

POTOWMACK COMPANY CANAL AND LOCKS

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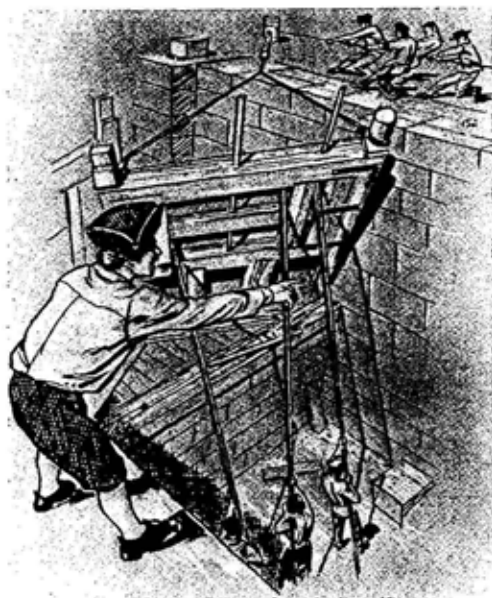
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HISTORIC STRUCTURES REPORT
GREAT FALLS, VIRGINIA

APR 6 2004

BY

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TABLE OF CONTENTS

Preface	i
Introduction	1
Surveys of the Great Falls Site	8
General Considerations	16
Washington seeks expert advice	21
Digging the Canal	24
Engineer Weston's advice on the Locks	29
Construction Activities under Myers	35
Leonard Harbaugh completes the Locks	48
Final Specifications	57
Canal Locks	61
Lock Gates and Sluices	65
Locking Up and Down	71
Maintenance and Repairs: 1802 - 1828	76
Bibliography	85
Illustrations following page	88

MAPS, PLANS, SKETCHES

- Exhibit I. Route of the Potomac Canal (Location Plan)
- Exhibit II. Plan and Profile of Great Falls Canal and Locks
- Exhibit III. Plan of Canal and Locks (1763), Parts 1 - 3
- Exhibit IV. Plan of Canal and Sluices (1767)
- Exhibit V. Plan of Canal and Locks (1771)
- Exhibit VI. Lock of a Canal (1792)
- Exhibit VII. Plan of Great Falls Lock Canal (1785, Parts 1 - 2)
- Exhibit VIII. Plan of Great Falls Canal (late 18th Century)
- Exhibit IX. Potomac Company's Canal (19th Century ?), Parts 1 - 5
- Exhibit X. Painting - Washington surveying canal construction
- Exhibit XI. Plan of proposed restoration of Lock 1
- Exhibit XII. Seal of the Potomack Company

WAGNER PHOTOGRAPHS (1893)

- Plate 1. Entrance to canal above the Great Falls.
- Plate 2. General view of section of canal
- Plate 3. Office of the Great Falls Manufacturing Company
- Plate 4. The Log Warehouse
- Plate 5. Lock 2
- Plate 6. Lock 3
- Plate 7. Locks 4 and 5, looking up the canal
- Plate 8. Locks 4 and 5, looking up towards the river

NELSON PHOTOGRAPHS (1910)

- Plate 9. Great Falls from the Maryland side
- Plate 10. Lock 1
- Plate 11. Lock 2
- Plate 12. Lock 3
- Plate 13. Locks 4 and 5 from the river
- Plate 14. Locks 4 and 5 towards the river

EXISTING CONDITIONS

- Plate 15. Entrance of the canal
- Plate 16. Stone wall along canal bank
- Plate 17. Dam on one section of the canal
- Plate 18. Canal behind the Visitor Center
- Plate 19. Canal along the glade
- Plate 20. Entrance of headgate
- Plate 21. Lock 1
- Plate 22. Lock 2
- Plate 23. Lock 3
- Plate 24. Locks 4 and 5
- Plate 25. Locks 4 and 5

PREFACE

The purpose of this report is to fulfill the needs outlined in RSP GWMP - 8. It deals mainly with the architectural and construction features of the old Potowmack Canal at Great Falls, Virginia. As expressed in the Research Proposal, the information is needed by the park to support and form the basis of an accurate program of interpretation, stabilization, and restoration.

Today the remains of the canal and locks constitute the most important historical resource of the park. Yet, in many respects, they present a weird picture of abandon. From the entrance of the canal, above the falls, water still flows through a considerable distance. Just beyond the Visitor Center, the dry bed of the ditch vanishes in the glade where nature has taken full possession of its course. In the uppermost locks, forest trees have pushed their roots down and many of the hand-cut blocks of Seneca stones out. Many of the stones, however, are still fitted with precision and some trim alignment.

On July 23, 1969, the President of the American Society of Civil Engineers presented to the Director of the National Park Service at Great Falls, Virginia, a bronze plaque designating the Great Falls Canal and Locks of the Potowmack Company as a National Historic Civil Engineering Landmark. This presentation culminated

four decades of effort to memorialize this pioneer engineering achievement begun under the leadership of George Washington in 1785.

As early as 1929, the National Capital Park and Planning Commission proposed the preservation of the Great Falls canal and locks as an appropriate historic engineering memorial to our first President. It was endorsed at that time by the American Engineering Council. In 1930, in anticipation of Washington's Bicentennial, General Brehon Somervell, then Major and District Engineer of the Corps of Engineers for the Washington District, proposed the canal and locks as an engineering memorial to George Washington.

Twenty years later, during the 1949 ASCE Meeting in Washington, Major General U. S. Grant III, then Chairman of the National Capital Park and Planning Commission, suggested to the Society's Board of Direction that it initiate a movement to obtain and present to the public the original canal and locks at Great Falls, then privately owned.

The Society, through its George Washington Memorials Task Committee, supported by the local Section's George Washington Canal and Locks Committee, has worked over the years with the public agencies and private interests concerned, to assure, by one means

or another, the preservation of the canal and locks. At the present time the National Capital Section of ASCE, through its George Washington Canal and Locks Committee, has responsibility to carry forward the following long range objectives: (1) Restoration of the Headgate and Upper Lock No. 1; (2) Preservation and stabilization of the remains of the other locks; (3) Construction of a suitably housed model of the entire canal and locks; (4) Production of such pertinent exhibits and historical documents as may be needed to develop public interest and understanding.

Though the subject of this report is the Great Falls Canal and its five locks, we have included many references to other canals of the Potomac. This was done for two main reasons: (1) to maintain all phases of the Potomac navigation project in a proper frame of reference: (2) to illustrate particular construction problems, building techniques, and practices which were common to all the canals. Some information about other buildings of the area has been included also as being by-products of the whole canal construction process.

Through practically all the documents dealing with the canal, the names of the river and the Company are inconsistently referred to as Patowmack, Potowmack, Potomack, Potowmac, and Potomac. The Company's great seal, adopted in 1803, had the name Patowmack,

although the Company Charter referred to Potowmack. To be consistent we have used the term Potomac throughout this report.

A special note of appreciation is acknowledged here to Mrs. Ruby J. Shields, Chief of Reference, Manuscripts Department, Minnesota Historical Society, for sending us photostatic copies of Thomas Johnson's sketches of the proposed Great Falls Canal and Locks, 1785. These excellent sketches or plans, whose originals are held by the Historical Society, are the earliest known proposals for the Canal. Johnson's design of the miter gates for the locks is essentially the one adopted at the Great and the Little Falls Canals.

Mr. John Nolen, Jr., Vice-Chairman of the George Washington Canal and Locks Committee, ASCE, National Capital Section, offered valuable suggestions during the preparation of the report. A special thank you goes to Miss Dorothy Junkin of the Division of History for a fast and excellent typing job.

INTRODUCTION

Under the energetic leadership of George Washington, the Potomac Company was organized in 1785 for clearing and making navigable the Potomac River from tidewater to its source. The vast project, of which the Great Falls Canal was an essential part, was an ambitious effort to bind the West to the thirteen states by making the river the avenue of commerce for the back country. An inducement to canal building was the great extent of the American territory. Colonial roads, the only avenues of commerce, were often impassable in winter and wretched in wet weather. Rivers were navigable for long distances into the interior, but these distances varied in different seasons of the year. Many settlers ascended the rivers farther than before during the Revolution, and the need of opening unnavigable waters to the west came to the fore.¹

Washington became the first president of the Company board and continued in that capacity until he became President of the

1. Corra Bacon-Foster, "Early Chapters in the Development of the Potomac Route to the West," *Records of the Columbia Historical Society* (Washington, D. C., 1912), XV, pp. 96-322; "Washington and the Potomac: Manuscripts of the Minnesota Historical Society, 1769-1796," *The American Historical Review*, XXVIII, No. 3, April 1923, pp. 497-520, No. 4, July, pp. 705-12. Bacon-Foster's work is the best source on the Potomac Company and the Canal and is based almost

United States. Four directors were selected to aid him in setting the Company in motion: Thomas Johnson, John Fitzgerald, Simeon Lee, and George Gilpin. Johnson and Lee were former governors of Maryland and Gilpin and Fitzpatrick prominent merchants in Alexandria.²

According to the Acts and Resolutions of Virginia and Maryland concerning the Potomac Company, the river project called for opening and extending the navigation from tidewater to the highest place practicable on the North Branch. Canals would be cut, when necessary, and locks and other works erected on both sides of the river. Vessels drawing one foot of water should be able to navigate in dry seasons. Work between the Great Falls and Cumberland should be completed in three years,

entirely on the Potomac Company papers deposited in the National Archives; the documents in the *American Historical Review* are excellent for background information before the Company was organized. See also Archer Butler Hulbert, "The Great American Canals," *Historic Highways of America* (The Arthur H. Clark Company, Cleveland, Ohio), XIII, pp. 1-64.

2. National Archives, Records of the Potomac Company, Proceedings of the Stockholders of the Potomac Company, May 30, 1785, Letter Book A, pp. 1-3. The minutes of the early meetings of the stockholders are recorded in a volume entitled "Letter Book A." The annual meetings were held in August, and will be cited as Annual Meetings, followed by the date; there were numerous special meetings of the stockholders that will be cited as Special meetings, followed by the date also.

and from the Great Falls to tidewater within ten, otherwise the Company charter would be forfeited.³

In improving the river, the Company had to provide a safe and passable channel for boats over the winding, rocky, and sometimes precipitous bed of the river, which stretched some 218 miles from Cumberland to tidewater at Georgetown. Clearing out some bars and loose rubble from the river bed was the simplest of operations, but the natural obstacles were extensive and unpredictable. A more difficult operation involved the blasting of channels in shallow places from a river bottom of solid rock to provide sufficient depth for boats to pass. In other cases, depth was provided by building dams and diverting water into sluices, or walled channels.⁴

Still more difficult and challenging was to make the river falls navigable. When a river sloped steeply or had rapids, canal locks of the same rise were the most common device for overcoming the waterfalls. A canal lock was a pound, cistern, or pen placed lengthways in a river or canal with gates and sluices to regulate

3. Bacon-Foster, pp. 299-314, copy of Acts and Resolutions.

4. What the Potomac Company adapted was the sluice navigation. *American State Papers* (Washington, D. C., 1834), Miscellaneous, II, 1809-1823, pp. 990-91.

the flow of water. By means of the locks the vessels were raised or lowered from one reach to another.

From Georgetown to Harper's Ferry there were five falls through which navigation was impossible: Little Falls, Great Falls, Seneca, Shenandoah and Houses Falls. After various surveys of the river by the Company board, it was determined that in all the falls skirting canals would be needed; only the Great and Little Falls required locks. At the Great Falls the Potomac cut a swift passage through a host of ancient rocks in the river gorge. Here a fall of about 76 feet in a distance of more than a mile had to be overcome by means of several locks.⁵

It was clearly understood, at least by Washington, that the difficult parts of the river projects, like construction of locks, would require an engineer of skill and practical knowledge, perhaps from France where canal building was practiced with great success, or from England or even Holland. He thought that the Great Falls were "tremendous" and the improvement of navigation there, in whatever manner it was executed, would require much technical

5. Special Meetings, Book A, pp. 8-9, Shenandoah Falls, August 8, 1785; Jared Sparks, *The Writings of George Washington* (Boston, 1835), IX, p. 126, Washington to William Grayson, Mount Vernon, August 22, 1785; John C. Fitzpatrick, *The Diaries of George Washington* (New York, 1925), II, pp. 395-97. See Exhibit 1 for location of falls and canals.

skill that was only available in Europe. Other phases of the navigation works, such as removing obstructions from the river bed, the directors of the Company had enough confidence to undertake themselves.⁶

When the efforts to find an engineer or "person of practical knowledge" to direct the construction work failed, the ingenious James Rumsey was selected as manager. In the United States there simply were no engineers. An inventor and mechanician by trade, Rumsey was one of the most picturesque characters of the period and a man of true genius. His main credential was the invention of a mechanical device for ascending rapid river currents, a model which he had exhibited in private to Washington in 1784.⁷

As a whole the Potomac navigation project, especially the lock canals at the Great and the Little Falls, was a technical

6. John C. Fitzpatrick, editor, *The Writings of George Washington* (U.S. Printing Office, 1931-1944), XXVIII, p. 255, Washington to Marquis de Chastellux, Mount Vernon, September 5, 1785; p. 245, Washington to Marquis de Lafayette, Mount Vernon, September 1, 1785; Bacon-Foster, pp. 158-60, Washington to the directors of the James River Company, September 16, 1785.

7. Rumsey's model worked perfectly up the Potomac and he secured a certificate from Washington. How much Washington's encouragement aided the inventor is not known, but later Rumsey evolved the application of steam as the motion power for his model and shares with John Fitch the credit of being the inventor of the steamboat. Archer B. Hulbert, *Washington and the West* (New York, 1905, Journal of 1784),

venture for which there was no precedent in the United States. At that time there were very few persons in the country who had seen a canal lock, and no canal had yet been built. Few persons understood the mechanical principles involved in the construction of locks. Canal building embraced many untried skills. Builders had to be practical engineers or skilled mechanics with abilities to cope with problems of hydraulics, like the rate of the river fall, the difficulties of clearing the obstructions from the river bed, underwater blasting, the strength of materials, geology, levelling, surveying, and the like.

It is erroneous, however, to assume that the men who were responsible for the operations of the project were completely ignorant of canal technology. Both documentary and physical evidence bear out the fact that the builders followed the general principles and practices of canal construction that prevailed in Europe, particularly England.⁸

At least two of the directors of the Company--Washington and Johnson--had been familiar and associated with one earlier

pp. 125-30; Fitzparick, *The Diaries of George Washington*, II, p. 282; *Harper's Encyclopaedia of United States History*, VII; Thomas J. Scharf, *History of Maryland* (1879), II, p. 525; Hugh T. Taggard, "Old Georgetown," *Records of the Columbia Historical Society* (1908), XI, pp. 180-81.

8. English influence came directly through the services of three engineers--Brindly, Weston, and Myers.

scheme for making the Potomac navigable. Part of that scheme, promoted by John Ballendine in 1773, included a canal through the "gut" of the Great Falls with eight locks to overcome the fall. Ballendine was not a canal engineer, but he went to Europe and carefully examined canals and inland navigation in England, Scotland, Ireland, and France, "after which he engaged a number of skilful engineers and mechanics." He actually began the construction of a lock canal at the Little Falls. His utopian plan failed, but he acquired considerable knowledge about lock canals which undoubtedly passed on to receptive and fertile minds like those of Washington and Johnson, who later became promoters of the Potomac Company. What the builders lacked was practical knowledge.⁹

9. Ballendine's scheme is summarized in Bacon-Foster, pp. 117-23.

SURVEY OF THE GREAT FALLS SITE

Though the operations of removing the obstructions from the river bed began on August 5, 1785,¹⁰ the Great Falls area had to be surveyed to determine the exact location for a canal around the rapids, either on the Maryland or Virginia side. The choice of the ground through which the canal was to pass from one place to another was of extreme importance, for on this depended the cost and solidity of the work. There were an infinite number of difficulties to surmount if the wrong place was selected. If possible the canal should be carried through a route as nearly on a level as possible, on firm, solid ground, and avoiding bogs and rocks which would increase construction cost exceedingly. The tract for the canal had to be exactly surveyed, borings made and levels taken over the whole extent, without which no judgment could be formed. Although locks made it possible to surmount rises and falls in the ground, they were expensive to build and operate. It was very important not to use any more locks than were absolutely necessary. Hence, the more the actual length of the ditch could be shortened, the less the canal would cost.¹¹

10. Fitzpatrick, *The Writings of George Washington*, XXVIII, p. 245, Washington to Marquis de Lafayette, Mount Vernon, September 1, 1785.

11. Charles Vallancey, *A Treatise on Inland Navigation* (Dublin, 1763), pp. 123-25.

On September 22, Washington and director Gilpin were on the Virginia side of the Great Falls for an inspection of the site. Washington noted in his diary that the place proposed for a canal was clearly marked along a glade which ran quite from the still water above the spout or cataract, to the river three quarters of a mile below. From appearance, the place did not seem to require dip digging for a canal, although the upper and lower ends of the track had the inconveniences of many rocks; the glade itself appeared to be free of rocks. But, as Washington wrote, "how the bottom may turn out when the soil is taken of I know not. More than probably it will be found stony."¹²

Washington was again at the Great Falls on October 18, with George William Fairfax and Thomas Johnson. A two days' session of the full board was held. Washington and Johnson found the other directors in the operation of levelling the ground for the proposed cut or canal, from the place where it was supposed to take the water out to the other where it would be let into the river again. At the highest point, and for nearly 70 rods, the ground was between five and seven feet higher than the surface of the water at the head:

12. Fitzpatrick, *The Diaries of George Washington*, II, pp. 415-16.

After which it descends, and for at least 300 yards at the end, rapidly. This cut, upon the whole, does not appear to be attended with more difficulty than was apprehended, for tho the ground is higher than was expected, it appears from some experiments of sticking a spike stake down in those parts, that there is two or three feet of soft earth at top and the lower end of the canal well calculated to receive locks to advantage; as also to dam the water, to throw it back into the canal and thereby reduce the digging; which may also be done at the head of loose stones being thrown into the river to a Rocky Island. The length of the cut from the work of to day, is found to be about 2400 yards, a little more or less, upon exact measurements.

