

PITTSBURGH'S RIVERS: FROM URBAN INDUSTRIAL INFRASTRUCTURE TO ENVIRONMENTAL INFRASTRUCTURE

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Like most river cities in Europe and America, Pittsburgh has looked upon its three principal rivers---the Allegheny, Monongahela, and Ohio---as an invaluable natural resource to be used in support of economic development and everyday life. These urban rivers have always been as much a part of Pittsburgh's infrastructure as its roads, railroads, mass transportation lines, or electrical grids. For decades many of the natural aspects of these river systems vanished or were subsumed by human actions. Despite these dramatic changes, the natural systems adapted, survived, and now flourish once again as part of a new vision for the region's future.

Over the course of more than two centuries, the city has forged very different relationships with its rivers, corresponding with three distinct periods of economic life. During its initial 100 years or so, Pittsburgh depended on the rivers for transporting the trade that was its lifeblood; nevertheless, it only lightly and ineffectively attempted to manage them physically. The city's headlong embrace of industrialism, commencing around the mid-nineteenth century, radically transformed the rivers' hydrology and ecology. In order to serve the needs of rapid industrial and urban growth, Pittsburgh elites sought to regulate the rivers' flow, shape their

banks, and augment the flat floodplain lands. They also used the rivers' water for both household and industrial consumption and waste disposal. In so doing, they conceived of the rivers in this second period as an integral part of the city's infrastructure. Thus, the rivers were harnessed, managed, and rationalized for the smooth functioning of the city and its industrial machine.

Turning the rivers into water infrastructure had negative consequences for their ecological systems as well as the public's health and safety. A "second" or "industrial" riverine nature evolved as a result of the altered hydrology and massive pollutants that degraded water quality and greatly diminished the diversity and abundance of flora and fauna. In the first half of the twentieth century, progressive reformers sought to mitigate the most hazardous conditions for human existence due to water pollution and flooding through additional engineering and conservation measures. The subsequent improvements in water quality gradually awakened, especially after the mid-twentieth century, renewed interest in the possibilities of recreational and scenic uses of the rivers.

Federal water quality laws in the 1970s and the massive collapse of the region's traditional industries in the 1980s, however, provided the major factors making it possible for Pittsburgh, once again, to rethink its relationship to the rivers. Recognizing the recent and impressive revitalization of waterfronts in many American cities, Pittsburgh civic leaders came to view the rivers as providing valuable scenic and recreational amenities that could be part of a new regional development strategy. Others in the community have begun to advocate the restoration and preservation of a riverine ecology more like its pre-industrial state. In this view the rivers, the river lands, and the air comprise a public commons, as they did before industrialization. Thus, even though the amenity and restoration goals sometimes could come

into conflict, together they promise an evolving third riverine nature as an environmental infrastructure for the region's future.

The Rivers Before Industrialization

Flying into Pittsburgh today, a traveler readily spots from the airplane the region's outstanding physical feature---the convergence of two broad rivers to form a third even larger river. At this junction, the tall buildings of Pittsburgh's downtown rise up from a small peninsula formed by the joining of the Allegheny and Monongahela rivers. These skyscrapers stand like sentinels over the Ohio River, as it begins its journey westward for nearly 1000 miles to the Mississippi River.¹ Far to the south the sources of the Monongahela lie in the Appalachian Mountains of West Virginia. The Tygart and West Fork rivers come down from the mountains and join at Fairmont, West Virginia, to form the Monongahela, which leisurely flows northward for 128 miles to Pittsburgh. In contrast, the more swiftly flowing Allegheny River begins in the mountains of north central Pennsylvania and flows briefly north and westward into New York state before turning southwest for 325 miles through western Pennsylvania for its meeting with the Monongahela. These three rivers and the point of land they create comprise the physical framework around which the Pittsburgh region developed. Three secondary rivers - the Beaver, Kiskiminetas, and Youghiogheny - as well as dozens of tributary streams, creeks, or runs augment this riverine structure.²

Before the invasion of Western Pennsylvania by French and English military expeditions, traders and colonists, these rivers and their valleys were occupied at different times by various tribes of Amerindians, including the Delaware, the Shawnee, and several tribes from the Iroquois nation.³ By the turn of the nineteenth century, settlers with the assistance of the U.S. Army had

largely pushed the various tribes out of the region's heart and taken over the land. The rivers, as they existed in nature, supplied the primary organizational framework for this new settlement, providing a transport corridor in drought free years, an abundance of fish, and fertile land in the floodplains. Moreover, the location at the head of the Ohio River presented the young city of Pittsburgh the opportunity to be the commercial gateway to the newly settling Midwestern frontier. Thus, the three rivers were both central to the city's economic function and aspirations, and an integral part of people's everyday lives.⁴

Despite their critical role in supporting Pittsburgh's economy, the rivers presented serious impediments to commercial navigation. Water was an ideal surface to travel upon, but the fluctuations in flow, dangerous snags and boulders, treacherous riffles, and shifting sand bars all limited commercial uses. At the urging of politically connected, local residents, both the state and federal governments funded modest attempts to clear the rivers of obstacles and deepen the channels. They contracted private companies to dynamite rocks in riffles, remove flotsam and jetsam, and establish small "wing" dams to insure minimum depth for transport. However, these efforts to physically manage the rivers produced only minimal improvements by the end of the Civil War.⁵ One solution was to create a network of canals, which regulated water flow in separate, often parallel waterways. Among the many miles of canalized waterways that the state constructed, the 1834 Pennsylvania Main Line system, a combination of inclined plane, railroad, and canal extending from Philadelphia to Pittsburgh, was the most important. For almost twenty years Pittsburgh's commercial life benefited enormously from this awkward system as it snaked into the city along the northern floodplain of the Allegheny River. The commercial value of Monongahela River traffic, especially coal, persuaded the state of Pennsylvania to commission the Monongahela Navigation Company in the mid-1840s to develop the first dams and locks

between Pittsburgh and the West Virginia State Line. This modestly successful, slack water venture established privatized toll navigation.⁶

The rivers fulfilled essential functions for the young city, such as providing water for households and industry and a sink for municipal sewage, storm water, and the waste of commerce and industry. Pittsburgh residents used the rivers for recreation, and annually coped with the cleanup required by spring and fall floods that inundated low-lying neighborhoods. As urban development emerged on the banks of the Allegheny and Monongahela across from the city at the Point, private companies erected bridges to replace the slower, less reliable ferries. As a result of the city's growth in the first of the nineteenth century, the wooded banks of all three rivers gave way to wharves, docks and other infrastructure that aided mercantile sales, commercial navigation, and early industries.⁷ Nevertheless, the human impact on the natural ecosystem was still limited.

