dam facility. In addition to its eligibility as part of the Rice's Landing Historic District, the site is eligible for the National Register as part of the historic Monongahela River Navigation System; the boundaries correspond to the legal boundaries of the federally-owned property.

**Grays Landing Lock and Dam
Right Bank at River Mile 82.0
Gray's Landing, Pennsylvania
Operational, Federal Ownership**

The Grays Landing Lock and Dam was constructed by the U.S. Army Corps of Engineers between 1988 and 1996 at Grays Landing, Pennsylvania. It consists of a dam, one lock chamber, a concrete esplanade, an operations building, and a service building. The Grays Landing Lock and Dam facility replaced COE Lock and Dam No. 7 which was located three miles upstream.

The 576-foot ogee-shaped concrete fixed-weir dam is founded on rock with a stilling basin 28 feet below the dam crest. The concrete abutment, guard walls, and guide walls are founded on rock. The length of the Grays Landing Pool is 8.8 miles, and its elevation is 778.0 feet.

The lock chamber measures 84 by 720 feet with a lift of 15 feet at normal pool. The walls are concrete and are founded on rock. The chamber is filled and emptied by four hydraulically-operated reverse welded-steel Tainter valves in a side-port system. The lock gates and the valves are operated by a package hydraulic system using oil as a medium. The submersible motor and pump are of the reversible type, eliminating the need for directional control valves and continuously-running motors. Each unit is controlled by a multiconductor cable rather than interconnecting piping from a centralized hydraulic system. Electricity powers the hydraulic system.

Welded-steel bulkheads for the lock are installed in slots in the masonry upstream and downstream of each culvert valve to permit de-watering of the valve area for inspection and repair. The bulkhead hoist and auxiliary crane are located on top of the service bridge.

The two-story operations building is located on the esplanade adjacent to the land wall about midway between the lock gates. The service building is located landward of the esplanade adjacent to the parking area. Both are architecturally-undistinguished modern structures.

This facility is a recent complex that does not meet the National Register age requirement.

MNC Lock and Dam No. 7
Left Bank at River Mile 82.3
Below Greensboro, Pennsylvania
Abandoned, Private Ownership

The site of MNC Lock and Dam No. 7, built by the Monongahela Navigation Company in 1882-1883, is located about two miles downriver from the villages of Greensboro and New Geneva, Pennsylvania. It was the last lock and dam complex on the river to be privately constructed. The complex originally consisted of a fixed-crest dam, a single lock chamber, an esplanade, and several support buildings.

The 525.5-foot long stone-filled timber-crib dam was founded on gravel. In 1895 the guard crib above the landwall was rebuilt and filled with stone, and in 1900 the abutment face was sloped to reduce the countercurrents that were caused by the narrow passage. The pool behind MNC Lock and Dam No. 7 was 4.81 miles in length and 770.0 feet in elevation.

The lock chamber was 50 feet wide by 162 feet long, made of locally-quarried stone founded on rock, and had a lift of 9.2 feet at low water. It had wooden miter gates and wooden butterfly valves. The fill valves were located in the head bay that discharged water into the lock under the miter sill, and the wickets, located at the bottom of the lower gates, drained the chamber. The valves used for filling and emptying the chamber were operated by hand-powered winches, as were the lock gates. In 1921 new valves were placed in the bottom section of the lock gates.

The original support buildings included the collector's house (a two-and three-story cross-gabled frame structure with a rear ell and a wraparound porch), a carpenter shop, and a coal shed (U.S. Congress, House, *Ex. Doc. No. 112*, 49th Congress, 2nd sess., 1887: 25). By 1897 when the federal government acquired the property, a storehouse/stable and carriage shed had been added. In 1904 the Corps of Engineers constructed a second two-story frame house, essentially modeled after the MNC house. It had an I-shaped plan and a porch on the river elevation. The house was built primarily as locktenders' quarters, but it also had an office in the basement level. The original plans for the structure, dated June 1901, survive in the Pittsburgh District files (Hardlines 1998: 48). All of the support structures stood on an embankment overlooking the lock and esplanade.

MNC Lock and Dam No. 7 was closed in 1925, when the Corps of Engineers opened its new Lock and Dam No. 7 about three miles upstream. All structures probably were removed soon afterward. Today, the only extant remains are the stone land wall of the lock, the stone esplanade, and several foundations, including those of the 1883 collector's house and the 1904 locktenders' house. The site is overgrown and deteriorating. The road to the site is impassable, but access is possible from the river.

Although the remaining structures at MNC Lock and Dam No. 7 are abandoned and deteriorated, they are still identifiable as an historic lock and dam complex. The site retains integrity of location, setting, design materials, feeling and association, and previously was

determined to be eligible for the National Register as part of the Section 106 coordination for the Grays Landing Lock and Dam Project. The property is an eligible component of the historic Monongahela River Navigation System. The boundaries correspond to the legal boundaries of the former MNC/federal property on the left bank of the river, including an area of one acre and 2.4 perches.

COE Lock and Dam No. 7
Left Bank at River Mile 85.0
Greensboro, Pennsylvania
Abandoned, Federal Ownership

In 1923-1926, the U.S. Army Corps of Engineers constructed a new Lock and Dam No. 7 near Greensboro, Pennsylvania, designed to replace MNC No. 7. The facility consisted of a concrete dam, a single lock chamber, a concrete esplanade, a powerhouse, and two locktenders houses.

Pool No. 7 was 5.8 miles long, with a normal level of 778.0 feet. The solid concrete monolith gravity dam was founded on rock and was 610 feet long. In 1928 the upper guidewall was extended, and in 1934 the guardwall was extended using cellular steel sheet pile construction. In 1978 a whole new upper guardwall was added using the same construction technique.

The lock chamber was 56 feet wide by 360 feet long, had a lift of 15 feet at normal pool, and was filled and emptied using steel butterfly valves. These valves were opened and shut by a strut and rocker arm mechanism powered by a hydraulic piston; the valves were operated by paired levers. The miter gates were opened and closed by hydraulic cylinder gears.

The two-story concrete powerhouse (extant) is located on the esplanade. It exemplifies the Corps' standard design for 1920s-era Monongahela River powerhouses, with its upriver end resembling a rounded ship's bow. Similar structures, both one-story and two-story, were constructed at other Monongahela River locks and dams in the early twentieth century. Power to the lock was originally provided by a water turbine installed in the dam. In 1926 a spinning vertical-wicket turbine was installed to operate the hydraulic pump; three other pumps were also added in 1926. The electrical system was located on the upper floor of the powerhouse and included a turbine-driven hydroelectric generator, a diesel generator that was installed in 1976, and an electric air compressor added in 1981.

In 1927 the Corps of Engineers constructed identical pairs of houses at Locks and Dams Nos. 7 and 8, the last Monongahela River locktenders' houses built by the Pittsburgh District. The houses were two-story side-gable bungalows constructed of terra cotta tile with brick veneer. According to a recent study of civil works housing constructed by the Pittsburgh District (Hardlines 1998: 61-64), this design was one of the most extensively used house types in the District, and was built at Monongahela Nos. 6-8 and Allegheny Nos. 4-6. As was standard Corps practice, each pair of houses were mirror images of each other, built

on reverse plans. Those at Monongahela Locks and Dams Nos. 7 and 8 have not survived, but the pair at No. 6 (Rice's Landing) are still extant and occupied. Unlike the houses associated with the Corps' other early twentieth century Monongahela River locks, those at No. 7 were not located at the site but were instead built about a thousand feet downstream. This became a general trend in the Pittsburgh District during the late 1920s and 1930s, but at Monongahela No. 7, the siting of the houses may also have been related to the severe topographic constraints at the location of the lock and dam (Hardlines 1998: 63).

COE Lock and Dam No. 7 was closed in 1994 when the new Grays Landing Lock and Dam was placed into service. The dam and most of the lock at No. 7 were removed at that time, but the land wall, powerhouse, and esplanade are extant and enclosed by a security fence to prevent public access. The esplanade is overgrown with vegetation and is slowly deteriorating because of the lack of regular maintenance. Nevertheless, the powerhouse and land wall remain in excellent condition. Despite the loss of the dam and most of the lock, the extant remains otherwise have retained strong integrity and are an excellent example of a 1920s-era Corps of Engineers lock and dam facility. In 1994 the site was documented by the Historic American Engineering Record. It was determined to be eligible for the National Register as part of the Section 106 coordination for the Grays Landing Lock and Dam Project. The boundaries correspond to the legal boundaries of the federally-owned property.