Washington also took a close view of the river from the spout or cataract to the proposed entrance of the canal below, to see if he could discover the advantage of a canal on the Maryland side, but his reaction was negative:

About 400 yards below the cataract, there is a cove, into which emptys a small part of the river thro deep and steep rocks on both sides, which is a good defence to it; and some little distance below this again, is another cove; but how a canal was to be brought thither I could not (having the river between) discover. However at, and below both, is rapid water, one little, if any, inferior to the Spout at Shannandoah.

After taking a rough level of the intended cut and discussing general ideas about the canal, the directors determined to go ahead with it during the winter when the operations in the river bed would be stopped.¹³

13. *Ibid.*, pp. 424-25.

No definite decision was made about the canal track, but apparently the subject of locks was fully discussed by the board members. Two weeks after the meeting, Johnson wrote Washington about some doubts, reservations, and technical considerations which should be resolved before the construction of the locks was undertaken; the letter shows that Johnson was doing some homework on the subject:

The little time we had at our last meeting just allowed an Opportunity to mention several Things which were left very imperfect though we seemed much in the same Opinion

Since my Return Home my Thoughts have run a good deal on the situation of the Great Falls for Locks and the Manner of constructing them and their Gates. I was puzzled about the lateral pressure of Water for the Situation seems to point out Locks of great depth but unless we can come at some Rule to know the Force of a given Body of Water we do not know the Quantity of Force or degree of Strength necessary to oppose to it or whether we have it in our power to oppose it with Success or not. I have no Books of my own nor am I in a favourable place to borrow Books on the Subject, however I obtained one and have extracted . . . what I thought applicable¹⁴ I cannot but be struck with the Hints started at the Falls and hope we may accomplish a resisting Force superior to the Action of the Water; let us raise it in the Locks to what height we please and I candidly

14. The reference book mentioned by Johnson was John Rowning's *A Compendious System of Natural Philosophy* (London, 1772 ed.), I, p. 25.

confess I feel a kind of Pride in the originality or at least uncommonness of the Gates proposed; if by a Deviation from the usual Manner we can combine Strength, Dispatch, and Ease in a superior degree and at a less Expense than the Europeans my Ambition will be highly gratified and I flatter myself the Occasion offers. I should either forbear giving you this Trouble or apologize for it if I did not think your desire to pick out some thing useful from the crudest Thoughts and my unreserve will make this prolixity acceptable for I much more wish to add to than take from the few of your leisure Moments.¹⁵

Johnson's passing mention of the "Gates proposed" refers to an earlier letter sent to Washington in which he stated, in part:

I have amused myself with writing my Ideas on the Canal and Locks in detail and making Calculations of the Expençe which indeed surprises me for its smallness in the Amount though I do not see where to add to bring it nearer my former Conjectures. I enclose them to you, my intention must be their recommendation.

What he enclosed were two carefully drawn sketches, one representing a miter lock gate, and the other a proposed canal for the Great Falls. The sketches will be explained later in this report.¹⁶

It was not until February 1, 1786, that Washington went again to the Great Falls for a meeting of the directors; he found Gilpin

15. *The American Historical Review*, XXVIII, No. 4, July 1923, pp. 714-15.

16. Bacon-Foster, p. 161, September 1785; Exhibit VII.

levelling the ground. In the afternoon of that day the directors surveyed the different grounds along which the canal could be cut. During the next day Washington examined the ground more attentively and levelled the different ways that he and the directors had inspected the day before. On account of the swollen state of the river and the rapidity of the current, they could not determine with certainty upon the best route for cutting the canal. Therefore, they directed Mr. Stuart, the assistant manager, to have all the different "ways" cleared out, accurately measured, levelled, and their bottoms sounded, by the month of March when the directors were to be requested pointedly to meet again for the final choice of a canal track. Mr. Stuart was also instructed to prepare an accurate drawing of a specific track that the directors considered the best location for the canal, showing the "courses and distances and also the different risings and fallings in the ground." All the hands available at the Great Falls would be employed first in opening the canal above the falls where the water was to be taken out of the bed of the river.¹⁷

Once again, on March 1, Washington was at the Great Falls for a three-day session with the other board members. Rumsey was

17. Fitzpatrick, *The Diaries of George Washington*, III, pp. 10-11.

directed to contract for finishing the work in the gut at the Falls of the Shenandoah on the best possible terms, and to give his personal attention to the point where the largest force was employed; James Smith was appointed an assistant manager for one year. According to the session's minutes, "upon a view and examination of the different tracks proposed to carry the canal in, it was unanimously determined that the one last examined between the river and the Falls Island is the most eligible and that it be taken in that course."¹⁸

Washington's diary, however, infers that the final selection of the canal track was done in a rather hasty manner. The first day of the meeting, he wrote, little or no business was done; next day was so stormy that they could neither level, nor survey the different tracks considered for the canal, nor select the best one, which was the principal object of the meeting. On the last day, he noted:

The snow which fell yesterday and last night covered the ground at least a foot deep, and continuing snowing a little all day, and blowing hard from the North West, we were obliged, tho' we assembled at the huts, again to relinquish all hopes of levelling and

18. Special meetings, Book A, pp. 16-17, Great Falls, March 1-2, 1786.

surveying the ground this trip; and therefore resolved on the rout for the canal from the best view we could take, and information get, and after doing some other business, as a board--particularly resolving to advertize a contract for the supply of our labourers with provisions--we broke up the meeting.

Thus the exact track for the canal at the Great Falls was finally selected after eight months of indecision. In the meantime, the work of clearing the obstructions from the river bed continued, but only when the water level was low enough to permit it.¹⁹

19. Fitzpatrick, *The Diaries of George Washington*, III, pp. 25-26, March 1-3, 1786.

GENERAL CONSIDERATIONS

Because of the general fall of the ground at the lower end of the track selected for the canal, the cut had to be laid out in a series of level reaches at varying heights, each closed by a lock, to enable vessels to be transported from one reach to another without any danger.

Apart from considerations of water supply, the dimensions of the canal and locks were dictated by the size of the vessels then used. By the Act of 1784, authorizing the incorporation of the Potomac Company, the canal at the Great Falls should be 25 feet wide, and 4 feet deep, with sufficient locks, if necessary, each of 80 feet in length, 16 feet in breadth, and capable of conveying vessels or rafts drawing 4 feet of water at the least. A canal would be built also, if necessary, at the Little Falls.²⁰

During the course of the work the above specifications were changed several times. A significant change was made in 1785 when the directors of the Potomac Company requested the assemblies of both states to be relieved from the depth of canal--4 feet--required by the 1784 Act. The text of the request, prepared by Johnson, had a forceful argument:

20. Bacon-Foster, pp. 312-13.

That your Petitioners believe so great a depth in the Canals was required for the convenient and easy passage of Rafts and deep Boats which might pass in the River when it is pretty full on the presumption that there would not be an equal or indeed any considerable increase of depth in the Canal on the rise of the Water in the River a supposition which would be well founded as to the Spaces between the Locks if they were from Necessity or Convenience placed distant from each other.

That your Petitioners have examined and levelled the Ground from where the Canal must be taken out above the Great Falls to some distance below the Falls where the Navigation must be led again into the Bed of the River and find that a Cut on one Level and connected Locks will be the simplest cheapest and most convenient Way of effecting Navigation there; they may add that almost of Necessity it must be made in that Manner.

That on executing that plan at the Great Falls, as they intend, the depth will as certainly be increased in the Canal on the rise of the River as that Water will flow to it's own Level and they are under the strongest Impressions, if a Canal and Locks should be necessary or useful at the Little Falls, that a Cut on one Level and a Waste of the whole Fall by a set of connected Locks at Tide Water will be far the best on every Account and therefore the depth of water will be increased there by the same material means as at the Great Falls.

That as in the Canal purposed to be made at the Great Falls as well, probably, as in that, if any at the Little Falls the rise of Water will unavoidably keep pace with the rise in the River when only Rafts and Boats of considerable Draft can pass, all useful purposes would be

equally answered by Canals of even less than two feet depth of Water in dry Seasons as if they were made to contain four which would according to the annexed Calculations not only save one fourth part of their Expence at the least but would by so much lessen the Work and save that proportion of the time necessary to effect it and render the Canals, when finished, in a degree more secure.

Your Petitioners therefore pray that Acts of both Assembly's may pass whereby it may be made necessary that a Canal at each or either of the said Falls if carried on one Level and supplied by the Current of the River contain two feet only instead of four feet depth of Water as required by the said Acts or that if the Level should be broke by Locks placed apart from each other that the first Level may necessarily contain only two feet depth and the others or rest four.²¹

Both Maryland and Virginia passed laws that permitted the Company to reduce the depth in canals at the Great and the Little Falls, from 4 to 2 feet, at the least in dry seasons, and if there were spaces between locks, to be 4 feet deep.²²

Actual work of cutting the Great Falls canal was initiated by Rumsey some time in March 1786. He commenced his job with assurance, using his crew of hands on the upper river projects

21. *The American Historical Review*, XXVIII, No. 4, July 1923, pp. 715-16.

22. *American State Papers*, Miscellaneous, II, p. 998; William Waller Hening, *The Statutes at Large* (Richmond, 1823), p. 69.

during low water, and moving them to the site of the Great Falls at other seasons. Almost from the beginning he experienced difficulties with the unskilled indentured workers who were employed, and especially with the rebellious Irish immigrants. Eventually the Company gave up the use of indentured immigrants and fell back wholly on negro slaves.²³

Making the cut on level and firm ground presented no problems, as long as locks were not involved. Canals in those days were dug by hand with pick and shovel. Loose dirt was removed by wheelbarrows; it took many laborers a long time to dig the ditch for a canal with such crude tools. Top soil was first removed for later return to the completed banks and neighboring land. When solid rock was struck, the job became more difficult. Small rocks were slowly and laboriously chipped out with drills and broken up with sledge hammers; large rock formations were blasted out with gunpowder.

The ditch excavated for a canal was generally formed with a flat bottom, and sloping sides varying with the nature of the soil. Its width and depth were regulated according to the size of the largest barges or vessels for which provision has to be made.

23. Bacon-Foster, pp. 160-64.

If the ditch was excavated through porous soil, the bottoms and the sides were made watertight by a lining of clay or other suitable material; when clay was used, it was spread over in layers and was known as "puddling." If the cutting was through clay, rock, or other watertight soil, no lining was necessary. Sometimes it was a general practice to lay wooden piles by hand along the sides and bottoms of the ditch to keep it from collapsing. The canal was dug deep enough so that boats would not get stuck on the bottom; embankments on both sides were carefully raised. After the ditch was open to the required depth, the lock seats were dug out; the location and size of locks were determined by the height of the fall to be surmounted and the water supply available.²⁴

24. J. Phillips, *A General History of Inland Navigation* (London, 1792), p. 360; Charles Hadfield, *Introducing Canals* (Ernest Benn Limited, London, 1955), p. 87; *The Canal Age* (New York, 1969), p. 59; Walter Buehr, *Through the Locks, Canals Today and Yesterday* (New York, 1954), p. 11-14; Leveson Francis Vernon-Harcourt, *Rivers and Canals* (Oxford, 1896, 2 vols.), II, 353-54; Fon W. Boardman, Jr., *Canals* (New York, 1959), p. 12.

WASHINGTON SEEKS EXPERT ADVICE

It is significant that the beginning of operations at the Great Falls coincided more or less with the visit of an English engineer to the site, arranged by Washington.

Robert Morris was one of the first persons to pay serious attention to the improvement of inland waterways as a means of communication with the west. He organized a company for uniting the Schuylkill with the Susquehanna by means of a canal and brought a number of consulting engineers before actually commencing any work. One of those consultants was James Brindley, nephew of the celebrated engineer of that name who had conducted the work of the famous Duke of Bridgewater Canal and planned many others in England. Brindley had worked with his uncle and had "practical knowledge of cuts and locks." Washington met and entertained this engineer while he was on his way to advise with the promoters of the James River scheme.²⁵

En route to Richmond, and at the suggestion of Washington, Brindley stopped at the Great Falls late in March and approved the track for the canal. He thought that because of the elevation and the rock formation on the lower part of the canal site, a

25. Bacon-Foster, p. 167.

good deal of attention and judgment was required in building locks in the place. He observed that the height of locks was always governed by the ground; their height frequently varied from 4 to 18 feet, and sometimes as high as 24 feet. According to him, the nature and declination of the ground was "alone to direct, and where this will admit he thinks the larger the Locks are made the better, because more convenient."

Washington engaged Brindley to call upon Director Gilpin on his way back from Richmond. In a letter to Gilpin and Fitzgerald, he gives reasons for his desire to secure officially the expert advice of Brindley:

With respect to this part of the business I feel, and always have confessed an entire incompetency: nor do I conceive that theoretical knowledge alone is adequate to the undertaking. Locks, upon the most judicious plan, will certainly be expensive; if not properly constructed and judiciously placed, may be altogether useless. It is for these reasons therefore that I have frequently suggested (though no decision has been had) the propriety of employing a professional man . . . ; as it is said no person in this country has more practical knowledge than Mr. Brindley, I submit to your consideration the propriety of engaging him to take the Falls in his way back; to examine, level and digest a plan for Locks at that place . . . ; Taking Mr. Brindley to the works now, may, ultimately, save expence; at the same time, having a plan before us, would enable us at all convenient times, to be providing materials for its execution.²⁶

26. Fitzpatrick, *The Writings of George Washington*, XXVIII, pp. 397-98, Washington to John Fitzgerald and George Gilpin, Mount Vernon, March 31, 1786.

Work at the Great Falls progressed in a manner that exceeded all expectations and difficulties vanished as the workers proceeded with the ditch. Washington had some reservations about the prevailing optimism: "What difficulties may be found where no difficulty was apprehended, I will not take upon me to declare: where they were thought wholly to lie, we are free from apprehension."²⁷ He wrote to friends in England and France to find out in what terms a person of competent skill could be brought from Europe. His friend Lafayette sent the following answer:

There is no doubt but that a good engineer may be found in this country to conduct the work. France, in this point, exceeds England; and will have, I think, every advantage but that of the language, which is something, although it may be supplied by an interpreter. An application from Mr. Jefferson and myself to the ministry, and more particularly an intimation that you set a value on that measure, will insure to us the choice of a good engineer. They are different from the military ones, and are called, Ingénieurs des Ponts et Chaussées.²⁸

27. *Ibid.*, pp. 401-02, Washington to Henry Lee, Mount Vernon, April 5, 1786.

28. *Ibid.*, p. 423, Washington to Lafayette, Mount Vernon, May 10, 1786; Sparks, *The Writings of George Washington*, XII, pp. 281-82, Washington to William Moultrie, Governor of South Carolina, Mount Vernon, May 25, 1786.

DIGGING THE CANAL

In the first annual report of Washington as president of the Potomac Company he informed that work was carried on at the Seneca and Shenandoah Falls while the waters were low; when the water level was high, the hands were removed to the Great Falls where considerable progress was made in cutting the canal. During the whole year the amount of rainfall was remarkable; on several occasions the great forty-foot rock that towers above the flood at the Great Falls was submerged. Quite often the hands employed in the bed of the river above the Great Falls were driven from their work by the rises of the water and frequently kept out for several days; under this condition, work in the bed of the stream was impossible and very little progress was made. The incessant rains often prevented and at all times retarded the removal of earth from the Great Falls ditch.²⁹

His second annual report of 1787 informed that the canal at the Great Falls was extended down to the place "at which the Locks must begin, the whole of which Canal is nearly completed."³⁰

29. In July Rumsey resigned as Company manager and Mr. Smith, his assistant, took his place. Annual meeting, Book A, pp. 18-20, August 1786; Fitzpatrick, *Writings of George Washington*, XXVIII, p. 459, Washington to Henry Lee, Mount Vernon, June 18, 1786; Fitzpatrick, *Diaries of George Washington*, III, pp. 83-85, July 1786.

30. Annual meeting, August 1787, Bacon-Foster, pp. 171-72.

In a letter to James Madison, Washington gave more details about the work already done at the Great Falls and other places:

No draught that can convey a proper idea of the work on this River has yet been taken. Much of the labor except at the great falls has been bestowed in the bed of the River in a removal of the rocks and deepening the Water. At the Great Falls the labour has indeed been great; the water there is taken into a canal about 200 yards above the Cataract and conveyed by a level cut (thro' a solid rock in some places and very stony ground in others) more than a mile to the lock seats; [five?] in number, by means of which the Craft when these locks are compleated will be let into the River below the fall (which in all is 76 feet). At the Seneca Falls six miles above the great falls a channel which has been formed by the river in freshes is under improvement for the navigation; the same at Shannandoah in part. At the lower fall (where nothing has yet been done) a level cut and locks are proposed. These constitute the principal part of the work to compleat the navigation; the parts of the river between requiring loose stones only to be removed in order to deepen the water where it is too shallow in dry seasons.³¹

Washington was still trying to obtain the technical advice of Engineer Brindley in connection with the Great and the Little Falls. Lee and Johnson suggested that Brindley should prepare a model for the locks at the Great Falls, and Washington accepted

31. Fitzpatrick, *The Writings of George Washington*, XXIX, pp. 332-33, Washington to James Madison, Mount Vernon, December 7, 1787.

the idea since the canal had already reached the point where the first lock would be built. There is no record of Brindley having prepared the model or plans for the locks.³²

En route to a meeting of directors at Shenandoah, Washington stopped at the Great Falls on June 1, 1788. He and Mr. Smith, the assistant manager, examined the canal, banks and other operations, and were pleased to find them in an advanced state of progress and very well executed:

The upper part of the canal, however, still requires to be widened, stones, etc. removed out of it and the lower side banked. From hence we proceeded by a small cut, and wall about a mile higher up the River to the Seneca falls, where much digging and blowing had been performed for the purpose of conducting the navigation through one of the marshes on the Virginia side, and a good deal of substantial wall erected; but the whole being in a rude and unfinished state no judgment could be formed of the time necessary to execute it; but Mr. Smith supposes 20 hands will be able to accomplish it this summer, as a like number wd. do that at the Great Falls above the lock seats.³³

The unusual height of the waters during spring and summer greatly retarded the operations in the river bed. Though the canal at the Great Falls was only nearly completed by August 1788,

32. *Ibid.*, p. 130, Washington to Thomas Johnson, Mount Vernon, December 28, 1786.

