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NATIONAL REGISTER OF HISTORIC PLACES
MULTIPLE PROPERTY DOCUMENTATION FORM

This form is for use in documenting multiple property groups relating to one or several historic contexts. See instructions in Guidelines for Completing National Register Forms (National Register Bulletin 16). Complete each item by marking "x" in the appropriate box or by entering the requested information. For additional space use continuation sheets (Form 10-900a) and identify the section being continued. Type all entries. Use letter quality printer in 12 pitch, using an 85 space line and 10 space left margin. Use only archival quality paper (20 pound, acid free paper with a 2% alkaline reserve

A. NAME OF MULTIPLE PROPERTY LISTING

Waterway Resources of the Lower Fox River, 1850-1941

B. ASSOCIATED HISTORIC CONTEXTS

Transportation in Nineteenth and Early Twentieth Century Wisconsin, 1850-1941
Technology - Evolution of Lock Construction, 1850-1941
Wisconsin Political History, 1830-1872

C. GEOGRAPHICAL DATA

Winnebago, Outagamie & Brown Counties, Wisconsin

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D. CERTIFICATION

As the designated authority under the National Historic Preservation Act of 1966, as amended, I hereby certify that this multiple property documentation form meets the National Register documentation standards and sets forth requirements for the listing of related properties consistent with the National Register criteria. This submission meets the procedural and professional requirements set forth in 36 CFR Part 60 and the Secretary of the Interior's Standards for Planning and Evaluation.

x Dr. William L. Klink — 14 Oct '93
Signature of certifying official — Date

Corps of Engineers
State or Federal agency and bureau

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

Beth Boland — 12/7/93
Signature of the Keeper of the National Register — Date

Introduction:

The Lower Fox lock and canal system forms the basis of this nomination. Situated between Menasha and Green Bay, the Lower Fox facilities were initially incorporated into the larger Fox-Wisconsin waterway. Construction on the Fox-Wisconsin system began in the early 1850s, after many years of political debate. The system was intended to establish a navigable route between Green Bay and Prairie du Chien. Slowly, as the economic viability of different segments of the completed system was questioned, parts were abandoned. The Lower Fox River/Canal was the last portion of the original system to provide commercial service -- and that generally ended around 1960. The US Army Corps of Engineers subsequently maintained control over the waterway and its facilities for recreational boaters, as well as industrial interests that are located along the river.

This nomination focuses on the resources that are part of the Lower Fox lock and canal system. The specific components of the thematic nomination include locks, dams, lock shacks, lockkeeper's houses and the canalized segments of the waterway. These nomination components had been identified as part of the 1988/1989 Fox River Corridor Survey, a State Historical Society of Wisconsin sponsored effort to identify all industrial and transportation resources that were in some fashion associated with the Lower Fox River. Industrial resources identified by the survey included numerous paper milling enterprises and hydro-electric generation plants. They are not part of the Waterway Resources of the Lower Fox River thematic National Register nomination.

This multiple property/thematic nomination is organized around canal segments. There are nineteen locks, nine dams, ten lockkeeper's houses, several small lock shacks, and eight canal segments within the system. Any and all resources that are associated with a given segment are included in that segment's nomination. The primary Appleton canal segment, for instance, contains three locks and associated structures. Those resources are dealt with in one nomination form as a contiguous district. The fourth Appleton lock, however, is located within its own small canal segment -- it is not connected to the larger Appleton canal. The fourth lock, and its canal segment, therefore, is dealt with through its own, individual district nomination. Nine individual district nominations, consequently, accompany this document.

Canals & Locks: General United States Development

Taking advantage of their utility in navigation systems, canals have helped meet the transportation needs of western societies since first used by the Babylonians in 1600

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BC. They were subsequently used to join the Red Sea and the Mediterranean Sea around 1400 BC, as well as the Mediterranean Sea and the City of Tiber during the reign of Rome's Emperor Claudius. By the 14th Century AD, the Chinese had built a canal that was thought to be almost 1,000 miles long. Locks were introduced as a component in canal systems after 1481, the year in which a chamber capable of moving a craft from one level of a river to another was designed by the Domenico Brothers of Viterbo, Italy.[1] Leonardo da Vinci utilized locks in his plans for the Milan, Italy, canal system in 1487. One of the first canals in Western Europe was the Languedoc of France. Designed by Baron Paul Riquet de Bonrepos, the 148 mile canal was completed in 1681 and contained more than one hundred locks and fifty aqueducts.[2]

In North America, a heavily wooded continent drained by many rivers, canals were envisioned as a way to connect those rivers in the hopes of creating a transportation system where none existed. Father Marquette proposed building the first North American canal between Lake Michigan and the Illinois River in 1673. Another North American canal was proposed in 1676. It was to cross Cape Cod, thus improving transportation between New Amsterdam and Boston. In addition, a canal joining Delaware Bay and Chesapeake Bay was discussed in 1679.[3]

Over one hundred years passed between those early schemes and the construction of the first North American canal. In the intervening time, the United States established its independence from England and began to develop a national economy. As well, settlers began to push west of the Appalachian Mountains. Canals were envisioned as a way to help the economy develop and maintain communications with those moving west. But, when construction did start, rarely were more than small segments of a project completed. The Patowmack [sic] and James River Companies were both incorporated in Virginia in 1785, for instance. Work on the Potomac began in 1786, but twenty-two years later only five short segments had been completed between Washington, D.C. and

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[1] Alvin F. Harlow, Old Towpaths: The Story of the American Canal Era (New York: D. Appleton and Company, 1926), 2-4; Jack Gieck, A Photo Album of Ohio's Canal Era, 1825-1913 (Kent, OH: Kent State University Press, 1988), 2.

[2] Harlow, Old Towpaths, 2-4.

[3] Ibid., 5-6; Madeline Sadler Waggoner, The Long Haul West: The Great Canal Era, 1817-1850 (New York: G.P. Putnam's Sons, 1958), 15.

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Harper's Ferry.[4] Similarly, the James River Company was to improve the James River for navigation, as well as to build a canal around the falls at Westham. A seven mile canal by-passing the Richmond -Westham rapids was completed in 1789, but money ran out shortly thereafter and the project stalled.[5]

Pennsylvania and New York also had early canal companies that failed to complete projects. Two canals were proposed for Pennsylvania in 1791 and 1792. One was to join the Susquehanna and Schuylkill Rivers, while the second was to provide access between Norristown and Delaware. Only fifteen miles of work was completed between the two projects, at a cost of $440,000.00. Funds were soon gone, however, and no more work was done in Pennsylvania for twenty-seven years.[6] New York's failed attempts included the Western Canal from the Hudson River to Lake Ontario and Seneca Lake.[7] It tried, as did many early North American canals, to take advantage of natural rivers by improving them, and then building canals and locks only where needed to avoid rapids and other hazards. Economist Julius Rubin ascribes the Western's failure to that very procedure.[8]

The inability to complete these early projects suggests that a number of problems existed. Perhaps the two greatest problems were labor and capital shortages. Canal construction was a labor intensive endeavor, and since the United States was sparsely populated at the time, especially in the areas in which the canals were to be built, laborers were scarce. That problem was compounded by the fact that no type of mechanical assistance was available. Canal construction was further hampered by the lack of investment capital available. American canals were generally built to spur a region's development. But development had to occur before canals could make money for their investors, and that delay made it difficult for canal companies to attract

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[4] Harlow, Old Towpaths, 10-11.

[5] Ibid., 12.

[6] Ibid., 8.

[7] Julius Rubin, "An Innovating Public Improvement: The Erie Canal," in Canals and American Economic Development, edited by Carter Goodrich (New York: Columbia University Press, 1961), 22-23; Waggoner, Long Haul, 40.

[8] Ibid., 24-25.

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investment capital.[9]

Problems notwithstanding, enthusiasm for canals grew as the nineteenth century began. One factor influencing that excitement was the failure of the Western Canal. Apparently it was thought that improving rivers, where available, would hasten a project's completion and minimize costs. Rubin believed that was a short sighted approach that looked for quick results and minimal costs -- it did not promote long term analysis and planning, both key ingredients in a successful canal venture. Rubin explained that the demise of the Western Canal

> helped to pry some men loose from their accustomed preference for the simplest and cheapest possible modification of nature [that was utilizing and improving existing rivers]; by eliminating this alternative it forced them to think of large-scale expenditures, long-range public planning and construction, and the radical transformation - not the mere improvement - of the state's geography.[10]

Another factor was the increasing number of settlers moving towards the Appalachians and beyond. The Land Ordinances of 1784 and 1785, and the Northwest Ordinance of 1787 had established the procedures through which that region between the Ohio River and the Mississippi would be settled, and settled that region was becoming. Ohio and Indiana, for instance, two prolific canal building states, achieved statehood in 1803 and 1816 respectively -- a status that meant each contained at least 60,000 people.

With the increasing number of settlers moving west, came an increasing number of calls for transportation routes and internal improvements. In fact, the calls became so numerous that Albert Gallatin, the Secretary of the Treasury, was commissioned to study national transportation needs in March, 1807.[11] Gallatin's report was submitted in April, 1808, and offered four general recommendations. First, he wanted to see Atlantic Sea Coast canals developed that could tie New England and the region south together. Among canals he suggested were ones that could link the Raritan and

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[9] Ibid., 4-5.

[10] Ibid., 24-25.

[11] Caroline E. MacGill, History of Transportation in the United States before 1860 (Washington, D.C: Carnegie Institution of Washington, n.d.; reprint, Peter Smith: 1948), 135-136.

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Delaware Rivers in New Jersey, the Delaware River to the Chesapeake, and the Chesapeake to Albermarle Sound. Next, Gallatin proposed canals that would tie the Atlantic Sea Coast with areas inland. He wanted to see work on the James River and the Potomac River, for instance. The third general recommendation called for canals that could tie the Atlantic Coast to the Great Lakes -- perhaps between the Hudson River and Lake Champlain or between the Mohawk and Lake Ontario. Gallatin's final proposal, then, called for other interior canals. He projected that all this work could be completed within ten years at a cost of 20 million dollars.[12] Unfortunately for Gallatin's plan, however, the War of 1812 intervened before any action was taken on it.

The War of 1812 was successfully concluded in 1814. It was an experience that is generally credited with creating what has become known as the "Era of Good Feelings" in the United States -- a period in which American Nationalism was prominent. Congress had a substantial, nationalistic legislative agenda during this period. It created the Second National Bank of the United States, passed a protective tariff to help fledgling American industries, and tried, unsuccessfully, to fund internal improvements. The "Era of Good Feelings" aside, Congress feared no constitutional basis existed for funding internal improvements, thus the federal government could do little to promote their construction. Despite this reluctance, the demand for internal improvements in general, and canals in particular, remained strong.

The American canal network was built primarily around two different types of systems. Developmental canals were the first type. They were built to develop settlement and trade in a given area, and were typically financed by the government. The second type of system consisted of exploitive canals. They were a "profit opportunity to be seized," and were likely funded by private investors.[13]

United States canal growth occurred in three cycles. The first phase was between 1815 and 1834, during which 2,188 miles of canal valued at $58.6 million were built. The second cycle began in 1834 and ended in 1844, a period in which a capital investment of $72.2 million produced 1,172 miles of canal. The final phase occurred between 1844

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[12] Ibid.

[13] H. Jerome Cranmer, "Improvements Without Public Funds: The New Jersey Canals," in Canals and American Economic Development, edited by Carter Goodrich (New York: Columbia University Press, 1961), 157-159.

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and 1860, during which 894 miles of canal valued at $57.4 million were built.[14] These cycles were differentiated by three periods of concentrated canal building, and the lulls in construction that separated them. They are also evident by the geographic distribution of canals built. The first phase generally focused on the east, while the second phase focused on Ohio and Indiana and the third cycle generally focused on canals farther west.

The Erie canal was the catalyst behind America's 19th century canal construction explosion in general, and the first cycle in particular. Work on the canal began in 1817, although it was first proposed in 1777 and surveyed in 1808. As planning for the canal evolved, a decision was made to avoid improving rivers as part of the project. One factor upon which that decision was based was the experience of the Western Canal Company. Much of the first cycle canal construction was financed by the sale of bonds which were generally marketed to investors in the United States and London. That was not the case with the Erie Canal, however, since New York decided to fund the project itself.[15] The Erie Canal was completed in 1825. It was 363 miles long and cost $7,143,790.00. The canal had eighty-four locks, 689 feet of lockage, and was twenty-eight feet wide at the bottom, forty feet wide at water level, and four feet deep. It was also a tremendous financial success. By the time the canal was eight years old, it had amassed a surplus of 2.25 million dollars. Canal profits were more than 42.5 million dollars in sixty years of operation.[16]

The success of the Erie Canal was overwhelming and, to a degree, unexpected. Much of its success came from the fact that there had been an accumulating demand for easier, less expensive transportation from the northeast to the Great Lakes region. And since the Erie was the first to provide the service, its use was extensive. On a more theoretical level, however, Julius Rubin attributed the Erie's success to the

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[14] Harvey H. Segal, "Cycles of Canal Construction," in Canals and American Economic Development, edited by Carter Goodrich (New York: Columbia University Press, 1961), 169, 171-172.

[15] Rubin, "Innovating Public Improvement," 47-48; Waggoner, Long Haul, 52-62.

[16] Segal, "Cycles," 182; Rubin, "An Innovating Public Improvement," 25, 31, 40, 43-48; Goodrich, "Introduction," 6; Julius Rubin, "An Imitative Public Improvement: The Pennsylvania Mainline," in Canals and American Economic Development, edited by Carter Goodrich (New York: Columbia University Press, 1961), 73; Waggoner, Long Haul, 37, 178.

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"abandonment of the traditional technique of river improvement with short canals and the projection of a full canal independent of the direction of the water courses of the state...."[17] Regardless of the reasons behind the Erie's success, other states quickly lined up canal ventures hoping to accomplish what those in New York had. One such state was Pennsylvania.

Whereas the State of New York and the Erie Canal benefitted from good surveys, realistic cost estimates and a well conceived technical approach, Pennsylvania's canal project suffered from unrealistic cost estimates, route uncertainty and an inability to resolve the technical aspects of crossing the mountains found in the state.[18] Pennsylvania's project also suffered because it received no unified support. Wagon drivers who made their living hauling freight west wanted no part of it since it would drive them out of work. As well, people in regions that would not be served by the canal wanted no part of it.[19]

Perhaps the most significant canal opposition came from those residents who were promoting railroad development. They believed that railroads, not canals, were the wave of the future. Canal advocates argued that trains could not pass each other going in opposite directions, nor could they move in the same direction at different speeds. The ability for one train to pass another could only be accomplished by building a double track, and that was very expensive they said. Canals, on the other hand, readily promoted two way transportation.[20]

Canal supporters ultimately prevailed in Pennsylvania because canals utilized a known technology and railroads did not. Despite the fact that construction on the Pennsylvania Mainline started on 4 July 1826, the battle over the canal continued. Supporters, consequently, kept promising branch canals to various regions, hoping that such action would help secure the state-wide support needed to successfully complete the project. Although the need to dig the branch lines delayed completion, the canal

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[17] Rubin, "An Imitative Public Improvement," 69.

[18] Ibid., 68; Waggoner, Long Haul, 193-194.

[19] Waggoner, Long Haul, 193-194.

[20] Rubin, "An Imitative Public Improvement," 68, 84-85, 90; Waggoner, Long Haul, 193-194.

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finally opened in 1834.[21]

Built at a cost of $12,106,788, the Pennsylvania Mainline was a failure. First, it never captured the profits that the Erie had because it never matched the volume achieved by the Erie. In this case success came to that canal built first, for it relieved the pent-up demand for inexpensive transportation west. Problems of a more technical nature included too many locks on the system (twice as many as on the Erie), which made for slow passage, and the fact that the canal had a number of tricky currents. Portages over the mountains in the center of the state were also slow. They created bottle necks as boat traffic waited their turns on the inclined railroad that facilitated the portage.[22] All of these problems made the Pennsylvania Mainline a less desirable canal upon which to travel than the Erie.

Competition from the railroad, however, was the single most significant factor contributing to the waterway's failure. The Pennsylvania Railroad began to construct a line that competed for the same business in 1846. Finally yielding to the competition, the canal was sold to the railroad in 1857 for $7.5 million. It operated for a time longer, the western segment being abandoned in 1864, and the eastern segment around 1900. Rubin noted that "the evidence is clear. Pennsylvania had a real choice of methods [open] to her, and a mistake was made."[23]

The success of the Erie also inspired the construction of first cycle canals in New Jersey and Ohio. Unlike the publicly funded canals in New York and Pennsylvania, New Jersey's canals were financed privately. Likely aware of the forces that fought over the Pennsylvania Mainline, the State of New Jersey decided that if a canal was not supported unanimously, and if private investors were able to finance a venture, those investors could build it.[24] That willingness notwithstanding, there were also concerns about private funding. DeWitt Clinton, for instance, feared that an investor might not be able to sell the necessary stock, thus resulting in an unfinished project. He was also concerned that a private company might be sensitive only to its

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[21] Rubin, "An Imitative Public Improvement," 93-94, 98, 105-106; Waggoner, Long Haul, 194.

[22] Waggoner, Long Haul, 201-203,293.

[23] Rubin, "An Imitative Public Improvement," 105-108, 112; Waggoner, Long Haul, 293.

[24] Cranmer, "Improvements," 115-116, 161-162.