**COE Original Lock and Dam No. 8
Right Bank at River Mile 87.1
Dunkards Creek, Pennsylvania
Abandoned, Private Ownership**

Between 1882 and 1889, the U.S. Army Corps of Engineers constructed the original Lock and Dam No. 8 at River Mile 87.1, opposite the mouth of Dunkards Creek. It was the second Monongahela River lock complex to be built directly by the Corps. The facility originally included a timber crib dam, a single chamber stone masonry lock, an esplanade, and various support structures.

The 600-foot long stone-filled timber-crib dam was founded on gravel, but its masonry abutment was founded on rock. The guide and guard walls were constructed of timber. The pool behind Original Lock and Dam No. 8 was 5.75 miles in length and 780.8 feet in elevation.

The lock chamber measured 50 by 200 feet, with a usable length of 161.6 feet. It had a lift of 10.6 feet at low water. The stone masonry lock walls were founded on rock. The original lock construction included wooden miter gates that were later replaced with steel gates. They were operated by the cross-chain method: one leaf was opened by a chain attached to the toe of the gate at the bottom and on the upstream side, while the closing chain for the same leaf was attached in a similar position on the lower side with the chain leading to the lower drum on the opposite wall. In 1893 sheaves with wire rope were added to the operating machinery so that both gates could be opened at the same time by the machinery on either wall. In 1893 worm wheels operated the gates and valves, but by 1910 they were

moving on swinging pulleys and chains. The valves and gates operated by power developed by 15-inch turbines, one located at each gate.

Buildings included two frame houses for the lockmaster and lockman, an office, several workshops, and a wooden storage shed. The houses probably were built in 1890-1891, soon after the lock and dam. The Pittsburgh District files contain original 1890 plans for the houses, revealing that they were simple two-story frame structures of two different types, one "T"-shaped and one "I"-shaped (Hardlines 1998: 38-42). Although the drawings may have been intended as prototypes for all such structures on the Monongahela River, it appears that Original Lock and Dam No. 8 was the only facility where they were actually built (a variation of the plan for the lockmaster's house was used at Lock and Dam No. 9). The office was a small rectangular frame building with a curved window bay on its river elevation, apparently identical to the offices at COE Locks and Dams Nos. 9-15. Maps from 1921 and 1923 depict the layout of the facility, with the two houses on an elevation overlooking the lock and esplanade, and the other support structures (office, two shops, and two sheds) all grouped together at the south end of the property. This was a typical arrangement for the Corps' upper Monongahela River lock and dam facilities constructed during the 1890-1910 period.

The lock and dam were closed in 1925 and replaced by COE New Lock and Dam No. 8 above Point Marion. Today, the land wall, part of the esplanade, and the office remain. Two extant sheds and a scale are associated with the site's later use as a coal-loading facility. Much of the site appears to have been graded, and large amounts of fill were placed over part of the esplanade. The property is now abandoned, and all of the structures are overgrown and deteriorating. The former lock office is in very poor condition. Public access to the property is restricted by a metal gate across the access road.

Although the remaining structures at COE Original Lock and Dam No. 8 are abandoned and deteriorated, they are still identifiable as an historic lock and dam complex. Although alterations were made to the property when it was a privately-owned coal-loading facility, most intrusive elements were removed after the coal operation was discontinued, and the site has reverted to its former isolated, rural appearance. Despite later changes, the site has retained integrity of location, setting, design, materials, feeling, and association. Thus, COE Original Lock and Dam No. 8 is eligible for the National Register as part of the Monongahela River Navigation System, with boundaries corresponding to the legal boundaries of the former federally-owned property in its entirety.

COE New Lock and Dam No. 8/Point Marion Lock and Dam
Left Bank at River Mile 90.8
Point Marion, Pennsylvania
Operational, Federal Ownership

COE New Lock and Dam No. 8, near Point Marion, Pennsylvania, was placed in operation in the fall of 1925, replacing COE Original Lock and Dam 8, which was located 3.5 miles downstream. The various components have been replaced over the years, and the

complex now consists of a combination fixed-weir and gated dam, a single lock chamber, an operations building, a service building, and a concrete esplanade.

As originally built, the facility included a 560-foot long concrete fixed-weir dam. In 1958-1959, the U.S. Army Corps of Engineers constructed a new dam, retaining the old dam as the fixed-weir section of the new structure. The current dam is 682 feet long, with two fixed-weir sections and six gated sections (non-overflow movable trunnion Tainter gates of the Sidney design) that are power-operated from a service bridge founded on piers on the dam crest. The dam gates are closed by steel emergency bulkheads that ride in grooves in the sides of the dam piers. Unlike the other movable-crest dam structures on the Monongahela, this dam does not have the Tainter gate machinery housed in penthouses on machinery platforms off the service bridge. Instead, the machinery is located beneath the service bridge. The latter is a steel-framed structure constructed of girders with a steel-grid surface.

The original lock chamber measured 56 by 360 feet, but in 1989-1994 a new lock measuring 84 by 720 feet was constructed. The original lock was filled and emptied using longitudinal culverts (with curved ceilings) placed in each wall, each with a filling valve near the upper gate and an emptying valve near the lower. The butterfly valves were rectangular and operated on a horizontal axis; they opened and closed by a strut and rocker-arm mechanism powered by a hydraulic piston and were operated by paired levers located on the lock walls. In the new lock, the culvert valves have been replaced by reverse Tainter valves.

The emergency bulkhead structure consists of two sets of two reinforced concrete piers on the land wall and the river wall. These piers are located upstream of the upper miter gates and serve as both the storage platform for the bulkhead units and as support for the track-mounted traveling bulkhead hoist. The bulkheads themselves are of welded construction, fabricated from plate and wide flange sections.

COE New Lock and Dam No. 8 originally had a two-story concrete powerhouse on the land wall, built according to the Corps' standard 1920s-era design for Monongahela River powerhouses. It was identical to the one at COE Lock and Dam No. 7, which was built at the same time and is still extant. In 1927 identical pairs of houses were constructed at Locks and Dams Nos. 7 and 8, the last Monongahela River locktenders' houses built by the Pittsburgh District. The houses were two-story side-gable bungalows constructed of terra cotta tile with brick veneer. According to a recent study of civil works housing constructed by the Pittsburgh District (Hardlines 1998: 61-64), this design was one of the most extensively used house types in the District, and was built at Monongahela Nos. 6-8 and Allegheny Nos. 4-6. As was standard Corps practice, each pair of houses were mirror images of each other, built on reverse plans. At No. 8, the two houses stood together at the upstream end of the site, overlooking the esplanade. Extensive orchards and gardens were located behind the houses. At the downstream end of the complex were the carpenter shop and blacksmith shop, which resembled their counterparts at other contemporary Corps facilities on the upper river. None of these buildings are extant. By 1990 the support buildings included only the old powerhouse (then used as a combination powerhouse/operations building), a new maintenance

building, and a garage/storage shed (Figure 2). All three were removed when the lock was reconstructed in the 1990s.

Support buildings in the present complex include only a modern operations building and a service building. The two-story concrete-block operations building was constructed in 1989-1994 and is located on the esplanade landward of the landwall at the lower miter gates. The one-story concrete block service building is located landward of the esplanade adjacent to the parking area.

The dam, lock, and buildings at the COE New Lock and Dam No. 8/Point Marion site were all replaced between 1958 and 1994. There are no visible remains from the original 1925 complex. Because it does not meet the National Register age requirement, the existing facility is not an eligible component of the Monongahela River Navigation System.

COE Lock and Dam No. 9
Right Bank at River Mile 92.4
Hoard's Rock, West Virginia
Abandoned, Private Ownership

COE Lock and Dam No. 9 was located on the right bank of the Monongahela River at Hoard's Rock, West Virginia, 92.4 miles above the mouth of the river. It was built by the U.S. Army Corps of Engineers between 1874 and 1879, the first Monongahela lock and dam facility to be built directly by the Corps rather than the Monongahela Navigation Company. The original site proposed for Lock and Dam No. 9 was Collins Ripple, about 4.5 miles further upriver, but this was abandoned in favor of Hoard's Rock, where bedrock extended entirely across the river and provided a solid foundation for the dam (Gannett Fleming Corddry and Carpenter, Inc. 1980: 6-7). The facility was completed and opened for navigation on September 29, 1879, extending slackwater navigation to Morgantown, West Virginia. Lock and Dam No. 9 consisted of a stone masonry dam, a stone lock with steel miter gates, and support buildings.