33. Fitzpatrick, *Diaries of George Washington*, III, pp. 360-61.

the principal force was being used at Shenandoah and Seneca Falls.³⁴

In September 1789 Johnson became president of the Potomac Company, but Washington, as President of the United States, maintained great interest in the river project, especially in the Great Falls Canal. During the next three years, according to the meager records available, very little progress was done at the Great Falls with the exception of some excavations for the lock seats. The use of hired labor for specialized canal work was becoming a real drag; reliance was being placed in contract work whenever it was found.³⁵

At the Little Falls, however, a canal was cut on the Maryland side of the river, "nearly the whole distance necessary, and in general to the full depth, the stone is swept out and a wall built for nearly a mile." Instead of using hired labor, a contract

34. Annual meeting, August 1788, Bacon-Foster, pp. 174-75; Sparks, *The Writings of George Washington*, IX, p. 423, Washington to Jefferson, Mount Vernon, August 31, 1788.

35. The only record available about construction work, from December 1790 to January 1792, is "Return of movements by the Potowmack Company's hands being 9 times from December 18, 1790 to January 7th, 1792," *The American Historical Review*, XXVIII, No. 4, July 1923, pp. 717-18.

was made for the digging of the lock seats, a measure which was later followed in connection with the Great Falls.³⁶

36. Annual meeting, Book A, August 1792. The navigation at Hook's Fall was made perfectly safe by making the passage straight along the Virginia side. Captain Thomas Beall of Fort Cumberland made a contract to complete the navigation from that place to Gregg's Mill. Mr. Denton Jaques was engaged to employ hands and clear a small rapid near Fort Frederick called Garrison Falls. Captain Henry was now employed in clearing the Shepherdstown Falls.

ENGINEER WESTON'S ADVICE ON THE LOCKS

After 1792 work in the river project continued to drag on, in part due to financial problems and the great demand for laborers in every part of the country. The canal and locks at the Great Falls remained incomplete; when funds were exhausted, the workers were idle and only those absolutely required to take care of the Company's properties were retained in service.³⁷

Work at the Great Falls was at a standstill and Washington was concerned about it. In 1793 he wrote the following letter to William Deakins, a Company director:

I was much pleased with the information you gave me in your Letter of the 19 Inst: relative to the progress of the work on the Potomac, and the prospect there is of navigation being so nearly completed in the course of the ensuing Summer.

I observe, however, that you say nothing of what is doing or about to be done at the Great Falls, but as it is so obvious that the rendering that place navigable is one of the most important objects in the whole business, I presume that every exertion will be made there, in conjunction with the progress of the work in other parts of the river, that the funds of the Company will admit of, and I was happy to learn when I was

37. Special meeting, Book A, September 6, 1793. Captain Thomas Beall had nearly completed that part of the river between Fort Cumberland and Gregg's Mill which he contracted for in 1792, and had made great progress in clearing the river between Gregg's Mill and the mouth of Canococheague.

last in Virginia, that there was no probability of a delay for the want of cash.³⁸

Apparently, the real problem in connection with the Great Falls was that the builders had reached a construction stage which required the technical skill of an engineer. To break the stalemate, the Potomac Company directors resolved, in July 1794, to obtain the services of William Weston, English engineer of the Schuylkill and Susquehanna Canal Company of Pennsylvania. Weston had directed the execution of some of the principal canals of England. He was to come to the Great Falls, examine the works and give his expert advice on how to proceed with the locks. On December 12, 1794, Washington wrote Lear that he would use his influence to arrange the visit of Mr. Weston to the Great Falls.³⁹

While the technical problems at the Great Falls remained unsolved, considerable progress was made in clearing the bed of the river between the Great Falls and the Little Falls; the frames of the locks at the Little Falls were "put in, planked and walled

38. Fitzpatrick, *The Writings of George Washington*, XXXIII, pp. 353-54, Washington to William Deakins, Philadelphia, February 24, 1793. At the general Company meeting in 1793, James Fitzgerald was elected president; George Gilpin, William Deakins, Jr., James Keith and Thomas Beall became directors.

39. Special meeting, Book A, p. 48, Georgetown, July 14, 1794; Fitzpatrick, *The Writings of George Washington*, XXXIV, p. 54, Washington to Tobias Lear, Philadelphia, December 12, 1794.

up." Leonard Harbaugh was the contractor in charge of the lock construction. It can be noted that the locks at the Little Falls, for unknown reasons, were being built of wood; usually bricks or stones were used.⁴⁰

In December 1794 Washington wrote Lear that Mr. Morris, president of the Schuylkill and Susquehanna Company, had promised to urge Mr. Weston to visit the Great Falls as soon as possible.

The question of locks seems to have cost Washington many anxious hours; it is repeatedly alluded to in his correspondence with friends and those who were actively connected with the affairs and management of the river enterprise. Even before the Company was organized, he had been interested in alternatives to locks; many engineers in Europe were doing the same. One plan proposed to Washington in 1794, by one Claiborn, was aimed at avoiding locks altogether. According to the plan, vessels would be received into a basket or cradle and let down by means of a "laver and pullies"; vessels would be raised by weights at the rear extremity of the "laver, which works on an axis at the top of a substantial post fixed about the centre of the laver."

40. Annual meeting, Letter Book A, Alexandria, August 4, 1794.

Washington doubted the practicality of the plan, but was in favor of

hearing the opinions, and explanations of any, and every Scientific, and practical character that could be easily got at, on this subject; and therefore, would hear Claiborn's Engineer, as well as Mr. Weston; especially as he professes to be particularly well skilled in the application of them, in propelling boats (in any easy and cheap manner) against the Stream, and in conducting of water to cities, or for any other purpose whatsoever.⁴¹

Early in January 1795 Washington wrote Lear that the Pennsylvania Canal Company had granted Mr. Weston permission to visit the lock seats at the Great Falls.⁴²

Again he wrote in February:

Weston has been detained by canal matters; much has been said of late of the inclined plane in Connecticut river--of the utility of it I mean. It would be well to question Mr. Weston pretty fully of this mode of raising and lowering boats, as the simplicity, cheapness and effect is the subject of eulogism.⁴³

Later, in March, he wrote:

From what you have written and from what I have heard from others, I hope Mr. Weston is on the Potomac 'ere this and that much benefit may be expected from his visit. He is certainly a

41. Fitzpatrick, *The Writings of George Washington*, XXXIV, pp. 66-7, Washington to Tobias Lear, Philadelphia, December 21, 1794; pp. 69-70, Washington to Lear, Philadelphia, December 22, 1794.

42. *Ibid.*, p. 82, Washington to Lear, Philadelphia, January 9, 1795.

43. Bacon-Foster, p. 180.

judicious man, with both theory and practice united. I am pleased to hear that the Locks which have been erected at the little falls have stood the test of a first trial so well; and this pleasure will be increased if Mr. Weston should make a favorable report of them.⁴⁴

Weston was at the Great Falls by the middle of March during which time every kind of work there was necessarily suspended. He was requested to take a view of the Falls and give his opinion as to the most eligible way of conducting the locks from the foot of the canal below to the summit above. Upon examination of the ground and river, Weston recommended to relinquish the place where considerable progress had been made in sinking some of the lock seats; he suggested in turn to conduct the locks toward that part of the river which had been originally marked out for that purpose; the original place had been given up upon the recommendation of Mr. Smith, the man in charge of the work, in order to avoid the construction of an extra lock. Weston inspected also some of the works done at other parts of the river, especially the locks at the Little Falls, which he approved. His observations and recommendations were put into writing for the Company's officials.

44. Fitzpatrick, *The Writings of George Washington*, XXXIV, p. 132, Washington to Lear, Philadelphia, March 5, 1795.

No time was lost after Weston's inspection of the Great Falls in taking the necessary measures to carry out his recommendations; it was hoped to complete three of the locks early in the summer of 1796 and the other three by the following spring.⁴⁵

45. Annual meeting, Book A, pp. 60-2, Georgetown, August 3, 1795.

CONSTRUCTION ACTIVITIES UNDER MYERS

Weston's visit and examination of the Great Falls confirmed the course of the canal and locks originally selected by Washington and the other Company directors in the winter of 1786 and confirmed by Engineer Brindley that same year.

With a new sense of direction, renewed vigor, and greater expectations on sight, the Company directors advertised bids for undertaking the lock seats at the Great Falls by contract. It was estimated at this time that six brick locks would be required to surmount the falls' height. When no acceptable proposals were made, the directors resolved the following in June:

(1) that according to a plan of the lock seats prepared by director Gilpin, the first three locks, from the basin of the canal above, together with the walls extending that distance, be carried on by the Company with hired labor.

(2) that the three lock seats nearest the river be done by contract, and that the directors would continue their advertisement and use their personal endeavors to have such contract made with a proper person or persons.

(3) that the bricks for the locks should be contracted for by the thousand on the best terms that could be obtained.

(4) agreed with Edward Nap to make 500,000 bricks at the Great Falls and lay them near the lock seats.⁴⁶

At the annual Company meeting of August 1795, President Lear announced the completion of the wooden locks and canal of the Little Falls and "upon trial found to answer the most sanguine expectations." Several loaded boats had passed through them "with the greatest safety and dispatch." The navigation between the Great and the Little Falls was still interrupted by many river obstacles. A number of hands had been removing the impediments for some time, but progress was slow. However, the greater part of the obstructions had been removed and it was expected that in a few weeks the work between the two Falls would be completed.

Work at the Great Falls was not mentioned in the annual report. Workmen were employed in many places along the river, but still an experienced engineer was badly needed to erect the large locks of the Great Falls. Lear appealed to Washington, who soon replied:

If the directors are in want of such a character as the enclosed letter describes,

46. Special meetings, Book A, pp. 52-54, Alexandria, June 12, 1795, and Georgetown, June 22. The directors also resolved that Gilpin should sketch a plan for the necessary locks to be erected on the Connigacheque River; that for improving the navigation above the Great Falls, the work could be done by contract, including locks.

it may be well to intimate it as soon as possible as it is not likely Mr. Myers will remain long unemployed as lock navigation is contemplated in many parts of the country. I have not seen the gentleman myself but understand from others that his testimonials are full and ample and that he is a stout and healthy man.

. . . P.S. I will send to and have a little conversation with Mr. Myers and give you the result in my next.⁴⁷

Several weeks later Washington wrote again about Christopher Myers, an English engineer:

This letter will be handed you by Capt. Myers, of whom I have made mention in a former letter. Being desirous of knowing whether the Directors of the Potomack Company are disposed to employ him as an engineer and superintendent of their lock construction, and on what terms, he has resolved to wait on them for those purposes. The testimonials of his skill as an Architect, and of his knowledge relative to locks, etc., will I presume be presented to you. These with such farther inquiries as prudence may induce you to make, will enable you to decide on your measures and thereby place Capt. Myers on the ground of certainty.⁴⁸

Washington saw and interviewed Myers, who was then working in Philadelphia. According to his own account, Myers had been

47. Annual meetings, Letter Book A, Georgetown, August 3, 1795; Bacon-Foster, p. 181, Washington to Lear, November 30, 1795.

48. *Ibid.*, pp. 181-82.

employed in the "Lancashire navigation in England." He did not favor wooden locks, but understood everything about lock construction. "He is healthy in appearance, stout and robust, and of good humored countenance. He professes to be moderate in his expectations, and willing to put himself upon trial a year."⁴⁹

In January 1796 Myers was appointed engineer and superintendent of the Potomac works; his main concern would be the construction of the locks at the Great Falls.⁵⁰

At the Company meeting in February, the following resolutions were passed:

(1) to immediately complete the superintendent's residence already begun on the lot belonging to the company at the Great Falls, of stone and brick, two stories, 25 feet front and 35 feet in depth.

(2) to erect such other works as may be necessary for the accommodation of the hands to be employed in the construction of the lock seats; the dimensions of the buildings would be 72 feet long by 18 wide, 7 feet high in the clear, covered with planks.

49. Tobias Lear, *Letters and Recollections of George Washington* (Doubleday, Page and Company, New York, 1906), pp. 98-99, Washington to Lear, Philadelphia, December 2, 1795.

50. Special meeting, Book A, p. 66, Georgetown, January 4, 1796.

(3) that a quantity of three-inch rope, no less than two coils, be procured and fixed to ring bolts below the Great Falls for the purpose of hauling boats up the river until the locks were completed.

(4) that the engineer be directed to examine such quarries of stone upon the river as may be convenient and suitable for the locks to be made at the Great Falls.⁵¹

On March 13, 1796, Tobias Lear answered several questions asked by Jefferson respecting the navigation of the Potomac. At least 80 percent of the work was done, according to Lear. Boats carrying from 100 to 120 barrels of flour passed freely from New Creek, twelve miles above Cumberland, to the Great Falls. A few places in this distance required improvements that could be done during summer when the water was low. He informed that the canal leading to the lock seats at the Great Falls was completed and that building materials like stone, lime, and bricks were contracted for the construction of the lock seats which

remain to be excavated and the locks finished. This is the great work now to be done. Six locks, of 12 feet each, are required here; the three first, from the situation of the ground, or rather rock, will require more walling than excavation; but the 3 last, next the River, must be sunk in a Rock and this Rock being of a tough, sluggish nature, but

51. *Ibid.*, pp. 68-70, Georgetown February 5, 1796.

too hard to be broken with picks, will cause great expense of powder and much hard persevering labour. The course of the locks is changed from the original plan and they will now communicate with the River in a secure and eligible situation. The portage from the basin of the Canal at the Great Falls to a good and safe landing place below the Lock seats on the River is scarcely half a mile. Great pains have been taken in perfecting the navigation between the Great and little falls, which is now safe and good, and may be used at all seasons. The Canal and locks at the little falls are finished and have been in use upward of 8 months. So that excepting the portage at the Great Falls the River is used from 12 miles above Cumberland to tidewater.⁵²

It can be noted in Lear's letter that the course of the locks seats was changed from the original plan, and that there would be a basin with a portage, or control gate on the summit.

Since the completion of the locks was the most urgent matter, it was suggested to offer the engineer a liberal reward if he completed them in a short period. Myers was allowed \$2,400 per annum for the first two years and the further sum of \$5,000 if he completed the locks at Great Falls so that loaded boats could pass in twelve months, or \$2,500 if in fifteen months, or in proportion for any time above twelve and under fifteen. The breadth of the locks was extended from 12 to 14 feet and Myers

52. *The American Historical Review*, XXVIII, No. 4, July 1923, pp. 718-22.

was ordered to provide a drawing of them, agreeable to the plan recommended in his report for the month of September.⁵³

At the annual meeting of August 6 it was reported that the great and almost only Company operations during the previous year had taken place at the Great Falls, "preparatory for carrying on the important work there with such activity and steadiness as to insure its completion within a reasonable time." It had been planned to build the locks of brick, but finding that part of the bricks made for building them were not suitable for that purpose, Captain Myers recommended the use of free stone as preferable for that work. The directors, therefore, relinquished the original intention of building with bricks.

Without loss of time, operations began on a very good quarry of free stone about the mouth of Seneca Creek; the Company entered into a contract with Mr. John Henry to furnish the whole quantity of stone which would be needed for the completion of the locks. A contract was also made for furnishing lime at a reasonable price. The necessary timber--white oak--

53. Annual meetings, Letter Book A, Alexandria, August 1, 1796; Book A, Special meetings, p. 84, September 13, 1796.

for the lock gates was either prepared for that purpose or was already in preparation. Several buildings were erected on the Company land for the accommodation of the artificers and laborers; considerable work was done in excavation and walling for the lock seats. A plan of the locks and the monthly and bi-annual reports prepared by Myers were presented to the Company shareholders for a better understanding of the work accomplished so far. Construction expenditures were high due to the unprecedented rise of labor wages and costs of provisions, and especially the high price of powder and the unavoidable amounts consumed in blasting operations.⁵⁴

An investigation of operation expenditures at the Great Falls on January 14, 1796, demonstrated the accelerated pace of the construction work during the last several months under the direction of Engineer Myers. It was impossible for the directors to judge how far the excavations and other work done on the lock seats corresponded with the labor expended at the place. A considerable excavation had been done between the bason, or basin, and the river in the course of the lock seats, but much more still remained to be done. Walls of rough stone had been

54. Annual meeting, Letter Book A, Georgetown, August 6, 1796.

extended for several hundred feet from the basin towards the location of the first lock gate which appeared to have been executed in a strong "workman-like manner."

A guard-wall was made on the upper side of the entrance into the locks; a dam was built to secure the "fixing of the outer side of the lower locks, which if it stands the attack of the ice it will be securing a very important point."

One pair of guard gates and one pair of lock gates were ready to be put in place. The greater part of the timbers for the other gates were provided and paid for, but the low waters during the past summer prevented their transportation down the river. A pair of iron sluices for the Great and the Little Falls was made and paid for.

About 4,000 feet of cut stone--"superficial measure"--enough to build two locks, was ready for delivery and paid for, according to contract. The low state of the waters also prevented these from being brought down. One thousand bushels of lime were ready for transportation "in the kiln on the river at Col. Bully Plantation."

Captain Myers had been ordered to provide accommodations for such persons as might be employed in the Company's service at the Great Falls. Five houses were built on the Company lot, each about 16 feet square, one story high in front and two on the back; the

ground story on the back was built of stone, the other was a frame filled with brick, laid in clay, the whole covered with shingles. Four of the houses were occupied by the mechanics employed by the Company and one was directed to be furnished for an office. Two other houses under one roof, similar to the others described, were occupied by the "low gate maker" and the office clerk. A number of huts for laborers were also built in different places, with berths, and capable of accommodating 150 men.

Not far from the Company buildings was the town of Matildaville, on land Washington conceived to be very valuable. Great things were expected of this town. With a forge, a sawmill, a market house, and a grist mill, the town was already a manufacturing center.⁵⁵

The investigation by the board revealed that £ 11,724 had been expended in 1796 at the Great Falls. Retrenchment became the order of the day. At a called meeting of the stockholders it was ordered that the work to be done for the present be confined to the space between the bason and the two lower lock seats least

55. Special meetings, Book A, pp. 93-5, Great Falls, January 12-14, 1797; Bacon-Foster, p. 178.

the remaining funds should not be sufficient to finish the whole; that measures be taken for carrying on the work in the most economical manner; that a platform or inclined plane be constructed to take flour and other goods from the two lower lock seats to the river.⁵⁶

Early in January 1797 the directory resolved to engage a person to superintend the excavation of the remaining lock seats, and to have carts, horses, and the like, to transport flour from the bason to the inclined plane and to haul sand; Captain Myers was engaged to haul clay and back the walls. Early in the month the coffer dam above the locks broke down.⁵⁷

In a memorandum of particular stones wanted to complete two locks, Myers divided or classified the stones as follows:

First lock:⁵⁸

43 feet heel stones
4 pot stones
2 table stones
4 sill stones

56. Special meetings, Book A, Alexandria, January 21, 1797.

57. *Ibid.*, p. 97, Great Falls, February 6, 1797; Potomac Papers, Entry #216, Observations and Orders by John Templeman, Great Falls, February 21, 1797.