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own needs and not those of the state. A commissioner from New Jersey said that he believed private development and operation to be "'the pernicious, the deadly principle of confiding the vital interests of our country to the guardianship of men, whose only view can be pecuniary advantage to themselves.'"[25] Despite these concerns, New Jersey's two canals, the Morris, a developmental canal, and the Raritan, an exploitive canal, were both completed with private funds.[26]

First cycle canals in Ohio were the earliest in the Old Northwest. Preliminary calls for an Ohio canal came in 1816, when Cincinnati Judge Ethan Allen Brown proposed linking the Ohio River with Lake Erie. Work on the Ohio & Erie Canal started on 4 July 1825, but its completion was not assured until Congress awarded the state a land grant of 464,000 acres to support it in 1828. Congress also awarded Ohio a 500,000 acre grant to finance the Miami & Erie Canal.[27] The Ohio & Erie Canal, which opened on 1 December 1832, was 308 miles long and cost $7,904,971.00. The Ohio & Miami opened to Toledo in 1843.[28]

As the first canal building cycle came to a close and the second one began, David Stevenson, a Scottish engineer toured the United States. Writing about that tour in his 1838 book Sketch of Civil Engineering of North America, Stevenson was impressed with, among other things, the length of American canals. The longest in Europe was France's 148 mile Languedoc, consequently he marveled at the Erie's 363 miles. He was also impressed with the traffic he found on the Erie -- 3167 boats in 1836, or an average of 118 a day. Indeed, Stevenson observed that the "stupendous canals which have already been executed enable vessels, suited to the inland navigation of the country, to pass from the Gulf of St. Lawrence to the Gulf of Mexico, and also from New York to Quebec ..., or to New Orleans on the Mississippi, without encountering the dangers of the Atlantic Ocean."[29]

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[25] Ibid., 131.

[26] Ibid., 165.

[27] Harlow, Old Towpaths, 241, 245, 249.

[28] Harlow, Old Towpaths, 250, 252.

[29] David Stevenson, Sketch of the Civil Engineering of North America (London: J. Weale, 1838), 187, 190, 195.

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The development of the Old Northwest continued in the second cycle of canal construction, a cycle that was largely inspired by increased national development, speculation, and rising commodity prices. Foreign capital was initially available in the second cycle, but, as a result of the Panic of 1837, it was largely gone by 1840. That loss resulted in much unfinished construction by 1842, as well as the bankruptcy of many canal companies. Indeed, as the second cycle terminated, the value of unfinished projects totalled $60 million.[30]

Second cycle activity in the Old Northwest occurred largely in Indiana and Illinois. The Indiana governor called for a road and canal system for his state.[31] Plans progressed, and a private company was chartered in 1827 to build a canal from Fort Wayne to the Ohio River.[32] That effort quickly faltered, yet the idea remained alive since Congress had offered a land grant to the state in 1827. Construction on the canal finally began in 1832, but little work was completed until the state agreed to make a thirteen million dollar loan available for internal improvements in 1836.[33] Despite that pledge of assistance, timely completion of the project was not assured.

A canal linking Lake Michigan to the Illinois River had been envisioned since Father Marquette's 1673 reference. The Indians yielded a twenty mile wide strip of land for a canal in 1816, which was projected to run from Fort Dearborn, along the Chicago River to the Des Plaines River, and finally to a suitable boating point on the Illinois River. A route was surveyed in 1824, and construction costs were projected at about $700,000.00. Although Congress gave the state a 300,000 acre land grant in 1827, work did not begin until the Illinois Legislature committed $6 million to the project in 1836. The state had previously hesitated to make such a commitment because it did not want to incur any debt, but the potential for development along the canal route likely outweighed that concern.[34] Work on the Illinois & Michigan Canal began on 4 July 1836, and progressed until 1842 when the state bank, which had to sell bonds

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[30] Segal, "Cycles," 182-183.

[31] It should also be noted that 194 miles of canal laterals were built in Ohio during the second cycle. Segal, "Cycles," 193.

[32] Harlow, Old Towpaths, 263-264.

[33] Harlow, Old Towpaths, 265; Segal, "Cycles," 193.

[34] Harlow, Old Towpaths, 279-280; Segal, "Cycles," 194.

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to continue work after the Panic of 1837, collapsed.[35]

The third canal construction cycle was the period during which many projects from the previous cycle were completed. Two examples were the Wabash & Erie and Illinois & Michigan canals. Virtually all foreign investment capital was gone by the third cycle, therefore states that wanted to pursue canal projects had little choice but to tax their residents to generate the required capital.[36] The Indiana canal was completed in 1852, and, at 467 miles, was the "largest artificial waterway in the U.S."[37] Boats were able to enter the canal in 1843, and reached Terre Haute by 1849. But canal construction bankrupted Indiana, and the state was not able to maintain the facility. As wooden portions of the system rotted, income generated by tolls had to be reinvested in maintenance and improvements. In 1857, for example, the canal generated $60,000 in tolls, at least $40,000 of which went to repairs.[38] Very little, indeed, was left to repay the capital development costs.

Work on the Illinois & Michigan Canal resumed in 1845 and was completed on 19 April 1848. Unlike the Indiana canal, the I&M had a more productive life. Canal historian Alvin F. Harlow observed that the canal greatly enhanced Chicago's development. The city had a population of 12,088 in 1845, he noted. It grew to 20,000 by 1848, the year the canal opened, and reached 74,500 only six years later. Further, he argued that Chicago became a major shipping center due largely to the agricultural goods that the canal delivered from the Illinois prairies. The canal was most successful in 1865 and 1866, when it generated $300,000 in tolls. Thereafter tonnage increased but railroad competition drove rates down.[39]

Despite the difficulties encountered building and operating canals, they were engineering triumphs. What makes the canals even more significant is the fact that they were designed and built when there were few, if any, formally trained engineers in the United States. The two men appointed to oversee construction of the Erie

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[35] Harlow, Old Towpaths, 284-285.

[36] Segal, "Cycles," 183.

[37] Ibid., 193.

[38] Harlow, Old Towpaths, 275-276.

[39] Ibid., 284-286, 287.

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Canal, for instance, were lawyers who "'had done a little amateur surveying -- nothing more.'"[40] Of these men and their assistants, Ashbel Welsh, a past president of the American Society of Civil Engineers, observed

> 'many of the distinctive characteristics of American Engineering originated with those Erie Canal Engineers. We practice their methods today....As a class they wrote little. There were then no engineering papers prepared, and no engineering societies to perpetrate them, if they had been prepared. They were not scientific men, but knew by intuition what other men know by calculation....What science they had they knew well how to apply to the best advantage. Few men have ever accomplished so much with so little means.'[41]

And indeed, their means were few. Canal excavation was labor intensive. Plows, scrapers, wheelbarrows, root cutting shovels and stump pullers were the primary tools used. When rocks had to be blasted, holes were drilled by hand. The holes were then filled with powder, tamped with clay, and ignited by brown wrapping paper fuses soaked in saltpeter. Construction methods were clearly not sophisticated, and they were dangerous. One engineer, having to justify the absence of two men, explained that "'one run off, the other blown up.'" The primitive nature and danger of these methods notwithstanding, they worked.[42]

Lock construction for these early canals also presented some unique engineering challenges. David Stevenson observed that the "undressed slopes of cuttings and embankments, roughly built rubble arches, stone parapet-walls coped with timber, and canal locks wholly constructed of that material everywhere offend the eye accustomed to view European workmanship. "[43] But, he quickly noted, that appearance was not due to the lack of engineering skill. It was instead due to the plentiful supply of wood in the United States, and the fact that its use promoted the ability to put canals in service faster. Wood locks, he further observed, could also be enlarged faster since there was no stone foundation to rip out.

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[40] Waggoner, Long Haul, 67.

[41] Harlow, Old Towpaths, 299-300.

[42] Segal, "Cycles," 174; Harlow, Old Towpaths, 23, 53; Waggoner, Long Haul, 20-21.

[43] Stevenson, Sketch, 192-193, 194.

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Designers of the Erie Canal, nevertheless, were uncertain if their locks should be built of wood or European cement. Boards would rot, but cement was expensive. Builders decided to use stone joined with quicklime mortar and pointed with the European cement. It was a solution with many skeptics. To resolve the dilemma, DeWitt Clinton, the chief engineer on the Erie, sent an associate to Europe to study canal locks and their construction. Upon his return, he discovered a type of stone near the canal that produced an excellent hydraulic cement. The locks of the Erie, consequently, were built with the newly discovered stone and the cement it produced.[44]

The Erie Canal's stone locks were exceptions since most early locks were "composite" locks. That is they were built of a combination of dry rubble and timber planks. Undressed stones comprised the dry rubble portion of the lock which lined the chamber and created most of the facility's structural rigidity. Two layers of wood, which protected boats from damage by the stones, were then placed over the dry rubble. This type of lock was used on the Delaware & Raritan.[45] Despite the stone used in composite locks, they were high maintenance structures since the planking periodically needed replacing. David Stevenson observed that rotting wooden locks were usually replaced with those built of stone.[46] And indeed they were. As lock technology progressed, designers used the same materials as the Erie locks -- cut stones and hydraulic cement -- more often. Locks were stronger when built of cut stone, and did not incur the maintenance costs that composite locks did.

Perhaps the most significant innovation in lock chamber construction came in 1891, during planning for the Hennipen Canal in Illinois. In that year, a decision was made to build the new canal's locks from Portland Cement instead of the traditional cut stone and mortar. The new method, which had been used in Europe, created more durable, yet less expensive locks.[47]

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[44] Harlow, Old Towpaths, 52; Waggoner, Long Haul, 68-69.

[45] William J. McKelvey, Jr., Champlain to Chesapeake: A Canal Era Pictorial Cruise (Exton, PA: Canal Press Incorporated, n.d.), 90; Elizabeth Kytle, Home on the Canal (Cabin John, MD: Seven Locks Press, 1983), 71.

[46] Stevenson, Sketch, 193.

[47] Mary M. Yeater, "The Hennepin Canal," American Canals: Bulletin of the American Canal Society (reprint of a 1976-1978 series), 4.

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Lock gates were also originally built of wood, the most common type of which was the miter gate. There were four miter gates to a lock, each gate being hung vertically in one of the lock's four corners. Operated in pairs (two upstream and two downstream), the gates opened upstream, and were operated by long "balance beams" that were affixed to the top of the gate and extended over the adjacent ground. The beam helped balance the weight of the gate, thus making it easier for an operator to push a gate open or closed. To operate this type of gate, a man stood at the end of a beam with his back to it and pushed. A walkway with treads helped the operator keep his footing when operating the gate.[48] Miter gates are the most commonly used gates today. Their operating mechanism has improved over the years, and is now motorized in large lock systems. In smaller systems, though the geared drive mechanism is similar to that used in the motorized systems, the gates are still operated by hand.

Another type of gate found on nineteenth century United States locks is the drop gate. Similar to Josiah White's "bear trap gate," the drop gate was developed on the Lehigh River in 1818. It was a solid, one piece gate that was used only on the up river end of a lock. It too opened upstream, but unlike the vertically hinged miter gate, the drop gate had a horizontally placed hinge on the bottom. As such the gate opened by "falling" upstream. Since the gate opened upstream, the water pressure held it in place when it was closed. Significantly, this type gate was easily operated by one man; an impossibility with the miter gates.[49]

Gates served another function on the nation's early locks in that they contained the flooding and discharge valves. Called wickets, the valves were located at the foot of each gate. They were also known as butterfly valves, and were solid, rectangular pieces of metal that pivoted on a shaft. Operated by a lever at the top of the gate, the valves on the downstream gates were opened and the valves on the upstream side were closed when a lock had to be discharged. When a lock chamber was flooded, the upstream valves were opened while those downstream were closed.[50]

Dams were an integral part of slackwater canal systems. That is the type of system wherein a river is improved for navigation and canals are built only to circumvent

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[48] Gieck, Photo Album, 16; McKelvey, Champlain to Chesapeake, 14; Harlow, Old Towpaths, 21; Stevenson, Sketch, 201.

[49] McKelvey, Champlain to Chesapeake, 168.

[50] Gieck, Photo Album, 12, 16; McKelvey, Champlain to Chesapeake, 168.

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hazards that a dam could not flood, as well as the dams themselves. This is the type of system that was used on the Western Canal, and that Julius Rubin condemned. Apparently, slackwater canals were not totally ignored after the failure of the Western since David Stevenson found them to be "...extensively and successfully introduced in America..." in the course of his 1837 tour.[51]

Stevenson saw one dam that was part of a slackwater canal system on the Schuylkill River in Pennsylvania. Built on a rock portion of the riverbed, he described a 1600 foot long crib dam. It was built of logs eighteen to twenty inches in diameter. The logs were dovetailed with three inch deep notches. Cribs were built in twenty foot long and seventy-two foot wide pieces, which were then filled with stones. That portion of the dam over which the water passed, was then covered with six inch timber planks.[52] James Leffel, a nineteenth century dam expert, also described a dam at Henry, Illinois, on the Illinois & Michigan Canal, in his book Construction of Mill Dams. It was a crib dam.[53] Many other types of dams could also be built, the type of which depended on the nature of the river, the location of the dam and the type of material available. They included stone dams, built of quarried stone, and brush and stone dams, which consisted of nothing more than brush laid across a river and held in place with stones.

American canals were originally designed for tow boats, that is boats that were towed by animals walking along the adjacent bank. As the technology of boat design and propulsion progressed, people wondered how useful the old tow canals would be for the new self propelled vessels that were evolving. Steamers attempted to navigate the Schuylkill in 1846 or 1847, the Miami & Erie in 1847, and the Chesapeake & Ohio in 1855, but those attempts were apparently not successful. Based on the Chesapeake & Ohio experience, and canal historian Alvin Harlow's observation that they "did not repeat the experiment,"[54] we can conclude these experiments were not successful.

The United States canal system grew to include 4200 miles of canals found in twenty-

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[51] Stevenson, Sketch, 199-200.

[52] Stevenson, Sketch, 279-281.

[53] James Leffel, Construction of Mill Dams (Springfield, OH: James Leffel & Company, 1881; reprint, Park Ridge, NJ: Noyes Press, 1972), 69.

[54] Harlow, Old Towpaths, 259, 324-325.

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three states by 1860.[55] Despite these impressive figures, however, the success experienced by the Erie Canal was not repeated by any other. Indeed, canal transportation enjoyed only a brief "heyday." One factor that contributed to the decline of canals was the fact that industry began to move away from the rivers. And the farther away it moved, canals became a less and less viable method of freight transportation.[56]

Perhaps the most significant factor contributing to the demise of the canal era was the railroad. They were able to haul freight quicker and protect it better. Railroads also had agents throughout the country who solicited traffic for their companies, and canals did not have similar marketing systems. In cases where someone wanted to ship freight on a canal, but were in an area not so serviced, they needed to rely on a railroad to move the goods to the canal. This was a service which railroads generally refused to offer, consequently they were able to deprive canals of traffic that may otherwise have been theirs. As railroads grew larger, they achieved the ability to not only deprive canals of traffic, but to actually buy the canal. Examples of this include the Mahoning Railroad which bought the Ohio & Pennsylvania Canal of Ohio, the Richmond & Alleghany Railroad which bought the James River & Kanuwha Canal of Virginia, and the Pennsylvania Railroad, which leased the Delaware & Raritan Canal for 999 years.[57]

Wisconsin's major canal building venture, the Fox-Wisconsin waterway, occurred during the third canal building cycle.[58] It was a developmental, as opposed to an exploitive, canal. Despite the failure of the early slackwater navigation systems that tried to improve rivers for navigation by building locks and canals only where natural hazards could not be improved, that is the very approach taken on the Fox-

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[55] Segal, "Cycles," 169.

[56] Harold G. Moulton, Waterways Versus Railways (Cambridge, MA: Riverside Press, 1914), 91.

[57] Ibid., 81-90.

[58] It should be noted that another canal scheme had also been promoted in Wisconsin. The Milwaukee and Rock River Canal was to run west from Milwaukee to the Rock River, and thence to the Mississippi. Barely a mile of this canal was ever constructed. The Fox/Wisconsin waterway, therefore, exists as Wisconsin's sole venture in the nation's canal building craze.

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Wisconsin. As the other states in the Old Northwest had, Wisconsin financed its canal through land grant sales. Unlike Illinois and Indiana, however, the state was constitutionally prohibited from incurring any debt to complete the canal. The first locks in the canal system were composite locks, one of which remains (Kaukauna 5). Thirteen of the locks were subsequently rebuilt of cut stone and mortar (Appleton 1, Appleton 2, Appleton 3, Appleton 4, Cedars, Little Chute 2, Little Chute 3 & 4, a.k.a. Combined Locks, Kaukauna 1, Kaukauna 2, Kaukauna 3, Kaukauna 4, Kaukauna 5). Four of the locks were rebuilt of concrete (Menasha, Rapide Croche, Little Kaukauna, DePere). All the Lower Fox locks have miter gates. Finally, the Fox-Wisconsin Waterway is unique because it was designed for steamboats and not towboats.

Canals & Locks: The Lower Fox River

The Fox and Wisconsin Rivers have long been significant in the region's history. Except for the several hundred yards that separated them in Portage, they provided a continuous water route for the Indians from Green Bay to the Mississippi River. Father Jacques Marquette and Louis Joliet traveled the route in 1673, as they sought a route from the Great Lakes to California.[59] Soon an interest in fur trading developed among the European explorers in the region, and the Fox and Wisconsin Rivers became a major route on which they traveled. The importance of the Fox and Wisconsin Rivers as a regional transportation route developed as more and more Europeans came to the Great Lakes Region, and especially after American independence had been won from England. It was, after all, an important route across the Old Northwest, between the Great Lakes and the Mississippi, then the nation's western border.

The thirty seven mile long Lower Fox was only one segment of the Fox-Wisconsin Waterway. It was, nevertheless, the most enduring portion of that system. The Lower Fox connects Green Bay and Lake Winnebago, the state's largest inland lake. From Lake Winnebago, the Upper Fox generally runs westward to Portage, where it comes to within several hundred yards of the Wisconsin River. The Lower Fox, consequently, facilitated access to a large portion of the state.