The 410-foot stone and cement dam was founded on rock and was in the form of an arch circling up the river. It was the only masonry dam to be built on the Monongahela River. The dam included a flat stone-filled timber-crib apron, a sloped masonry abutment, and guide- and guardwalls. Pool No. 9 was 9.3 miles long and 793.4 feet in elevation.

The stone lock was founded on rock and measured 50 feet by 160 feet. It had a lift of 12.35 feet at low water. The lock was filled and emptied through culverts in the side walls, instead of through valves in the wooden lock gates; this marked the first use of such culverts at Monongahela River locks. Another innovation was the use of Stoney valves for the first time in the United States.

Support structures included houses for the lockmaster and lockman, an office, carpenter shop, blacksmith shop, storehouse, coal house, and privies. As was typical, the houses and other support buildings all stood on an elevation overlooking the lock and stone

esplanade. The houses were mirror images of each other, built on reverse plans. A storehouse and privy stood between them. At the south end of the complex were the carpenter and blacksmith shops, and at the other end were the office and a second privy. The shops and office were built according to standard plans and were virtually identical to their counterparts at Lock and Dams Nos. 8-15. The carpenter shop was somewhat different from its counterparts in that it was one-story in height, while the others were two-stories.

Lock and Dam No. 9 was closed and abandoned in 1926 when the Corps of Engineers completed its new Lock and Dam No. 8 near Point Marion, Pennsylvania. Lock and Dam No. 8 was relocated several miles upriver from the original Corps Lock and Dam No. 8 so that Lock and Dam No. 9 could be eliminated.

Many of the original structures in the No. 9 complex still survive, and they compose one of three (with Nos. 12 and 13) relatively intact Monongahela River lock and dam complexes from the 1874-1906 period. Both houses (1893) are extant, the oldest surviving Corps-built locktenders' houses on the Monongahela River. They are two-story, wood-framed, "L"-shaped structures, resembling typical vernacular farmhouses of the period. According to a recent survey (Hardlines 1998), they are the only examples of this type of locktenders' house in the Pittsburgh District. Unfortunately, one of the houses has been altered substantially within the past ten years, and the other is currently undergoing similar alterations. Both shops, as well as the sheds and privies, are in excellent condition and have retained their architectural integrity; they are the best examples of their respective building types on the Monongahela River. All are well-maintained. The lock office is not extant, but the shape of the brick foundation reveals that it probably was typical of the office structures at Lock and Dams Nos. 8-15: a small one-story rectangular frame structure with a steep pyramidal roof and a curved window bay on the river elevation (see Lock and Dams Nos. 12 and 13). The stone landwall and esplanade are in excellent condition.

Despite some modifications, Lock and Dam No. 9 is a relatively intact lock complex which is representative of the West Virginia facilities constructed by the U.S. Army Corps of Engineers in the late nineteenth and early twentieth centuries. The property is eligible for the National Register as part of the Monongahela River Navigation System. The surviving navigation-related structures at Lock and Dam No. 9 (landwall, esplanade, houses, carpenter shop, blacksmith shop, storehouse, privy) all are contributing elements of the resource. Because of the strong integrity of the site, the historic resource boundaries should correspond to the legal boundaries of the former federally-owned property in its entirety. The locktenders' houses at Lock and Dam No. 9 previously were recommended as eligible in the Pittsburgh District's National Register nomination entitled "Civil Works Housing of the U.S. Army Corps of Engineers, Pittsburgh District" (Hardlines 1998: 177-178).

COE Lock and Dam No. 10
Left Bank at River Mile 101.5
Morgantown, West Virginia
Abandoned, Private/Federal Ownership

Construction of Lock and Dam No. 10 at Morgantown, West Virginia, was begun in 1897. It was opened for navigation in December 1903, at a total construction cost of \$210,445. The concrete gravity-section dam was 804.7 feet long and founded on rock. It had a flat stilling basin and a sloped concrete abutment that was founded on rock. The lower guidewall and upper guardwalls were stone-filled timber cribs, while the upper guidewall was constructed of concrete on a pile foundation. Pool No. 10 was 804 feet in elevation, and because of the river's steep gradient in this section, was only 2.35 miles in length.

Lock No. 10 was built to the same specifications as the other five West Virginia locks built at that time, with a 56-foot by 182-foot chamber and a lift of 10.67 feet. The miter gates were originally wood but were later replaced with steel. The gates and valves were operated by hand.

The support structures for Lock and Dam No. 10 consisted of two houses for the lockmaster and lockman, an office, carpenter shop, blacksmith shop, coal house, and privy. The complex at No. 10 was typical of those built by the U.S. Army Corps of Engineers at its locks and dams on the upper Monongahela River between 1874 and 1906. The houses and other support buildings all stood on an elevation overlooking the lock and esplanade. The office stood between the two houses, and at one end of the complex were the carpenter shop, blacksmith shop and coal house. Except for the houses, all of the support structures were similar to their counterparts at Nos. 8-15.

The houses at No. 10 were studied in detail as part of a recent survey of civil works housing constructed by the Pittsburgh District (Hardlines 1998). Unlike the simple vernacular houses at other facilities, these structures exhibit a variety of formal stylistic elements that help to make this complex especially notable. The houses are identical but built on reverse plans. Fine examples of the Queen Anne style, they possess many typical Queen Anne features: an asymmetrical plan, intersecting gables and roof lines, projecting bays, multiple attached and integral porches, windows of various sizes and types, and exterior wall cladding of ornamental shingles on the second story and wood siding on the first story.

The Hardlines study called these houses "by far the most luxurious and elaborate lockkeeper dwellings on the Monongahela River and possibly in the entire Pittsburgh District. This comment applies both to their exterior appearance and to their interior features." The authors speculated that unusual care was taken with the design of the houses at No. 10 because of their highly visible setting on the outskirts of Morgantown, an important commercial and industrial city. Locks and Dams Nos. 11-15 were located in rural, isolated settings, where they would be seen by relatively few people (Hardlines 1998: 45-46). Both houses are now privately-owned, occupied, and in excellent condition. Alterations have been relatively minor: the original slate roofs of both houses have been replaced with asphalt

shingles; asbestos siding has been applied over the wooden siding and shingles of the southernmost house (House 1), and some of the windows of the northern house (House 2) have been replaced.

The original two-story frame carpenter shop also survives at the site. This structure conforms to standard specifications for structures of its type on the upper Monongahela. Three bays wide by one room deep, it is of frame construction with a gable roof. The original double doors on both levels have been obscured by a recent two-story addition attached to the south gable end. It has less integrity than the carpenter shop at Locks and Dams No. 9 and 12 but is an important remnant of the original complex at Lock and Dam No. 10. The one-story frame blacksmith shop, also original, stands just north of the carpenter shop. It has a gable roof, wood siding, and a double door in the gable end. It is unaltered and in excellent condition. A privy stands behind it. The lock office was located between the two houses but is not extant, and its site is now a garden. No other buildings exist at the site, except for a non-historic frame garage at the south end of the property and a small non-historic shed at the north end. Concrete steps lead down to the brick esplanade. The adjacent concrete landwall is intact and in relatively good condition. The esplanade is overgrown but otherwise in good condition.

The Corps of Engineers closed this complex in 1950 when the adjacent Morgantown Lock and Dam was placed in service. The federal government retains ownership of a portion of the Lock and Dam No. 10 property, including the esplanade and landwall. The rest, including all of the buildings, is privately owned.

The locktenders' houses at No. 10 have the strongest integrity and are the best-preserved of any on the upper Monongahela River. The houses, the associated carpenter shop, blacksmith shop, brick esplanade, and concrete landwall together compose a relatively-intact early twentieth century lock complex. The configuration of these features is representative of the Corps' early twentieth-century navigational facilities on the upper river, and the site retains integrity of design, location, setting, materials, feeling, and association. The houses previously were considered to be eligible under Criteria A and C in the Pittsburgh District's National Register nomination entitled "Civil Works Housing of the U.S. Army Corps of Engineers, Pittsburgh District" (Hardlines 1998).

Former Lock and Dam No. 10 is eligible for the National Register under Criteria A and C, as part of the Monongahela River Navigation System. All of the extant historic structures and features at No. 10 are contributing elements of the National Register resource. Due to the site's strong integrity, the boundaries should include the entire former federal property on the left bank of the river, encompassing all of the extant structures and features. Part of this property is included within the boundaries of Morgantown Lock and Dam, itself an eligible component of the Monongahela River Navigation System.

