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HISTORIC STRUCTURE REPORT

THE SOUTH FORK DAM

HISTORICAL DATA

JOHNSTOWN FLOOD NATIONAL MEMORIAL

PENNSYLVANIA

PACKAGE NO. 124

by

Harlan D. Unrau

DENVER SERVICE CENTER
BRANCH OF HISTORIC PRESERVATION
MID-ATLANTIC/NORTH ATLANTIC TEAM
NATIONAL PARK SERVICE
UNITED STATES DEPARTMENT OF THE INTERIOR
DENVER, COLORADO

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PREFACE

This historic structure report (historical data section) has been prepared to satisfy in part the research needs as stated in the task directive (dated June 1979, revised October 1979) concerning the South Fork Dam and Western Reservoir (later Lake Conemaugh) at Johnstown Flood National Memorial under Package No. 124. The historical data section of the report is intended to provide basic data for the stabilization/preservation treatment of the remnants of the dam and reservoir and for the accurate interpretation of the original construction of the dam (1834-1852), as well as for its reconstruction (1879-1881) and the causes of its failure on May 31, 1889, resulting in the Johnstown Flood disaster. Data from this report will provide an information base for the full interpretation of the site. At the request of Superintendent James R. Zinck special attention in this report has been given to material relating to the South Fork Fishing and Hunting Club of Pittsburgh and the historic scene as it existed at the dam and reservoir at the time of the Johnstown Flood on May 31, 1889.

A number of persons have assisted in the preparation of this report. Special thanks are due to Superintendent Zinck and his staff at the park for discussing the project with me, providing helpful insights into the nature of the research required for the project, and making available to me the park documentary, photographic, cartographic, and library files. Dean Garrett, Chief, Interpretation and Resource Management, at the park was particularly helpful in conducting me on an extensive guided tour of the resources and facilities at Johnstown Flood National Memorial. Three individuals at the Mid-Atlantic Regional Office in Philadelphia, S. Sydney Bradford, Associate Regional Director, Planning and Resource Preservation, John W. Bond, Chief,

Resource Preservation, and Henry J. Magaziner, Historical Architect, also provided useful suggestions concerning the outlines of the report.

I also wish to acknowledge the assistance given to me in gathering material for this report. Archivist Martha Simonette in the Bureau of Archives and History of the Pennsylvania Historical and Museum Commission provided invaluable help with the Land Records in the Pennsylvania State Archives. Irving L. London, who probably possesses the most comprehensive collection of Johnstown Flood photographs, also spent several hours with me and provided most of the photographs which appear in this report. I also wish to express my thanks to the various staff members who aided my research efforts at the following institutions: Denver Public Library; University of Colorado Library, Boulder; Rocky Mountain Regional Office (National Park Service) Library; Cambria County Historical Society, Museum, and Library, Ebensburg, Pennsylvania; Pennsylvania State Library, Harrisburg; Carnegie Library of Pittsburgh; Cambria County Library, Johnstown; Johnstown Flood Museum; Cambria County Courthouse, Ebensburg; and the Historical Society of Western Pennsylvania, Pittsburgh.

Harlan D. Unrau
August 1, 1979

STATEMENT OF HISTORICAL SIGNIFICANCE

The South Fork Dam was completed in 1853 to provide water for the operation of the Western Division of the Pennsylvania Main Line Canal between Johnstown and Pittsburgh, particularly during the summer season when rainfall was often unpredictable and infrequent. Located some 12 miles east of Johnstown, the earthen dam was constructed to hold the water of the Western Reservoir at a point where the South Fork of the Little Conemaugh River and several mountain streams converged. The dam created what was, at the time it was built, one of the largest artificial lakes in the nation, more than two miles long and more than a mile wide in some places.

The Pennsylvania Railroad Company purchased the entire Main Line works in July 1857 and left the dam and reservoir virtually unattended until May 1863 when the entire Western Division of the canal was abandoned. In 1879, a group of Pittsburgh industrialists formed the South Fork Hunting and Fishing Club and purchased the dam and reservoir for a private summer resort. By 1881 the dam, which had suffered its first serious break in July 1862, was repaired and the reservoir, renamed Lake Conemaugh, was refilled.

Torrential rains sent the level of water in the lake beyond the danger point on May 31, 1889, causing the dam to break and engulfing the valley below and Johnstown in a wall of water that resulted in the loss of over 2,200 lives and more than $17 million in property damage. It was the most notable flood of the nineteenth century in the United States and the greatest national catastrophe in the post-Civil War era, and it provided a humanitarian cause for the entire country.

ADMINISTRATIVE DATA

Name: The remains of the South Fork Dam are located near the junction of U.S. 219 and PA. 896, near St. Michael, PA and is classified as a first order significance structure.

Proposed Treatment

In order to properly interpret the theme of the tragic Johnstown Flood of 1889, the historic scene will be restored. The dam abutments will be restored and stabilized to historic proportions. The historic scene on the top of the dam and the original appearance of the historic spillway will be restored. The spillway restoration would include the reconstruction of the historic spillway bridge that crossed from the north abutment over the spillway itself. This bridge will allow public access from the proposed visitor facility overlooking the north abutment to the abutment itself which is the best view point in the park. The culvert foundation stones and foundation of the control tower needs to be stabilized and preserved as portions of them are presently exposed and in danger of deterioration.

There are no cooperative agreements or other documents that are restraints on management in connection with this structure. One factor that should be noted is the existence of a Conrail spur line that runs between the two dam abutments. This rail line will interfere with the interpretation of the historic scene and is an intrusion of the dam itself.

James R. Zinck, Supt.
September 30, 1979

CHAPTER ONE

ORIGINAL CONSTRUCTION OF THE SOUTH FORK DAM AND WESTERN RESERVOIR: 1834-1852

A. PRELIMINARY SURVEYS FOR THE SOUTH FORK DAM AND WESTERN RESERVOIR: 1834-1839

In 1826 the Commonwealth of Pennsylvania officially began construction of its "Main Line" canal system that would ultimately connect Philadelphia and Pittsburgh, thus providing access to the former for the timber, mining, agricultural, and manufacturing resources of the central and western portions of the State. By the early 1830's, the 394-mile "Main Line" system, consisting partly of canals and partly of railroads, was in operation. The "Main Line" was divided into five divisions:

Columbia and Philadelphia Railroad (Philadelphia to Susquehanna River at Columbia) - 81.6 miles

Eastern Division (Canal from Columbia to Clarks Ferry along Susquehanna River) - 44.5 miles

Juniata Division (Canal from Clarks Ferry to Hollidaysburg along the Juniata River) - 127.5 miles

Allegheny Portage Railroad (Hollidaysburg to Johnstown) - 36.69 miles

Western Division (Johnstown to Pittsburgh) - 104.25 miles[1]

As soon as the Western Division was put into operation, it became clear that the "Main Line" works did not have a sufficient

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1. Willard R. Rhoads, "The Pennsylvania Canal," The Western Pennsylvania Historical Magazine, XLIII (September, 1960), 203-208; William H. Shank, The Amazing Pennsylvania Canals (York, 1965), pp. 11-12, 15-18; Pennsylvania Historical and Museum Commission, "The Pennsylvania Canals," Historic Pennsylvania Leaflet No. 1 (Harrisburg, 1969), pp. 1-4; and Pennsylvania Historical and Museum Commission, "The Allegheny Portage Railroad," Historic Pennsylvania Leaflet No. 19 (Harrisburg, 1974), pp. 1-4.

water supply to maintain the level of the canal from Johnstown to Pittsburgh during the dry summer season. The Pennsylvania canal commissioners first reported to the state legislature in 1834 that the streams along the division were not able to furnish the necessary amount of water for the full operation of that section of the canal in summer. Although the "Main Line" system possessed a dam across the Conemaugh River east of the canal basin in Johnstown and a feeder dam for the basin on the Stonycreek, additional supplies of water were needed to maintain the level of the canal particularly from Johnstown to Blairsville. Thus they sought authority and funds to conduct surveys for a reservoir site for the Western Division at an undetermined point east of Johnstown.[2]

During the summer and fall of 1834 Sylvester Welch, the engineer of the Juniata and Western Divisions, conducted preliminary surveys for the location of the reservoir. In November 1834 Welch reported that the most favorable site for a dam and reservoir would be on the south fork of the Little Conemaugh River, commencing "about two miles above its mouth" and extending "up the stream about two and a fourth miles." He observed:

> The flat which would be covered with water, varies in width from eight hundred and forty, to about four thousand feet, exclusive of the lateral ravines or valleys which extend out from both sides of the principal valley.
>
> The accompanying map shows the extent of ground which would be covered, by a dam which would raise the water sixty feet at bench mark No. 1. This dam or mound of earth and wall, would be fourteen hundred and forty-five feet long. The quantity of water which the reservoir would contain, is estimated at a little more than four hundred cubic feet, and the surface would cover about four hundred and thirty-five acres of ground.

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2. "Report of the Canal Commissioners," December 1834, printed in Pennsylvania Senate Journal, Appendix to Vol. 2, 1833-34, pp. 10, 95, 105-106.

The ground at bench mark No. 3, is seven feet higher than at No. 1. A dam of the same height at No. 3, would raise the surface of the reservoir seven feet higher, or it would make the water seven feet deeper than the marks on the map represent it. The surface would also be extended on the sides and at the upper end beyond the line represented in the map. A dam at this point would be eight hundred and forty feet long. The reservoir would contain about four hundred and eighty-five million cubic feet of water, and the surface would cover about four hundred and seventeen acres of ground. This appears to be the most favorable site for a dam. The distance across the valley is less than at any other point above or below it, and it appears from the measurements made, that a dam of the height proposed, placed here, will form a reservoir of greater capacity, than one placed at any other point above or below. The valley increases in width above the upper end of the proposed reservoir, but the inclination of the ground is too great to make it available without a dam of very great height.

The site of the proposed reservoir with the exception of one small field, is covered with timber. The adjacent country for some miles in extent, is principally a forest, and the land is of comparatively little value.

The enclosed diagram represents a section, through the centre, of a dam which I would recommend for adoption by the board. The wall and paddle bank should be commenced if practicable upon the solid rock. The slope towards the water should be made of materials that would be impervious to water. The lower slope may be made of coarse heavy materials of any description.

The sluices for letting out the water may be made at any point in the bottom of the dam, where a substantial foundation can be had. A channel sufficiently capacious to discharge the waste water during freshets, should be cut out of the hill, at one end of the dam. The hill at both ends of the dam, with the exception of a thin layer of earth on the surface, is formed of rock. The bed of the channel would therefore consist of solid rock, and not be liable to wear away. The water would not in any event pass over the dam.

The reservoir is estimated to contain about 485,000,000 of cubic feet. If the surface be reduced by evaporation during the dry season eighteen inches, equal to about 27,000,000 cubic feet, there will remain for the use of the canal 458,000,000 cubic feet of water. This, at the maximum quantity required for the passing of two hundred boats per day, will, in addition to the water that flows naturally in the river, supply the canal for a period of nearly one hundred and thirty days without any augmentation from rain.

In making the above estimate, the quantity of water lost by evaporation, from the channel of the river and from the canal, is not taken into consideration, as it is supposed the evaporation will not be increased by adding to the quantity of flowing water in the stream.

Welch estimated that the dam and reservoir construction would cost $127,705. The breakdown of this total was as follows:

Clearing a site for the reservoir, 417 acres, at $15,	$ 6,255.00
19,000 perches of rubble wall laid with hydraulic lime, at 2.50	47,500.00
14,000 cubic yards of excavation in puddle ditch, channel, &c. at 25,	3,500.00
41,000 cubic yards of puddling, at 25,	10,250.00
256,000 cubic yards embankment, at 20,	51,200.00
Contingencies, including gates and sluices,	9,000.00
	$125,705.00

If the wall be taken out, and its place supplied by puddled embankment, the cost of the reservoir, would be reduced to eighty- four thousand six hundred and three dollars.[3]

3. "Report of S. Welch, Engineer, Upon a Reservoir for the Western Division," November 22, 1834, printed in Pennsylvania House Journal, Appendix to Vol. 2, 1835-36, pp. 5458. A copy of the full report by Welch may be seen in Appendix A.

In April 1835 the state legislature appropriated $100,000 for various public works, including "the commencement of a reservoir near Johnstown." Under this act Welch made further surveys of Stoneycreek and the Little Conemaugh River and their branches and concluded by recommending that a reservoir be constructed at the same location as that indicated in his report of November 1834. The reservoir would cover 465 acres and would be capable of containing 524,000,000 cubic feet of water, "which, after making allowance for evaporation, will yield four thousand cubic feet of water per minute, for three months." This amount, together with "the yield of the streams of their lowest stage," would be ample for the "greatest demands of trade." The dam and reservoir were estimated to cost $113,330.