Navigation on the Lower Fox had its difficulties. The river, which dropped 170 feet in its thirty seven miles, contained many rapids. Those using the river had to usually portage around the large rapids, a very inconvenient procedure whereby a vessel was either transported around, or lifted over a navigational hazard. In many cases vessels

[59] Robert C. Nesbit, Wisconsin: A History (Madison: University of Wisconsin Press, 1973), 25.

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had to be unloaded in order to be portaged, an action that made the portage that much more difficult because the freight then had to be carried.

The inconvenience of portaging on the Lower Fox is evident in the accounts left by those who did it. Henry Merrell, recalled a venture in which he needed to send some Durham boats (thought to be flat-bottom vessels) up the Lower Fox. He wrote that

> At Grand Kaukalo [Kaukauna], they [Indians]had to unload and cart the goods about one mile, and the Indians going into the water, pushing, lifting and hauling the boats over the rapids; then re-loading, and poling them up to the Grand Chute -- where Appleton is now situated. There they had to unload, and carry the goods up a hill and down the other side above the Chute, which was a perpendicular fall of three or four feet. The Indians would wade in, as many as could stand around the boat, and lift it over, while others had a long cordelle with a turn around a tree above, taking up the slack, and pulling as much as they could. When the boats were over, they were re-loaded, and they pushed ahead and poled from there to Fort Winnebago.[60]

The difficulty of circumventing the hazards on the Lower Fox were also noted in a survey report made by Colonel John Petival in 1838. Petival wrote that

> On leaving Green Bay, a barge of 20 tons burden takes a crew of 8 men, 2 or 3 of whom are half-breeds. The barges, going always 3 or 4 together help each other in ascending. At 'Grand Kaukalau' all the freight is landed and carried over a portage of about 2 miles, to the head of the rapids, and from 50 to 60 Indians are hired to haul the barges up the cascade. They, being reloaded, arrive with the same assistance at the foot of Grand Chute, where they are again unloaded and by the same means carried up the rapids; then the Indians are discharged, and the cres, by poles, oars, or sail, reach the pace of destination, Fort Winnebago, at the rate of about 3 miles per hour.[61]

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[60] Henry Merrell, "Pioneer Live in Wisconsin: Merrell's Narrative," Wisconsin Historical Collections Volume 7 (Madison: State Historical Society of Wisconsin, 1876; Reprint, 1908), 370-371.

[61] [?]"Petival's Report,"[?] Executive Documents, 25th Congress, 3rd Session, Serial 347, House Document Number 102, 9-10.

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Clearly, if navigation along or above the Lower Fox was to be promoted, improvements in the waterway had to be made.

A navigable Fox-Wisconsin route had been advocated as early as 1829. George Armroyd, in his book A Connected View of the Whole Internal Navigation of the United States, Natural and Artificial, Present and Prospective, observed that "steam-boats now run from [the] New York Canal at Buffalo, through the several lakes, to Green Bay, and [the] Fox River, notwithstanding the rapids below Winnebago Lake; and there is only needed a canal of 2,500 yards in length...[before steamboats can] pass on, through the Ouisconsin [sic] to the Mississippi...and thence down the stream to New Orleans."[62] Further, Armroyd argued, development of the Fox-Wisconsin would help the territory exploit its rich mineral and mining resources.[63]

Another Fox-Wisconsin advocate was Morgan L. Martin. Indeed, Wisconsin historian Reuben G. Thwaites credits Martin with being the waterway's prime mover. Martin arrived in Green Bay in 1827, and was publicly advocating the canal by 1829 when he presided over a waterway related meeting there.[64] Morgan Martin was the quintessential speculator. In partnership with Solomon Juneau, he acquired and platted the site of the Village of Milwaukee, as well as being involved in various railroad and banking endeavors. Martin was also a politician, serving in the state Legislature as an assemblyman and senator, as well as the territorial delegate to Congress. He was president of the second state constitutional convention in 1848, and was a Brown County judge when he died in 1887. These various activities notwithstanding, Martin has been most closely associated with the Fox-Wisconsin

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[62] George Armroyd, A Connected View of the whole Internal Navigation of the United States, Natural and Artificial, Present and Prospective (1830; reprint, New York: Burt Franklin, 1971), 349.

[63] Ibid., 350.

[64] Reuben G. Thwaits, "Sketch and Narrative of Morgan L. Martin," Wisconsin Historical Collections Volume 11 (Madison: State Historical Society of Wisconsin, 1888), 414-415; William F. Raney, Wisconsin A Story of Progress (New York: , 1940), 109; Samuel Mermin, The Fox-Wisconsin Rivers Improvement: An Historical Study in Legal Institutions and Political Economy (Madison: 1968), 17.

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waterway, an endeavor with which he was involved for over fifty years.[65]

The Michigan Territorial Legislature twice tried to move the project along. The first attempt was in 1829 when it incorporated the Summit Portage Canal Company and Road Company. That company was to dig a canal that would join the Wisconsin and Fox Rivers at Portage, as well as build roads around the major rapids on the Lower Fox, but no work was done.[66] The second attempt came in 1834 when the legislature chartered the Portage Canal Company to dig a canal at the Fox-Wisconsin portage. Unlike the previous attempt, construction actually began this time. Still, the effort went for naught. As Martin observed later, it was "'a ditch ...dug across the prairie,'" and nothing more.[67]

Frustrated by these unsuccessful efforts, a group of Green Bay merchants decided at the very least to improve the Lower Fox at DePere. Unfortunately, however, their 1835 efforts were as unsuccessful as those that had preceded them.[68] The Michigan Legislature made another attempt to resolve the issue in 1835, when it chartered the Wisconsin Internal Improvements Company. The objective of the new organization was to open communication between the Mississippi River and Green Bay by land or by water. Under this plan, the Fox-Wisconsin waterway was only one option. As with the two previous efforts, however, this venture failed. Fox-Wisconsin historian Samuel Mermin suggests that this failure may be due to Wisconsin's impending territorial status, and the possibility that nobody wanted to act on the Michigan charter.[69]

Impetus for an improved waterway continued to grow in Green Bay where merchants desperately wanted to capture some of the southwestern Wisconsin lead trade. Their staple, the fur trade, was declining and they were looking for new commodities. Green Bay residents believed much of the lead trade could be theirs, if only the rivers were

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[65] Dictionary of Wisconsin Biography (Madison: State Historical Society of Wisconsin, 1960), 241-242.

[66] Reuben G. Thwaits, The Story of Wisconsin (Boston: , 1891), 255; Mermin, Fox-Wisconsin, 2.

[67] Mermin, Fox-Wisconsin, 2; Thwaits, "Narrative," 403.

[68] Mermin, Fox-Wisconsin, 2-3.

[69] Ibid., 3.

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connected and improved.[70]

In 1837, a group of eastern capitalists saw the advantage of connecting the Fox and Wisconsin Rivers into a single, navigable system. They financed the formation of yet another Portage Canal Company. Work totalling $10,000.00 was completed by this venture before it, too, was abandoned.[71]

Ineffective efforts to improve the waterway continued. When the first Wisconsin Territorial Legislature met in early 1838, it asked Congress for $25,000.00 to improve the Fox River. Later that spring, Martin and his Green Bay area canal supporters asked for a special Wisconsin internal improvements convention, during which they hoped to generate support for the Fox-Wisconsin canal.

Finally there was a cause for optimism. In the fall of 1838, Territorial Governor Henry Dodge urged memorials be sent to Congress asking that 150,000 acres of land be put up for sale, the proceeds from which would be used to improve the Wisconsin, Fox, and Rock Rivers.[72] The federal government agreed to help with the Fox-Wisconsin project, noting that a need did exist for a national waterway that would promote troop movement along the frontier. James Doty wrote Morgan Martin, telling him that the "Secretary of War has promised me that the improvement of the Fox-Wiskonsin [sic] Rivers shall be undertaken as a national work."[73]

To get the work underway, the federal government conducted two survey's of the Fox-Wisconsin. The first, by Colonel John Petival, was made in 1837, a year before the territory sent its memorials to Congress. Petival's report was published in 1839, and dealt primarily with the Fox River, then known as the Neenah, and the Portage Canal.

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[70] Robert M. McCluggage, "The Fox-Wisconsin Waterway, 1836-1872: Land Speculation and Regional Rivalries" (Ph.D. diss., University of Wisconsin, 1954), 39.

[71] Henry C. Campbell, Wisconsin in Three Centuries, 1634-1905 (New York: Century History Company, 1906), 104.

[72] Mermin, Fox-Wisconsin, 4; Louis Pelzer, Henry Dodge (Iowa City: State Historical Society of Iowa, 1911), 147.

[73] Raney, Wisconsin, 109; Alice Smith, The History of Wisconsin: From Exploration to Statehood (Madison: The State Historical Society of Wisconsin, 1973), 456.

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Petival observed that navigation on the Fox had changed very little over time. The many rapids on the Lower Fox, he reported, made it "tedious and expensive" upon which to ship freight. Indeed, charges for transportation on the Fox often doubled the retail prices of goods when they finally reached their destination. Petival further noted that the black mud and sand through which the Portage canal would be cut would cause long term stability problems, and would probably require lining the canal walls.[74]

The second federal survey was conducted by Captain Thomas Cram, a politically savvy engineer who "was not confining himself to technical considerations...."[75] Cram's report emphasized how militarily and economically important the improved system would be for the entire country in general, and the area west of the Mississippi in particular. According to Cram, "the agricultural, commercial, and manufacturing interests of all the New England states, also of the states of New York and Pennsylvania, would be greatly promoted by the construction of a continuous water communication, upon a proper scale, between the Mississippi River and Lake Michigan."[76] Interior states, Cram continued, would benefit from the improved waterway because they would be able to ship and receive goods using the Upper Mississippi and the Great Lakes if ever the Gulf of Mexico was blockaded.[77] Cram's report included a survey of the Fox-Wisconsin route, which he believed could be made navigable for larger vessels at a cost of about $500,000.00. Approximately eighty five percent of that cost, however, was attributed to necessary improvements on the Lower Fox.[78]

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[74] [?]"Petival's Report"[?], Executive Documents (25th Congress, 3rd Session, Serial 347, House Document Number 102), 1, 6, 9-10.

[75] Mermin, Fox-Wisconsin, 7.

[76] [?]Cram's Report[?], Senate Documents (26th Congress, 1st Session, Serial 359, Senate Document Number 318), 2.

[77] Ibid.

[78] Ibid., 11; Alice Smith, Millstone and Saw: The Origins of Neenah-Menasha (Madison: The State Historical Society of Wisconsin, 1966), 25. The lack of objective analysis in Cram's report can only be understood in the context of the efforts that were actually needed to develop the waterway. Numerous side channels, shifting sand bars, and low, overhanging trees were serious impairments to navigation

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Fox-Wisconsin proponents were busy in 1839. In addition to the completion of Cram's survey, Governor Dodge again requested assistance from the federal government. As well, public meetings supporting the waterway were held in Green Bay and Buffalo, New York. Those in Green Bay asked for federal help, arguing that the project was too big to be privatized in an area with such low population. The Buffalo residents wanted the waterway improved in order to create a New York-Great Lakes through route, and thus increase traffic on the Erie Canal. Indeed, they wanted an "'extension of the Erie Canal to the Mississippi.'"[79] Despite these requests, as well as the Petival and Cram surveys, Congress took minimal action on the waterway between 1839 and 1845.

But efforts to promote the canal continued in Wisconsin. An internal improvements bill was introduced, but failed to pass the Legislature in 1839 -- a loss that Moses Strong decried. He thought the bill was "of vastly more importance than any or all which did pass."[80] Between 1840 and 1843 several more attempts were made by the Territory to deal with internal improvements, none of which were successful. This ineffectiveness on the part of the Fox-Wisconsin promoters was due in part to the area's low population. Few people in a region meant less political power for that region's representatives.[81]

The inability to improve the Fox notwithstanding, Captain Peter Hotaling of Buffalo decided to operate a steamboat between Fort Winnebago and Green Bay. He and his boat, the Blackhawk, were enticed to the area by the prospect of attracting the lead trade, and by Green Bay merchants who stressed their strategic location between Galena and New York City. Prior to this, Durham boats were the only type of vessel that could navigate the river; and those had to be lifted and pushed past the rapids in several

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on the Wisconsin. The Upper Fox required dredging and the digging of a six mile long straight-cut canal to avoid thirty eight miles of twisting river. The Lower Fox was even more difficult. It required an intricate combination of locks, dams and canals. C.D. Westbrook, Jr., Fox and Wisconsin Improvement (Kingston, NY: S.S. Hommel, 1853), 2, 4. Of course all these difficulties are largely what the balance of this story is all about.

[79] Mermin, Fox-Wisconsin, 5, 10.

[80] Moses M. Strong, History of the Territory of Wisconsin from 1836 to 1848 (Madison: State Historical Society of Wisconsin, 1885), 279.

[81] Ibid., 340-374; McCluggage, "The Fox-Wisconsin Waterway," 5.

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places. The success of Hotaling's venture rested on the hope that the Fox would soon be cleared for steamer traffic. To that end, he outfitted an Erie canal boat with a steam engine, and left Buffalo in May, 1843.[82]

Hotaling easily reached Green Bay with his vessel, but was soon stuck at the Kaukauna Rapids. Deciding that he would be unable to pass, he spent the rest of the year working the Lower Fox between DePere and Kaukauna. That winter, Hotaling built a hull above the rapids, using parts from the Blackhawk. Since the Fox was not to be improved soon, and making the best of the situation, his new steamer, the Manchester, was largely used on Lake Winnebago. It made the journey between Fond du Lac and Oshkosh in two days, and was used almost exclusively for towing logs and lumber.[83]

Funding the Fox-Wisconsin Waterway was a problem at the heart of which was an inability to resolve who or what should be responsible for financing it. Candidates included the federal government, the Territory of Wisconsin, and private interests.

Public financing proponents argued that the project should not be privatized because tolls would have to be collected to cover construction costs, as well as to create the profits that would be necessary to attract private money. Additionally, tolls would limit the ability of some citizens to use the system. Privatization foes argued that the exclusivity that would result from tolls would be in violation of the Northwest Ordinance of 1787. Article IV stated that all the waters leading to and in between the Mississippi River and the St. Lawrence River "shall be common highways and forever free...without any tax, import or duty therefore."[84]

Those favoring privatization countered that Article IV only applied to naturally navigable waters, and not to those that had been improved. The Wisconsin Argus, a Madison newspaper, also favored privatization. Citing the corruption, bureaucracy and waste of state government, it claimed that "private capitalists, having a direct and personal motivation not present in the case of state enterprise, would construct communication improvements more cheaply and at more appropriate locations than would

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[82] Justus F. and Barbara Dotts Paul, The Badger State: A Documentary History of Wisconsin (Grand Rapids, MI: William B. Erdmans Publishing Co., 1979), 170.

[83] Ibid., 172-174; W.A. Titus, "Early Navigation on Fox and Wolf Rivers and Lake Winnebago," Wisconsin Magazine of History 25 (1941):18.

[84] Mermin, Fox-Wisconsin, 12.

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the state."[85]

Efforts to secure a federal land grant continued in 1843, when New York's Senator Nathaniel Talmadge supported a proposal before the Committee on Public Lands. Talmadge, through his friend James Doty, Wisconsin's territorial delegate to congress and a cousin of Morgan Martin's, had recently invested in some land immediately adjacent to the proposed waterway. In fact, Martin, Doty and others joined Senator Talmadge in securing land along the proposed route, and they were all busy exploiting their positions for the same reason -- profit.[86] Due in large part to Talmadge's effort, the Senate Committee did recommend a 320,000 acre land grant. The grant, however, followed the path of its predecessors and died in Congress in March, 1844.[87]

The national strategic importance of the Fox-Wisconsin was again stressed during the 1844 Presidential campaign. The issue of war with England over Oregon was one of the issues debated, and if that war ever evolved, interior waterway transportation would be one of the keys to victory. This argument played into the hands of the waterway's supporters, because they had realized that the only way to persuade Washington to spend money on the project was to stress its national importance.[88]

By 1845, Nathaniel Talmadge was Wisconsin's territorial governor and Henry Dodge the delegate to Congress. But Talmadge's term as governor was short and Henry Dodge replaced him later on that year. Dodge's reappointment as Governor opened the position of territorial delegate, for which Morgan Martin then decided to run. Martin was opposed by the Milwaukee Sentinel, which feared a "Northern Conspiracy." The paper warned that Martin, as Dodge had, would promote "'the Fox River improvement...to the exclusion of all other interests.'"[89] Martin won the election.

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[85] Ibid., 13, 21.

[86] Vilas A. Bender, "Morgan Martin and the Improvement of the Fox River" (Master's thesis, University of Wisconsin, 1951) 16, 25.

[87] Mermin, Fox-Wisconsin, 13-15.

[88] Joseph Schafer, The Winnebago-Horicon Basin (Madison: , 1937), 97; McCluggage, "Fox-Wisconsin Waterway," 74.

[89] Mermin, Fox-Wisconsin, 16.