**Morgantown Lock and Dam
Left Bank at River Mile 102.0
Morgantown, West Virginia
Operational, Federal Ownership**

Morgantown Lock and Dam is located on the left bank of the Monongahela River at river mile 102.0, on the outskirts of Morgantown, West Virginia. This complex was constructed by the U.S. Army Corps of Engineers between 1948 and 1950 and was designed to replace nearby Lock and Dam Nos. 10 and 11, which had been in operation since 1903 and were now obsolete. It was the first new facility to be constructed under the Corps' post-World War II program to replace six early twentieth century lock and dam complexes on the upper Monongahela with three modern facilities.

The Morgantown Lock and Dam, placed in operation in July 1950, consists of a concrete and steel gated dam, concrete lock, concrete esplanade, operations building, and maintenance building. The length of the Morgantown Pool is 6.0 miles, and its elevation is 814.0 feet.

The 410-foot concrete and steel dam is founded on rock and has six non-submergible welded Tainter crest gates. The concrete gravity wall abutment is also founded on rock. Operating machinery consists of individual electric hoists located on piers between service bridge girders. Emergency bulkheads ride in slots upstream from the portions of the piers that support the bridge. The steel tops of the pier-control buildings house the individual gate machinery. Electricity powers the dam lighting, electric hoists, bulkhead machinery, and crane.

The concrete lock chamber is 84 feet wide by 600 feet long, and has a 17-foot lift at normal pool. Two 10 foot by 12 foot butterfly valves fill the chamber, and two more empty it. The lock employs a longitudinal culvert system for filling and emptying, and, due to a high rock level and a moderate lift, it also uses lateral chamber ports, rather than a bottom-filling system.

The 1950s-era operations building stands on the landwall near the lower gate bay and is the most architecturally-distinctive building of any at an operating Monongahela River lock complex. In contrast to the utilitarian and architecturally-undistinguished operations buildings at the other facilities, the Morgantown structure was designed in the mid-twentieth century Streamline Moderne style, a style which typically featured smooth wall surfaces with horizontal decorative designs, a low profile, flat roof, and asymmetrical façade, often with curved corners. Characteristic design elements of the Morgantown operations building include brick stringcourses and a rounded second story bay that provides a view of the lock chamber. As at the older Lock and Dam No. 10, located just downstream, aesthetic considerations perhaps played an unusually important role in the design of the Morgantown facility because of its prominent urban setting. The equipment in the operations building includes oil pumps, a switchboard and lighting transformer, an emergency generator, an air

compressor, and a raw-water pump. A one-story box-type maintenance building is also located on the esplanade south of the operations building.

Although the Morgantown Lock and Dam (built 1948-1950) only marginally meets the National Register fifty-year age requirement, it contributes to the significance of the Monongahela River Navigation System. As part of the system, the property is eligible for the National Register under Criteria A and C. All of its components (dam, lock, esplanade, operations building, and minor structures) are contributing elements of the National Register resource. It is the oldest of the Corps' post-World War II locks on the Monongahela River and represents an important stage in the evolution of lock and dam technology on the Monongahela. The operations building is also the most architecturally distinctive building at any of the operating Monongahela River facilities.

Because of the site's integrity, the historic resource boundaries should include the entire federally-owned property, encompassing approximately twenty-four acres. A portion of abandoned Lock and Dam No. 10 (the landwall and esplanade, but not the buildings, which are now privately owned) is included within the boundaries for the Morgantown Lock and Dam.

COE Lock and Dam No. 11
Left Bank at River Mile 104.1
Uffington, West Virginia
Abandoned, Private Ownership

Lock and Dam No. 11 was located on the left bank of the river near the village of Uffington (Round Bottom), West Virginia, 104.1 miles from the mouth of the Monongahela at Pittsburgh. Opened for navigation in December 1903, it had a single concrete lock chamber, a concrete fixed-crest dam, and various support buildings.

The fixed-crest concrete dam was founded on rock and extended 500 feet across the river. Pool No. 11 was 4.9 miles in length. The dam was repaired in 1907 and 1913-1914 and partially rebuilt in 1917. The lock chamber measured 56 by 182 feet and had a lift of 10.67 feet at low water. It was built to the same specifications as the other West Virginia locks built at that time. The lock was founded on rock and was constructed with filling valves located at six openings beneath the upper miter sill. The emptying valves were in the lock walls beyond the lower miter sill. The original timber miter gates were later replaced by steel gates. Four hand-operated capstans were used for opening and closing the gates, with winches used to operate the wickets. All of the locks that used this equipment were operated manually until World War II.

The support structures included two houses for the lockmaster and lockman, an office, carpenter shop, blacksmith shop, storehouse, and privy. The complex was typical of those at the early twentieth century West Virginia facilities. The houses and other support buildings stood on an elevation overlooking the lock and esplanade. The houses were mirror images of each other, built on reverse plans, and they were identical to those at Nos. 12-15. At No. 11,

the office and storehouse stood between the two houses, and at the west end of the complex were the carpenter and blacksmith shops. The arrangement of buildings was identical to that at No. 12.

The complex was closed in 1950, following completion of Morgantown Lock and Dam. The property was sold, and most structures were removed. The site is now privately owned, and public access is not permitted, but it can be viewed from across the river. The concrete land wall, concrete esplanade, shops, and storehouse all remain, but in deteriorated condition. Both of the shops were recently remodeled. In their original condition, the shops at No. 11 were similar to their counterparts at Nos. 9, 10, and 12. However, while those structures still retain all or most of their original features, the recent modifications at Lock and Dam No. 11 have detracted from their architectural integrity. The storehouse is similar to those at Locks and Dams Nos. 9, 12, and 13.

The extant buildings and structures at Lock and Dam No. 11, although some have been recently altered, are easily recognizable as an historic lock complex. The property is eligible for the National Register under Criteria A and C, as part of the Monongahela River Navigation System. The configuration of the land wall, the esplanade, the two shops, the storehouse, and the elevated platform containing the building complex is representative of the Corps' early twentieth-century navigational facilities on the upper river, and the site retains integrity of design, location, setting, and association. There are no intrusive modern structures. All of the extant historic structures and features at No. 11 are contributing elements of the National Register resource. The boundaries should include the entire former federal property on the left bank of the river, encompassing the land wall, esplanade, and surviving buildings.

Hildebrand Lock and Dam
Left Bank at River Mile 108.2
Hildebrand, West Virginia
Operational, Federal Ownership

Hildebrand Lock and Dam is located near Hildebrand and Round Bottom, West Virginia, at river mile 108.2. This complex was constructed by the U.S. Army Corps of Engineers between 1956 and 1960, and was designed to replace nearby Locks and Dams Nos. 12 and 13, which had been in operation since 1903 and were now obsolete. The new lock was placed in operation in June 1959, and the dam was completed in March 1960. At present the complex consists of a concrete and steel gated dam, a single concrete lock chamber, a concrete esplanade, an operations building, and a maintenance building.

The length of the Hildebrand Pool is 7.4 miles, and its elevation is 835.0 feet. The 530-foot long concrete and steel dam is founded on rock and contains six Tainter gates with some fixed-weir sections. The six movable welded Tainter gates are similar to those installed at Morgantown Dam. The welded-plate steel girder service bridge is also similar to that installed at Morgantown; it extends from the river wall pier to the abutment pier. Electric

cables provide the power for the gate-operating machinery, the lighting, and the bulkhead hoist.

The single-chamber concrete lock is founded on rock and measures 84 feet wide by 600 feet long, with a lift of 21 feet at normal pool. The lock chamber is filled and emptied by hydraulically-operated reversed Tainter valves, two to fill, and two to empty. The filling and emptying system consists of culverts, ports, and valves in the lock walls. The horizontally-framed welded-steel plate miter gates with the skin plate on the downstream side are similar to those installed at the Morgantown and Opekiska facilities. The gate machinery is also similar to that used at Morgantown and Opekiska. The main elements of the machinery include a cylinder, piston, piston rod, rack, sector gear, sector arm, and strut.

The lock operates on a hydraulic closed constant-pressure system with oil used as the medium. Intake and discharge ports are located in the river and land walls of the lock. The land wall culvert discharges into the river through a tunnel beneath the chamber floor, and water flows into the chamber through 10-foot wide rectangular culverts with floors that are raised slightly above the floor of the lock chamber. The box-girder bridge hoist structure for the emergency bulkhead is mounted on the upstream end of the land and river walls upstream from the upper lock gate. The bulkheads are installed in vertical guide slots in the lock walls.