Welch now proposed to construct the dam to provide a 72-foot water depth above the bottom of the feeding pipes. The dam would consist of embankment and a wall of masonry. The waste water would be carried through a channel to be made around the end of the dam and passed into the ravine below it. The bed of this channel would be solid rock. No water would be permitted to pass over the dam. The sluice, through which the water would be drawn from the reservoir, would be made of cast-iron set in masonry.[4]

The entire appropriation of $100,000 passed by the state legislature was required for other public works and thus nothing was done on the dam and reservoir. Prospects for the early

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4. "Report of the Canal Commissioners," December 2, 1835, printed in Pennsylvania House Journal, Appendix to Vol. 2, 1835-36, p. 12, and "Report of the Committee on the Cause of the Failure of the South Fork Dam," American Society of Civil Engineers, Transactions, XXIV (June, 1891), 436-437.

construction of the dam and reservoir were bleak as Joseph Ritmer, the newly elected governor, and the Anti-Masonic legislature were promising an era of retrenchment in outlays of State funds for public improvements.[5] Accordingly, the canal commissioners reported in December 1835 that:

> Although no inconvenience was felt for want of water on the main line during the past season, except for about two weeks in the month of September, on the Frankstown line between Hollidaysburg and Williamsburg--yet it has become manifest that in dry seasons there will be a deficiency in the Conemaugh river and the upper part of the Juniata, for the purposes of an active trade. The necessary quantity, however, can readily be obtained by reservoirs which ought to be constructed as soon as practicable.
>
> In their last annual report, the Board suggested the propriety of having a reservoir constructed near Johnstown for supplying the Western division with water in dry seasons, and for that purpose as well as for works then in progress, or that were necessary to be done upon old lines, asked for an appropriation of one hundred and twenty-five thousand dollars, of which about twenty-thousand dollars were intended to commence the reservoir. Yet although the building of the reservoir was authorized by law, it has not been put under contract because, in the general appropriation act for new work on finished lines, and for other purposes, one hundred thousand dollars only was granted to effect the several objects contemplated. This fund of one hundred thousand dollars, although reduced below what was deemed necessary to carry out the views of the Board, was also charged with the cost of extending the arch, and filling up the tunnel at Grant's hill in the city of Pittsburg . . .
>
> Other charges upon the same fund were also added, that were not anticipated by the Board in their last report.[6]

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5. Johnstown Daily Tribune, August 10, 1900.

6. "Report of the Canal Commissioners," December 2, 1835, printed in Pennsylvania House Journal, Appendix to Vol. 2, 1835-36, pp. 11-12.

Although the state legislature passed an act on February 18, 1836, authorizing the canal commissioners to commence the construction of the eastern and western reservoirs, no work was begun. In their annual report in December 1838, the canal commissioners observed:

> There has been but little interruption to the navigation on this division during the past season, with the exception of a scarcity of water for a few weeks. The water was so low that the levels could not be kept sufficiently full for the passage of freight boats, in consequence of which goods were detained some time at Johnstown, after reaching that place.
>
> The summer has been an unusually dry one. The drought has been general over the State, earlier in the eastern, and later in the western part, affecting all our rivers, and causing a scarcity of water on most of the Divisions of our public works. The water has not been so low for years, nor for so long a duration. Our public works have heretofore suffered from this cause, and will hereafter, unless we guard against its recurrence. From past experience we cannot rely upon the supplies furnished by the Conemaugh, and the upper Juniata in a dry season. Reservoirs will have to be constructed (or some other mode adopted to overcome the difficulty) on each side of the Allegheny mountain. Reservoirs are deemed practicable. The Legislature, aware of the importance of constructing them, appropriated money at the sessions 1834-35 and 1835-36, for their commencement. They were not commenced for the reasons assigned in the reports of the Board of Canal Commissioners, made in 1836 and 1837.
>
> These reservoirs are absolutely necessary, and should be commenced and finished as soon as practicable, either upon the plan and location designated by Sylvester Welch, in his report made on that subject in 1836, or some other plan. The Board would therefore recommend a liberal appropriation to be made for this object.[7]

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7. "Report of the Canal Commissioners," December 21, 1838, printed in Pennsylvania House Journal, Appendix to Vol. 2, 1838-1839, p. 11, and "Report of the Canal Commissioners," January 21, 1840, printed in Pennsylvania House Journal, 1840, Vol. 2 - Appendix, p. 45.

After further lobbying by the canal commissioners, the state legislature, under the prodding of Governor David R. Porter who was a staunch supporter of state works, appropriated $70,000 for the commencement of the construction of the eastern and western reservoirs on July 19, 1839. Four days earlier, the canal commissioners had placed the work under the general charge of William E. Morris as principal engineer.[8]

Some time during the summer of 1839 the Commonwealth of Pennsylvania purchased the land on which the dam and reservoir would be located. The following parcels were included in the land acquisition program:

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8. "Report of the Canal Commissioners," January 21, 1840, and Johnstown Daily Tribune, August 10, 1900. A brief biographical sketch of Morris is as follows:

> William E. Morris was born at Muncy, Lycoming County, Pa. in 1812. In 1839 he was appointed one of the State engineers of the Western Division of the Pennsylvania Canal, and in August of that year he was sent to Hollidaysburgh to take charge of the construction of the South Fork Reservoir Dam and other works on the western division. In the winter of 1842, on account of financial difficulties, the works were suspended, and he, together with other engineers, was discharged. He was subsequently appointed Chief Engineer and President of the Germantown and Norristown Railroad, in 1853 he was appointed President of the Long Island Railroad, and resided in Brooklyn, and was for several years a vice-president of the Harlem Railroad. He subsequently returned to Germantown, where he employed much of his time as a hydraulic engineer, constructing waterworks for the City of Philadelphia; Trenton, N.J.; Wilmington, Del., etc. He died in Philadelphia, October, 1875.

"Report of the Committee on the Cause of the Failure of the South Fork Dam," 437.

George Murray - 316 acres, 127 perches
Joseph Lechey - 2 acres, 119 perches
Philip Myers - 4 acres, 4 perches
Daniel Baumgardner - 3 acres, 144 perches
Estate of Conrad Fye - 14 acres, 57 perches
Unknown - 93 acres, 133 perches

Thus, a total of 435 acres and 104 perches of land was acquired on which to build the dam and reservoir.[9]

B. SPECIFICATIONS, PLANS, DESIGNS, AND CONTRACTS FOR THE CONSTRUCTION OF THE SOUTH FORK DAM AND WESTERN RESERVOIR: 1839-1840

During the summer and fall of 1839 Morris conducted engineering surveys for the site of the South Fork Dam and Western Reservoir and drew up plans and specifications for their construction. On November 1, he reported on his surveys. Concerning the quantity of water required by the canal to sustain full trade during the dry summer months, he observed:

> The first inquiry that presents itself, and upon which, the size of the reservoir depends, is the quantity of water requisite to supply the canal for the <u>most active</u> trade, and during the longest continued drought.
>
> Three months <u>without rain</u>, and a trade that can be passed by two hundred locks full of water per day, are considered safe data for calculation. Under the most favorable circumstances, one lock full of water will pass two boats; under the greatest <u>disadvantages</u>, with a brisk

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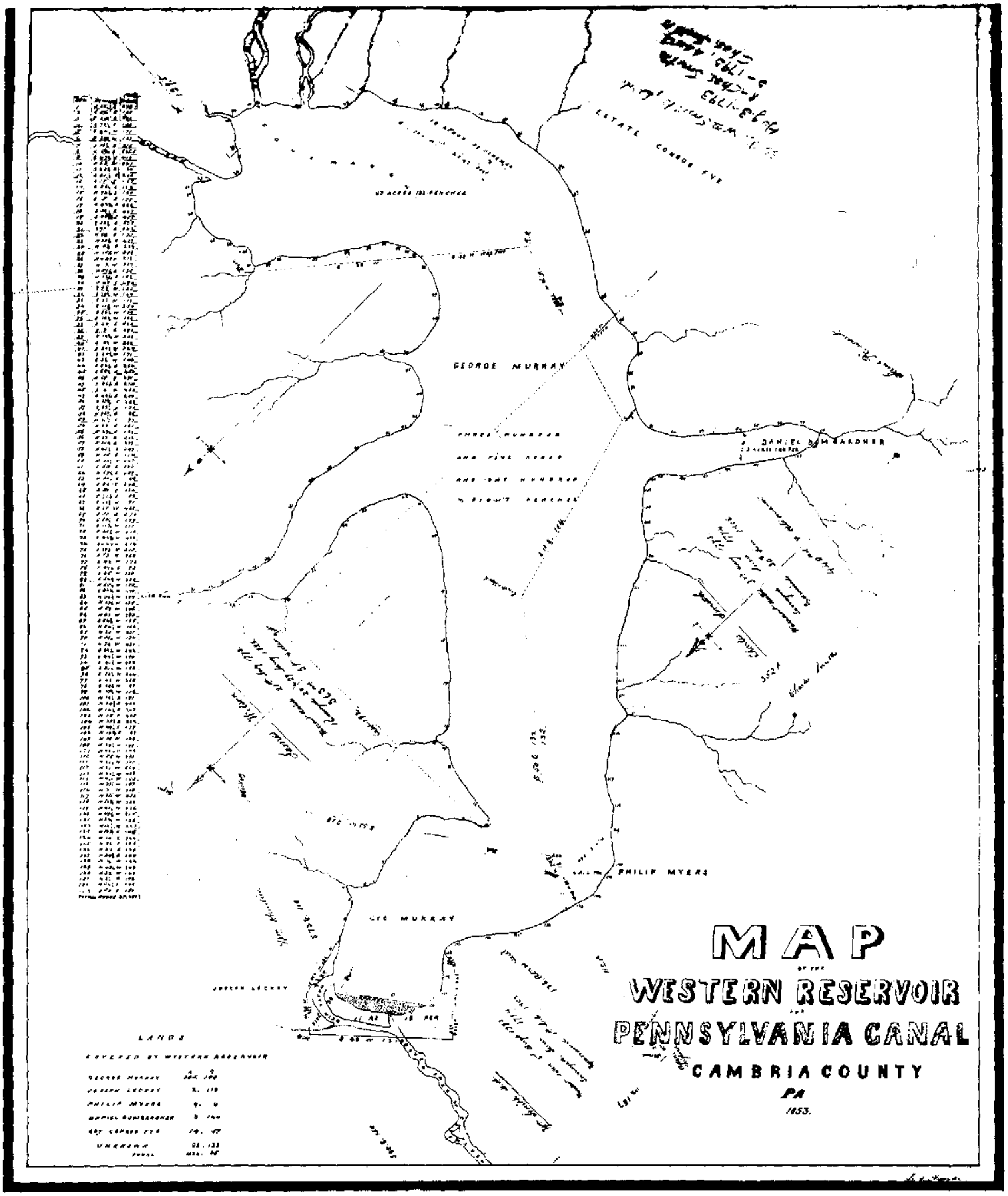
9. "Map of the Western Reservoir for Pennsylvania Canal, Cambria County, Pa., 1853," Pennsylvania Historical and Museum Commission, Division of Archives and History, Record Group 17, Records of Land Office, Board of Canal Commissioners, Map Books, No. 4: 1829-1866, o. Hereinafter material from this record group will be referred to as RG 17. A copy of this map may be seen on the following page.



In Testimony, That the above is a correct copy of the Map of the Western Reservoir for Pennsylvania Canal, in Cambria county, being No. 15 in Book No. 4 of the maps, plans &c. of the Pennsylvania Canal, remaining on file in the Department of Internal Affairs of Pennsylvania. I have hereunto set my hand and caused the seal of said Department to be affixed, at Harrisburg, the tenth day of September, 1901.

trade, two locks full are sufficient for the passage of three boats. Three hundred boats per day, at an average of thirty tons per boat, would pass a trade equal to nine thousand tons per day.

The greatest amount of tonnage, that passed this season upon the Portage rail road, in one day, was about fifteen hundred tons.

The quantity of water, required for the amount of trade just mentioned, will be as follows: for the canal fed from the dams at Johnstown, which is about six miles in length; and to supply the weigh lock, the waste water from which, is discharged into the Conemaugh, and taken again into the canal at the next dam below.

Two hundred locks full per day, including waste would be equal to	2,100	cubit ft. pr. min.
Leakage and evaporation upon six miles of canal,	600	do
Weighing three hundred boats,	2,000	do
Greatest demand,	4,700	do
Deduct amount estimated by Mr. Welch, to be furnished per minute, by the Conemaugh and Stony creek in the dryest seasons.	1,700	do
Amount required per minute for the reservoir,	3,000	

Which multiplied by 129,600 the No. of minutes in three months, equals three hundred and ninety millions, nearly the required available contents of the reservoir.

