

historic structure report

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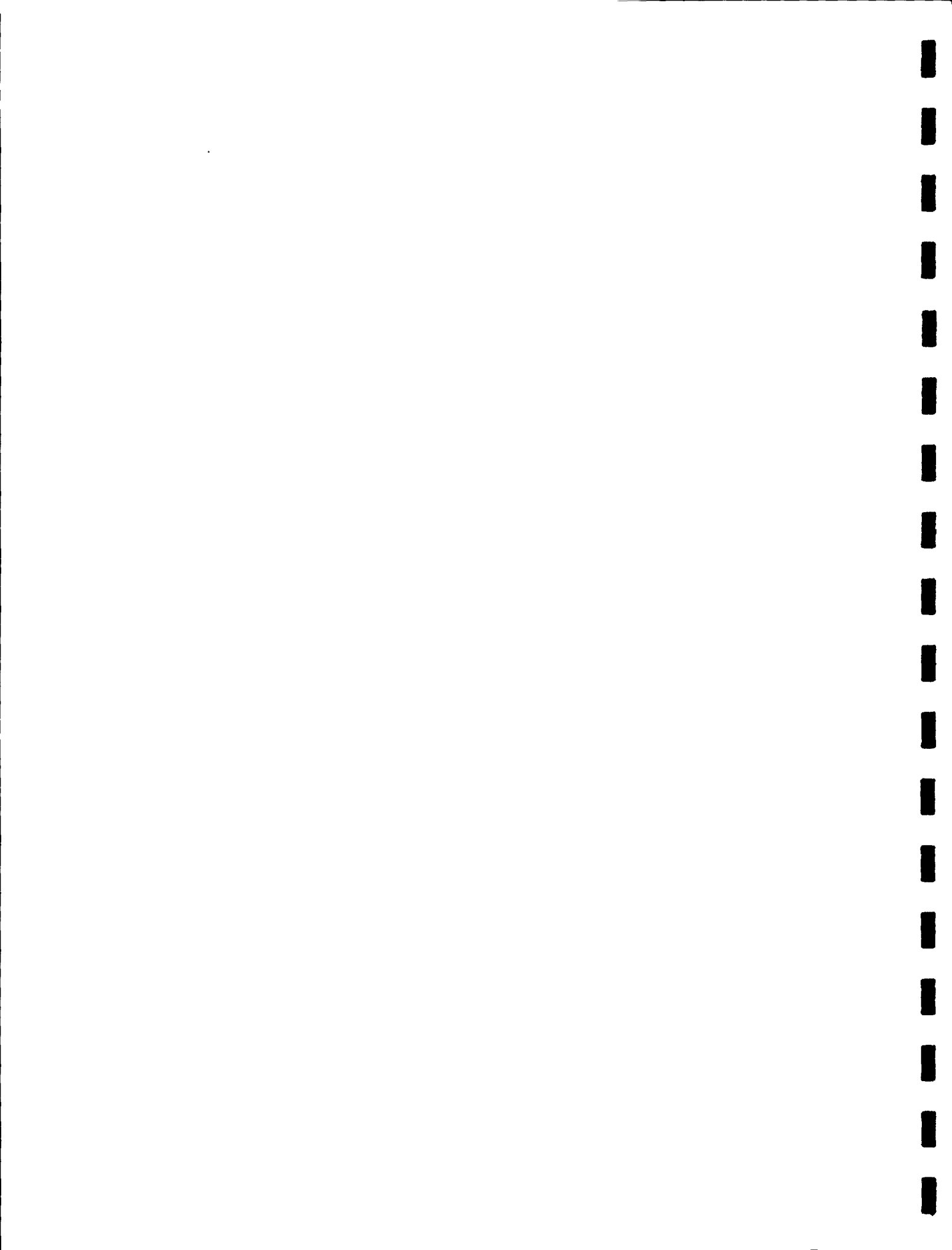
CHESAPEAKE AND OHIO CANAL

THE CANAL PRISM

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HISTORIC STRUCTURE REPORT
THE CANAL PRISM
INCLUDING TOWPATH WITH CANAL BERM
AND RIVER REVETMENTS
HISTORICAL DATA
CHESAPEAKE AND OHIO CANAL NATIONAL HISTORICAL PARK
MD.-D.C.-W.VA.

by

Harlan D. Unrau

DENVER SERVICE CENTER
HISTORIC PRESERVATION TEAM
NATIONAL PARK SERVICE
UNITED STATES DEPARTMENT OF THE INTERIOR
DENVER, COLORADO

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PREFACE

This report has been prepared to satisfy in part the research needs for the restoration and preservation of the canal prism including the towpath, canal berm, and river revetments of the Chesapeake and Ohio Canal. Previous to this report, John F. Luzader did a general study of documentary sources related to the construction of the canal towpath. The purpose of this present study is to expand upon John Luzader's research and broaden its scope to include other elements of the canal prism.

Since this historic structure report on the canal trunk encompasses the entire 185-mile length of the waterway, an effort has been made to deal with its general dimensions while pointing out significant variations in its design throughout its 22-year period of construction. General problems in the excavation, embankment, and external walling of the canal have been considered, with stress being given to topics of critical importance to the maintenance of a functional waterway.

A number of persons have assisted in the preparation of this report. Thanks are due to Richard Huber and James Askins of the C & O Canal Restoration Team (DSC) for introducing me to the area and its significance; to Interpretive Specialist Ellwood Wineholt for assistance at the park headquarters; to Maria Joy and Robert Kvasnicka of the National Archives who were especially helpful in suggesting and locating unpublished documents; and to Dr. Harry Pfanz and Barry Mackintosh of Park Historic Preservation, Superintendent William R. Failor of C & O Canal NHP, Supervisory Historian F. Ross Holland, Historical Architect Thomas N. Crellin, and Editor Linda Wedel for reading the manuscript and providing editorial assistance.

Harlan D. Unrau
Jan. 17, 1974

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INTRODUCTION

The Chesapeake and Ohio Canal was constructed from the District of Columbia to Cumberland, Maryland, between 1828 and 1850, as an outgrowth of the westward movement to connect the tidewater of the Potomac with the trans-Allegheny region at the Ohio. This movement to provide a direct and economical trade route by which the raw products of the western hinterland might reach the eastern seaboard first saw actuality in the pioneer work of the Potomac Company. Chartered in 1785 by George Washington and associates, this company attempted unsuccessfully in the early nineteenth century to open navigation on the Potomac from Georgetown to the Alleghenies. Attempts to improve navigation by deepening the river bed and by constructing a series of five short canals around natural obstructions were abandoned on August 15, 1828, when the nearly defunct Potomac Company surrendered its chartered rights to the Chesapeake and Ohio Canal Company.¹

During the early 1820s agitation began in Virginia and Maryland for the establishment of a new canal company which would unite the Potomac and the Ohio by means of a continuous canal. As early as 1820 the State of Virginia authorized its Board of Public Works to conduct surveys of the land between the Potomac and the southern branches of the Ohio for a possible continuous canal to connect the two rivers. In his report of the first survey, Thomas Moore, the Civil Engineer of Virginia, confirmed the opinion that such a connection was practicable and estimated its cost at about \$1,114,300.²

1. U.S., Congress, House, Committee on Roads and Canals, Chesapeake and Ohio Canal, H. Rept. 414 to accompany H. R. 94, 23d Cong., 1st sess., 1834, pp. 1-6, 14, hereafter cited as House Report 414. For more information on the transferral of the legal rights of the Potomac Company to the Chesapeake and Ohio Canal Company, see Acts of the States of Virginia, Maryland, and Pennsylvania, and of the Congress of the United States, in relation to the Chesapeake & Ohio Canal Company; with the Proceedings of the Convention, which led to the formation of the said Company (Washington, 1828).

2. Report of the Engineer of Virginia re a Canal to the Ohio, printed in U.S., Congress, House, Report of the Committee on Roads and Canals, H. Rept. 90, 19th Cong., 2d sess., 1827, Appendix 3, pp. 33 ff., hereafter cited as House Report 90.

In 1822 Isaac Briggs, the Civil Engineer of Maryland who had received special authorization to complete the second survey after the untimely death of Thomas Moore, estimated the cost of a canal measuring 30 feet wide at the surface, 3 feet deep, and 20 feet wide at the bottom, from Little Falls to Fort Cumberland, at \$1,578,954.³

Following the issuance of these reports, the movement for a continuous canal gathered momentum. After some prodding, President James Monroe and Congress endorsed the project, and in 1824 Congress provided \$30,000 for a detailed survey of the proposed route.⁴ The United States Board of Engineers made a preliminary report on February 14, 1825, in which it recommended the route of an artificial waterway that would connect the upper Potomac and the Youghiogheny, or Monongahela, rivers.⁵ The report seemed to assure the ultimate success of the project, and Congress shortly thereafter chartered the canal company in a measure approved by President Monroe on March 3, 1825.⁶

According to the terms of the charter, the Chesapeake and Ohio Canal Company was empowered to accept subscriptions for the purpose of financing the construction of an artificial waterway. The route of the continuous canal was to extend from tidewater on the Potomac in the District of Columbia to the highest point of permanent navigation on the Ohio River at Pittsburgh via the shortest practicable route. The dimensions of the waterway were to be at least 40 feet wide at the surface, 4 feet deep, and 28 feet wide at the bottom. One hundred miles of canal were to be completed and put into use within 5 years, and the entire project was to be completed in 12 years.⁷

3. Report to the Stockholders on the Completion of the Chesapeake & Ohio Canal to Cumberland, with a Sketch of the Potomac Company, and a General Outline of the History of the Chesapeake & Ohio Canal Co., from its origin to February 1851 (Frederick, 1851), pp. 16-17.

4. Walter S. Sanderlin, The Great National Project (Baltimore, 1946), p. 53.

5. An extract of the report is printed in House Report 90, Appendix 3, p. 37.

6. U.S., Congress, Senate, Documents Relating to the Chesapeake and Ohio Canal, S. Doc. 610, 26th Cong., 1st sess., 1840, p. 13.

7. Ibid.

While supporters of the project promptly plunged into the campaign for public support, the full report of the Board of Engineers issued on October 23, 1826, and transmitted to Congress on December 7, 1826, dealt the project a temporary setback. The report reiterated the belief that the project was practicable, but estimated the cost of the waterway based upon its proposed enlarged dimensions at \$22,375,429.69.⁸ The enlarged dimensions of their new proposal called for

a breadth at bottom of 33 feet; at the surface of 48 feet; the depth of water 5 feet; the towpath 9 feet wide; the guard banks 5 feet at the top; the surf berms kept on the level of the water, 2 feet wide each; towpath and tops of the guard bank 2 feet above the surface of the canal; the transverse section to be modified where local circumstance require it, and more especially in the cases of deep cutting, steep side cutting, embanking, and also where the canal is to be supported by walls.⁹

This apparently prohibitive estimate so aroused the proponents of the canal movement that friends of the project in Congress induced President John Quincy Adams to submit the conflicting estimates made by the state engineers and the Board of Engineers to a review by experienced canal builders. The President agreed and appointed James Geddes and Nathan Roberts, both of whom had worked on the Erie Canal in New York. They hurriedly surveyed the eastern section of the proposed canal route from Georgetown to Cumberland, and estimated the cost of construction at slightly more than \$4,000,000, which was about half the Board's estimate for the same section.¹⁰

The estimates of Geddes and Roberts were based on a canal with three possible dimensions. Their first proposal was based on the minimum dimensions set forth in the Chesapeake and Ohio Canal Company's charter, while their second proposal exactly duplicated the dimensions suggested by the Board of Engineers. Their third estimate, which received a great deal of attention, called for an enlarged canal trunk "where practicable by common excavation, to 60 feet at the surface, with a proportionate breadth at the bottom, which is computed to be 42 feet; and 5 feet depth of water."¹¹

8. House Report 414, pp. 8-9.

9. Ibid., p. 9.

10. Ibid., pp. 8-10.

11. Ibid., pp. 9-11.

Heartened by the reduced estimates of Geddes and Roberts, the canal supporters were successful in urging Congress to pass an act subscribing \$1,000,000 of the public funds to the stock of the Chesapeake and Ohio Canal Company.¹² Formally organized at a meeting of stockholders in Washington on June 20-23, 1828, the company had a capital stock aggregating \$3,608,400, most of the shares of which had been subscribed by the Federal Government, the cities of Washington, Alexandria, and Georgetown, the State of Maryland, and private individuals.¹³ After completing the business of organization, the directors immediately selected Judge Benjamin Wright as Chief Engineer, who had previously been associated with the construction of the Erie Canal and was at the time of his appointment the chief engineer of the Chesapeake and Delaware Canal.¹⁴ On July 4, ceremonies marking the formal inauguration of the canal project were held at the Powder Magazine near the head of Little Falls where President John Quincy Adams dug the first spadeful of earth from the canal.¹⁵ This affair, held on the 52d anniversary of American independence, was highly successful and focused national attention on the canal project, and the canal's sponsors confidently expected that it would soon be carrying a heavy volume of commerce between the Potomac and the Ohio River valleys.

12. National Intelligencer (Washington, D.C.), May 27, 1828.

13. House Report 414, pp. 13-14.

14. Proceedings of the Stockholders, A, 16-17. All manuscript source materials referred to in this report are deposited in the Department of the Interior files at the National Archives and are designated Record Group 79.

15. National Intelligencer, July 7, 1828. Also see Proceedings of the President and Board of Directors, A, 5.

I. STATEMENT OF HISTORICAL SIGNIFICANCE

The study of the prism of the Chesapeake and Ohio Canal is basic to an understanding of the functioning of the waterway. To conduct the flow of water, the trunk of the canal was constructed in the form of a prism, the top being wider than the bottom. The towpath was on the river side of the canal and served as a walkway for the mules which pulled the boats that plied the channel. The opposite bank of the canal, on the side away from the river, was known as the berm.

In many places it was necessary to build retaining walls against the sides of the canal in order to prevent them from caving in. Some of these were dry walls, without mortar, and others consisted only of riprap--stones thrown together without order. There were also walls built on the river side of the towpath in order to protect the canal during periods of high water.

II. ADMINISTRATIVE DATA

A. Name of Structure

Canal Prism, including towpath, berm, and river revetments, Chesapeake and Ohio Canal National Historical Park, District of Columbia, and Montgomery, Frederick, Washington, and Allegany counties, Maryland.

B. Proposed Use of Structure and Justification for Such Use

The List of Classified Structures has not been completed yet for the canal. Therefore, the Order of Significance of the canal prism has not been established, nor has the level of treatment been determined. Since the canal prism, including towpath, berm, and river revetments, was basic to the functioning of the waterway, it will undoubtedly figure prominently among the historic resources of the canal.

As the 22-mile section of the canal between Georgetown and Seneca is heavily visited due to its proximity to the Washington metropolitan area, it is proposed that the canal prism, including towpath, berm, and river revetments, for this stretch of the canal be restored to its operating appearance to interpret the construction, maintenance, and operation of the canal. Other areas where the restoration of the canal prism and its associated structures should be considered because of their proximity to local population centers, potential recreation developments, or proposed "national interpretive centers" as recommended by the draft Master Plan are: Brunswick, Harpers Ferry, Antietam Creek, Williamsport, Four Locks, and the terminus at Cumberland.

Throughout the rest of the canal, it is not feasible to restore the canal prism entirely. On these sections, the draft Master Plan proposes lower density visitor use, limited access points, and short-term to long-term primitive hiking, biking, or horseback experiences for the visitor. Accordingly, the towpath in these areas should be restored but otherwise not interpreted. It is also proposed that river revetments should be restored in areas where the canal is subject to flood damage in order to protect the waterway from further deterioration.

C. Provision for Operating Structure

The canal prism, including towpath, berm, and river revetments, should be used as an historic structure exhibit in place to interpret the construction, maintenance, and operation of the canal.

D. Cooperative Agreement, if any, Executed or Proposed
for Operating Structure

Along the canal there are numerous cooperative agreements for the use of the towpath. Some property owners retain the right to use the towpath as access to their land between the canal and the Potomac River. In some areas there are agreements with local municipalities for use of the towpath as access to their holdings. Before work commences on any section of the canal prism, these cooperative agreements should be thoroughly examined.

E. Description of Proposed Construction Activity

In those areas where the canal prism, including towpath, berm, and river revetments, is to be restored to its operating appearance, the following proposed projects should be considered: (a) the towpath and berm should be restored to their historic grades and dimensions; (b) the surface of the towpath should be restored in the manner that was apparently used by the original builders, i.e., utilization of the best available native materials along the canal in a manner consistent with rendering the path reasonably free from erosion, breakage, and rutting; (c) the canal prism should be dredged to remove siltation deposits, sand bars, brush, trees, and other debris from the bottom and banks of the canal; (d) the canal prism should be restored to its historic dimensions and sealed with a "clay liner" to make it watertight; (e) stone masonry river revetments should be rebuilt, repointed, or regrouted, and riprap river revetments should be strengthened and reinforced; trees, brush, and debris should be removed from all masonry structures.

In those areas where only the towpath and river revetments are to be restored, points (a), (b), and (e) above are recommended for consideration.

III. GENERAL PLAN AND SPECIFICATIONS OF CANAL PRISM

Before contracts could be let and construction begin, the board of directors concerned itself with determining the location of the line of the canal. The route surveyed by the United States Board of Engineers and by Geddes and Roberts along the north bank of the Potomac was adopted, but aside from this general decision the exact location of the canal was left indefinite until the last possible moment.¹ In this way, the company hoped to prevent speculation and keep down land acquisition costs as much as possible.²

The board also divided the entire canal into divisions for the purpose of effective supervision of construction. The line of the canal was divided into sections of about half a mile each. Twenty sections constituted a Residency, and six residencies were designated a Division. An engineer and inspector of masonry were assigned to each Division. Each Residency was allotted an assistant and a staff-bearer, or rod-man, as well as volunteers who were to receive training that would be put to use as the construction progressed. The engineers of the three Divisions which comprised the eastern section of the canal formed an advisory board presided over by the engineer of the 1st Division. Because an injunction obtained by the Baltimore and Ohio Railroad prevented work on the canal above Point of Rocks, operations at first were restricted to the 48 miles of the 1st Division below that spot.³

In July and August 1828, canal engineers laid out 34 sections immediately above Little Falls. After a month of public advertisement, the board let contracts for all these sections within a 3-day period toward the end of August. Nearly 100 contractors had been present to submit a total of 462 proposals. Most of the successful bidders had had experience in the construction of canals in New York, Pennsylvania, Connecticut, Ohio, and Canada. Men from New York and Pennsylvania secured 18 of the contracts, amounting to \$160,000 of the total \$218,000 let.⁴

1. Proceedings of the President and Board of Directors, A, 8.

2. First Annual Report (1829), C & O Co., in Proceedings of the Stockholders, A, 41.

3. Rules Adopted By the President and Directors of the Chesapeake and Ohio Canal Company, for the Government of the Corps of Engineers (Washington, 1828), pp. 1-10.

4. Proceedings of the Stockholders, A, 17-18.

Late in October the directors let 50 more sections of the line from Seneca Creek to Point of Rocks. A total of 1,308 proposals were received from October 23-25 for these sections as well as for the locks, aqueducts, and culverts from Little Falls to Point of Rocks. The contracts for the masonry works on the part of the line let in August had been delayed until canal surveyors had found stone in convenient locations and hydraulic lime of suitable quality.⁵

On December 5, the 5 miles between Little Falls and Georgetown were divided into eight sections and placed under contract, together with Dams No. 1 and No. 2 at Little Falls and Seneca Falls respectively.⁶

These contracted sections were to be built according to the maximum dimensions called for by the Geddes and Roberts report. On September 10, 1828, at the first general meeting of the stockholders of the company, President Charles F. Mercer announced that the board, after considerable deliberation, had decided on the following dimensions:

The breadth of the Canal, where practicable, without a very enlarged expenditure, they have fixed at sixty feet, for the surface of the water, its depth, for the present, at never less than five, but, ultimately, at six feet. Its narrowest breadth at the surface, (and this will but seldom occur,) will be fifty feet. Its breadth, at bottom, (generally forty-two feet) will depend upon the quality of the earth through which the canal passes, and the facilities afforded for the inner pavement of its slopes, as it progresses. . . .⁷

These enlarged dimensions were apparently adopted in the effort to construct a model canal for the developing nation, but the canal board soon found that it was mistaken in its belief that these increased dimensions could be executed at little additional cost.

5. First Annual Report (1829), C & O Co., in Proceedings of the Stockholders, A, 33. Some stone was found near the river's edge at various points, and lime of good quality was found near Shepherdstown.

6. Proceedings of the President and Board of Directors, A, 127.

7. Ibid., pp. 70-71.

The typical contracts for excavation of the canal prism undertaken on the line of the canal between Georgetown and Point of Rocks contained the specific provisions that

The Canal will be sixty feet wide at the water-line and six feet deep below it, with such slope as an Engineer of the Company, or the President and Directors shall order with a towing path, at least twelve feet wide at top, on an embankment of such height as the Engineer may direct, the cost of the embankment not to be estimated, unless the earth therefor has been necessarily transported farther than 120 feet. The surface of the bank opposite the towing-path may be required to be eight feet wide, or wider, if deemed necessary; and all slopes near the side of the canal shall have their inclination determined by the Engineer, who shall also point out the place from which materials for embankment may be taken.⁸

These provisions apparently vested the engineers with considerable latitude in determining the exact dimensions along the line of the canal.

As the contractors began work on the canal, the board of directors began to issue letters and circulars advising engineers and contractors alike on all phases of the work. Many of these dealt with the various aspects of excavation, embankment, and walling of the canal trunk. Every possible contingency in the construction seemed to have been anticipated and provided for. There was an equally heavy deluge of instructions from the engineers themselves to their subordinates and to the contractors. This was partly in self-defense and partly the result of a tendency to interfere in all phases of construction, in the manner of the directors. While many of the instructions were helpful, this constant interference was often a cause of bewilderment and irritation to the contractors.⁹

Within a short time after the initial construction began, the board of directors and the Board of Engineers drew up a comprehensive set of general specifications for the excavation, embankment, and

8. Childs to Board of Directors, Mar. 1, 1829, Ltrs. Recd., C & O Co. Canal engineers drew up a "Table of Excavation for 60 feet of a Canal 32 ft. wide at bottom--Slope 1-1/2 to 1" which was submitted to each contractor to use in constructing the canal prism. A copy of this table is reproduced as Appendix A. A thorough search of the C & O Canal Company records at the National Archives failed to turn up any early "Articles of Agreement" between contractors for sections and the canal company. However, the Articles of Agreement for Section No. 175 signed in November 1833 were located and are reproduced as Appendix B.

9. Sanderlin, Great National Project, pp. 68-69.

walling of the canal trunk. The plan and dimensions of the canal prism were as follows:

Each of the banks shall rise above the water line at least two feet, if required; and such a slope shall be preserved on the inner and outward side of the banks as that every foot of perpendicular rise shall have an horizontal base of eighteen inches, or more if required. The towing path shall be on the river side of the canal; its summit shall be at least twelve feet wide; the summit of the opposite bank at least eight feet; and both banks shall have a lateral declination at their summit from their inner to their outer edges, at the rate of one inch to the foot. The banks shall be constructed of as pure and solid water-proof earth, as the excavation will afford; they shall be made smooth and even, on the outside as well as on the inside; and more effectually to unite the banks with the natural soil on which they rest, all the grass or other vegetable growth, including trees, bushes, stumps, roots, along with the vegetable mould, shall be removed from the entire space occupied by the canal, its embankments and slopes, and the mould shall be carefully reserved, that it may constitute a cover for the outer slope of the bank, when finished. Unless otherwise authorized by the written permission of the resident Engineer, all the grubbing, clearing, and preparation for the embankment, upon the whole section, shall be completed and inspected by the resident Engineer, before the excavation of the canal, or the formation of the embankment, shall be commenced; and no estimate shall be made on the section until this shall have been done, without the certificate of the engineer upon such estimate, that such permission has been granted. In addition to the grubbing and clearing abovementioned, all trees or bushes shall be cleared even with the ground for a space twenty feet wide and running along both sides of the section if required by the engineer.

Instructions were also given concerning the excavation of the canal trunk. These details applied not only to the canal prism but also to any drains, mucking, and puddle ditches that might be necessary for the construction of the section. These specifications were as follows:

The spoil banks, or surplus earth, shall be laid evenly and regularly, leaving a space between the canal bank and spoil bank, four feet wide for a

land drain. There shall also be left suitable outlets through the spoil bank from this drain at every three hundred feet in length. The slope of the spoil bank next to the canal shall be the same as that on the inner slope of the canal banks and the inclinations on the top, at least two inches to the foot, from the canal. The Engineer may require all the surplus earth to be deposited on either side of the canal, provided however, that the contractors shall not be required to transport it more than 120 feet, measuring in a direct line from the place from which it is taken to the place of deposit, without extra compensation, to be adjudged by the Engineer.

Stone excavated from the section and not required in its construction, shall be deposited as may be directed by the Engineer; provided however, that the contractor shall not be required to transport it more than 120 feet, without extra compensation, to be adjudged by the engineer. And the Canal Company shall be at liberty to agree with the Contractor for the section, or with any other person, for paving the inner slopes of the Canal, either before or after the completion of the Section.

Details for the construction of the canal embankments were also supplied to the contractors. The term "embankment" included the filling up of the side banks and the bottom of the canal and when required by the engineer, the covering and formation of embankments upon bridges, culverts, and aqueducts. Any low grounds adjacent to the canal were to be filled by the contractor of that particular section. These instructions were as follows:

In cases where the base of the embankment shall be below the bottom of the canal, the embankment shall be made with carts; and in all cases where carts are used in making embankment, it shall be formed in successive horizontal layers of six inches in thickness, uniformly laid over the entire breadth of the embankment, so that one course shall be completed over the entire length of the embankment, as nearly as practicable, according to the judgment of the Engineer, before the next shall be begun. In lighter embankment, where wheelbarrows may be used, it shall be formed in horizontal layers, not exceeding one foot in thickness, and in raising one portion of such embankment higher than another, the end of each successive layer shall stop short of the preceding layer at

least three feet, so that the end of the embankment shall form a slope of three to one. If the section shall not afford sufficient earth for embankment, the Engineer may require that the banks shall be left three feet below the established height.

No material excavated from the canal and placed on the embankment, will be estimated as embankment, unless it shall have been necessarily transported over 120 feet.

No logs, trees, brush, stumps, roots, leaves, grass, or stones, shall be left or admitted into any part of the embankment.

No allowance shall be made for earth washed away, or removed by floods.

After the entire Section shall have been completed in every other respect, the soil and muck removed in preparing for the embankment shall, if so ordered in writing by the Engineer, be thrown up so as to form the outward cover of the embankment, in which case a reasonable specific allowance shall be adjudged by the Engineer.

Where it shall be deemed expedient to increase the canal to a width not exceeding 70 feet at water surface, for the purpose of obtaining earth for embankment, the earth so obtained shall be considered as "materials excavated from the canal;" but where the width is increased for this purpose to more than 70 feet, then the earth taken from such excess of width will be estimated as "materials not excavated from the canal."

The directions issued concerning puddling, which was the process of working clay or a smiliar substance with water so as to make a watertight mixture that would serve as a sealer on the canal embankments, were as follows:

The puddling, when any is required by the Engineer, shall be regulated by him as to quality, thickness, and disposition. It will be measured and paid for as embankment, (unless taken from canal and within 120 feet,) in addition to the price affixed in the following proposals, that being understood to cover only the expense of wetting and reducing the clay to a proper consistency.