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In January, 1846 Martin asked Congress for financial support for the Fox-Wisconsin waterway. The request was made on behalf of the Territorial Legislature, various Wisconsin citizens, as well as the citizens of Oswego, New York. The land grant bill of 1846 languished in Congress for a time, due to the pre-occupation with events in Oregon and Mexico. But by the end of the year, the bill had cleared both houses of Congress. This bill was successful due, in large part, to the fact that both the National Whig and Democratic Parties wanted the votes of the future state, and did not want to jeopardize their chances of obtaining those votes by again refusing the land grant.[90] The land grant put the territory in charge of improvements, and allowed that enough land to raise $20,000 could be sold at any one time. The money raised had to be spent before offering more land for sale.[91]

Despite the favorable action by Congress, the land grant was a volatile issue in Wisconsin. The problem evolved from the term that work on the waterway had to be started within three years and finished within twenty. If it was not, the proceeds of the grant would revert to the federal government. The award was made just before Wisconsin's first Constitutional Convention convened in 1846. The proposed Constitution allowed the state to encourage internal improvements by private companies, and permitted it to carry on work itself when a land grant was offered by the federal government. But the proposed constitution forbade the state from incurring any debt over $100,000 for the work, and that seemed to be at odds with the federal requirement that the state assume responsibility for the project if not completed within the twenty year period.[92]

That conflict notwithstanding, some at the convention felt there was an urgent need to accept the land grant before the federal government decided to withdraw it. One advocate was Dane County Democrat Nathaniel Hyer. He argued for the canal by noting that "it is very well understood that the lands in the interior are more productive than on the lake shore...and if we can have a market for our produce at home nearly equal to that on the lake shore, then our lands are as valuable as theirs...a

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[90] Ibid., 17; Alice E. Smith, Millstone and Saw: The Origins of Neenah-Menasha (Madison: State Historical Society of Wisconsin, 1966), 25.

[91] Thwaits, Story, 256; Mermin, Fox-Wisconsin, 18.

[92] Edward A. Fitzpatrick, Wisconsin (Milwaukee: , 1931), 229; Mermin, Fox-Wisconsin, 18-19.

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judicious system of internal improvements will create that market."[93]

Ultimately, the proposed constitution of 1846 failed to mention the Fox-Wisconsin improvement at all.[94] The constitution itself was rejected by the voters, however, and a new convention was called for 1848. The second convention, with Morgan Martin presiding, produced a document very similar to that of 1846, but several key amendments were included in the 1848 package that made it more acceptable. Primary among them was the provision that allowed the state to spend money derived from improvements on the improvements themselves.[95] The example Martin offered to illustrate that provision involved the Central Railroad, which the State of Michigan had been unable to complete. The state, subsequently, "arranged with a Boston company to 'complete it, and keep it until they had paid themselves out of the revenue of it, and then it would revert back to the state. There was no debt incurred -- no credit of the state pledged.'"[96] To Martin's delight, the 1848 constitution was ratified and the federal land grant accepted.

With funding of the Fox-Wisconsin improvement apparently secured, attention turned to creating the governmental body that would oversee construction -- the Board of Public Works. By September, 1848, the board was in place, and met to appoint Condy R. Alton as the project's chief engineer. Alton's first job was to survey the proposed route, suggest specific improvements, and estimate the costs of those improvements.[97]

Alton made a number of recommendations in the report he presented to the Board in December, 1848.[98] He noted that DePere already had a dam and wooden lock that were in

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[93] McCluggage, "Fox-Wisconsin Waterway," 123.

[94] Mermin, Fox-Wisconsin, 20.

[95] Ibid., 21.

[96] Ibid.

[97] Report of the Board of Public Works Made to the Legislative Assembly, January 19, 1949 (Madison: 1849), 5.

[98] The Milwaukee Sentinel, 9 December 1848.

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poor condition,[99] and suggested that a stone lock with a seven and one half foot lift be built instead. That lock, he projected, would require a 1,200 foot canal and cost about $16,201.15.[100] At Rapide Croche, Alton observed a slight rapids. There he proposed that a 650 foot long, six foot high dam be built. One lock with a six foot lift and placed within an 800 foot canal would be sufficient, he believed, to pass boats there.[101]

Surveying the river at Kaukauna, Alton noted about one and one half miles of rapids. He recommended that they be by-passed with a one and one half mile canal containing five locks. Two of the locks were to have a ten foot lift, two were to have a nine foot lift and the final one was to be eleven feet. The cost of these locks, the canal, as well as the 660 foot long, five foot high dam needed to create the slackwater to flood the canal, was set at $88,330.26.[102] The rapids Alton encountered at Little Chute were equally as formidable. There he proposed a 500 foot long, six foot high dam, an 8,316 foot canal and four locks. Alton estimated the cost of the Little Chute improvements at $70,929.13.[103] Recommendations for the small rapids at Cedars included a 700 foot dam with a six foot head, one lock with a ten foot drop and about 660 feet of canal -- all of which would cost $19,294.11.[104]

Appleton, then known as Grand Chute, presented perhaps the biggest challenge. There were one and one half miles of rapids there, as well as a four foot falls. Alton wanted a canal in excess of 9,600 feet to pass those hazards, and a 660 foot dam with a six and one half foot head built above the rapids to flood the canal. Four locks should be used at this site, he believed, two with a ten foot lift, one with a nine foot lift and one with an eight foot lift. Costs for these improvements, he

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[99] These may have been the structures built by the Green Bay merchants in 1835.

[100] Report of the Board, January 19, 1949, 18.

[101] Ibid., 18.

[102] Ibid.

[103] Ibid., 17.

[104] Ibid.

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projected, would be $76,709.30.[105] Only one more rapids existed below Lake Winnebago, and those were at Neenah/Menasha. Alton recommended that they be circumvented by a $13,000.00 canal and an $11,000.00 lock.[106]

In dramatic contrast to the Lower Fox, Alton believed the Upper Fox could be sufficiently improved through dredging alone. Accordingly, he proposed that a $7,000.00 steam boat/dredge be built, and that $9,065.00 be budgeted for the labor and supplies necessary to operate the dredge.[107] Finally, Alton projected that the Portage Canal, which would connect the Wisconsin and Fox Rivers, could be completed for $50,954.00.[108]

Among his general recommendations for the entire system, Alton suggested that all canals be forty feet wide at the bottom, and at least four feet deep at low water. He wanted the banks of the canals to be eight feet high and have slope ratios of 1:2 or 1.5:2. The locks, Alton continued, should be able to pass "the small steamboats, that would probably do the principal part of the carrying trade on the rivers..."[109] Noting that the steamboats could be 110 feet long, he recommended that the locks be 125 feet long and thirty feet wide. Alton then suggested that the Portage canal, dredging of the Upper Fox, and the locks at DePere and Rapide Croche be the first projects undertaken. That work, he reasoned, would make the greatest portion of the river navigable the quickest.[110] Indeed, almost twenty years after Morgan Martin called that first meeting in Green Bay to advocate an improved waterway between Green Bay and the Mississippi, work was ready to begin.

Construction of the Fox-Wisconsin Waterway got underway in 1849. Contracts were awarded for the facilities at DePere and Rapide Croche in May. Originally, Joseph Maynard was to build them both. Prior to signing the contracts, however, Joshua F.

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[105] Ibid.

[106] Ibid., 16.

[107] Ibid., 15.

[108] Ibid., 14.

[109] Ibid., 11-12.

[110] Ibid., 19.

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Cox offered to build the DePere facility for $1.00, and the state accepted his offer. The motivation behind Cox's offer is not clear. It is possible, nevertheless, that he thought he could benefit from the commerce the DePere lock would generate, and thus offered to build the lock at his own expense.[111] Despite losing the DePere lock, Maynard was retained to build the lock and dam at Rapide Croche.[112]

The contract to build the Portage Canal was given to Thomas Reynolds, Madison, while the job of constructing the locks went to Nelson McNeal, Southport (Kenosha). Contracts for these two projects totaled $37,200.00.[113] Reflecting one of the problems that had plagued American canals from the start, Reynolds resorted to advertising in the Milwaukee Sentinel for laborers. He was willing to pay $1.00 a day.[114]

Construction of the steam dredge for the Upper Fox was also commissioned in 1849. The contract for the dredge was signed on 6 March, and the vessel was delivered on 3 October. In little more than six weeks, the dredge had cleared the river from Lake Winnebago to Princeton. Alton was pleased with the dredge's service. "The machine," he wrote in his 1849 report, "as far as completed, displays every evidence of strength and stability, and there is no question but that it will fully answer all the purposes for which it was designed."[115]

The Board of Public Works met in November, 1849, to consider proposals for work at Winnebago Rapids and Grand Chute. Following the precedent set at DePere, the Board retained a contractor who said he would build the Winnebago Rapids facility at Menasha at no cost to the state. The contractor, Curtis Reed, even offered to pay the state $5,000.00 if it gave him the contract -- which of course it did. Proposed costs for the Grand Chute facilities were more than the Board wanted to pay at the time,

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[111] Report of the Board of Public Works (Madison: 1850), 27; "Bids for Work at DePere and Rapide Croche," Milwaukee Sentinel, 6 July 1849.

[112] Report of the Board (1850), 27.

[113] Ibid., 26-27; "The Improvements - Good News," Milwaukee Sentinel, 18 May 1849.

[114] Milwaukee Sentinel, 27 March 1849.

[115] Report of the Board (1850), 15-16, 26.

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therefore no action was taken on those.[116]

As the 1849 construction season closed, Alton reported to the Board that the DePere lock, which was being built from dry rubble and planks at Cox's request, was nearing completion and almost ready for gates.[117] The brush and stone dam at Rapide Croche was completed, he continued, while the adjacent canal and lock, as well as the Winnebago Rapids dam at Menasha and the Portage canal, were under construction.[118] Work completed in 1849 totalled $45,196.19. Land sales, on the other hand, had generated $59,500.45. The year closed, consequently, with the project having a $14,304.26 balance.[119] With work underway and cash remaining, the project's outlook was good. Revelling at this auspicious start, the Milwaukee Sentinel suggested that soon the "whole north west of our flourishing Wisconsin will be changed from an unsettled uncultivated and...uncivilized state, to one of life, bustle, activity and happiness."[120]

Activity for 1850 got underway as the Board of Public Works accepted bids for the facilities at Grand Chute and Cedars. Rejecting a lower bid because the contractor wanted water power rights, the Board accepted Fitch P. Talmadge's proposal to build the Grand Chute canal and locks for $56,747.64.[121] The contract for the Cedars dam and lock was awarded to Messrs. White, Resly and Arndt, who bid $16,427.90. They proposed a timber lock, but the state decided to have them build a composite structure for $600.00 more.[122]

While work was starting on the structures at Grand Chute and Cedars, it was being

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[116] "Progress of the Improvement," Milwaukee Sentinel 7 November 1849.

[117] Ibid., 27, 35.

[118] Report of the Board (1850), 35, 36.

[119] Ibid., 47.

[120] "The Improvements - Good News," Milwaukee Sentinel, 18 May 1849.

[121] Report of the Board of Public Works, For the Improvement of the Fox and Wisconsin Rivers (Madison: 1851), 3.

[122] Ibid., 4.

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completed at DePere. The first boat passed through that lock on 14 June, and was able to sail up the River to Rapide Croche. By August a Green Bay steamship, the Indiana, was making daily trips to Rapide Croche. The boat left Green Bay at 4:00 A.M. and returned in the afternoon. Needless to say, all were anxious for the facilities at Rapide Croche to open, which the Milwaukee Sentinel reported would happen in the middle of September.[123]

According to Alton, much was accomplished in 1850. The DePere lock was completed and opened, although it was too shallow during periods of low water.[124] The lock and dam at Rapide Croche were also completed, despite a cost overrun incurred when the floor of that lock had to be dropped. The Cedars dam was completed and the lock was under construction.[125] At Grand Chute, about twenty chains of canal had been excavated, as was the upper lock chamber.[126] The dam was finished and about two thirds of the canal excavated at Winnebago Rapids. On the Upper Fox, the dredge had cleared a channel between Lake Puckaway and Buffalo Lake, dredged Buffalo Lake, and dug a new channel to avoid Mud Lake.[127] Finally, Alton reported that the Portage canal was progressing and should be ready for flooding around 1 May 1851.[128]

The evolving waterway generated much excitement and many expectations. Residents at Omro were pleased with the project, for example, because they believed it was responsible for drawing a new tavern and stores to town.[129] Expectations were another matter, for they were easily dashed. The steamer Tiger, docked on the Wisconsin River, was waiting for the Portage Canal to be flooded so that it could make its way

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[123] Milwaukee Sentinel, 24 June 1850; Milwaukee Sentinel, 21 August 1850; Milwaukee Sentinel, 12 September 1850.

[124] Accordingly, the lock floor was to be dropped two feet during the 1850-1851 winter. The cost was estimated at $1,350.87. Report of the Board (1851), 17.

[125] Report of the Board (1851), 16.

[126] Ibid.

[127] Ibid., 12-13, 15.

[128] Ibid., 14-15.

[129] Milwaukee Sentinel, 3 July 1850.

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to Lake Winnebago. At the end of July, it was thought that the steamer could make the trip sometime in August. But by the middle of August, a September passing was projected. Finally, at the end of August, Captain Cook, the Tiger's master, decided that twelve weeks was long enough to wait. He wanted the legislature to reimburse him for the losses incurred through the delayed opening of the Portage Canal.[130]

While Alton's report noted that construction was progressing at Cedars and Grand Rapids, it was the commissioners' report that indicated why more had not been accomplished. The problem, they reported, was that funds available for the year were depleted.[131] Apparently they believed that would be a recurring problem, since their report explained that "eastern capitalists" had been approached about financing the facilities at Little Chute and Kaukauna. The easterners were willing to consider the project, but they wanted to collect tolls, as well as be given the rights to the surplus water at those sites. The state was willing to accommodate their requirements. The plan fell through, however, when one of the deal-makers died.[132]

The prospect of involving private interests in the project drew mixed reactions. The Milwaukee Sentinel originally suggested that private money might be wise to solicit because "our river improvement will...be placed beyond a contingency...." As well, the Sentinel stated, manufacturing concerns would quickly develop at those sites.[133] Two months later, however, the Sentinel argued that accepting private money would be like discarding the state's property.[134] The Green Bay Advocate, on the other hand, believed that private money would rapidly facilitate completion of the work.[135]

The private money debate continued. It did not, however, prevent the Board of Public Works from contracting with Morgan Martin to construct the Kaukauna facilities in 1851

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[130] Milwaukee Sentinel, 31 July 1850; Milwaukee Sentinel, 22 August 1850; "The Fox & Wisconsin River Improvement," Milwaukee Sentinel, 30 August 1850.

[131] Report of the Board (1851), 4.

[132] Ibid., 7.

[133] Milwaukee Sentinel, 4 October 1850.

[134] Milwaukee Sentinel, 24 December 1850.

[135] Ibid.

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and those at Little Chute in 1852.[136] Significantly, Martin's contract called for all new locks to be 160 feet long, instead of 140 feet, be five feet deep, instead of four, and to remain thirty five feet wide. Apparently there was a concern that smaller locks might limit the use of the system as steamers grew larger. Those building the locks at Grand Chute and Cedars were also told to use the new dimensions.[137] In addition, the commissioners wanted all new locks to be built of stone and timber.[138]

Work on the system continued throughout 1851. According to J. Kipp Anderson, Alton's assistant and the man who succeeded him when he resigned in 1851, the modifications on the DePere lock were completed and the lock opened for navigation in May.[139] The Rapide Croche dam was rebuilt since the old brush and stone dam kept washing out. Apparently the flat rock river bed was not suited for a dam that was not somehow affixed to it, therefore, a new spar dam, one bolted to the rock, was under construction.[140] The dam and canal at Cedars were finished, and completion of the lock was projected for the Summer of 1852.[141] Although somewhat belatedly, work resumed on the facilities at Grand Chute in August.[142] Finally, the dredge continued to work on the Upper Fox. Its season started in April, and by the end of the year it had completed the Mud Lake by-pass, as well as spent time in Portage helping to resolve problems at the canal. Anderson was pleased with the work of the dredge, and

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[136] Annual Report of the Board of Public Works of the State of Wisconsin (Madison: 1852), 9, 10; Milwaukee Sentinel, 4 April 1851.

[137] Annual Report (1852), 43-44.

[138] Ibid., 10-11. It should be noted that the first locks were intended to be built with timber. Some were built as composite locks, however, as the circumstances dictated. Note that Cox suggested a composite lock at DePere instead of timber, and that a composite lock was being built at Cedars, although the original bid was for one of timber.

[139] Annual Report (1852), 43.

[140] Ibid., 44.

[141] Ibid., 46.

[142] Ibid.

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stated that "there can be no doubt but that the continued use of the Dredge is the best and most effectual method of improving the navigation of this stream."[143] All were anxious for the project's completion, and in preparation for that, the Board established tolls that were published in its annual report. Waterway users were to pay, for example, four cents a ton to ship grain, forty cents per 100 barrels to ship flour, three cents per 1,000 feet of lumber and one and one half cents for passengers.[144]

Plans for completion notwithstanding, Martin's contract to complete the Kaukauna and Little Chute facilities ignited a debate that continued for two and a half years. Indeed, the debate became so lively that it overshadowed whatever work was completed between 1851 and 1853. Morgan Martin proposed to complete all work on the waterway

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[143] Ibid., 35-38, 48.