58. Potomac Papers, Entry #162, May 2, 1797.

Second lock:

76 feet heel stones
4 pot stones
2 table stones
4 sill stones

Summary:

119 feet heel stones
8 pot stones
4 table stones
8 sill stones

Quantity now at the Great Falls:

35 feet heel stones
1 pot stones
1 table stones
2 sill stones

At a meeting of the directors, held at the Great Falls in May 1797, it was resolved that the engineer, Captain Christopher Myers, be immediately dismissed from the service of the Potomac Company. Myers, though a competent canal engineer, was a disagreeable person, and the directors had many unpleasant affairs with him. He obstinately refused to deliver to them his specifications and plans for the locks, demanded an annual stipend of \$4,000, and frequently absented himself for weeks from the works. Among the several other serious accusations made against Myers, one stated that his refusal to furnish working plans to the different artificers had either impeded the progress of their work, or they had done

it in such a manner as to make it necessary to pull it to pieces again; in some instances the work was probably improperly executed.

After his dismissal, Myers delivered the plans of the locks which had been approved by the board on July 15, 1796. Apparently because of lack of funds it was ordered that all the masons employed at the Great Falls "be immediately discharged."⁵⁹

59. Special meetings, Book A, pp. 100-03, Great Falls, May 1-2, 1797; Potomac Papers, Entry #160, Special meetings, November 2, 1796, pp. 86-88 and January 6, pp. 90-91.

LEONARD HARBAUGH COMPLETES THE LOCKS

On June 9, 1797, a little over a month after Engineer Myers was dismissed from the Company service, Leonard Harbaugh, the builder of the Little Falls locks, was employed to superintend the construction of the locks at the Great Falls. A Morris Dulaney signed an agreement to "conclude the locks." Several weeks before, the Company had employed Nicholas King to survey and draw the plan of the canal, presumably showing existing conditions.⁶⁰

Harbaugh's most difficult job was piercing the walls of the Potomac Gorge, about 76 feet high, to form the seats of the two lower locks, each surmounting a height of 18 feet. These walls were formed of a rock similar in hardness to granite.

At first, a borer's work excavating for the lower locks was estimated at five feet per day, more or less, to be added or deducted from their wages in that proportion. As the excavation proceeded, the superintendent of the borers reported that the quality of the rocks was softer than the other rocks previously blasted. It was

60. Special meetings, Book A, p. 105, Great Falls, June 6, 1797; June 9, pp. 105-06; Potomac Company Papers (Entry 162), Correspondence and Reports, 1785-1828, Box 1, Washington city, May 25, 1797, Nicholas King to Tobias Lear and John Templeman.

therefore ordered that a day's work be now rated at six feet, and in case any person employed as a borer "shall fail to perform that quantity of work daily, he shall be deprived of his allowance of whisky for that day."⁶¹

Work under Harbaugh proceeded at a snail's pace due to the shortage of hands. The available information about construction is so meager and fragmentary that it is impossible to point out the exact nature of the progress.⁶² By February 1798 the Company funds were entirely exhausted and only one lock had been completed at the Great Falls. Building operations at the Great Falls were further complicated by the collection of tolls authorized by Maryland and Virginia. Since the locks were unfinished, the Company was obligated to transport across the lock seats, and put into the boats below, such articles as might be brought there for transportation. Harbaugh was instructed to fix a platform and build a machine for conveying flour and the like, into boats at a place designated and to build a shed or warehouse capable of receiving about 750 barrels of flour. "You will take care that

61. Special meetings, Book A, p. 106, Great Falls, July 4, 1797; Annual meetings, Book A, p. 108, Great Falls, August 1, 1797.

62. Potomac Papers, Correspondence and Reports (Entry 162), Memo by Harbaugh to the directors, August 1, 1797; memo by Harbaugh to the board, September 5, 1797; Instructions of Lear to Harbaugh, March 9, 1798.

as many of the hands as are necessary for that purpose be employed therein when flour is to be conveyed as aforesaid."⁶³

As lack of funds would not permit more work in the locks, Harbaugh and the overseer were discharged. Some funds must have been obtained several months later, for in September there were hands employed in banking and other necessary repairs; in October the following order was issued:

Mr. Panton, Sir, As soon as Mr. Loeffler brings hands from Seneca have a small guard put in the canal at some convenient place twenty or thirty yards below the bridge at the Forge to throw the water below off, then clear out the passage through the basin, next that the stumps and obstacles be cleared out of the way at the little basin below the lock and place so stopped as to let the water discharge itself over the top of the dam.⁶⁴

From the Great Falls, the Company directors issued a call in 1799 to the stockholders; in part it summarized briefly the work accomplished so far in the river project.

The difficulty and expence have proved much greater than at first contemplated; at Shenandoah and Seneca Falls, extensive Canals have been formed by which boats are enabled to avoid the

63. Special meetings, Book A, pp. 124-28, Georgetown, February 8, 1798; Fitzpatrick, *Diaries of George Washington*, IV, p. 270.

64. Special meetings, Book A, pp. 148-49, Great Falls, September 4, 1798; pp. 151-53, Great Falls, October 1798; Bacon-Foster, pp. 188-89.

rocks and sudden descents in the bed of the river; At the Great and Little Falls similar canals have been constructed but at those places, it has been found that Locks were indispensable; At the Little Falls three have been made, through which boats from the foot of the Great Falls pass with the greatest ease and safety into tide water; At the Great Falls one lock has been formed-- four more are requisite; the seat of one of those is nearly excavated; To aid the intercourse till the work is completed at this place, a machine is constructed to pass articles from the waters above, to the waters below, which is found to answer extremely well; but the experience of two years has convinced us, that so long as any obstacle remains to a free passage into tide water, the navigation will not prove so serviceable to the public, or beneficial to the proprietors, as has been generally expected and now certainly known it will prove to be, when those are wholly removed.

Independent of those four principal falls, comprizing altogether 224 feet, 9 inches, there is, from the head of the Shenandoah Falls, fifty five miles above tide water, to Georges Creek, a continued succession of smaller Falls and Ripples, forming in the aggregate, a fall of 874 feet 4 inches, these have been so far removed and improved upon, that boats safely pass them.

From the best and most accurate estimates that have been formed, it is supposed that the cost of the remaining work at the Great Falls will not exceed \$60,000, and that it may be effected in the course of twelve months from the time funds are provided.⁶⁵

65. Call from the President and Directors of the Patowmack Company, Great Falls, July 2, 1799, Bacon-Foster, pp. 259-61.

According to an English traveler of the period, the machine used at the Great Falls for transporting goods was an inclined plane made of wood. Barrels of flour and hogheads of tobacco, which were the principal articles brought down the river, were rolled down the plane to vessels that waited for them below.⁶⁶

Funds became available early in 1800. With money, work at the Great Falls was pushed hard. An inspection was made by the directors of the proposed gates for the remaining locks; they spent several days on the spot taking levels, distances, and examining the ground. The result of the survey was to adopt a plan for the locks that differed "materially from the formerly adopted," particularly in the length and width of the locks.

Formerly the locks were planned to be 100 feet long by 16 wide, but the legislatures of Maryland and Virginia allowed them to be reduced to 80 by 14; the directors, however, decided to follow the opinion of Engineer Weston and make them 80 by 12. The boats which navigated the Potomac were rarely more than seven or eight feet wide and 60 feet long, none were more than 10 feet wide and 70 feet long; the difficulty of ascent would never admit boats of greater size. Other reasons for making the locks smaller

66. Bacon-Foster, pp. 275-76.

were the difficulty encountered in excavating the seats for the lower locks in a solid bed of rock, the economy of water in filling them, and consequently, the saving of time in passing of boats.

Announcements of contracts for the completion of the locks were inserted, for four weeks, in the following gazettes: Georgetown, Baltimore, Alexandria, Winchester, and Fredericktown. According to the bids, four locks to be completed; the seat of one lock was already excavated; the seats of the other three were "still to be excavated." Contracts would be accepted for the completion of the four locks, or only for the excavations of the locks, or for any part of the construction work. There would be about 4,300 cubic yards of stone to remove in the excavations for the lower locks; the Company was willing to grant liberal terms; there was a plan of the work to be done. Nicholas King was engaged again to prepare "drawings and calculations respecting the locks."⁶⁷

New alterations to the plan of the locks were ordered by the directors: lock 1 should rise 21 feet instead of 18; lock

67. Special meetings, Book A, pp. 173-83, Georgetown, January 20, 1800; "Diary of Mrs. William Thornton," *Records of the Columbia Historical Society*, X, p. 98, January 23, 1800.

2 changed from 15 to 18; lock 3 from 12 feet to 10 feet 8 inches; lock 3 to be widened to admit two boats of usual size; lock 4 to be completed as a canal to communicate between locks 3 and 5; lock 5 to rise from 12 feet to 16 and if necessary to be enlarged or lengthened to contain enough water for filling any of the lower locks; that if necessary, a reservoir be made east of lock 3 for the purpose of supplying water to the three lower locks; that in constructing the walls of lock 3, proper and sufficient apertures be left, when necessary, for the purpose of introducing the water from the said reservoir into the three lower locks.⁶⁸

No satisfactory and acceptable bids were received to complete the whole or any of the locks. After considerable delay and disappointment, nothing remained for the Company but to attempt to carry on the work by hired labor. The season, however, was so far advanced that great difficulty was found in procuring hands, and the Company was only enabled to commence the work in April 1800, with about 15 persons. Later this number was increased to 35, and work continued through July with an average of 35 hands. With that small force, about 800 cubic yards of rock were excavated in four

68. Special meetings, Book A, pp. 211-14, Georgetown, May 4, 1801; the alterations to the plan of the locks was referred to in a report of stockholders on January 20, 1800.

months at the places intended for the seats of the two lower locks; this was estimated to be fully one seventh part of the whole excavation required. There was already upon the spot a considerable amount of free stone and other materials required for the formation of the locks.⁶⁹

As work progressed, it was found absolutely necessary to have constantly on the spot a person of experience and judgment to secure the speedy and faithful execution of every part of the plan. Accordingly, early in the season, the Company entered into an agreement with Harbaugh again. He agreed to have the locks finished in time for boats to pass "with the water of spring 1802."⁷⁰ Harbaugh was instructed to procure and bring down the necessary stone for the lock seats, obtain timber for the lock gates, procure the necessary lime, and to contract for the "workmanship of the locks."⁷¹

At last, on December 3, 1801, the directors reported that the whole excavation for the lower locks was finished, all the necessary walling was completed, and the only thing left was the

69. Annual meetings, Book A, pp. 200-04, Alexandria, August 4, 1800.

70. *Ibid.*, pp. 217-23.

71. Special meetings, Book A, pp. 192-93, Great Falls, May 6, 1800.

hanging of the gates. As the greater part of the gates were already framed, it was expected to hang them before Christmas.

Thus at the opening of the season, after the approaching frost, no obstacle on any part of the main river will remain to the free and safe transportation of the produce of the upper country, from George's Creek to tidewater market: a distance of more than 200 miles, during all but the dry season of the year.⁷²

It was perhaps the irony of fate that George Washington, the master mind behind the Potomac navigation project, did not live long enough to see the completion of the Great Falls Canal in 1802. He missed the event by just two years.

72. Special meetings, Book A, pp. 229-32, report of president and directors to the Governor of Virginia.

FINAL SPECIFICATIONS

Many travelers, domestic and foreign, visited the Great Falls to see the locks. The Rev. Manasseh Cutler, a Bostonian, inspected the place on January 30, 1802, and left a brief account:⁷³

Went early in the morning to Georgetown where Mr. Frank Dodge, Mr. Tenney and I took horses and went up to the Great Falls, about twelve miles. Visited on the way the cannon foundry, saw them boring the solid cast iron cannon. Viewed the locks at the lower Falls where the boats pass with ease. The canal is about two miles in length. Passed the great bridge which is a very handsome one and well built in the form of the bridge over the Merrimac above Newburyport. The river very narrow near and at the bridge, but said to be deep. Arrived at the Great Falls and put up at Mrs. Myers. The appearance of the river is singular; filled with rocks about three fourths of a mile--no large cataracts but frequent falls and brought into a narrow bed with high rocky banks at the locks. At the lower locks appeared about forty feet wide; said to be thirty five feet deep. The work of the locks (six in number) very neat. The lower lock cut through a solid rock by blasting about forty seven feet deep and twelve feet wide. The water was to have passed this day but not being quite completed is to be opened for the passage of boats on Tuesday, February second.

73. Bacon-Foster, pp. 194-95.

The canal is three fourths of a mile. It is a place capable of much business by water works, but indolence reigns and the country through which we passed the picture of laziness, negligence and poverty. Old fields and woods.

In the annual report of August 1802, the president of the Company informed that the locks were completed by the end of February; that the whole work was executed in a very "substantial and durable manner, and in every respect likely to answer well the object contemplated."⁷⁴

As completed in 1802, the Great Falls Canal was 1,200 yards long, 6 feet deep, 25 feet broad at the top and 20 feet at the bottom; the Little Falls Canal had the same depth and breadth but was 3,814 yards long. At the Great Falls a difference in level of 76 $\frac{9}{12}$ feet was overcome by five locks, with a large and a small basin to control the water supply. All the locks had the same length--100 feet--and the same width--12 feet--except the uppermost lock (No. 1) which was 14 feet wide. Locks 3, 4, and 5 were joined, forming a riser of three steps; locks 1 and 2 were separated and connected by canal walls of hand hewn stones. The lift and capacity of each lock was as follows:

74. Annual meetings, Book A, pp. 246-50, Alexandria, August 2, 1802.

<u>Lock No.</u>	<u>Lift or Fall</u>	<u>Volume Capacity</u>
1	10 feet	18,200 cubic feet
2	16 "	22,800 " "
3	14 "	20,400 " "
4	18 "	25,200 " "
5	18 "	25,200 " "

All the locks were rectangular in plan, with the walls of the cheeks, or sides raised perpendicular; the walls of the first three locks were faced with hewn free stone laid in mortar to the top; the last two locks, closest to the river bed, were walled with the natural rock worked tolerably smooth to form the sides, but some mason work was done on the spots where the fixtures were inserted for supporting the stout wooden gates.

Both the Great and Little Falls canals were engineering feats that had taxed the ingenuity of the builders. Many minor and some major errors were no doubt made in the commencement and prosecution of the canals, but the result was a significant breakthrough in American canal technology. In the early stages of construction a great deal of money and time was lost for the want of the necessary practical knowledge in canal engineering, but most of the errors were gradually remedied by experience.

Two costly errors were made at the Little Falls that fortunately were not repeated at the Great Falls. At the former place, the three

locks were constructed of wood and wider than requisite, that is, 18 feet wide. These errors resulted in unnecessary building expenses and a loss of time and water in filling the locks. The first lock built at the Great Falls was No. 1 and was made 14 feet wide. A little further experience, however, convinced the Company directors that the width of 12 feet was sufficient for any vessels that would navigate the river; hence, the other four locks were made 12 feet wide and an adjoining basin was added to fill more readily the lower locks. At the Little Falls it was proposed to rebuild the locks of granite when the wood decayed and to contract them to 12 feet in width.^{74a}

74a. John Mason report, Georgetown, January 20, 1808, Special meetings, Book A, pp. 21-41.

CANAL LOCKS

A thorough physical examination of the extensive canal remains at the Great Falls would answer many questions about the construction of the locks which cannot be obtained from the fragments of extant documentary evidence. There are many details of construction and design, however, which can be inferred only from the prevailing European general techniques, practices, and principles of canal engineering. Although no locks were exactly similar, there were many similar features in all of them.

No matter whether the lock is a small one on an old canal, or a large one on a modern waterway, it works on the basis of three elements: a pen large enough for boats, gates to provide entrance and exit of boats, and some way of letting the water into and out of the lock independent of the gates. These are all that are needed to take boats uphill and down.

Locks were often constructed entirely of timber, but the most common material for the whole chamber was either brick or masonry. They varied much in size, but nearly all were of the same pattern, parallel brick, masonry or timber walls enclosed with gates. Whether of masonry or timber, the side walls were of the greatest strength. Where the natural formation was weak, special care had to be taken. Often "land-ties" were used

in order to resist the great pressure of earth from behind the walls.

A canal lock was similar in construction to a river lock, with the exception that a lift wall served as a retaining wall where the excavation was stepped down; the lift wall was built at the upper end upon which the upper sill rested, so that the upper gate was less in height than the lower gate by the amount of the lock lift.

If the fall was a high one, more than one lock was needed. Water is heavy, and the deeper the lock the greater the pressure on the gates and on the walls of the pen. If a lock was too deep, the sheer weight of the water would crack the walls or break the stout planking of the gates. As the lower gates were strained in proportion to the depth of water they supported, when the perpendicular height of the fall exceeded 12 or 13 feet, it was usually divided in many other reaches, each having its lock and sluice. Thus if the fall was 17 feet, two locks were made, each having 8 1/2 feet fall; if the fall was 26 feet, it was divided into three locks, each having eight feet eight inches fall. Few locks had less than six feet, or more than 10 feet. Sometimes, however, the number of locks was reduced to save expenses, which meant fewer but higher locks. It was cheaper

to have many locks together, if possible, to save the number of gates. For instance, three locks separated needed six gates, but if they were united like the last three locks at the Great Falls, they required but four gates because the bottom gate of one lock was the top gate of the next. More gates meant more money to build them, more sluices to be kept in order, and more men to operate and maintain them.