General specifications for the construction of the external walling that would buttress the canal trunk were also spelled out:

The external walling, vertical or slope, shall be of such quality, height and thickness, as the Engineer may direct, and shall be carried up from an approved foundation. The foundation of every slope wall shall be at right angles with the slope of the embankment it is designed to protect, and the successive beds formed in carrying it up shall be parallel to its foundation. No wall shall be constructed against any embankment which has not had sufficient time in the estimation of the Engineer, to settle, before it is made to press upon it. In all cases when the outside wall of the canal is liable to be covered by river freshets, the embankment behind the same shall be carried up with the spalls of the quarries or excavated rock of the Section, one foot in thickness, and if there be no spalls, the Contractor may be required to pound or reduce part of the excavated rock of the Section to a size to pass through a three inch ring. The labor of pounding the rock to be paid for at the estimate of the Engineer; provided it shall in no case exceed 25 cents per perch for pounding, and the material when placed, shall be measured as embankment.

Where vertical walling shall be used it shall be coped with the best of the stone furnished by the quarries.

Where the outer surface of the embankment shall require protection of rock, in addition to the vertical or slope wall, and such rock shall be furnished from the excavation of the Section, and shall require to be transported more than 120 feet, the Engineer shall adjudge a fair compensation for any excess of distance over 120 feet.

No stone shall be used in walling until it shall have been approved by the Engineer. When stone not furnished from the Canal excavation shall be required for walling, and the Contractor cannot agree with the owner thereof for the same on reasonable terms, the President and Directors will, upon application, cause the same to be condemned according to the charter of the Company, the Contractor paying the expense of condemnation as well as the verdict of the Jury. When it shall become necessary to transport stone, not excavated from the canal, more

than a quarter of a mile, the Engineer shall estimate the just value of such excess of transportation.¹⁰

In the first year of large-scale construction, additional information was issued from time to time by the board of directors and Board of Engineers to the contractors to supplement these general specifications. While many of these new instructions simply reinforced previous directives, others drew attention to specific problems that had been unforeseen in the initial phases of construction. Some of these circulars also serve to emphasize the continuous efforts of the canal board to provide for uniform construction techniques among the various contractors along the line of the canal.

Early in the construction period, it became apparent that the towpath would be weakened unless provisions were made for proper drainage. When Herman Boye was notified of his assignment as Resident Engineer of the 5th Residency (Sections 65-84) on December 1, 1828, he was given specific instructions concerning the construction of the surface of the towpath to provide for the necessary drainage. The directions were as follows:

In forming the Towpath on its top you will please recollect that the front of the Towpath when first finished ought to be 2-1/2 ft. above water and the back side 1-1/2 ft. above surface water so as to give a cast [declination] of the water from the face of the bank to the back side.¹¹

As the construction progressed, the embankment walls became the object of much concern on the part of the canal board. Because of the frequent flooding in the Potomac River valley, President Mercer directed the Board of Engineers to insure that the elevation of the canal banks along the entire line was above the highest-known flood levels of the river.¹² For the same reason, the durability of the embankment walls with foundations in the river bed itself was

10. Specifications for Sections (Drawings and Other Records Concerning Construction, C & O Co.). Although these specifications are not dated, the general dimensions they give for the canal were used in construction from Georgetown to Harpers Ferry from 1828 to 1833. A copy of these specifications may be found in Appendix C. As construction of the canal moved up the valley, the general specification for sections was periodically revised. Two such revisions were located in the C & O Canal Company records at the National Archives. A copy of the Specification for Sections used for construction between Harpers Ferry and the Cacapon River (ca. 1834-37) may be seen in Appendix D, and a copy of the specification used between the Cacapon and Cumberland (1837-50) in Appendix E.

11. Wright to Boye, Dec. 1, 1828, Ltrs. Recd., Letter Book of the Resident Engineer of the 5th Residency of the 1st Division.

12. Proceedings of the President and Board of Directors, A, 50-53.

questioned. Following an official inspection of the masonry work on the 1st Division, Robert Leckie reported to the canal board on December 3, 1828, his dissatisfaction with the quality of many of these embankment wall foundations.¹³

Soon, instructions were issued to increase the strength of the embankment foundations to enable them to withstand the eroding effects of the river as well as to survive the periodic fall and spring freshets. On December 26, 1828, Nathan S. Roberts, a member of the Board of Engineers, wrote a letter to Wilson M. L. Fairfax, the engineer on the 3rd Residency, giving the new directions. The instructions were as follows:

The foundation of the slope wall on several sections of the Canal on your Residency I observe, must be commenced in from 2 to 6 feet of water. In all those places, I am of the opinion that the most practicable mode is to raise an embankment of stone, from the bottom of the River in the direction of the line of the Wall having a slope outward of one and a half foot base to each foot in depth & the same on the inside. This embankment should be about 6 feet wide at the surface of the water, and as it approaches the surface, the stone should be placed with as much care and compactness as may be practicable, and stone of suitable length, to be laid in manner of headers to bind the wall, or embankment. The span between this stone embankment, & the shore being filled up to the surface of the water with stone & earth as the case may be,--the slope wall will commence--occupying about 3 feet on the inner side of the surface of this stone embankment, & having about 3 feet of the same on the outside next the river, as an abutment to hold the foot of the slope wall. All the first course of stone in the slope wall thus laid should more especially consist of long headers with good beds & be laid very nearly at right angles with the line of the wall which is to form the hypotenuse of a triangle of 45° from the horizon, and every course of stone, above the senback or first course should be laid in [the] manner of a header & at right angles with the

13. Leckie to Board of Directors, Dec. 3, 1828, Ltrs. Recd., C & O Co.

line of the wall, being thus placed the ice & drift wood when forced against the wall will not force out the stone, but will tend to drive them more firmly against the embankment which the wall is intended to protect.

The embankment next the slope wall, should be well packed as the wall is laid on it, and it would be well to form that part of the embankment next the wall for about a foot in thickness of the small stone which comes out of the rock excavation,--on this the slope wall will rest more firmly and the bank be less able to wash & settle more even. It is to be observed that where the water is less than 2 feet deep & rocky bottom, that long headers should be placed on the bottom, of the river to commence with, where practicable as recommended by the superintendant of stone work. . . .¹⁴

Another unforeseen construction problem that received increasing attention in the first eighteen months of work concerned the pavement of the inner slopes of the canal trunk. By the spring of 1830, portions of the inner sloped pavement, which generally terminated about the middle of the embankment, had slipped down. Because this slipping made the canal banks vulnerable to the action of the water in the trunk, Thomas F. Purcell, a resident engineer on the 1st Division, recommended to the Chief Engineer that the defective parts be taken down as soon as possible and be commenced on a firmer foundation at the bottom of the canal embankment.¹⁵

Instructions to strengthen the inner slopes of the canal were soon forthcoming in a letter sent by President Mercer to the Chief Engineer, copies of which were later transmitted to the resident engineers. These directions were as follows:

They are to have the inner slope of the tow path bank from the bottom of the canal to some short distance, six inches or a foot above the water line, where the canal is full. To do this, in all cases, when there is stone sufficient on the canal, without hauling it from a distance, and it can be done at 12½ cents the superficial yard of one foot average thickness.

14. Roberts to Fairfax, Dec. 26, 1828, Ltrs. Recd., C & O Co.

15. Purcell to Fisk, Mar. 12, 1830, Ltrs. Sent, Letter Book of the Resident Engineer of the 1st Residency of the 1st Division.

Where there is not stone enough, without hauling, to use what may be in the canal, and carry the wall as high as the bank, as such quantity to be obtained without hauling at cost to the Company will carry it, that the wall may be left in a condition to be finished, afterwards, from the scows on which the stone may be transported by water from where it abounds to where there is none.

Where the contractor will not put up the wall at 12½ cents the superficial yard of one foot thickness, then to cause him to leave in the canal, three feet from the bottom slope, so that it may not be covered by the sliding of the bank, all the stone he may have found in the canal, if not more than necessary for the inner pavement of his section. . . .

It is the determination of the Board to wall the inner slopes of the canal, on one side at least, and where artificial embankments have been formed on both sides, to pave ultimately both slopes, so as to guard them from abration /sic/.

Your views on the subject have been respectfully considered at all times; and when the banks have been freshly formed, I concur entirely in your opinion, that it will be expedient to delay the inner pavements, as long as practicable before the admission of the water and to carry it up, some cases, where such delay may not suffice to give the banks sufficient firmness, to sustain the slope wall only as far from the bottom as two or three feet. Having two or three in the canal, it can be afterward carried up from the scows. . . .¹⁶

The board realized that these procedures would involve increased initial expenditures, but they believed that this pavement would save the canal company money by decreasing the need for future repairs.¹⁷

16. Mercer to Fisk, Mar. 29, 1830, Ltrs. Sent, C & O Co.

17. Third Annual Report (1831), C & O Co., in Proceedings of the Stockholders, A, 147-48.

IV. CONSTRUCTION FROM GEORGETOWN TO HARPERS FERRY: 1828-1833

As full-scale construction began, the progress of the canal was repeatedly hampered by problems growing out of the actual work despite the issuance of the detailed circulars. Many of these early trials closely foreshadowed the future obstacles to the successful completion of the waterway. The shortage of labor was felt early in the construction period. Land disputes plagued the canal company as local proprietors sought to extract the maximum benefit from the loss of their lands. The company itself soon became involved in financial difficulties arising from other problems and from its own enthusiasm to enlarge the canal dimensions. On top of all these distractions, a legal controversy developed out of a dispute with the Baltimore and Ohio Railroad Company over the right-of-way in the Potomac Valley and an injunction obtained by the railway directors prohibiting the construction of the canal above Point of Rocks.¹

As early as May 1829, many contractors were having financial difficulties.² Some of these problems stemmed from the fact that the bids made by the contractors the previous year were too low to pay the prevailing level of wages and prices for materials.³ Even had the bids been high enough to cover these construction costs in 1828, some difficulty would have arisen from the general inflation which followed. In the first year, the actual costs of construction greatly exceeded the estimates of Geddes and Roberts for lumber, stone, hydraulic lime, and labor.⁴ For example, hydraulic lime used in walling exceeded its estimated price by 200 to 300 percent because of the necessity of transporting it over bad roads or by the often-obstructed river.⁵ The rate of wages

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1. Sanderlin, Great National Project, p. 69
 2. Proceedings of the President and Board of Directors, A, 230-31.
 3. Wright to Mercer, February 9, 1830, Ltrs. Recd., C & O Co.
 4. First Annual Report (1829), C & O Co., in Proceedings of the Stockholders, A, 39, 52.
 5. Second Annual Report (1830), C & O Co., in Proceedings of the Stockholders, A, 84.

also nearly doubled between 1828 and 1832.⁶ As a result, some contracts for sections were abandoned and relet, while others were subdivided into several parts in order to expedite their completion.⁷

Other early unforeseen developments in construction tended to increase costs for the contractors. The excavations above Georgetown revealed great quantities of gravel, hardpan, and granite below the surface which had not been expected from the surface surveys.⁸ The cost of excavating these sections was nearly double the original estimates.⁹ The blasting which was necessary because of the rocky nature of the ground resulted in much property damage and public relations problems with the local populace. The concussion of the explosions and flying rock damaged several buildings, and the terrified citizenry often scurried for cover when the signal for the beginning of blasting was given.¹⁰ To lessen the problems caused by blasting, the canal board announced on September 4, 1830, that it would no longer pay for damages arising from blasting accidents. The board ordered the use of smaller charges and required that the blasting be covered with brush that was to be procured from the opposite side of the river at the expense of the company.¹¹ The net result of these policies was more delay and increased costs.

The weather was responsible for other costly delays in digging the canal. The winter of 1828-29 was unusually severe, and many contractors who had begun work were forced to suspend operations

6. Fourth Annual Report (1832), C & O Co., in Proceedings of the Stockholders, A, 221-22.

7. First Annual Report (1829), C & O Co., in Proceedings of the Stockholders, A, 38-39. Also see Proceedings of the President and Board of Directors, A, 198.

8. Second Annual Report (1830), C & O Co., in Proceedings of the Stockholders, A, 83.

9. Ibid., pp. 83-84.

10. Balch to Board of Directors, Aug. 28, 1830, Ltrs. Recd., C & O Co. Also see Proceedings of the President and Board of Directors, B, 87-88, 152.

11. Purcell to Dibble and Baker, Sept. 4, 1830, Ltrs. Sent, Letter Book of the Resident Engineer of the 1st Residency of the 1st Division.

until spring. As was to happen throughout the period of construction and operation of the canal, the freshets, which occurred periodically in the fall and spring, often filled the lock pits and canal trunk with mud, debris, and sand bars, further delaying the completion of the work.¹²

The high rocky cliffs below Great Falls on the river side of the canal were another source of increased construction costs. The actual expenditures for excavating the canal trunk in this area were considerably higher than the estimated costs, and the instability of these banks gave rise to measures which added to these costs.¹³ The contractors proceeded with care so as to leave some trees standing to give the banks greater stability, and the company also directed that others be planted along the new walls to help retain the earth.¹⁴

Contractors resorted to various expedients to avoid financial losses. The responsible ones sought redress in petitions for the payment of retained money and for increased allowances.¹⁵ When forced to suspend operations due to lack of sufficient funds, conscientious contractors would request monetary advances offering bonds as collateral security.¹⁶ Their pleas often met with the recommendations of the Chief Engineer and favorable action of the board, although the board became increasingly less receptive as the company's financial condition worsened.¹⁷ Other contractors sought to avoid losses by slipshod or fraudulent construction, while others absconded with their monthly payments on the estimates,

12. First Annual Report (1829), C & O Co., in Proceedings of the Stockholders, A, 54. Also see Holdsworth and Sherwood to Board of Directors, Sept. 24, 1829, Ltrs. Recd., C & O Co.

13. McP. Brien to Board of Directors, Feb. 3, 1835, Ltrs. Recd., C & O Co.

14. Proceedings of the President and Board of Directors, B, 309. Later, this practice of planting trees along the new walls would be stopped.

15. Wright to Mercer, Feb. 21, 1830, Ltrs. Recd., C & O Co.

16. Proceedings of the President and Board of Directors, A, 297.

17. Ibid., B, 198.

leaving both creditors and laborers unpaid.¹⁸ There were many cases where contractors would even steal provisions and building materials from other contractors on neighboring sections. This practice, which was prevalent wherever there was suspended work, contributed to growing suspicion and tension along the line of the canal.¹⁹

One of the most critical problems with which the company had to contend during the actual digging of the canal was the shortage of labor. Because of the agricultural character of the Potomac Valley, there were few laborers available to begin with. The harvest season coincided with the best time for construction and made even fewer workers available. It was difficult to attract great numbers of laborers from other areas because of the unhealthy living conditions in summer along the Potomac and the construction of other public works in the East.²⁰ As a result of these recruitment problems, 2,113 men were working on the line of the canal in June 1829 while it was estimated that 6,000 were needed in order to complete the canal in the time specified in the contracts.²¹

To alleviate the scarcity of labor, the company considered the employment of Virginia slaves for a limited period.²² Efforts to work out this arrangement proved futile, and the company soon began efforts to encourage the migration of workers from all parts of the United States and from various countries in Europe, particularly Great Britain, Germany, and the Netherlands.²³ Advertisements were placed in English and Irish newspapers, and agents were sent across the Atlantic to recruit working men under a system of indentured

18. Van Slyke to Board of Directors, July 21, 1830, Ltrs. Recd., C & O Co.

19. Millerd to Board of Directors, Nov. 11, 1829, Ltrs. Recd., C & O Co.

20. First Annual Report (1829), C & O Co., in Proceedings of the Stockholders, A, 52. Also see Second Annual Report (1830), in ibid., pp. 84-85.

21. First Annual Report (1829), C & O Co., in Proceedings of the Stockholders, A, 52.

22. Second Annual Report (1830), C & O Co., in Proceedings of the Stockholders, A, 109-11.

23. Mercer to Cope, Nov. 18, 1828, Ltrs. Sent, C & O Co.

labor, much like the system that had flourished in the early colonial period.²⁴

At the time, England was in the midst of a political and economic crisis marked by widespread unemployment, rising inflation, and unrest among its working classes.²⁵ Under these conditions, Irish, Welsh, and English workers were receptive to the terms offered by the canal agents. These terms, as outlined by President Mercer, were in part: "meat three times a day, a plenty of bread and vegetable, with a reasonable allowance of liquor and eight, ten or twelve dollars a month for wages."²⁶

The experiment in using indentured servants proved to be expensive and failed to solve the labor shortage in the long run. The canal company found it difficult to enforce the agreements under existing laws. There were numerous lawsuits over the rights of the emigrants, and the local citizenry resented the influx of these foreigners, a hatred engendered in part by strong nativist elements in the valley.²⁷ Nevertheless, the use of imported laborers succeeded in momentarily stabilizing the rate of wages on the canal. The total working force on the line rose from a low of about 1,800 in the summer months to over 3,100 by November 1829.²⁸

Another major obstacle encountered in the construction of the canal resulted from the unexpected high cost of land. Many of the local landholders insisted on holding out for the highest possible prices, and others refused to sell their land under any conditions. Condemnation efforts were resisted by calling for new hearings and other delaying tactics. The landowners were often under the influence of the Baltimore and Ohio Railroad, the archrival of the canal. The effect of all this was to obstruct the progress of the canal and increase the costs of construction.²⁹

24. Proceedings of the President and Board of Directors, A, 153.

25. George Washington Ward, The Early Development of the Chesapeake and Ohio Canal Project (Baltimore, 1899), pp. 90-91.

26. Mercer to Maury, Nov. 18, 1828, Ltrs. Sent, C & O Co.

27. Proceedings of the President and Board of Directors, A, 353-54.

28. Ibid.

29. First Annual Report (1829), C & O Co., in Proceedings of the Stockholders, A, 42.

Perhaps the greatest deterrent to the westward progress of the canal after 1828 was the legal controversy between the canal company and the Baltimore and Ohio Railroad over the right-of-way from Point of Rocks to Harpers Ferry. The railroad held ground-breaking ceremonies in Baltimore on the same day as the canal in 1828, and both companies were eager to exploit the trade potential of the trans-Allegheny region. A series of court injunctions in 1828 prevented both the canal and the railroad from building beyond the Point of Rocks through the narrow passes along the steep banks of the Potomac River, thereby inhibiting the progress of both works.³⁰

After slow and costly legal proceedings, the Court of Appeals of Maryland in January 1832 reversed an earlier decision by the Chancery Court of Annapolis and confirmed the canal company in its claim to the right of prior location.³¹ When it received the official copy of the decision, the canal board ordered contracts to be let on February 23, 1832, for the 12 miles between Point of Rocks and Harpers Ferry.³² In August the directors reconsidered their action and authorized the president to make contracts for the 2 miles immediately above Point of Rocks without the usual public advertisement.³³ These 2 miles included some of the narrowest of the disputed passes, and the haste with which the board contracted for these sections indicated an intent to exclude the railroad from the Maryland side of the river.³⁴

Despite the favorable court decision, the Baltimore and Ohio Railroad continued to agitate against the canal company. The Maryland legislature requested the canal company to consider joint construction of the railroad and the canal from Point of Rocks to Harpers Ferry. Despite its misgivings, the canal company (because of its deteriorating financial condition) was not in a position to ignore this proposal. In the final settlement, the railroad

30. Ibid., p. 55.

31. Proceedings of the President and Board of Directors, C, 48. Also see Fourth Annual Report (1832), C & O Co., in Proceedings of the Stockholders, A, 200.

32. Proceedings of the President and Board of Directors, C, 48-49.

33. Ibid., pp. 52-53.

34. Mercer to Cruger and Purcell, Jan. 23, 1832, Ltrs. Sent, C & O Co.

company agreed to subscribe to 2,500 shares of canal company stock in return for permission to construct its tracks from Point of Rocks to Harpers Ferry. Thus, the canal company begrudgingly undertook the actual construction of both works through the precipitous passes at which they came together.³⁵

As the result of a decision by the canal board to enlarge the dimensions of the waterway in the initial stages of construction, the costs of construction were significantly raised. Not only did the directors decide to adopt the maximum dimensions of the canal as proposed by the United States Board of Engineers and Geddes and Roberts, but they also enlarged upon these. At the first annual meeting of the Chesapeake and Ohio Canal Company in June 1829, the determination of the board to deepen the canal trunk along the line to 6 feet was confirmed by the following statement:

By this Board, it has been resolved, to extend the breadth of the surface of the water, in this canal, as far as Harpers Ferry, to 60 feet; its depth to 6, and its breadth at bottom to 42 feet, giving 301 feet for its cross section, and 58,862-2/9 cubic yards for the contents of its prism for a mile in length, below its water line.³⁶

The directors decided to adopt the larger dimensions because of the increased advantages attainable at presumably little additional cost. This greater size would favorably compare to the New York, Pennsylvania, and Ohio canals which had average cross sections of 136 square feet and prisms of 26,595-5/9 cubic yards. It was estimated that the increased prism dimensions would reduce water resistance to the equivalent of unimpeded sea navigation. Much of the masonry work, the most expensive part of the construction, would be unaffected by the increase in size. On some sections, the Georgetown level for example, it was thought that the larger dimensions would pay for themselves through the greater quantity of water power which would be available for sale to mill operators. To these optimistic men, these advantages far outweighed the small estimated cost increases, but time would show that their enthusiasm to build a model structure would severely handicap the canal's prospects for ultimate success.³⁷

35. Proceedings of the Stockholders, A, 270-74.

36. First Annual Report (1829), C & O Co., in Proceedings of the Stockholders, A, 40.

37. Second Annual Report (1830), C & O Co., in Proceedings of the Stockholders, A, 86.

Reports made early in 1830 on the progress of the construction of the canal trunk show that completed sections of the canal did vary from the dimensions proposed by the United States Board of Engineers and Geddes and Roberts. For example, Charles F. Mercer, the president of the canal company, later reported to the House Committee on Roads and Canals that "as far as the first twenty miles /beyond Georgetown/, its depth was extended from five to six feet water, after the contracts had been formed for its construction; and its levels had been adjusted to the depth first contemplated."³⁸ Other early changes in the canal dimensions noted by Mercer included "the surface of its towpath, from nine to twelve; and its guard banks, from five to eight feet. . . ."³⁹ However, as will be shown later, even this 20-mile stretch of the canal was not uniformly 60 feet wide at the surface, 42 feet wide at the bottom, and 6 feet deep.

The physical difficulties faced by the canal company in attempting to maintain any uniformity in the canal dimensions is revealed in correspondence between President Mercer and Benjamin Wright, the Chief Engineer, in February 1830. In reply to Mercer's letter of February 2 asking for information relative to the plans of the canal, Wright replied at length on February 2 and 3. Wright observed that he was unable to give an exact plan with detailed dimensions of the portion of the canal then under construction as such questions could not "be answered to exact accuracy until the Canal is finished in every part." In explanation of this statement, he continued:

The Canal of 60 feet surface, 42 feet bottom & 6 feet deep gives a cross section of 306 feet--This is preserved wherever there is common excavation, or embankment, on both sides:--and in many places this Section is very greatly increased owing to local formation of the ground:--Where there is a ledge of Rock, which necessarily drives the Canal into the River Potomac--it is a general direction and has & will be observed to give the full bottom width--and I do not believe there will be 400 yards between the west side of Georgetown City and the West end of the 84th Section where there is excavation or embankment which will be less than 42 feet

38. House Report 414, pp. 29-30.

39. Ibid.

in the bottom--neither do I believe there will be 100 yards in length (above Georgetown) which will be less than 290 feet in a cross section and not 1250 which will be less than 300 feet exclusive of Locks & Aqueducts.

You can readily concur that where Rocks are blown to form the left side of the Canal it is difficult & almost impossible to shape them so that they will not have a little slope and that slope varies according to the particular stratification of the Rock . . . these changes are as various as the fissures or peculiar formation of the Rock and the application of powder varies them again.⁴⁰

The second annual report of the canal company which outlines construction progress on the canal through May 31, 1830, stated that the increased cost of the work done between Georgetown and Point of Rocks had been largely due to the increased general dimensions of the waterway.⁴¹ This report also observed that in regard to the dimensions of the 5-mile level from the Little Falls feeder to Georgetown

which the condition attached to the United States' subscription to the stocks of the Company, required to be not less than sixty, generally exceeds seventy; and for the greater part of that distance is in depth more, and never less, than seven feet.⁴²

A survey by the United States Topographical Engineers in the early summer of 1831 further described certain variations in the general dimensions on the Georgetown level:

The width of the canal up to Frederick street is forty-six feet, and its depth six; from this street it gradually widens to eighty feet, and increases in its depth to seven, which it maintains through the

40. Wright to Mercer, Feb. 2 and 3, 1830, Ltrs. Recd., C & O Co.

41. Second Annual Report (1830), C & O Co., in Proceedings of the Stockholders, A, 82-83.

42. Ibid.

remaining part of this level up to Lock No. 5. . . .
The great dimensions of the canal heretofore stated,
terminate at this lock, beyond which the width at
the water surface is sixty feet, and the depth six.⁴³

The third annual report of the canal company made in June 1831 announced that the 48-mile stretch of canal from Georgetown to Point of Rocks was nearly completed. The report described the dimensions as being generally 60 feet in width at the waterline, 42 feet in width at the bottom, and 6 feet in depth. However, the directors carefully pointed out that the canal had been reduced below the general dimensions as given

. . . for less than a single mile altogether. . . .
It is, indeed, much more frequently enlarged than
reduced: it is never less than six feet deep; and
where its breadth as far as the four miles next above
Georgetown, is less than 80 feet, its depth is ex-
tended to 7 feet below the top--water line, forming
a cross section throughout of about 420 feet below
water.⁴⁴

During November 1830, the canal was opened from Little Falls to the Seneca feeder.⁴⁵ This early opening of navigation on a section of the canal appears to have been disrupted temporarily by the mid-winter ice, but it was reopened on March 19, 1831.⁴⁶ During that spring, final construction on the 5-mile Georgetown level below Little Falls was hurriedly completed to the point that it was placed in partial use to Georgetown, and by June a mail boat was making daily trips as far as Seneca. The opening of official navigation of the newly-opened section between Georgetown and Seneca was announced by the president and directors on July 22, 1831.⁴⁷

43. Report of Col. John J. Abert and Col. James Kearney of the United States Topographical Engineers, upon an Examination of the Chesapeake and Ohio Canal from Washington City to "Point of Rocks" (Washington, 1831), reprinted in House Report 414, pp. 91, 93, hereafter cited as Report of Abert and Kearney.