[144] Ibid., 74-75. The Fox River, however, only comprised half of the proposed waterway system -- the Wisconsin River was the other half. The Wisconsin has always been known as a very shallow, constantly changing river. That characterization notwithstanding, it was not thought to need the type or number of improvements as the Lower Fox. Alton toured the Wisconsin River in 1849, after which he reported "the general character of the stream is such that it would be extremely difficult, if not impossible, to make any improvement in the channel by the ordinary method." Alton believed that the trees hanging over the river presented the greatest obstacle to navigation on the Wisconsin. If they were cut back, or removed altogether, he thought the river would be navigable, at least for shallow draft boats, for the entire shipping season. Consequently, Alton recommended that twenty or thirty men be sent out to cut the trees back at some point when the river was frozen. When that work was done, he acknowledged that the channel might have to be confined in some places to achieve a navigable depth, but anticipated no more work than that. Alton estimated the cost for this work at $3,500.00. Following Alton's recommendations, many of the trees along the river had been cut back by 1850. Further, a boat had been built to help clear the river of snags and other submerged hazards. By 1851, however, it was apparent that clearing the river would not be enough to facilitate navigation. Caleb Croswell, one of the commissioners on the Board of Public Works, then suggested that the river could be made navigable through the use of wing dams. They were small structures built out into a river, and were designed to cut off side channels and constrict river flow, thereby increasing the depth of a river's main channel. Report of the Board (1850), 29, 30, 32-34; Report of the Board (1851), 14; Annual Report (1852), 41-42.

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within two years of 1 May 1851, and to be paid for that work from the income generated by the land grant sales. Further, Martin proposed that if any balance remained due after those proceeds were applied, that balance would "remain as a debt against the improvement, to draw interest at twelve percent per annum, to be discharged from the tolls received and as the residue of the lands shall be sold by the state."[145]

One of the most vociferous critics of Martin's plan was a Milwaukee Sentinel correspondent identified simply as "B." "B" first wrote on 5 May 1851, and stated that Martin was pursuing his plan simply for whatever political and financial gains he could make. Further, "B" argued, the remaining 60,000 land grant acres were largely undesirable, and thus had little value. If they did not sell, and Martin was allowed to hold a debt against the improvement, it was actually the state that incurred the debt since it owned the waterway; and the constitution prohibited the incursion of a debt for internal improvements. "B" called Doty "a quack" for agreeing to Martin's proposal.[146]

About six weeks later "B" again wrote the Sentinel. He was very disappointed that so little of the system had been finished. The lack of progress was attributed to poor surveys, inefficient contractors and an inattentive legislature.[147] "B" completed his harangue against Governor Doty, Martin, and the others associated with the waterway a week later when he observed that the canal was financially doomed from the start because Governor D oty had selected valueless marshland for the land grant. Through that poor selection, "B" believed, the grant had not provided the financial resources needed to complete the canal quickly and correctly.[148]

Despite the criticism, Governor Dewey signed the contract with Martin in May, 1851. Soon Martin was in the east raising money with which to complete the project. Indeed, as the Green Bay Spectator editorialized, "it is really fortunate that private enterprise can be brought to the aid of Public Functionaries and can be made available to bolster up a faction that has signally distinguished itself for prodigality, and

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[145] Milwaukee Sentinel, 19 February 1851.

[146] Milwaukee Sentinel, 5 May 1851.

[147] Milwaukee Sentinel, 24 May 1851.

[148] Milwaukee Sentinel, 29 May 1851.

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reckless squandering of monies that have been committed to its care."[149]

The Fall of 1851 was not a good time for supporters of the waterway. First, the project ran out of cash.[150] Second, the Milwaukee Sentinel declared the whole development a failure, characterizing it as useless and very costly.[151] And third, the Portage canal was virtually washed away by rampaging flood waters on the Wisconsin River. The loss of the canal was not attributed so much to the Wisconsin as it was to poor workmanship in the canal itself. People believed that for $70,000, they should have received a facility of some quality.[152] Inevitably, a move to investigate the waterway and its construction began to mount. It was thought by some, however, that the only objective hearing would come if the Whigs assumed control of the state government in the forthcoming elections.[153]

The Whigs did win the election, and by January the waterway issue was being investigated by a joint legislative committee. In an almost anti-climatical report, the committee affirmed the honesty and integrity of the commissioners on the Board of Public Works, and noted that any financial discrepancies were the result of inexperience, not intentional wrong doing.[154]

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[149] Milwaukee Sentinel, 31 May 1851; Milwaukee Sentinel, 7 August 1851.

[150] Milwaukee Sentinel, 16 September 1851.

[151] "The Fox and Wisconsin River Improvements," Milwaukee Sentinel, 30 September 1851; "More of the Improvement," Milwaukee Sentinel, 30 September 1851.

[152] "The Canal at Portage Gone," Milwaukee Sentinel, 8 October 1851.

[153] Milwaukee Sentinel, 11 October 1851; "The Improvement a 'failure,'" Milwaukee Sentinel, 14 October 1851.

[154] Milwaukee Sentinel, 26 November 1851; Milwaukee Sentinel, 23 January 1851; Milwaukee Sentinel, 8 March 1852. An example of the financial discrepancies found is as follows: "The Tabular Statement states that $53,969.46 have been paid out in cash and warrants in 1851. The amount of warrants drawn on the Treasurer during the year was $44,040.74, while the Treasurer reports that he has paid out in cash $12,841.94. In the Tabular Statement there is nothing said about any expenses of the dredge-boat, yet the acting commissioner reports that $5,638.76 was really expended in its operations. Milwaukee Sentinel, 21 February 1852.

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In addition to the investigation, the election of the Whigs had another affect on the waterway and its construction. Morgan Martin was submitting scrip to the state for work completed on the canal, for which land grant money was not available. Once the governor signed the scrip, as Doty contractually agreed to do, it became an encumbrance against the improvement. Governor Farwell, however, a Whig, refused to sign Martin's scrip.[155] In effect, the governor was refusing to pay Martin because he did not agree with Doty's original contract. Martin again explained his proposal, but Farwell maintained that no law existed that could force him to sign the scrip -- so he did not.[156]

In late March, 1852, a legislative effort was made to end the Farwell/Martin face-off that was evolving, as well as to get work on the improvement underway. Specifically, a bill that facilitated completing the Fox-Wisconsin waterway passed the State Senate on 23 March.[157] In the Assembly, the debate quickly focused on the previous contract with Martin. A Mr. Barber argued that the Martin contract should have been passed with at least three-fifths of the members present. It was not, he continued, thus the contract was invalid. Barber also objected to the bill because it required that the sale price of the remaining land grant land be raised from $1.25 to $2.50 per acre. That, he complained, "would extort a usurious payment from the settler, making the purchaser of an eighty acre tract to pay $300.00 and over for it."[158] Others argued in favor of the bill. They noted that the joint committee found no fault with those working on the canal, and that it was important to get the waterway finished. The bill passed the Assembly thirty one to twenty four.[159]

Governor Farwell vetoed the Fox bill for four specific reasons. First, he believed that it called for completion of the facility on credit, since it was to be completed in advance of the remaining land grant sales. Second, he feared that work would proceed regardless of the condition of the land grant fund. The third reason was that the bill pledged waterway revenues to pay for any debt created by its completion that

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[155] Milwaukee Sentinel, 21 February 1852.

[156] Milwaukee Sentinel, 15 March 1852; Milwaukee Sentinel, 1 April 1852.

[157] Milwaukee Sentinel, 24 March 1852.

[158] Milwaukee Sentinel, 6 April 1852.

[159] Milwaukee Sentinel, 6 April 1852.

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could not be paid by the land grant fund. And finally, Farwell feared that completion would create so large a debt against the land grant fund that its land sales could not meet it.[160] Despite the fact that many supported the Governor's veto, it was over ridden. In an editorial lamenting the veto override, it was noted that "the passage of the Fox and Wisconsin Rivers Improvement bill in spite of the Governor's veto will only cost the state some million and a half dollars, but political scheming always costs money and the commercial interest have to suffer where they stand in the way of office seekers."[161]

The Martin/Farwell conflict continued through 1852. In May, Martin sought a "Writ of Mandamus" from the State Supreme Court, with which he hoped to force Farwell to honor the scrip. The "Writ" was served on the Governor in June, but with no apparent success.[162] Finally, by December, the question of whether the scrip constituted a state debt appeared to be resolved by Judge Larabee. He ruled that the certificates issued were not a state debt because "they were to be paid out of the improvement fund." They could not, he said, be paid from any other state fund.[163]

The court ruling notwithstanding, the issue of who should complete the waterway system continued to be argued in 1853. It was finally resolved, but not before another waterway related investigation was requested. The investigation committee, which was constituted by April, was out in the field in May, and issued its report in June.[164]

The report summarized the condition of the project well. Work required at DePere, it noted, totaled $34,922.02.[165] Apparently the work of the original contractor, the one who promised construction at no cost to the state, was inadequate. Work at Rapide

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[160] Milwaukee Sentinel, 14 April 1852.

[161] Milwaukee Sentinel, 30 April 1852; Milwaukee Sentinel, 17 April 1852; Milwaukee Sentinel, 19 April 1852.

[162] Milwaukee Sentinel, 13 May 1852; Milwaukee Sentinel, 4 June 1852.

[163] Milwaukee Sentinel, 11 December 1852.

[164] Milwaukee Sentinel, 6 April 1853; Milwaukee Sentinel, 14 May 1853; Milwaukee Sentinel, 27 May 1853; Milwaukee Sentinel, 25 June, 1853.

[165] Milwaukee Sentinel, 25 June 1853.

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Croche was not thorough, but corrections could be made for about $17,000.00.[166] Facilities at Kaukauna, the report stated, would require about $65,000.00 to complete.[167] The committee observed that work was not completed at Cedars, and estimated that another $14,197.84 was needed at that point.[168] Although the report suggested that $65,000.00 of work remained at Grand Rapids, unlike the other facilities reviewed, it stated that the work there had been done well.[169] The report was critical of the site chosen for the Neenah canal, however,and noted that work was progressing very slowly on the Upper Fox. Finally, the report concluded that there was not enough land grant money available to complete the system. Therefore, it concluded, the state should consider selling the improvement to a bond backed company with the provision that it would be paid with the revenues earned by the waterway.[170]

Actually, the concept of a private company sale was being seriously discussed by May. The editors of the Milwaukee Sentinel liked the idea, and suggested that a company be given a liberal charter that would allow it to regulate toll rates, lease or sell water power, and sell, lease or assign associated land as it saw fit. The paper noted that a convention was to be held in Oshkosh on 25 May, for the purpose of discussing the idea.[171]

The convention was not well attended. Despite the poor turn out, however, two resolutions eventually took shape. One was advocated by the Board of Public Works, and suggested that the state retain the waterway and complete it. The other was advocated by the legislature, which wanted to turn the project over to a private company.[172] This debate was apparent by the editorial positions of the Green Bay Advocate and an Oshkosh paper. The Advocate supported a group of individuals who

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[166] Ibid.

[167] Ibid.

[168] Ibid.

[169] Ibid.

[170] Ibid.

[171] Milwaukee Sentinel, 7 May 1853.

[172] Milwaukee Sentinel, 2 June 1853.

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wanted to take over the improvement and complete it at no cost to the state, while the Oshkosh paper advocated state retention.[173]

The legislature resolved the question in early July, when it passed a bill that incorporated a company to complete the project. The bill gave all rights pertaining to the waterway to the new company, provided that it allow the transport of U.S. troops on the waterway without charge. Among other provisions, the bill specified that the main channel of the river was not to be subject to tolls, that each member of the company had to post a bond with the Secretary of State, that the project had to be completed within three years, that the company must assume all financial liabilities against the state, and that the state be allowed to buy back the facility within twenty years.[174] The officers of the new company were Mason Darling, president, Otto Tank, vice president, Joseph Lawton, secretary, Edgar Conklin, treasurer and J. Kip Anderson, engineer.[175]

Looking forward to a completed project, the people of Appleton greeted the creation of the new Fox River Improvement Company with fireworks and speeches.[176] By July the company had its bonds in place and the waterway in its possession. For the first time since original construction was imminent in 1848, there was a general feeling of satisfaction about the waterway and its chances for success. Despite the debate over private ownership in the 1846/1848 constitutional debate, there seemed to be a sense of relief that the canal was no longer the state's responsibility.[177]

Problems remained for the new Fox and Wisconsin Improvement Company, however, the

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[173] Milwaukee Sentinel, 13 June 1853; Milwaukee Sentinel, 18 June 1853.

[174] Milwaukee Sentinel, 7 July 1853.

[175] Milwaukee Sentinel, 21 July 1853.

[176] Milwaukee Sentinel, 15 July 1853.

[177] Milwaukee Sentinel, 23 July 1853; Milwaukee Sentinel, 30 July 1853; Milwaukee Sentinel, 4 August 1853.

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primary one of which was the ever present need for funding.[178] Fortunately, the company was able to resolve its financial plight, at least temporarily, by securing another land grant. It also sold bonds in the east.

With cash at hand, the Fox and Wisconsin Improvement Company began the task of finishing the waterway. It advertised for 1,000 men in September, 1853, and by October, work had resumed at Cedar Rapids, Kaukauna, Little Chute, Grand Chute and Menasha.[179] In December, 300 men were still working on the improvement, and they anticipated doing so throughout the winter.[180] By the end of the year, the company had spent $24,956.18 on new construction.[181]

Work continued in 1854, as optimism along the waterway grew. The Milwaukee Sentinel noted in May, 1854 that steamboats made daily trips between Green Bay and Kaukauna. The paper also speculated that Green Bay's prosperity would grow significantly as a result of the canal, and that the canal would likely promote settlement along the entire Fox River. Indeed, the paper noted that the City of Green Bay would owe much to the canal and its development.[182] The Fox and Wisconsin Improvement Company itself outfitted a steamer to run from Green Bay to Grand Rapids in the fall of 1854.[183] And at year end, Morgan Martin reported that work on the improvement would be completed in plenty of time for spring navigation. "The improvement," he stated, "will enable boats of 150 or even 160 feet in length...to pass from Lake Michigan to the

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[178] See Samuel Mermin's The Fox-Wisconsin Rivers Improvement: An Historical Study in Legal Institutions and Political Economy (Madison: The University of Wisconsin, 1968) for an excellent discussion about the quest to secure continued funding.

[179] Milwaukee Sentinel 17 September 1853; Milwaukee Sentinel, 10 October 1853.

[180] Milwaukee Sentinel, 17 December 1853.

[181] "Fox & Wisconsin Improvement, Report of the Directors," Milwaukee Sentinel, 8 February 1854.

[182] Milwaukee Sentinel, 16 May 1854; Milwaukee Sentinel, 23 May 1854; Milwaukee Sentinel, 29 May 1854.

[183] Milwaukee Sentinel, 14 July 1854.

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Mississippi, by way of the Fox and Wisconsin Rivers."[184]

Despite Martin's optimism, the improvement was not completed for the 1855 navigation season. Work totalling $166,512.48 had been finished by the Improvement Company through 1854, but work estimated at $32,388.83 remained as the year started -- including 10,000 yards of excavation on the Little Chute canal. Late 1855 predictions were for an 1856 opening.[185]

The inability to achieve through navigation between Green Bay and Lake Winnebago in 1855 notwithstanding, many warehouses were built along the river for that eventuality. One of these warehouses, for example, was built at Fort Howard by the Fox and Wisconsin Improvement Company. It was forty feet by eighty feet, and two stories tall. In conjunction with that warehouse, a four story, fifty foot by eighty foot grain elevator was also being built. The dock for these facilities extended 275 feet into the river, and had 170 feet of river frontage.[186] Another Fort Howard warehouse was four stories high, as well as fifty feet by eighty feet. It had steam elevators, a 275 foot pier, and 500 feet of river front wharf. Indeed, $16,948.05 had been spent on docks, warehouses and barges in the hope that through navigation would be achieved in 1855.[187]

What had been predicted for 1855, finally occurred in 1856. The first steamer successfully navigated the Fox and Wisconsin waterway between the Mississippi River and Green Bay. The steamer was the Aquila, and Alice Smith described the final leg of its journey. "'The event,'" she wrote, "'was celebrated the length of the lower river. At each stop below Lake Winnebago excited citizens climbed aboard, to be met at Green Bay on June 16 with all the pomp and ceremony the little city could muster, followed by a noisy jubilation that lasted far into the night.'"[188] Morgan Martin was

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[184] Milwaukee Sentinel, 10 October 1854.

[185] Milwaukee Sentinel, 17 January 1855; Milwaukee Sentinel, 17 September 1855; Milwaukee Sentinel, 4 December 1855.

[186] Milwaukee Sentinel, 17 May 1855.

[187] Milwaukee Sentinel, 5 January 1855; Milwaukee Sentinel, 13 January 1855.

[188] Mermin, Fox-Wisconsin, 77; Milwaukee Sentinel, 21 June 1856.

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reportedly moved to tears by the event.[189]

But the Aquila's trip did not mean that the success of the waterway was assured. A report prepared for the State Assembly noted that

> 'On the Upper Fox, steamboats have run regularly between Oshkosh and Berlin for several years past. Above Berlin, navigation has hitherto, with the exception of occasional trips as far as Marquette or Montello, been confined to lumbermen from Wolf River, who with their flat boats have reached a point within a mile or two of the locks at Portage, and have taken their lumber through the canal to the Wisconsin, by dividing the freight and thus diminishing the draught of their boats. On the Lower Fox, small steamboats have for more than three years run quite regularly between Green Bay and the foot of the Grand Kaukauna, a distance of twenty miles, when not interrupted by the difficulties at the Little Kaukauna. The Aquila, a steamer drawing about twenty inches when light, and thirty inches with a fair freight, made a few trips during the past season, as we were informed, between Lake Winnebago and Green Bay, with light freight. These trips ceased in July, or early in August, and on the 7th of August all navigation between Green Bay and Lake Winnebago was suspended on account of obstructions in the river and canals. The committee were informed that the Aquila passed with a light freight from the Mississippi River through the Wisconsin and Fox rivers and the Portage canal, to Green Bay, in April or May last. It was during high water, when both rivers were about two feet above ordinary low water.'[190]

Clearly, the waterway would not be successful until navigability could be achieved at ordinary low water.