According to the estimate of Mr. Welch, for the same trade, the quantity of water required from the reservoir, to supply the canal between dam No. 3, of the Ligonier line; and the next pool below, a distance of fourteen miles, (being the longest piece of canal above Leechburg, fed from one dam) is 1,643 cubit feet per minute; and for the canal below Leechburg, 2,450 cubit feet per minute, both these amounts are less than that required, as shown above, for the canal at Johnstown.

Morris noted that his surveys confirmed the recommendation of Welch to locate the dam and reservoir on the South Fork of the Little Conemaugh River:

> Of the other branches, the south fork is the only one that drains a sufficient extent of country, to render certain a supply of water for the reservoir. The junction of this stream with the main branch, is about eight miles from Johnstown.
>
> There can be no doubt of the sufficiency of the stream, to fill a reservoir, of any desired capacity. It was carefully gauged in September, after one day's rain, and found to discharge in twenty-four hours, sixty millions of cubic feet of water. At the same time, there were flood marks along the stream, two feet higher; it would be a moderate estimate, to suppose a flood of two feet additional height, it would discharge three times as much water; equal to one hundred and sixty millions of cubit feet, in twenty-four hours.
>
> The most suitable point upon this stream for the construction of a reservoir, is about two and one fourth miles from the mouth and is the same recommended in 1834 and '35 by Mr. Welch.
>
> A dam at this point, that would raise the water sixty-two feet, would be eight hundred and fifty feet long on top, would form a reservoir containing, four hundred and eighty millions of cubit feet of water, and cover four hundred acres of ground.

The advantages of this site were:

> This site combines more advantages for the construction of a reservoir, than any other upon the waters of the Conemaugh, or Stony creek. It is not remote from Johnstown, and is less than two miles from the railroad. It is situated upon a stream that will furnish an abundance of water to fill the reservoir; and from the floods of which but little danger is to be apprehended; if proper channels are to be constructed for their discharge. The valley is narrow at the dam, and widens immediately above, into an extensive basin. The land intended to be flooded, except a few acres, is covered with timber, and consequently but small injury

will result to private property. There is solid rock at both ends of the dam, in which channels may be cut for the discharge of waste water, in time of floods. This fact has been satisfactorily ascertained by a full examination, by means of drifts and shafts sunk for the purpose. Abundance of the best material for the formation of the dam, is found convenient. The "feed water" with but little loss from evaporation will pass to the canal of Johnstown, down the natural channel of the stream, which is narrow and protected from the sun by woods and mountains. Allowing the surface of the reservoir to be reduced two feet by evaporation, there will remain for supplying the canal, four hundred and fifty millions of cubic feet of water; which will yield for three months, three thousand five hundred cubit feet per minute; being sixty millions of cubit feet of water more than the amount required, equal to five hundred cubit feet per minute for three months.

After considering the merits of a timber and stone crib dam, he determined that the dam should be formed by stone and earth embankment as follows:

> Two plans for the dams, present themselves for consideration, one to be constructed in the usual manner of crib dams, with timber and stone--having a wier upon the top, over which the waste water shall pass, in times of freshets. The other to be formed by a mound or embankment of stone and earth, made perfectly water tight, and raised ten feet above the surface of the pool--having a waste or channel cut in solid rock at one or both ends of the dam, for the passage of the flood water.
>
> To the former plan there are serious objections, great difficulty would be experienced in uniting the body of the dam with the embankments, in such a manner, as to prevent leakage, under so immense a pressure; it would require a large expenditure to secure the base of the dam from undermining; the perishable nature of the material used in its construction, would render early and continued repairs necessary, and thus furnish another constant source of expense to the commonwealth. By the latter plan, both of these objections are avoided, and the dam, when once properly constructed, promises to be permanent and durable, and capable of being maintained at small expense.

Regarding the sluice mechanism of the dam he noted:

> The sluice for passing the "feed water" should be placed through the dam, near the surface of the ground, for the purpose of rendering the entire content of the reservoir available.
>
> It may consist of cast iron pipes for about sixty feet next the water, and a cut stone culvert, the remainder of the distance through the dam; a sett [sic] of stop cocks faced with brass, should be placed at each end of the pipes. Those at the lower end for general use, and those at the upper end, as safety gates. The pipes as laid, should be tested by a force pump, under a pressure, equal to three hundred feet head of water.

According to his plans, the estimate of the work involved in constructing the dam and reservoir were as follows:

> 400 acres clearing ground covered by water,
> 8 acres grubbing, base of dam and wastes,
> 15,000 yards excavation, foundation for dam, puddle ditches, &c.,
> 40,000 do do rock in wastes,
> 110,000 yards embankment of dam, good earth,
> 100,000 do do do slate and stone
> 2,000 yards puddling about sluice,
> 5,000 perches ruble [sic] wall, laid in cement,
> 6,000 perches slope wall, dry,
> 3,000 perches cut wall for sluices, laid in cement,
> 7 1/2 tons wrought iron,
> 75 tons cast iron for pipes,
> 10 stop cocks with brass facings, lever and screw,
> House for sluice tender.
>
> Estimated cost $188,000,.00, exclusive of damages, engineering and office expenses.10

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10. "Report of William E. Morris, Engineer, Reservoirs," November 1, 1839, printed in Pennsylvania House Journal, Appendix to Vol. 2, 1840, pp. 158-164. The complete report by Morris may be seen in Appendix B. A general summation of the art of dam construction in the United States during the mid-19th century may be found in two works by David Stevinson: Sketch of Civil

Morris submitted specifications for the South Fork Dam and the Western Reservoir along with his reports which were quickly approved by the canal commissioners. The specification for the dam, entitled "Western Reservoir, Specification of the manner of Constructing Dams for Reservoirs," was as follows:

GRUBBING AND CLEARING

> This term is understood to include the removal and burning up of all trees, stumps, logs, roots, leaves, and vegetable matter whatsoever, from a space 20 feet larger in each direction, than that which it may be necessary to procure embankment. And in addition to the above, any trees, that in the opinion of the engineer, may be likely to fall into the wastes or upon the dam, shall be felled and burned. About 5 acres of chopping and clearing next above, and adjoining dam, will be included in the contract for dam.
>
> No part of the aforesaid material shall be thrown into the stream, nor shall it be deposited upon the adjoining land, without the permission of the landholders, in writing, endorsed by the engineer. The whole grubbing must be completed before any embankment is made. The quantity of ground attached to western reservoir is about 13 acres. The quantity of ground attached to eastern reservoir is about 10 acres. Timber, scattering. A gross sum will be bid for grubbing the site of dam and ground attached.

FOUNDATION

> After the grubbing is completed, and previous to commencing the embankment, the foundation shall be prepared by removing from the base of the dam, all sod, vegetable matter, and light, porous material, which shall be deposited in such places as may be directed by the engineer, not less than 10 feet outside and below the slope stakes of the embankment.

Engineering of North America (2nd ed., London, 1859) and Canal and River Engineering (Edinburgh, 1858). See Appendix C for a "General Description of Engineering Technology Employed in Dam Construction in the United States in the 1830's."

Puddle ditches shall then be dug, of such depth and width as may be directed by the engineer, and if necessary, sunk to and into the rock. When the stripping is done, and the puddle ditches dug, the whole area so prepared shall be plowed, with deep and close furrows, parallel to the range of the dam.

THE DAM

will be constructed as represented in the plan, with a slope of 2 to 1 on the upper side, and 1 1/2 to 1 on the lower side, it will be raised 10 feet above the water line, and be 10 feet on top. The lower angle composed entirely of stone, of such nature as to resist the decomposing action of air, frost and water.

In the outer portion of the stone, for 4 feet thick at top and 20 feet thick at bottom, no stone must be used which does not contain at least 4 cubic feet. The remaining part of the stone may be of any size. Next to the stone will be a body of slate rock or coarse gravel 3 feet thick on top, and 30 feet thick at bottom for western, and 20 feet for eastern reservoir.

The remainder of the bank or dam, being that between the water and the slate, shall be composed of the best water-tight, solid and most imperishable material that can be procured, within 1/4 mile of the dam. No light, spongy, alluvial, or vegetable matter will be used in its construction. Neither will any coarse gravel or stones larger than 4 inches square be permitted to form any part of it. The whole material of the dam, viz., stone, slate and earth, shall be brought and deposited in the proper place in carts and wagons, and no portion of the dam shall be made by transporting the material in barrows, by schutes, or upon a railway. If it shall be deemed necessary by the engineer, a puddle course of the best fine river gravel, 20 feet in width, shall be carried from bottom of puddle ditch to 4 feet above water line, which said puddle course shall be kept at 1 foot higher than the other portions of the embankment, and at all times to be well wet and carted upon, and next the walls, if necessary, well pounded, with a 4-inch rammer. The whole bank shall be made in layers 2 feet thick, be started at the same time, and carried up together, without troughs or hollows, and as nearly level as practicable throughout its whole extent. No part of it shall be made in freezing weather. If, during the progress of the work, any part of the embankment, by long exposure or too frequent passage upon it by carts or wagons, shall become so compact upon the surface as to be incapable of uniting completely with the material above to be deposited upon it, such surface shall be well plowed, and, if thought necessary by the engineer, puddle ditches cut, at the expense of the contractor.

In the embankment of the western reservoir, a wall of rubble masonry, made of well-shaped quarried stone, laid in a full bed of cement, with the faces undressed, and the beds and joints close and free from spalls, shall be carried up in the puddle course before-mentioned (or if it be omitted) in the earth embankment. This wall will be started 3 feet below the surface of the rock, if it should be found in excavating puddle ditches, and made completely to fill a trench excavated in the rock for the purpose. It will be 6 feet thick at the bottom, 25 feet high, and 2 feet thick on top; made with buttresses upon each side at intervals of 20 feet, and the difference of thickness between bottom and top; disposed of in offsets of 6 inches in width. No stone shall be used in the wall, of a less size than 2 feet long by 1 foot wide, and 6 inches thick, larger stones to have similar proportions. The wall to be well bound by a system of headers and stretchers so arranged as there shall generally occur one header to two stretchers. The masonry shall be progressed with as the embankment is raised. Any portion condemned by the engineer, shall be immediately taken down and rebuilt.

A slope of wall of dry masonry will be built upon the upper slope of the dam, 15 inches in thickness, backed in by a layer of slate rock or coarse gravel, 6 inches thick. No stone shall be used in its construction which do not reach through the wall, nor any that are of a less size than 4 inches thick by 8 inches wide. This wall shall be neatly laid, the beds of the stone at right angles with the face of the bank, the joints close and free from spalls. A paving of 18 inches depth laid in a similar manner, will cover the top of the embankment.

The cement for the rubble wall and masonry connected with sluices, will be furnished by the Commonwealth, and delivered at the nearest and most convenient point along the line of public improvements, and the contractor will be held responsible for all taken from such places. In working, it shall be mixed while dry with such proportions of clean sharp sand, as the engineer may specify, and the mortar made in small quantities and used immediately. No mortar that has stood over night shall be used in the work. If sand sufficiently clean in its natural state cannot be found, it shall be thoroughly washed.

A waste or waterway will be excavated in the hill at one or both ends of the dam, for the discharge of surplus water in the time of floods, the aggregate width of channels will not be less than 150 feet. The earth covering the rock will first be stripped off, the channel will then be excavated in the rock, leaving for an abutment or guard bank, between the ends of the embankment and the inner slope of the channel, a mass of solid rock, of such width and height, as the engineer may think sufficient. The entrance to the waste or wastes will be as close above the dam as its safety will permit, and its lower termination at least 50 feet beyond the outer slope of the dam.

The material taken from the wastes may be put in its proper place in the embankment of the dam, the stripping of earth upon them will be paid for only as an embankment. The slate, detachable rock, and solid rock, found in the wastes will be paid for both as excavation and embankments, except any stone that may be fit for masonry, and used in the walls, which will be paid for only as walls.

Slate rock is such as can be worked with a pick. Detached rock is that which occurs in loose pieces, containing more than 2 cubic feet, and less than 1 cubic yard, or that can be quarried and broken into movable masses without blasting. Solid rock is such as can only be worked by blasting.

Temporary waste wiers, composed of timber and plank, must be constructed by the contractor, at his own expense, at points in the embankment, not more than 15 feet in height above each other, for the purpose of passing with safety to the embankment, any surplus waste water which at any time of high floods, cannot escape through sluices.

CULVERTS

The foundations for the culverts or arched way for sluices will be excavated to, and if thought necessary by the engineer, into the rock, which must be suitably leveled for the reception of the walls.

will be range work laid in a full bed of cement mortar, no courses will be less than 8 inches in thickness, nor any stone used in the wall of a less size than 2 1/2 feet long, 16 inches wide and 8 inches thick. The beds and joints of the face stone are to be dressed to a smooth and even bearing 12 inches in width from the face, and brought, when laid, to a joint of not more than 1/4 of an inch in thickness. The backing will have the same height as the face stone, the horizontal joints of which shall not exceed 3/4 of an inch, nor the vertical joints be at any point more than 2 inches wide, nor will thay average more than 1 inch in width of the length for any joint. All joints shall be broken at least 8 inches.