44. Third Annual Report (1831), C & O Co., in Proceedings of the Stockholders, A, 141.

45. Ibid., pp. 132-33.

46. Van Slyke to Mercer, Apr. 2, 1831, Ltrs. Recd., C & O Co.

47. Proceedings of the President and Board of Directors, B, 431.

Shortly before the line of the canal between Seneca Falls and Point of Rocks was finally completed, an examination of the canal was made by Lieutenant Colonels John J. Abert and James Kearney of the United States Board of Engineers at the request of the canal board. On June 13, 1831, the two topographical engineers began their inspection of this stretch of the canal, reporting favorably on the quality of construction completed and describing the existing conditions along the line of the waterway. The report issued by these two men furnishes a glimpse of the problems encountered in excavating the canal trunk as well as one of the most complete analyses of the canal's embankments and external walling.⁴⁸

Of particular interest to Abert and Kearney were the canal embankments and their inner lining and the external walling that buttressed the canal trunk. They noted that the whole line of the canal through Georgetown was revetted by a well-built stone wall. At the upper end of the city, the embankment of the canal was supported by a strong dry stone wall on its outside. As the wall had recently shown some indication of yielding to the pressure of the earth, strong buttresses had been erected to reinforce it. The engineers observed that the bottom and embankment of the canal "for a great distance in its line on each side of this wall, has been carefully puddled."⁴⁹

The walling on the four-mile distance from Lock No. 4 at the upper end of Georgetown to Lock No. 5 near Little Falls also received favorable comment from the two engineers. They commented that the towpath side of the canal was

sustained by a heavy and high embankment, revetted at its base by a substantial stone slope wall wherever it is exposed to the action of the river, and the interior slope of this embankment is lined throughout nearly the whole of this distance by a stone wall, rising from the bottom of the embankment, and resting upon its slope. The opposite bank of the canal, over which the road to the Little Falls passes, is sustained by a well constructed perpendicular wall wherever the road is immediately adjacent to the canal; and where it extends back a short distance, the bank is generally revetted by a slope wall.⁵⁰

48. Report of Abert and Kearney, pp. 88-89.

49. Ibid., p. 91.

50. Ibid., p. 92.

Despite the apparent security of this protection wall a series of floods in the 1840s and 1850s would eventually force the canal company to further strengthen these embankment walls.

Farther up the canal between Lock No. 14 and Lock No. 15, the engineers found a 4-mile level where the embankment frequently encroached on the river. In this area, the upper portion of which is now commonly known as Widewater, the embankment was protected by a slope wall of dry masonry which rose in places to 40 feet. The engineers found that this wall was made unusually strong

not only to sustain the pressure to which it is exposed, but also because it was the most convenient and economical way of disposing of the vast quantities of stone which had to be blasted out of the path of the canal in its vicinity.⁵¹

Abert and Kearney found that where the embankment walls reached such heights, special measures were taken to secure their foundations. Rows of plank piling were driven on the inside slopes, and the canal trunk was filled with earth and secured by puddling. In places where the canal widened into large ponds as in the Widewater area, the inside of the embankment was also secured by plank piling and puddle walls.⁵²

When the two engineers had completed their inspection of the line of the canal then in operation, they set down some general conclusions. Although they pointed out several places where slipshod work had been performed, they were generally pleased with the quality of the construction work. Concerning the dry walling, they summed up their observations in the following words:

We were particularly struck with the extent and excellence of this part of the work, and of the judicious collection in places of the superfluous stone, forming masses projecting into the river, and aiding to turn its current from the walls.⁵³

51. Ibid., p. 95.

52. Ibid., pp. 95-96. Here in the Widewater area, the canal engineers decided to use the old river channel instead of constructing the canal in the cliffs to the right which would have involved much blasting and extra expenditure. For three-quarters of a mile, the canal widens to an average of 500 feet with a maximum depth of 40 feet.

53. Ibid., p. 97.

Continuing their examination of the still unfinished portions of the canal above the Seneca Aqueduct, the two engineers remained impressed by the quality of the external walling. They noted that "wherever the embankment touches upon the river, it is carefully protected against its action by extensive and well constructed walls of dry masonry."⁵⁴ Along the precipitous cliffs which projected into the river in many places above Seneca, they found that the contractors had been forced to blast the canal waterway through the heavy rock formations. In these areas, the contractors had no choice but to establish the embankment wall foundations in the river itself.⁵⁵

One such wall that was nearing completion at the time of their inspection was located on Section 66 just below Lock No. 26. Here 85-foot-high red cliffs of Triassic sandstone projected into the river several miles above White's Ferry and constricted the canal to a narrow ledge overlooking the Potomac. Earlier in February 1830, Herman Boye, the resident engineer of the 5th Residency on the 1st Division, had sent detailed instructions to Almon H. Millerd, the contractor.⁵⁶ These specific directions illustrate the difficulties of constructing protective embankment walls in the high cliff areas as well as the care which many of the resident engineers took in spelling out the details of construction to the contractors. These directions were as follows:

An embankment of stone to be raised from the bottom of the river in the line of wall, having a

54. Ibid., p. 101.

55. Ibid.

56. Aside from scattered detailed instructions such as these, there is little other technical construction information on the building of walls that can be found in the Chesapeake and Ohio Canal Company records. Although the canal company drew up general specifications for external walling (see section III, pp. 15-16), the topographical features of the land through which the waterway passed often dictated modifications to the general guidelines. The study of the few surviving contracts for sections reveals that in many cases specific details concerning the construction of walling was left to the discretion of the resident engineers in consultation with the individual contractors. The construction costs of walling are also difficult to determine since the contracts for the sections generally lumped together broad categories of materials to be used in excavation, embankment, and external walling.

slope of $1\frac{1}{2}$ to one both outward and inward. This embankment should be about 6 ft. at surface. As it approaches the surface of the water it should be laid with as much care and compactness as may be practicable--the longest stone to be laid in manner of headers.

The space between this stone embankment and the shore being well filled up, the slope wall will commence, occupying about 3 ft. on the inner side of the surface of this stone embankment, leaving about 3 feet of the same on the outside as an abutment to hold the foot of the slope wall. All the first course in the slope wall should consist of long headers with good beds & laid at right angles with the line of the wall, and every course of stone above the scubacks or first course should be laid in the manner of headers and at right angles with the line of the wall, being thus placed the blows from ice and drift wood, instead of forcing the stone out of the wall, will only drive it more firmly against the embankment which this wall is designed to protect. The embankment next the wall should be well packed as the wall rises, and it would be well to form that part of the embankment next the wall for about 1 foot in thickness of the small stone which comes out of the rock excavation; on this the wall will rest more firmly and the bank be less liable to wash and will settle more even. The slope of the wall should be 1 to 1 and the stones should be laid with their beds perpendicular (or at right angles) to their faces.

It is desirable that where it is practicable long headers should be placed on the bottom of the river to commence with where the bottom is rock & the depth of water renders it practicable.⁵⁷

Abert and Kearney found mostly unfinished excavation and lock construction in progress above Seneca. Nonetheless, they felt that, with the exception of the Monocacy Aqueduct, the entire line of

57. "Directions for Slope Wall on Section 66," Ltrs. Sent, Letter Book of the Resident Engineer of the 5th Residency of the 1st Division.

the canal from Georgetown to Point of Rocks would be ready to be watered by November 1831.⁵⁸ Navigation on the short section of the canal between the western edge of Georgetown and the basin at Rock Creek was opened on September 19, 1831.⁵⁹ On that date, the canal board embarked on the packet boat C. F. Mercer and descended through Locks Nos. 1, 2, 3, and 4 into the basin at Rock Creek and landed at the pier.

The final construction operations on the stretch of canal between Seneca and Point of Rocks did not proceed as rapidly as Abert and Kearney expected. In June 1832 the fourth annual report stated that these remaining works had proceeded tardily because of the controversy with the Baltimore and Ohio Railroad.⁶⁰ Work was also hampered by an epidemic of Asian cholera which struck the Potomac Valley at Harpers Ferry and rapidly spread east to Point of Rocks, killing hundreds of workers and causing many of the survivors to flee.⁶¹ As a result, the canal was not completed to Point of Rocks until June 1833.⁶²

58. Report of Abert and Kearney, p. 102.

59. Proceedings of the President and Board of Directors, C, 4-5.

60. Fourth Annual Report (1832), C & O Co., in Proceedings of the Stockholders, A, 199-206.

61. Rush to Board of Directors, Aug. 5, 1833, Ltrs. Recd., C & O Co.

62. Report of Captain Wm. G. McNeill on the Condition of the Chesapeake and Ohio Canal (Boston, 1833), reprinted in House Report 414, p. 141. The total quantity of excavation and embankment, with their respective costs needed to form the trunk of the canal from the Rock Creek Basin at Georgetown to the point of Rocks was as follows:

		Average per yd. Common av.	
Grubbing, - - - - -	12,892		
1,893,666 cubic yds. common excavation	190,917 cts.	10 $\frac{8}{100}$	} 12 $\frac{62}{100}$
439,071 do hard pan	103,412	23 $\frac{55}{100}$	
75,472 do quarry rock,	23,761	31 $\frac{48}{100}$	
398,524 do rock blasted,	295,996	74 $\frac{27}{100}$	
571,121 do embank. from canal,	75,284	-	13 $\frac{13}{100}$
962,729 do do <u>not</u> fr. canal,	185,749	-	19 $\frac{28}{100}$
97,092 do puddling,	25,107	-	25 $\frac{56}{100}$
215,701 perches of walling, from stone,	} 116,407	- perch 53	} 27 $\frac{27}{100}$
paid for as excavation			
15,363 perches of walling, from stone,	} 15,528	-	} \$1 01 $\frac{1}{100}$
not paid for as excavation			
Extras - - - - -	40,800		
Total	\$1,085,853		

As work on the canal to Harpers Ferry was nearing completion, a second official inspection of the canal was made by the United States Board of Engineers in June 1833. Captain William Gibbs McNeill surveyed the quality of construction of the culverts, aqueducts, dams, locks, and walling from Georgetown to Harpers Ferry. He found that "for more than one-quarter of the whole distance, an inner paving of stone effectually secures the towpath from abrasion."⁶³ Because of the quality of the canal's embankments and protection walls, he concluded that "few repairs, therefore, will be requisite, and the enhanced cost attributable to the more than ordinarily stable character of every part of the work, will eventually result in a saving to the stockholders."⁶⁴

McNeill also recommended a plan to strengthen the durability of the towpath, a proposal that would be raised again in the 1870s. He felt that the entire towpath surface should be paved with a standard broken stone surface. In his opinion, where suitable materials were available and could be economically transported, some provision should be made for their deposit at convenient locations to be used for the eventual paving operation. To underscore his argument, McNeill reminded his readers that where his proposal had been attempted, the cost per superficial yard for a 1-foot thickness of stone was 12-1/2 cents when the stone was within 120 feet.⁶⁵

Directing his attention to the works still in progress above the Point of Rocks, McNeill noted the difficulties of construction through the narrow passes up to Harpers Ferry. He found that massive protective walls projected into the river for 10 of the 12 miles between these two points. On this portion of the canal, he also observed that increased care had been taken in paving the inner slope of the towing path for 7.9 miles.⁶⁶

By October 1, 1833, some 64 miles of the canal above the Georgetown Basin to the head of the Harpers Ferry falls were

63. Ibid., pp. 144-45.

64. Ibid.

65. Ibid.

66. Ibid., p. 147. The purpose of these man-made walls was to protect the canal embankments from the action of the water in this flood-prone area.

completed.⁶⁷ Concerning the general dimensions of this completed portion of the waterway, President Mercer reported the following to the House Committee on Roads and Canals:

The canal, now in use, below the head of Harpers Ferry falls, sixty-four miles in extent, has for its cross section 306 square feet; its breadth at the water surface being sixty feet, at bottom forty-two feet, and its depth of water six feet. Its tow-path is twelve feet wide at top, its guard or berm bank on the opposite side, eight feet, and both are raised two feet above the water, and of course eight feet above the bottom, which gives to the inner slope of its banks a rise of one foot in one and a half. . . .⁶⁸

At the same time, the canal president emphasized that variations did exist, stating:

The canal is reduced in breadth below those dimensions, wherever much additional expense would have attended a close adherence to them, which was the case for a few miles only. For a much greater distance, where no extra cost attended it, its breadth is enlarged beyond them.⁶⁹

This report reveals that the canal board chose to overlook the construction cost increases caused by its own decision to enlarge the proposed pre-construction dimensions at a time when it was appealing for more public financial support.

67. Sixth Annual Report (1834), C & O Co., p. 4.

68. House Report 414, p. 20.

69. Ibid.

V. CONSTRUCTION FROM HARPERS FERRY TO CUMBERLAND: 1833-1850

Following the successful termination of the controversy with the Baltimore and Ohio Railroad, the directors quickly made preparations to resume construction of their waterway. It was now a two-fold race, as the 5 years allowed by the charter for the construction of the first 100 miles would expire in 1833 and the exhaustion of the company's immediate financial resources was rapidly approaching. Not only did the canal board let contracts for the 12-mile stretch between Point of Rocks and Harpers Ferry, but on January 9, 1832, it also solicited proposals for the canal all the way to Williamsport.¹ However, the severe winter forced the board to suspend operations for all work above Harpers Ferry, and later, on March 14 and June 2, canal officials let enough of the line above Harpers Ferry to complete, with slackwater navigation in the pools behind Dams No. 4 and No. 5, the 100 miles required by the charter.² While the company asserted that it had sufficient funds to complete the contracts, the approaching financial difficulties were manifested by the revival of the proposal to substitute slackwater for canal navigation and other suggestions for economy measures.

The renewal of construction above Harpers Ferry brought a renewal of earlier grievances. Land acquisition costs remained high as the property owners along the line of the canal continued to resist the efforts of the company to purchase land for its right-of-way. Heavy spring freshets often wrecked half-finished sections of the canal trunk and made extensive repairs necessary while construction was still in progress. The lack of good building stone in the region above Harpers Ferry led to logistical problems and higher construction costs because the needed building material often had to be transported over land or water for great distances.³ At times, the canal company was unable to pay the contractors for several months, and many of the contractors, lacking money, provisions, and credit, were forced into bankruptcy.⁴ When the

1. Fourth Annual Report (1832), C & O Co., in Proceedings of the Stockholders, A, 204-7.

2. Sanderlin, Great National Project, p. 90.

3. Purcell to Board of Directors, May 26, 1835, Ltrs. Recd., C & O Co.

4. Sixth Annual Report (1834), C & O Co., p. 4.

contracts were reassigned, they were let at higher prices because of the inflationary economy of the 1830s that was driving the cost of labor and building materials up by as much as 40 percent in some years.⁵ Because of the rapidly rising costs of construction, many contractors began to demand monetary advances as a condition of signing building contracts, thereby putting added pressure on the insecure financial position of the company.⁶ Finally, the instability of the labor force and the numerous physical construction difficulties posed by the terrain above Harpers Ferry had the effect of hampering the westward progress of the canal.⁷

The insecure financial position of the canal company forced the directors to make a number of difficult decisions to expedite the construction work above Harpers Ferry. In late 1832 unsuccessful attempts were made to secure loans from Eastern banks.⁸ Appeals to Congress and the Virginia state legislature for aid were also rejected, but the State of Maryland agreed to subscribe to an additional \$125,000 of canal company stock in March 1834.⁹

At the end of 1834, however, the canal company treasury was again depleted. By this time, the engineers had revised their estimates of construction costs. According to their revised figures, an additional \$2,000,000 would be required to complete the canal to Cumberland, making the total cost for the eastern section in excess of \$6,500,000.¹⁰ In this situation, the State of Maryland again came to the aid of the virtually bankrupt canal company by authorizing a \$2,000,000 loan to the canal company in 1835.¹¹ When

5. "Report to the Maryland Legislature, February 5, 1838," reprinted in Tenth Annual Report (1838), C & O Co., p. 25.

6. Fisk to Board of Directors, Mar. 30, 1840, Ltrs. Recd., C & O Co.

7. Sanderlin, Great National Project, pp. 115-16.

8. Proceedings of the President and Board of Directors, C, 174, 240.

9. Report to the Stockholders on the Completion of the Canal, p. 336.

10. Journal of the Internal Improvement Convention (Baltimore, 1835), pp. 3-7.

11. Proceedings of the President and Board of Directors, D, 265.

this sum failed to be sufficient, an additional appropriation of \$3,000,000 was authorized the following year to purchase stock in the canal company, thus making the State of Maryland the majority stockholder in the company.¹² Although these appropriations breathed new life into the operation, the latter sum was in the form of state government bonds which proved difficult to negotiate, especially after a major economic depression hit the country in 1837. The credit of the State of Maryland was undermined by 1839, and few were willing to purchase the state bonds. When they were finally negotiated with banks in Baltimore, Washington, New York, and London in late 1839, it was at a depreciated value, the total loss to the company from the transactions amounting to more than \$1,000,000.¹³ Needless to say, work along the line of the canal proceeded at an irregular pace into the early 1840s, reflecting the financial fluctuations of the canal company.

The construction of the canal was further hampered by the instability of the labor force. The laborers on the line of the canal were predominantly Irish, and at times drunkenness, disorders, and open warfare among different factions of the emigrants disrupted the progress of construction. Several encounters took place in January 1834 between the Corkonians, who were working near Dam No. 5, and the Longfords, or Fardowners, from the vicinity of Dam No. 4. After a preliminary skirmish above Williamsport in which several were killed, the two factions met on a hilltop near Dam No. 5 several days later in a pitched battle in which a number of workers were killed and wounded. The local militia was called out to suppress the disturbances until several companies of United States troops arrived from Fort McHenry.¹⁴

Recurring strikes and clashes among workers continued to mar the construction of the canal above Dam No. 5 for several years. Much of the unrest was caused by the generally unsatisfactory living facilities set up for the laborers. Their working conditions were difficult and often dangerous, and their discontent was compounded by the inability of the canal company to meet its payroll at times because of its financial difficulties. This led to strikes and further rioting until the canal board took effective steps to curb the violence and remove the troublemakers. After a number of

12. Eighth Annual Report (1836), C & O Co., p. 6.

13. Thirteenth Annual Report (1841), C & O Co., p. 27.

14. Purcell to Board of Directors, Jan. 29, 1834, Ltrs. Recd., C & O Co.

disturbances near the Paw Paw Tunnel in July and August 1838, the company suspended work along some sections of the canal and ordered the dismissal and blacklisting of disorderly persons.¹⁵ Although isolated incidents continued to occur, these forceful measures, together with the use of strikebreakers, appear to have been effective in restoring order.¹⁶

In addition to these labor difficulties, periodic epidemics would strike the Potomac Valley, further hindering progress along the canal. One of the most severe epidemics occurred in September 1832 when Asiatic cholera virtually swept along the entire line of construction. The epidemic moved southward from Montreal and hit the workers near Harpers Ferry and quickly spread east to Point of Rocks. In spite of the establishment of field hospitals and other emergency measures designed to care for the sick, the epidemic gradually moved up the valley to the west of Harpers Ferry. A heavy toll of lives was taken in the vicinities of Shepherdstown, Sharpsburg, and Williamsport, and many of the survivors panicked and fled.¹⁷ As a result, work was suspended on many parts of the canal, and, when work resumed in the spring of 1833, the cost of labor and building materials rose sharply because of the general inflation of the period.¹⁸ In subsequent years, less serious outbreaks of sickness occurred along the line of construction, as in the summer of 1833 near Williamsport, creating fear among the workers and causing the suspension of operations for a time.¹⁹

With the continuing financial support of the State of Maryland, construction proceeded slowly. By June 1834, the section of the waterway from Harpers Ferry to Dam No. 4 below Williamsport was completed and opened to trade.²⁰ At this point the canal had been completed for 86 miles. Boats using the Big Slackwater pool backed up by Dam No. 4 could now reach Williamsport.²¹

15. Fisk to Board of Directors, July 3, 1838, Ltrs. Recd., C & O Co.

16. Proceedings of the President and Board of Directors, F, 405.

17. Sanderlin, Great National Project, pp. 93-97.

18. Sixth Annual Report (1834), C & O Co., pp. 3-5.

19. Purcell to Board of Directors, August 1, 1833, Ltrs. Recd., C & O Co.

20. Sixth Annual Report (1834), C & O Co., p. 4.

21. Seventh Annual Report (1835), C & O Co., p. 4.

In the early part of April 1835 the portion of the waterway between Dams No. 4 and No. 5, 8 miles above Williamsport, was finished.²² The dimensions of the waterway from Harpers Ferry to Dam No. 5 were narrower than the 64-mile stretch of canal east of Harpers Ferry. According to the seventh annual report of the canal company, the dimensions of the newly-opened sections were "reduced to 50 [feet at the surface of the water] in width, and 6 in depth, and will retain the same proportions to Cumberland."²³ While this reduction can be interpreted as an economy measure, the decision was also in keeping with the projected general dimensions for the canal above Harpers Ferry recommended by the board of directors in 1828.²⁴

Due to the rugged terrain and costly work involved in excavating difficult sections above Harpers Ferry, the canal board was forced to reconsider its original plan for a continuous, independent canal. The impounded waters behind Dams No. 4 and No. 5 offered the directors a chance to substitute slackwater navigation for continuous line navigation as an economy measure.²⁵ For a distance of nearly 3-1/2 miles immediately above Dam No. 4, there was an impoundment in the Potomac River which was used to supply water for that portion of the canal between the Government Dam at Harpers Ferry and the Guard Lock above Dam No. 4. For most of this distance, the river, 10 to 15 feet in depth, washed the base of 100-foot vertical bluffs, known as Galloway's Cliffs. The construction of an artificial waterway through this terrain would be very costly. Even the estimated cost of a towpath was not less than \$30,000.²⁶ In the interests of economy, General Bernard of the United States Board of Internal Improvements had earlier recommended the use of the natural bed of the river here for navigation with a towpath along its precipitous cliffs, and the canal board accepted his recommendation in 1834.

The following specification for such a towpath (Sections Nos. 157-165) was prepared by either Thomas F. Purcell or Charles B. Fisk:

The towing path shall not be less than twelve feet wide on the top and shall raise [sic] at least 8 feet above the top of the dam when finished, that is now being built by Joseph Hollman below said Section 157; it shall be level on

22. Ibid.

23. Ibid.

24. Proceedings of the President and Board of Directors, A, 80.

25. Mercer to Purcell, May 7, 1832, Ltrs. Sent, C & O Co.

26. Seventh Annual Report (1835), C & O Co., pp. 8-9.

the top if required, but shall never in any case vary more from a level than two feet in a hundred of its length. & its greatest elevation above the surface of the water shall never exceed twelve feet.

In forming the embankment along the shore the filling behind the wall shall in all cases extend back to the face of the hill, so that no vacant space shall be left between the towpath and the hill, even though the breadth on the top may thus exceed 12 feet first specified. The entire length of the towing path shall be faced with a stone wall in the following manner. All that part of the towpath from the Guard Lock on the Section 157 up to the rocky cliff known as "Galloway Mills Cliff" shall be protected with a pavement or slope wall, at least one foot thick and the entire height of the bank. The remainder of the distance to be faced & protected by a slope, or vertical wall, as the Engineer may prefer. The vertical walls when built shall be three & a half feet thick at the top, & batter 3 inches for every foot of the height; the slope wall when built, shall be three [feet] thick at the bottom, & two feet at the top, & slope at an angle of forty five degrees: the foot of every wall shall be so placed as to be at least six feet below the top of the aforesaid dam building by Joseph Holleman and shall rest on a rock foundation. The filling behind the walls shall be of small stone and sprawls; and in no case shall clay or other earth be put next to the wall. The top of the horse path shall be made smooth & even, & no large stone shall appear on its surface.

Whenever in the opinion of the Engineer having charge of the work it is advisable, stone culverts, or bridges of stone & wooden as to him seems best, shall be erected of such dimensions as he shall direct: & back drains or ditches cut communicating with said culverts was to pass under the path the water that may flow from the adjacent hills. And it is hereby directed that the towpath shall be so fashioned that the curvature shall never exceed that formed by [illegible] of two hundred feet. The grubbing and clearing shall extend to the distance of twenty feet above the upper side of the path & below the same so that no trees, stumps, roots, or rocks, shall remain in any part of the river within two hundred feet of the face of this path, with less than six feet of water on them at the lowest stage of the water.

An no tree or stump obtained from the grubbing shall be cast into the river.

The resident Engineer shall direct the manner in which the work is to be performed and decide all questions arising under this specification & the monthly estimates shall be graded by him so as to commensurate with the relative value of the parts of the work done & to be done.²⁷

27. Specification for Sections Nos. 157-165 (Drawings and Other Records Concerning Construction). Also see Proceedings of the President and Board of Directors, E, 4.

Similar difficulties were encountered in the construction of the canal for a distance of about 1 mile behind Dam No. 5. Here 100-foot bluffs of limestone, known as Charles' Cliffs, overhung the river, which was 20 feet in depth at their base. Before slackwater navigation was considered for this section of the canal, Geddes and Roberts estimated the cost of 1 mile of construction at this point to be \$65,941.75.²⁸ Thus, the cost of a continuous line of canal from the dam to the upper end of Charles' Cliffs would cost nearly \$100,000 if the company included the increased costs due to inflation in the final estimate. On June 16, 1835, Charles B. Fisk, the Chief Engineer, issued a report recommending that an artificial waterway be cut through these cliffs, but Thomas F. Purcell, the resident engineer for this division, effectively pressed for slackwater navigation in a letter to the canal board, which adopted the latter view.²⁹

In using the river's impoundment for navigation behind both dams, the canal boats were locked out of the canal into the slackwater. This took care of the boats, but provision had to be made for the mules that towed them. They could be taken aboard, but this would have left the boats without controlled power. The canal boats were not equipped for independent river navigation and were forced to use oars since the water was too deep for the use of poles. For a time, the canal company studied a remedial course of action by considering proposals for steam navigation on the impounded waters.³⁰ After receiving many complaints that navigation in the slackwater areas was causing delays and danger to the boats, the canal board decided to construct towpaths along the base of the cliffs behind both dams to provide the boats with mule-power in the impounded waters.³¹

28. Seventh Annual Report (1835), C & O Co., p. 9.

29. Purcell to Board of Directors, Sept. 17, 1835, Ltrs. Recd., C & O Co. Also see Proceedings of the President and Board of Directors, D, 442-43.

30. Seventh Annual Report (1835), C & O Co., pp. 8-10.

31. Ibid. For a more in-depth study of the slackwater towpath behind Dam No. 4, see John F. Luzader, "Historic Structures Survey: Towpath, Parts I and II," Part II, 1963. No comparable information on the specifications for the towpath behind Dam No. 5 could be found after a thorough search of the C & O Canal Company records at the National Archives. The bare-ledged towpath around the rocky point at Charles' Cliffs above Dam No. 5 has been considerably altered since 1969 to serve as a maintenance road. This action has changed the historical appearance of the area, and similar activities in the future should be prohibited. This altering of the historical scene behind Dam No. 5 is documented by two photographs on page 64 of the Towpath Guide to the C & O Canal, Section 3, by Thomas F. Hahn. One photo shows the historical appearance of Charles' Cliffs before 1969 while the other shows the present appearance of the same area.