The Transformation To Urban Industrial Infrastructure

When the Pennsylvania Railroad brought the first rail service to Pittsburgh in 1852, the role of the three rivers, as well as the civic leaders' conception of them, underwent a dramatic and long-term shift. Pittsburgh's commercial dream as a transportation gateway servicing westward migration and commerce via its canals and rivers was destroyed. The city, however, soon reinvented itself and its relationship to the rivers, as part of the massive industrialization and concomitant rapid urban growth that transformed the region. Civic leaders increasingly conceived of the rivers as essential infrastructure for industrial production and urban development. As infrastructure, engineers shaped and controlled the rivers to fit the needs of industry and the city.

Industrialization supplanted the city's river-based mercantilism in the three-quarters of a century following the railroad's arrival. The most intensive development occurred in the iron and steel and regional coal and coke industries. After 1875 the explosive growth of the mass production steel industry most defined the city's industrial transformation. Industrialists sited their large mills on the broad river floodplains nestled within the sweeping river meanders with railroad tracks running along the landward side of the mill. Other capital intensive, mass production plants in glass, railroad equipment, aluminum, food processing, and electrical equipment industries, to name the most prominent, also spread out to sites stretching along the three rivers floodplain for 30 to 40 miles from the Pittsburgh Point. By providing cheap transportation for fuel supplies from the region's coalfields and for other natural resources such as timber and oil, the rivers played a critical role in the region's industrialization.⁸

Although the total number of people and vessels engaged in commercial river traffic shrunk steadily during the remainder of the century, the actual tonnage of goods shipped along the rivers increased dramatically. Bulk commodities, like oil, sand, gravel and especially coal, along with some finished iron and steel products, dominated this traffic. With the end of the Civil War, the U.S. Army Corp of Engineers took over management of the rivers from private interests and the state. Reshaping them into stable, manageable infrastructure systems had significant economic returns for commercial traffic since each additional six inches of channel depth allowed boats and barges to increase their cargo by 70 tons. Under pressure from Ohio Valley business interests, Congress in 1875 authorized the construction of locks and dams for the Ohio River. Significant river traffic improvement due to the Davis Island Lock and Dam, located five miles below the Point, intensified political pressure for the "canalization" of the entire three rivers system. By the turn-of-the-century locks had been completed down to

Marietta, Ohio and up both the Allegheny and Monongahela rivers. The Army Corps of Engineers finally completed the Ohio River system to Cairo, Illinois in 1929. The now completely engineered rivers consisted of a series of pools with navigation channels maintained from six to nine feet deep.⁹

Controlled river flow and the concomitant growth of industry along the riverfronts changed the river edges nearly as dramatically as the rivers themselves had been altered. The new "pools" permanently raised water levels, drowning previous mud flats and establishing new river banks. Industries constructed wooden and cement bulkheads for river terminals and flood control. They built large round mooring cells, sprinkled the banks with cranes, conveyor belts, and loading chutes, and added water intake and waste discharge pipes. Some companies extended and heightened the banks with extensive fill, much of it slag from the iron and steel mills, and even closed back channels to nearby islands. Boat-building firms erected launching facilities, and repair yards extended along the banks in several places. Shanty boats, sunken watercraft, and abandoned barges littered the river edges and banks. Railroads lined the riverfronts as well, and in many places steep hillsides narrowed the floodplains so that only the railroads occupied them.¹⁰

Both municipalities and industries used prodigious amounts of water. They pumped water for household consumption and industrial production, while discharging wastewater contaminated with human and industrial wastes back into the rivers. Writing in 1912, N.S. Sprague, Superintendent of the Pittsburgh Bureau of Construction, observed that, "Rivers are the natural and logical drains and are formed for the purpose of carrying the wastes to the sea."¹¹ No more succinct statement could be made about the attitude of most municipal officials and industrial leaders towards Pittsburgh's rivers for the years from 1850 to 1940. This position was

codified into administrative law for Pittsburgh in 1923 when the Pennsylvania Sanitary Water Board created a classification system that designated streams into three categories for municipal and industrial users. This system classified streams as ones relatively clean and pure, streams in which pollution existed but could be controlled, and streams so polluted that they could not be used as public water supplies without treatment or for fishing and recreational purposes. The latter streams could continue to be used for the discharge of untreated wastes - that is, as open sewers. Pittsburgh's three rivers fell into this last classification.¹²

Pollution flows into Pittsburgh's rivers were of three principal kinds: municipal sewage, industrial wastewater, and mine acid drainage. Cumulatively, they all degraded stream quality, although their effects differed somewhat in regard to public health and stream ecology. From the point of view of acute public health effects, municipal sewage had the most devastating affect.

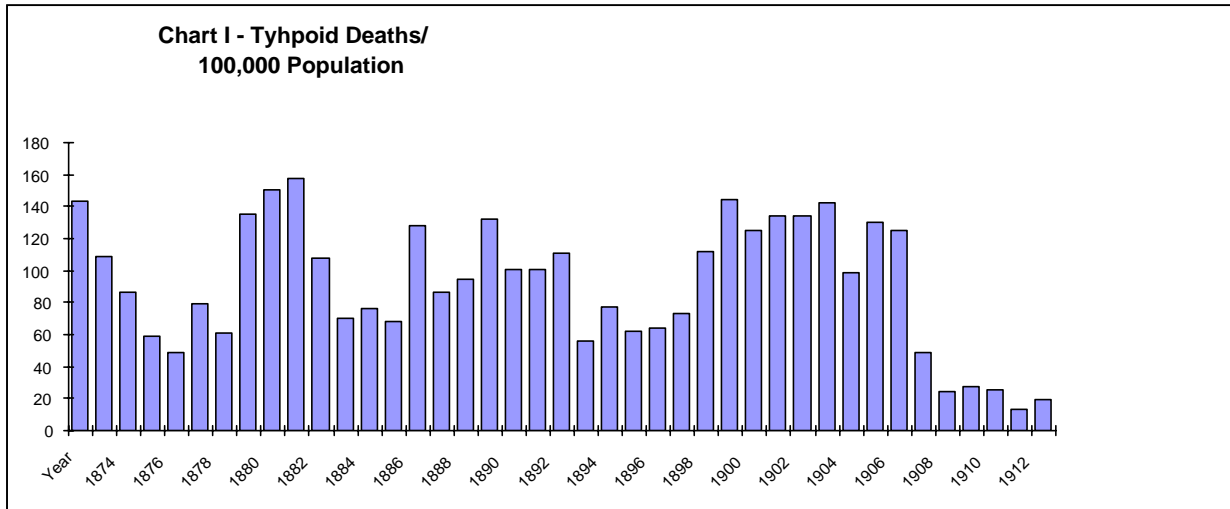
Beginning in the second quarter of the nineteenth century, Pittsburghers drew their water supply largely from the nearby rivers, although some working class areas continued to depend on groundwater and pumps into the twentieth century. By 1915, the City of Pittsburgh's system had grown to 743 miles of distribution pipes.¹³ The provision of running water to households and the mass adoption of water using appliances such as sinks, showers, and water closets benefited households in many ways, but they also exacerbated the problem of wastewater disposal.