Accordingly, the Fox and Wisconsin Improvement Company made plans to increase the depth of the waterway. New specifications called for the locks and canals between Lake Winnebago and Green Bay to be enlarged to the point that they could facilitate ships drawing four feet of water. Likewise, facilities on the Upper Fox were to be capable of floating ships drawing three and one half feet of water. In addition, a new lock and dam were to be built at Little Kaukauna Rapids, on the Lower Fox. Contractors retained to start this work included A.E. Cromwell and W.W. Hopkins at

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[189] Mermin, Fox-Wisconsin, 77.

[190] Ibid., 219-220.

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Little Kaukauna, Arthur Resley at Rapide Croche, Henry Hewitt at Menasha, John Richardson and Company at Montello, Nelson McNeal and Company at Fort Winnebago, and George Paddock at Portage City. Estimates for enlarging the system to meet the required depths totalled an additional $198,550.00.[191]

And so the project went for the next nine years. Navigation between Green Bay and Lake Winnebago was set to open on 18 April 1857, if water levels allowed. Although work on the waterway continued, all but construction at Little Kaukauna was halted by the financial Panic of 1857.[192] The waterway continued to open in April each year throughout the balance of the decade,[193] as work enlarging and maintaining the system continued. The Milwaukee Sentinel reported in 1858 that the locks on the Fox are "the largest in the U.S. except those at Sault St. Marie." The paper also stated, with the same optimism displayed for the previous ten years, that boats with 100 tons of freight should soon be able to run from Portage to Green Bay.[194]

Construction on the waterway had generally been continuous since it began in 1848. Although it looked like the improvement was successfully completed when the Aquila navigated the entire system in 1856, it was not. The depth of the waterway, including canals and locks, had to be increased to make it an economically viable system. As well, maintaining the facilities was a constant and costly need. Tolls, unfortunately, did not meet the need adequately. Indeed, tolls could not generate an income of any size until the waterway was large enough to easily facilitate shipping. That constant need for cash, as well as the inability to raise it through tolls, meant that the Fox and Wisconsin Improvement Company had to secure funding from other sources -- usually from eastern financiers. Finally, however, the financial burden became too great, and the company went bankrupt. In 1866, consequently, the eastern bond holders bought the assets of the company at the bankruptcy sale, and reorganized

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[191] Milwaukee Sentinel, 16 October 1856; "Portage City and Its Prospects - The Improvement," Milwaukee Sentinel, 17 November 1856; Milwaukee Sentinel, 9 December 1856.

[192] Milwaukee Sentinel, 30 March 1857; Milwaukee Sentinel, 2 June 1857; Milwaukee Sentinel, 27 October 1857.

[193] Milwaukee Sentinel, 30 March 1858; Milwaukee Sentinel, 12 April 1858; Milwaukee Sentinel, 5 April 1859.

[194] Milwaukee Sentinel, 26 August 1858.

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the waterway improvement as the Green Bay and Mississippi Canal Company.[195]

The federal government retained its interest in the canal throughout this period. After all, it counted on a successfully completed waterway to facilitate troop movements if necessary. Accordingly, Major Charles Sutter arrived in the Lower Fox Valley on 22 September 1866. His orders were to survey the entire system. Sutter surveyed the Lower Fox from 30 September to 16 October, the Upper Fox from 17 October to 23 October, and the Wisconsin River from 30 October to 11 November. What Sutter found on the Lower Fox was a slackwater navigation system capable of handling boats with a three and a half foot draft during periods of low water. He also found new industries developing, especially flour and saw mills at Neenah, Menasha, Appleton and DePere.[196]

Surveying each facility on the river, Sutter found the dam at DePere to be 1,400 feet long and six feet high. He noted that it was in good shape, and was by-passed by a 750 foot canal that contained a 140 foot by thirty five foot lock. Sutter did not like the location of the DePere lock, as well as the depth of the lock-pit. He also noted that the lock was twenty feet shorter than the other locks on the system.[197] Conversely, he found the lock at Little Kaukauna to be in good condition. It was placed in a 1,166 foot canal that by-passed a 550 foot long, six foot high dam. The dam, Sutter observed, leaked badly.[198]

At Rapide Croche, the Major found a "fine stone lock," positioned within an 1,800 foot canal. The dam at that point was 440 feet long and six feet high. It was the only stone dam Sutter found in the system, and had been built recently at a cost of

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[195] Richard N. Current, The History of Wisconsin, Volume 2: The Civil War Era, 1848-1873 (Madison: State Historical Society of Wisconsin, 1976), 203; Fred L. Holmes, ed., Wisconsin: Stability, Progress, Beauty Volume 1 (Chicago: Lewis Publishing Company, 1946), 406; Milwaukee Sentinel, 28 June 1866.

[196] U.S. Congress, Senate, S. Misc. Doc. 16, 39th Congress, 2d session, Serial 1278, 7 February 1867, 4-6.

[197] Ibid., 13.

[198] Ibid.

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$60,000.00.[199] The Kaukauna portion of the system contained a 7,400 foot canal with two passing basins, five locks and a 583 foot long, six foot high dam. Sutter stated that all five locks needed varying degrees of work, and that locks two, three and four also needed at least two new gates.[200]

Moving farther up the river, Sutter studied the 690 foot long, seven foot high dam at Little Chute. That dam was by-passed by a 6,467 foot canal that contained four locks. Locks one, three and four needed varying degrees of maintenance. Lock two needed the same maintenance, as well as two new gates.[201] Facilities at Cedars included a 740 foot long, seven foot high dam that had settled from one to eighteen inches over a 370 foot stretch. A stone lined, 1,200 foot canal carried traffic around the dam, and contained a lock. The lock needed gate repairs and some new wood.[202]

Sutter found two dams and four locks at Appleton. The lower dam was 440 feet long and water tight. The upper dam was 800 feet long and seven feet high. It experienced a little seepage, and 430 feet of it had settled. Locks one, two and three were positioned in a 3,600 foot canal that carried traffic around the upper dam. Each of the three locks required some new planking and two new gates. Appleton lock four, situated in a 1,267 foot canal that passed the lower dam, was in good condition, although it was thought to need one new gate.[203]

Two canals, two locks and two dams comprised the facilities that Sutter studied at Neenah and Menasha. The geography of the Neenah and Menasha area was such that there was a south channel of the Fox, along which Neenah was built, and a north channel, along which Menasha was built. Sutter found the Neenah dam was in poor shape and leaking badly. The companion lock was also in poor shape, needing new planking in places, as well as new gates. The Menasha lock and dam, on the other hand, were found to be in relatively good condition. Sutter noted that the Menasha canal was the only one drawing commercial traffic, and was also the one that could be most readily

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[199] Ibid., 12.

[200] Ibid.

[201] Ibid.

[202] Ibid., 9.

[203] Ibid., 8.

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improved. Sutter concluded his work on the Lower Fox by estimating that the waterway's depth could be increased to accommodate ships with a four foot draft for about $118,400.00. If the system was to be modified to handle ships with a six foot draft, he projected the cost at $493,370.00.[204]

The period during which the Green Bay and Mississippi Canal Company operated the waterway was not a particularly active one. Historian Fred Holmes explained that the Canal Company found little advantage and much expense in owning and maintaining the waterway for navigation. It decided, instead, to develop the waterpower along the river, and sought to turn the navigability concerns over to the federal government.[205] Despite that plan, the company did act on some of Major Sutter's recommendations. The Menasha canal, for instance, was cleared of obstructions to the point that it could maintain a minimum level of four feet -- even during low water.[206] As well, the lock at DePere was rebuilt in 1869.[207]

By 1870 the Green Bay and Mississippi Canal Company had successfully interested the United States government in taking over the waterway and all aspects of achieving and maintaining navigation on it. Accordingly, Congress passed legislation authorizing the purchase of the waterway improvement. The bill empowered the Secretary of War to adopt a plan developed by the Chief of the Bureau of Engineers. It also gave the Secretary three years to establish the amount the Company would be paid for the improvement, and stipulated that no money could be spent on the waterway until the Company agreed to yield all rights and property on the waterway based on that price. The bill also stipulated that all tolls in excess of those needed to maintain and operate the waterway were to go to the United States treasury -- until such time that all previous grants were repaid. After that, tolls would be reduced to meet operation and maintenance costs only.[208]

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[204] Ibid., 7-8, 14.

[205] Holmes, Wisconsin: Stability, 406-407; Mermin, Fox-Wisconsin, 120.

[206] Milwaukee Sentinel, 30 July 1867.

[207] Milwaukee Sentinel, 15 January 1869; Milwaukee Sentinel, 14 December 1869.

[208] Milwaukee Sentinel, 8 July 1870; Annual Report Upon the Improvement of the Harbors on Lake Superior East of Keweenaw Point, and Harbors on the West and South Shores of Lake Michigan, Improvement of the Fox and Wisconsin Rivers, in charge of

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The price finally agreed upon was set by an arbitration board. Briefly, the board set the total value of the waterway, including waterpower rights, at $1,047,000.00. It then reduced that figure by the amount of income generated by land grant sales. That left the award at $324,000.00, after which the government deducted the value of the waterpower along the waterway, estimated at $140,000.00, as well as $40,000.00 for personal property. The final award to the Company, therefore, was $145,000.00.[209] In its 27 September 1872 issue, the Milwaukee Sentinel noted that "purchase of the Green Bay and Mississippi Canal Company by the government has been completed...."[210] The deed for the transfer was recorded on 28 October 1872.[211]

Major D.C. Houston was placed in charge of the waterway, which consisted of twenty two-locks, eleven dams and seven and one half miles of canal, on 25 September 1872.[212] His initial responsibility was to inspect and ascertain the condition of the improvement. As plans for the system were formulated, however, Houston warned that "the character of the improvement should be decided upon, taking into consideration the demands of trade and the question of construction."[213] In other words, he wanted the government to decide if the system was to be used as a through Fox/Wisconsin waterway, or a terminal Fox River waterway.

The survey itself was made by an officer named Edwards. He found the DePere lock to be

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D.C. Houston, Major of Engineers, Bvt. Colonel, U.S.A.; Being Appendix B of the Annual Report of the Chief of Engineers for 1873 (Washington, D.C.: Government Printing Office, 1873), 37-38.

[209] Milwaukee Sentinel, 6 December 1871; Mermin, Fox-Wisconsin, 131. Note that a full account of the arbitration process can be found in Mermin.

[210] Milwaukee Sentinel, 27 September 1872.

[211] Milwaukee Sentinel, 28 October 1872.

[212] Annual Report (Houston, 1873), 32-33; Annual Report Upon the Improvement of the Harbors of Milwaukee, Racine, Kenosha, and Waukegan, Lake Michigan and Improvement of the Fox and Wisconsin Rivers in Charge of D.C. Houston, Major of Engineers, Bvt. Colonel, U.S.A.; Being Appendix FF of the Annual Report of the Chief of Engineers for 1881 (Washington, D.C.: Government Printing Office, 1881), 2131.

[213] Annual Report (Houston, 1873), 32-33.

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163 feet long, and the dam to be in decent shape. He anticipated further improvements at that point as attempts to develop the waterpower were made.[214] At Little Kaukauna, Edwards reported that the lock needed new plank lining. He also reported that the dam, which had been partially washed out in 1869, had been rebuilt and was "greatly strengthened."[215]

The lock at Rapide Croche was described as "a fine piece of work, being of cut-stone masonry," but the dam, while maintaining a good level, needed reinforcement and more gravel.[216] Edwards recommended that the dam at Kaukauna be rebuilt of stone, which, he noted, was very conveniently located. He also observed that the five Kaukauna locks had received some repairs since 1866, but that they required additional work to be put in optimal operating condition.[217]

There were four locks at Little Chute, two of which created the combined locks. The combined locks were found to be in very poor condition, indeed, condition so poor that Edwards believed they should be totally rebuilt. Again, Edwards noted that a stone supply was conveniently nearby and recommended that the rebuilt locks utilize that material. The Little Chute dam, he reported, could be put in good order with some repair work and more gravel. However, Edwards indicated that the dam could not hold another foot of head. If additional head was needed, he proposed that a new stone dam be built.[218]

The Cedars lock and dam appeared to be in good shape, although Edwards did not believe that the dam could withstand any increase in head.[219] But the facilities at Appleton were not in good condition. The upper dam "required a continual expense each season in graveling" to keep it tight. Additionally, locks one, three and four needed

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[214] U.S. Congress, House, H. Exec. Doc. 111, 42nd Congress, 3d Session, Serial 1566, 2 January 1873, 4.

[215] Ibid., 4.

[216] Ibid., 4.

[217] Ibid., 4-5.

[218] Ibid., 5.

[219] Ibid., 6.

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replanking below the water line, and lock two needed replacing since its south was being undermined. It was "unsightly and liable to fail."[220] Finally, Edwards noted that the Menasha lock had been repaired since 1866, and that the canal had been deepened and widened.[221]

In his 1873 report, Major Houston discussed the future of the Fox-Wisconsin waterway system. He noted that the locks of the system measured 160 feet by thirty five feet, "adapted as it [the entire system] is to the use of steam alone,...."[222] Houston continued that

> There is no public work more national in its character than this. By it the products of the northwest will find cheap transportation to the sea-board, and the lumber and iron of the north to the Mississippi Valley. One great problem of the day is to secure cheap transportation for these indispensable and bulky commodities; and while no one route will meet the demands of the country, there is no other route which will meet the necessities of so large

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[220] Ibid., 6.

[221] Ibid., 7.

[222] Annual Report (Houston, 1873), 46. Interestingly, Houston observed that "the width of locks depends upon the character of the navigation to be obtained." He then proceeded to compare the dimensions of the Fox locks to the locks in other systems around the country. He used the following examples: Abemarle & Chesapeake - 220 feet by forty feet; Chesapeake & Delaware - 220 feet by twenty four feet; Champlain - 110 feet by eighteen feet; Cayuga & Seneca - 110 feet by eighteen feet; Delaware & Raritan -220 feet by twenty four feet; Dismal Swamp - ninety feet by seventeen and a half feet; Erie Canal - 110 feet by eighteen feet; Falls of the Ohio, Kentucky - 350 feet by 80 feet; Oneida -ninety feet by fifteen feet; Oneida Improvement - 120 feet by thirty and one half feet; Oswego Canal - 110 feet by eighteen feet; Welland Canal - 150 feet by twenty six and one half feet; the Black River, Crooked lake, Chenango, Chemung, and Genesee Valley canals, all ninety feet by fifteen feet. Annual Report (Houston, 1873), 34. It can be clearly deduced from these comparisons that all canals with locks of 110 feet by eighteen feet or smaller were designed for tow boats. It is equally clear that the Fox River locks, even at their original length of 140 feet, were designed for steamboats. What is unclear, however, is if the balance of the locks larger than the 110 feet by eighteen feet were designed specifically for steam, or if they were subsequently modified to accommodate it.

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a section of the United States at so small an expense as this.[223]

Accordingly, the report included a five point plan to revitalize the Fox-Wisconsin waterway. First, all facilities on the Lower Fox would be repaired as needed to keep the system navigable. Second, the government would build whatever locks and dams were necessary on the Upper Fox to make it navigable. [This point was tantamount to admitting that dredging on the Upper Fox never actually accomplished the purpose intended.] Third, all canals would be dredged as needed. Fourth, the Wisconsin River would be improved by constricting its channel. And fifth, all extant locks and dams would be replaced with permanent fixtures comprised of masonry, or in the case of the dams, either of masonry or crib-work filled with stone.[224]

And so it was that the Lower Fox River infrastructure that survives today came to pass. The United States immediately began replacing the weakest facilities on the Lower Fox. By 1880, for instance, the locks at Appleton two, Combined Locks (Little Chute three and four), and Kaukauna three and four had been rebuilt.[225] These locks

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[223] Annual Report (Houston, 1873), 34.

[224] Ibid., 7; U.S. Congress, House, H. Doc. 146, 67th Congress, 2d session, Serial 80005, 31 December 1921, 18; Annual Report (Houston, 1881), vi-vii.

[225] Annual Report (Houston, 1873), 39; Annual Report Upon the Improvement of the Harbors on the West and South Shores of Lake Michigan, Improvement of the Fox and Wisconsin Rivers, in Charge of D.C. Houston, Major of Engineers, Bvt. Colonel, U.S.A.; Being Appendix B of the Annual Report of the Chief of Engineers for 1874 (Washington, D.C.: General Printing Office, 1874), 36; Annual Report Upon the Improvement of the Harbors of Milwaukee, Racine, and Kenosha, Lake Michigan, Improvement of the Fox and Wisconsin Rivers, and Harbors, in charge of D.C. Houston, Major of Engineers, Bvt. Colonel, U.S.A.; Being Appendix C of the Annual Report of the Chief of Engineers for 1875 (Washington, D.C.: General Printing Office, 1875), 14; Annual Report Upon the Improvement of the Harbors of Milwaukee, Racine, and Kenosha, Lake Michigan, and Improvement of the Fox and Wisconsin Rivers, in charge of D.C. Houston, Major of Engineers, Bvt. Colonel, U.S.A.; Being Appendix X of the Annual Report of the Chief of Engineers for 1876 (Washington, D.C.; General Printing Office, 1876), 33-34; Annual Report Upon the Improvement of the Harbors of Milwaukee, Racine, and Kenosha, Lake Michigan, and Improvement of the Fox and Wisconsin Rivers, in charge of D.C. Houston, Major of Engineers, Bvt. Colonel, U.S.A.; Being Appendix Z of the Annual Report of the Chief of Engineers for 1877 (Washington, D.C.; General Printing Office, 1877), 883-

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were permanent structures built of quarried stone blocks.

Of course maintenance, and in some cases substantial work, was performed on all structures, whether they were slated for immediate rebuilding or not. The government rebuilt Appleton one, Cedars, Little Chute one, Little Chute two and Kaukauna one between 1880 and 1890.[226] Kaukauna one is a good example of the effort and technique required for rebuilding the locks.