Both faces of the walls, or the face and back, shall be formed by a regular system of headers and stretchers, laid alternately, and so arranged that the headers upon the front shall be opposite the stretchers on the back.

Both sides of the jambs or abutment walls and both ends of the crosswalls will be considered as facework. The side walls and ends of the chambers, or entrance of the sluices, both within and without, shall have a rock dress upon the face with a cut draught 1/4 inch wide around the edges. Upon the inner sides and ends, the rock dress-work shall not vary from the line or draught more than 1/2 inch, but upon the outside of the jambs it may be left rough.

The abutment of the part of the culvert below the ends of the pipes, shall be made in the same manner, except the inner face-work shall be picked off to within 1/2 an inch of variation from the cut draught.

The whole beds or joints of that part of the masonry between the two divisions of the culvert, upon which the pipes are laid, shall be dressed to a smooth even bearing, and so laid as to form joints of not more than 1/4 of an inch in thickness. The upper courses shall be 20 inches in thickness and cut to fit the pipes for half their circumference.

If required, a paving shall be placed between the side walls, laid in cement, and in the same manner as the jambs of the culvert. The arch shall be 20 inches in thickness. No stones to be used in its construction, which do not fill the entire depth, are not 18 inches wide, and which do not measure at least 6 inches in thickness on the outside of the arch. They shall be dressed by a pattern to full bed; the joints not to exceed 1/4 of an inch in thickness.

Piling walls or yokes shall be constructed at such points as the engineer may direct, and the walls of the sluices well united with the vertical wall of dam.

All stone used in the walls must be sound and durable, and approved by the engineer, and materials condemned by him shall immediately be taken to such places as he may direct. That part of the wall exposed to the action of the water, issuing from the pipes, must be made from the hardest and most durable sandstone. Stone more easily dressed may be used in other parts of the work. The mortar will be made as specified for vertical wall of dam. The lower end of the culvert shall be of neatly cut-stone, finished with pilasters and mouldings, as represented in the plan. The parapet and wing walls to be finished with a cut coping of sandstone, 2 1/2 feet in width, securely clamped and leaded. The iron, wrought and cast, the stop-cocks, and fixtures, and lead for joints of pipes, will be furnished by the Commonwealth, and delivered at the site of the reservoir, when the contractor will be required to put them in their respective places in the walls.

The wall irons will in all cases be bedded in the stone. The Commonwealth will furnish a force pump to test the pipes, joint by joint, and an experienced machinist to superintend and direct the laying of the pipes, leading the joints, and applying the test, the contractor to put up the force pump and be at all other necessary expenses, for fixtures, hands, etc., to make a secure and perfect job. Any length of pipe or joint that shall prove defective upon the application of a pressure equal to 300 feet head of water shall be taken up and rejected or relaid; proposals will state a price per foot lineal for laying pipes. The culvert walls and pipes to be puddled in such places as the engineer may direct. A suspension way or walk will be constructed from the lower end of the culvert to the stop-cocks at the end of the pipes; it will consist of a plankway 2 1/2 feet wide, and 2 inches thick, suspended from the arch of the culvert by iron rods and terminating upon the culvert wing.

A stack of masonry, laid as specified for jambs of culvert, with a rock dress on the faces will start at the lower ends of chamber as presented in the plan, and be raised to a height equal to that of the dam, finished with a coping of sandstone, 12 inches thick and 3 feet wide, securely clamped and leaded; no allowance made for bailing water, coffer dams or other extras.[11]

The specification for the sluice, or discharge pipe system, entitled "Specification of the manner of making Iron Work for Sluices of Reservoir," was also submitted. Its text was as follows:

> The testings will be made of Juniata iron, of the best, soft, lively-gray pig metal, such as may be approved by the Engineer. They shall be made at a Foundry and no part of the metal shall be melted over a second time.
>
> The pipes for sluices, will be two feet in the bore, and 1 1/2 inch thick for the Western, and 1 1/4 inch thick for the Eastern Reservoir. The length of each piece will be about 7 feet, male with socket joints, wedge shaped. They must be cast in Dry Sand, with the mould inclined, at about an angle of 30 degrees. Sufficient 'sinking plates' must be provided, to supply the increased density of the castings while cooling and prevent 'blisters.'
>
> The pipes must be cast exactly of a uniform thickness throughout; to be tested by actual measurement; and free from cracks, flaws, or other defects, to be tested by the sledge hammer. These two tests must be applied to each piece, before leaving the foundry; and previous to being taken off the hands of the contractor, when laid in place, the quality of the pipes shall be farther proved by a force pump, under a pressure equal to 300 feet head of water.
>
> Approximate weight of pipes for Western Reservoir 140,000 lbs.
>
> Do. do do. Eastern do. 100,000 lbs.

---

11. "Specifications, Bills of Materials, Notices, Etc., Exhibited at letting of Eastern and Western Reservoirs held November 6 and 9, 1839," 1 vol., 20 pp., RG 17, Map Books, No. 39: 1839, 1846, 1855, a. See Appendix C for the "Approximate Estimate of Work - Dam for the Western Reservoir."

The breast plates will be about 4 feet by 6, and 2 inches thick--with circular holes to receive the ends of the pipes, and such other holes, as may be directed, for the passage of bolts, and projections, to fasten the plates to the breast walls. The valve plates will be about 12 feet long, 2 feet wide, and 2 inches thick; with such holes and projections as the Engineer may direct, to receive valve rods and fixtures.

The pipes for valve rods will be 3 inches in diameter, and 5-8 of an inch thick, cast with projecting ears for securing the masonry.

Total estimated weight of castings for			Western Reservoir		150,000 lbs.
Do.	do.	do.	Eastern	do.	111,000 lbs.

The wrought iron work will be made from the best maleable iron. The Bars of the Grate riveted at each end to the outside frame, and in the middle to the cross piece, except two bars made moveable, and secured with keys.

The valve rods must be made in lengths of not less than 15 feet, and spliced by means of a screw box, 3 1/2 inches in diameter, and 16 inches long, to be neatly and strongly welded on the rod.

The bolts for breast plates will have a screw at each end 10 inches long, with washers, and nuts 2 inches thick.

The fastenings for valve plate will have a screw at upper end 10 inches long; nuts and washers: those for valve rods, will be so constructed to receive and retain by keys a brass box, through which the rods will pass.

Total estimated weight of wrought iron for			Western Reservoir	13,000 lbs.
Do.	do.	do.	Eastern do.	9,000 lbs.

Proposals to state a price per lb. for cast, of each reservoir will be given to the same individual or company. The iron must be delivered at the site of the respective reservoirs as it may be required by the state of the work. The whole amount will be needed between the 1st of April and the 1st of September, 1840.

The whole work must be done in the best style, and in the most mechanical and workmanlike manner; agreeably to the specification and plan, and in accordance with the directions in detail of the Engineer, and subject to such modifications as he may deem proper.[12]

A specification for the reservoir was also provided. It was entitled "Specification of the manner of Clearing Ground overflowed by Reservoir" and read as follows:

The whole area of ground intended to be covered by water: and if required, to twenty feet outside and beyond water line, shall be cleared of all trees, stumps, logs, brush, leaves and vegetable matter of every description whatsoever--and of any roots, that may be turned up;-all of which shall be <u>entirely burned</u>.

In addition to the above, any trees in the vicinity of the Reservoir, which, in the opinion of the Engineer, are likely to fall into the water, shall be felled and burned.

All trees and saplings, that are less than 10 inches in diameter, shall be chopped off even with the surface of the ground. Trees of larger size may be cut with a stump a foot in height.

In no case will the contractors be permitted to throw any portion of the aforesaid material into the streams--neither shall they deposit it upon the adjacent land, without a <u>written</u> permission from the Landholder, endorsed by the Engineer. The streams shall, at all times during the progress of the clearing, be kept free from obstruction, and open to the passage of water, by the <u>immediate</u> removal of any trees, brush, or other matter that may fall into them.

Any timber that may be suitable for any part of the work about the reservoir, and shall be wanted for such purpose, and any fencing rails or posts, that may be left on the ground by the landholder, upon notice from the Engineer, shall be carefully deposited in some secure place and not destroyed, and the contractor will be held responsible for the same.

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12. <u>Ibid.</u> See Appendixes D and E for "Bill of Wrought Iron for Western Reservoir" and "Bill of Cast Iron for Western Reservoir," respectively.

The CLEARING will be let in lots, numbered from the dam upwards, marked upon the ground, each containing about fifty acres of woodland. That portion of the ground now cleared and enclosed, will not be bid for as land to clear, nor measured as such, except so far as to include fence rows, and any uncleared land, properly such, within the fences.

The bids will state a price per acre for each lot. Any number of lots may however be let to the same individual or company.

The contracts will be entered into at the canal office in Hollidaysburg, within two weeks after the allotment: notice of which will be published, and forwarded to the address of those to whom the work shall be allotted.

The clearing shall then be immediately commenced and prosecuted actively, and completely finished to the satisfaction of the Engineer on or before the first day of August, 1840.

The use of ardent spirits is strictly forbidden, and good order must be enforced among the laborers, and every effort used to prevent their committing depradations upon the neighbors.

The whole work will be done according to the plans and specifications, and agreebly to the directions in detail of the Engineer.[13]

Morris submitted two drawings with the specifications to provide visual plans for the dam, culvert, and sluice. The two drawings (which may be seen on the following pages) were entitled "Dam and Sluice for Reservoirs by Wm. E. Morris, C.E., 1839 (Original Plan No. 1)," and "Sketch of Piling Iron [for] Western Reservoir" [1839].[14]

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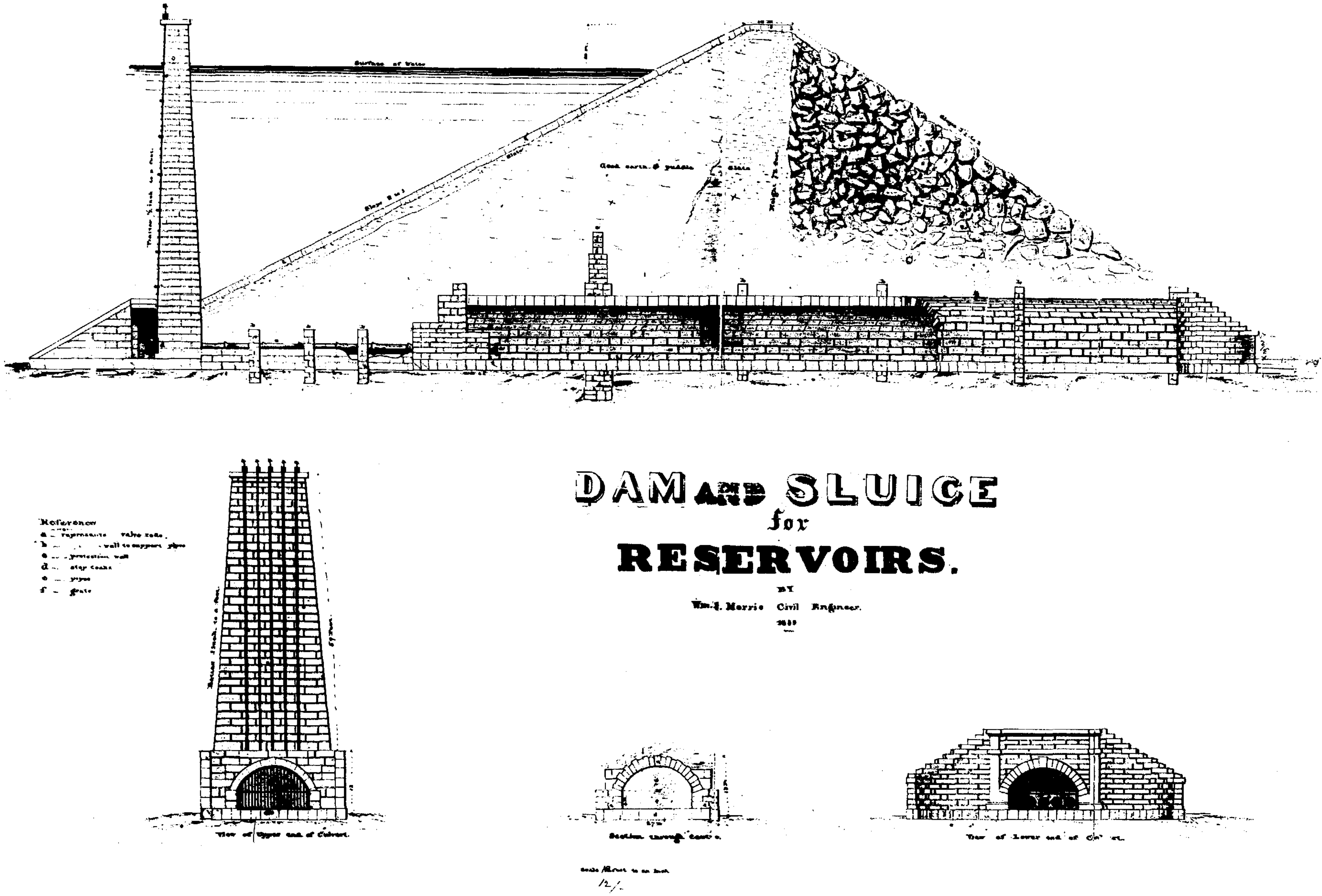
13. Ibid.