Upon receipt of the first installment of the \$2,000,000 loan from the State of Maryland in April 1835, the canal company ordered the route from Dam No. 5 to the Cacapon River, a distance of 27½ miles, be put under contract.³² Before the contracts were let, Charles B. Fisk, the chief Engineer, reviewed the survey of the location of the line made in 1834 by Alfred Cruger who had estimated that the construction of this portion of the canal would cost \$663,676. Fisk revised this estimate upward to \$1,022,534 in a report submitted on June 16, 1835, and in June 1838 another revision raised the cost to about four times the original estimate: \$2,427,497.³³

The ninth annual report of the canal company issued in June 1837 indicated that the increased funding from the State of Maryland was not only a spur to construction but also to the improvement of the line of the canal from Georgetown to Dam No. 5, as well as the portion under contract to the Cacapon River. They were pleased to find "that the embankments are acquiring strength and solidity, which secures the canal from the hazard of future breaches, and the consequent interruption of its trade."³⁴ The board also found that "the inner slope of the towpath has been covered with broken stone to a considerable extent," and they "deemed it advisable to proceed gradually with this improvement on the whole line where it may be necessary."³⁵ According to their report, experience had proven that this pavement of the inner towpath slopes was more protective and less costly than other measures that had been attempted to strengthen the canal embankments. This work was to be performed by laborers in the service of the company under the direction of the superintendents on each division at times when they could not be more profitably employed.³⁶

As a result of the increased funding by the State of Maryland, other improvements were made on the line of the canal in 1836 and 1837. After a number of accidents had occurred on the high walls and dangerous passes below Great Falls, the canal board directed that a strong post-and-rail fence be erected on the river side of

32. Washington to Treasurer of the Western Shore, June 4, 1835, Ltrs. Sent, C & O Co.

33. Eighth Annual Report (1836), C & O Co., pp. 3-4.

34. Ninth Annual Report (1837), C & O Co., p. 3.

35. Ibid.

36. Ibid.

the towpath at all unsafe points.³⁷ As part of a final settlement to the long-standing controversy between the Baltimore and Ohio Railroad and the canal company, the railroad agreed on June 1836 to pay for the erection of a post-and-rail fence on the river side of the towpath wherever the canal and railroad were side by side between Point of Rocks and Harpers Ferry.³⁸

The canal board also directed its attention to strengthening the canal embankments to prevent breaches. Until 1836 one of the chief interruptions to navigation had resulted from the practice of constructing the canal trunk too near the banks of the river through alluvial bottoms where sand or clay had been gradually deposited by the action of the water. This practice had resulted from the effort to keep land acquisition costs down by locating the trunk near the river. However, the directors found that in many instances the increased expense from stopping leaks, repairing breaches, and building protection walls and ripraps along the shore to prevent the earth slides common on these alluvial banks was about double the sum saved in the condemnation of the land.³⁹

After their examination of the canal, the board of directors began policies to correct these faults. The angle of the embankment slopes was changed from $1\frac{1}{2}:1$ to $2:1$ in the sections then under contract above Dam No. 5, thereby giving greater breadth to the foundations, more security to the protective walling, and more resistance to abrasion. Puddle ditches were also carried through the center of the embankment longitudinally and were sunk some depth below the natural surface. The embankment was deposited on top of this in layers of 6 inches at a time over which carts were to be driven for compacting the material. Under this new plan, the directors optimistically announced that the embankment would be as firm as it would have been on the old plan after having settled for several years.⁴⁰

Following a period of intermittent construction, the canal between Dams No. 5 and No. 6, 10 miles above Hancock at the

37. Ibid., p. 4.

38. Ibid.

39. Ibid., pp. 7-8.

40. Ibid.

Cacapon River, was watered in April 1839.⁴¹ Now the canal company looked forward to the completion of the last 50 miles of construction to Cumberland. However, the canal engineers were soon forced to deal with the problem of lime sinks, one of the most critical problems to face the canal company in its years of construction above Harpers Ferry.

The Great Valley, known in Virginia as the Shenandoah and in Maryland and Pennsylvania as the Cumberland, is in reality a series of folds averaging 500 feet above sea level. This is the limestone area for which the Potomac Valley has long been known. Large limestone formations dominate its natural terrain, and the region abounds with underground caverns and sinkholes which have often caused the bottom of the canal trunk to give way.⁴²

Some of the areas along the line of the canal where these troublesome limestone formations are found are near Shepherdstown, the Two Locks area above Dam No. 4, the Four Locks area on Praether's Neck, the Big Pool area above Fort Frederick, and the Roundtop Hill area near Dam No. 6.⁴³ The canal engineers were cognizant of the problems incident to these limestone regions, but they were confident that their experience would prevent structural accidents. In the seventh annual report issued in June 1835 the canal directors had optimistically stated:

It is well known that time is required to give solidity to embankments, and to detect the leaks from fissures and sinks incident to a limestone region, being the character of that through which the works pass of recent construction. The experience of our engineers and contractors in practical construction, it is confidently believed, will, in the further prosecution of the work, ensure it against those accidents which have heretofore occurred on this and other canals.⁴⁴

41. Fisk to Board of Directors, May 23, 1840, Ltrs. Recd., C & O Co.

42. U. S., Congress, House, Committee on Public Lands, Chesapeake and Ohio Canal Report, H. Doc. 687, 81st Cong., 2d sess., 1950, pp. 9-10, hereafter cited as House Document 687.

43. For more information on the location of limestone formations along the canal, see the C & O Canal Natural History Base Map by John R. Miele, 1963.

44. Seventh Annual Report (1835), C & O Co., p. 6.

This optimism proved to be premature as correspondence received by the president and directors from 1834 to 1836 indicates numerous reports of recurring breaches in the lime sink area between Shepherdstown and the Cacapon River.⁴⁵

As construction progressed up the Potomac Valley, there appear to have been some precautionary measures taken against lime sinks. The Big Pool area near Fort Frederick was such an example. Big Pool had been built as the result of the engineers' decision to utilize the natural contour of the land rather than excavate a trunk through a low piece of swampy ground. Extending for nearly 2 miles in length above Lock No. 50, Big Pool had an average width of about 700 feet. In the report of the General Committee of Stockholders made in August 1839, the lime sink problem and precautionary measures taken to deal with them in the Big Pool area were discussed:

From lock No. 50, for a distance of one and half miles to McCoy's ferry, the canal passes over a limestone country at an elevation of 47 feet above the low water surface of the river. The various difficulties which usually belong to this character of country were anticipated and guarded against, so that although sinks are met with even in the middle of the deep cut across Prather's neck, they have not been of sufficient moment to require the water to be drawn off the level; or the navigation to be suspended.

About midway of this level is a masonry waste weir; and at the upper end of it at the point of junction between the limestone below, and the slate which is now reached, is a stop gate to be used should any serious leak appear through the limestone sinks.⁴⁶

By means of these stop gates, the level of the canal could be lowered above or below the pool should a leak occur.

Despite precautions such as these, breaches in the limestone country continued to interrupt navigation on the canal. In November

45. Purcell to Board of Directors, Apr. 25, 1834, and Rodgers to Board of Directors, Sept. 6, 1836, Ltrs. Recd., C & O Co.

46. Report of the General Committee of the Stockholders of the Chesapeake and Ohio Canal Company (Washington, 1839), p. 8.

1839, Superintendent George W. Rodgers reported that four breaches had occurred in the canal near Lock No. 37 that month. Stating that the canal could no longer deal with the lime sink problem in a superficial manner, he wrote:

The damage is about one half it was before and would require 5 or 6 days to putt /sic/ it up in the usual manner of repairing Breaches which shew the same appearance this does at this time and did every time it gave way. From the nature of the country for more than a mile in extent I have no confidence in repairing it again unless the bottom of Canal and berm bank is removed for a considerable distance and made a new. There were a number of lime sinks in the vicinity of the Breach which no doubt has made the canal bottom hollow though we cannot discover anything unusual after a Breach has taken place. There is a sink in a field (say) 200 ft. from the berm bank which has taken place within the last two months. There is also a small stream of water which sinks and passes under the canal. If we remove the bottom and berm bank as it now proves must be done will require three weeks which will stop the navigation for this season.⁴⁷

After a thorough examination of the lime sink problems near Lock No. 37, Chief Engineer Fisk made a comprehensive report to the canal board on December 6, 1839. In his opinion, the canal in this area could never be regarded as secure against breaches until extensive and costly repairs were undertaken. Fisk described the nature of the lime sinks, their effects on the canal operations, and the repair work needed to remedy the problem:

These breaks have all evidently been occasioned by limestone sinks which exhibit themselves by a falling down of the bottom of the Canal into limestone caverns that are lower than, and extend out under the bed of the river:--in consequence of which the water from the Canal is at first conducted down below canal bottom perhaps twenty or thirty feet and thence out along under the bed of the river to

47. Rodgers to Board of Directors, Nov. 1, 1839, Ltrs. Recd., C & O Co.

some weak point where it bursts up and rises through openings that have the appearance of large insular walls. These sink openings in the bed of the river are now to be seen opposite to the breach.

The falling in of the bottom of the Canal in this way in limestone countries, very often does not happen for several years after the first filling of a Canal with water, as earth will frequently sustain itself for a long time over large openings, tho' at the same time gradually giving way but when once broken through and a large opening in the bed of the river has in consequence been formed as an outlet for the water, it becomes a matter of great difficulty to make the Canal permanent. . . .

It has been a matter of surprise to me that our Canal thus far has suffered so little from limesinks. We may yet however have much trouble from this source near and above the breach at Lock No. 37. For about a mile, there is scarcely a hundred feet in length of the Canal in which there are not several small lime sink holes in the bottom of the Canal and up along the slopes of the banks. These have long required close watching. They are fitted up from time to time but almost invariably the effect is to cause other holes close by.

Sooner or later, to make the mile of Canal secure above Lock No. 37 will require not less than \$10,000. There are other parts of the Canal where similar difficulties are to be feared.

If the plan of repair now adopted should not answer the purpose I should advise planking over the breach. But I am rather of opinion that this particular place will stand hereafter. Mr. Rodgers is now putting in a new berm bank which will add very much to the security of the work. This was not done in making the former repairs, as Mr. Rodgers had not on previous occasions found such a course to be necessary.⁴⁸

48. Fisk to Board of Directors, Dec. 6, 1839, Ltrs. Recd., C & O Co.

The canal board accepted Fisk's recommendation to continue the new berm bank several hundred feet on both ends of the lock. When navigation was suspended for the winter, the area was to be closely examined, and, where there were problem points in the bottom of the trunk, excavation work was to be carried out along the berm side and a more permanent watertight bank was to be built. Parts of the bottom were also newly excavated and filled up with watertight materials that were connected with the new berm bank.⁴⁹

On the same day that Fisk made his report on the lime sink problems near Lock No. 37, he also recommended measures to remedy similar cases on Sections Nos. 208 and 229-230. Section No. 208 just above Praether's Neck had been left partially unfinished for the purpose of enabling the company to do what it found to be necessary to stabilize the section once it was watered. Earlier a wooden trunk had been recommended as a remedy for the lime sink problem on this section, but Fisk now proposed that a new berm bank similar to that near Lock No. 37 be built. On Sections Nos. 229-230 above Big Pool, the Chief Engineer recommended that a puddle ditch be cut down to the rock for a distance of 500 feet and that the defective building materials previously used be removed. Part of the ditch had already been dug on these sections, and Fisk suggested that it be finished.⁵⁰

After approving Fisk's proposals to deal with the lime sinks, the canal board ordered that proposals be received for the work. On January 22, 1840, contracts were let for the repair work.⁵¹ Although the repair work had originally been estimated by Fisk not to exceed \$10,000, the work accomplished on these sections during the winter of 1839-40 cost the company \$45,000.⁵² When the work was completed in July 1840 on the sections near Lock No. 37, it was reported that the lime sink problem in that area was settled. According to the report, these sections had "received a thorough and expensive repair by the formation, for the bed of the canal, of a complete trough of water tight material, which has thus far proved entirely effectual." The repairs on Sections Nos. 208 and 229-230 were completed in mid-August, and Fisk indicated that he was satisfied that these repairs would be sufficient.⁵³

49. Ibid.

50. Ibid.

51. Proceedings of the President and Board of Directors, F, 151.

52. Proceedings of the Stockholders, B, 362-64.

53. Ibid. The repairs did not prove to be sufficient, because the canal company annual reports for subsequent years mention similar recurring problems that remained unsolved.

Following the subscription of the State of Maryland to \$3,000,000 worth of stock in the canal company in 1836, the board of directors made the necessary arrangements to place the line of the canal for the 50 miles between the Cacapon River and Cumberland under contract. As soon as revised estimates could be prepared by the engineers and the problem of obtaining sufficient laborers was assured, the directors contracted the heaviest sections and masonry between those two points. This was done to ensure that the heavier sections would be completed in time for their connection with the lighter sections.⁵⁴

After several years of construction in the rugged country above the Cacapon, Chief Engineer Fisk issued a report on January 22, 1839, concerning revised estimates. The estimated cost for the completion of this 50-mile stretch to Cumberland was increased 71 percent over the prices estimated in January 1836, to a total of \$4,440,657.⁵⁵ Most of the higher costs were attributed to the increasing costs of labor, the transportation of good building materials to this isolated region, and the physical difficulties of cutting through the rugged terrain.⁵⁶ As a result of these rapidly rising prices, many contractors abandoned their sections. When the contracts were relet, the new contractors often insisted on agreements that included advance payments of 30 percent in addition to provisions to cover the rate of annual inflation.⁵⁷

The physical difficulties in constructing the canal through the rugged terrain in the upper Potomac Valley increasingly became a prime reason for higher construction expenditures. The canal above Dam No. 6 passed through the Appalachian region, and in Maryland alone there were 15 separate ridges in this massive mountain barrier. The ridges range upward from 1,600 feet, and include North Mountain, Round Top, Tonoloway Mountain, Sideling Hill, Four Hill, Green Ridge, Polish, Warrior, and Evitts mountains. The region is basically sandstone and slate in composition. Steep cliffs often rising to

54. Proceedings of the President and Board of Directors, D, 342. Sections costing from \$17,500 to \$40,000 were called "heavy sections," and those costing upwards of \$40,000 were called "very heavy sections."

55. Fisk to Board of Directors, Jan. 22, 1839, Ltrs. Recd., C & O Co.

56. Tenth Annual Report (1838), C & O Co., p. 25.

57. Fisk to Board of Directors, Jan. 22, 1839, Ltrs. Recd., C & O Co.

more than 100 feet above the river and short, precipitous streams dominated the landscape and made excavation work particularly difficult.⁵⁸

The adoption of the plan to cut through these rocky cliffs proved to be costly both in terms of finances and time consumed. Strong protection walls were required in this region, and heavy blasting was often needed to excavate the canal trunk. An example of some of these difficulties was the area immediately above Dam No. 6. Construction work in progress in this area was described in the report of the General Committee of Stockholders issued on August 5, 1839, in the following terms:

For a distance of 2 miles above this aqueduct /Sideling Hill Creek/ are very heavy sections of embankment and rock excavation. These in common with all the work extending 8 miles above Dam No. 6 are far advanced towards completion. Along these two miles upwards of 200,000 cubic yards of embankment have been and will be hauled from the Virginia side of the river, which is brought over by bridges temporarily constructed of boats. This heavy embankment, much of which has a width of 70 feet at the base, is constructed in the pool formed by the dam below, which has a depth of from 10 to 15 feet, and it is raised 26 feet above the surface of the pool. /Dam No. 6/

There are heavy embankments requiring protection against the river, along one half of this five mile level, /Lock 57-58/ and heavy rock hillside excavation. The work in general is well advanced, and in part completed.⁵⁹

The report went on to describe the physical difficulties in excavating the deep cuts on both sides of the Paw Paw Tunnel. Here the material through which the excavation was made consisted of blue slate in elliptical strata with a very slight admixture of earth. Concerning the lower or eastern entrance of the tunnel, the report stated that it was "2,400 feet in length, containing 100,000 cubic yards of rock excavation. At the deepest point, which is at the opening of the tunnel, the cutting will be 79 feet in depth through a slate rock."⁶⁰

58. House Document 687, pp. 10-11.

59. Report of the General Committee, p. 13. In addition, a "General Plan for Rock Dikes across Ravines to catch wash & c" was drawn up by Principal Assistant Engineer Ellwood Morris on April 23, 1840. A copy of this plan may be seen as Appendix F.

60. Ibid., p. 15.

The deep cut at the upper or western end of the tunnel also created physical difficulties in construction. The cut, about three-quarters of a mile in length, conducted the canal from the tunnel to the valley at an elevation of 45 feet above the river. By building this cut across a bend of the river, 1 mile of distance was saved. This, added to the 5 miles saved by the construction of the tunnel, was a substantial savings to the company. However, the plan of operations did not go as smoothly as at first predicted. According to the report, the excavation of the cut was continually hampered with problems:

This deep cut at Mitchell's neck, was placed under contract two years since, and after but comparatively a small portion of the work was accomplished, was abandoned by the contractor. It has been recently relet, and the work is again in progress. From the peculiar difficulties which are presented at this place, this section, in relation to the time required for its completion, is one of the heaviest, if not the very heaviest, which remains to be completed below Cumberland. The deepest cutting is 40 feet, and a large part of the excavation will be slate work.⁶¹

The construction of the canal trunk proceeded slowly westward toward Cumberland in the early 1840s. On May 1, 1840, a labor force of 1,902 were working on the line of the canal, but by July there were estimated to be only 1,500. At the same time, Fisk estimated that if a force of 3,000 were constantly employed for a period of 2 years the canal would be completed to Cumberland.⁶² In December 1841 Fisk reported that 18.3 miles of the canal were still unfinished between Dam No. 6 and Cumberland.⁶³ By 1842 the series of obstacles that had marred construction above Dam No. 6 brought the work to a standstill. The officials of the company publicly acknowledged debts of \$1,196,400 above all means, while the engineers estimated that an additional \$1,545,000 was required to finish the 18 miles.⁶⁴

61. Ibid., p. 17.

62. Fisk to Board of Directors, July 17, 1840, Ltrs. Recd., C & O Co.

63. Fisk to Board of Directors, Dec. 20, 1841, Ltrs. Recd., C & O Co.

64. Fisk to Board of Directors, Dec. 1, 1842, Ltrs. Recd., C & O Co. Also see Sixteenth Annual Report (1844), C & O Co., p. 5.

Meanwhile a series of devastating floods struck the Potomac Valley, causing great damage to the finished portions of the canal and increasing the financial distress of the canal company. A heavy flood in April 1843 destroyed many sections of the canal between Georgetown and Edward's Ferry, necessitating a \$20,000 loan from a District of Columbia bank.⁶⁵ Another freshet in September 1843, which was reportedly the highest flood in 40 years, struck the Georgetown level and suspended navigation on the waterway for 103 days.⁶⁶ In the fall flood, the water ran over the towpath in places to the depth of 4 feet, causing severe breaches just below Lock No. 5.⁶⁷

The canal company began to take precautionary measures to protect its waterway from these freshets in the winter months of 1843. The part of the towpath liable to overflow and also the embankments of the Little Falls feeder below the guard gates were raised at least 1 foot above the highest watermark of the September flood--the highest watermark then known in the Potomac Valley. A tumbling waste 250 feet long was built on the towpath side of the canal near the fourth milestone, and several other minor repairs were also constructed to prevent further inroads of the river on the canal trunk. Farther up the canal, the river end of the Shenandoah outlet lock near Harpers Ferry, which had also suffered damage in the floods, was raised and the adjacent canal banks slightly elevated. Several more freshets struck the canal in the spring of 1844, thereby forcing the canal company to make costly improvements at a time when it was unable to finance the construction of the remaining 18 miles to Cumberland.⁶⁸

With the sale of bonds totaling more than \$1,000,000, the canal company negotiated a contract with Hunter, Harris & Co. to complete the canal by November 1847.⁶⁹ Work along the line of the canal resumed immediately, and all efforts were concentrated on the one object of completing the canal at the earliest possible date. Finally after 22 years of intermittent enthusiasm and despair, the final portion of the canal between Dam No. 6 and

65. Fifteenth Annual Report (1843), C & O Co., pp. 3-4.

66. Fisk to Board of Directors, June 3, 1844, Ltrs. Recd., C & O Co.

67. Ibid.

68. Seventeenth Annual Report (1845), C & O Co., pp. 17-18.

69. Proceedings of the President and Board of Directors, H, 92. Also see Twentieth Annual Report (1848), C & O Co., pp. 3-4.

Cumberland was formally opened to trade on October 10, 1850, with gala ceremonies at Cumberland.⁷⁰

After celebrating the opening of the entire canal to navigation, the directors assessed the final cost of the waterway. For construction, engineer expenses, land acquisition, and other contingencies, the final amount was \$11,071,176.21, or \$59,618.61 per mile.⁷¹ The original estimate made by the United States Board of Engineers for a canal of somewhat smaller dimensions had been \$8,177,081.05, or \$43,963 per mile. However, these original figures had not made allowances for the costly land purchases that the company was forced to make for its right-of-way.⁷² Nevertheless, the canal board found that after adding this sum of about \$270,000 to the original estimate, the excess of actual construction cost over this figure was 23.2 percent.⁷³ An interesting footnote to this special report is that the board failed to mention the 1828 Geddes and Roberts survey estimates of approximately \$4,500,000, or about \$24,325 per mile.⁷⁴

70. Proceedings of the President and Board of Directors, D, 390-95. Also see Twenty-First Annual Report (1849), C & O Co., pp. 3-22; and Twenty-Second Annual Report (1850), C & O Co., pp. 3-12.

71. Report to the Stockholders on the Completion of the Canal, p. 112. No precise figures for the cost of the excavation, embankment, and walling of the sections could be found.

72. Ibid., pp. 112-13.

73. Ibid.

74. House Report 414, pp. 8-10.

VI. MAINTENANCE OF THE CANAL PRISM: 1850-1924

When the canal was completed and put into full operation, a system of by-laws and regulations was adopted to govern the canal and preserve its works. One of the rules adopted concerned the use of the towpath. It read as follows:

No person or persons shall drive a cart, wagon, or wheel carriage of any description, nor lead or drive any horse, mule, ox or other animal, except for the purpose of towing boats or floats, upon the tow-path or berm-bank of the Canal, except in crossing them, in the shortest convenient direction, at some authorized ferry, nor shall any person or persons, except an officer or agent of the Company, ride any horse or mule, along or upon the tow-path in the Tunnel, or along or upon the tow-path in the Deep Cuts adjoining the Tunnel, that is not, at the time, employed in towing some boat or float. PENALTY for a violation of this regulation, for the first offence, five dollars, and for any subsequent offence, ten dollars.¹

Other rules prohibited the placing of logs or materials on the embankment and putting dead animals, filth, or rock in the canal or on its banks.²

The canal maintained a great degree of regularity in navigation in its early years of operation, but improvements continued to be made to the waterway. The directors stated in June 1851 that the "depth of water in a large portion of the canal is six feet, but on some few levels it is thought advisable not yet to admit more than five feet water, until the embankments are raised, and some deposits removed which are now in progress."³ They were confident, however, that when the canal would be opened for

1. By-Laws, Rules, and Regulations; In Force on the Chesapeake and Ohio Canal, 1st April, 1851 (Frederick, 1851), p. 19.

2. Ibid., pp. 14-15.

3. Twenty-Third Annual Report (1851), C & O Co., pp. 4-5.

navigation in the spring of 1852 "six feet water may be safely maintained throughout its entire length."⁴

After most of these improvements had been completed to secure the waterway, the highest flood in 60 years struck the Potomac Valley in April 1852. The waters rose 6 feet higher than in the 1847 freshet, and heavy damage was inflicted on the section between Seneca and Great Falls.⁵ Following a survey of the destruction, the Chief Engineer estimated that \$80,000 would be needed to restore the canal and protect it from a flood of equal proportions.⁶ Loans were secured from banks in Georgetown, Washington, and Alexandria and restoration work was soon begun.⁷ Wastes were constructed on all levels subject to overflow, protection walls of heavy masonry were substituted for embankments that had been carried away, and guard banks were raised several feet higher than the flood's highwater mark at various points.⁸ The total expenditures amounted to over \$100,000, and boats did not pass on the canal until the first part of August. Aside from the heavy expenses incurred by the canal company to fix the flood damage, the freshet was responsible for the loss of 3 months of revenue and the loss of confidence in the reliability of the work.⁹

During the 1850s, the towpath in Georgetown was transferred from the south to the north side of the canal in an attempt to encourage the coal trade.¹⁰ In July 1853 the canal board approved the request brought by some Georgetown property owners who wanted to provide increased facilities for wharfage on the south side of

4. Ibid.

5. Twenty-Fourth Annual Report (1852), C & O Co., pp. 3-4.

6. Ibid.

7. Twenty-Fifth Annual Report (1853), C & O Co., p. 3.

8. Twenty-Fourth Annual Report (1852), C & O Co., pp. 3-4.

9. Twenty-Seventh Annual Report (1855), C & O Co., p. 12.

10. Proceedings of the President and Board of Directors, H, 513-14.

the canal free of charge.¹¹ In return for financing a new towpath bridge above the Alexandria Aqueduct, these proprietors were given the right to use the old towpath for loading and unloading. After some delays arising out of condemnation disputes, the new towpath was completed in April 1856 from a point west of the Alexandria Aqueduct to Frederick Street.¹²

As a result of the Civil War in the early 1860s, the canal trade was disrupted and the physical condition of its works deteriorated. In March 1862 Superintendent Lowe of the Cumberland Division reported that the towpath and berm banks along certain sections for which he was responsible had been damaged by government wagons passing along them.¹³ The Confederates seized and held portions of the canal in the summers of 1861, 1862, 1863, and 1864, cutting the embankments and wrecking some locks and culverts.¹⁴ The general unrest in the area throughout the hostilities kept the canal company from making extensive repairs, and the embankments, protective walling, and canal prism suffered from the resulting neglect.¹⁵ Restoration work began as soon as the war ended, but the towpath and embankments were not completely repaired until 1868. A number of dredges were put to work in removing the sandbars and silt deposits that had accumulated, and in June 1868 the canal board announced that the waterway had been restored to its original depth.¹⁶

The most promising period of the Chesapeake and Ohio Canal's history occurred during the early 1870s, when capable management and generally prosperous economic conditions enabled the canal company to make a profit. Beginning in June 1870 the canal enjoyed 5 years of unprecedented financial profits.¹⁷ In this situation, the board of

11. Ibid., I, 41-42.

12. Ibid., 254.

13. Lowe to Ringgold, Mar. 8, 1862, Ltrs. Recd., C & O Co.

14. Proceedings of the President and Board of Directors, L, 56. Also see Thirty-Seventh Annual Report (1865), C & O Co., p. 10.

15. Manning to Board of Directors, May 31, 1866, Ltrs. Recd., C & O Co. Also see Proceedings of the President and Board of Directors, K, 488-89.

16. Thirty-Seventh Annual Report (1865), C & O Co., pp. 3-7. Also see Thirty-Eighth Annual Report (1866), pp. 3-6; Thirty-Ninth Annual Report (1867), pp. 3-9; and Fortieth Annual Report (1868), pp. 3-9.

17. Sanderlin, Great National Project, p. 226.

directors continued the program of restoration and improvement that had been going on since the Civil War.¹⁸

Despite the repairs already made, there was still much to be done. The Chief Engineer recommended a thorough overhauling of the canal in July 1870, including repairs to the locks, aqueducts, and trunk itself.¹⁹ The estimated cost of these improvements was \$77,620, of which \$14,500 was to go toward the raising and repair of 20 miles of towpath on the Monocacy Division.²⁰

Following the inauguration of a new administration in June 1872, the new canal board ordered another inspection of the entire line of the waterway by William R. Hutton, the Chief Engineer.²¹ Hutton made his inspection and submitted recommendations for extensive repairs, and some of his proposals were acted upon during the short period of prosperity. Others were deferred, and the conditions that he described in his report tended to become chronic as the financial prospects of the canal company waned in the late 1870s.²²

Hutton's comments on the towpath and canal prism included the following statements:

The tow-path has recently been made up over a large part of its length, and most of it looks well. The remainder can be put in order by repair hands. Where made up with slate it has a moderate durability, but where earth is used, as it has on long portions, it cuts out immediately, and in wet weather becomes almost impassable. Some parts have been covered with large stones and earth, and some short pieces with properly prepared broken stone. This last method, recommended in the report of 1870, is, in my judgment, the proper one, and will prove, in the end most economical. . . .