The operations building is located on the esplanade, midway between the upper and lower gates. It is a one-story box building with a basement. The main floor includes an equipment room, an office, a maintenance equipment storage room, and locker and toilet facilities. The basement holds the air receiver, a storage and work area, and a heater room. The maintenance building, another nondescript box-type structure, is located near the operations building at the end of the esplanade. There are control shelters on the land wall for each gate. These control shelters provide a view of approaching tows and contain the machinery for starting and stopping the system pressure pumps, the control-valve operation, and the operation of the lock gates.

This component of the Monongahela River Navigation System was constructed between 1956 and 1960 and does not meet the National Register fifty-year age requirement. For this reason, it is not an eligible component of the system.

COE Lock and Dam No. 12
Left Bank at River Mile 109.1
Little Falls, West Virginia
Abandoned, Private Ownership

In 1903 the U.S. Army Corps of Engineers constructed Monongahela Lock and Dam No. 12 at Little Falls, West Virginia, 109.1 miles from the mouth of the river at Pittsburgh. It had a single lock chamber, a concrete fixed-crest dam, and various support buildings.

The 447-foot long fixed-crest concrete dam was founded on rock. Pool No. 12 was 826 feet in elevation, and because of the river's steep gradient in this section, the pool was

only 1.95 miles in length. The concrete lock measured 56 by 182 feet and had a lift of 10.67 feet at low water. The lock was founded on rock and was constructed with filling valves located at six openings beneath the upper miter sill. The emptying valves were in the lock walls beyond the lower miter sill. The original timber miter gates were later replaced by steel gates. Four hand-operated capstans were used for opening and closing the gates, with winches used to operate the wickets.

The support structures for Lock and Dam No. 12 consisted of two houses for the lockmaster and lockman, an office, carpenter shop, blacksmith shop, storehouse, coal house, and privy, all of which were completed in 1904. As was typical, the houses and other support buildings all stood on an elevation overlooking the lock and esplanade. The houses were mirror images of each other, built on reverse plans, and were identical to the houses at Lock and Dam Nos. 11-15. At No. 12, the office and storehouse stood between the two houses, and at the east end of the complex were the carpenter shop, blacksmith shop, and coal house. All were built on standard plans and were identical to their counterparts at Lock and Dam Nos. 8-15.

The houses at No. 12 were studied in detail as part of a previous survey of civil works housing constructed by the Pittsburgh District (Hardlines 1998). Unfortunately, following the Hardlines survey and just prior to a site visit in November 1999, the westernmost house (House 2) burned to the ground. House 1 continues to be occupied, but has been modified through the addition of an enclosed front porch and an attached greenhouse. Like the houses at Nos. 11-15, those at No. 12 were built according to a 1902 plan developed under the direction of Captain William L. Sibert, the district engineer at that time. According to the Hardlines report (1998), "these houses are consistent with the pattern established of building plain, simple houses on rural stretches of the Monongahela River, but they were larger and more comfortable than the lockkeepers houses built in the early 1890s," with three rooms on each floor. They were two and one-half stories in height and built on an "L"-shaped plan. Each had a hipped roof with gable dormers, one-over-one light double-hung sash windows with modest ornamentation, and lapped siding. However, though comfortable, the houses lacked indoor toilet facilities and other amenities.

Lock and Dam No. 12 has the most intact and least-altered group of support buildings of any on the upper Monongahela. Along the rear edge of the property, adjacent to the railroad, is the row of three related structures that was typical of the lock and dam facilities. The two-story frame carpenter shop is in extremely good condition and has not been altered, unlike its surviving counterparts at other facilities. It retains its six-over-six light double-hung sash windows and double doors in both levels of the gable end. Next to it is the unaltered one-story frame blacksmith shop, with six-over-six light windows and double doors in the gable end. Although neither shop has been altered, a frame shed has been constructed between them, evidently intended as a carport. The last building in the row is a small frame coal shed, also unaltered. The arrangement of these three structures is logical, given their interrelated functions.

A one-and-one-half story frame storehouse is located at some distance from the above buildings, between the two houses. It has wood siding, a gable roof, and a series of small windows in the loft level. The frame lock office is located along the edge of the elevation overlooking the esplanade. It has wood siding, a central brick chimney, and a hipped roof covered with slate shingles. Hipped dormers are found at both front and rear. One bay wide by two bays deep, the one-story structure has paired one-over-one light double-hung sash windows on the sides and an entrance door with a single-light transom. This is one of only two lock offices to survive at any of the West Virginia facilities (the other is at Lock and Dam No. 13). Although it retains strong integrity, the office at No. 12 is no longer being used or maintained, and consequently it is beginning to deteriorate.

Lock and Dam No. 12 was closed in 1960 when Hildebrand Lock and Dam was placed in service. The dam and most of the lock walls were removed at that time. The land wall is still extant but is submerged three feet below the present pool level. Flights of concrete steps still lead down to the former esplanade, now underwater. The site is now privately owned and occupied, and public access is restricted.

The buildings and structures at Lock and Dam No. 12 are easily recognizable as an historic lock complex. Even after the loss of one house, No. 12 is perhaps the best-preserved and least-altered historic navigational facility on the upper Monongahela. The configuration of the surviving buildings and features is representative of the Corps' early twentieth-century facilities on the upper river, and the site retains integrity of design, location, setting, materials, feeling, and association. The property is eligible for the National Register as part of the Monongahela River Navigation System. The National Register boundaries should include the entire former federal property on the right bank of the river, encompassing the former federally-owned property in its entirety. The houses previously were included in the Pittsburgh District's National Register nomination entitled "Civil Works Housing of the U.S. Army Corps of Engineers, Pittsburgh District" (Hardlines 1998).

COE Lock and Dam No. 13
Left Bank at River Mile 111.6
Flaggy Meadow, West Virginia
Abandoned, Private Ownership

In 1904 the U.S. Army Corps of Engineers completed Monongahela Lock and Dam No. 13, at river mile 111.6 (Trippett's Ripple), near Flaggy Meadow, West Virginia. Like the other West Virginia facilities built at the same time, No. 13 had a single lock chamber, a concrete fixed-crest dam, and various support buildings.

The fixed-crest concrete dam was founded on rock and was similar to those at Nos. 10-15. It had a flat concrete apron and sloped concrete abutments. The guard- and guidewalls consisted of a concrete cap on stone-filled timber cribs. The concrete lock was 56 feet wide by 182 feet long and had a lift of 10.67 feet at low water. Lock No. 13 was constructed to the same basic plan as Nos. 10, 11, 12, 14, and 15. The filling valves were located in six arch-top openings beneath the upper miter sill. The emptying valves were in

the lock walls beyond the lower miter sill. The power for the manual valve-operating machinery was transferred from levers to the valves by means of cast iron sector gears and pinions. In 1906 the Corps replaced the filling-valve levers with worm gears, and in 1921 new valves were installed in the bottom sectors of all of the lock gates. Four hand-operated capstans were used for opening and closing the gates, with winches used to operate the wickets.

The support structures for Lock and Dam No. 13 consisted of two houses for the lockmaster and lockman, an office, carpenter shop, blacksmith shop, coal house, storehouse, and privy, all of which were completed in 1904. As at the other facilities, the houses and other support buildings all stood on an elevation overlooking the lock and esplanade. The houses were mirror images of each other, built on reverse plans, and were identical to the houses at Lock and Dam Nos. 11-15. At No. 13, the office and storehouse stood between the two houses, and at the south end of the complex were the carpenter shop, blacksmith shop, and coal house. The shops, office, storehouse, and coal house also were built according to standard plans and were identical to their counterparts at Lock and Dams Nos. 8-15.

The houses at No. 13 were studied in detail as part of a previous survey of civil works housing constructed by the Pittsburgh District (Hardlines 1998). Like the houses at Nos. 11-15, those at No. 13 were built according to a 1902 plan developed under the direction of Captain William L. Sibert, the district engineer at that time. Two and one-half stories in height and built on an "L"-shaped plan, each house consisted of two intersecting two-bay sections, with a porch filling the angle of the ell. Each had a hipped roof with gable dormers, one-over-one light double-hung sash windows with modest ornamentation, and lapped siding. Because they faced the railroad on one side and the river on the other, both the front and rear elevations were designed with relatively formal facades.