During most of the nineteenth century, Pittsburghers placed household wastes and wastewater in cesspools and privy vaults, not in sewers. They continued this practice even after the availability of running water greatly increased the volume of wastewater. In 1881, for instance, about 4,000 of the city's 6,500 water closets were connected to privy vaults and cesspools with only about 1,500 linked to street sewers that the city had begun constructing at

mid-century. Overflowing privies were a constant nuisance noted the Pittsburgh Board of Health, presenting the city with a major health issue.

Such conditions raised the possibility of epidemics from infectious disease and highlighted the need for improved sanitation and construction of a sewage system. Beginning in the 1880s, a fierce debate ensued between engineers and physicians concerning whether the sewer system should be a separate system carrying only household and some industrial wastes or a combined system that could accommodate both wastewater and storm water in one pipe. The engineers triumphed, and the city began constructing a combined sewer system, building over 412 miles of combined sewers between 1889 and 1912. The design decision had large implications for future river water quality.¹⁴

Like other cities, Pittsburgh discharged its untreated sewage from public sewer outlets (145 of them) directly into neighboring waterways on the theory that running water purified itself and diluted and dispelled the wastes. Simultaneously, upstream communities were also building sewers and discharging their wastes into the same rivers. By 1900, more than 350,000 inhabitants in 75 upstream municipalities discharged their untreated sewage into the Allegheny River, the river that provided drinking water for most of the City of Pittsburgh's population. Even some of Pittsburgh's own sewers discharged into the river at locations above its water supply intake pumping stations. The resulting pollution gave Pittsburgh the highest death rate from typhoid fever of the nation's large cities---well over 100 deaths per 100,000 people from 1873 to 1907. In contrast, in 1905, the average death rate for northern cities was 35 per 100,000 persons (see Chart I).¹⁵



Typhoid Death Rates in Pittsburgh, 1870-1912

SOURCE: Erwin E. Lanpher and C. F. Drake, *City of Pittsburgh: Its Water Works and Typhoid Fever Statistics* (Pittsburgh: City of Pittsburgh, 1930), 23-5.

Concerned over the growing typhoid mortality and morbidity rates, several professional groups and the Pittsburgh Ladies Health Protective Association formed a citizen's Joint Commission in the 1890s to study the question of water pollution and water quality. Their 1894 report found that Pittsburgh and Allegheny City water supplies were "not only not up to a proper standard of potable water but...actually pernicious," and recommended filtering the water supply of both cities. In 1896, following this report, the Mayor appointed a Pittsburgh Filtration Commission which made a similar recommendation. In December 1907 after several years of delay caused by political infighting and technical issues, the water department delivered the first filtered water to the city. Pittsburgh thus joined cities such as Philadelphia and Cincinnati, which took their water from their neighboring rivers and filtered it, while cities such as Boston and New York chose to rely upon supplies from a protected watershed. Pittsburgh's typhoid rates

immediately began to decline and by 1912, after chlorination of the water supply, its typhoid death rate dropped to the level of the national average for large cities.¹⁶

Water filtration provided one safety net in regard to protection from polluted water, but many sanitarians and public health physicians believed that a second safety net, sewage treatment, was required for maximum protection. In 1905, responding to a severe typhoid epidemic, the Pennsylvania legislature passed the Pure Waters Act "to preserve the purity of the waters of the State for the protection of the public health." It forbade the discharge of any untreated sewage into state waterways by new municipal systems. While it permitted cities already discharging to continue the practice, it required them to secure a permit from the State Commissioner of Health if they wished to extend their systems.

In the beginning of 1910, Pittsburgh asked the Pennsylvania Department of Health to grant it a permit allowing it to extend its sewerage system, thus creating a confrontation with the state agency. The Department, then headed by Dr. Samuel G. Dixon, a follower of the New Public Health doctrine, responded by requesting a "comprehensive sewerage plan for the collection and disposal of all of the sewage of the municipality" before it would grant the permit. In addition, the Department argued that in order to attain efficient treatment, the city should consider changing from the combined sewer system to the separate system.

The municipality responded to Dixon's order by hiring the nationally renowned engineering firm of Allen Hazen and George C. Whipple to act as consultants to study the issue. In their 1912 report, Hazen and Whipple argued that a Pittsburgh sewage treatment plant would not free the downstream towns either from threats to their water supplies or from the need to filter them, since other communities would continue to discharge raw sewage into the rivers. The method of disposal by dilution in the rivers, they maintained, sufficed to prevent nuisances,

particularly if storage reservoirs were constructed upstream from Pittsburgh to augment flow during periods of low stream volume. Thus rivers would continue to serve as sinks for urban wastes.¹⁷

Health Commissioner Dixon found the Hazen and Whipple report an insufficient response to his original request for a long-range plan for a comprehensive regional sewerage system, but most members of the engineering community agreed with its premises. The issue for them was costs and avoidance of nuisance, but for Dixon there was a larger question of developing "a campaign in order that the streams shall not become stinking sewers and culture beds for pathogenic organisms..." Given the political context, however, and the financial limitations upon the city, Dixon had no realistic means by which to enforce his order. In 1913 he capitulated and issued Pittsburgh a temporary discharge permit, thus continuing the use of Pittsburgh's rivers as open sewers.¹⁸

While agitation for sewage treatment had been building, another major river pollutant, mine acid, had escaped regulation. While other industrial pollutants were problems, the sulfuric acidic discharge from coal mines was the most ecologically damaging water contaminant in western Pennsylvania's industrial history. Mine acid destroyed fish life and altered the flora along small streams and in major rivers, caused millions of dollars of damages to domestic and industrial water users, and enlarged the costs of water and sewage treatment.¹⁹

The economic importance of coal production in southwestern Pennsylvania impeded attempts by government to counter the burden of acid mine drainage. The coal industry argued that no "suitable" method existed for the treatment of mine water. In addition, the courts had granted the industry legal protection in the infamous 1886 case of *Pennsylvania Coal Company v Sanderson and Wife*, which concerned the destruction by mine acid of the water supplies of a

farm near Scranton, Pennsylvania. In this case the Pennsylvania Supreme Court maintained that "the right to mine coal is not a nuisance in itself," and that the acidic substances entered the stream via natural forces that were beyond company control. The justices also noted the economic importance of the coal industry, arguing, "the trifling inconvenience to particular persons must sometimes give way to the necessities of a great community." In 1905, when the Pennsylvania legislature passed the Purity of Waters Act, it specifically exempted "waters pumped or flowing from coal mines," as it did again in 1937 in the Clean Streams Act.²⁰

In general, therefore, as reflected in the failure to regulate sewage disposal and mine acid, the three rivers and their river valleys throughout the Pittsburgh industrial region had become and remained industrial infrastructure, engineered and utilitarian. They had been so altered by the 1920s that few older residents would have recognized the rivers they had experienced a half century earlier.