18. Proceedings of the President and Board of Directors, L, 439.

19. Proceedings of the Stockholders, E, 170-71.

20. Report of W. R. Hutton, Chief Engineer, as to condition of Chesapeake and Ohio Canal, with estimate of cost of Extraordinary Repairs Required during the Current Year (Annapolis, 1872), pp. 5-6.

21. Proceedings of the President and Board of Directors, M, 32.

22. Report of W. R. Hutton, pp. 1-24.

The estimate of July 1870, included some \$14,500 to raise and repair 20 miles of towing-path, considered too low, which has been in small part expended. Expended, I mean, for extra labor to raise it, for much larger amounts have been paid since that time for maintenance of tow-path. It would be better if all the work were done, but I do not think it necessary to make up more than 5 or 6 miles on the lower divisions. Portions of it have been raised on the front edge, while the rest of the bank remains low. No towing path should be considered satisfactory which is not, for a width of ten feet, at least, one foot above Canal surface, two feet being the regular height. The excavation of the bottom however, will in some places permit the water surface to be lowered, and thus leave the towing path a sufficient height above it. . . .

In his recommendation concerning the towpath, he wrote:

I strongly urge that the towing path be made up for a width of four or five feet with sound broken stone, laid on a thickness of about six inches. The adoption of this plan will render advisable the purchase of a stone breaking machine, which can be moved from point to point on Canal, as may be found convenient. One or both of the steam engines owned by the Company can probably be used for this purpose.²³

Upon the recommendation of Hutton, the towpath protection wall below Lock No. 18, commonly called "High Wall," was strengthened in the spring of 1873. This action was considered necessary, because a breach at that point where the embankment was about 60 feet above the river would have entailed a heavy loss to the company. The supporting wall contained 3,127 perches of stone at a cost of \$7,123.44.²⁴

23. Ibid., pp. 5-6.

24. Forty-Fifth Annual Report (1873), C & O Co., pp. 9-11.

Efforts were soon begun to restore the canal prism to its original dimensions. The carrying capacity of the waterway had been reduced by the gradual accumulation of earth, gravel, and sand washed from its banks and slopes. Now the canal company built a steam dredge, and by June 1875 more than 25,000 cubic yards of earth had been removed from the Rock Creek Basin and the Georgetown level. To expedite the removal of deposits farther up the canal, the board of directors, in addition, committed itself to building another steam dredge as soon as revenues would permit.²⁵ These measures slowly increased the average annual carrying capacity of the canal from 109-1/2 tons in 1872 to 112 tons in 1873 and to 113-1/2 tons in 1874.²⁶

Improvements beyond the mere restoration of the waterway included the macadamizing of a portion of the towpath on the Monocacy Division just east of Aqueduct No. 2 on which the clay composition was so bad that the path became virtually impassable in wet weather.²⁷ To keep this portion of the towpath in repair up to 1872, the cost per mile had been more than treble that where stone was used, according to Hutton. The canal company purchased a steam stone crusher in 1874, and in its first year of operation more than 6,500 perch of stone were crushed and put on the towpath at an average cost of 95 cents per perch.²⁸ Since this expenditure was less than half of the cost for the same work by hand, the president

25. Forty-Seventh Annual Report (1875), C & O Co., p. 8.

26. Ibid., p. 9.

27. Report of W. R. Hutton, p. 24. For more information on this subject, see John F. Luzader, "Towpath," Part II.

28. Forty-Seventh Annual Report (1875), C & O Co., pp. 8-9. Because the work on the towpath was accomplished by company employees, the canal company records do not indicate with any degree of exactness the extent to which this recommendation was followed. However, physical evidence at various points seems to indicate that Hutton's suggestion was acted upon on various sections of the Monocacy Division.

recommended that additional steam stone crushers be purchased to macadamize the entire towpath.²⁹

This program of restoring the works of the canal was cut short in 1876 when the effects of the nationwide depression finally reached the canal company. Trade fell off sharply and the resultant loss of canal revenues forced the company to adopt severe economy measures.³⁰ The fortunes of the canal were further impaired by a devastating flood in 1877, the worst in 150 years of recorded history in the Potomac Valley. The flood left the canal a virtual wreck, necessitating the procurement of large loans for repairs.³¹ Although the canal was restored to full operation, trade did not improve as business remained generally depressed and coal prices continued to drop.³² In 1886 three heavy floods again left the canal a wreck, and in 1889 a flood of titanic proportions forced the canal company to go into a receivership, with the Baltimore and Ohio Railroad emerging as the majority owner of the canal company bonds.³³

Under the railroad's direction, trustees were appointed and the canal entered the last period of operation. In 1924, after the railroad had captured almost all of its carrying trade, the Chesapeake and Ohio Canal ceased to operate. While documentary data in the Chesapeake and Ohio Canal Company records for the period 1850-89 is sketchy, there is virtually no information dealing with these subjects for the years 1889-1924. However, secondary sources such as Sanderlin seem to indicate that the canal operated under the railroad's guidance much as it had in previous years.

29. Ibid.

30. Proceedings of the President and Board of Directors, M, 255.

31. Ibid., N, 11-13.

32. Sanderlin, Great National Project, p. 243.

33. Proceedings of the President and Board of Directors, N, 329-31, 413. Also see Sixty-First Annual Report (1889), C & O Co., pp. 8-11.

VII. REHABILITATION OF THE CANAL PRISM: 1938-1942

Due to the apparent decline of the canal in the 1880s there had been speculation about Federal acquisition of the waterway. The suspension of navigation following the disastrous spring freshet in 1924 ushered in a period of renewed and intensified speculation as to the possible sale of the ruin to the United States. Voices were raised in support of three proposed projects--restoration, park development, and highway construction. The attitude of the Baltimore and Ohio Railroad, which owned the waterway, was that the canal was not abandoned and could quickly be put into navigable condition if trade were offered. It was determined that if any sale were made the contract should guarantee that under no circumstances would the canal fall into the hands of a competitor.¹

The interest of the Federal Government in the acquisition of the canal was limited at first to the section between Rock Creek and Point of Rocks. Gradually, however, the idea of buying the entire canal and restoring it as a national park gained widespread acceptance. After some years of negotiation, a new development altered the situation. The Baltimore and Ohio Railroad, hard hit by the depression, applied to the Reconstruction Finance Corporation in December 1937 for an additional loan. As collateral for this increased indebtedness, the railroad company produced along with other security the title to the Chesapeake and Ohio Canal. The railroad expressed itself willing to dispose of the entire canal for \$2,500,000 or \$3,000,000, the proceeds of which would be applied to its \$80,000,000 debt to the Reconstruction Finance Corporation. After several months of further negotiation, the transfer was finally agreed upon for approximately \$2,000,000. Ownership formally changed hands in September 1938.²

The National Park Service promptly set about to restore the waterway as a scenic natural recreation area. As an experiment, it planned first to reconstruct the 22 miles between Georgetown and Dam No. 2 at Seneca. Two Civilian Conservation Corps camps were established on the canal to carry out this project. In a December 10, 1938, memorandum

1. Walter S. Sanderlin, A Study of the History of the Potomac River Valley (Washington, 1950), pp. 140-41.

2. Sanderlin, Great National Project, pp. 279-80.

to Arno B. Cammerer, the Director of the National Park Service, Edmund B. Rogers, the Superintendent of Yellowstone National Park, who was serving on a special assignment in Washington at the time, reported that the major work of the CCC camps was

the rehabilitation of the canal which will involve the cleaning of the accumulated debris in the canal and along the towpath, the re-establishment of the grade of the floor of the canal, and reconstruction and re-enforcement of the canal dykes and towpath at some points and the reconstruction of the lock-gates.

Concerning the work that had already been done, Superintendent Rogers reported that

So far only the removal of the accumulated debris and volunteer growth which has come up since the canal was abandoned has been undertaken. No dirt has been moved. On the side opposite from the towpath the clearing is being carried only to the high-water line of the slope. On the towpath side the clearing is being carried at present only to a point sufficient to permit the operation of trucks on the towpath. Slash and brush is being burned and all timber which might be used in the work is being temporarily stacked along the towpath in an orderly manner.³

The following summer, on July 20, 1939, Project Supervisor Lawrence F. Murray informed the Director of the general specifications that had been adopted for the restoration of the canal prism:

To accomplish this we have accepted a 30 foot channel of 6 feet depth and in order to keep the dredging at a minimum, have based its location on a 2 to 1 slope on the towpath side. Thus the channel can always be designated as 9 feet from the water's edge.

3. Rogers to Cammerer, December 10, 1938, National Park Service Central Classified Files, National Capital Parks, 1933-1949.

The existing slope varies from one on one to one on two and so long as the present slope is stable it will not be changed. The 2 to 1 slope was used in designating the channel location so that the existing slopes will not have to be changed. The 30 foot channel has been accepted first, because it is the width previously maintained by the Canal Company and second, because it is sufficient that any boat which can just pass through the locks would be able to pass one of equal size any place along the length of the canal.

If the restoration of the canal prism was to be extended above Seneca to Harpers Ferry, Murray recommended that:

The minimum width of the canal which I believe acceptable, in the areas restricted by the Baltimore and Ohio Railroad reservations [in the narrow passes above Point of Rocks] should be that just described plus a 2 to 1 slope on the berm side which would make a width at the water surface of 48 feet. This measure should be made at the water surface and not from the top of the towpath as previously done by the railroad engineers, because the towpath varies in height above the water from 6 inches to several feet; therefore, measurements made in this way would not give a continuous channel of equal width.⁴

The dedication of the canal as a public park was celebrated on Washington's Birthday 1939, with appropriate ceremonies featuring Mutt, a 38-year-old canal mule. The canal was opened as far as Seneca in August 1940, but a major flood in 1942 smashed the canal back into the wrecked condition in which the government had found it.⁵

4. Murray to Cammerer, July 20, 1939, National Park Service Central Classified Files, National Capital Parks, 1933-1949.

5. Sanderlin, Great National Project, pp. 280-81.

VIII. RECOMMENDATIONS

This report was an attempt to gather the basic historical data on the canal prism of the Chesapeake and Ohio Canal and relate it to the construction, maintenance, and operation of the waterway. Further aspects of research that should be given more attention are:

1. Changes in the general specification for the canal prism to meet local building conditions or peculiar geological features.
2. The history of freshets in the Potomac Valley including the sites of specific major damage, the dates and extent of repairs, and evidence of faulty design or construction of the canal trunk.
3. The problem of "lime sinks" and the methods employed by the canal company to overcome this "historic" problem.
4. A catalogue of the original sections of the canal prism that would include their boundaries as well as a listing of the structures and geological features situated on each.
5. A series of archeological digs at periodic intervals along the canal prism (especially on sections that are to be restored) should be undertaken to determine the original dimensions and to provide a cross-sectional analysis of the canal trunk.

APPENDICES

ATTENTION:

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Appendix A

"Table of Excavation for 60 feet of a Canal
32 ft. wide at bottom--Slope 1-1/2 to 1,"
ca. 1828

* *Table of Excavation for object of a Canal 32 ft wide -
at bottom -- Slope 1 to 1*

[illegible]

- Excavation table continued -

Depth of Cut	Number	Cuttings	Subsiding	Cuttings	Subsiding	Cuttings	Subsiding	Cuttings	Subsiding
10.20	1071.153	11.50	1303.244	13.40	1351.422	15.00	1386.667		
.15	1077.247	.95	1310.742	.45	1309.133				
.30	1080.675	.90	1319.255	.50	1367.800				
.35	1093.075	.95	1326.756	.55	1375.264				
.40	1100.034	12.00	1332.333	.60	1383.644				
.45	1107.114	.5	1340.597	.65	1391.742				
.50	1114.167	.10	1348.478	.70	1399.855				
.55	1121.230	.15	1356.075	.75	1407.986				
.60	1128.311	.20	1363.689	.80	1416.133				
.65	1135.408	.25	1371.314	.85	1424.297				
.70	1142.522	.30	1378.967	.90	1432.478				
.75	1149.655	.35	1386.630	.95	1440.675				
.80	1156.800	.40	1394.311	14.00	1448.884				
.85	1163.964	.45	1402.003	.05	1457.119				
.90	1171.144	.50	1409.722	.10	1465.367				
.95	1178.342	.55	1417.453	.15	1473.636				
11.00	1185.555	.60	1425.200	.20	1481.911				
.05	1192.732	.65	1432.969	.25	1490.203				
.10	1200.433	.70	1440.744	.30	1498.522				
.15	1207.247	.75	1448.543	.35	1506.853				
.20	1214.578	.80	1456.255	.40	1515.200				
.25	1221.575	.85	1464.136	.45	1523.564				
.30	1229.159	.90	1472.033	.50	1531.944				
.35	1236.519	.95	1479.897	.55	1540.342				
.40	1243.567	13.00	1487.778	.60	1548.755				
.45	1251.205	.05	1495.715	.65	1557.186				
.50	1258.611	.10	1503.634	.70	1565.633				
.55	1266.608	.15	1511.534	.75	1574.597				
.60	1273.422	.20	1519.547	.80	1582.578				
.65	1280.313	.25	1527.432	.85	1591.575				
.70	1288.300	.30	1535.311	.90	1599.587				
.75	1295.764	.35	1543.408	.95	1608.119				

Appendix B

Articles of Agreement for Section 175,
November 1833

CONTRACT FOR SECTION 175

ARTICLES OF AGREEMENT

Entered into this 17th day of November in the year 1833 between John Wilson & Thomas Riley

of the State of Maryland of the first part, and the Chesapeake and Ohio Canal Company, by the President thereof, of the second part.

WITNESSETH, That the said John Wilson promise and agree in conformity with the annexed Specification, and with the plan of the Chesapeake and Ohio Canal as now located, and with such changes or alterations thereof as may be hereafter adopted, either by an Engineer of the Company, or by the President and Directors thereof, to grub, clear, excavate, embank, puddle, wall up, and construct, in a substantial and workmanlike manner, all that part of the Chesapeake and Ohio Canal, designated as the Section thereof.

Some competent Engineer in the employment of the President and Directors of the Chesapeake and Ohio Canal Company, shall from time to time, not more frequently than once a month, estimate the quantity and value of each species of work done pursuant to this contract, at the prices contained in the annexed Proposal, and also of any extra work done in consequence of any alteration of the line or plan of the Canal; and determine every question necessary for the payment of the monthly as well as the final estimates; but no change of the line or plan of the Canal shall entitle the Contractor to an increase of price upon any item of work, although it may relatively, or in the aggregate, increase or diminish the quantities of the several species of work to be done, unless such change shall involve a removal of the centre line of the Canal, entirely on the site first chosen for the Section, and which shall, at the same time, render the construction of the Section more costly, in which event, the acting Engineer shall make such allowance as he shall deem just for the increased cost by reason of such change. And it is mutually agreed and understood between the contracting parties, that any estimate made, as aforesaid, shall be final and conclusive, unless objected to, before payment thereof, and within twenty days after it shall have been returned to the President and Directors; in which case, notice must be given by the party objecting, to the other party, in writing, and any estimate so objected to, shall thereupon, be referred by the President and Directors to the acting Resident Engineer, or the Engineer having the superintendence of that portion of the Canal comprehending the aforesaid Section, or in case of his death, resignation, absence, or inability, to such one of the Resident or Assistant Engineers as the President of the Company may depute to fill his place, and the decision of such Engineer thereupon, whether he shall have previously approved, and signed the estimate or not, shall be conclusive against both parties, without further appeal; and in like manner, shall be conclusive the decision of any such Engineer upon any question that may arise as to the meaning of this agreement, such question having been referred as aforesaid, by the President and Directors.

Within ten days after the return of any estimate to the President and Directors, not less than four-fifths of the sum appearing to be due for work performed since the preceding estimate, shall be paid, in the mode in which payments are made by the regulations of the Company, the balance being reserved by the President and Directors to ensure the fulfilment of this contract; no portion of which reserved money will under any circumstances be paid until this contract is fulfilled. And within thirty days after the completion of the aforesaid Section, according to the terms of this contract, the final estimate shall be made, and the balance due thereon shall be paid.

The works shall always be open to examination during their progress by the President and Directors, their Engineers, or any persons they may depute for that purpose; and the Contractor shall at all times, keep open, at his own expense, for that purpose, a horse path way, through or along the side his Section, so that the officers of the Company and their Engineers, may readily pass through the same, to the Section above or below.

At the expiration of every week's work, a report shall be made by the said Contractor to the Resident Engineer, or to his Assistant, upon the residency of which the said Section is a part, of the average force of hands, carts, &c. employed on the Section for the past week, according to such forms as may be supplied by order of the President and Directors of the Company.

It is mutually agreed between the parties, that the work on the aforesaid Section shall be commenced within *Five* days from this date, and thereafter steadily prosecuted without intermission, with such force as shall in the opinion of the Resident Engineer secure its completion by the *First* day of *March* 1834, at which time it shall be fully completed and delivered up; and it is further agreed that in the event that the said work shall not be so commenced, or prosecuted and completed, or, if the Contractor on being required thereto by the Resident Engineer, shall fail or refuse to increase the force employed on the Section, to such extent as in the opinion of the Engineer, shall be necessary to ensure its completion in the stipulated time; or in case the Contractor shall disobey any of the orders of the acting Resident Engineer for the time being, or shall violate any of the express conditions of this agreement; then on a certificate of the fact by any Engineer of the Company, the President of the Chesapeake and Ohio Canal Company may declare this contract abandoned, and the said Canal Company shall thereupon be exonerated from every obligation thence arising; and the reserved percentage on the contract price shall become the property of the Canal Company, to indemnify them for such breach of contract. And the President and Directors, or President of the said Company may thereafter let the said Section, or the unfinished work thereof, to any other contractor in the same manner as if this contract had never been made.

No contractor shall give or sell to the men employed by him, or suffer to be given or sold to them by others, if in his power to prevent it, any spirituous liquor; and if any contractor shall become notorious for bad temper, or shall be himself, subject to intoxication, or shall allow drunkenness, or disorder, or violence, among his hands, or any injury to be done by them, to the peace of the neighbouring country, or to any property or person in the vicinity of the Canal; or, having in his service the authors of any such violence, shall not promptly dismiss them, when discovered; on such fact being proved, by the certificate of an Engineer, or in any other satisfactory manner, to the President and Directors, such Contractor shall be, at their pleasure, discharged, and his contract considered abandoned as in the case already mentioned.

This contract shall not be let, or assigned, either in whole or in part, to any other person, without the consent of the President and Directors of the Chesapeake and Ohio Canal Company nor will any account be kept by the President and Directors with any sub-contractor; but should any part of the work be let to a sub-contractor, either with the consent of the President and Directors, or without, then the aforesaid *John P. Cress & Thomas*

Wiley doth hereby assume and bind *himself* to pay all just debts contracted by any such sub-contractor, either for labor performed on the before mentioned Section, or for supplies furnished for it; and also to be responsible for all the acts, and negligence of any such sub-contractor, and further, to be responsible to the owners of land, through which the Section may pass, for all damages done to their property, by any persons employed upon the Section.

No Draft will be accepted by the President and Directors from any Contractor.

All the materials of stone or earth, removed or loosened in the excavation, as well as the fallen timber shall be the property of the Canal Company, and after supplying such part thereof as may be required in the construction of the Section, and the necessary fuel for the Contractor, and timber for the construction of his shantees, the President and Directors may empower any other Contractor, or person, to work up, or remove from the Section, or in any other way dispose of such surplus material, and every facility for the removal thereof shall be afforded by the Contractor for the Section, provided he shall not thereby incur any additional expense without proportional compensation, to be fixed by the Engineer.

All buildings or fences on the line of the Canal shall be preserved, in such manner as the Engineer may direct, by the Contractor—who shall protect them from injury by his hands or laborers, and as far as practicable by any other persons.

The superintending Engineer shall have power to prescribe the manner of preparing for, beginning and conducting every species of work to be done under this agreement, with reference to its purpose, and the durability of such work, and his instructions shall be promptly obeyed, and if he shall disapprove of the quality of any work, it shall be the duty of the Contractor to take down at his own expense, and rebuild so much thereof as shall be disapproved of, and if the Contractor shall neglect or refuse to take down and rebuild work so disapproved of, the Engineer shall cause the same to be done at his cost.

And it is mutually agreed between the parties to this Contract, that all the terms and conditions therein expressed, as well as the terms and conditions contained in the annexed Specification and Proposal, which are deemed and taken to be a part of this Contract, shall be binding upon the parties respectively, according to their true intent and meaning.

IN WITNESS WHEREOF, the said parties have hereunto set their hands and seals, the day and year first abovementioned.

President of the Chesapeake and Ohio Canal Company,
by order of the President and Directors, in behalf
of the Company.

John H. Hines [L. S.]
his x
Thomas R. Rely [L. S.]
mark

WITNESS,

Edmund Watts

[L. S.]

[L. S.]

NOTE.—It is expressly declared by the President and directors that no increase of the prices agreed upon in this contract, will be allowed under any circumstances whatever; nor will they consider any application that may be made for that purpose.

Appendix C

Specification for Sections,
ca. 1828-1833

SPECIFICATION

For Section No. _____ of the Chesapeake and Ohio Canal.

PLAN AND DIMENSIONS OF THE CANAL.

The canal banks are to be so constructed that the water may at all places be at least fifty feet wide at the surface, usually denominated the water line, thirty feet at the bottom of the Canal, and six feet deep, except where from particular circumstances it may be necessary to reduce the width.

Each of the banks shall rise above the water line at least two feet, if required; and such a slope shall be preserved on the inner and outward side of the banks as that every foot of perpendicular rise shall have an horizontal base of eighteen inches, or more if required. The towing path shall be on the river side of the canal; its summit shall be at least twelve feet wide; the summit of the opposite bank at least eight feet; and both banks shall have a lateral declination at their summit from their inner to their outer edges, at the rate of one inch to the foot. The banks shall be constructed of as pure and solid water-proof earth, as the excavation will afford; they shall be made smooth and even, on the outside as well as on the inside; and more effectually to unite the banks with the natural soil on which they rest, all the grass or other vegetable growth, including trees, bushes, stumps, roots, along with the vegetable mould, shall be moved from the entire space occupied by the canal, its embankments and slopes, and the mould shall be carefully reserved, that it may constitute a cover for the outer slope of the bank, when finished. Unless otherwise authorized by the written permission of the resident Engineer, all the grubbing, clearing, and preparation for the embankment, upon the whole section, shall be completed and inspected by the resident Engineer, before the excavation of the canal, or the formation of the embankment, shall be commenced; and no estimate shall be made on the section until this shall have been done, without the certificate of the engineer upon such estimate, that such permission has been granted. In addition to the grubbing and clearing abovementioned, all trees or bushes shall be cleared even with the ground for a space twenty feet wide and running along both sides of the section, if required by the engineer.

EXCAVATION OF THE CANAL.

This is meant to include not only the excavation of the trunk of the canal, but also of all drains that may be rendered necessary by the construction of the section; and also of all muckling and of all paddle ditches; but the right is reserved by the Canal Company to exclude from the contract for this section, such portions of the section as may be occupied by any aqueduct, lock, or culvert, and a reasonable distance above and below the same, so as to afford space for the use of the constructor of any such works and material for the embankments to cover the same when constructed.

Detached stone, not exceeding a cubic foot in size, are to be included in the first denomination of excavation in the following proposal. All other stone, except slate, will be included in the second.

The spoil banks, or surplus earth, shall be laid even and regularly, leaving a space between the canal bank and spoil bank, four feet wide for a land drain. There shall also be left suitable outlets through the spoil bank from this drain at every three hundred feet in length. The slope of the spoil bank next to the canal shall be the same as that on the inner slope of the canal banks and the inclinations on the top, at least two inches to the foot, from the canal. The Engineer may require all the surplus earth to be deposited on either side of the canal, provided however, that the contractors shall not be required to transport it more than 120 feet, measuring in a direct line from the place from which it is taken to the place of deposit, without extra compensation, to be adjudged by the Engineer.

Stone excavated from the section and not required in its construction, shall be deposited as may be directed by the Engineer; provided however, that the contractor shall not be required to transport it more than 120 feet, without extra compensation, to be adjudged by the engineer. And the Canal Company shall be at liberty to agree with the Contractor for the section, or with any other person, for paving the inner slopes of the Canal, either before or after the completion of the Section.

No allowance is to be made for pumping or bailing water.

EMBANKMENT.

This term includes the filling up of the side-banks, and bottom of the canal, and also when required by the Engineer, in writing, the covering of bridges, culverts and aqueducts, and the formation of the embankments upon, or slopes leading to or from them; and the filling up of low grounds adjacent to the canal.

In cases where the base of the embankment shall be below the bottom of the canal, the embankment shall be made with carts; and in all cases where carts are used in making embankment, it shall be formed in successive horizontal layers of six inches in thickness, uniformly laid over the entire breadth of the embankment, so that one course shall be completed over the entire length of the embankment, as nearly as practicable, according to the judgment of the Engineer, before the next shall be begun. In lighter embankment, where wheelbarrows may be used, it shall be formed in horizontal layers, not exceeding one foot in thickness, and in raising one portion of such embankment higher than another, the end of each successive layer shall stop short of the preceding layer at least three feet, so that the end of the embankment shall form a slope of three to one. If the section shall not afford sufficient earth for embankment, the Engineer may require that the banks shall be left three feet below the established height.

No material excavated from the canal and placed on the embankment, will be estimated as embankment, unless it shall have been necessarily transported over 120 feet.

No logs, trees, brush, stumps, roots, leaves, grass, or stones, shall be left or admitted into any part of the embankment.

No allowance shall be made for earth washed away, or removed by floods.

After the entire Section shall have been completed in every other respect, the soil and muck removed in preparing for the embankment shall, if so ordered in writing by the Engineer, be thrown up so as to form the outward cover of the embankment, in which case a reasonable specific allowance shall be adjudged by the Engineer.

Where it shall be deemed expedient to increase the canal to a width not exceeding 70 feet at water surface, for the purpose of obtaining earth for embankment, the earth so obtained shall be considered as "materials excavated from the canal;" but where the width is increased for this purpose to more than 70 feet, then the earth taken from such excess of width will be estimated as "materials not excavated from the canal."

PUDDLING.

The puddling, when any is required by the Engineer, shall be regulated by him as to quality, thickness, and disposition. It will be measured and paid for as embankment, (unless taken from canal and within 120 feet,) in addition to the price stated in the following proposals, that being understood to cover only the expense of wetting and reducing the clay to a proper consistency.

WALLING.

The external walling, vertical or slope, shall be of such quality, height and thickness, as the Engineer may direct, and shall be carried up from an approved foundation. The foundation of every slope wall shall

be at right angles with the slope of the embankment it is designed to protect, and the successive beds formed in carrying it up shall be parallel to its foundation. No wall shall be constructed against any embankment which has not had sufficient time in the estimation of the Engineer, to settle, before it is made to press upon it. In all cases when the outside wall of the canal is liable to be covered by river freshets, the embankment behind the same shall be carried up with the spalls of the quarries or excavated rock of the Section, one foot in thickness, and if there be no spalls, the Contractor may be required to pound or reduce part of the excavated rock of the Section to a size to pass through a three inch ring. The labor of pounding the rock to be paid for at the estimate of the Engineer; provided it shall in no case exceed 25 cents per perch for pounding, and the material when placed, shall be measured as embankment.