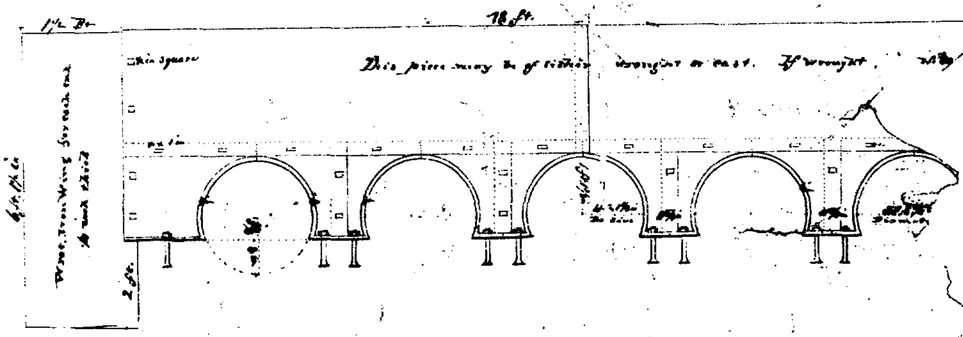
14. "Dam and Sluice for Reservoirs by Wm. E. Morris, C.E., 1839, (Original Plan No. 1) for Western Reservoir," [1839], RG 17, Map Books, No. 4: 1829-1866, h and l, respectively.



Surface of Water
Good earth & puddle
DAM AND SLUICE
for
RESERVOIRS.
BY
Wm. J. Morris Civil Engineer.
Reference
a – valve rods.
b – wall to support pipe
c – protection wall
d – stop cocks
e – pipe
f – grate
View of Upper end of Culvert.
Section through Centre.
View of Lower end of Culvert.
12/.

SKETCH of PILING IRON WESTERN RESERVOIR

FRONT ELEVATION

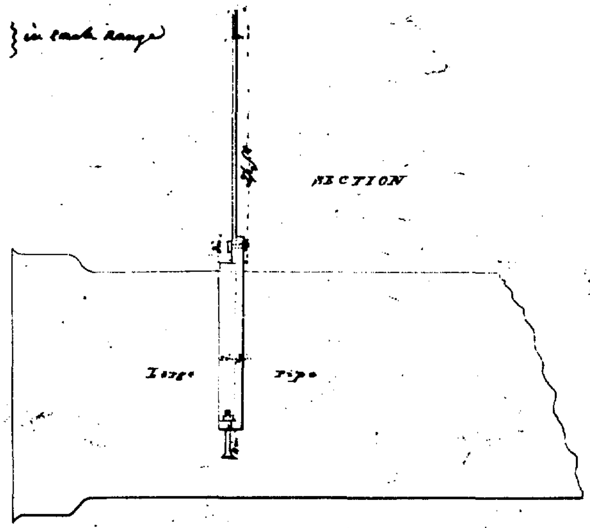


Holes in Bottom Flange 5/8 in Sq.
do in Ends of Plate 1/2 " "
do at all other places 1/2 + 1 in.

10 Anchor Bolts - 5/8 in Sq. - 7 in long. Nut & Screw & head stand up } in each Range
30 joint do 1/2 " " 3 1/2 " " " " " ~~to square head~~ }

4 Ranges wanted

SECTION



The work was hurriedly submitted to public competition, and the contract for the construction of the dam was allotted to General James R. Morehead of Pittsburgh and Judge Hezekiah B. Packer of Williamsport on November 6, 1839. Morehead was known as a reputable builder of dams throughout Pennsylvania and Parker was the brother of a future governor of the Commonwealth. Apparantly, the contractors named as the superintendent of their work force George Murray, who had sold more than 300 acres to the Commonwealth for the location of the dam and reservoir.[15]

The contract was approved by the canal commissioners on December 1, and David Watson was appointed supervisor of the work with authorization to enter into the contract. The contract, which was formally dated January 31, 1840, included the following prices:

Grubbing and clearing, gross sum	$1,700.00
Common excavating above water in puddle ditches	.15 per yard
Solid rock excavation above water in puddle ditches	.50 per yard
Common excavation below water in puddle ditches	.34 per yard
Solid rock excavation below water in puddle ditches	1.00 per yard
Slate excavation in wastes	.34 1/2 per yard
Embankment of dam, good earth	.25 per yard
Embankment of dam, coarse stuff	.30 per yard
Puddling	.38 per yard
Masonry of sluices	6.43 per perch
Masonry of slope wall	1.64 per perch
Masonry rubble	3.93 per perch
Laying pipe	1.00 per lineal foot[16]

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15. Willis Fletcher Johnson, History of the Johnstown Flood (Philadelphia, 1839), p. 39.

16. "Report of the Committee on the Cause of the Failure of the South Fork Dam," 438.

Meanwhile, the canal commissioners reported on January 21, 1840, concerning the progress on the South Fork Dam and Western Reservoir. Their report included the following description of the work:

> The Western Reservoir is located on the south branch of the Little Conemaugh river, ten miles from Johnstown, and two from the Portage railroad, at the point recommended by Sylvester Welch, Esq. in 1835. The Board think this selection the best that can be made.
>
> A dam that will raise the water sixty-two feet, will be 850 feet long on top, will form a pool which will contain 480 millions of cubic feet of water, and cover four hundred acres of ground. Allowing the surface to be reduced two feet by evaporation, the reservoir will yield, without any supply for three months, 3,500-cubic feet of water per minute--being 500 cubic feet per minute more than the greatest amount that will be required. This work is estimated to cost $188,000.[17]

A contract for the iron work on the sluices was let to Samuel Kennedy on January 27, 1840, and approved on June 4. The prices allowed by the contract were 3 3/4 cents per pound for cast iron and 9 cents per pound for wrought iron.[18]

The land that would be covered by the reservoir was divided into seven lots and separate contracts were let for the clearing of each lot. The contracts were as follows:

Lot 1
- Contractor - James Clarke
- Price - $33 per acre
- Date signed - May 20, 1840
- Date approved - August 15, 1840
- Date to be completed - November 1, 1840

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17. "Report of the Canal Commissioners, January 21, 1840," printed in Pennsylvania House Journal, 1840, Vol. 2 - Appendix, p. 45.

18. Contracts, 1826-1859, Box 1, 1 vol., RG 17, Divisional Records, Western Division, 1825-1859.

Lot 2

Contractor - Samuel Dillon, Charles Wilson, and Charles Dillon
Price - $55 per acre
Date signed - January 27, 1840
Date approved - June 4, 1840
Date to be completed - August 1, 1840

Lot 3

Contractor - John McGough
Price - $54.75 per acre
Date signed - January 27, 1840
Date approved - June 4, 1840
Date to be completed - August 1, 1840

Lot 4

Contractor - Rogers Marshall, Jesse Patterson, and Jordan Marbourg
Price - $70 per acre
Date signed - January 27, 1840
Date approved - June 4, 1840
Date to be completed - August 1, 1840

Lot 5

Contractor - John McFarland
Price - $60 per acre
Date signed - February 7, 1840
Date approved - June 4, 1840
Date to be completed - August 1, 1840

Lot 6

Contractor - Samuel S. Johnson & W. W. Bell
Price - $52 per acre
Date signed - January 25, 1840
Date approved - June 4, 1840
Date to be completed - August 1, 1840

Lot 7

Contractor - Daniel Huber & John Hildebrand
Price - $73 per acre
Date signed - February 1, 1840
Date approved - June 4, 1840
Date to be completed - August 1, 1840[19]

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19. Ibid.

In May 1840 another contract was let to Barr & Pennington for the construction of a brick and stone house and a stable at the reservoir site. The house and stable, which would cost $797.48, apparently would provide housing for the construction supervisor, David Watson, and later for the person charged with the maintenance and operation of the dam and reservoir.[20]

C. PROGRESS OF CONSTRUCTION ON THE SOUTH FORK DAM AND WESTERN RESERVOIR: 1840-1841

Operations for the construction of the South Fork Dam and Western Reservoir were commenced by Morehead and Packer in April 1840. The work included clearing the land for the dam and reservoir - logging, cutting, chopping, brush piling and burning. By mid-June some 7 1/2 acres had been cleared and grubbed for the base of the dam. Excavation of earth and stone for the dam was begun in May and continued throughout the summer and early autumn. Samuel Kennedy began casting the necessary pipes in Johnstown in July and completed the work, consisting of 56 pipes and approximately 150 clamps weighing 121,620 pounds, in October. By the time that operations ceased in November because of cold weather the following work had been accomplished:

Grubbing and clearing
17,000 cubic yards of common excavation above water
470 cubic yards of rock excavation above water
9,370 cubic yards of common excavation below water
548 cubic yards of rock excavation below water
9,000 cubic yards of good earth embankment below water
5,200 cubic yards of coarse stuff below water
800 cubic yards of coarse stuff above water

---

20. Watson to Wilson, May 30, 1840, Reports and Misc. Docs., 1826-43, Box 10, Vol. 3, RG 17, Divisional Records, Western Division, 1825-59.

170	perches of stone - slope wall
80	perches of stone dressed and delivered
50	perches of stone not dressed and delivered
200	cubic yards solid rock in wastes
600	cubic yards slate
100	perches of stone - sluices
7,036	feet of lumber for culvert foundations[21]

In November 1840 Engineer Morris reported on the progress of the work and the importance of completing the dam and reservoir as soon as possible. His comments relative to the status of the work were as follows:

> The Western Reservoir is situated on the south fork of the Little Conemaugh river, about ten miles above Johnstown, and two miles from the Portage railroad. The letting was held on the 6th of November, 1839. Operations were commenced by the contractors for constructing dam, clearing the ground, and furnishing the castings for pipes, early in the spring, and the work has been constantly progressed with since that time. The clearing is nearly completed, the pipes have been cast, and are at Johnstown ready for delivery. At the dam, a force of hands varying from forty to eighty has been employed. All the work below surface of water in the stream has been done, except the sluice walls, consequently, there will be no interruption or detention hereafter from high water. Every opportunity is thus offered to urge forward the work to completion.

Cost of work done at clearing, at contract prices, is	$25,097.00
Work done at dam,	15,000.00
Work done at pipes,	4,950.00
Total cost of work done at contract prices,	$45,047.00

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21. Field Book, Western Reservoir, 1840, Box 1, 1 vol., RG 17, Engineering Records, 1825-52. The "Bill of Lumber in Culvert Foundations" was included in the volume and may be seen in Appendix F.

> The Western Reservoir was estimated in my report for 1839, to cost $188,000, exclusive of damages, engineering and office expenses. No doubt is entertained of the sufficiency of this sum to complete the work.
>
> If an appropriation is made in time to enable the contractors to improve the early part of the season, this reservoir may be rendered available in supplying the canal in the summer of 1841; but as little work can be done in winter, it will require a part of the next year to complete it.

Morris also elaborated upon the necessity for completing the work because of the canal traffic slowdowns caused by water deficiencies on the Western Division.[22]

Work on the South Fork Dam and Western Reservoir was hindered during 1841 by the deteriorating finances of the Commonwealth of Pennsylvania. The economic crisis occurred after the Second Bank of the United States, now a Pennsylvania-chartered bank, closed its doors following an unsuccessful attempt to sustain cotton prices. The protracted depression which resulted curtailed numerous public works activities to only essential operations in the Commonwealth as well as across the nation, particularly after the institution suspended payment on February 4, 1840. Finally, the state legislature on April 3, 1841, passed an act appropriating $50,000 to pay for all work done on the Western and Eastern Reservoirs up to May 1, 1841. Thereafter, the contractors continued their work sporadically using their own funds to proscute the work.[23]

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22. "Reservoirs, Report of Wm. E. Morris, Engineer," November 20, 1840, printed in Pennsylvania House Journal: Appendix to Vol. 2, 1841, pp. 401-405. A copy of the remainder of Morris' report may be seen in Appendix G.

23. Richard B. Morris, ed., Encyclopedia of American History (New York, 1976), p. 747, and "Report of the Committee on the Cause of the Failure of the South Fork Dam," p. 444.