Reforming Industrial Nature

The rapid growth and unbridled development of the Pittsburgh region left in its wake a number of social, political and, as noted above, environmental problems that many early twentieth century Pittsburghers believed threatened the city's civic order and long term economic welfare. As with the nation as a whole, local progressive reformers viewed improving the built and natural environments as a means to uplift the society's moral character and health conditions as well as to create a more efficient and successful business community. Although often emphasizing different aspects of the reform agenda, both voluntary citizen's groups such as the Civic Club of Allegheny County and business organizations like the Chamber of Commerce agreed on the importance of addressing problems associated with the rivers and the riverfronts.

Never challenging the primacy of business prerogatives and private property rights, these reform efforts did represent a modification of the prevailing philosophy of the rivers as industrial infrastructure, which was consistent with progressive reform and the conservation movement then gaining power at the national level. [TED: “traction” too close to infrastructure!]

Pittsburgh's elites increasingly participated in national networks where they encountered movements to conserve forest resources and watersheds, preserve land for parks, and adopt urban planning.

Following the disastrous flood of 1907 and the threat of another a year later, the Pittsburgh Chamber of Commerce appointed a Flood Commission of Pittsburgh, chaired by industrialist H. J. Heinz and comprised of representatives from local government, reform groups, and business as well as men with engineering expertise. It hired an executive director identified with national concerns for planned watershed development. In its massive technical report published four years later, the Commission projected both locally pragmatic thinking and a regional conservation vision. Predicting that continued urban industrial development and clear-cut logging in the mountainous watersheds of the Allegheny and Monongahela rivers would exacerbate the frequency and intensity of flooding, the Commission called for building a flood wall to protect downtown, filling in back channels of islands near the city's center, creating 17 regional impoundment reservoirs, and establishing forest preserves in the headwater areas. Although it had success in getting the federal government to purchase land for reforestation in the upper watersheds, mirroring President Theodore Roosevelt's and his Chief Forester Gifford Pinchot's forest conservation triumphs, the Flood Commission ran into a protracted struggle with Congress and federal agencies. In particular, the Army Corps of Engineers resisted broadening its mandate to manage inland rivers for more than navigational purposes. Only successive years

of drought, economic depression, and the ruinous floods of 1936 and 1937 impelled local and federal leaders to prevail on Congress to authorize a comprehensive flood control program.²¹

At the same time as the Flood Commission tackled its work, civic leaders contracted with landscape architect Frederick Law Olmsted, Jr., to prepare a plan for Pittsburgh. His work focused primarily on issues of traffic congestion and future highway development, but in his 1910 report Olmsted also lamented the dilapidated condition of downtown riverfront lands and urged the city to rethink their possibilities. While he advocated modernization of the Monongahela Wharf cargo handling facilities, incorrectly predicting a resurgence of general merchandise business on the rivers, he also envisioned the industrial rivers as a potential amenity for their picturesque qualities. Thus, with several European cities in mind, he pictured promenades and overlooks above the waterfronts, which would coexist with an expanded roadway to channel traffic rapidly around the periphery of the congested downtown. Moreover, the Boston planner tapped into an ongoing discussion of recovering the land where the three rivers converged for a symbolic park and monument at this historical and geographical inception point of the city. Reminiscent of the various plans for the preservation of open spaces and river lands in Boston, he also suggested the preservation of several undeveloped tributary stream valleys for parks.²²

For the next three decades Olmsted's successors in planning for Pittsburgh kept these ideas for the waterfronts alive in one form or another, but the industrial and infrastructural utility of the rivers and riverfront lands foreclosed their implementation. In 1923, for example, a subcommittee on waterways of the Citizens Committee on City Planning (an elite voluntary group that put forth a city plan in six parts) summed up the business community's view of the rivers as infrastructure when it reported: "navigation interests have a prior right to the use of

those portions of the City's water front which can be advantageously used for water transportation, and that no encroachments should be permitted thereon which will interfere with such activities."²³ Further, the subcommittee recommended the development of several rail-to-river terminals on the waterfronts in and around downtown.

While a few decades into the century civic leaders still wished to manage the rivers for flood control and city planners envisioned the redesign of some riverfront lands, other reformers and conservationists continued to worry about the disposal of waste in the rivers and the resulting public health questions. They refocused their energies on water quality issues. Although by 1934 the drinking water supplies of 80 percent of the state's population were treated, 85 percent of Pennsylvania waterways suffered from various degrees of degradation from raw sewage and industrial wastes. For instance, only 18 per cent of the sewage from a population of 920,000 in the Allegheny River basin, the river from which the City of Pittsburgh drew most of its water supply, was treated. Sewage from Pittsburgh and other communities overwhelmed the oxidation capacity of the streams, creating offensive sights and smells on the rivers. Gross pollution levels in streams impacted the public health; and while water treatment had sharply reduced typhoid deaths, diarrhea, and enteritis death rates remained elevated. Fish were absent from long dead stretches of the rivers, and chemical pollution fouled the taste of many drinking water supplies. In addition, mine acid drainage increased the costs of water filtration for Pittsburgh residents.²⁴

By the end of the 1930s, these conditions had substantially increased the number of advocates of clean streams. Conservationists, notably outdoor sportsmen's groups, were especially active in demanding environmental improvements. In 1937, the Pennsylvania General Assembly passed the Clean Streams Act, giving the Sanitary Water Board power to issue and

enforce waste treatment orders to all municipalities and most industries except for acid drainage from coal mines. In 1944, the Sanitary Board announced comprehensive plans to reduce pollution of Pennsylvania streams, requiring all municipalities to treat their sewage "to a primary degree." The following year the Board issued orders to the City of Pittsburgh and 101 other municipalities, as well as to more than 90 Allegheny County industries, to cease the discharge of untreated wastes into the state waterways.