Where vertical walling shall be used it shall be coped with the best of the stone furnished by the quarries.

Where the outer surface of the embankment shall require protection of rock, in addition to the vertical or slope wall, and such rock shall be furnished from the excavation of the Section, and shall require to be transported more than 120 feet, the Engineer shall adjudge a fair compensation for any excess of distance over 120 feet.

No stone shall be used in walling until it shall have been approved by an Engineer. When stone not furnished from the Canal excavation shall be required for walling, and the Contractor cannot agree with the owner thereof for the same on reasonable terms, the President and Directors will, upon application, cause the same to be condemned according to the charter of the Company, the Contractor paying the expense of the condemnation as well as the verdict of the Jury. When it shall become necessary to transport stone, not excavated from the canal, more than a quarter of a mile, the Engineer shall estimate the just value of such excess of transportation.

In all cases where distances are prescribed for transportation, the same mode of measurement will be adopted as is provided for in the transportation of "surplus earth," except where material shall be necessarily transported across the Potomac river, in which case the most direct practicable route will be measured.

PROPOSALS.

The subscriber offers to contract for the grubbing, excavation, embankment, puddling and external walling of the section of the Chesapeake and Ohio Canal, as laid down by the Company, at the prices inserted in the subjoined columns, and to complete the work according to the preceding specification, and upon the terms and conditions stipulated in the contract which I shall hereafter subscribe, a copy of which has been exhibited to and read by me.

Grubbing.	Excavation.		Embankment.		Puddling.	External Walling.		
Grubbing and clearing the trees, bushes, stumps, and roots, for the width of the Canal, its embankments and slopes, and for cutting a breadth of 25 feet on each side of the section.	Of earth, gravel or loose stone, or any materials other than that described in the succeeding columns, per cubic yard.		Of materials excavated from the Canal, and transported more than 120 feet. In addition to the price for excavation, per cubic yard.		Of materials not excavated from the Canal, transported more than $\frac{1}{2}$ a mile—the engineer to estimate the value for the additional distance.	Whether vertical or slope, where the stone is furnished from the Canal excavations, per perch of 25 cubic feet.		
	Of granite or other rock, per cubic yard.		Of materials not excavated from the Canal, nor transported more than 120 feet, per cubic yard.					
	Of slate, per cubic yard.		Of materials not excavated from the Canal, transported more than 120 feet, but less than $\frac{1}{4}$ of a mile, per cubic yard.					
			Of materials not excavated from the Canal, transported more than $\frac{1}{4}$ of a mile, but less than $\frac{1}{2}$ a mile, per cubic yard.					
			Of materials not excavated from the Canal, transported more than $\frac{1}{2}$ a mile—the engineer to estimate the value for the additional distance.					
Dollars.	D.	C.	D.	C.	D.	C.	D.	C.
					Of suitable materials, where required by the engineer, in addition to the charge therefor in embankment, per cubic yard.			
							The same, where the stone is not furnished from the Canal excavation, transported less than $\frac{1}{4}$ of a mile, per perch of 25 cubic feet.	
							D.	C.

Signed by me, this

day of

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No contract will be made with more than one individual.

No spirituous liquor will be allowed to be used on the section.

If the section affords timber not required for the construction of the section, the contractor will be allowed to use so much of it as he may need for fuel and the construction of his shanties.

Appendix D

Specification for Sections,
ca. 1834-1837

SPECIFICATION

For Section No. _____ of the Chesapeake and Ohio Canal.

PLAN AND DIMENSIONS OF THE CANAL.

The Canal banks are to be so constructed that the water may at all places, be at least _____ feet wide at the surface, usually denominated the water line, _____ feet deep.

_____ feet at the bottom

Each of the banks shall rise above the water line at least two feet if required; and such a slope shall be preserved on the inner and outward side of the banks, above and below the water, as that every foot of perpendicular rise shall have an horizontal base of eighteen inches, or more if required. The towing path shall be on the river side of the Canal; its summit shall be, at least twelve feet wide; the summit of the opposite bank at least eight feet; and both banks shall have a lateral declination at their summit from their inner to their outer edges, at the rate of ten inches in ten feet. The banks shall be constructed of as pure and solid water-proof earth, as the excavation will afford; they shall be made smooth and even, with a slope on the outer side not less if required than on the inner; and, more effectually to unite the banks with the natural soil on which they rest, all the grass or other vegetable growth, including trees, bushes, stumps, roots, along with the vegetable mould, shall be removed from the entire space occupied by the Canal, its embankments and slopes, and shall be carefully reserved, that it may constitute a cover for the outer slope of the bank, when finished. The grubbing and clearing shall be inspected by some Engineer attached to the Residency, of which the Section forms a part, and such further labor shall be bestowed thereupon as he may require. Besides the Canal, its towing path, and the outer slope of the latter, and of the opposite bank of the Canal, all of which shall be grubbed and cleared, a strip without them, twenty feet in breadth, and running along both sides of the Canal, shall, if required by the Engineer, be cut near the earth, and cleared, for the convenience of passing along the Canal for intercourse and inspection, as well as to prevent the temporary interruption of the Canal by falling timber.

EXCAVATION OF THE CANAL

This is meant to include not only the excavation of the trunk of the Canal, but also of all drains that may occur on the Section.

All detached stone which two men can conveniently lift, and place in a cart or wheelbarrow, are to be included in the first denomination of excavation in the following proposal. All other stone, except slate, will be included in the second.

The spoil banks or surplus earth, shall be laid with as much evenness and regularity, and with as little injury to the adjacent lands as may be, and the Engineer may require all the surplus earth to be deposited on either side of the Canal, provided, however, that the Contractor shall not be required to transport it more than 120 feet horizontal measure, without additional compensation, to be adjudged by the Engineer.

The Contractor shall preserve in the bottom of the Canal, if directed by the Engineer, and distribute along the same all such stone as may be suited for paving the inner slopes of the Canal, and the President and Directors may agree, either with the Contractor for the Section, or with any other person, for paving the said slopes, either before or after the completion of the Section.

No allowance is to be made for pumping or bailing water.

EMBANKMENT.

This term includes the filling up of the side banks and bottom of the Canal, covering Bridges, Culverts and Aqueducts, and the formation of the embankments upon, or slopes leading to or from them.

In all cases the earth for embankment shall be taken from such place as may be directed by the Engineer of the residency of the Canal of which the Section constitutes a part. Where the Section does not afford a sufficiency of suitable materials for embankment, the President and Directors will, at their own cost, obtain the right to such material as shall be approved, and when the transportation of embankment so procured, (not from Canal excavation,) shall necessarily exceed a quarter of a mile, the Engineer shall adjudge such compensation for such extra distance as he may deem just.

In all cases of broad embankments over Culverts or elsewhere, the Engineer may prescribe that the same be made with carts instead of wheelbarrows, and shall require that the embankment be carried up from the bottom by successive strata of earth, uniformly laid over its entire breadth, so that one course for the entire breadth of the embankment shall be completed before the next be begun.

No material excavated from the Canal and placed on the embankment will be estimated as embankment, unless it shall be necessarily transported over 120 feet, horizontal measure.

No logs, trees, brush, stumps, roots, leaves, grass or stones shall be left or admitted into any part of the embankment.

No allowance will be made for earth washed away, or removed by floods.

After the external slopes of the embankment have been nearly completed, the soil and muck removed in grubbing from the ground occupied by the Canal shall be thrown up so as to form the outward cover of the embankment, and the outward slopes shall be thereafter sown down, with such grass seed as shall be furnished by the Canal Company prior to the final estimate being returned by the Engineer, or paid by the Company. For this service the Engineer shall adjudge a fair compensation.

PUDDLING.

The Puddling, when any is required by the Engineer, shall be regulated by him as to quality, thickness, and disposition. It will be measured and paid for as embankment. (unless taken from Canal and within 120 feet.) in addition to the price affixed in the following proposal, that being understood to cover only the expense of wetting and reducing the clay to a proper consistency.

WALLING.

The external walling, vertical or slope, shall be of such quality, height and thickness, as the Engineer may direct, and shall be carried up from an approved foundation, if to be laid. The foundation of every slope wall shall be at right angles with the slope of the embankment it is designed to protect, and the successive beds formed in carrying it up shall be parallel to its foundation. No wall shall be constructed against any embankment which has not had sufficient time in the estimation of the Engineer, to settle, before it is made to press upon it. In all cases when the outside wall of the Canal is liable to be covered by river freshets, the embankment behind the same shall be carried up with the spalls of the quarries or excavated rock of the Section, one foot in thickness, and if there be no spalls, the Contractor may be required to pound or reduce part of the excavated rock of the Section to a size to pass through a three inch ring. The labor of pounding the rock to be paid for at the estimate of the Engineer; provided it shall in no case exceed 25 cents per perch for pounding, and the material when placed, shall be measured as embankment.

No stone shall be used in walling until it shall have been approved by an Engineer. When stone not furnished from the Canal excavation shall be required for walling, and the Contractor cannot agree with the owner thereof for the same, on reasonable terms, the President and Directors will, upon application, cause the same to be condemned according to the charter of the Company, the Contractor paying the expense of the condemnation as well as the verdict of the Jury. When it shall become necessary to transport stone, not excavated from the Canal, more than a quarter of a mile, the Engineer shall estimate the just value of such excess of transportation.

PROPOSAL.

THE SUBSCRIBER offer to contract for the grubbing, excavation, embankment, puddling and external walling, of the 171 Section of the Chesapeake and Ohio Canal, as laid down by the Company, at the prices inserted in the subjoined columns, under the descriptions of work to be done, to complete the work according to the preceding Specification, and within such time as may be stipulated in a contract which shall hereafter subscribe, a copy of which has been exhibited to and read by

No.	Grubbing.	Excavation from Canal.			Embankment.			Puddling.	External or protection walling.		
Number of the Section.	Grubbing, clearing, and removal, of the trees, saplings, bushes, stumps and roots, for the breadth of the Canal and towing path, and cutting for a strip twenty feet wide on each side thereof, for the Section.	Of earth, gravel, or loose stone, or materials other than that described in the succeeding columns, per cubic yard.			Of materials paid for as excavation and necessarily transported more than 120 feet, per cubic yard.			Of suitable clay, where required by the Engineer. In addition to the charge, therefor as embankment, per cubic yard.	Whether worked or sloped, of any thickness or quality, required by the Engineer where the stone is furnished from the canal; per perch of 25 cubic feet.		
No.	D. H.	D. C.	D. C.	D. C.	D. C.	D. C.	D. C.	D. C.	D. C.	D. C.	D. C.
171	<i>Estimated</i>	12	65	30	10	12	23	10	50	75	
					Of materials not paid for as excavation, nor requiring to be transported more than 120 feet per cubic yard.			Of materials not paid for as excavation, but transported more than 1/4 of a mile, the Engineer to estimate the value for the excess of distance.			When stone for walling, not excavated from the Canal, is necessarily transported more than 1/4 of a mile, the Engineer to estimate the value for the excess of distance.

Signed this

day of

1834

Gideon A. Sommer
Edward A. Sommer

No partner will be admitted into the contract whose name does not appear on this proposal.

If the Section affords timber not required for the construction of the Section, the Contractor may be allowed to use so much of it as he may need for fuel and the construction of his shanties.

Appendix E

Specification for Sections,
ca. 1837-1850

1837.

SPECIFICATION

For Section No. of the Chesapeake and Ohio Canal.

PLAN AND DIMENSIONS OF THE CANAL.

1. The width of canal at water line shall be fifty-four feet, and at the bottom thirty feet. Its depth of water shall be six feet, with the addition of one tenth of a foot per mile, for the distance of the section below the lock at the head of the level.
2. Each of the banks shall rise above the water line two feet; and the outer and inner slopes of the banks shall have a horizontal base of two feet for every foot of perpendicular rise. The towing path shall be on the river side of the canal; its summit shall be twelve feet wide, and that of the berm bank eight feet; and both banks shall have a lateral declination on their top, outwards, of one inch to the foot.
3. The width of the canal—of the banks, and their slopes, may be increased or diminished, as circumstances shall require and the Engineer direct.
4. The banks shall be constructed of such materials as the Engineer shall direct. They shall be made smooth and even on the outside as well as on the inside; and all the grass or other vegetable growth, including trees, bushes, stumps, roots, along with the vegetable mould, shall be moved from the entire space occupied by the canal and its embankments; and the mould shall be carefully reserved, that it may constitute a cover for the outer slope of the banks, when finished. Unless otherwise authorized, by the written permission of the Engineer, all the grubbing, clearing, and preparation for the embankment, over the whole section, shall be completed and inspected by him before the excavation of the canal or the formation of the embankment shall be commenced; and no estimate shall be made on the section until this shall have been done, unless such permission shall have been granted.
5. If required by the Engineer, all trees and bushes shall be cleared even with the ground for a space twenty feet wide, and running along both sides of the canal.

EXCAVATION.

6. This is meant to include the excavation of the trunk of the canal, and of all drains that are rendered necessary by the construction of the section; and of all mucking, and of all puddle ditches.
7. Detached stone, not exceeding a cubic foot in size, will be included in the first denomination of excavation in the following proposal, (item No 2.) All other stone, except slate, will be included in item No. 3.
8. The spoil banks, or surplus earth, shall be laid even and regular, leaving a space between the canal bank and spoil bank, four feet wide, for a drain. There shall also be left suitable outlets through the spoil bank from this drain at every three hundred feet in length. The slope of the spoil bank next to the canal shall be the same as that of the inner slope of the canal banks, and the inclination on the top, shall be at least two inches to the foot, from the canal. The Engineer may require all the surplus earth to be deposited on either side of the canal; provided, however, that the Contractor shall not be required to transport it more than one hundred and twenty feet, measuring in a direct line from the place from which it is taken to the place of deposit, without extra compensation, to be adjudged by the Engineer.
9. Stone excavated from the section, and not required in its construction, shall be deposited as may be directed by the Engineer; provided, however, that the Contractor shall not be required to transport it more than one hundred and twenty feet, without extra compensation, to be adjudged by the Engineer.
10. No allowance is to be made for pumping or bailing water.

EMBANKMENT.

11. This term includes the formation of the banks, the filling in of the canal to bottom, and also, when required by the Engineer in writing, the covering of culverts, and the filling against aqueducts, and the formation of embankments leading to and from bridges, and the filling up of low grounds adjacent to the section.
12. In cases where the base of the embankment shall be below the bottom of the canal, the embankment shall be made with carts, formed in successive horizontal layers of six inches in thickness, and uniformly laid over the entire breadth of the embankment, so that one course shall be completed over the entire length of the embankment, as early as practicable, according to the judgment of the Engineer, before the next shall be begun. In lighter embankments, where wheelbarrows may be used, they shall be formed in horizontal layers not exceeding one foot in thickness; and, in raising one portion higher than another, the end of each successive layer shall stop short of the preceding layer at least three feet, so that the end of the embankment shall form a slope of three to one.
13. No material excavated from the canal and placed on the embankment will be estimated as embankment, unless it shall have been necessarily transported over one hundred and twenty feet.
14. No logs, trees, brush, stumps, roots, leaves, grass, or stones, shall be left in, or admitted into, any part of the embankment.
15. No allowance shall be made for earth washed away or removed by floods.
16. After the entire section shall have been completed in every other respect, the soil and muck removed in preparing for the embankment shall, if so ordered in writing by the Engineer, be thrown up so as to form the outward cover of the embankment; in which case a reasonable specific allowance shall be adjudged by the Engineer.
17. Where it shall be deemed expedient to increase the canal to a width not exceeding seventy feet at water line, for the purpose of obtaining earth for embankment, the earth so obtained shall be considered and paid for as "materials excavated from the canal;" but where the width is increased for this purpose to more than seventy feet, then the earth taken from such excess of width will be estimated as "materials not excavated from the canal."

PUDDLING.

18. The puddling, when any is required by the Engineer, shall be regulated by him as to quality, thickness, and disposition. It will be measured and paid for as embankment, (unless taken from the canal and within one hundred and twenty feet,) in addition to the price affixed in the following proposals—that being understood to cover only the expense of wetting and reducing the clay to a proper consistency.

WALLING.

19. The external walling, vertical or slope, shall be of such quality, height, and thickness, as the Engineer may direct, and shall be carried up from an approved foundation. The foundation of every slope wall shall be at right angles with the slope of the embankment it is designed to protect, and the successive beds formed in carrying it up shall be parallel to its foundation. No wall shall be constructed against any embankment which has not had sufficient time, in the opinion of the Engineer, to settle, before it is made to press upon it. In all cases when the outside wall of the canal is liable to be covered by river freshets, the embankment behind the same shall be carried up with the spalls of the quarries or excavated rock of the section, one foot in thickness; and if there be no spalls, the Contractor may be required to pound or reduce part of the excavated rock of the section to a size to pass through a three-inch ring. The labor of pounding the rock to be paid for at the estimate of the Engineer; provided

Dr. J. C. Smith, Jr.
for m. m. 3, 31 -
334-3625-267

it shall in no case exceed twenty-five cents per perch for pounding, and the material, when placed, shall be measured as embankment.

20. Where vertical walling shall be used, it shall be coped with the best of the stone furnished by the quarries.

21. Where outer walling shall be dispensed with, in whole or in part, and an outer protection of loose rock shall in consequence be required, and such rock shall be furnished from the excavation of the section, and shall require to be transported more than one hundred and twenty feet, the Engineer shall adjudge a fair compensation for the excess of distance. And in cases where extra labor shall be required in arranging the outer surface of the loose stone protection, the value of such extra labor shall also be adjudged by the Engineer; but if said rock used in the outer protection shall not be had from the canal excavation, then the quarrying, and the entire transportation, as well as the extra labor of arranging the stone, shall be estimated by the Engineer.

22. No stone shall be used in walling or outer protection until it shall have been approved of by the Engineer.

23. When stone shall be required for walling or for loose protection, and the same cannot be had from canal excavation, and the Contractor cannot agree with the owner thereof for the same on reasonable terms, the President and Directors will, upon application, cause the same to be condemned, according to the charter of the Company, the Contractor paying the expense of the condemnation as well as the verdict of the jury.

24. When stone not excavated from the canal, required for walling, shall necessarily be transported more than one fourth of a mile, the Engineer shall estimate the just value of such excess of transportation.

25. Where materials of any kind are required from outside of the canal, they shall be had from such place as the Engineer shall direct.

26. If the Engineer shall direct one or more bridges to be constructed, at a point or points to be designated by him, for the purpose of obtaining earth from Virginia, or from any of the Islands of the Potomac, the Contractor shall be paid for the cost and the keeping up of said bridge or bridges at the estimate of the Engineer; and in estimating the keeping up of said bridge or bridges, the Engineer shall value only such expenses as he may deem to have been necessary, with proper care, on the part of the Contractor.

27. In all cases where distances are prescribed for transportation, the same mode of measurement will be adopted as is provided for in the transportation of "surplus earth," except where material shall be necessarily transported across the Potomac river, in which case the most direct practicable route will be measured.

28. The right is reserved by the Canal Company at any time to exclude from the contract for this section such portions of the section as may be occupied by any aqueduct, lock, culvert, or other masonry, and a reasonable distance above and below the same, so as to afford space for the use of the constructor of any such works and materials for embankment to cover the same when constructed. And if said masonry shall be finished earlier than the balance of the section remaining to the Contractor, then the Company may require of said Contractor to do all or any of the work previously excluded.

PROPOSALS.

The subscriber offers to contract for the construction of the section of the Chesapeake and Ohio Canal, as laid down by the Company, at the prices inserted in the subjoined columns, and to complete the work according to the preceding specification, and upon the terms and conditions stipulated in the contract which I shall hereafter subscribe, a copy of which has been exhibited to and read by me.

Grubbing.		Excavation.		Embankment.					Puddling	External walling.	
1	2	3	4	5	6	7	8	9	10	11	12
Grubbing and clearing the trees, bushes, stumps, and roots, for the width of the canal, and its embankments, and for cutting a breadth of 20 feet on each side of the section.	Of earth, gravel, or loose stone, or any materials other than that described in the succeeding columns, per cubic yard.	Of granite or other rock, per cubic yard.	Of slate, per cubic yard.	Of materials excavated from the canal, and transported more than 120 feet. In addition to the price for excavation, per cubic yard.	Of materials not excavated from the canal, not transported more than 120 feet, per cubic yard.	Of materials not excavated from the canal, transported more than 120 feet, but less than 4th of a mile, per cubic yard.	Of materials not excavated from the canal, transported more than 4th of a mile, but less than 3/4 of a mile, per cubic yard.	Of materials not excavated from the canal, transported more than 3/4 of a mile, per cubic yard.	Of suitable materials, where required by the Engineer, in addition to the charge therefor as embankment, per cubic yard.	Whether vertical or slope, where the stone is furnished from the canal excavation, per perch of 25 cubic feet.	The same, where the stone is not furnished from the canal excavation, transported less than 4th of a mile, per perch of 25 cubic feet—transportation over that distance being paid for at the estimate of the Engineer.
Dollars	D. C.	D. C.	D. C.	D. C.	D. C.	D. C.	D. C.	D. C.	D. C.	D. C.	D. C.

Section 267

Signed by me, this

day of

183

362 10 20 100 60 10 23 26 35 25 100 200
 354 650 16 100 60 13 20 25 35 25 100 200
 351 100 18 100 60 10 20 25 35 25 100 200

No contract will be made with more than one individual.

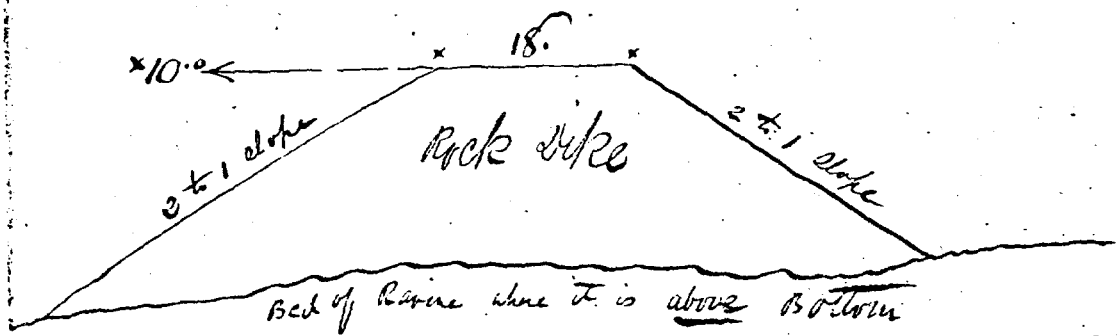
If the section affords timber not required for its construction, the Contractor will be allowed to use so much of it as he may need for fuel and the construction of his shanties.

Patrick Driskell

Appendix F

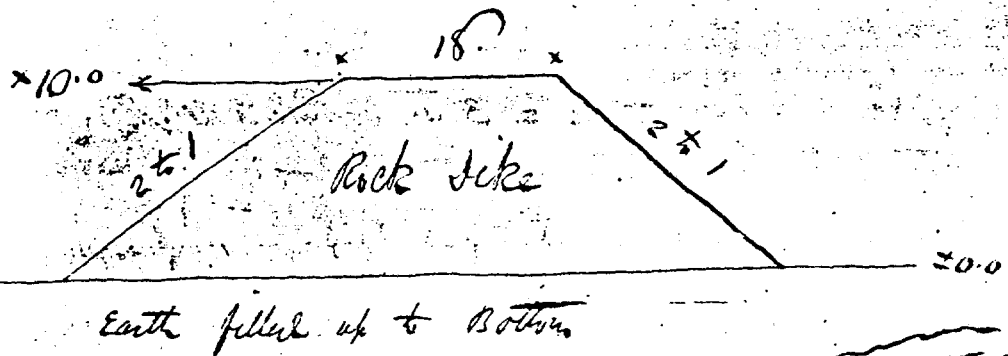
"General Plan for Rock Dikes across Ravines
to catch wash & c,"
April 23, 1840

General Plan for Rock Sikes across Ravine to catch wash. &c



Plan of Sikes in Ravine
across it

Section When bed of ravine is below Bottom of Canal

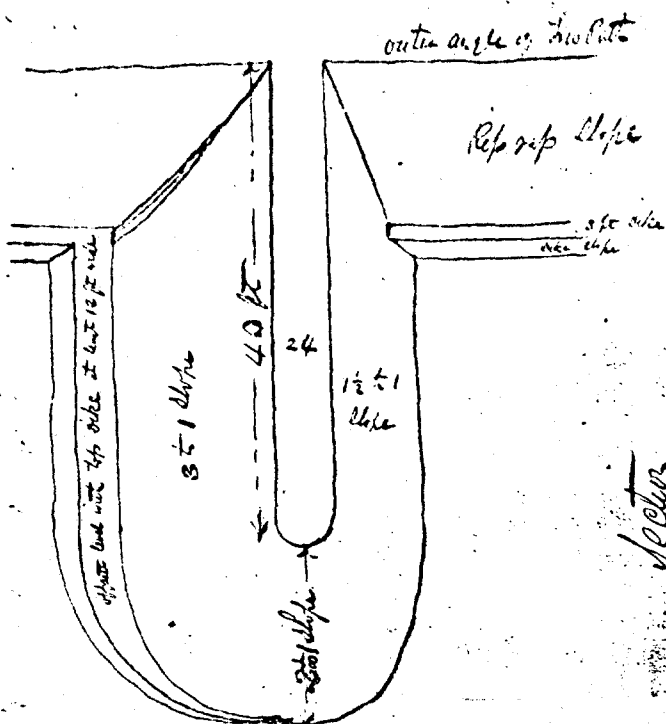


Side Bed of Ravine Carefully cleaned off to receive the Earth Embankment

To be set a little out of the Canal width:

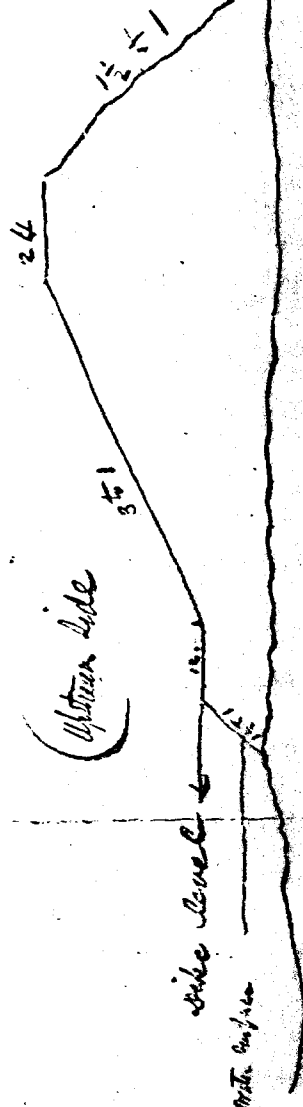
Plan for

burying Run plus Rock in Ponds
 connecting 40 feet (at top) into
 the River



Plan

Section
 across the Pond



Water Level

Run Bed

April 23rd 1840

Edw.

At bottom $\frac{1}{2}$ ft = 3 times River depth (at bottom)
 but not less than 12 ft wide

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ILLUSTRATIONS

Illustration 1.

Photograph taken ca. 1903 of canal in
Georgetown showing towpath and trunk.

From Brady-Handy Collection, Library of Congress.