A riser, or staircase of locks, was cheaper to build, operate and maintain, but it was not always the best idea when the traffic of boats was heavy. When the locks were separated, like the first two at the Great Falls, up-going boats could pass down-going boats in the canal spaces between them. In the last three locks this was not possible, and a downward-going boat had to wait at the top until an up-coming one had finished the climb. More vessels could pass up and down in a day through three single locks than through a riser with three pens. The delay could only be avoided by building two risers side by side, so that a boat would climb up one staircase while another one was dropping down the other. Another disadvantage of building locks end to end was that a riser used more water than the same number of separate locks; this could be a serious matter

during dry seasons and in places where the water supply was scarce.⁷⁵

75. Roger Pilkington, *How Boats Go Uphill* (Abelard-Schuman, New York, 1959), pp. 19, 22, 30-34; Leveson Francis Vernon-Harcourt, *Rivers and Canals* (Oxford, Clarendon Press, 1896, 2 vols.) I, p. 102, II, pp. 374, 378-79; Charles Vallancey, *A Treatise on Inland Navigation* (Dublin, 1763), pp. 65-66, 145-67; J. Phillips, *A General History of Inland Navigation, Foreign and Domestic* (London, 1792), pp. 83, 361-62, 382; Eric de More, *The Canals of England* (London, 1961), p. 23; Charles Hadfield, *The Canal Age* (Frederick A. Praeger, New York, 1969), pp. 59-63.

LOCK GATES AND SLUICES

Except in small locks, both ends of a lock chamber were closed by a pair of wooden gates, each gate being rather higher than half the width of the passage. Each gate was formed by a series of horizontal beams connecting a rounded heel or pivot post and a miter-post or breast, against which vertical and diagonal planking were fastened. Usually, the beams were placed closer together towards the bottom of the gates, in order to sustain the increased pressure due to the depth of water; the whole was caulked, pitched and tarred to prevent leakage.⁷⁶

When the gates were closed, they met at an angle, like a very spread-out V, with the point of the V always facing the uphill direction. At the bottom, each pair of gates fitted quite closely against the V-shaped front edge of a stone, brick or wooden sill.

Hollow quoins, which were large hewn stones with a regular space cut out of one of their angles, were worked into the walls for the heel-post to turn in. If a good durable free stone was difficult to procure, the hollow quoins could be made of very large bricks made in proper moulds for the purpose; in large works, a piece of cast iron of the proper shape to work into the wall

76. Most of the Exhibits have plans of gates and sluices.

was sometimes used instead of quoins of stones or bricks. A recess was made in each wall next to the hollow quoins, large and deep enough for the gates to open back into and remain out of the reach of barges passing into or out of the lock.

The weight of the lock-gate was supported by the pivot on which the heel-post turned, and by the anchor strap or collar which encircled the top of the heel-post. A socket at the bottom of the heel-post fitted over a pivot fastened to the heel-post stone; the anchor strap was fastened to the anchor, usually formed by a cast-iron frame, in the form of a sextant, bedded into the masonry and further secured by tie bolts.

Gates were designed to meet in an angle in order to resist the strain and hold out the water better. When the pair of gates met in the center line of the lock, each gate was subjected to the water pressure on its inner face acting as a transverse strain; each gate also supported a compressive strain in the direction of its length, due to the pressure of the opposite gate against its miter-post.

When the water was higher on the uphill side of the gate, its weight pressed on the whole gate and forced the heel-post tightly up against the groove in the brickwork or stone in which it was standing. Even if the water was only a few inches higher

on one side than on the other, it pressed with such force that the gate could not be opened. Because the gates were pressed so tightly together and pushed hard up against the edges of the lock, the miter joint permitted the escape of very little water at all.

Top gates were short and reached only to the bottom of the upper lock, the space below being filled with the sill; the bottom gates were higher and reached to the level of the bottom of the lower lock, which was also the level of the bottom of the lock itself.

Each gate had a very heavy balance beam running out across the top and over the side of the lock. It was usually made from a tree trunk squared off, or left unhewed; part of its job was to balance the weight of the gates so that there was no strain on the collar. To open and close the gates, the lockkeeper and his assistant simply pushed against the beams. If the gate was well balanced, it opened quite easily.

Top miter gates could be swung only when the lock was full, and the lower ones only when it was empty. This meant that the top and the lower gates could never be open at the same time; always the weight of the water kept one pair tightly shut.

Because the twin-miter gates could not be opened against a head of water, openings near the bottom planking admitted water into a lock before the gate was open. These openings were called sluices, wickets, or paddle holes. Because of the sluices, the pressure on each side of the gate was equalized before the balanced beams pulled or pushed the gates against the recesses of the side walls of the lock. The sluices were usually located as near the pivot post as possible to lighten the farther end of the gates and prevent their sinking.

Sluices came in different forms, depending on the taste of the builders. In some gates it was a plate of wood or steel which slid in grooves down near the bottom of the gate on the uphill side.⁷⁷

It is fixed to the bottom of a long shaft which can be wound up or down by a handle, or sometimes by a big smooth wheel with spokes, rather like a ship's wheel. Just occasionally a lock has paddles which are worked by a level instead. And sometimes the paddles are not in the gates at all, but in the side of the lock.⁷⁸

Another variation of sluice was as follows:

A square hole is left in the planking of each lower gate, to which a paddle is

77. Vernon-Harcourt, I, pp. 104-05; Pilkington, p. 19.

78. Pilkington, p. 22.

adapted, with its stem or rod rising up above the top of the gate, by the side of a standard of wood, fixed to the top rail or balance beam of the gate in which is a pinion working into a rack of cast iron on the paddle-stem, which is turned by a winch-handle, and the paddle is retained at any height to which it may be drawn, by a ratchet or stop, that can readily be turned up to lock it into the teeth of the rack, or turned down to discharge or let down the paddle.⁷⁹

Director Mason, in his special report of 1808, refers to two different types of sluices used in the locks of the Potomac canals. In deep locks, like Nos. 2, 3, 4, and 5 at the Great Falls, a butterfly type of sluice was used. This was a flat plate of cast iron that turned on a pivot fixed in the center. To open the sluice, the plate was turned edgewise to the stream. This type of sluice or valve worked very easy and "are managed in deep locks much more readily than those of the ordinary construction." By ordinary construction Mason meant paddles of the lifting or sliding type. Both types were operated by hand and with devices attached to the balanced beams. Physical evidence indicates that the uppermost lock at the Great Falls had a valve of the lifting type.⁸⁰

79. Vallancey, pp. 88-89.

80. Mason report, 1808, Bacon-Foster, pp. 265-66.

Thomas Johnson's sketches of 1785, showing a miter lock gate and a proposed canal for the Great Falls, are the earliest known cartographical representation of the lock canal. His gate is of standard and typical European design, with the sluice at the center and on the lower part of each gate and controlled from above the balance beam by means of devices similar to a ship's wheel and a winch. Johnson sketches were just proposals, but they represented essentially what was adopted at the Great Falls.⁸¹

An undated map of the Great Falls Canal, but presumably drawn during the late part of the 19th century, has several views as follows: location plan, quoin showing gate fastening, cross-section of canal, lock gate, plan view at lock gate recess, and elevation plan of a lock.⁸²

81. See Exhibit VII.

82. See Exhibit IX.

LOCKING UP AND DOWN

How locks, gates, and sluices functioned can be more clearly explained by noting the routine steps taken by a hypothetical boat locking up and down the Great Falls Canal.

Let's assume a boat is ready to ascend through Lock 5. If the lock happens to be full, the weight of the water makes it impossible to open the lower gate in order to let the boat in. Therefore, the lock has to be emptied by opening the sluices in the bottom gate. But first of all, the top gate has to be shut, and its sluices closed, so that no more water may run in. So the lockkeeper closes the top gate and its sluices, and then moves down to the bottom end of the lock.

He is now ready to open the sluices of the lower gate, and as soon as it is done, the water begins to swirl out into the river. After a few minutes the lock is empty, that is, the water has dropped to the level of the river.

Now that the lock is empty, the lock-keeper and his assistant lean on the balance beams, and as soon as the gate is opened, the boat enters the lock; the lock-keeper closes the lower gate and sluices again, and moves back to the top of the gate which is the lower gate of Lock 4.

When the lock-keeper opens the sluices of the top gate, strong jets of water come shooting down into the lock, right over the sill. The level in the lock begins to rise quickly, and the boat is lifted up--inch by inch, to the lock side; the flow slackens and at last it dies away. This means that the level inside the lock is the same as in Lock 4 and the top gate can be opened; the boat moves into the lock and the gates are closed behind. Again the water is let into Lock 4, and the boat rises to the level of Lock 3. When the boat has risen to the top of Lock 1, it is at the level of the upper canal. When the last gates are open, the boat floats out to continue its voyage up the Potomac.

To descend, the order is simply reversed; the boat enters Lock 1; the water is slowly drained away through the sluices until the boat has dropped to the level of Lock 2. This operation is repeated until Lock 5 discharges the boat into the river.

It seems that the whole sequence of going through the locks took a long time, but that was not the case. Two boats, seventy-five feet long, five feet wide, drawing eighteen inches

of water, and carrying more than a hundred barrels of flour each, could pass the five locks in the space of one hour.⁸³

A lot of water, obviously, was wasted in the whole operation of going through the locks. Since the three downstream or lower locks were deep and formed a riser of three steps, they used more water than the first two locks which were separated and of different depth. That is, a boat ascending Locks 5, 4, and 3 drew 70,800 gallons of water from Locks 2 and 1 which had capacity for 41,000 gallons. This extravagant use of water, especially during dry seasons, was solved by the device of a large mooring basin, or waste dam, next to the entrance of Lock 1, and a small reservoir, or pond, adjacent and east of Lock 3. A guard, or control gate at the entrance of Lock 1 regulated the flow of water from the dam to the first lock. Excess water from the dam passed on to the river through wasteways located over its walls. Water was fed from the dam into the side pond, and from here into the lower locks by gravity.⁸⁴

83. Warden, D. W., *Description of the District of Columbia* (Paris, 1816), p. 7.

84. Special meetings, Book A, Great Falls, September 4, 1798, pp. 148-49; Great Falls, October, 1798, pp. 151-53.

Extant records do not show how many boats locked up and down the Great Falls during the existence of the Potomac Company. From August 1799 to August 1822, the Company collected tolls from 13,924 boats using the navigation facilities of the river, and carrying a total of 163,798 1/2 tons of products, mainly flour, whisky, tobacco, and iron. In 1815, during the months of May through September, 354 boats locked through the Great Falls, and in 1816, during the same months, only 179 used the locks.⁸⁵

Two kinds of boats were used--gondolas and sharpers, or sharpshooters. Gondolas were flat-bottomed scows from 50 to 75 feet in length, 9 feet wide and 1 foot in depth. They were generally managed by a crew of five men and were propelled by poles. When these gondolas reached their destination, they were sold and the timbers used in constructing homes at Georgetown and along the river front. The sharpers were about 60 feet in length, 7 feet wide and 2 feet in depth, pointed at the ends.

85. Book B, pp. 281-308; Book C, p. 5. Other products carried through the canals were: clover seed, bacon, pork, butter, lard, castings, flax seed, potash, fish, oil, and lime. See also Frederick Gutheim, *The Potomac* (Rinehart and Company, Inc., New York, 1949), p. 255.

When they unloaded their freight, they returned light on the return trip, poling against the current up the canal and river.⁸⁶

An official seal adopted by the Potomac Company shows one of the narrow river bateaux, loaded with flour barrels, being poled into one of the locks; in the background there is a perspective of the river, and another boat.⁸⁷

86. *The Evening Star* (Washington, D. C.), Saturday, May 13, 1893, p. 12; Wilhelmus Bogart Bryan, *A History of the National Capital* (The Macmillan Company, New York, 1914), I, 70.

87. See Exhibits IV and V for a boat locking up and down.

MAINTENANCE AND REPAIRS: 1802 - 1828

After the completion of the Great Falls Canal, the Potomac Company continued with the improvement of the river bed. As far as canal building was concerned, the biggest job ahead was the rebuilding of the locks at the Little Falls with free stone.⁸⁸

Many of the records of the Potomac Company after 1802 are missing, but the few which are available show that maintenance and repair of the canals and locks were heavy burdens on the meager Company resources. High waters caused numerous problems to the canal walls and to the stone dams, or wing walls built at the entrance of the canals to funnel more water into the latter. The waters eroded the banks of the canals and the walls of the locks, and carried down considerable amounts of silt, gravel, and drift wood, which had to be cleaned out periodically.

Water was precious, especially in dry seasons, and it was essential to have a minimum amount of water leakage through the lock gates. Lock maintenance, particularly the making and fitting of new lock gates or the fitting of a new wooden sill, was a highly skilled job. The heavy oak gates had to be constructed in

88. Annual meetings, Book A, pp. 246-50, Alexandria, August 2, 1802; pp. 268-71, Georgetown, August 1, 1803.

such a way as to fit snugly against the sill and also into the hollow quoins in the lock walls in which the gates swung.

By August 1808 the lower gates at the Great Falls were very much affected by natural decay; one was so rotten that it had to be replaced. Both the canal and the wing wall of the Little Falls needed repairs also.⁸⁹

In August 1810 the Company directors resolved to authorize Superintendent Thompson to employ as many laborers as were necessary to repair the locks and canals at the Great Falls, the Little Falls, Seneca, and Harpers Ferry, and to carry on the repairs under proper supervision.⁹⁰

The wooden locks at the Little Falls held out until 1815, when the set of locks at the foot of the canal "gave way" in such a manner that it became necessary to renew them entirely. A new site was selected and four new stone locks were built.⁹¹

In the summer of 1818 the pair of gates in the lower lock at the Great Falls unexpectedly gave way. At the same time it

89. Annual meetings, Book A, Alexandria, August 1, 1808.

90. *Ibid.*, pp. 97-81, August 6, 1810.

91. *Ibid.*, Book B, pp. 320-24, August 1816; communication of December 6, 1817, Book B, pp. 342-50; Bacon-Foster, p. 272.

was found that all the other gates were decayed and might be liable in like manner to break down suddenly. Consequently, arrangements were made to build five pairs of gates as soon as possible, together with some repairs to the walls of the locks. Early in 1820 the new gates were completed and finally hung.⁹²

In the annual report of August 1821, the president of the Potomac Company informed that "everything in the power of the Directors" was done to preserve the works in good repair, and to keep the navigation at least in as favorable a state as it had been in late years. At the head of the canal at the Great Falls there was a deficiency of water, as compared with that flowing in the river above. This shortage of water was corrected by raising and extending the wing dam considerably and in a stable manner; the whole line of canal and lockage was cleaned.

On the Seneca canal some work has been done in clearing it of the collection of drift timber and of the stone and gravel that the freshes had deposited there. At the Little Falls the works are in good repair, the canal has for some time been gradually filling up by means of ordinary deposit and the wash from the hills, and though no material delays

92. Annual meetings, Book B, pp. 365-70, August 3, 1818; pp. 383-86, August 2, 1819; NA, Entry #163, Letters sent (1817-1828), pp. 33-34, Mason to Secretary of Board of Public Works of Virginia, Georgetown, November 29, 1819; Entry #162, Correspondence and Reports (1812-1825), Box #2. Report to Board of Public Works of Virginia, Georgetown, December 5, 1820; Annual meetings, Book B, pp. 411-18, August 7, 1820.

or injuries have as yet been experienced from this circumstance, it has become necessary to provide against it; to facilitate the cleansing of this and the canal at the Great Falls the Directors have determined to build a small mud-machine to be worked by manual labor, calculated to save both time and expense in an operation which must from the nature of the case be frequently repeated. This machine is now on hand, and it is expected will be at work during the low water of the present season. The navigation has been carried on during the last season as usual and without interruption.⁹³

Later in the year President Mason reported that the lock gates at the Great Falls had been damaged by the pressure of ice against them. The mud-machine, calculated to pass through the locks, was used "to much advantage" in cleaning them.⁹⁴

As usual, the transportation through the river and canals was considerable and constant at all times, except in the driest seasons and during the hard frosts. Repair works became necessary at any time and there was always the threat of an interruption to the navigation. Late in 1822 the walls in two of the locks at the Great Falls partially gave way; the canal at the Little Falls

93. Annual meetings, Book C, August 6, 1821; Bacon-Foster, pp. 221-23.

94. NA, Entry #163, Letters sent (1817-1828), pp. 69-70, Mason's report to Board of Public Works, Virginia, December 5, 1821.

became almost completely filled with sediments. These kinds of repairs had to wait for the dry season.⁹⁵

During 1825 the navigation in the several parts of the river was kept in good state with very little expense. Later in the year, however, the navigation became somewhat obstructed by the partial falling of the walls of some of the canals, and by the deposit of mud in others, as well as from decay of some of the lock gates.⁹⁶

It became indispensably necessary to effect considerable repairs to the works at the Little Falls. The canal, which had not been cleaned out for several years, was dredged out along its whole length; the wall at its entrance was repaired and heightened, the boat course at its mouth cleaned of the rocks which obstructed the passage of boats, one of the tumbling dams was rebuilt from its foundation, and other necessary repairs were completed. Also contracts were made for the immediate erection of a new pair of upper gates to be in readiness in case of accident or sudden disrepair.

95. Annual meetings, Book C, August 5, 1822, Correspondence and Reports, Box #2; August 4, 1823, Georgetown, pp. 13-17; August 2, 1824, Alexandria, pp. 23-27.

96. Annual meetings, Book C, pp. 45-50, Georgetown, August 1, 1825.

At the Great Falls, the lowermost pair of lock gates--the largest and most important of the works at that place--were replaced by a new pair of "substantial materials and good workmanship." A new waste water sluice of stone masonry was built; the entire canal was cleaned out and the wing wall at the entrance of the canal above was repaired and heightened so as to afford 18 inches more of water in a low stage of the river than formerly.

The sluices and dams between the Great Falls and Seneca were repaired and rebuilt so far as the season would permit; the passage through Seneca canal was considerably improved.⁹⁷

In 1827 the Company directors realized that in spite of all previous repairs, much work was still required to preserve the river navigation. This work included the repair of the locks at the Great and the Little Falls, rebuilding the dams, sluices and wing walls in the upper part of the river and mending the courses.

Advantage was taken of the low stage of the water in the latter part of last summer, and in the fall to execute these works to a considerable amount from Harpers Ferry to the

97. Annual meetings, Book C, pp. 72-77, August 7, 1826.

head of Seneca and thence to tide water, but the approach of winter rendered the days too short to work with effect, and the rise in the waters rendered it necessary to desist from further operations. A portion therefore was not finally completed. What was done however has so far improved the navigation as to admit of the transport of ten barrels more of flour in the same stage of water Much however yet remains to be done, both on the river and at Great and Little Falls; at the latter places, a competent force under the direction of skilful workmen and judicious superintendence is now in train of executing such repairs as are essential there.