The state authorized the formation of the Allegheny County Sanitary Authority (ALCOSAN) in 1946, but negotiations dragged on for several years due to political complications. Finally, on October 1, 1958, ALCOSAN's centralized, activated sludge treatment plant located on the northern bank of the Ohio River below the Pittsburgh Point began treating the wastewater of Pittsburgh and 81 county boroughs and towns. A major step had finally been taken to improve the water quality of Pittsburgh's rivers.²⁵

The Pittsburgh Renaissance and the Rivers

Despite Pittsburgh's economic revival during World War II after years of depression, civic leaders feared that peace would return the city to the relatively declining industrial prospects which it had experienced since 1920. These concerns for retaining existing firms and attracting new companies, especially ones that diversified the region's industrial base, dominated the post-war civic agenda. In 1945, Pittsburgh initiated a 25-year redevelopment program, its so-called "Renaissance," under the leadership of civic leader Richard King Mellon, Mayor David Lawrence, and the newly formed Allegheny Conference on Community Development, a nonprofit civic organization dominated by the presidents of the largest corporations. Renaissance addressed issues of economic development, renewal of infrastructure, and

downtown redevelopment. By 1960 the national media heralded the Smoky City's revitalization. Even the three rivers received some attention from Renaissance. Besides the completion of sewage treatment facilities and flood control measures, the city cleared the railroad yards, warehouses, and last remaining dingy residences from the historic Point and undertook the construction of a state park there, which invited contemplation of both the beauty of the water and the historical significance of the three rivers' confluence. Moreover, recreational boating began to return to the city's waters.²⁶

These steps towards the rehabilitation of the rivers, however, proved to be relatively small ones. The flood protection program only expanded management of the rivers, which had begun in the nineteenth century. Despite Olmsted's dreams, pre-war plans of pragmatic planners to use downtown's waterfronts for highways and parking lots were completed during the Renaissance. The continued disposal into the rivers of industrial wastes, mine acid drainage, and sewage from the overflow pipes of the combined sewer system of Pittsburgh and other county municipalities, kept the rivers from making a dramatic ecological recovery.²⁷

In the 1970s, the failure to exploit the ambient and public relations potential of the rivers for two major developments demonstrated the persistent grip of the industrial nature mentality on the perceptions of civic leaders. Despite its name and location across the Ohio River from the historic Point, the enclosed circular Three Rivers Stadium, which opened in 1970 and became a nationally recognizable sports venue due to the professional baseball and football teams' successes, did not even provide a view of either the rivers or the downtown. Similarly, the new Convention Center, opened in 1977, had its back side and loading docks facing toward the Allegheny River.²⁸ Even the region's principal conservation organization, which emerged in concert with the growing national movement for the preservation of wilderness lands, abjured the

city's three rivers. The elite-sponsored Western Pennsylvania Conservancy, which became active and increasingly powerful after World War II, mostly protected river environments either well beyond the urban area or on the metropolitan fringe.²⁹

Based on the Renaissance's successful smoke abatement program, new sewage treatment facility, flood control project, and preservation efforts beyond the urban region, the city proudly claimed the mantle of a leader of the national environmental movement in the 1960s. But, a 1959 plan for the riverfronts belied this assertion, at least as far as the rivers were concerned. The planners noted that Renaissance had neglected the conservation of the rivers and riverfronts. They recommended several opportunities for riverfront parks and river-oriented recreational opportunities. Nevertheless, they still argued that "most of the flat land adjacent to the rivers must continue to be occupied by the industry and commerce which support the City." At best they hoped to "balance" the diverse interests in the rivers, because "the rivers can provide an additional opportunity for recreation without detracting anything from industry."³⁰ Thus, despite the dramatic post-World War Renaissance program, city leaders retained the longstanding conception of the three rivers as engineered, infrastructural systems for industry and urban development. Conservation strategies since early in the twentieth century had only ameliorated the worst health consequences of this conception and marginally improved water quality and some riverfront lands.

Reinventing the Rivers as Environmental Infrastructure

The dramatic collapse of Pittsburgh's industrial base in the last quarter of the twentieth century forced a reconceptualization of the city's economic and social life, including the three rivers' role in that future. Although at the time it seemed as though civic leaders were slow to

rethink the city's relationship to the rivers, in fact they began to develop a new understanding in a little more than a decade. After initially scrambling to attract any job-providing businesses to former industrial sites, civic leaders, some developers, and community activists envisioned the rivers for scenic, recreational, and natural amenities that would give Pittsburgh a better quality of life and, thereby, make it more attractive to new businesses, especially advanced technology firms and the professionals they employ. This revised conception of the rivers repositioned them as a key component, once again, of the region's economic development strategy. But, as this view became generally accepted, a new tension surfaced between environmentalists and municipal boosters as growing appeals for the restoration and preservation of river ecosystems potentially conflicted with development that sought to exploit scenic and recreational possibilities.

In the late 1970s, earlier predictions of absolute decline in Pittsburgh's industrial base began to come true. By the early 1980s, older steel mills, factories, and coal mines were shuttered permanently, leaving the region in crisis. Seemingly all at once, thousands of acres of once industrially vital riverfront land turned into vacant and often polluted brownfields, commercial river traffic plummeted, and river infrastructure fell into disuse. Under intense pressure to replace the loss of many thousands of manufacturing jobs with new sources of employment, civic leaders cast about for all kinds of development opportunities and governmental support. Pittsburgh's weakened economy and rustbelt image, the real and perceived toxic condition of brownfields, the outdated character of the industrial areas' highway network, and the lack of an unified development strategy among the region's many local governments stymied new investment, especially on the older industrial riverfronts.³¹ This failure

ironically saved these critical sites from the prospect of redevelopment without adequate consideration of the rivers' potential in the "new" Pittsburgh.

Although generally met with polite indifference by civic leaders, several studies by governmental agencies and nonprofit organizations in the 1980s explored the use of the rivers for raising the region's quality of life. Most Pittsburghers dismissed the recommendations of these reports as impractical and elitist because of the region's cascading under- and unemployment that spelled hard times for thousands of families. Nevertheless, a few new riverfront projects indicated that the rivers might become popular with the public and eventually investors, just as waterfront developments had already demonstrated in Baltimore, Portland (Oregon), and several other American cities. A small public boat launching ramp and linear park along the city's South Side river bank attracted hordes of weekend boaters. The new, high profile annual River Regatta, punctuated by Formula One speed boat races, drew large crowds. A marina, riverfront park, and hiking and biking trail similarly enlivened the tired, small industrial city of McKeesport several miles south of Pittsburgh, while a water slide amusement park flourished on the edge of a riverfront brownfield in run-down West Homestead, which formerly housed a massive industrial machinery works. Finally, a small sculpture park and office development called Allegheny Landing spruced up the riverfront across from downtown on that river's north shore.³²