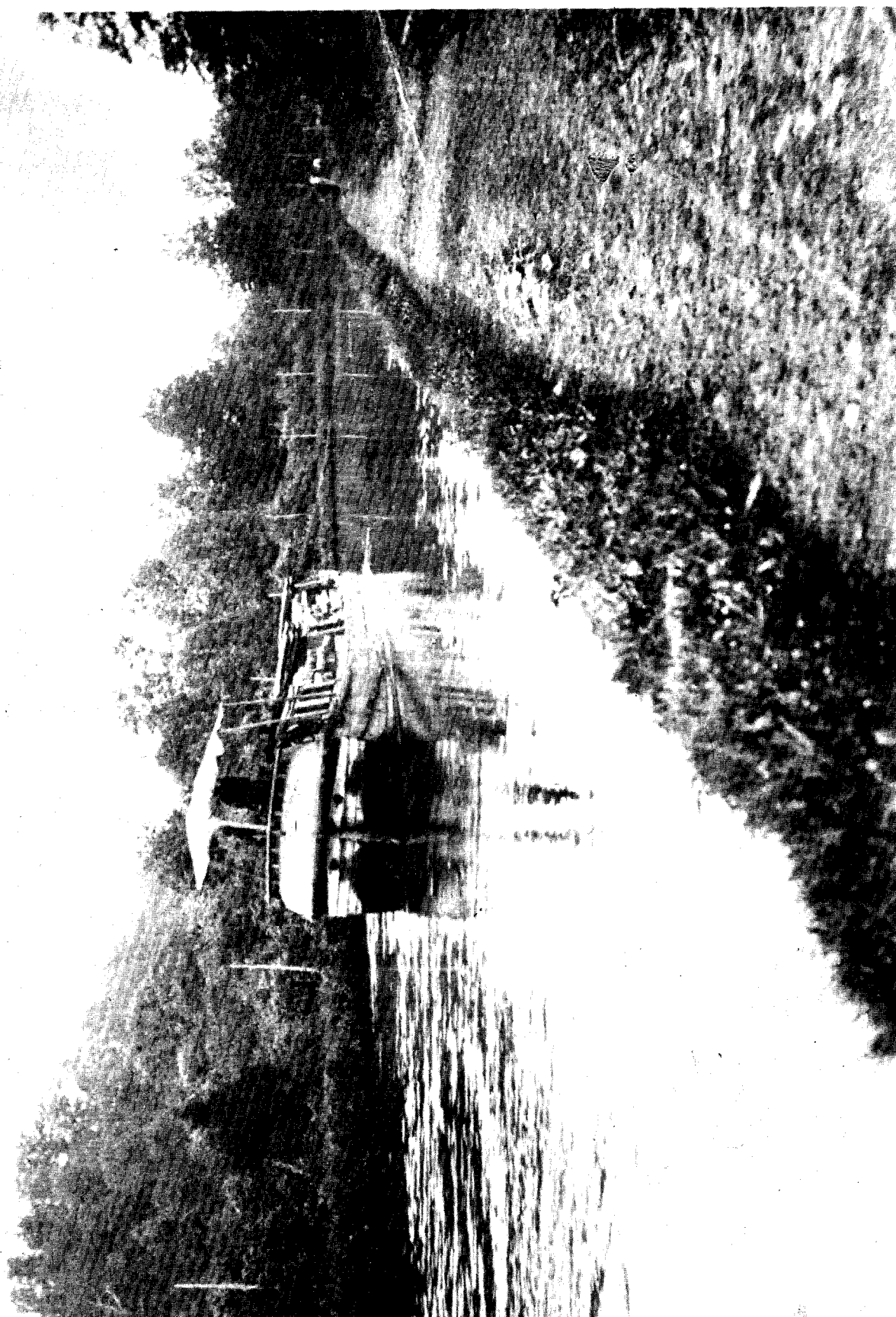
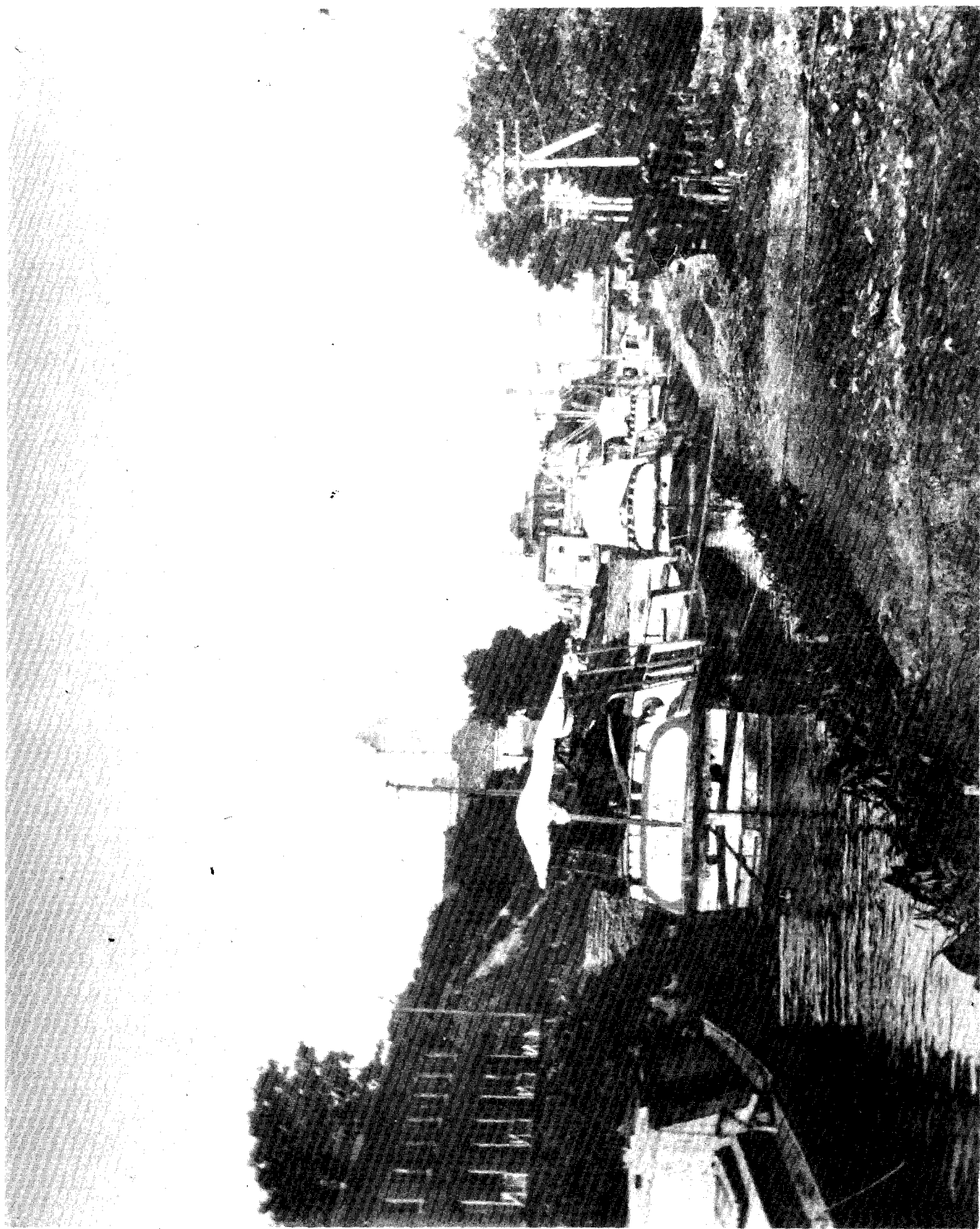




Illustration 2.

Photograph taken ca. 1903 of canal above
Georgetown, showing towpath, berm, and trunk.

From Brady-Handy Collection, Library of Congress.



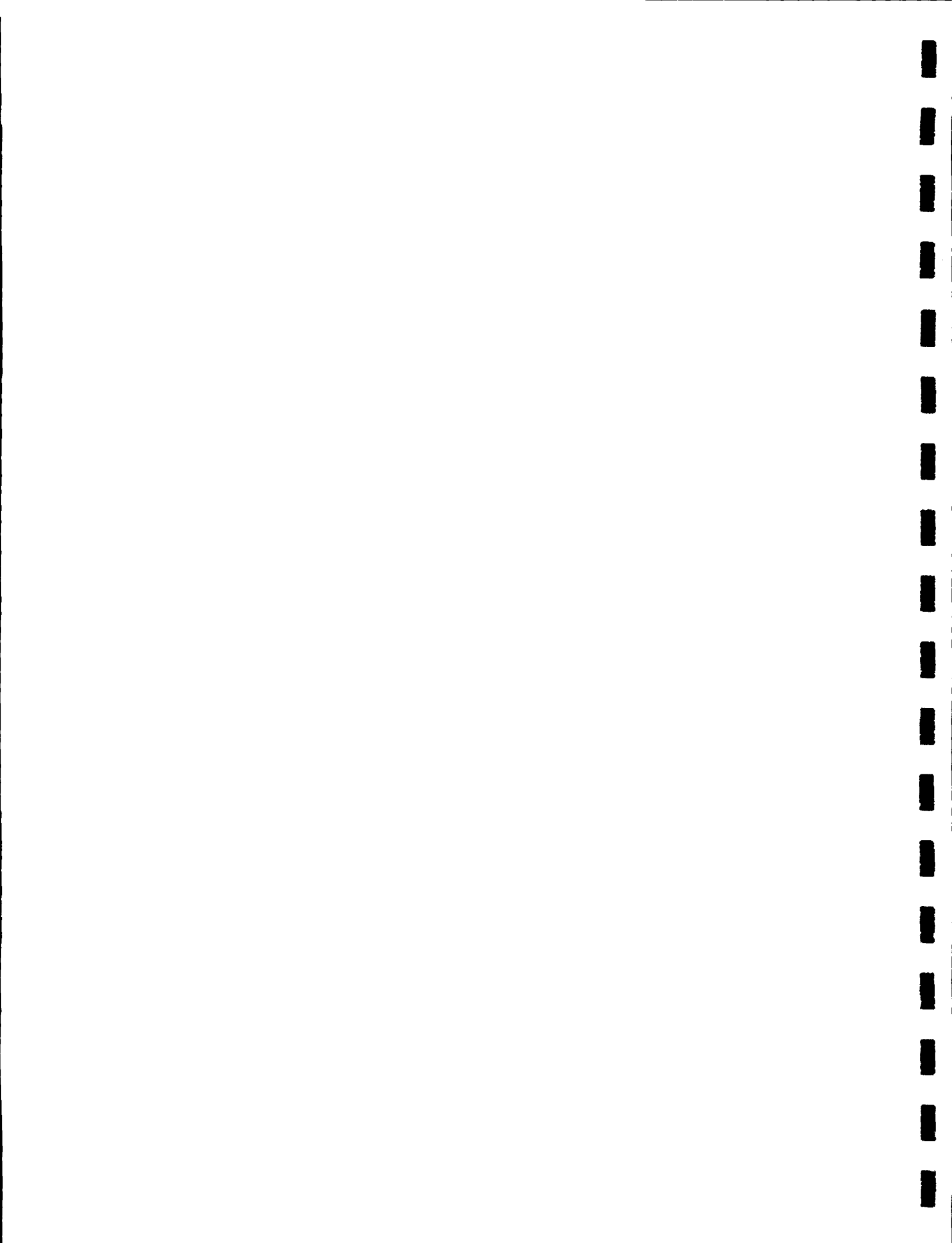


Illustration 3.

Photograph taken in 1967 of dry masonry wall on south side of canal along M Street in Georgetown.

Photograph by George Eisenman.
From Historic American Buildings Survey File, Library of Congress.



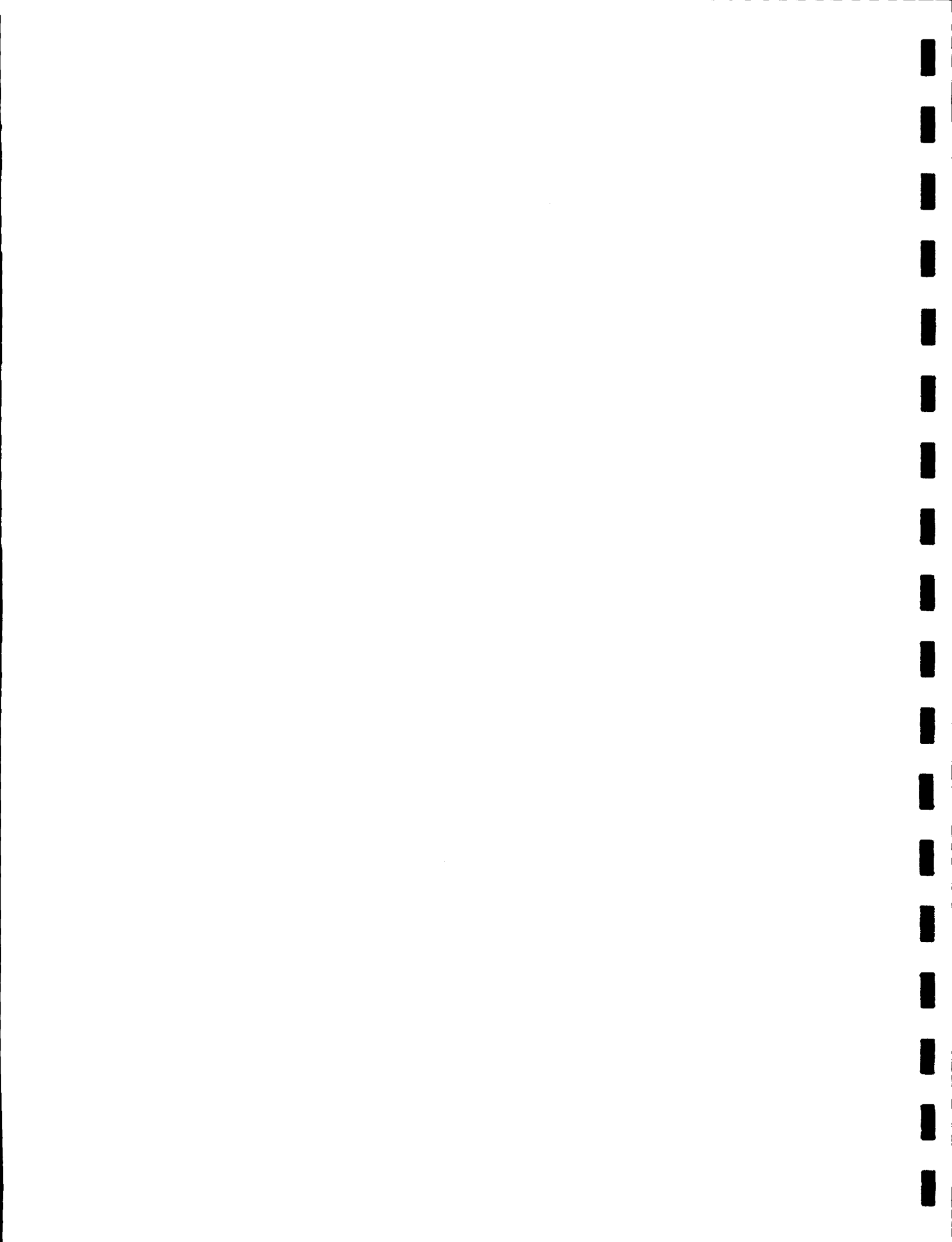


Illustration 4.

Photograph taken in 1967 of dry masonry wall on north side of canal between Warehouse Alley and Wisconsin Avenue in Georgetown.

Photograph by George Eisenman.
From Historic American Buildings Survey File, Library of Congress.

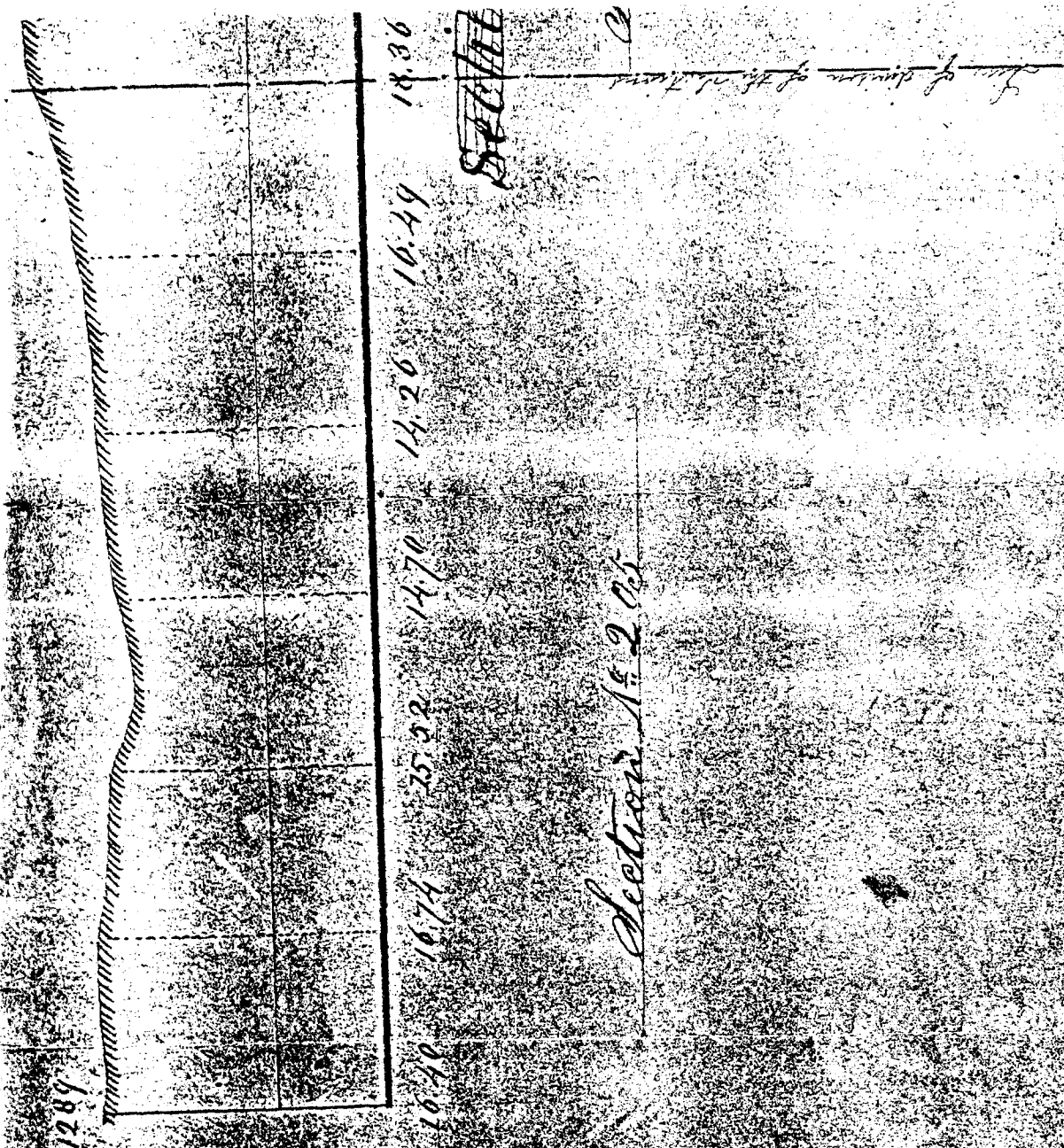


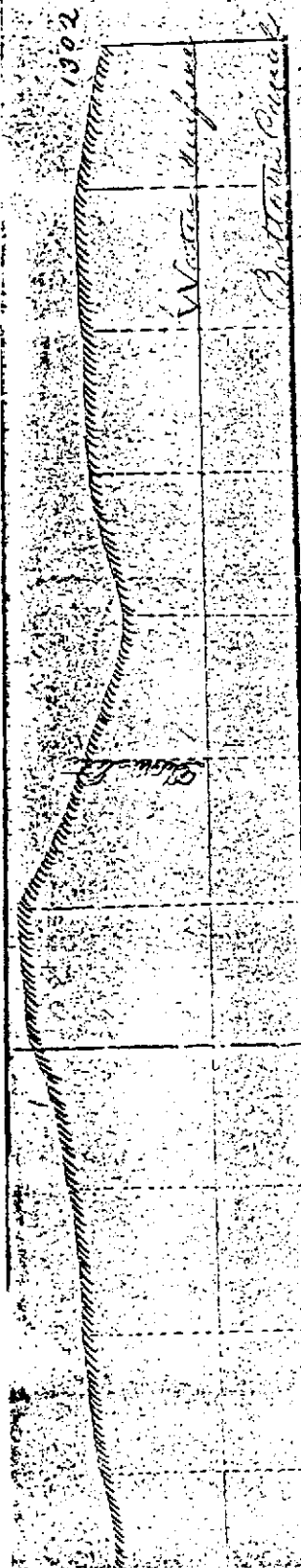


DRAWINGS

To keep the cost of reproduction down, these drawings have been incorporated into this report as representative samples of the profiles and cross-sections of the canal prism that may be found in Record Group 79 at the National Archives. Xerox copies of the following items from this record group are on file at the Antietam-C & O Canal Group headquarters:

1. Profiles of Sections Nos. 90-112,
115-155, 173-206.
2. Drawings for Sections Nos. 222-237.
3. Drawings for Sections Nos. 314-316,
318-323.





1470 14.26 16.44 18.36 19.48 20.09 14.89 13.85 14.13 14.37 12.32

~~Section No. 202~~

14.205 Section No. 206

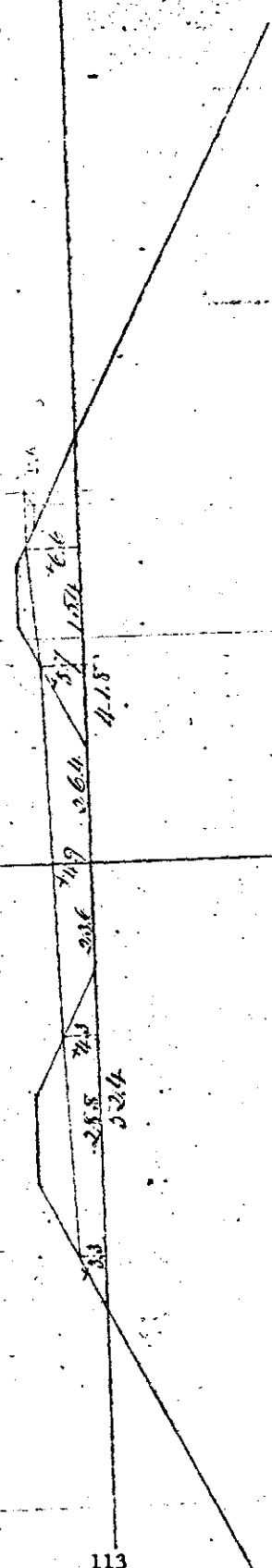
This section follows along with the creek which divides towards the
 junction of the 20th of the 1st part of the section the River
 may well be chiefly gravel the remainder of the section the typica-
 tion will be black gravel. The Embankment will have to be built
 from lower end of section.

Down to Grade Lock at 1297
 Gather 24 chain survey Mark 27th the Stone of which will
 come from operation

DRAWINGS AND CALCULATIONS FOR SECTION NO. 223

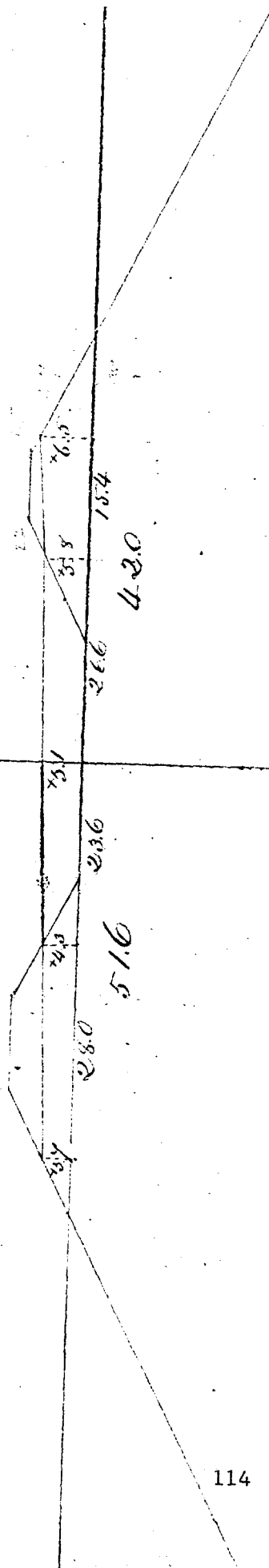
1446

Section No 223, Begun



Excav
cArea = 500.00

EmABC
cArea = 107.10

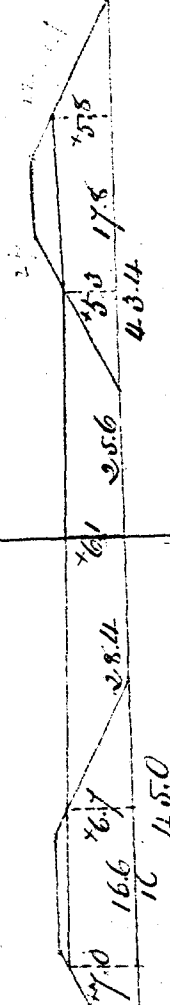


Embank
Area = 101.92
Vol = 387.0

(100)

Excav
Area = 206.27
Vol = 752.4

848

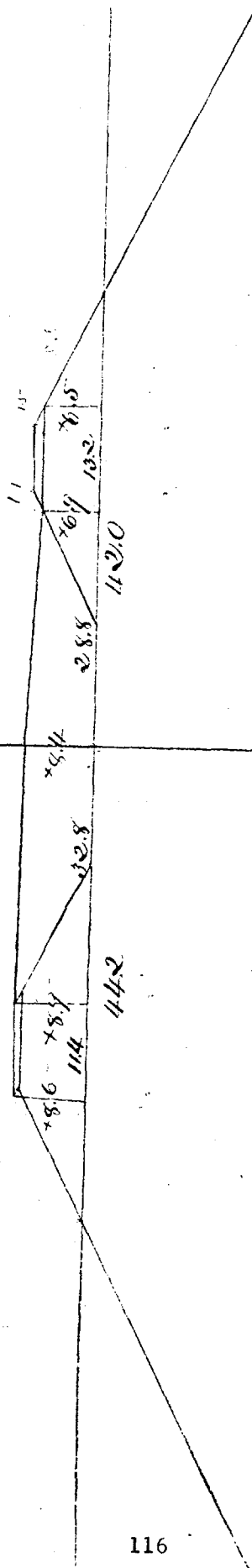


Excavation
 Area = 257.40
 Vol = 858.7

(100)

Embankment
 Area = 49.52
 Vol = 280.4

849

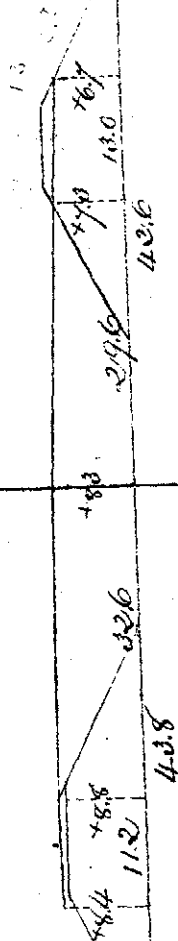


Embank
Area = 12.00
C.M. = 113.9

(100)