Careful examination of the works at the Great Falls displayed the imperious necessity of replacing many of the timbers which were attached and formed part of the locks--like the sills. These timbers were in a state of natural decay. It was necessary also to pull down and rebuild, from the foundation, the masonry of some of the locks. This masonry was in a "state of dilapidation from the imperfection originally in the mode of facing them with hewn stone."

At the Little Falls the upper pair of gates was replaced; skilful carpenters were employed in framing new gates for the remaining locks, "in order for insertion whenever required."⁹⁸

98. Annual meetings, Book C, pp. 97-102, August 17, 1827.

According to the annual report of 1828, in addition to the repairs and improvements done in the previous year on the different locks, canals, and other works in various parts of the river, three of the locks at the Great Falls received "now" a thorough repair in the stone work. Two of the locks were rebuilt from the ground; a large portion of the middle lock (No. 3) was replaced from the foundation. Another considerable expenditure was also made in repairs of the gates and other works requiring carpenter's assistance.

At the Little Falls, a considerable portion of the canal was cleaned out and one of the tumbling dams was rebuilt with stone from its foundation. Three pairs of new gates, framed of first rate timber, were inserted to replace others which had become unsafe from long use and the natural decay incident to works of that nature. Timber for a fourth pair was also provided and was placed on the spot and partially framed for the purpose.

At Payne's Falls, below Harpers Ferry, and at Stubbeville Falls, below the Great Falls, permanent and advantageous improvements were made.⁹⁹

99. Annual meetings, Book C, pp. 123-28, August 4, 1828.

With the above annual report of the President, the records of the Potomac Company abruptly end. On the 15th of August 1828, the Company passed into oblivion when its charter and official papers were conveyed to the Chesapeake and Ohio Canal Company. Work in the new canal had commenced on July 4, 1826, but the old works continued in use until 1830 "when the locks at the Great Falls were dismantled and abandoned."¹⁰⁰ Subsequently, nature took full possession of the old canal, with huge trees and underbrush growing and flourishing in its fertile bed.

100. Bacon-Foster, pp. 242-43.

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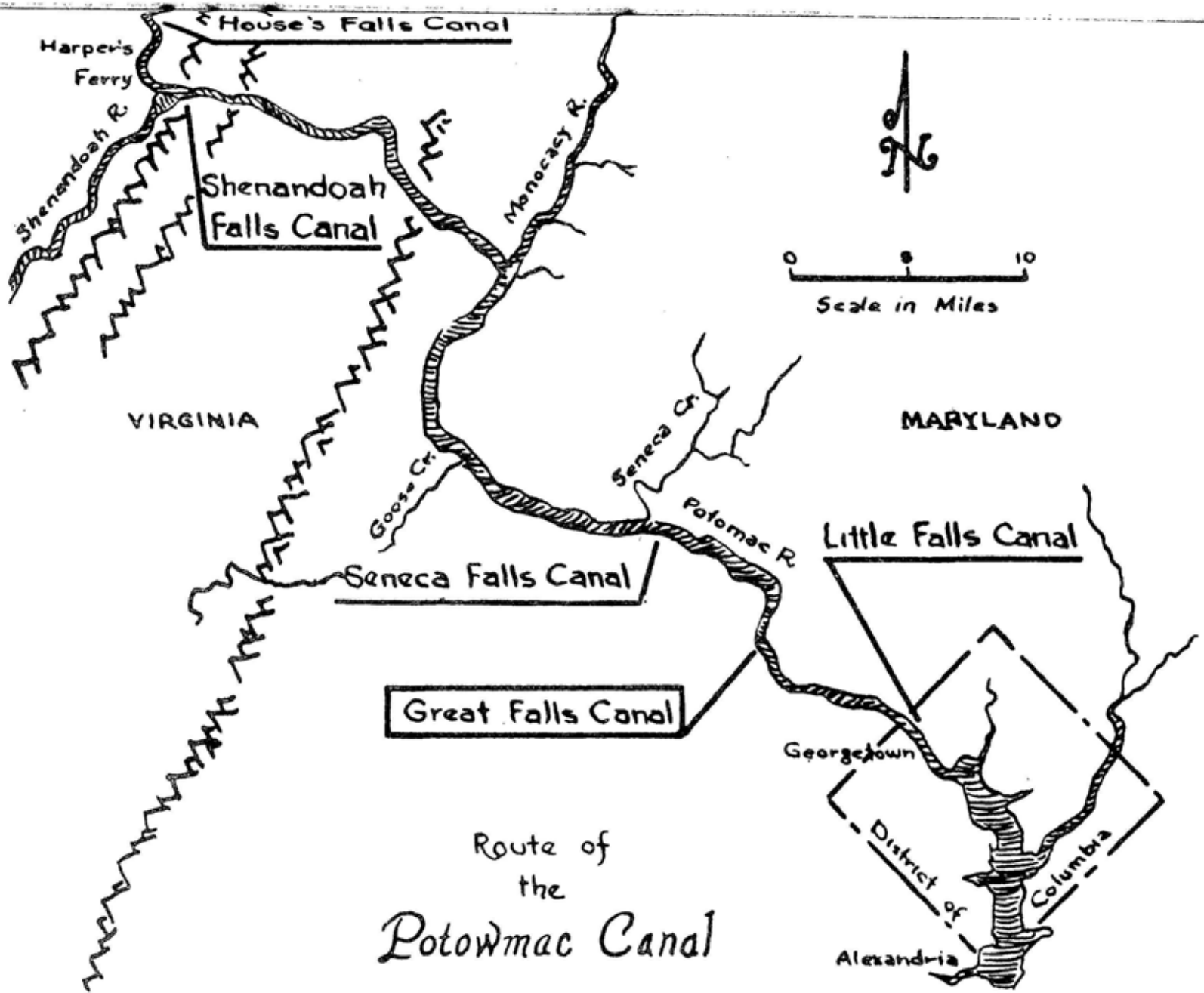
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MAPS, PLANS, AND SKETCHES

Exhibit 1. Route of the Potowmac Canal--location
plan (from *History of the Great Falls
Canal and Locks*, 1969, ASCE Publication).



Route of
 the
 Potowmac Canal

Exhibit II. Plan and Profile of Great Falls Canal
and Locks (*History of the Great Falls
and Locks*, 1969, ASCE Publication).

PLAN AND PROFILE OF GREAT FALLS CANAL & LOCKS

(adapted from an early map)

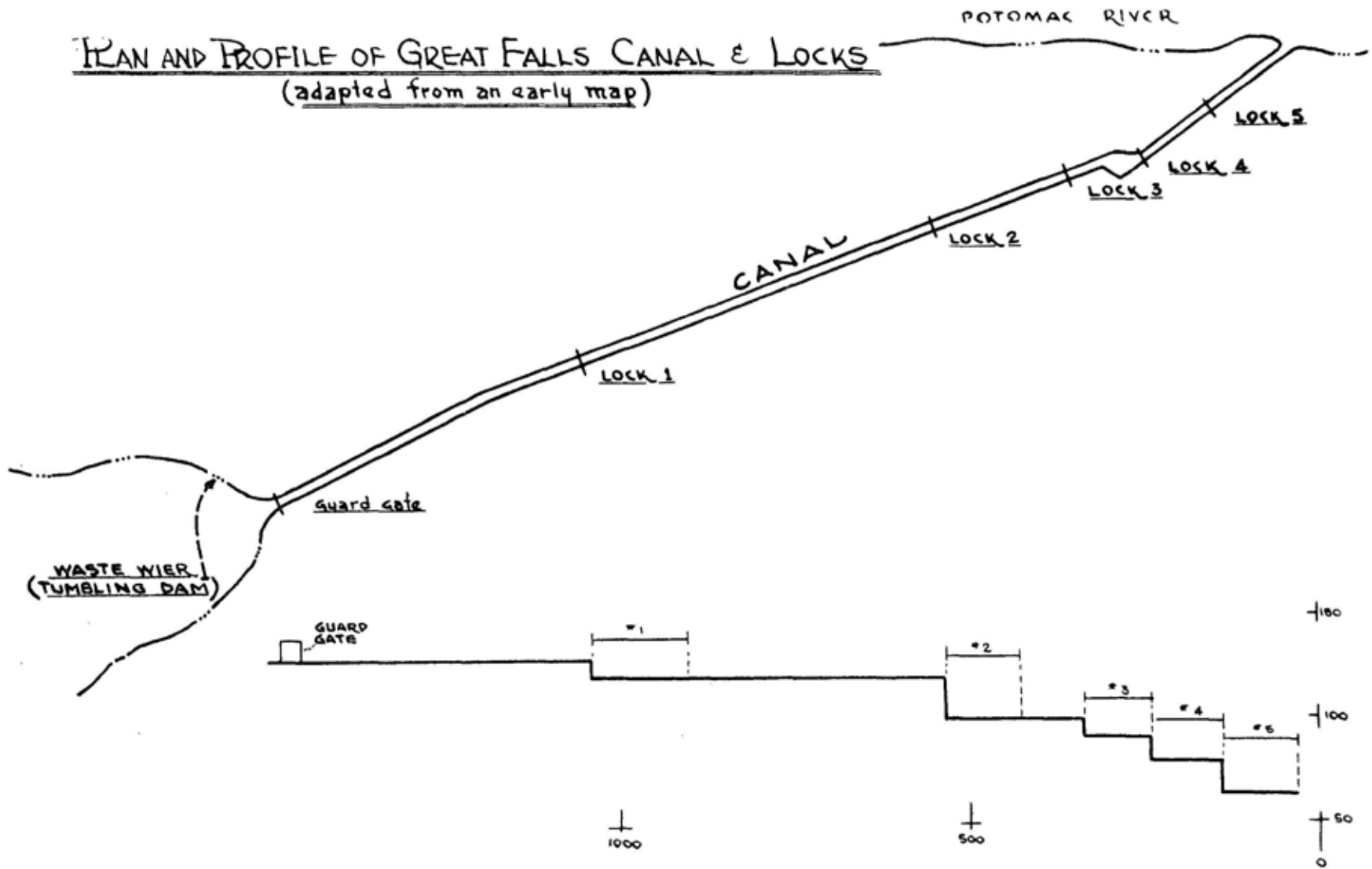


Exhibit III. Plan of locks, gates and sluices (Vallancey,
A Treatise on Inland Navigation, 1763),
Parts 1-3.

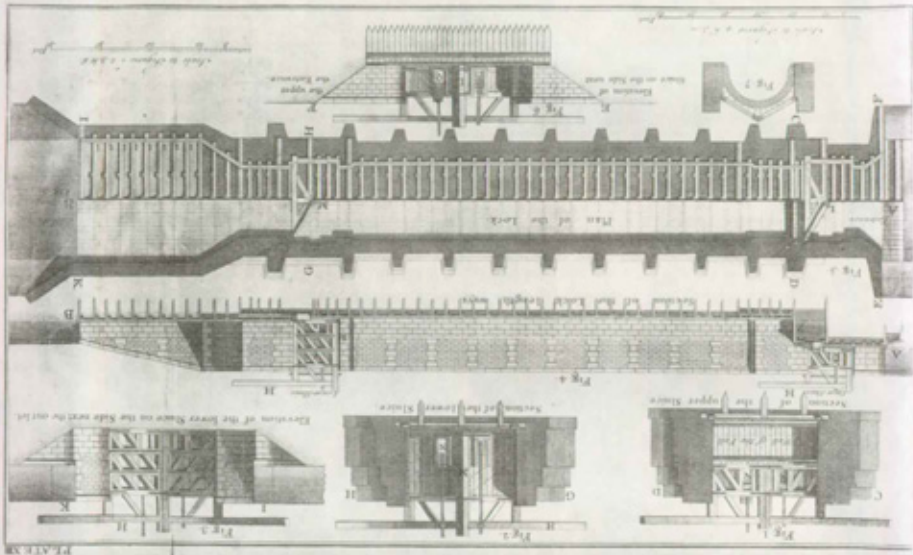
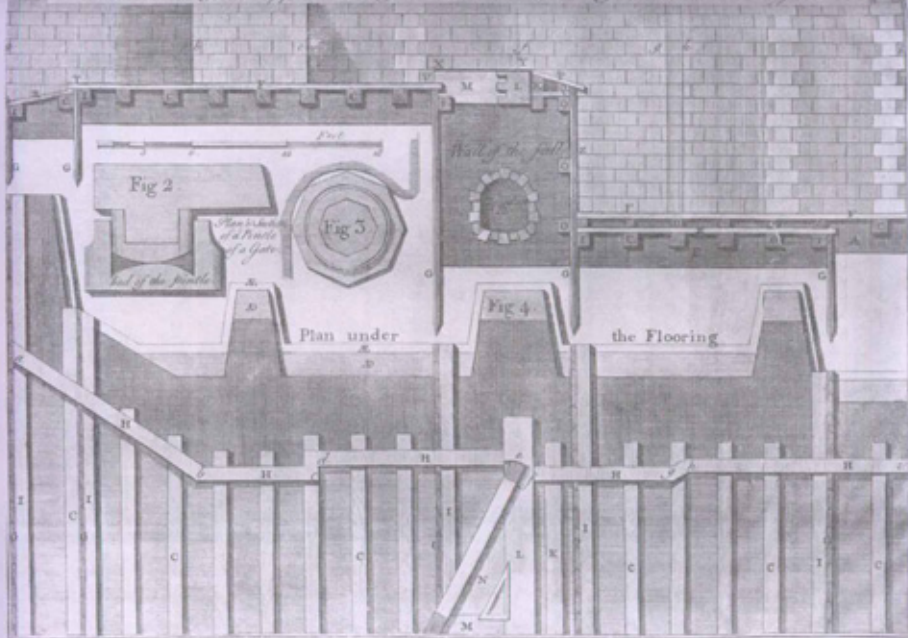
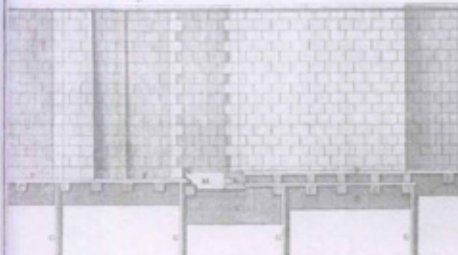


Plate a section of the upper Store of a Lock with the Head of the Bullion in large state



SECTION of the lower Sluice at large
 Figure 1.



PLAN of half the lower Sluice under the flooring

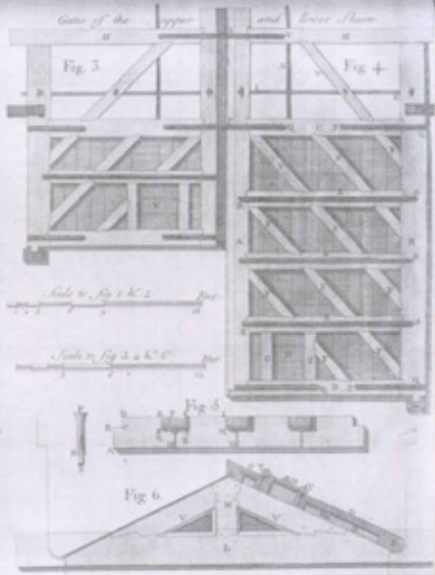
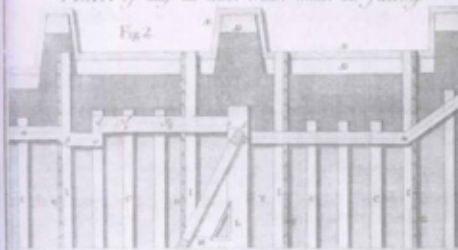


Exhibit IV. Canal and Sluices (*Recueil De Planches*,
1767).

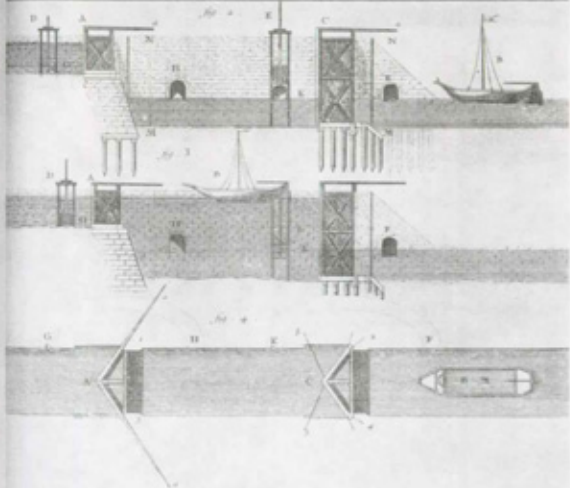


Exhibit V. Plan of Canal and Locks (Encyclopaedia, Britannica, 1771).

Figure 1 A perspective view of part of a canal with locks: L, vessel within the lock AC; XY, flood-gates; D, canal; Ab, Ab, Cb, Cb, levers or balanced beams.

Figure 2 Section of an open lock: the vessel L about to enter lock AC; GH, sluice or subterranean passage for letting water from canal D to lock AC; KF, sluice or subterranean passage for water from lock to the inferior canal B.

Figure 3 Section of a lock full of water: the vessel L raised to a level with the water in the superior canal D.

Figure 4 Plan of a lock: L, a vessel in the inferior canal; C, the lower or under gate; A, the upper gate; GH, KF, sluices; Ab, Ab, balanced beams.



Fig. 2.
Section of a Lock



Fig. 3. Section
of a Lock full of Water



Fig. 4. Plan
of a
Lock

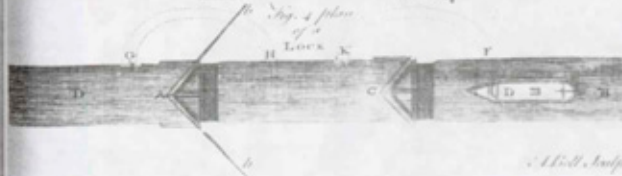
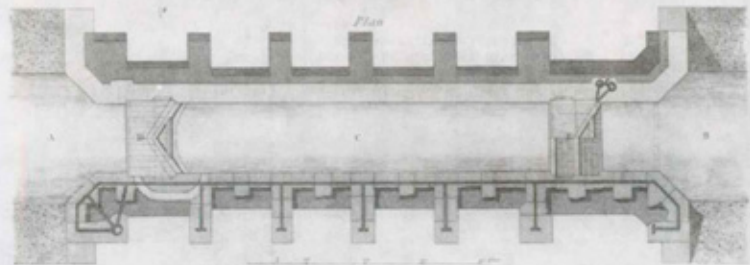
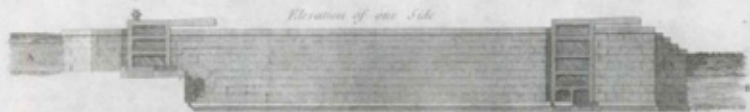


Exhibit VI. Lock for a Canal (Phillips, *Inland Navigation*, 1792).