At Lock and Dam No. 13, the entire complement of original support buildings survives, but most of the structures have been modified. Both houses are currently occupied. The southernmost house has been substantially altered, with two separate two-story additions attached to the south side. Its roof has been replaced and aluminum soffit and fascia applied. The northernmost house remains essentially unaltered. The office survives intact, except for a large one-story rear addition that is incompatible with the original design; the structure is now used as a residence.

A frame storehouse, identical to the one at Lock and Dam No. 12, stands between the office and the railroad, just as at No. 12. It is unaltered. At the south end of the property, adjacent to the railroad, are the two-story carpenter shop and one-story blacksmith shop, which were present at all of the upper river lock complexes. Both structures are basically intact, but a two-story addition now fills the space between them. The carpenter shop and the addition are both covered with vinyl siding. The addition was built to match the size and appearance of the carpenter shop, but its presence obscures the physical relationship between the original buildings. A frame coal house stands near the shops. The concrete land wall of the lock and the brick esplanade are both in relatively good condition. Several flights of steps lead up from the esplanade to the buildings.

Several intrusive, non-contributing modern buildings stand on the site. These include a one-story frame house between the carpenter shop and the river, a corrugated metal garage at the north end of the complex, and a frame utility shed/garage at the south end.

Lock and Dam No. 13 was closed in 1960 when Hildebrand Lock and Dam was placed in service. The dam and most of lock were removed at that time. The site is now privately owned and occupied, and public access is restricted. The buildings appear to be well-maintained.

Despite the presence of intrusive modern buildings and insensitive additions to most of the historic buildings, the site of Lock and Dam No. 13 continues to be recognizable as an historic lock complex. The configuration of these features is representative of the Corps' early twentieth-century navigational facilities on the upper Monongahela River. Together with the surviving complexes at Nos. 9, 10, and 12, this site effectively illustrates the physical layout and appearance of the Corps' upper Monongahela facilities constructed during that period. Accordingly, the property is eligible for the National Register as part of the historic Monongahela River Navigation System. The National Register boundaries of Lock and Dam No. 13 include the entire former federal property on the left bank of the river.

COE Lock and Dam No. 14
Left Bank at River Mile 115.0
Lowsville, West Virginia
Abandoned, Federal Ownership

Lock and Dam No. 14 was located on the left bank of the Monongahela River near the village of Lowsville, West Virginia, 115.0 miles above the mouth of the river. It was built by the U.S. Army Corps of Engineers between 1901 and 1903. Each of the six upper river facilities built during this period were much the same, containing a concrete fixed-crest dam, a single 56 foot by 182 foot lock chamber with a 10.67 foot lift, and a similar complement of support buildings. All of the locks were operated by hand. Lock and Dam No. 14 was opened for navigation in December 1903.

The concrete dam was founded on rock and extended 433 feet across the river. It included a wide concrete apron, a sloped concrete abutment founded on rock, and concrete-on-timber guide and guard walls. The pool behind Dam No. 14 was 8.6 miles long and 847.33 feet in elevation. The lock was constructed of concrete and was filled and emptied through wickets in the gates. The valves were operated with levers connected to the valves with cast iron sector gears and pinions. In 1906 the Corps replaced the filling-valve levers with worm gears and in 1921 installed new valves in the bottom sectors of all of the lock gates. Four hand-operated capstans were used for opening and closing the gates, with winches being used to move the wickets.

The support structures for Lock and Dam No. 14 included two houses for the lockmaster and lockman, an office, carpenter shop, blacksmith shop, coal house, and privy,

all of which were completed in 1904. The complex at No. 14 was typical of those built by the U.S. Army Corps of Engineers at its locks and dams on the upper Monongahela River between 1874 and 1906. The houses and other support buildings all stood on an elevation overlooking the lock and esplanade. The houses were mirror images of each other, built on reverse plans and were identical to the houses at Lock and Dam Nos. 11-15. At No. 14, the office stood between the two houses, and at the north end of the complex were the carpenter and blacksmith shops. The shops, office, and coal house were built according to standard plans and were similar to their counterparts at Lock and Dam Nos. 8-15. The arrangement of buildings at No. 14 was identical to that at Nos. 10 and 13.

The Corps of Engineers closed the complex in 1967 when it opened Opekiska Lock and Dam immediately across the river. The concrete land wall and esplanade are the only extant structures at Lock and Dam No. 14.

Although no buildings survive at Lock and Dam No. 14, the concrete land wall and esplanade, as well as the landscape plan, are representative of the Corps' early twentieth-century navigational facilities on the upper Monongahela River. Removal of the buildings has adversely affected the site's integrity, but it continues to evoke the feeling of an early twentieth century lock complex, and it possesses integrity of location, feeling and association. The surviving navigation-related features are contributing elements of the National Register resource. The National Register boundaries should include all portions of the original Lock and Dam No. 14 site on the left bank of the river which were not altered by construction of the Opekiska Lock and Dam complex. These boundaries encompass the land wall, esplanade, and elevated platform on which the buildings were situated.

Opekiska Lock and Dam
Right Bank at River Mile 115.4
Lowsville, West Virginia
Operational, Federal Ownership

Opekiska Lock and Dam is located near the towns of Opekiska and Smithtown, West Virginia, at river mile 115.4. This complex was constructed by the U.S. Army Corps of Engineers in 1961-1967 and was placed into service in August 1964. In 1998 the Corps undertook substantial renovation of the lock. The facility is located directly across the river from Lock and Dam No. 14, which it replaced. At present the complex consists of a concrete and steel gated dam, a single concrete lock chamber, a concrete esplanade, an operations building, and a maintenance building.

The 366-foot long concrete and steel dam is founded on rock and consists of four Tainter gates. A stilling basin is not required because the streambed is rock at this point. The concrete abutment is founded on firm rock and incorporates the former land wall of Lock No. 14. The upper and lower concrete guide walls extend from each end of the esplanade. The two outer dam gates are movable-crest type, while the middle two are non-overflow gates. The concrete dam piers are founded in rock. The length of the Opekiska Pool is 13.33 miles, and its elevation is 857.0 feet.

The closure structure is an extension of the emergency bulkhead and traveling hoist system that serves the dam crest gate openings (located just upstream from the upper gates). A bulkhead hoist crane is mounted on top of the service bridge, and emergency bulkheads ride in slots on the dam piers. The service bridge is of prestressed concrete girder construction and extends from the land wall to the left abutment.

The single-chamber concrete lock is founded on rock and measures 84 feet wide by 600 feet long, with a lift of 22 feet at normal pool. This is the highest lift in the Monongahela River Navigation System. The lock chamber is filled and emptied by hydraulically-operated reversed Tainter valves, two to fill and two to empty. The filling and emptying system consists of culverts, ports, and valves in the lock walls. The mechanism is nearly the same as that installed at the Hildebrand lock. The main elements include a cylinder, a piston, a piston rod, a connecting rod, a crosshead, crosshead guides, a rocker, and a strut. The horizontally-framed welded-steel plate miter gates with the skin plate on the downstream side are identical to those installed at Hildebrand, as is the gate machinery. The main elements of the machinery include a cylinder, piston, piston rod, rack, sector gear, sector arm, and strut. The lock operates on a hydraulic closed constant-pressure system with oil used as the medium.

The operations building is situated on the esplanade, midway between the upper and lower gates. It is a one-story box building faced with brick on the exterior and glazed structural tile on the interior. The building is divided into an equipment room, an office, a storage room, a heater room, a locker room with restroom facilities, a potable-water supply pump and equipment room, a kitchenette and dining area, and a shop room. The maintenance building is also located on the esplanade, and there are control shelters on the land wall for each gate. These control shelters provide a view of approaching tows and contain the machinery for starting and stopping the system pressure pumps, the control-valve operation, and the operation of the lock gates.

This component of the Monongahela River Navigation System was constructed between 1961 and 1967 and does not meet the National Register fifty-year age requirement. For this reason, it is not an eligible component of the system.