By the early 1990s, the attitudes of investors and public officials towards the development prospects of the riverfronts for scenic and recreational opportunities had clearly shifted. The successful redevelopment of an old industrial island, named Washington's Landing, located a couple of miles above downtown in the Allegheny River, into a complex of offices, light industry, a large marina, and townhouses with a circumferential walking and biking trail

overlooking the water, proved the point of those who promoted the importance of the rivers for the region's future. Recreational boating replete with marinas and yacht clubs proliferated throughout the river valleys. The revival of rowing added another dimension to river participation, while river tours and commercial party boats attracted other clienteles. Most importantly, in direct contrast to the 1970s' neglect of the rivers, civic leaders grasped the idea of turning the north shore of the Allegheny River across from downtown into a signature development dependent on the river ambience. The North Shore Corridor, as it has been called, featured two new stadiums (one each for baseball and football) oriented to the river with views of downtown. The Aluminum Company of America (ALCOA) built its new headquarters along the river. The city is currently supporting the development of offices, entertainment venues, retail shops, and residences there as well. On the south (downtown) bank of the Allegheny, the newly rebuilt and enlarged "green" Convention Center was reoriented to face the river scene. The adjacent Cultural District that has been emerging for over 20 years contributed to the North Shore Corridor with new buildings, signage, and lighting as well as a linear park along the river's edge. A group of civic leaders and foundations formed the Riverlife Task Force, which conceived of a Three Rivers Park of public spaces along the city's central riverfronts. The Riverlife Task Force takes it upon itself to steward the development of these public spaces, coordinating with private developers and public agencies as well as negotiating for appropriate designs.³³

Not all development of riverfront brownfields, however, has taken advantage of their river location. For example, the new development on the former massive Homestead Steel Works, stretching nearly three miles along the Monongahela about eight miles from Pittsburgh, generally ignores the river despite its name as The Waterfront. The developers designed the

complex as a suburban-style retail, restaurant, and office mall. Only a walking trail on the river bank, some townhouses, and a few restaurants and office buildings face the river.³⁴

The collapse of industry and the freeing of the rivers from many of its uses, along with state and federal clean water regulations, have markedly improved both water quality and the river ecology. Biologists have determined that in the past "the Ohio River Drainage basin was so grossly degraded that these systems were [nearly] devoid of life."³⁵ The ecological recovery has been surprisingly rapid and extensive. Fish have returned to the rivers. In one recent study of fish in tributaries to the three rivers, 29 species were discovered in streams flowing to the Allegheny, 16 species in tributaries to the Monongahela, and 32 species in a tributary to the Ohio River. This significant recovery has sportsmen, environmentalists, and the Pennsylvania State Fish and Boat Commission employees cooperating to bring the first Bass Master Classic fishing tournament to Pittsburgh.³⁶

The woody vegetation of the region's river banks was also severely degraded, but like the fisheries woody plants have vigorously returned to the once bare and eroded edges. A recent study of the Monongahela and Allegheny rivers identified the existence of four native woody plant communities and one native herbaceous plant community typical of large rivers in North America. It also determined that the frequency of invasive species decreases with distance from the city's Point.³⁷ This rapid regeneration of riparian vegetation has taken observers by surprise. Organizations concerned with riverine ecology such as the Friends of the Riverfront, the Pennsylvania Environmental Council, 3 Rivers 2nd Nature, and the Western Pennsylvania Field Institute have held several workshops on the rivers to discuss the creation of water trails and in the process have discovered local hotbeds of natural diversity. For instance, Sycamore Island, a large wooded island in the Allegheny River 9 miles from downtown Pittsburgh, has few

Sycamore trees today, but possesses a forest of Silver Maples of such significant girth and height that people seeing photographs taken in the middle of the grove assume the setting is in a national forest.

The ability of the rivers and streams to support life and the return of typical riparian vegetation reveal a natural potential that has been dormant for over a century and suggest the possibility for human intervention to aid the process. Planning for the restoration of riverine natural systems is appearing on several regional sites. The U.S. Army Corps of Engineers, for example, is engaged in the process of restoring an urban stream, Nine Mile Run. The stream flows from creeks that have long been buried in sewer pipes and from springs in a city park through a 300-acre, reclaimed brownfield site into the Monongahela River.³⁸ Additional plans and actions are underway to restore, conserve and preserve natural systems. Recent river restoration studies by the U. S. Army Corps of Engineers, river-island studies by the Fish and Wildlife Service, and river-land conservation by the Allegheny Land Trust reveal the gathering shift in thinking from the traditional conservation of the hinterlands to the conservation and restoration of land along the region's most industrialized waterways.³⁹

Ecological restoration faces difficulties in spite of the remarkable recovery of natural systems. Riverine ecological systems encounter wet-weather, water quality threats due to outdated sewage systems and the highest number of combined sewer outfalls in the country. Continued outbursts of mine acid also endanger ecological rejuvenation. Further, some of Pittsburgh's forested hills and slopes near the rivers are once again under consideration for rezoning for development. These proposals include construction of an expressway through four Monongahela riverfront communities that would affect two miles of reforested waterfront, the longest contiguous natural edge in the central Pittsburgh pool. Clearly, the old development

values still tug at Pittsburghers, even as natural systems have begun regenerating in the brief 20-year respite from intense industrial use.

Despite these obstacles, the ecological recovery has spawned a growing interest in the aesthetics of river viewing. Public spaces with the panoramic river views from vantage points like walkways, bridges, hills, parks, or when out on the water itself create highly desirable opportunities for looking at the rivers, their recovering banks and hillsides. Real estate developers are erecting townhouses on private property with a water view as a means to capture the increasing economic value created by this aesthetic. Thus, this panoramic aesthetic enhances the city's intention to become known for the ability to play in, on and along the rivers and riverbanks.

The post-industrial view of nature emphasizing preservation and restoration of riverine ecologies, however, clashes at times with development that leverages the rivers' recreational and scenic attributes. Intensive housing and office complexes, manicured landscaping of the banks, and noisy, high speed boating roiling river waters all contrast with the aesthetic of ecological preservation. Rowers and power boaters uneasily share the water; birdwatchers despair at the highly managed vegetation of developers' complexes; and commercial shipping still retains navigational priority.

The concepts of the environment as an amenity and as an ecological aesthetic both depend on a physical, sensual relationship to place, appealing to fashionable values of youth and an active healthy life outside of work. Clean healthy rivers with green edges and trails, it is argued, help with a healthy lifestyle. Both concepts in their distinct ways depend on continued management of the three rivers. Both together, despite their inherent contradictions, have become critical environmental infrastructure that is essential to compete with other regions.

Urban Rivers

Throughout the city's history, Pittsburgh's civic leaders defined the rivers with respect to the three periods of its economic life. These three periods of the relationship between the city and its rivers conform generally with the experiences of other American river cities. Although the timing and specifics vary, Pittsburgh's river story also resonates with those of many European cities. The experiences of older industrial cities such as Newcastle on the Tyne in England closely parallel that of Pittsburgh, but even Paris' relationship with the Seine River, as suggested by Isabelle Backouche, shares many of the same general characteristics.⁴¹ Like Pittsburgh's three rivers, the Seine supported multiple functions and the "ordinary" life of Parisians until the late eighteenth century. After 1760 business elites and government officials increasingly regulated and reshaped this famous river in service of a "mono-functional" vision of it as a national trade artery in an industrializing economy. Slowly the Seine became a "stranger" to residents, writes Backouche, though not to tourists. Thus, in the minds of European and North American leaders who wielded decision-making power, rivers became highly regulated and engineered infrastructure in the service of urban industrial development. Completing the unlikely comparison between Pittsburgh and France's capital city, Parisian leaders in recent years have tried to reconnect the river to the lives of their citizens in the spirit of making the Seine part of public space once again.