> Navigation through the lock was suspended on 19 October 1881, and the water drawn off from the levels. A coffer-dam above the head of the lock was

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884; Annual Report Upon the Improvement of the Harbors of Milwaukee, Racine, and Kenosha, Lake Michigan, and Improvement of the Fox and Wisconsin Rivers, in charge of D.C. Houston, Major of Engineers, Bvt. Colonel, U.S.A.; Being Appendix AA of the Annual Report of the Chief of Engineers for 1878 (Washington, D.C.; General Printing Office, 1878), 1179-1180.

[226] Annual Report Upon the Improvement of the Harbors of Milwaukee, Racine, Kenosha, and Waukegan, Lake Michigan, and Improvement of the Fox and Wisconsin Rivers, in charge of D.C. Houston, Major of Engineers, Bvt. Colonel, U.S.A.; Being Appendix DD of the Annual Report of the Chief of Engineers for 1880 (Washington, D.C.: General Printing Office, 1880), 1970-1971; Annual Report Upon the Improvement of the Harbors of Milwaukee, Racine, Kenosha, and Waukegan, Lake Michigan, and Improvement of the Fox and Wisconsin Rivers, in charge of D.C. Houston, Major of Engineers, Bvt. Colonel, U.S.A.; Being Appendix EE of the Annual Report of the Chief of Engineers for 1882 (Washington, D.C.: General Printing Office, 1882), 2180; Annual Report Upon the Improvement of the Harbors of Milwaukee, Racine, Kenosha, and Waukegan, Lake Michigan, and Improvement of the Fox and Wisconsin Rivers, in charge of D.C. Houston, Major of Engineers, Bvt. Colonel, U.S.A.; Being Appendix GG of the Annual Report of the Chief of Engineers for 1884 (Washington, D.C.: General Printing Office, 1884), 1877; Annual Report Upon the Construction of Harbor of Refuge, Milwaukee Bay; Improvement of the Harbors of Milwaukee, Racine, Kenosha and Waukegan; and Improvement of Fox and Wisconsin Rivers, in charge of W.L. Marshall, Captain of Engineers, U.S.A.; being Appendix II of the Annual Report of the Chief of Engineers for 1885 (Washington, D.C.: Government Printing Office, 1885), 2036; Annual Report Upon the Construction of Harbor of Refuge, Milwaukee Bay; Improvement of the Harbors of Milwaukee, Racine, Kenosha and Waukegan; and Improvement of Fox and Wisconsin Rivers, in charge of W.L. Marshall, Captain of Engineers, U.S.A.; being Appendix HH of the Annual Report of the Chief of Engineers for 1887 (Washington, D.C.: Government Printing Office, 1887), 2086.

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> built, and the old lock taken out, requiring the removal of 2,300 cubic yards of clay and 3,328 cubic yards of stone; 250 cubic yards of rock were excavated for foundations, and the foundations to the south wall laid up to the level of the lower miter sill....The walls were laid up to level of bottom of coping and pointed, and the lock, except the coping, completed.[227]

Boats again passed through the lock on 5 June 1882. Rebuilding this lock used 745 yards of dressed stone, 1,643 cubic yards of backing stone and 610 yards of rubble stone foundation, all set in mortar. 327 cubic yards of dry stone were laid in the upper and lower wings. All of the dressed stone and about one half of the backing stone came from Kaukauna quarry. Further, the project used 2,175 barrels of cement; 762 cubic yards of sand; 5,298 pounds of bar iron; 408 pounds of steel; 218 pounds of bolts, nuts and washers; 5,931 pounds of iron valves; 256 pounds of miter-sill castings; 1,055 pounds of nails; 600 pounds of spikes; and thirty nine pounds of lead.[228]

Appleton three was likely rebuilt sometime in the 1890s.[229] Kaukauna two was rebuilt in 1903 and Appleton four in 1907.[230] Three other locks, Rapide Croche, Little Kaukauna and DePere were all rebuilt between 1931 and 1939. Significantly, these were the first locks to be constructed from reinforced concrete. Following the precedent set on the Hennepin Canal in Illinois, although somewhat belatedly, the government

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[227] Annual Report, (Houston, 1882), 2180.

[228] Ibid.

[229] No Corps of Engineers reports were located for the 1890-1900 period. Appleton three, however, is the only lock for which a reconstruction date can not be confirmed within the reports reviewed. It is logical to assume, therefore, that Appleton three was rebuilt between 1890 and 1900.

[230] Annual Report Upon the Improvement of Rivers and Harbors on the Western shore of Lake Michigan, In Charge of J.G. Warren, Major, Corps of Engineers, U.S.A.; Being Appendix LL of the Annual Report of the Chief of Engineers for 1903 (Washington, D.C.: Government Printing Office, 1903), 1873-1874; Annual Report of the Chief of Engineers, U.S. Army, 1907 Part III (Washington, D.C.: Government Printing Office, 1907), 1911.

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finally abandoned the cut-stone method of canal construction on the system.[231] Of the two remaining locks, Menasha was finally rebuilt in the early 1970s, and Kaukauna five was never rebuilt, although it received substantial repairs over time.

Since the Lower Fox utilized a slack water navigation system, dams were needed to create the pools that reached from dam to dam, and flooded the canals and locks. The early dams along the waterway were largely brush and stone dams. They were replaced by crib dams. When the government acquired the system in 1872, it started to rebuild several of the dams from stone. By the late 1920s, however, the dams along the system were unable to meet the needs placed upon them. Accordingly, the government embarked on a program to completely rebuild the dams from concrete between 1924 and 1941. The pile and timber dam at Little Kaukauna was replaced, and construction of the new dam

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[231] Annual Report of the Chief of Engineers, 1931: Extract - Report Upon the Improvements of Rivers and Harbors in the Milwaukee, Wis., District (Washington, D.C.: Government Printing Office, 1931), 1470-1471; Annual Report of the Chief of Engineers, 1932: Extract - Report Upon the Improvements of Rivers and Harbors in the Milwaukee, Wis., District (Washington, D.C.: Government Printing Office, 1932), 1375; Annual Report of the Chief of Engineers, 1933: Extract - Report Upon the Improvements of Rivers and Harbors in the Milwaukee, Wis., District (Washington, D.C.: Government Printing Office, 1933), 877; Annual Report of the Chief of Engineers, 1934: Extract - Report Upon the Improvements of Rivers and Harbors in the Milwaukee, Wis., District (Washington, D.C.: Government Printing Office, 1935), 1041, 1042; Annual Report of the Chief of Engineers, 1935: Extract - Report Upon the Improvements of Rivers and Harbors in the Milwaukee, Wis., District (Washington, D.C.: Government Printing Office, 1936), 1184; Annual Report of the Chief of Engineers, 1936: Extract - Report Upon the Improvements of Rivers and Harbors in the Milwaukee, Wis., District (Washington, D.C.: Government Printing Office, 1937), 1189, 1190; Annual Report of the Chief of Engineers, 1937: Extract - Report Upon the Improvements of Rivers and Harbors in the Milwaukee, Wis., District (Washington, D.C.: Government Printing Office, 1938), 1192; Annual Report of the Chief of Engineers, 1938: Extract - Report Upon the Improvements of Rivers and Harbors in the Milwaukee, Wis., District (Washington, D.C.: Government Printing Office, 1938), 1438; Annual Report of the Chief of Engineers, 1939: Extract - Report Upon the Improvements of Rivers and Harbors in the Milwaukee, Wis., District (Washington, D.C.: Government Printing Office, 1940), 1582.

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completed in 1927.[232] The new dam at DePere was completed in 1930.[233] And on up the river construction progressed. Rapide Croche was completed in 1931, Kaukauna in 1932, Little Chute in 1933, Cedars in 1934, Lower Appleton in 1935, Menasha in 1937 and Upper Appleton in 1941.[234]

Rebuilding and maintaining the facilities on the waterway was costly. The government explained, however, that it undertook the project "to provide reliable water transportation between the Mississippi and the lakes, by which the transportation of bulky products can be cheapened...."[235] This statement indicates that the government resolved Major Houston's 1873 question. The system was to be used as a through waterway -- not a terminal Fox River route.

The government attempted to improve the Wisconsin River for thirteen years. During that period, it spent almost $600,000.00, generally for the construction of wing dams that were designed to constrict the river's flow and thus improve navigability. But the Wisconsin, by its changeable and unstable nature, stymied all attempts to utilize it for regular navigation. The elusive dream of through navigation ended in 1886 when

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[232] Annual Report of the Chief of Engineers, 1927: Extract - Report Upon the Improvements of Rivers and Harbors in the Milwaukee, Wis., District (Washington, D.C.: Government Printing Office, 1927), 1299.

[233] Annual Report of the Chief of Engineers, 1930: Extract - Report Upon the Improvements of Rivers and Harbors in the Milwaukee, Wis., District (Washington, D.C.: Government Printing Office, 1930), 1451.

[234] Annual Report of the Chief of Engineers, 1931, 1469; Annual Report of the Chief of Engineers, 1932, 1373; Annual Report of the Chief of Engineers, 1933, 877; Annual Report of the Chief of Engineers, 1934, 1041; Annual Report of the Chief of Engineers, 1935, 1184; Annual Report of the Chief of Engineers, 1937, 1192; Annual Report of the Chief of Engineers, 1941: Extract - Report Upon the Improvement of Rivers and Harbors in the Milwaukee, Wis., District (Washington, D.C.: Government Printing Office, 1941), 1546.

[235] Annual Report Upon the Improvement of the Harbors of Milwaukee, Racine, and Kenosha, Lake Michigan, and Improvement of the Fox and Wisconsin Rivers, in charge of D.C. Houston, Major of Engineers, Bvt. Colonel, U.S.A.; Being Appendix DD of the Annual Report of the Chief of Engineers for 1879 (Washington, D.C.: Government Printing Office, 1879), 1532.

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the federal government decided that "no more money [should] be expended upon dikes and wing dams in the bed of the Wisconsin River."[236]

Despite abandoning the Wisconsin River and the concept of through navigation, as well as the fact that it carried only a small portion of the Fox Cities' commerce, operation of the Fox River system continued. By 1901, 309,800 tons of freight were being shipped on the Fox annually. The most commonly transported materials included bricks, coal, cordwood, stone, hay, logs, pulp wood and sand.[237] Tonnage dropped to 263,719 in 1902, and raised only slightly to 265,297 in 1903. By 1904, however, it was back at the 300,000 ton level. The most heavily used commercial routes in this period were those between Green Bay and Oshkosh, and Oshkosh and Berlin.[238]

Tonnage on the Fox River dropped dramatically between 1904 and 1918. It fell from 300,000 tons in 1904, to 215,199 in 1909, and 134,638 in 1913. One reason for this precipitous drop was that fewer and fewer saw logs were being shipped on the system. Freight shipment began a slow recovery in 1914, however, and was back up to 165,936

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[236] Holmes, Wisconsin: Stability, 408; H. Doc. 146, 18.

[237] Specific materials shipped on the Fox in 1901, and the tonnage of each are as follows: Apples - 75; Beer - 56; Brick - 10,026; Carriages - 6; cedar posts - 322; cement - 16; coal - 17,399; cordwood - 22,218; shingles - 638; stone - 2,043; drain tile - 50; flour, feed and grain - 2,099; general merchandise - 1,535; hay - 2,497; land plaster - 80; lath - 81; lime - 302; logs - 212,743; shingle bolts - 120; rags - 62; lumber - 10,240; kerosene - 37; paper - 82; pig iron - 45; pulpwood - 12,860; salt - 705; sand - 12,600; sewer pipe - 800; slab wood - 60.

[238] Annual Report Upon the Improvement of Rivers and Harbors on the Western Shore of Lake Michigan, In the Charge of J.G. Warren, Major, Corps of Engineers, U.S.A.; being Appendix JJ of the Annual Report of the Chief of Engineers for 1902 (Washington, D.C.: Government Printing Office, 1902), 2079; Annual Report Upon the Improvement of Rivers and Harbors on the Western Shore of Lake Michigan, In the Charge of J.G. Warren, Major, Corps of Engineers, U.S.A.; being Appendix LL of the Annual Report of the Chief of Engineers for 1903 (Washington, D.C.: Government Printing Office, 1903), 1868; Annual Report Upon the Improvement of Rivers and Harbors on the Western Shore of Lake Michigan, In the Charge of J.G. Warren, Major, Corps of Engineers, U.S.A.; being Appendix JJ of the Annual Report of the Chief of Engineers for 1904 (Washington, D.C.: Government Printing Office, 1904), 2849.

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tons in 1918.[239]

The primary commodities shipped on the waterway during this period remained coal, bricks, sand and gravel, grain and flour, lumber and sugarbeets. The traffic patterns on the system were such that forty five percent of the coal unloaded at Green Bay and destined for inland delivery went to Oshkosh, thirty percent went to Kaukauna, and nineteen percent went to Appleton. On the other hand, of all the grain and flour produced along the system, only thirty five percent went from Lake Winnebago harbors to Green Bay. The balance went to Fond du Lac for shipment to market by rail.[240]

By 1921, tonnage on the system had grown back to 285,590, thanks in part to the twenty vessels regularly plying the river. Eight of those boats were sternwheelers, seventy five to 146 feet long, thirteen to thirty one feet wide and with three and one half feet to six foot drafts, that were capable of hauling both freight and passengers. Four of the vessels were tugs that were fifty six to sixty five feet long, twelve feet wide and with five to six foot drafts. The remaining nine vessels were barges that were sixty to 139 feet long, twenty one to twenty six feet wide, and had three foot nine inch to five foot six inch drafts.[241]

Shipping on the Fox River returned to the 300,000 tons per year level in 1923, and remained there through the balance of the decade. Significantly, however, virtually all traffic was local. The average haul in 1932 was only thirty three miles. Also, the material hauled centered on coal and sand. Of the 325,658 tons shipped on the waterway in 1930, for instance, coal and sand comprised 315,000 tons of it.[242]

Despite the fact that shipping on the Fox rebounded in the 1930s, it never grew significantly beyond the 325,000 ton per year mark -- the level it reached at the turn of the century. When those tonnage figures are reviewed in the context of the industry that grew along the Fox in the first half of the twentieth century, it is clear that shippers were using the Fox less and less -- and that occurred despite the

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[239] H. Doc. 146, 23; U.S. Congress, House, H. Doc. 212, 72nd Congress, 1st session, Serial 9564, 6 January 1932, 12.

[240] H. Doc., 146, 22.

[241] H. Doc. 212, 12; H. Doc. 146, 22.

[242] H. Doc. 146, 20, 42; H. Doc. 212, 12-13.

fact that the rate on the river was sixty three cents per ton versus one dollar and thirty seven cents per ton by the railroad.[243]

It is apparent that the Fox and Wisconsin waterway was not successful. Its lack of success is characterized by two signal events. First, the concept of through transportation was discarded when the Wisconsin River portion of the system was abandoned in 1886. And second, the system, which finally had a well constructed and maintained infrastructure by about 1905, never saw its traffic increase appreciably in the first thirty years of the decade -- a period in which industry was growing rapidly along the river.

There were several reasons for the failure of the Fox and Wisconsin waterway in general, and the Fox in particular. Two problems were climate related. The system was frozen during the winter, a fact which did not significantly interfere with the shipping of agricultural items, which was done seasonally, but made it difficult to promote business with industries which had year round transportation needs.[244] In addition, evaporation from the system exceeded the flow into Lake Winnebago in dry years. That factor, along with leakage through the dams, dropped the water level beyond that which would accommodate navigation in many instances.[245]

Perhaps the most significant factor affecting the failure of the Fox was competition from the railroad. When the Fox and Wisconsin waterway was conceived, railroads were not foreseen as a factor with which to be dealt. Unfortunately, it took about fifty years to create the type of infrastructure that the canal needed to be a reliable source of transportation. And during that fifty year period the railroad became a significant factor in the transportation industry. The railroad, as a result, was a well established competitor with many advantages by the time the canal was fully developed with permanent facilities. Railroads, for instance, were faster than the boats on the river. Their lines also grew, thus facilitating freight movement with fewer cargo transfers. In addition railroads had the ability to drop their rates during transportation season, thereby assuring their ability to keep traffic that they obtained when the river was frozen away from the canal carriers when navigation was open. And finally, railroads could provide amenities, side tracks or spurs for

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[243] H. Doc. 146, 42.

[244] Holmes, Wisconsin: Stability, 406-407.

[245] H. Doc. 146, 25.

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instance, to their shippers much more readily than the canal operators could.

Shipping on the canal continued to decline over the years. The Upper Fox was deauthorized in 1958 and transferred to the State of Wisconsin in 1952. Indeed, 1959 was the last year that regular commercial service (a coal barge) was offered on the Lower Fox. With its demise, the waterway has been used exclusively by recreational boaters. The Corps of Engineers, however, continued to operate the system through the early 1980s, when it was put into caretaker status.

Despite the waterway's inability to achieve economic success and viability, it remains today an interesting chapter in the history of economic development and internal improvements in Wisconsin. More significantly, however, the facilities on the Lower Fox remain a complete, hand operated lock and canal system. It is a system that embodies the three major types of lock construction, composite, cut stone and reinforced concrete. It is a system that utilizes flooding and discharging technology that was developed in the nineteenth century, and remains well suited to the system and its use today. The Lower Fox River locks and canals create a system that makes a significant contribution to Wisconsin's historic landscape, both for what it attempted to be, a means to facilitate economic development, and for what it is today, a unique technological artifact.