In November and December 1841, after another year of work on the South Fork Dam and Western Reservoir had been completed, Engineer Morris and Superintendent Watson reported on the status of the project. On November 30 Morris observed:

> The depth of water in the dam is sixty-two feet--area of land flooded, four hundred and twenty acres--content of pool in cubic feet, four hundred and eighty millions. Deducting two feet in depth from the top for evaporation, will leave the available water in cubic feet, four hundred and fifty millions.
>
> The estimated quantity of water necessary for the transportation on the canal, of an amount of tonnage equal to the present capacity of the Portage railway, viz-two thousand five hundred tons per day, is about two millions of cubic feet per day. This whole quantity, without any allowance for the natural flow of the streams, can be drawn from the reservoir for more than six months, without any additional supply from rains. It is then clear that this reservoir will be amply sufficient for every possible demand upon it. If to this be added, that the portage railway has never for one month, even during the most busy season, averaged one thousand tons per day, all doubts must vanish, as to the sufficiency of the supply furnished by this reservoir.
>
> Since last fall, the contractors have continued steadily to push on the work at the dam, though from the smallness of the appropriation, with a moderate force; the sluice walls are raised sufficiently high for the reception of the pipes. Some difficulty has been encountered in testing these pipes with a pressure equal to three hundred per head of water; that difficulty has been overcome, however, and each range of pipes, about eighty feet in length, has been subjected to this severe test, and in every case, the tightness of the joints and the soundness of the castings, proved their fitness for the work.
>
> The importance of making a perfectly secure job of the sluice, and the impossibility of remedying any defect after the work is completed, and the fatal consequences resulting from a leak in these pipes are sufficient to warrant any additional expense and labor, to render the work as perfect as possible. The stop cocks (ten of which are required at each reservoir) have been ordered

from the Foundry of Wm. Weeks, at Lewistown-those for the upper end of pipes, (five in number) are completed, and will be put to their places in a few days.

The clearing is completed, with the exception of a few acres, which can be done in a short time, after an appropriation shall be made.

The Contractors for furnishing the wrought and cast iron, have nearly completed their contract: the castings and a portion of the wrought iron are delivered, and the remainder of the wrought iron is about ready for delivery.

The estimated cost of work done at contract prices, is

Work done at Dam,	$42,000
Work done at Clearing,	26,000
Cast and Wrought Iron,	7,000
Cement manufactured at Johnstown,	2,200
Stop cocks and Lead for joints of pipe, and laying and testing pipes,	2,800
Total,	$80,000

If funds are early provided by the Commonwealth for this work, it can be completed during the summer of 1842, and may be so far advanced early in the spring, as to furnish to the canal a supply of water during the dry months.

Superintendent Watson submitted his first report on the progress of the dam and reservoir in December 1841. He noted that:

. . . the work at the dam has also been regularly prosecuted since the time of its commencement, and the contractors are still prosecuting it with more vigor than could be expected, under their long continued embarrassment, arising from the want of funds.

A considerable portion of the embankment has been made, and the masonry is in such a state of forwardness, that the pipes were all laid a month ago . . .

The contractors for the dam and also for the iron work, who deserve much credit for their energy and perserverance in prosecuting their work without the necessary means being furnished by the Commonwealth, have expended large amounts on their respective jobs, and justice would appear to require early provision to be made for the payment of the amount due them . . .

There is at present no corps of engineers employed on this work-the duties being performed by Wm. E. Morris, Esq., principal, and John White, esq., assistant engineer, on the Juniata and Western division of canal, aided by W.W. Morris, since the first of May last, as superintendent of masonry . . .[24]

The canal commissioners issued a report on January 15, 1842, requesting a special appropriation from the state legislature to expedite the completion of the Western and Eastern Reservoirs. The report stated:

The work upon these indispensable feeders to the Juniata and Western Divisions has so far progressed as to ensure their completion during the next summer, if an early appropriation be made for that purpose. The importance of these Reservoirs to the main line, and the absolute necessity which exists for bringing them into use as early as practicable, were again fully demonstrated the past season. In the summer months it was found impossible to maintain a sufficient depth of water in the upper levels to pass boats containing more than half loads. To save water for the purposes of navigation, the weighlock at Johnstown was closed on the 17th of August, and not reopened until the 25th of September, and from the same cause but very few boats have been weighed at the lock at Hollidaysburg since July last. The evils resulting from these annual interruptions have been fully commented upon in former reports of the Board. Until a sufficient supply of water has been obtained to keep up the original capacity of the upper levels at all periods of

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24. "Reservoirs, Report of W.E. Morris, Engineer," November 30, 1841, and "Western Reservoir, Report of D. Watson, Superintendent," December 5, 1841, printed in Pennsylvania House Journal, Vol. 3, 1842, pp. 217-220, 223-224. The full report by Watson may be seen in Appendix H.

> the navigable season, the usefulness of the main line must continue to be impaired, the cost of transportation increased, and the revenues of the Commonwealth consequently diminished by the diversion of trade to other channels. The Reservoirs will be constructed of such capacity as to ensure a regular and permanent supply of water. To their completion, then, we can alone look for the removal of one of the prominent causes of delay and expense in the transportation of merchandize at those seasons of the year when the mountain streams do not yield a supply adequate to the requirements of the line.[25]

D. WORK ON THE SOUTH FORK DAM AND WESTERN RESERVOIR REMAINS SUSPENDED: 1842-1851

As no new appropriation was forthcoming for the completion of the work, the operations on the South Fork Dam and Western Reservoir were idle for some ten years beginning in 1842. During that period the canal commissioners repeatedly made efforts to obtain funds to complete the Western and Eastern Reservoirs. The partially finished projects, which had been estimated to cost $288,000 and on which $148,954.75 had been expended, were useless unless they were completed. In their uncompleted state, the projects were subject to decay and liable to be swept away by floods as there were no funds for the preservation of partial construction. Most of the expensive work had been accomplished; all that remained was the completion of the embankments.[26]

Moreover, there was a considerable loss of revenue each summer season due to the lack of a sufficient water supply for the

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25. "Report of the Canal Commissioners," January 15, 1842, printed in Pennsylvania Senate Journal, 1842, Vol. 3, p. 13.

26. "Report of the Canal Commissioners," November 1843, printed in Pennsylvania House Journal, Vol. 2, 1843, pp. 124-125, 158.

operation of the canal. In November 1844 the canal commissioners reported:

> Interruptions to the regular transportation of goods have occurred to some extent every year since the line has been in operation, occasioned by the want of a sufficient supply of water at the head of canal navigation, on one or both sides of the Allegheny mountain. Last year the supply on the west side was such as to prevent much delay, but this fact affords no guaranty that it will be sufficient the ensuing season. These interruptions always occur at one of the most important periods of the year for the transportation of merchandize west, and it cannot be doubted, that the State has lost, from this cause, much of the carrying trade, and consequently a very large amount of tolls. . . . the Board, therefore, cannot urge upon the Legislature too strongly the necessity of making provision for completing the Eastern and Western reservoirs at the Allegheny mountain as soon as may be practicable, consistent with sound economy. . . .[27]

As the economy improved in the mid-1840's efforts were begun to continue the construction of the South Fork Dam and Western Reservoir. On January 31, 1846, the state legislature appropriated $20,000 for the project and the canal commissioners were required to complete it with as little delay as possible. Morris was asked to prepare new plans and specifications to be exhibited at a letting on March 10, 1846. These documents were the same as those prepared by him in 1839, except that a wood frame valve control tower was substituted for one of masonry.[28]

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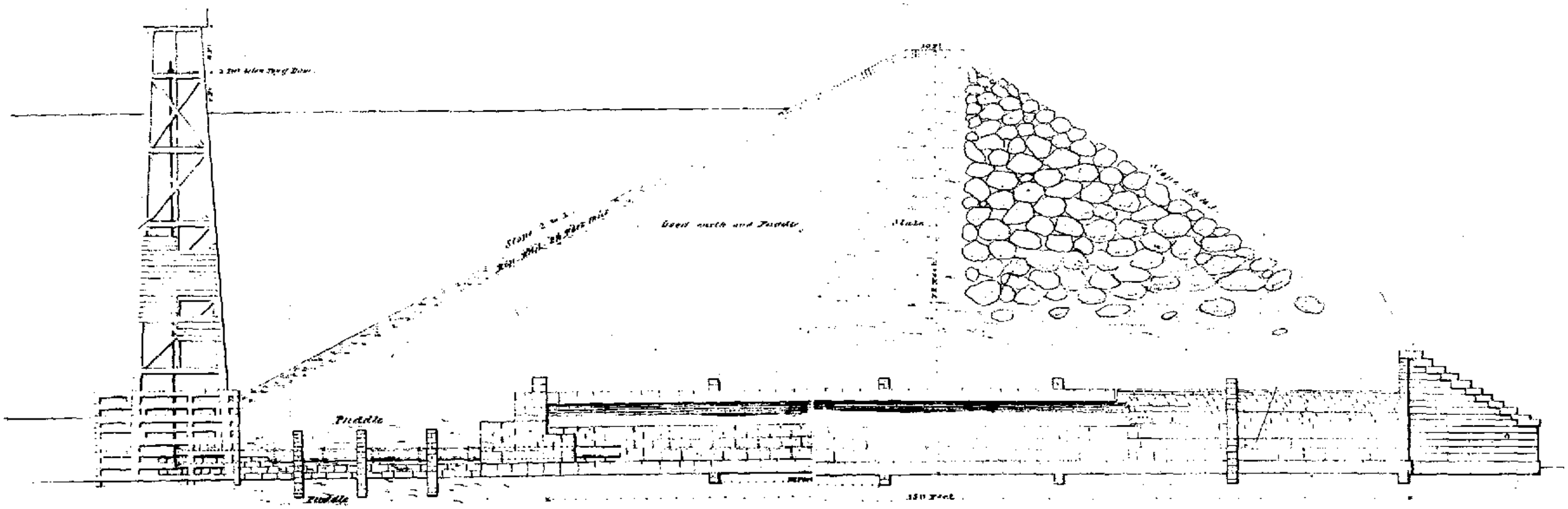
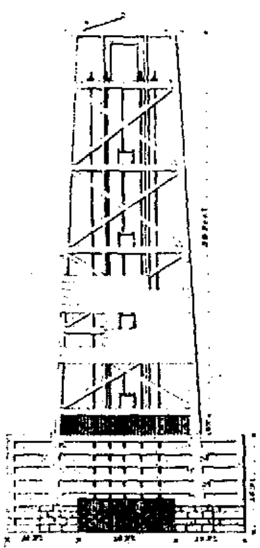
27. Annual Report of the Canal Commissioners, Transmitted to the Governor in Pursuance of Law, for the Financial Year Ending November 30, 1844 (Harrisburg, 1845), p. 8.

28. "Dam and Sluice for Western Reservoir, Exhibited at Letting March 10th, 1846, Wm. E. Morris, Civil Engineer," RG 17, Map Books, No. 4: 1829-1866,i. A copy of this plan may be seen on the following page.





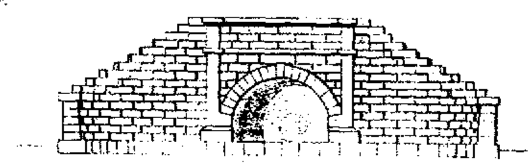
DAM AND SLUICE

FOR

WESTERN RESERVOIR

Exhibited at Letting, March 10th [illegible]

Wm. [illegible] Morris
Civil Engineer.



Scale 11½ Feet to 1 Inch.

Bids for the completion of the work were received from twelve contractors on March 10, 1846. The bids, which ranged from $46,280 to $71,090, covered the following items of work:

Grubbing and clearing
Excavation of puddle ditches above and below water
Excavation of wastes (slate and solid rock)
Embankment of dam (good earth, coarse stuff, puddling)
Masonry (sluices, slope wall, laying pipes)
Frame at head of pipes (cribbing and timber plank)[29]

In addition, bids were received for completing the clearing of the bed of the reservoir. These bids included cleaning out the debris that had accumulated since 1841 when the work had ceased. The bids were as follows:

James Potts - $800
George Murray - $850
James Clarke - $33 per acre and
$ 2 per acre for balance[30]

Despite the fact that Morehead and Packer each submitted individual bids for the work, they claimed the right to complete the dam and reservoir under their contract of January 31, 1840. Their claim was based on the fact that their contract had not been abandoned or rescinded and that the work had merely ceased when the appropriation was depleted.[31]

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29. "Bids for Reservoirs and Work Connected Therewith Recd., March 10, 1846," 1 vol., 5 pp. RG 17, Map Books, No. 39: 1839, 1846, 1855, b. A list of the bidders may be seen in Appendix I.

30. Ibid.

31. Morehead to Forster, February 25, 1846, Reports and Misc. Docs., 1844-59, Box 11, Vol. 2, RG 17, Divisional Records, Western Division, 1825-59.