- A - Upper water of the canal.
- B - Lower water of the canal.
- C - Chamber of the lock.
- D - Platform on which the upper gates are hung.
- E - Lower ditto, showing the manner of construction.
- F - Sluices through which the water passes into the chamber, to raise it equal with the upper chamber.
- G - Paddles in the gates, to reduce the water to the lower level.



Author's Patent for the Improvement in the Construction of the

Exhibit VII. Sketches of proposed Canal and Locks,
Great Falls, by Thomas Johnson, 1785
(Courtesy of Minnesota Historical
Society, where the originals are
located.)

Part 1 - Plan of Canal and Profile of Locks.

Part 2 - View and elevation of miter gates and
plan of a lock.

Shrub

S. 15. W. 20 ft

S. 23. E. 94 ft

S. 7. E. 30 ft

S. 33. E. 78 ft

S. 41. E. 70 ft

S. 20. E. 30 ft

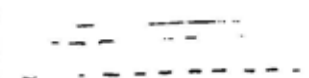
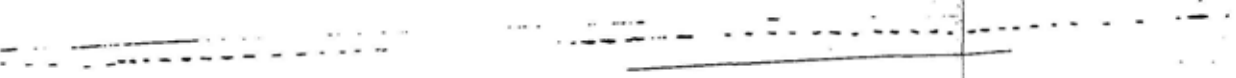
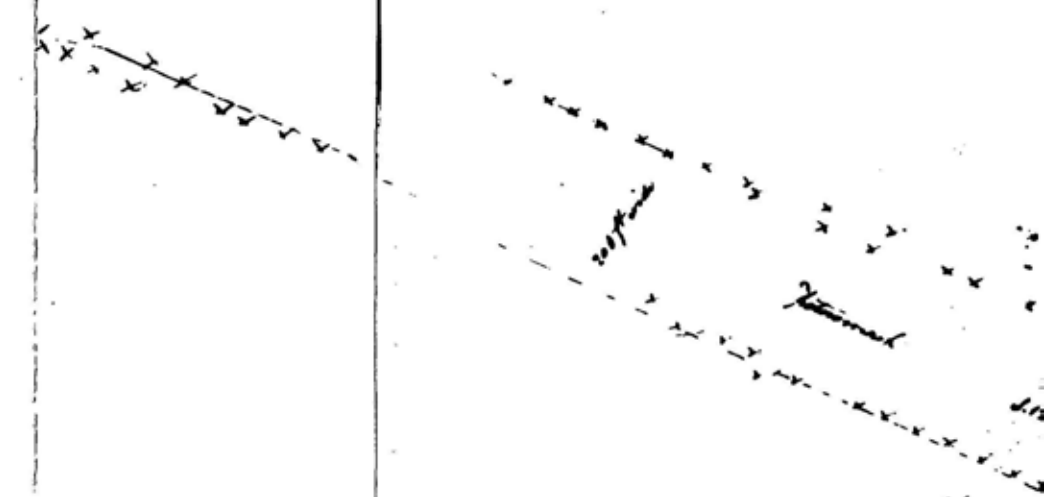
S. 17. E. 30 ft

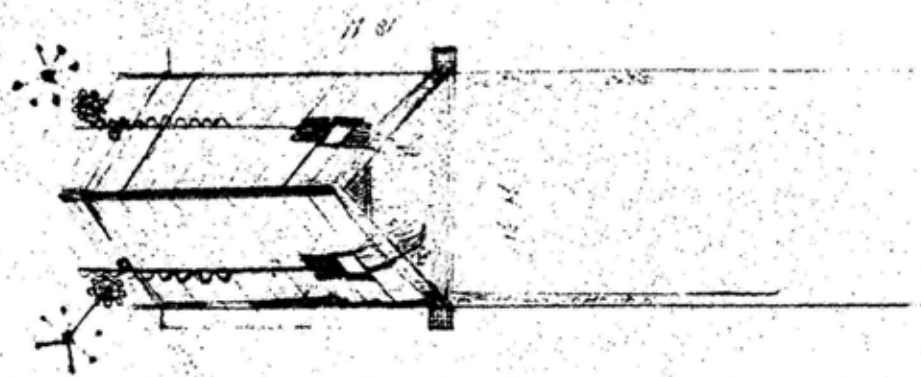
S. 37. E. 20 ft

S. 41. E. 36 ft

100 ft

50 ft





17 81

100 feet long by 11 ft

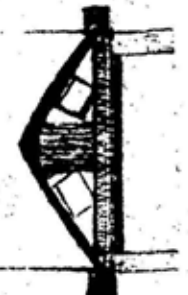
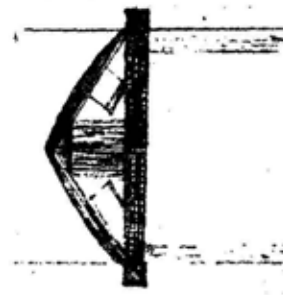


Exhibit VIII. Map of the Great Falls Canal, late
18th century (National Archives)

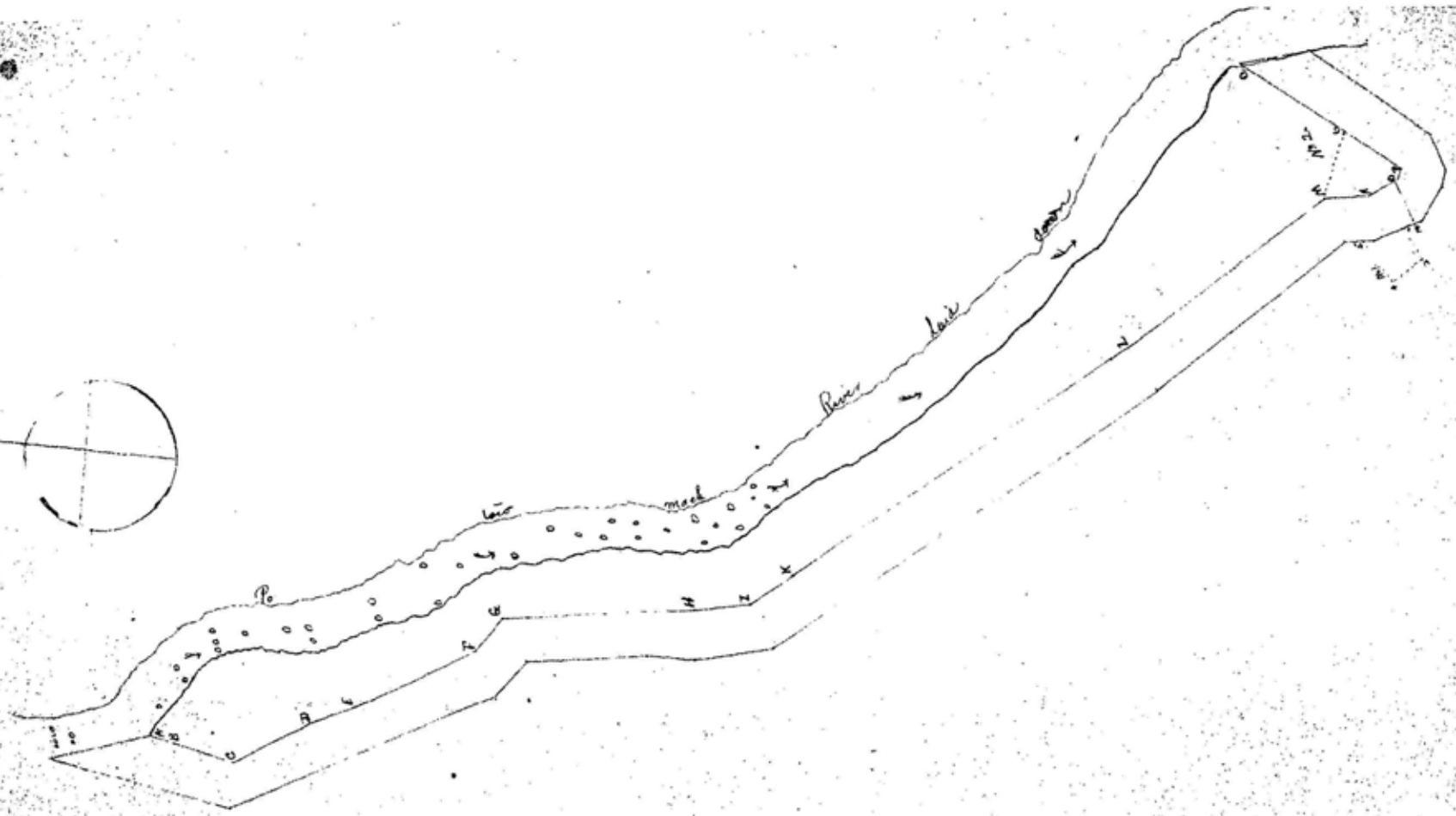


Exhibit IX. Potomac Company's Canal, 19th century(?)
(Copy from National Capital Planning
Commission), location of original,
unknown

Part 1 - Location plan for Great Falls Canal and
Locks

Part 2 - Elevation plan

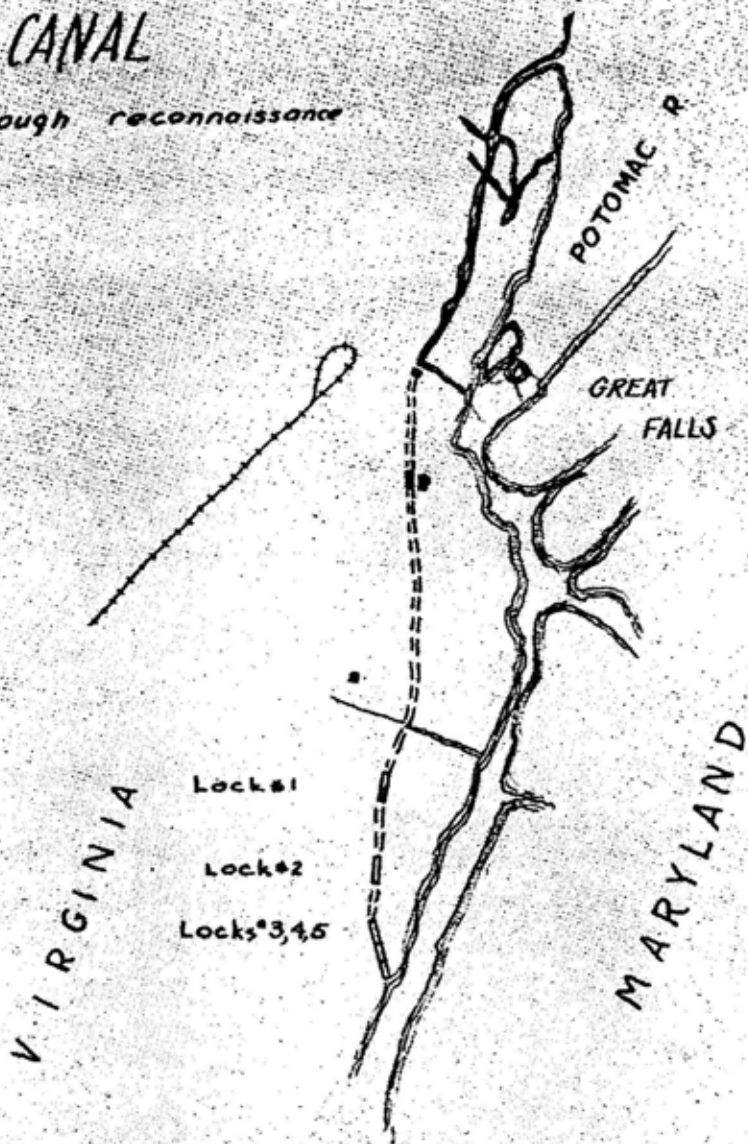
Part 3 - Quoin showing gate fastening and cross-
section of Canal

Part 4 - Plan view at Lock gate recess

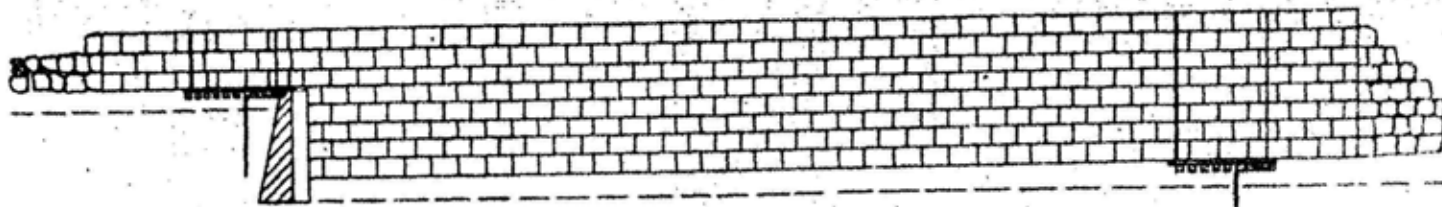
Part 5 - Lock Gate

Map Showing The
POTOMAC COMPANY'S
CANAL

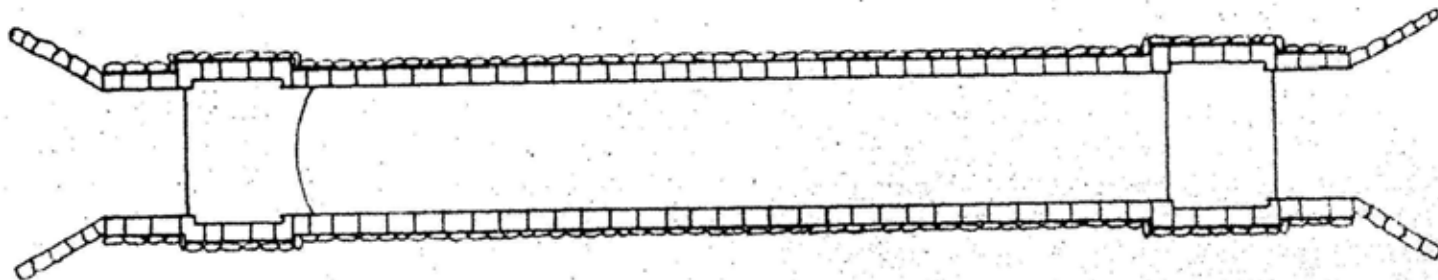
From a rough reconnaissance



ELEVATION

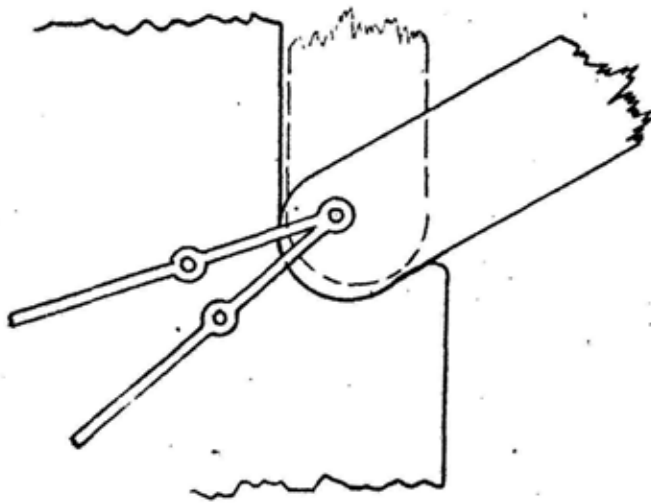


100' LOCK



PLAN

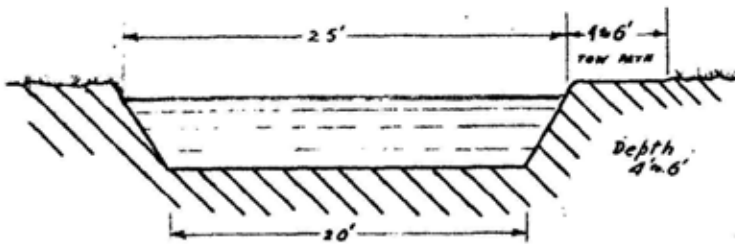
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QUOIN