In some ways the segments of rivers that flow through urban areas share many characteristics with their country cousins. Farmers, loggers, millers, and country merchants also looked upon rivers as natural resources critical to their economic enterprises; and, if need be, these rural entrepreneurs endeavored to regulate and manage them with, for example, dams or

diversion canals. Managed as they may be, these rivers in the countryside generally were not as intensively managed and exploited as the urban segments, where greater waste loads, hardening of edges, and land-filling often drastically altered the natural systems.⁴²

This intense intervention in urban rivers such as in the Pittsburgh region readily invites an historical interpretation that emphasizes the now familiar dichotomy between nature and culture.⁴³ While increasingly discredited in academic literature, this dichotomy existed in public perceptions. For most Pittsburgh residents up until recently, the highly engineered three rivers no longer seemed like "real" rivers. [Ted: do you have a citation for this statement?] Just as Backouche so poignantly characterizes the Seine becoming a "stranger" to Parisians, the three rivers became inaccessible and unusable to ordinary Pittsburghers. Man, that is business and political leaders, had so degraded both water quality and the flora and fauna in pursuit of their urban industrial vision that most citizens no longer thought of the rivers as part of nature. As infrastructure, the rivers might as well have been buried in culverts or concrete channels to do their job. In the search for nature's scenic and recreational amenities, Pittsburghers left the city for rural rivers or more distant water bodies. This industrial nature was "unnatural."⁴⁴

Today the ecological rejuvenation of the three rivers and their rediscovery as part of the public commons depends ironically on the continued regulation and management by those with the power to make policy, effect development, and enforce laws. The return to the rivers' "natural systems" of the pre-industrial era is, of course, no less a cultural construct than the "second nature" existing during the industrialization of the rivers was. As environmental historian William Cronon noted, nature "is a profoundly human construction...the way we describe and understand [it] is so entangled with our own values and assumptions that the two can never be fully separated."⁴⁵ The return to pre-industrial or so-called "first nature" will be

only partially a return to that state. The continued existence of some aspects of the industrial river infrastructure such as the locks and dams, the legacy of other alterations such as from dredging for sand and gravel or the hardened embankments, and the presence of invasive species will prevent the complete restoration of the earlier river hydrology and ecology. Further, the pressure for development, even some river-friendly recreational and residential projects, will introduce highly managed landscapes. Nonetheless, the three rivers as conceived and shaped by humans will continue to be part of Pittsburgh's definition of itself.

Notes

¹ Edward K. Muller, "The Point," in Donald G. Janelle, ed., Geographical Snapshots of North America (New York, 1992), 231-4.

² David J. Cuff, et. al., The Atlas of Pennsylvania (Philadelphia, 1989), 52-67. Some have questioned whether there are in fact three rivers, arguing that the Allegheny and the Ohio are one river, which the Monongahela joins. However, ever since Europeans explored this region, most people have viewed these as three separate rivers.

³ Paul A. W. Wallace, Indians in Pennsylvania (Harrisburg, 1993).

⁴ Leland D. Baldwin, Pittsburgh: The Story of a City, 1750-1865 (Pittsburgh, 1937).

⁵ Shera A. Moxley, From Rivers to Lakes, Engineering Pittsburgh's Three Rivers, a report for 3 Rivers, 2nd Nature, STUDIO for Creative Inquiry, Carnegie Mellon University (Pittsburgh, 2001), 18; Leland R. Johnson, The Headwaters District: A History of the Pittsburgh District, U.S. Army Corps of Engineers (Washington, DC, 1978), 1-101.

⁶ Catherine Elizabeth Reiser, Pittsburgh's Commercial Development, 1800-1850 (Harrisburg, PA, 1951); Richard C. Wade, The Urban Frontier: Pioneer Life in Early Pittsburgh, Cincinnati, Lexington, Louisville, and St. Louis (Chicago, 1959), 39-46.

⁷ Edward K. Muller, "River City," in Joel A. Tarr, ed., Devastation and Renewal: The Environmental History of Pittsburgh and Its Region (Pittsburgh, 2003), 45-51.

⁸ John. N. Ingham, Making of Iron and Steel: Independent Mills in Pittsburgh, 1820-1920 (Columbus, OH, 1991).

⁹ Moxley, From Rivers to Lakes, 10-25; Leland R. Johnson, The Davis Island Lock and Dam 1870-1922 (Pittsburgh, 1985).

¹⁰ Muller, "River City," 51-6; and Edward K. Muller and Joel A. Tarr, "The Interaction of Natural and Built Environments in the Pittsburgh Landscape," in Tarr, ed., Devastation and Renewal, 11-40.

¹¹ Quoted in Joel A. Tarr and Terry F. Yosie, "Critical Decisions in Pittsburgh Water and Wastewater Treatment," in Tarr, ed., Devastation and Renewal. 10.

¹² Ibid.

¹³ Erwin E. Lanpher and C. F. Drake, City of Pittsburgh: Its Water Works and Typhoid Fever Statistics (Pittsburgh, 1930), 23-5.

¹⁴ Tarr and Yosie, "Critical Decisions."

¹⁵ Ibid.

¹⁶ Ibid. Allegheny City was a separate city directly across the Allegheny River from Pittsburgh until annexed by its larger sister city in 1907.

¹⁷ Ibid.

¹⁸ Ibid..

¹⁹ Nicholas Casner, "Acid Mine Drainage and Pittsburgh's Water Quality," in Tarr, ed., Devastation and Renewal, 89-109.

²⁰ Ibid.

²¹ Report of the Flood Commission of Pittsburgh, Penna., (Pittsburgh, 1912); and Roland M. Smith, "The Politics of Pittsburgh Flood Control, 1908-1936," Pennsylvania History 42 (1975): 5-24.

²² Frederick Law Olmsted, Jr., Main Thoroughfares and the Downtown District (Pittsburgh, 1911), 19-30; John F. Bauman and Edward K. Muller, "The Olmsteds in Pittsburgh: Part II, Shaping the Progressive City," Pittsburgh History 76 (1993/1994): 191-205.

²³ Citizens Committee on City Plan of Pittsburgh, Waterways: A Part of The Pittsburgh Plan, Report No. 6, (Pittsburgh, 1923), 13-5.

²⁴ Tarr and Yosie, "Critical Decisions."

²⁵ Ibid.