Before the canal commissioners could determine who would complete the dam and reservoir, a flood struck many parts of Pennsylvania in the spring of 1846, causing extensive damage to the "Main Line" canal works. On account of the large expenditures required to repair the damage caused by the flood, the canal commissioners postponed the completion of the dam and reservoir and the appropriation reverted to the general fund to help pay for the flood repairs. In 1847 the partially-completed South Fork Dam, which was described as "annually wasting away," broke, causing a minor flood in Johnstown. According to one account, the water

> was from four to six feet high on the "Island" and the lower parts of the city. The waste weir from the Basin and the overhead bridge from Canal Street to Portage Street, were destroyed. A short distance below where is now located the Baltimore & Ohio Station, the northerly bank of the Canal was washed out for a distance of a hundred feet. Boats which were in the Basin were washed through the break and carried away, passing under the acqueduct [sic], and one of them knocked off the corner of Gaffer Davis' brick house on "Goose Island,. . .[32]

A cholera epidemic that swept through southwestern Pennsylvania in 1848 prevented the construction work from proceeding for two more years.[33]

During this period of inactivity the canal commissioners continued to urge the state legislature to pass an appropriation to resume the work. For example, they observed in late 1848:

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32. Henry Wilson Storey, History of Cambria County, Pennsylvania (3 vols., New York, 1907), I, 314.

33. Annual Report of the Board of Canal Commissioners, With Accompanying Documents, for the Year Ending November 30, 1848 (Harrisburg, 1849), pp. 12-13, and "Report of the Committee on the Cause of the Failure of the South Fork Dam," 444.

. . .No doubt of its utility as a feeder during the dry season of the year can now be entertained...it is due to the character of our works, and to the cheapness of transportation, that the feeder for the Western division should be completed and brought into use as soon as possible.[34]

E. WORK ON THE SOUTH FORK DAM AND WESTERN RESERVOIR IS COMPLETED: 1851-1853

In 1850 the state legislature, at the strong urging of Governor William F. Johnston, passed a new appropriation of $45,000 for the completion of the South Fork Dam and Western Reservoir. Morehead and Packer again demanded that they be allowed to finish the work under their contract of January 31, 1840. The canal commissioners referred their request to Judge B. Champneys of Philadelphia for an informal non-binding legal opinion. He found no legal basis for the claim of Morehead and Packer and reported that a new contract could be awarded to the lowest bidder of March 10, 1846. However, when Morehead and Packer threatened to take the case to the state supreme court, the canal commissioners permitted them to proceed with the work under their original contract. The delay caused by the controversy, however, resulted in the appropriation reverting to the general fund. A new appropriation was passed later on April 15, 1851.[35]

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34. Annual Report of the Board of Canal Commissioners . . . November 30, 1848, pp. 12-13.

35. Morehead and Packer to Longstreth, August 3, 1850, and Champneys to Longstreth, Painter, and Gamble, [September, 1850], RG 17, Divisional Records, Western Division, 1825-59, and "Report of the Committee on the Cause of the Failure of the South Fork Dam," 444.

Operations on the dam and reservoir were resumed around May 1 and the work was carried out as quickly as practicable.[36] By October 22 when the work ceased because of the depletion of the appropriation, the following work had been accomplished:

1,000 cu. yds. of earth excavation
37,000 cu. yds. of earth embankment
3,500 cu. yds. of stone excavation
1,500 cu. yds. of embankment and puddling
1,000 perches of stone - masonry
150 perches of stone - slope wall
6,000 lin. ft. lumber - plank beam
4,000 cu. yds. of common stuff excavation[37]

In November 1851 the canal commissioners reported on the status of the work and its need for completion. Among their observations were the following:

> About the 1st of September, the upper portion of this line was visited by a drought unprecedented for many years. At that period boats leaving Johnstown were limited to draw 22 inches of water. On the 4th of September, they were further restricted to 20 inches; on the 7th to 18 inches; and, from the 12th of September to the 1st of October, almost an entire suspension of transportation occurred. If the Western reservoir had been completed and in operation, the great loss to the revenues of the State, and to the business community, would have been avoided.

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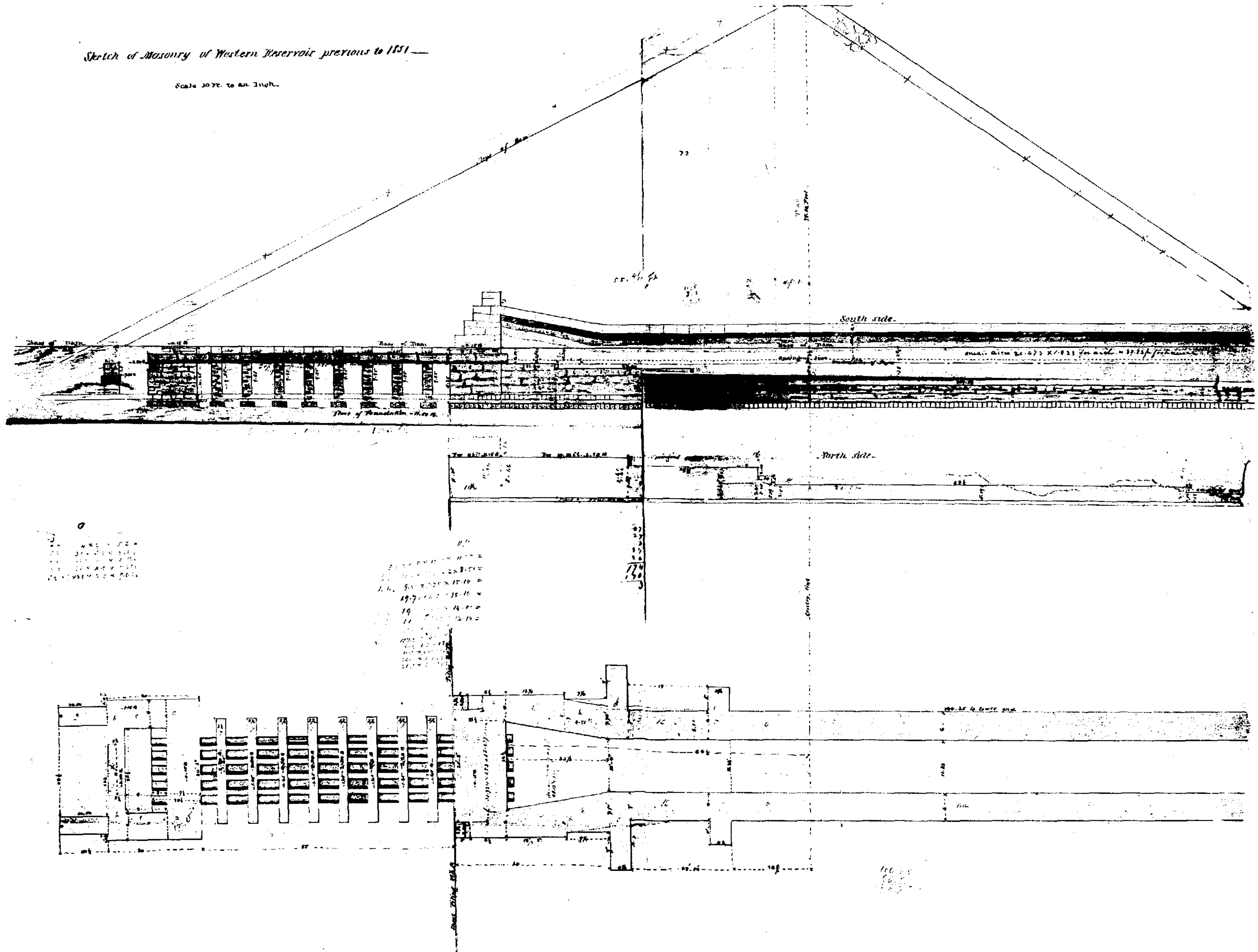
36. For a view of the dam as it existed at this date, see a copy of the "Sketch of Masonry of Western Reservoir Previous to 1851" on the following page. The drawing was found in RG 17, Map Books, No. 4: 1829-1866, e.

37. Field Book, Western Reservoir, 1851, Box 1, 1 vol., RG 17, Engineering Records, 1825-52. The field book contained "Notes of Pipes, Cross Walls, Stacks, Etc.," a copy of which may be seen in Appendix J.

Sketch of Masonry of Western Reservoir previous to 1851—

Scale 30 ft. to an Inch.



Concerning the nature of the work, the canal commissioners noted:

> . . .the necessity of giving a permanent character to a structure, containing when full, 480,000,000 cubic feet of available water, prevented any modification of the plan, which it was supposed might be made with a view of decreasing the cost of construction.

The sum of $55,000 was still needed to complete the work, and the commissioners urged the state legislature to provide the additional money.[38]

The legislature approved the requested appropriation on May 4, 1852, and the work continued apace under Morehead and Packer. Under the terms of the appropriation, Morehead and Packer filed a $30,000-bond with the state treasurer that would be reimbursed provided that the dam was completed by January 1, 1853. That year Daniel Killen was the first boss of the force working at the dam, and Charley Cassiday was the second. The bosses had Colonel Cain for a foreman and Little Nigger Jack as the pick-carrier. Archibald McCachren and Peter Varner were in charge of the construction of the frame tower, and the former also kept the clothing store for the workers and boarded the office men. Samuel Kopelin of Johnstown was employed as the blacksmith.[39]

Work on the frame valve control tower was advanced to the point that on June 10 the sluice gates were closed to prepare for

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38. <u>Annual Report of the Board of Canal Commissioners, With Accompanying Documents, for the Year Ending November 30, 1851</u> (Harrisburg, 1852), pp. 15, 18.

39. Unidentified newspaper article, in Item 793, Scrapbook, Johnstown Flood, 1889, Miss Tory Gagely, 1 folder, MG 8, Pennsylvania Collection (Miscellaneous), Pennsylvania Historical and Museum Commission, Division of Archives and History. Hereinafter, material from this collection will be referred to as MG 8.

the dry summer season. By the end of August water in the reservoir had accumulated to a depth of 40 feet above the feeding pipes. The water afforded an ample supply for fully-loaded boats to pass the Western Division of the canal throughout the summer. In November the canal commissioners reported that "this work will be entirely finished in a very short period. It has been constructed in a most substantial manner, reflecting great credit upon the contractors and the officers having it in charge."[40]

Since the embankment of the dam was new, it was considered unsafe to fill the reservoir to a height greater than 50 feet above the feeding pipes for the season of 1853. That summer was unusually dry and the reservoir was exhausted before fall. The contractors apparently completed the work on the dam and reservoir in the spring of 1853 at a cost of $166,647.50.[41]

F. DESCRIPTION OF THE COMPLETED SOUTH FORK DAM AND WESTERN RESERVOIR - 1853

When completed in 1853 the South Fork Dam and Western Reservoir was hailed as an engineering masterpiece. According to some sources, the dam was considered to be the largest earthen work of its kind in the world and the reservoir was said to be the largest artificial reservoir in the United States.

The dam was a mound of earth 931 feet long, more than 500 feet thick in the bottom, 72 feet high, and approximately 40 feet

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40. Annual Report of the Board of Canal Commissioners, With Accompanying Documents, for the Fiscal Year Ending November 30, 1852 (Harrisburg, 1853), p. 18.

41. "Report of the Committee on the Cause of the Failure of the South Fork Dam," 444-445.

wide across the top which was used as a roadway for wagons. The top of the dam was ten feet higher than the water level of the reservoir. It had no central core of masonry as the preliminary estimates had indicated. Instead it was composed of successive layers of clay earth that was found in the vicinity, each layer having been well rammed or packed down (puddled) by allowing it to sit under a skim of water for a period of time so as to be watertight. This puddled clay core was supported on both sides by stone and gravel layers. The outer face of the dam was riprapped with heavy loose rocks, while the inner face was riprapped with a layer of smaller stones 2 1/2 feet thick. Between the outer riprap and inner core was a layer of native slate broken down into a four-inch size. The slope of the outer face was 1 1/2 to 1 while that of the inner face was 2 to 1.

The control mechanism for the dam consisted of a sluice gate whose five 2-foot diameter cast iron pipes were covered by a cut stone arch culvert (25 feet wide at the base) that extended entirely through the base of the dam. Water was discharged from the reservoir through these pipes into the South Fork and ultimately down the Conemaugh to feed the canal at Johnstown some 12 to 14 miles downriver. A frame valve control tower, having a log and stone foundation at the bottom of the reservoir, extended about 15 feet above the top of the water surface and was used to regulate the discharge of water.