Showing Gate Fastening

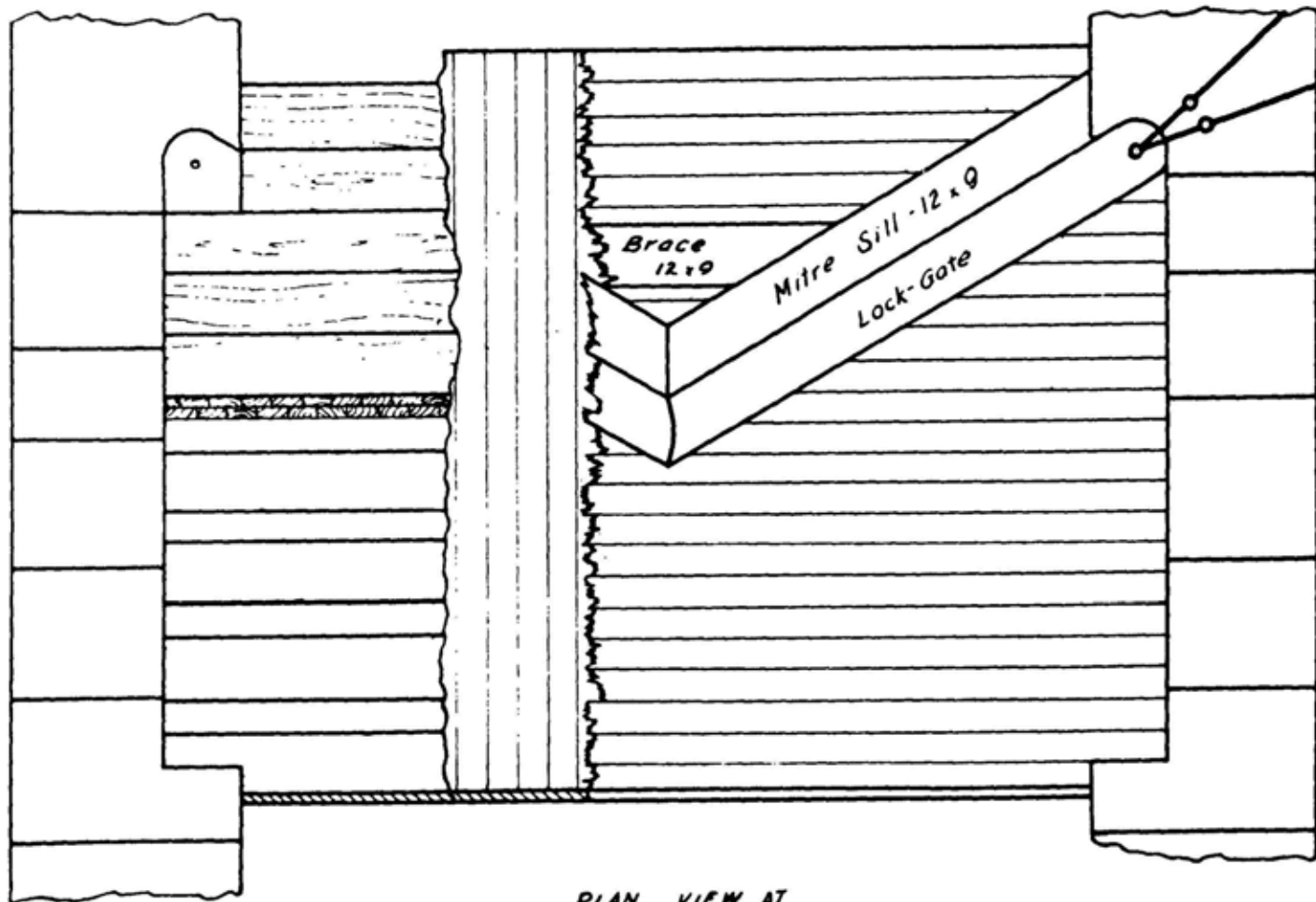
1" = 3'



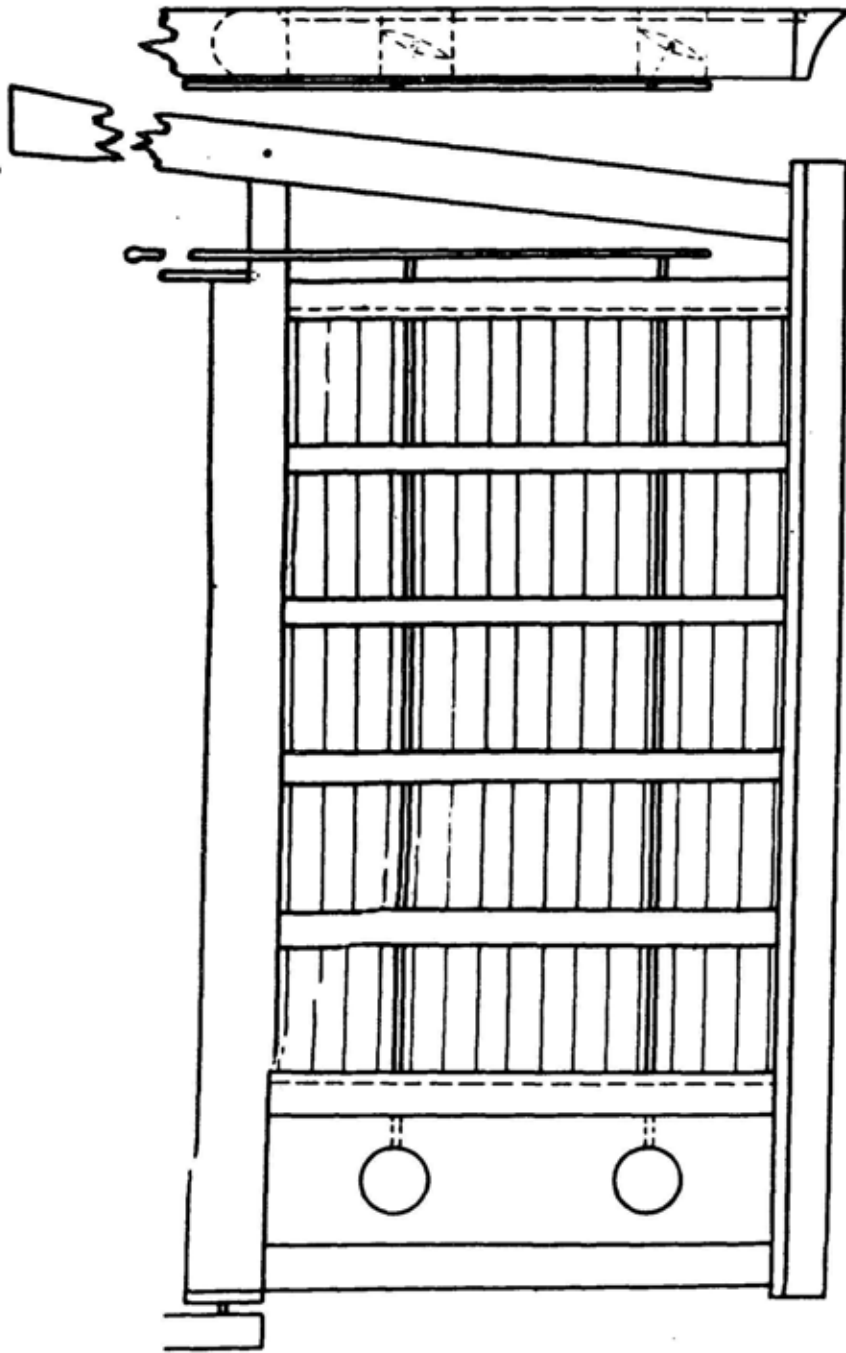
CROSS-SECTION
OF
CANAL

1" = 10'

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PLAN VIEW AT
LOCK GATE RECESS



LOCK GATE

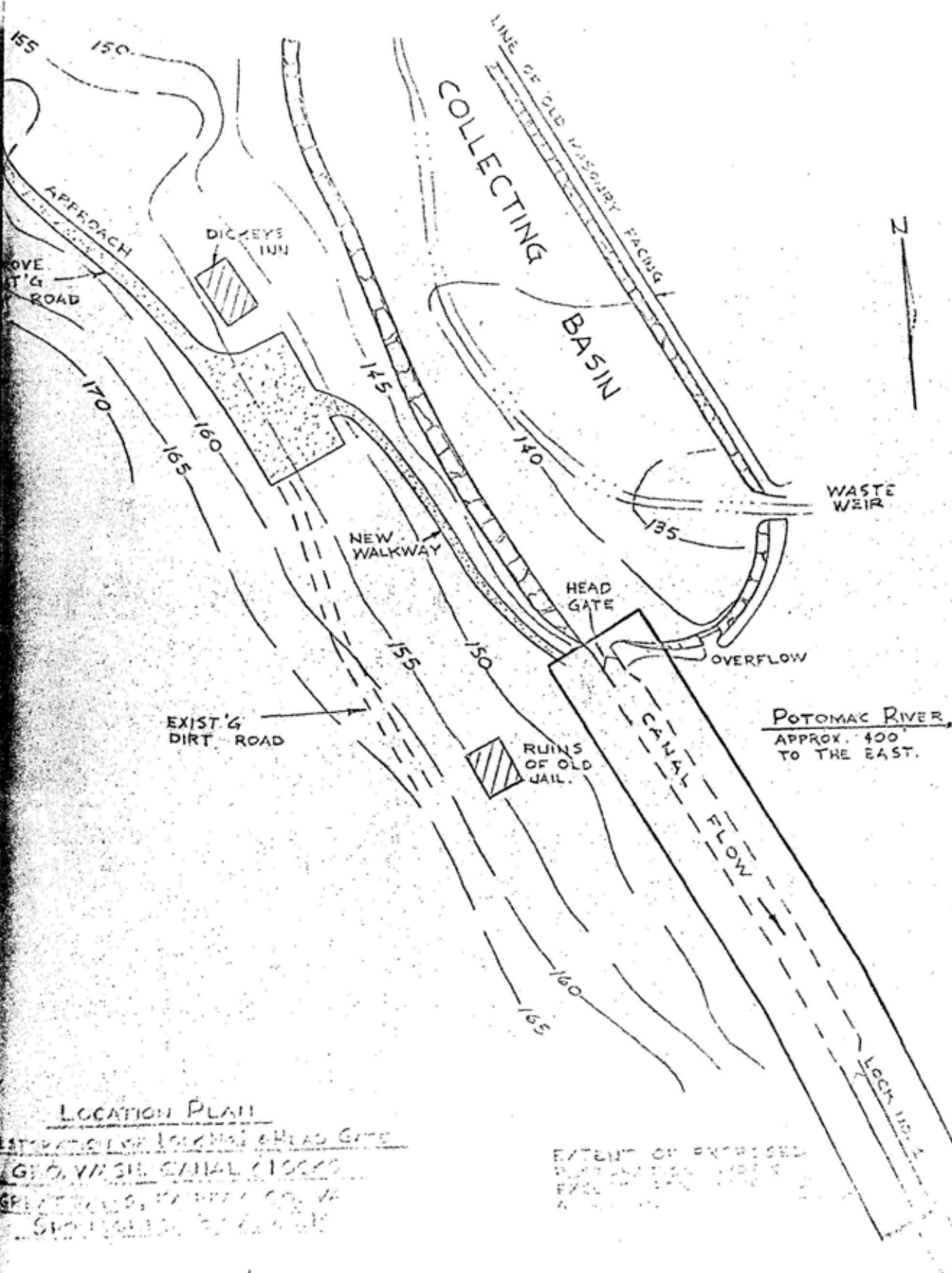
1" - 3/4'

75.46/2210.c - 3251

Exhibit X. Washington surveying Potomac Canal
construction (from painting in Hagley
Museum, Wilmington, Del.).



Exhibit XI. Plan of the proposed restoration of
Lock 1 by the American Society of Civil
Engineers.



LOCATION PLAN
 LOCATION OF LOCK AND HEAD GATE
 GEO. VINTAGE CANAL LOCKS
 GREAT FALLS, FARMER CO. VA
 GEORGETOWN, DISTRICT OF COLUMBIA

EXTENT OF PROPOSED
 IMPROVEMENTS AND
 EXISTING CANAL
 AND LOCKS

SCALE 1" = 100'

Exhibit XII. Seal of the Potomack Company.



THE GREAT SEAL OF THE POTOMACK COMPANY

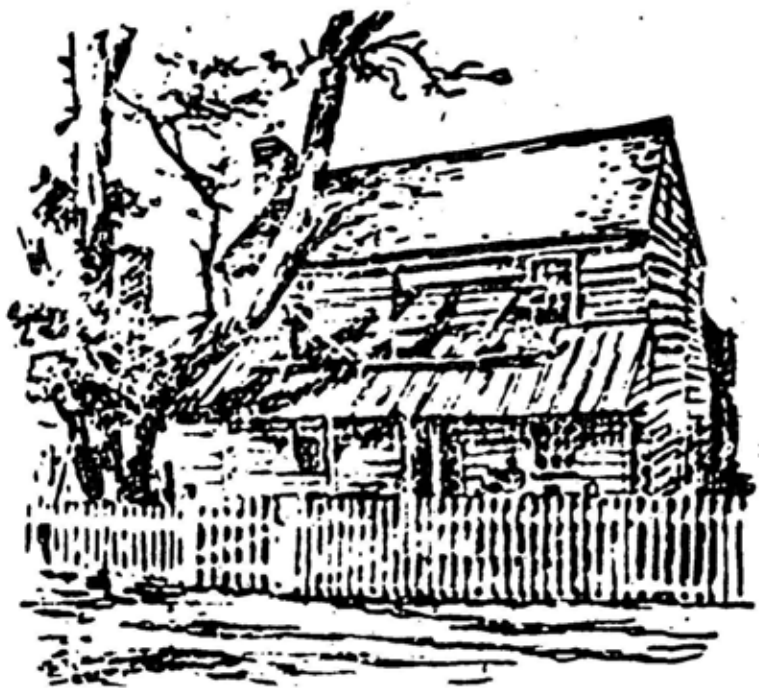
(Reproduced by the Maurice Joyce Co. for the Col. Hist. Society)

Henry G. Wagner photographs, "The Potomac Canal,"
The Evening Star, Washington, D. C., May 13, 1893.

Plates 1 and 2. Above, entrance to the canal above the falls; below, general view of the canal. "At the entrance of the canal above the falls the ripple in the river marks plainly the remnant of the dam that divided the waters from their natural course, and which still flow on and on 500 yards through the rockbound trough of the old canal, and then, releasing themselves, rush through the moss-covered bank and join the surging torrent below. The remainder of the ditch is dry, and huge trees have grown and flourish in its fertile bed."



Plates 3 and 4. Office of the Great Falls Manufacturing Company (above), and the Log Warehouse, below. Near Lock 1 "are the remains of once prosperous village. A sign over the entrance of a log dwelling informs you it was the 'office of the Great Falls Manufacturing Company.' It is now known as the Dickey Inn, where the wayfarer can satisfy the inner man. Near here stands the log warehouse and the tottering walls of the old jail--all that mark the spot where dwelt the villagers who no doubt dreamed that on that place would rise a prosperous city worthy of the progenitor of this great project, Gen. Washington."



Plates 5 and 6. At Lock 2 (above) "two large sycamore trees arise between the large gate caps of cut stone-silent sentinels to its entrance." Below, Lock 3, looking up the canal.



Plates 7 and 8. Locks 4 and 5, cut through solid rock, below the falls. These locks "chiseled through solid rock present a weird spectacle. Standing in the center of the gorge facing the river great walls rise on either side to the height of 100 feet. Fragments of rocks are hanging here and there, iron braces peer from the sides on which swung the gates that held the imprisoned waters, around are decayed timbers of the old locks behind a mass of broken rock and underbrush and in front the ever-flowing current."



THOMAS FORSYTHE NELSON PHOTOGRAPHS (*Washington's
Canal*, 1910)

Plate 9. Great Falls of the Potomac from the Maryland side

Plate 10. Lock 1 and nature



Plate 11. Lock 2

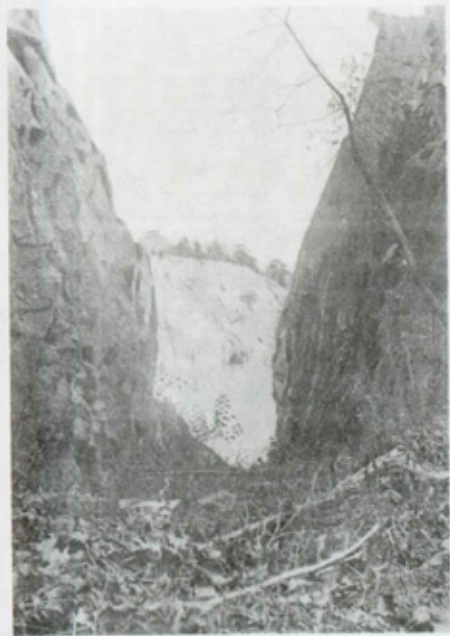
Plate 12. Lock 3



Plate 13. Locks 4 and 5 looking in from the river



Plate 14. Locks 4 and 5 looking out across the river
towards the Maryland side



EXISTING CONDITIONS

Plate 15. Entrance of canal, above the falls. On the left, and not shown in the photograph, are remnants of the dam that regulated the flow of water into the canal.



Plate 16. Typical stone wall to protect portions of
the canal banks.



Plate 17. A small dam with spillways prevents water from overflowing the existing portion of the canal.



Plate 18. The canal narrows as it passes behind the
Visitor Center, with the water scarcely
flowing.



Plate 19. The water still flows along a portion of the glade. Beyond the small wooden bridge at the background, the water disappears and the canal bed is completely overwhelmed by nature.



Plate 20. The entrance of the headgate is
almost completely obliterated.



Plate 21. Remains of Lock 1. Recesses in the walls mark the locations where the gates were hung.



Plate 22. Lock 2. The bulging inward of the walls
has been caused by the force of tree roots.



Plate 23. All that remains of Lock 3 is a portion of the wall on the left, with stagnant water at the bottom.



Plate 24. Deep cut looking toward the river,
for Locks 4 and 5.

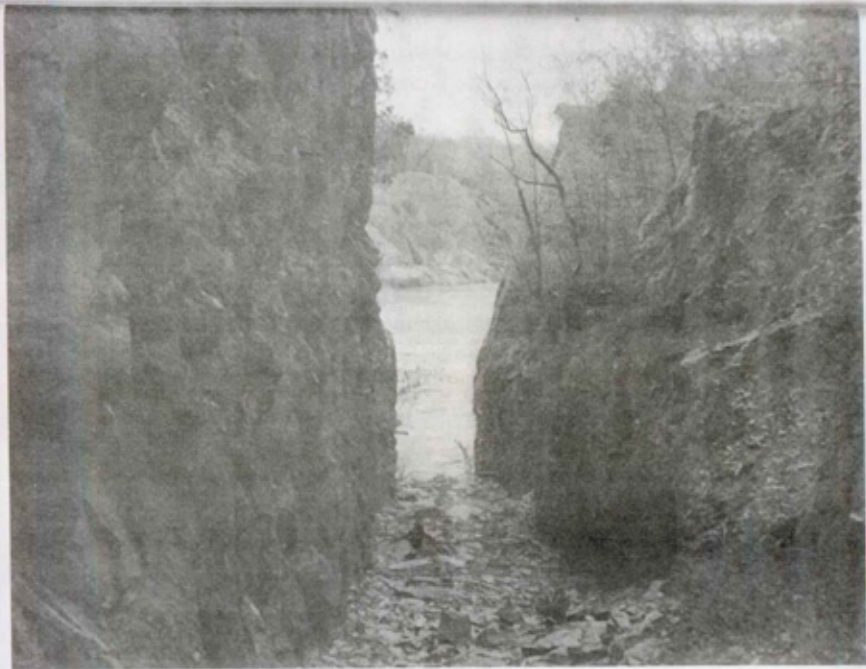


Plate 25. Deep cut for Locks 4 and 5, taken from the river; the ranger in the background is standing near Lock 3.