COE Lock and Dam No. 15
Right Bank at River Mile 124.2
Hoult, West Virginia
Abandoned, Private Ownership

Lock and Dam No. 15 was located on the left bank of the Monongahela River at Hoult, West Virginia, 124.2 miles above the mouth of the river. It was built by the U.S. Army Corps of Engineers between 1901 and 1903. The 420-foot concrete dam was founded on rock and had a concrete apron, a vertical-face masonry abutment founded on rock, and timber-crib guide- and guardwalls. The pool level was 858.0 feet. The concrete gravity-section lock was founded on rock. The lock was constructed of concrete and was filled and emptied through wickets in the gates. The valves were operated with levers connected to the

valves with cast iron sector gears and pinions. Four hand-operated capstans were used for opening and closing the gates, with winches being used to move the wickets. As in Locks Nos. 10-14, the paired miter gates were constructed originally of timber and later replaced with steel.

The support structures for Lock and Dam No. 15 consisted of two houses for the lockmaster and lockman, an office, carpenter shop, blacksmith shop, coal house, and privy, all of which were completed in 1904. The complex at No. 15 was typical of those built by the U.S. Army Corps of Engineers at its locks and dams on the upper Monongahela River between 1874 and 1906. The houses and other support buildings all stood on an elevation overlooking the lock and esplanade. The houses were mirror images of each other, built on reverse plans, and were identical to the houses at Lock and Dams Nos. 11-14. The shops, office, and coal house all were built according to standard plans and apparently were similar to their counterparts at Lock and Dam Nos. 8-14.

The Corps of Engineers closed the complex in 1967 upon completion of Opekiska Lock and Dam. The concrete land wall and esplanade are the only extant navigation-related structures at Lock and Dam No. 15. Today the site is used as a coal-loading facility.

Although no original buildings survive at Lock and Dam No. 15, the concrete land wall and esplanade, as well as the landscape plan, are representative of the Corps' early twentieth-century navigational facilities on the upper Monongahela River. Removal of the navigation-related buildings and addition of newer structures by the coal company have adversely affected the site's integrity, but it continues to evoke the feeling of an early twentieth century lock complex, and it possesses integrity of location, setting, materials, feeling, and association. The surviving navigation-related features are contributing elements of the National Register resource. The boundaries include all portions of the former federal property on the left bank of the river, encompassing the land wall, esplanade, and elevated platform on which the buildings were situated.

SUMMARY AND EVALUATION

General

Many historic components of the Monongahela River Navigation System still remain. The results of the inventory indicate that twenty-one sites along the river are eligible for the National Register as part of the system, including three operational facilities in Pennsylvania (Locks and Dams Nos. 2, 3, and 4) and one in West Virginia (Morgantown Lock and Dam); the site of the MNC/COE repair facilities and boatyard in North Charleroi; and extant remnants of sixteen abandoned lock complexes along the length of the Monongahela River in Pennsylvania and West Virginia. All of the eligible properties possess sufficient integrity of location, design, setting, materials, workmanship, feeling, and association to convey their significance as historic components of the navigation system.

Of the operational facilities, Locks and Dam No. 3 and Morgantown Lock and Dam retain their original features, and Locks and Dams Nos. 2 and 4 retain portions of theirs. None of the non-functioning sites retain their dams, as these would be impediments to navigation, but all retain structural remains associated with the original complexes and continue—to varying degrees—to be recognizable as historic navigational facilities. Each of these sites, with all of its extant features and structures, represents part of the story of the Monongahela River Navigation System and is eligible for the National Register as part of that system.

Several components of the system already have been determined eligible for the National Register of Historic Places. COE Locks and Dams Nos. 2, 3, and 4 were determined eligible through Section 106 consultation for the current Lower Mon Project. All contain important early-to-mid-twentieth century buildings and structures and clearly illustrate various aspects of historic navigational technology. MNC Lock and Dam No. 7 and COE Lock and Dam No. 7 were determined eligible in connection with the Grays Landing Lock and Dam Project. The remains of MNC/COE Locks and Dam No. 6 at Rice's Landing, including two locktenders' houses, the esplanade, and land wall, are contributing elements of the Rice's Landing Historic District, which is listed in the National Register. Tygart Dam in West Virginia, a reservoir designed to augment flow in the upper river, also is listed.

For sites that retain strong visual integrity—where the original landscape design is apparent, and there are few modern intrusions to detract from the historic setting—the National Register boundaries should include the entire parcel of land historically owned by the Monongahela Navigation Company and/or federal government, encompassing all of the associated buildings, structures, and features. For sites that have suffered a loss of integrity through landscape modifications and the addition of intrusive non-historic buildings, the boundaries should encompass only the buildings and features related to the Monongahela River Navigation System, and not the entire property.

Monongahela Navigation Company Properties (1840-1890)

The inventory revealed that there are few surviving remains of the navigation facilities constructed by the Monongahela Navigation Company during the initial period of the system's operation. Most of these were replaced by new facilities at different locations soon after the system's acquisition by the federal government in 1897. The sites of MNC Locks and Dams Nos. 1, 3, 5, and 7 contain no extant historic structures other than a stone land wall and in several cases a dam abutment (No. 1) or building foundations (No. 7); however, these sites still retain sufficient integrity to be recognizable as historic navigation facilities with visible features from their period of use. Most of these sites are privately-owned, and the few surviving navigation features could be destroyed at any time. Continuing natural deterioration poses an ongoing threat to these properties. In all cases, public access is prohibited or restricted.

At MNC No. 2 (Port Perry), subsequent railroad development was so extensive that no navigation features remain. Accordingly, this site is not considered a contributing component of the Monongahela River Navigation System. At MNC Locks and Dams Nos. 4 and 6, and at the North Charleroi boatyard and repair facility, the U.S. Army Corps of Engineers constructed new facilities at the same locations, obliterating all evidence of the MNC buildings and structures. These sites are significant only because of the Corps-era remains.

Early U.S. Army Corps of Engineers Properties (1879-1904)

COE Locks and Dams Nos. 9-15 in West Virginia and COE Original Lock and Dam No. 8 in Pennsylvania all were built within a short time period and share a basic similarity of design. Today each contains an extant land wall and esplanade, and many have one or more surviving support structures. Only Nos. 14 and 15 have not retained any buildings. Several outstanding examples of early Corps navigation complexes have survived along the upper river. The most intact are found at Locks and Dams Nos. 9, 12, and 13. Lock and Dam No. 9 (the earliest) has two houses, a carpenter shop, blacksmith shop, store house, and privy; the houses have been extensively altered, but the minor buildings retain strong integrity. No. 12 is the most intact complex, with one house, both shops, a coal house, store house, and office, all of which are virtually unaltered. At No. 13, the original complement of support buildings survives, but most of the structures have been modified, and intrusive modern buildings have been added. All three sites are privately-owned, and access must be negotiated. All appear to be well-maintained at present, but the surviving navigation-related structures can of course be altered or removed at any time by their owners. Recordation of these complexes should be considered an urgent management priority, especially at Nos. 9 and 12.

COE Lock and Dam No. 10 at Morgantown is notable mainly because of its elaborate Queen Anne-style locktenders' houses, that were unique in the Monongahela system. The houses have survived and are in excellent condition, as is the blacksmith shop. The carpenter shop survives but has been altered. No other support buildings are extant. The buildings at this property are privately-owned, but are all in good condition and do not appear to be

threatened. Part of the site is included within the boundaries of the adjacent Morgantown Lock and Dam.

Lock and Dam No. 11 has only three surviving support buildings (carpenter shop, blacksmith shop, storehouse), and these have been extensively altered. However, the landscape design of this site is essentially intact, despite the loss and alteration of buildings. It too is privately-owned, and access is exceedingly difficult. Based on the recent history of this property, its outlook for the future is not good.

Lock and Dam Nos. 14 and 15 retain no buildings and are poor examples of this property type. No. 14 is federally-owned, and No. 15 is privately-owned; access to both must be negotiated. Neither appears to face any immediate threat. Original COE No. 8 retains only its office (in ruinous condition). Abandoned and in an isolated location, continued natural deterioration is the main threat to the survival of this property.

Middle Period U.S. Army Corps of Engineers Properties (1904-1930)

The second generation of Corps facilities date to the first period of modernization on the lower and middle river and includes COE Nos. 1-3, MNC/COE No. 4, and COE Nos. 5-8. Locks and Dams No. 3, No. 4, and No. 7 are all particularly outstanding examples of this property type. Chief among them is Locks and Dam No. 3, an operational facility that retains much of its early twentieth century character. Its dam, locks, and support buildings together compose a complete and functioning navigation facility that illustrates the evolution of lock and dam technology in the twentieth century. Since it will be abandoned as part of the Corps' present modernization program, recordation of the existing structures and features should occur prior to their loss. Because the property is easily accessible and remains in excellent condition, this might be an excellent location at which the entire navigation system could be interpreted to the public, perhaps in conjunction with other selected abandoned facilities (primarily COE No. 7) and the operational locks and dams.