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INTRODUCTION:

The Lower Fox River Waterway extends from Menasha, on Lake Winnebago, to Green Bay, a length of thirty-seven miles. The waterway includes nineteen locks placed as follows: one at Menasha, four at Appleton, one at Cedars, four at Little Chute - one of which is a guard lock, six locks at Kaukauna - one of which is a guard lock, one at Rapide Croche, one at Little Kaukauna and one at DePere. Generally speaking, there are five types of structures in the corridor that are associated with the waterway. They are the locks themselves, dams, canal segments, lockkeepers' houses and lock shacks. The system does not derive its significance so much from its role in developing Wisconsin transportation facilities, as much as it does as a unique technological artifact. The canal was clearly designed to facilitate the passage of steamboats in an era when tow-path canals were still being built. In addition, the waterway contains examples of each of the major methods of lock construction experienced in the United States. It is Wisconsin's only such example.

It should be noted that all the resources associated with this theme are currently under consideration. As a result, no future additions will be made to this nomination. Please note further that a separate National Register nomination is being prepared for the Upper Fox River.

I. NAME OF PROPERTY TYPE: LOCKS [1850-1940]

II. DESCRIPTION:

There are three types of locks on the Lower Fox River Waterway: composite, quarried stone, and concrete. Each one represents a specific stage in the evolution of locks in the United States. The eligible locks on the Lower Fox were built between 1850 and 1935. Their chambers are from thirty-five feet to thirty-six feet by 144 feet to 146 feet. The lift on the system varies from between 7.2 feet to 13.6 feet per lock.

Quarried stone locks are the most prominent in the Lower Fox system. They are found at Appleton 1, 2, 3, & 4, Cedars, Little Chute 2, Combined Locks (Little Chute 3 & 4), Kaukauna Guard, and Kaukauna 1, 2, 3 & 4. These locks were generally built to replace composite/rubble stone locks, and have chambers constructed of quarried stone blocks, the sides of which are capped with quarried stone coping, or concrete, and a pipe railing. Each one of the lock's four gates is constructed of squared wooden timbers

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that are laid horizontally atop one another. Adjacent to each gate is a concrete platform that contains a tripod. A vertical shaft extends the height of the tripod. A handle is fixed to the top of the shaft, while the bottom of the shaft contains a gear that drives a horizontally placed spar, the end of which is attached to a lock gate. (It is a horizontal rack and pinion system.) Depending on which way the handle is turned, the spar is either taken in, thus opening the lock gate, or it is pushed out, in which case the gate closes. The chambers are flooded by four butterfly valves that are either set in the floor of the lock or in the bottom of the lock wall, immediately upstream from the structure. As the valves are opened, water passes down into a culvert with a 90 degree turn, which then directs it under the upstream sill and straight into the chamber. Each valve is adjusted by a geared mechanism that sits on the lock's coping. A metal shaft connects the valve to the adjusting mechanism, all four of which are placed in line adjacent to the northwest corner of the lock. The chamber is discharged through six small butterfly valves found at the bottom of the two downstream gates. There are three valves per gate. These valves are operated by the levers atop each gate. The gates contain a cat-walk that facilitates moving from one side of the lock to the other.

Composite locks were among the earliest used in United States canal construction. Dry rubble stones provide the structural basis for this type of lock. The stones are then covered with planks, which form the lining of the lock. In addition to sealing the lock in a fashion, the planks protect a boat's hull from any sharp edges the stones might have. The gates, valve arrangement and operating mechanism on this lock are all the same as those found on the quarried stone locks. In the Lower Fox system, the Kaukauna guard lock and the lock at Kaukauna 5 are composite structures.

Concrete locks are of the type that was pioneered in the United States at the Hennepin Canal in Illinois. These structures are very simple in that the entire facility is built of reinforced concrete, except, of course, the gates. There are four concrete locks on the Lower Fox system. They are located at Rapid Croche, Little Kaukauna, DePere and Menasha. (Note that the Menasha lock was constructed in 1970. It is not, therefore, eligible for the Register.) Each one of these locks has four, one piece, steel gates. Beyond that, the design and operating mechanism are the same as described for the quarried stone locks.

III. SIGNIFICANCE:

The locks on this system are significant because they are unique technological

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artifacts. The Lower Fox Waterway is a surprisingly thorough system since it contains an example of each type of lock construction method used in the United States -- those are composite, quarried stone, and concrete. The construction technology represented in this system, therefore, covers a period generally from 1830 to 1900. In addition, the chamber flooding and discharging mechanisms represent a mid-to late-nineteenth century technology (a technology that dates to the system's reconstruction which started when the federal government acquired ownership in 1872). And the entire system remains functional today. The locks are significant, consequently, as unique technological artifacts. They are the only such example in Wisconsin.

IV. REGISTRATION REQUIREMENTS:

A lock is eligible for Registration if it retains its integrity of location, building materials and design, and was built between 1850 and 1940. Each lock in the system exists today in the same location in which it was built, and is situated in an operable canal that has evolved since construction began on it in the early 1850s. Although gates have been replaced, and other forms of maintenance performed, the building materials are all original, especially in the quarried stone locks and concrete locks. The timber planking in Kaukauna 5 has been replaced numerous times, but that impact is substantially diminished because it is a representative example of a very early method of lock construction. The design of these locks is inherently simple, and has not been altered. The chambers are flooded through the same upriver valves they were when constructed, and they are discharged through the same downriver butterfly valves found in the gates. Their registration eligibility is further enhanced by being part of a complete, operable waterway system.

Because all locks along the lower Fox waterway are being considered for eligibility as part of this nomination, registration requirements for additional listings are not relevant. That fact notwithstanding, the greatest potential threat to the future eligibility of these locks comes from the need to replace gates. To date, that has not been a significant problem because gates have always been replaced in kind -- that is a wooden gate for a wooden gate. As long as that procedure is followed, gate replacement in the future should not adversely affect a lock's eligibility because it retains the integrity of building materials. The potential for trouble, however, exists if wooden gates on quarried stone locks are replaced with steel. As far as integrity of building materials are concerned, steel gates and quarried stone locks are not compatible. That problem could be ameliorated if new steel gates included a wooden veneer. Steel gates on the three concrete locks built in the 1930s (Little

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Kaukauna, Rapide Croche and De Pere) are fully compatible. Those were the types of gates, after all, with which the locks were built.

Because it does not meet the 50 year rule, the Menasha lock, which is a concrete lock that was re-built in the 1970s, is not eligible for registration.

I. NAME OF PROPERTY TYPE: DAMS [1924-1941]

II. DESCRIPTION:

The United States Government dams on the Lower Fox River Waterway were all built between 1927 and 1940. They are generally thought to have replaced quarried stone dams. All are placed in the main channel of the Lower Fox, and they are either anchored directly to the stone bottom of the river or to piles driven into the riverbed. [Please note that there are also some private/industry dams on the river. Those dams were in no way involved with developing the canal and waterway system.]

The U.S. dams are concrete structures, the overall length of which varies between 400 feet and 961 feet, although most are in the 500 to 600 foot range. They are generally built adjacent to a lock, or a canal segment with a series of locks. Each dam has at least two sections, a spillway that fixes the height of the dam and over which water flows, and the sluiceway, that portion of the dam that contains the gates. (Some dams have two spillway sections, one on either side of the sluiceway.) The gates on these structures are Tainter gates which are operated by a small, electrically operated mechanism that moves from gate to gate on a track. The "crab," as it is known, contains a wench to which the chain on each end of the gate is attached. As the wench is activated, the chain is taken in or let out, and the height of the gate is adjusted accordingly. A steel catwalk, which facilitates inspections and maintenance, extends the length of the dam.

Placed atop the dam is a single story front gabled shed that was erected to shelter the electric "crab." Spanning the abutments adjacent to the first gate, the lift house is reached by the catwalk. It is clad with drop siding, roofed with asphalt shingles, and has walls bounded with pilaster strips. The single window in each side wall and the panelled door at the right of the lockside endwall have simple surrounds. A pair of heavy wooden doors in the opposite endwall swing out to allow passage of the "crab" to whichever gate must be adjusted.

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III. SIGNIFICANCE:

The dams are significant components within the waterway system. They were responsible for creating the slackwater pools upon which boat traffic navigated between locks, as well as for flooding the canals themselves in which the locks are placed. Without them, the navigable waterway could not exist.

IV. REGISTRATION REQUIREMENTS:

The dams retain their integrity of location, building materials and design. There is nothing technologically unique about these dams, indeed they are almost generic type structures. They do, nevertheless, meet the fifty year rule, have not been altered since their construction, and do play a vital part in the navigation function of the waterway.

Because all United States dams on the waterway are eligible for listing, registration requirements, as the pertain to additional listings, are not pertinent. Registration requirements are a factor, however, as one looks at the possibility of modifying or reconstructing the present dams. Would they retain their eligibility after alteration? Providing that an alteration had little visible impact on a dam, eligibility should be retained. If, however, Tainter gates, a major structural and visible element of the dams, were to be replaced by slide gates -- that would have a major impact on the dam's visual and design integrity. After such work a dam would likely not be eligible for registration. Another example, however, is the "lift house" that is found on each dam. It shelters the electric "crab" that used to raise and lower a dam's gates. When the dams were built, these components were small frame buildings sheathed with drop siding. Because these structures are such a small element of the dam as a whole, their replacement, even if they are metal, should have no significant impact on a dam's overall integrity. They would not, therefore, affect a dam's eligibility for the register.

* The Rapide Croche dam was altered in the late 1980s with the addition of a "sea lamprey barrier."

I. PROPERTY TYPE: CANAL [1850-1941]

II. DESCRIPTION:

There are approximately five and one half miles of canal in the Lower Fox Waterway

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system. The canal is nothing more than an excavated ditch. Its depth does not exceed six feet, and its width varies between 100 and 125 feet across the top. There are no special embankment features along the canal, which has been dredged periodically throughout its history.

III. SIGNIFICANCE:

There is nothing technologically significant about the canals. They are, nevertheless, a vital component within the waterway navigation system in that they facilitate movement around the dams, the rapids and other hazards on the system. It is for that role within the overall operation of the system, for which the canals are significant.

IV. REGISTRATION REQUIREMENTS:

The canals are a feature of the historic landscape that contain no quantifiable components. In the sense that they are an identifiable entity, however, they retain their integrity of location and design. Because they retain that integrity, as well as the fact that they are a significant operational component within the waterway system, they meet the requirements for National Register Registration.

Lacking identifiable components, it is difficult to define specific registration requirements for canals. Any canal segment, however, that has generally retained its historic dimensions would likely retain its eligibility. That would exclude any segment that was enlarged after 1941. Similarly, if a canal segment that did retain its historical dimensions was dramatically altered, lined with concrete for instance, it would not be eligible for the register.

I. NAME OF PROPERTY TYPE: HOUSES [circa 1880-1941]

II. DESCRIPTION:

There are three general types of houses that were built in conjunction with the locks--gabled ell, side gable and Colonial Revival. These houses are immediately adjacent to the locks, and housed the lockkeeper. Ten of these houses exist today, where at least twelve once stood.

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According to Cultural Resource Management in Wisconsin, gabled ell houses are distinguished by their "L" or "T" plan, two gabled wings, front porch with either a hipped roof or a shed roof, and front door generally situated where the gabled wings meet.[1] Side gabled houses, on the other hand, have rectangular plans and gently sloping gabled roofs. In this style, the gables are parallel to the street and the main entrance is in the wall parallel to the street. This type of house often has a partial or full front porch.[2] Gabled ell houses are found at Appleton 1, Appleton 3 and Kaukauna 1. A side gabled house is found at Menasha.

Colonial Revival houses are evident by their symmetrical design, gabled roof and dormers and "a classically derived entrance." Some have columns, pilasters, denticulated cornices and shutters.[3] A Colonial Revival house is located at Rapide Croche.

The Dutch Colonial Revival is a variation on the Colonial Revival. There are five such houses along the waterway, at Cedars, Little Chute 2, Combined Locks, Little Kaukauna and DePere. These houses were built from the same plans, generally between 1910 and 1930. Using many of the features found in the Colonial Revival, the Dutch Colonial Revival also incorporates a Gambrel roof, as well as contrasting building materials -- brick walls and shingled gables, for instance.[4]

III. SIGNIFICANCE:

The houses are significant for their role within the waterway operation, that is in serving as an on site residence for those responsible for controlling the locks. In addition, the Dutch Colonial Revival houses are significant under Criterion C as unique examples of the style in their respective neighborhoods.

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[1]Barbara Wyatt, ed., Cultural Resource Management in Wisconsin (Madison: State Historical Society of Wisconsin, Historic Preservation Division, 1986), Architecture 3/5.

[2]Ibid., Architecture 3/3.

[3]Ibid., Architecture 2/29.

[4]Ibid.

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IV. REGISTRATION REQUIREMENTS:

As with the locks, an associated lockkeeper's house is eligible for registration if it retains its integrity of location, design and building materials. Each of the houses associated with the waterway retain their integrity of location and design. And all of the houses, except Menasha, retain their integrity of building materials. None of the houses are known to have been moved, nor have they been altered dramatically. Clearly, one who lived in any of the houses fifty years ago would recognize them today. Integrity of building materials, however, is another matter. All of the Dutch Colonial Revival houses retain their brick first floor veneers and wooden shingle second floors. As well, the Colonial Revival house at Rapide Croche and the Gabled Ells at Appleton 1 & 3 are all sheathed with asbestos shingles, a type of exterior wall material that could well be original. The single lockkeeper's house that is an example of one that did not retain its integrity of building materials is found at Menasha. That house has been totally resided with aluminum siding. While all the others meet eligibility requirements, the Menasha house does not.

* According to the Army Corps, the Rapide Croche lockkeeper's house is not in its original location, it was moved to the current location in 1939.

I. NAME OF PROPERTY TYPE: LOCK SHACKS [circa 1900-1941]

II. DESCRIPTION:

Lock shacks are found at each of the locks. They are small structures that served as an "office" for the lockkeepers when they were on duty, and, consequently, are usually located immediately adjacent to the lock. Although all locks have the lock shacks, except for the two guard locks at Little Chute and Kaukauna, only twelve retain old frame shacks. The others are modern metal sheds. Those locks with wooden shacks are Appleton 2 & 3, Cedars, Little Chute 2, Combined Locks (Little Chute 3 & 4), Kaukauna 1, 2, 3, 4 & 5, Rapide Croche and DePere.

Lock shacks were generally single story, front gabled sheds. Clad with drop siding and roofed with asphalt singles, their walls are bounded by pilaster strips. They have small metal smokestacks that protrude near the roofs' ridge. They also have overhanging roofs that have plain cornices.

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III. SIGNIFICANCE:

The lock shacks are significant for their role in the operation of the lock system. Specifically, that is in providing shelter for the lockkeepers when they were on duty and operating the locks.

IV. REGISTRATION REQUIREMENTS:

Given the fact that these small structures are significant for their role in the overall operation of the lock system, they meet registration requirements if they retain their integrity of location, design and building materials. Indeed, none of the wooden lock shacks appear to be moved. Nor do they appear to be modified or altered, or sided in any material other that with which they were built.

Examples of lock shacks that are not eligible are limited to those that have been rebuilt of metal. Because the metal shacks have a single, gently sloping roof plain instead of a shallow gable roof, and because they have been rebuilt in metal instead of wood, we may conclude that they retain neither their integrity of design or building materials. Nor do the new metal shacks meet the fifty year rule.

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G. SUMMARY OF IDENTIFICATION AND EVALUATION METHODS

Discuss the methods used in developing the multiple property listing

See continuation sheet

X See continuation sheet

H. MAJOR BIBLIOGRAPHICAL REFERENCES

See continuation sheet

X See continuation sheet

Primary location of additional documentation:

X State Historic Preservation Office	___ Local government
___ Other state agency	___ University
___ Federal agency	___ Other

Specific repository: _____

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SUMMARY OF IDENTIFICATION AND EVALUATION METHODS:

This nomination has evolved from an intensive survey of the Lower Fox River that took place in 1988 and 1989. The geographical limits of the survey were 100 yards on either side of the river, and the objective was to identify any resource that was historically tied to the river or the waterway. Once the survey was completed, it had been determined that one of the products would be a National Register nomination of all waterway related (associated with the Fox/Wisconsin canal system) resources.

Prior to undertaking the survey, all site files at the SHPO's office were reviewed to determine what resources along the waterway were already known. Aside from isolated structures that had been identified by surveys in communities that are along the river, it was clear that no comprehensive collection of waterway related resources existed. Accordingly, all lock and dam complexes were extensively observed in the course of the intensive survey's fieldwork phase.

The lock complexes were easy to locate on maps. Since many of the lock complexes are locked, we were accompanied by Mr. Ross Plains, a former Army Corps of Engineers supervisor on the waterway, and currently the gentleman who operates a limited number of locks each summer for the state. With the assistance of Mr. Plains, we were able to thoroughly survey each lock complex, as well as inspect each of the government dams. We were not, however, able to gain admittance to the lockkeeper's houses. They have not been lived in since 1984 and were boarded over.

Each lock complex was generally self contained, consequently, it was virtually impossible to miss any related structure. Each lock complex was extensively photographed during the survey and field notes made.

Once the survey was completed, I met with Mr. Paul Lusignan, then Chief of Survey and Planning at the State Historical Society of Wisconsin. Reviewing the survey cards together, we agreed on the structures that would be part of this nomination, as well as the format to be used. It was from that conversation, and our attempt to develop a format that would readily accommodate the variety of resources found in each lock complex, as well as the number of lock complexes and canal segments themselves, that this thematic National Register approach was developed.

The survey was undertaken by John N. Vogel, then a Doctoral Candidate in history at Marquette University, who served as Principal Investigator, and William P. O'Brien, then a Master's candidate in architectural history at the University of Wisconsin - Milwaukee.

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