Excav
Area = 377.00
C.M. = 1175.0

1050

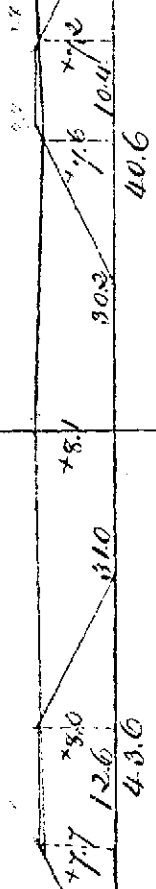


Excav
 Area = 381.99
 Vol = 1405.9

(100)

Embank
 Area = 00.0
 Vol = 222.2

8051

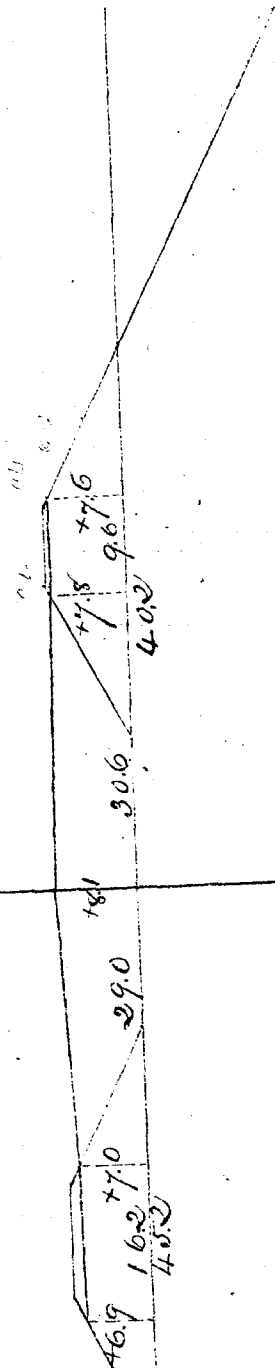


(100)

Excav.
Area = 367.92
Perim = 1388.7

Area =
Perim =

1052



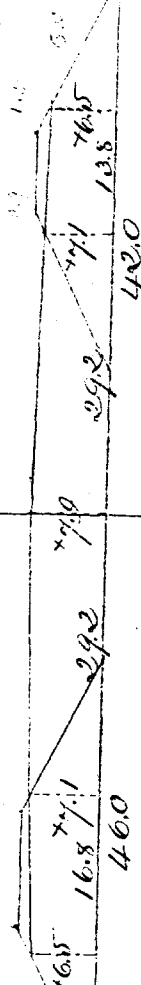
Excavation
Area = 355.56
C.M.D. = 1339.8

(100)

Embankment
Area = 18.00
C.M.D. = 33.3

8052+60

1.11



Embank

Area = 29.40

Vol = 52.6

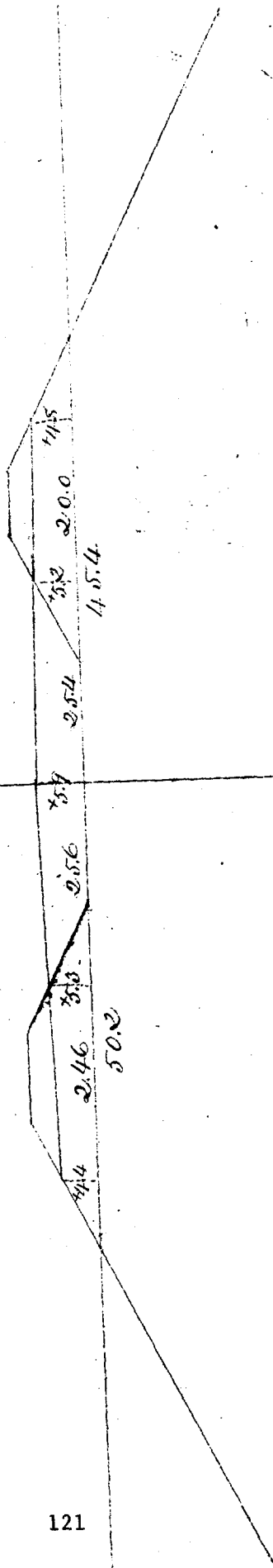
Excavate

Area = 340.10

Vol = 884.1

(60)

Y^o53



Excav
Area = 226.65
C.Mag = 419.7

(40)

Embank
Area = 100.30
C.Mag = 90.1

122

Exam
CMA = 31.09
CMA = 477.2

(100)

Басан

$\chi^2_{\text{red}} = 0.00$

$\text{Oxys} = 57.6$

(100)

MsO

Emmett

$Area = 541.58$

6229 = 1582.9

123

124

Emmet

Chica = 762.56

$2449 = 24415.0$

10

Dear

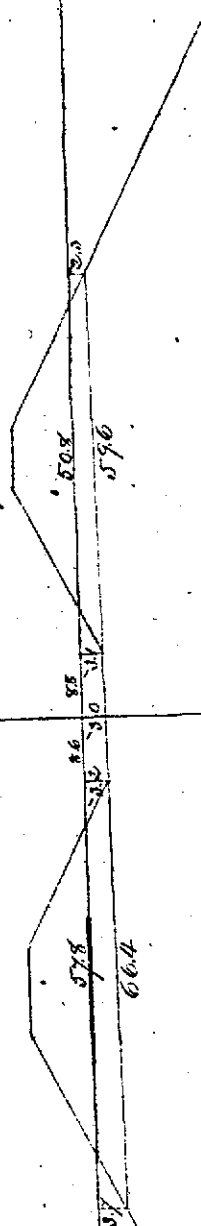
$$Area = 0.010$$

$\phi_{\text{dms}} = 0.0.0$

Culvert No 100

At this station on 57 Culvert No 100 passes under the Embankment it is of 6 ft span 2 ft rise & is built in Gravel; Puddling over Crown at the Bottom End = $3\frac{1}{4}$ ft at Canal Centre = $4\frac{1}{4}$ ft & at 1/4 mile path end = $5\frac{1}{4}$ ft under the Bottom of a 6 ft Canal; but under the Bottom as lift at C.C. = $3\frac{1}{2}$ ft descent of the Culvert 2 ft in its length, the framing between the abutts really is dry & the abutments are founded 2 ft below Top Paving. —

109



Embankment

Area = 755.46
C.P. 1/2 = 2811.1

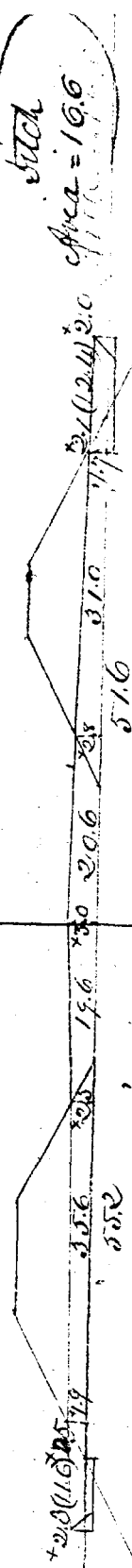
(100)

Area =
C.P. 1/2 =

125

858

Sketch
Area = 21.1
Circumference = 31.1



Emmett
Area = 253.30
Circumference = 1867.9

(100)

Emmett
Area = 98.55
Circumference = 175.3

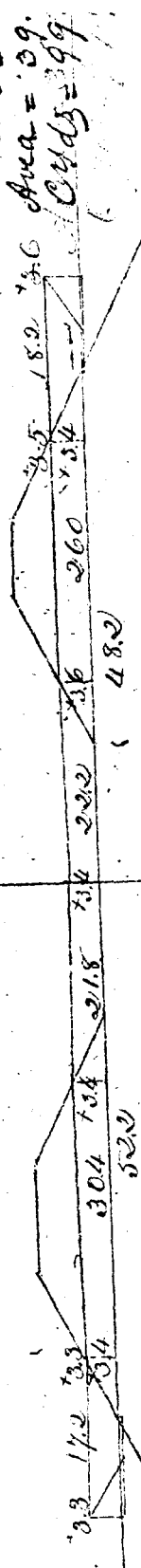
4059

fitch

Area = 35.00
Cudds = 99.70

fitch

Area = 39.
Cudds = 99



Emmet

Area = 174.02
Cudds = 759.0

Excav

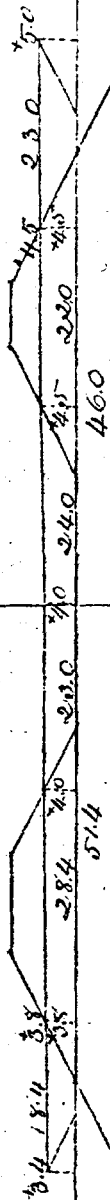
Area = 171.30
Cudds = 499.0

(96)

3460

etch
 area = 40.3
 C₁dg = 139.4

etch
 area = 64.1
 C₁dg = 191.6



Embank
 area = 135.30
 C₁dg = 5720.8

Excavate
 area = 157.75
 C₁dg = 424.1

(100)

Sketch
Area = 43.1
OMda = 15.4-11

38 79.0 73.7 38
28.6 73.7 22.8 73.9 22.6 73.8 23.4 74.3 23.5 74.1

Sketch
Area = 67.6
C/d dz = 643.9

45.0

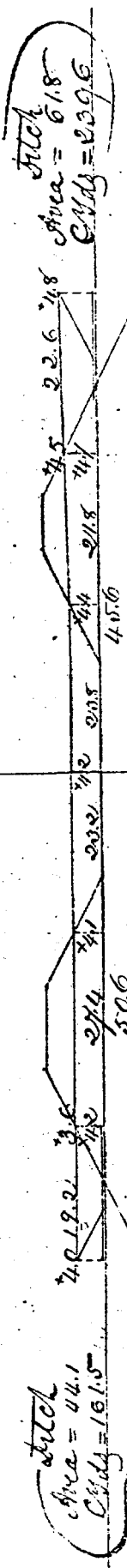
itch
Area = 43
Circumference = 154

129

Excom
Apr = 148.55
May = 567.2

Emmett
Area = 142.16
C₁₄₂₃ = 513.7

1062



ditch
Area = 161.5
Vol = 503.3

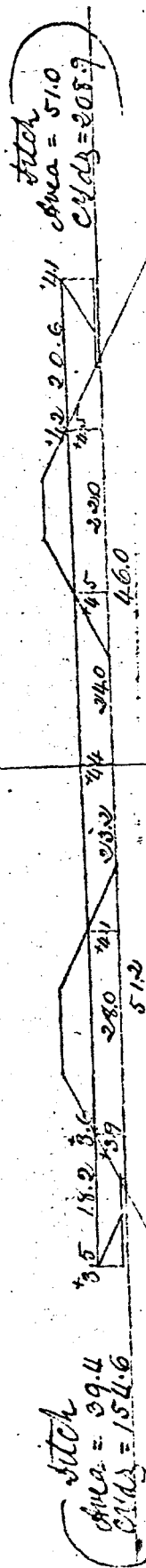
ditch
Area = 61.8
Vol = 239.6

(100)

Embankment
Area = 129.64
Vol = 503.3

Excavation
Area = 162.45
Vol = 575.9

163



Area = 39.4
C/ds = 154.6

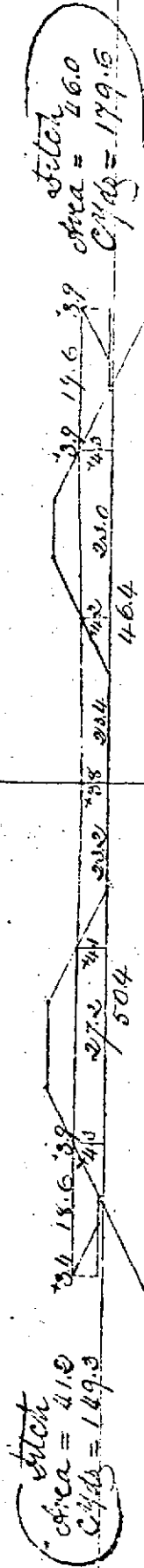
Area = 510
C/ds = 205.9

Emmet
Area = 132.50
C/ds = 485.4

Escaou
Area = 168.34
C/ds = 612.6

(100)

1064



(100)

Embankment
Area = 133.76
C/May = 493.1

Excavation
Area = 150.79
C/May = 590.9

Sect 223

(Summary)

Within the regular Canal Measurements of the foregoing "Cross Sections", (i.e.) In Excav to Bottom & in Embank to the natural surface & exclusion of Muck, Muck Sitches, Benches, Side Drains &c -

There are

No.

Total Quantities

Station	Excav		Embank		Excess Deficit	
	Area	Cu Yds	Area	Cu Yds	- 1/8	+ 1/8
100	200.00		107.10			
100	206.27	750.4	101.92	387.0	211.3	
"	257.40	858.7	49.52	280.4	21.0	
"	377.22	1175.2	12.00	113.9	2	
"	381.99	1405.9		22.3	1228.0	
"	367.92	1388.7			1215.1	
"	355.56	1339.8	18.00	33.3	1129.3	
60	340.10	884.1	2940	53.6	725.0	
40	226.65	419.7	100.30	96.1	57.1	
100	31.09	477.2	313.26	765.9		2484
"		57.6	541.58	1582.9		1530.5
"			762.56	2415.0		3415.0
"			755.46	2811.1		2511.1
"	98.58	175.3	253.30	1867.9		1714.5
96	171.30	499.6	1740.2	759.6		432.4
100	157.75	424.1	135.30	572.8		221.7
"	148.55	567.2	142.16	513.7		17.4
"	162.45	575.9	129.64	503.3		334.6
"	168.34	612.6	132.50	485.4		53.61
"	150.79	590.9	133.76	493.1		23.9
"	154.26	564.8	135.75	499.2		4.5
102	146.25	556.5	151.52	522.0		25.1
1998		13326.2		14787.4	6286.0	9412.9

Carried over.

Sec 223

Section 223 (Summary continued)

Station No	Excav Area	Emblt Area	Excess 1/8	Excess 1/8
2998	13326.2	14787.4	62860	9212.9
67	100 139.49	539.7	24386	557.9
68	100 84.49	418.5	215.14	664.8
69	" 76.65	302.0	23450	832.8
70	" 94.53	316.8	211.12	825.2
71	" 140.62	435.4	153.32	674.8
72	" 56.76	365.6	180.48	618.1
Length 2598 ft	15704.2	18961.0	6429.1	11505.7

Summary of the Fitches

Fitches	Beam ditch below Culvert 160, including	Beam ditch below Culvert 160, including
Beam & Path above Culvert 160	that behind the Beam Bank on	Section 223 emptying into Snyder's Basin
No	Spdth Area	Beam Area
59	99.7	99.7
60	139.4	198.6
61	154.4	243.9
62	161.5	239.6
63	154.6	208.9
64	149.3	179.6
65	147.6	165.0
66	139.3	147.8
67	136.9	147.2
68	105.4	124.6
69	55.2	90.0
70	70.5	80.8
71	93.3	84.7
72	87.9	91.1
	1695.0	2101.5
	3796.5	

Add ditch from Sta 555.57 to 119.6 x 400 = 177.2
Total = 693.0

Calculations of the Mucking, Puddleitching & Benching done on Section No 003, built by Lee Montgomery

Puddleitching	Multipliers	cyd3
Born to Low Path ditcher from sta 52+60 to 56+80	$= 420 \times 2.2 \times 12 \times 2 =$	858.2
ditto from sta 57+15 to 70	$= 1483 \times 1.4 \times 10 \times 2 =$	1537.2
Low Path from sta 46 to 48	$= 300 \times 1.2 \times 10 =$	96.2
Sitch cut in opening of Bank at sta 67	$= 30 \times 2.1 \times 10 =$	33.2
Preparation near Culvert 160	$= 25 \times 2.2 \times 10 =$	31.2
Total of Puddleitching		<u>2536.4</u>

Mucking	
Under the Born to Low Path Banker	
mainly from sta 46 to 70	$= 2598 \times 0.2 \times 5.2 = 1535.2$
Total Mucking & Puddleitching	<u>4072.2</u>

Covering the outer slopes with Mucking	
Low Path	$2598 \times 1.5 \times 5.2 = 808.2$
Low Path recp	$2598 \times 1.5 \times 0.2 = 144.2$
Born Bank	$2610 \times 1.5 \times 5.2 = 739.2$
Born Bank recp	$2610 \times 0.2 \times 2 = 145.2$
Additional about Culvert 160	$= 42.2$
Total	<u>1880.2</u>

Summary	cyd3
Puddleitching	<u>2536.4</u>
Mucking	<u>1535.2</u>
	<u>4072.2</u>

Excavation

of Canal Bank (See calculations)	= 15704. ²
Below Bottom = $28.6 \times 0.7 \times 2598$ ft in depth	= 1926. ²
Berm & Flow Path ditch above Culot 160 (See ditch summary)	= 3796. ²
Berm ditch below Culot 160 & extending along section No 222 to the small basin opp. Snyder's Tavern	= 893. ²
& the Ferry, on the line dividing sick & Snyder's land including excavation for the paving & all other cutting outside of common Canal width & slopes	= 991. ²
Excavation to receive the paving of the Ferry Road	= 248. ²
Excavation to receive the Walling at the head of Cul 160	= 50. ²
Clucking & Puddle ditching	= 407. ²
Total Excavation of all kinds done by Montgomery on this section except the Pit & outlet of Culvert No 160 which will be accounted for hereafter	= 27682. ²

Embankment

of the Canal proper (See calculations)	= 18961. ²
Willing up to 20.0 from 54 to 117.57	= 642. ²
Bank increased by Culot 160 mean area of Pit - Culvert = 117.57 117.57×110.0 mm length of increase	= 480. ²
Berm Bank below the Ferry including that along 222	= 1035. ²
Embankment made from the Pit of Culvert No 160	=
Embankment formed from the material thrown out of the outlet of Culot 160 & considered as Embankment - See over	=
Embankment at the Ferry Flow Path = 360.² Berm Bank = 40.⁶	= 404. ²
Aggregate measurement of the Embankment	= 21523. ²

When 222 was completed as far as done by Montgomery, a ditch was ordered by the Chief Engineer to be made from the Ferry above shown of along part of 223 & 222 to the small Basin in front of Snyder's Tavern; the material from this ditch was disposed as a Berm Bank along the part of both sections contiguous to them & the whole is here estimated as embankment on section No 222. The respective amounts are

Berm alluded to on 223 = 368.²
ditto on 222 = 666.² } Total = 1035.² @ 4d

Sec 333)

Sec 333.

The Embankment is made up of

$$\begin{array}{rcl}
 \text{Excavation 1.} & = \frac{23311^2}{8} - \frac{23311^2}{8} & = 20397^{\cdot 2} \text{ C Yds} \\
 \text{Embankment fm outside l/3 1/4 mile} & & = 234^{\cdot 0} \\
 \text{Embankment made fm bot of Culvert No 160} & & = 891^{\cdot 8} \\
 \text{Makes up the Aggregate measurement} & & = \underline{\underline{21523^{\cdot 1}}}
 \end{array}$$

Embankment not fm Canal
over 120 ft & less than 1/4 of a mile

Consists of materials placed in the Canal Bank which were originally thrown out of the outlet from Culvert No 160, which as ascertained by a measurement made on the spot at the time of removal amounted to

$$234^{\cdot 0} \text{ C Yds}$$

Embankment from Canal transported
over 120 ft

On account of the manner in which this section had to be worked to suit the drainage, advantage could not be taken of all the Excavation which might otherwise have been worked into Bank within 120 ft, so that the amount of necessary transportation is considerably greater than would be inferred by calculating the Excess & deficiency. — C Yds

$$\text{Excavation available in Bank the 1/8 being deducted} = 20397^{\cdot 2}$$

$$\text{Excavation put into Bank within 120 ft as got by the measures for the Estimators month by month} = 4343^{\cdot 1}$$

$$\text{Puddle ditches filled by carts in lengths of 500} = 16153^{\cdot 6}$$

$$\text{Total Embk't fm Canal + 120 ft} = \underline{\underline{18690^{\cdot 0}}}$$

Culvert Pit No 160

(Sec 223)

The whole of the pit & outlet of this Culvert to the Base of the Paving were taken out by Montgomery & estimated to him as an extra on this Section 223 P.

Total amount in C Yds

= 2699.2

Calculations see Masonry Book

Estimated this

Earth	{	1200 C Yds at 17c =	204.00
		1260 do at 23c =	289.80
		219 do at 25c =	54.75
Rock	=	20 do at 100c =	20

Total = \$ 568.55

Puddling

Calculations see Masonry Book

At Culvert 160, Puddling done by Montgomery

= 910.0 C Yds

Rock

Loose Rock over one cubic foot in size removed by Montgomery from this section = 50 C Yds by estimation

Therefore

C Yds

From the total of the Excavation — = 27682.2

deduct the Rock — = 50.0

leaves Excavation of Earth by Montgomery — 27632.2

Sec 223

Final Quantities

As finally estimated to be Montgomery the
Contractor, by Estimate
dated May 25th 1838

NR:

Grubbing & Clearing (per Contract) = \$100.-
Excavation of Earth ----- = 27633 C Yds
ditto of Rock ----- = 50 "
Emblt fm Canal + 120 ft ----- = 18690 "
Emblt fm outside over 120 ft - 1/4 dls = 234 "
Puddling ----- = 910 "

Excavating Culvert Pit No 160 as per
estimate of May 6th 1837 ----- = \$568.⁵⁵
Sanding Culvert No 160 ----- = \$72.⁰⁰
Muck Covering of the outer slopes
1880 C Yds valued at 30c per C Yds = \$564.⁰⁰

Extras

Paving Merry Way 180 x 3.²⁵ ----- = \$585.⁰⁰
* Walls & Paving at Head of Culvert 160 -
64 Perches at 350c = \$224.⁰⁰
Graveling, Rip-rapping &c at Culvert 160 = \$153.¹⁰
Sanding part of Paving, leveling Earth
from ditch fence, & Repairing slips
in the inner slopes ----- = \$115.⁰⁰
1028 C Yds of Mucking handled twice by
order of the Chief Engr, extra pay at 14c -- = \$143.⁹²

Elwood Morris

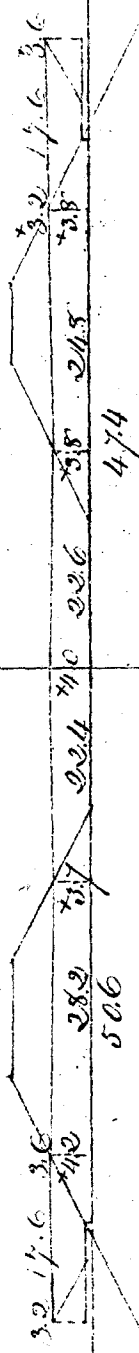
Asst Engr.

C. D. O. C.

1066

Area = 36.7
Cyd = 139.3

Area = 36.7
Cyd = 147.8



Embankment
Area = 151.52
Cyd = 532.0

(100)

Excavation
Area = 146.25
Cyd = 556.5

1067

etch
Area = 4124
Perim = 147.8

18.6 34
14.6
23.6
4.58

22.4 38
22.4 38
50.8

17.4 38
17.4 38

etch
Area = 558
Perim = 156.9

Excav
Area = 139.49
Perim = 539.7

(102)

Emblt
Area = 143.86
Perim = 557.9

1068

etch
area = 86
Mag = 12.4



etch
area = 105.4
Mag = 10.54

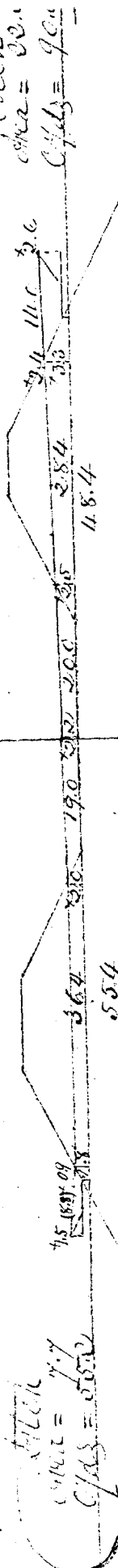


etch
area = 86.49
Mag = 418.5

100

etch
area = 215.14
Mag = 664.8

1969



Embrpt
Area = 234.52
Perim = 832.8

Excam
Area = 76.65
Perim = 502.0

(100)

Hetch
 Area = 21.1
 Chdg = 80.8

22 136 2.6
 240 486

196 27 2.06 587

334 530

27 13.4 2.0
 480

Hetch
 Area = 20.4
 Chdg = 72.5

Excav
 Area = 94.53
 Chdg = 316.8

(100)

Embank
 Area = 211.12
 Chdg = 825.2

$\frac{1}{2} \text{ inch}$
 $\text{area} = 24.6$
 $\text{Circ} = 84.7$

Station	Time	Distance	Direction
24	11.4	2.6	SE
25	11.4	2.6	SE
26	11.4	2.6	SE
27	11.4	2.6	SE
28	11.4	2.6	SE
29	11.4	2.6	SE
30	11.4	2.6	SE
31	11.4	2.6	SE
32	11.4	2.6	SE
33	11.4	2.6	SE
34	11.4	2.6	SE
35	11.4	2.6	SE
36	11.4	2.6	SE
37	11.4	2.6	SE
38	11.4	2.6	SE
39	11.4	2.6	SE
40	11.4	2.6	SE
41	11.4	2.6	SE
42	11.4	2.6	SE
43	11.4	2.6	SE
44	11.4	2.6	SE
45	11.4	2.6	SE
46	11.4	2.6	SE
47	11.4	2.6	SE
48	11.4	2.6	SE
49	11.4	2.6	SE
50	11.4	2.6	SE
51	11.4	2.6	SE
52	11.4	2.6	SE
53	11.4	2.6	SE
54	11.4	2.6	SE
55	11.4	2.6	SE
56	11.4	2.6	SE
57	11.4	2.6	SE
58	11.4	2.6	SE
59	11.4	2.6	SE
60	11.4	2.6	SE
61	11.4	2.6	SE
62	11.4	2.6	SE
63	11.4	2.6	SE
64	11.4	2.6	SE
65	11.4	2.6	SE
66	11.4	2.6	SE
67	11.4	2.6	SE
68	11.4	2.6	SE
69	11.4	2.6	SE
70	11.4	2.6	SE
71	11.4	2.6	SE
72	11.4	2.6	SE
73	11.4	2.6	SE
74	11.4	2.6	SE
75	11.4	2.6	SE
76	11.4	2.6	SE
77	11.4	2.6	SE
78	11.4	2.6	SE
79	11.4	2.6	SE
80	11.4	2.6	SE
81	11.4	2.6	SE
82	11.4	2.6	SE
83	11.4	2.6	SE
84	11.4	2.6	SE
85	11.4	2.6	SE
86	11.4	2.6	SE
87	11.4	2.6	SE
88	11.4	2.6	SE
89	11.4	2.6	SE
90	11.4	2.6	SE
91	11.4	2.6	SE
92	11.4	2.6	SE
93	11.4	2.6	SE
94	11.4	2.6	SE
95	11.4	2.6	SE
96	11.4	2.6	SE
97	11.4	2.6	SE
98	11.4	2.6	SE
99	11.4	2.6	SE
100	11.4	2.6	SE

Emmett
Area = 153.32
Circum = 674.8

Exam
Area = 140.62
Cyls = 435.4

(100)

Section no 223, End 3

~~Salch~~
area = 24.6
cyas = 9.1

Emmet
Area = 180.48
Mag = 618.1

Exam
Area = 56.76
CNDg = 365.6