MNC/COE No. 4 and No. 7 are only partially intact. The former is unique among abandoned facilities because it retains all three walls of its two lock chambers, as well as its middle wall powerhouse. Unfortunately, the landward portion of the property has suffered a severe loss of integrity through the removal of all navigation-related structures and their replacement by intrusive fuel storage tanks and modern oil company buildings. Ongoing deterioration poses a definite threat to the continued survival of this privately-owned property. Recordation should be a management priority in the near future. COE No. 7 near Greensboro was abandoned relatively recently, and retains all of its landward structures and features, including its two-story powerhouse. Despite the loss of its dam, lock river wall, and locktenders' houses, it remains an outstanding example of a 1920s-era Corps lock and dam facility. HAER recordation was completed in 1994, but this federally-owned property continues to possess considerable public interpretive potential, and some provision should be made for its long-term preservation and interpretation.

COE Locks and Dam No. 2 at Braddock is an operational facility that retains relatively few of its significant historic features. Its most outstanding historic component, the early twentieth century fixed-crest concrete dam, is due to be replaced as part of the Corps' Lower Mon Project. No historic structures or features survive at COE New No. 8, now Point Marion Lock and Dam. COE No. 1 at Pittsburgh contains only a concrete land wall and dam abutment and is barely recognizable as an historic navigation facility. The remaining abandoned properties, COE Nos. 5 and 6, each retains a concrete land wall, esplanade, two locktenders' houses, and minor elements of the original landscape design. Although all except No. 8 possess sufficient integrity to be eligible for the National Register as components of the navigation system, none can be considered an outstanding example of the property type, due to the loss of all or most of their support buildings. COE Nos. 5 and 6 are the best of the group and do not appear to face any imminent threat other than natural deterioration.

The MNC/COE boatyard and repair facility at North Charleroi is a unique property type in the navigation system, with its oldest surviving buildings constructed during the Corps' first modernization program in the early twentieth century. Although several buildings from the Corps era have been removed fairly recently, others still survive. They are currently well-maintained but could be removed or altered at any time. Recordation of the site should be a priority in the near future.

COE New Locks and Dam No. 4 was built in 1931-1933, at the end of the period. It included no locktenders' houses but had two powerhouses and an operations/administration building, as well as the narrow locks that had been the Monongahela River standard. In the types and arrangement of buildings that were present, it marked a transition between the second and third generation of Corps navigation facilities on the Monongahela River and thus is unique among those facilities. It retains its original narrow locks, middle wall operations building, and land wall powerhouse and, despite the modern gated dam, still exhibits the look and feel of an early twentieth century lock and dam complex. Because its integrity is now threatened, recordation of the significant features in this outstanding complex should occur prior to any changes made during the Corps' present modernization program.

Post-World War II Locks and Dams (after 1945)

Five of the six operational facilities constructed by the Corps of Engineers during this period do not meet the 50-year National Register age requirement. Although they all embody the distinctive characteristics of lock and dam technology in the second half of the twentieth century, at present these five properties do not contribute to the significance of the historic system. As the system's period of significance is extended forward, these properties probably will come to be considered contributing components. All are under federal ownership, and for the time being at least, they face no known threats other than periodic modernization of specific elements.

Morgantown Lock and Dam is the oldest of the post-war facilities, and is a contributing component of the historic system. It is unique among the surviving historic

properties for a variety of reasons. As an operational facility, it is under federal ownership, and there are no known threats. In the future, recordation of significant features should be completed prior to their replacement or alteration.

Management Priorities

Surviving historic components of the Monongahela River Navigation System can be grouped into several management categories based on their integrity, significance, and prospects for future preservation.

High Priority

Properties in this group are outstanding examples of their respective property types and possess strong integrity. Most face imminent destruction through deterioration, federal action, or private landowner action, while the others are currently well-maintained but are still at risk due to their ownership status. At the very least, these properties should be documented to HABS/HAER standards in the very near future, before the qualities that contribute to their significance are lost (documentation already has been completed for one property, COE No. 7). Preferably, options should be explored in order to ensure their long-term preservation and public interpretation. These properties include:

- COE Locks and Dams No. 3
- MNC/COE Locks and Dam No. 4
- COE New Locks and Dam No. 4
- COE Lock and Dam No. 7
- COE Lock and Dam No. 9
- COE Lock and Dam No. 12
- COE Lock and Dam No. 13

At COE New Locks and Dam No. 4, alterations to historic features at that site are unavoidable if the facility is to continue to be a functioning component of the navigation system. Recordation is the only feasible management option.

After its scheduled abandonment, COE Locks and Dam No. 3 at Elizabeth might provide an excellent interpretive site where the history and technology of the entire system could be presented to the public. Other locations, such as COE No. 7 and the various operational facilities, also could be incorporated into an integrated interpretive program for the entire system, at relatively little cost. Perhaps COE No. 7 could serve as a detached visitors center and local tourist bureau operated by a public/private partnership.

Moderate Priority

These properties fall into two subgroups. The first subgroup includes properties that face an imminent threat from neglect or alteration. Because of the previous loss or alteration of buildings and features, they cannot be considered outstanding examples of their type, but

they still retain some significant buildings and features which should be carefully documented before they are lost:

- COE Locks and Dam No. 2
- COE Original Lock and Dam No. 8
- COE Lock and Dam No. 11

The second subgroup face no imminent threat but are outstanding or good examples of their respective types. They too should be documented to HABS/HAER standards as soon as possible:

- MNC Lock and Dam No. 7
- COE Lock and Dam No. 10
- Morgantown Lock and Dam
- MNC/COE Boatyard

Although no buildings survive, MNC No. 7 has the most extensive group of remains of any of the MNC lock and dam facilities. It is the property that best conveys the significance of the early MNC system. Archaeological investigations might be useful in documenting the technical operation of the facility and the lifeways of its workers.

Low Priority

Properties in this category also fall into two subgroups. The first is comprised of properties where no buildings have survived and the setting has been altered significantly. They are relatively poor examples of their respective types, and do not warrant any documentation beyond that completed for the state historic inventory forms. They include:

- MNC/COE Locks and Dam No. 1
- MNC Locks and Dam No. 2
- MNC Locks and Dam No. 3
- MNC Lock and Dam No. 5
- COE New Lock and Dam No. 8 (Point Marion)
- COE Lock and Dam No. 14
- COE Lock and Dam No. 15

The second subgroup includes properties where there are no surviving buildings other than two locktenders' houses. The sites also contain a land wall and esplanade that do not appear to be endangered. In these cases, the houses and other features should be recorded to HABS/HAER standards, but this should be considered a distinctly lower priority than for the threatened and outstanding properties:

- COE Locks and Dam No. 5
- MNC/COE Locks and Dam No. 6

CONCLUSION

Many historically-significant components of the Monongahela Navigation System still survive along the 124 miles of river between Pittsburgh, Pennsylvania, and Fairmont, West Virginia. As a group, they help to tell the fascinating story of one of America's most successful and significant inland navigation systems, a system that helped to transform rural southwestern Pennsylvania and northern West Virginia into one of the country's premier industrial regions in the second half of the nineteenth century and the first half of the twentieth. The operational and abandoned navigation facilities along the river embody one-hundred-and-fifty years of lock and dam technology.

The navigation system is a significant but fragile historic resource. A century and a half of changing land-use and constant modifications to the system have exacted a heavy toll. The integrity and condition of individual properties vary tremendously. Many are worthy of preservation and additional study, while others are not. Measures should be taken immediately to ensure the preservation of the most outstanding components of the system or, at least, to preserve the information that they contain. The fragility of these properties is underscored by the recent destruction by fire of a locktender's house at COE Lock and Dam No. 12, the most intact turn-of-the-century lock and dam support complex on the river.

One of the two locktenders' houses at COE Lock and Dam No. 9 has been altered beyond recognition within the past six months, just as the other house at that site was less than a decade ago. The lock walls and powerhouse of MNC/COE Locks and Dam No. 4 continue to crumble into the river with each passing season. And the two most intact and historically significant of the older operational facilities, COE Locks and Dam No. 3 and COE New Locks and Dam No. 4, are both scheduled to be replaced or substantially altered within the next decade. Clearly, now is the time to record what is about to pass from the scene and to make plans to preserve and interpret the best of what remains.

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