²⁶ Roy Lubove, Twentieth Century Pittsburgh: Vol. I (Pittsburgh, 1995, originally published in 1969), 106-41; Shelby Stewman and Joel A. Tarr, "Four Decades of Public-Private Partnerships in Pittsburgh," in R. Scott Fosler and Renee A. Berger, eds, Public-Private Partnerships in American Cities (Lexington, MA, 1982), 59-127; Sherie R. Mershon, "Corporate Social Responsibility and Urban Revitalization: The Allegheny Conference on Community Development, 1943-1968," Ph.D. diss., Carnegie Mellon University, 2000; Roland M. Smith, "The Politics of Pittsburgh Flood Control, 1936-1960," Pennsylvania History 44 (1977): 3-24; Robert C. Alberts, The Shaping of the Point: Pittsburgh's Renaissance Park (Pittsburgh, 1980).

²⁷ Muller, "River City," 57-63.

²⁸ Roy Lubove, Twentieth Century Pittsburgh: Vol. II. The Post Steel Era (Pittsburgh, 1996), 201-2.

²⁹ 50 Years of The Western Pennsylvania Conservancy (Pittsburgh, 1982), 19.

³⁰ Griswold, Winters, and Swain, A Master Plan for the Development of Riverfronts and Hillsides in the City Pittsburgh (Pittsburgh, 1959), Dedication, 3-5.

³¹ Edgar M. Hoover, Economic Study of the Pittsburgh Region, 3 Volumes (Pittsburgh, 1963); John P. Hoerr, And The Wolf Finally Came: the Decline of the American Steel Industry (Pittsburgh 1988); Lubove Twentieth Century Pittsburgh, Vol. II. 5-23

³² Lubove Twentieth Century Pittsburgh, Vol. II. 5-23

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- ³³ Riverlife Task Force, A Vision Plan for Pittsburgh's Riverfronts (Pittsburgh, 2001). See also, www.riverlifetaskforce.org
- ³⁴ Muller, "River City," 62-3
- ³⁵ Robert Hoskins, Michael Koryak, Linda Stafford, Fishes of Small Tributaries to the Rivers of Allegheny County, 2004 Water Quality Report, 3 Rivers 2nd Nature, STUDIO for Creative Inquiry, Carnegie Mellon University, (Pittsburgh, 2004), Section II, a.
- ³⁶ Robert Hoskins, Michael Koryak et. al., "The Impact of Above Grade Sewerline Crossing on the Distribution and Abundance of Fishes in Recovering Small Urban Streams of the Upper Ohio River Valley," Journal of Freshwater Ecology 16 (2001): 594.
- ³⁷ Susan Kalisz and Jessica Dunn, 3 Rivers 2nd Nature Terrestrial Report: Allegheny River Phase 3 - 2002, Riverbank Vegetation, 3 River 2nd Nature, STUDIO for Creative Inquiry, Carnegie Mellon University (Pittsburgh, 2002),1.
-- Pennsylvania Economy League, Investing in Clean Water: A Report by the Southwestern Pennsylvania Water and Sewer Infrastructure Project Steering Committee (Pittsburgh, 2002), -- Attempts to resolve the mine acid problem included state and federal mine sealing programs, but they had only limited success. It would not be until state and federal legislation was passed requiring active mining operations to treat polluted water prior to discharge that conditions improved. See Casner, "Acid Drainage."
-- J. Ackerman, "Mount Washington Residents Question Development Plans," Pittsburgh Post Gazette, May 29, 2003, http://www.postgazette.com/neighbor_city/20030529hillsidec5.asp; T. Barnes, "Council OKs Mining Project as Precursor to Hays Development," Pittsburgh Post Gazette, July 31, 2003, <http://www.post-gazette.com>
- ³⁸ L. Hawkins, Nine Mile Run, Allegheny County, Pennsylvania, U.S. Army Corps of Engineers, <http://www.lrp.usace.army.mil/pm/9mile.htm>.e.com/neighbor_city/20030731miningc2.asp.
- ³⁹ Ohio River Main Stem Systems Study (ORMSS) Interim Feasibility Report: Ohio River Ecosystem Restoration Program. U.S. Army Corps of Engineers (2000), http://www.lrl.usace.army.mil/pd/orms_eco_system/ecosystem_final_report/Appendix_G.pdf;; Ohio River Islands, National Wildlife Refuge. U.S. Fish and Wildlife Service (undated), http://northeast.fws.gov/planning/ORI_WEB/chap1.htm; Allegheny Land Trust Acquires 212 Acre Riverfront Property. Allegheny Land Trust, (2003), <http://www.alleghenylandtrust.org/WhetzelPreserve.html>.
- ⁴¹ Dieter Schott, "Rivers as Urban Environments: Cycles and Constellations in the Management and Perception of British Cities," The Making of European Contemporary Cities: An Environmental History (?): Isabelle Backouche, "From a Parisian River to a National Waterway: Social Changes of the Seine River," in Christof Mauch and Thomas Zeller, eds., Rivers in History: Designing and Conceiving Waterways in Europe and North America (Oxford, 2005).
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- ⁴³ Eva Jakobsson, "How Do Historians of Technology and Environmental History Conceive Rivers," In Mauch and Zeller, eds., Rivers in History.
- ⁴⁴ Edward K. Muller, "The Legacy of Industrial Rivers," Pittsburgh History 72 (1989) 46-75.

⁴⁵ William Cronon, Introduction: In Search of nature," in William Cronon, ed., Uncommon Ground: Toward Reinventing Nature (New York, 1995), 25.

The significance of urban infrastructures finds mention in most of the literature pertaining to community resilience. The capacities of urban infrastructures are deterministic for disaster risk resilience and hence, for effective provisioning of services by local authorities, the conventional approaches of supply and augmentation must include demands for the resilience of the local population. Under this approach, the physical capacities of the infrastructures are evaluated against natural disasters, and the policy frameworks normally deliberate more on the mitigation options. It is argued that since the failure of infrastructures may lead communities to disasters, the resilience of infrastructures is a must for generating community resilience (Chang, 2009). Green infrastructure in urban spaces is planned strategically, maintained and developed by a range of actors in government, business and civil society. In keeping with the objective of socially, economically and environmentally sustainable urban development, green infrastructure can help to support multiple societal objectives. These include, for example, the promotion of health and well-being, adaptation to climate change, and biodiversity conservation.

Urban River Pollution Control and Remediation. abstract As an important subsystem of the urban environment, urban rivers offer various kinds of ecological services that benefit residents of the city. However, with the acceleration of urbanization and rapid economic development, urban river pollution problems are becoming more and more critical. A large number of domestic and industrial waste water flowing into the river, which leads to highly contaminated water into the system. Thus, the function of the river as a source of power loss and urban ecology and water environment deteriorates seriously. The problem of urban river pollution and ecological damage becomes more and more critical.