The western end of the dam was anchored to the hillside by a stone wall 20 feet high and buttressed every 20 feet through the base. To prevent the water behind the dam from rising to the top and flowing over its crest, a spillway was cut through the solid rock at the eastern end of the dam. The spillway was approximately 70 feet wide at its narrowest width and its bottom was 10 feet below the crest of the dam.[42]

The reservoir, which was limited to a 50-foot depth at the dam in 1853, covered an area of 424.85 acres, according to a "Map of the Western Reservoir for Pennsylvania Canal, Cambria County, Pa., 1853" prepared by R.S. Alexander for the Department of Internal Affairs of the Common-wealth of Pennsylvania. The water in the reservoir was described by Thomas J. Chapman in The Valley of the Conemaugh as being

> sufficient to fill a canal five hundred and sixty miles long, thirty feet wide, and five feet deep. If filled into hogshead thirty inches in diameter, and standing side by side, they would form a row that would more than encompass the earth; or, if diffused in the form of rain, it would be sufficient to water all of Pennsylvania west of the Alleghenies.[43]

The water for the reservoir came from a number of streams that rushed down from Blue Knob and Allegheny Mountain, draining nearly fifty square miles. The feeder streams included Rorabaugh Creek, Toppers Run, Yellow Run, Bottle Run, Muddy Run, South Fork Creek, and several unnamed creeks. South Fork Creek and Muddy Run were the largest of the feeders, but South Fork was at least twice the size of the others, stretching some twenty feet in width even in midsummer.[44]

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42. John Bach McMaster, "The Johnstown Flood, I," The Pennsylvania Magazine of History and Biography, LVII (July, 1933), 225-226; Nathan D. Shappee, "A History of Johnstown and the Great Flood of 1889: A Study of Disaster and Rehabilitation (unpublished Ph.D. dissertation; University of Pittsburgh, 1940), pp. 209-211; David G. McCullough, The Johnstown Flood (New York, 1968), pp. 52-53; and "The Appalling Calamity at Johnstown," Iron Age, XLIII (June 8, 1889).

43. Thomas J. Chapman, The Valley of the Conemaugh (Altoona, 1865), pp. 90-91, and "Map of the Western Reservoir for Pennsylvania Canal, Cambria County, Pa., 1853," RG 17.

44. McCullough, The Johnstown Flood, pp. 41-42.

CHAPTER TWO

THE SOUTH FORK DAM AND WESTERN RESERVOIR AS A FEEDER FOR THE PENNSYLVANIA CANAL: 1853-1863

A. THE SOUTH FORK DAM AND WESTERN RESERVOIR AS A FEEDER UNDER THE COMMONWEALTH OF PENNSYLVANIA: 1853-1857

The South Fork Dam and Western Reservoir served as a feeder for the Western Division of the Pennsylvania "Main Line" Canal from their completion in 1853 until May 1, 1863, when the stretch of canal between Johnstown and Blairsville was closed to navigation. During this ten-year period, the dam and reservoir suffered several breaks, including a major one in July 1862, and became the property of the Pennsylvania Railroad Company in 1857 along with the entire "Main Line" system.

In 1854 the dam and reservoir supplied a sufficient volume of water for the operation of the canal west of Johnstown. The canal commissioners reported in November 1854 that

> . . . the Western Reservoir continued to furnish a full supply of water until near the close of the season, thus establishing the fact that it can, unless in extraordinary dry seasons, such as the one which has just passed, be safely depended upon, at all times, for the demands of navigation.
>
> Two slight breaks occurred in the reservoir during the fiscal year, which were promptly repaired. This improvement having now been fully tested, may justly be regarded as a valuable and indispensable adjunct to the western line of the canal.[45]

During the spring of 1856 there were "grave fears entertained" by many residents in Johnstown "of the possibility of a break in the reservoir." The previous winter had witnessed a snowfall of 48

45. Annual Report of the Board of Canal Commissioners, With Accompanying Documents, For the Fiscal Year Ending November 30, 1854 (Harrisburg, 1855), p. 19.

inches, the heaviest in years, and an early warm spell in March caused the "snow to disappear with unparalleled rapidity." The reservoir overflowed its banks and a leak in the dam added to the general alarm. The Johnstown Tribune later observed that:

> . . . the sudden precipitation of the entire body of water upon the Conemaugh Valley would have done a vast amount of damage to personal property, while families who lived in the line of the threatened torrent went to bed of a night for a season with no security given them that they would not find a watery grave before morning.

The prevailing alarm led to an arrangement whereby the East Conemaugh telegraph office agreed to forward immediate word to Johnstown if the dam broke. However, the level of the water soon subsided and the leak was repaired.[46]

Later that spring general maintenance operations were carried out on the dam, including the gravelling of its surface. The canal commissioners reported in November that

> This line (Western Division) was kept in fine boatable order during the whole season, giving a practical evidence of the utility of the Western reservoir, when the dams are properly gravelled at the proper time.[47]

That same month the state engineer of Pennsylvania examined the dam and reservoir. He found both "to be in excellent condition." The reservoir "furnished a sufficient supply of water

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46. Johnstown Tribune, May 21, 1874.

47. Annual Report of the Board of Canal Commissioners, With Accompanying Documents, For the Fiscal Year Ending November 30, 1856 (Harrisburg, 1857), p. 21.

to keep up the navigation when other sources had entirely failed."[48]

B. THE SOUTH FORK DAM AND WESTERN RESERVOIR AS A FEEDER UNDER THE PENNSYLVANIA RAILROAD COMPANY: 1857-1863

While the Commonwealth of Pennsylvania was slowly completing the South Fork Dam and Western Reservoir, events were taking place that would soon put the "Main Line" out of business. The Pennsylvania Railroad Company was granted a charter on February 25, 1847. Following the grant they pushed the construction of the new railroad with vigor. Work started at both ends, and the first train from Philadelphia reached Pittsburgh on December 10, 1852, using the Columbia and Philadelphia Railroad and the Portage Railroad. Some fourteen months later, the world famous Horseshoe Curve was completed, the Portage Railroad was abandoned, and on February 15, 1854, the first train passed over the Alleghenies without using the inclined planes. It was apparent that the "Main Line" system was doomed, and on April 27, 1854, the state legislature ordered it to be sold. After attempts to sell the "Main Line" were unsuccessful in 1854 and 1855, the Pennsylvania Railroad Company purchased the entire system, including the Portage Railroad, South Fork Dam, and Western Reservoir for $7,500,000 at a public auction held on June 25, 1857, at the Merchants Exchange in Philadelphia. The deed of sale was dated July 31 and on August 1 the Governor transferred the properties to the railroad.[49]

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48. Report of the State Engineer, For the Fiscal Year Ending November 30, 1856 (Harrisburg, 1857), p. 16.

49. McMaster, "The Johnstown Flood, I," 226-227; Shappee, "History of Johnstown," p. 211; and Rhoads, "The Pennsylvania Canal," 234.

Under the railroad the old canal system gradually fell into disuse and the works, such as the dam and reservoir, were generally neglected. The railroad company maintained a watchman at the reservoir to protect its machinery and to drive off the residents who coveted the lead wipings in the exposed joints of the sluice pipes. On July 18, 1862, the dam and reservoir were reported to be in dangerous condition:

> The canal reservoir is represented by citizens who have visited it recently as in a dangerous condition. A portion of the arch in the breast wall has fallen, leaving but a feeble support at that point for the immense body of water behind it. Should the dam give way suddenly, as it is likely to do in the case of a heavy rain, unless the fallen wall is speedily repaired, the consequences would be serious. The matter was brought before the Borough Council on Tuesday evening, when Mr. Pershing promised to telegraph to the canal authorities aprising [sic] them of the impending danger.[50]

The problem at the culvert apparently was the result of slipshod construction and the lack of maintenance repairs. Later, the Johnstown Daily Tribune reported that:

> . . . It is said the specifications (for the dam) called for three puddle walls five feet thick, in ditches from which all the soil was to have been removed. This was not done, and the stone-arched culvert through which ran the pipes to let out the water was laid on "sheet-piling" on a boggy ground, with a consequence that there was always a leak in the dam. . .[51]

After a heavy rain on July 26 of that year the upper end of the stone arch culvert collapsed and nearly 200 feet of the dam embankment washed out to a depth of fifty feet. It was estimated

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50. Cambria Tribune, July 18, 1862.

51. Johnstown Daily Tribune, August 10, 1900.

that nearly 50,000 cubic yards of material were carried out. About twenty feet of the lower end of the culvert and the embankment over it remained. The reservoir was only partially filled because of the dry summer season, and since the dam had been leaking around the base of the culvert for some time and the reservoir slowly drained over an eleven-hour period, the Conemaugh was raised by only three feet. The damage to the surrounding area was slight with the chief problem being the washout of the embankment of the Pennsylvania Railroad at the eastern end of the South Fork Bridge.[52]

The Johnstown Daily Tribune reported the break in the dam on August 1. It noted:

> The Reservoir dam, the precarious condition of which we noticed two weeks ago, gave way on Saturday morning last and emptied its waters into the Conemaugh. The announcing of the breaking of the dam caused considerable alarm in town, but owing to the low stage of water in the creek, the flow from the Reservoir produced but an inconsiderable rise, and the excitement and the flood both soon subsided. No loss or damage was sustained by anybody so far as we can learn, except the carrying away of about two hundred dollars worth of bridge timber belonging to Wood, Morrell & Co., which was being floated down the creek, and the overflowing and washing away of a few rods of the railroad track at South Fork, which detained the morning train from the East until late in the afternoon - Many people were badly scared about the breaking of the Reservoir, but nobody was hurt by it.[53]

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52. McMaster, "The Johnstown Flood, I," 227; "Report of the Committee on the Cause of the Failure of the South Fork Dam," 445; and "The First Break in the South Fork Dam," Engineering News and American Railway Journal, XXI (June 15, 1889), 555.

53. Cambria Tribune, August 1, 1862.

Various articles in the Johnstown Daily Tribune provide further insight into this first major break in the South Fork Dam in July 1862. When Joseph Leckey, the railroad company watchman who lived on the hill above the dam where the present Unger farm is now located,

> saw a stream of muddy water issuing from the culvert outside of the pipes....he hastened to the dam, entered his boat, rowed to the derrick over the intake, opened the pipes, and then, riding post-haste to Wilmore, had the late George W. Kerbey, then P.R.R. ticket agent and operator at that place, telegraph the news to Johnstown.
>
> The dam was half a day in breaking, the water being about forty-eight feet deep in it at the time, and beyond washing away a sawmill, a short distance below the dam and a small house at the lower end of the "Island" in Johnstown, did comparatively little damage....[54]

Another article in the Johnstown Daily Tribune of February 11, 1881, stated:

> On Saturday, July 26, 1862, the reservoir dam broke, but fortunately there was only forty-five feet of water measuring at the bulkhead at the time, and even this quantity did not run out in a body, as the process was gradual, owing to a large hole being worn away around the timbers which supported the pipes in position, so that the only damage of moment was the partial sweeping away of a sawmill which stood in the stream a few hundred rods below.[55]

The railroad did not repair the break since there were plans to abandon the upper Western Division of the canal between Johnstown and Blairsville. On May 1, 1863, this stretch of the

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54. Johnstown Daily Tribune, August 10, 1900. Also see Chapman, Valley of the Conemaugh, p. 91.

55. Johnstown Daily Tribune, February 11, 1881.

canal was closed to navigation. Thereafter, neighboring farmers grazed their cattle on the dried slopes of the reservoir which soon returned to grassy pasture, and people fished in the pools, approximately eight feet deep, that still remained at the deep end against the remains of the dam.[56]

56. Wierman to President and Directors of Pennsylvania Railroad Company, January 1864, RG 17, Pennsylvania Canal Company, Pennsylvania Railroad Company, Canal Department, Various, 1857-1867, Box 2; Shappee, "History of Johnstown," pp. 211-212; McMaster, "The Johnstown Flood, I," 227; "Report of the Committee on the Cause of the Failure of the South Fork Dam," 445; and "The South Fork Dam and Johnstown Disaster," Engineering News and American Railway Journal, XXI (June 15, 1889), 543.

CHAPTER THREE
THE SOUTH FORK DAM AND WESTERN RESERVOIR IN DISUSE AND DECAY: 1863-1879

The South Fork Dam and Western Reservoir were left in a state of disuse and deterioration from 1863 to 1879. The former reservoir was little more than an outsize pond, eight feet deep at its deepest point next to the dam. At its southeastern end, grass quickly sprouted across the acres of dried-up lake bed and neighboring farmers cultivated fields and grazed their sheep and cattle there. According to one writer, the "dam simply moldered away up in the hills, visited only by hunters, fishers, and nature-lovers."[57]

It was during this seventeen-year period that the wooden valve tower for controlling the discharge pipes caught fire and burned to the ground. There are no records as to the date or circumstances of the fire, but it was reported in December 1880 that the tower had "stood many years" after the 1862 break and had been burned only "a few years" before.[58]

The Pennsylvania Railroad Company had little need for the dam and reservoir and thus sold the property, amounting to 500 acres and 54 perches, to John Reilly of Altoona on March 29, 1875, for $2,500. Reilly, who had worked for the railroad since 1854 and had served as superintendent of transportation from 1865 to 1875, had recently resigned from the company because of his election to the U.S. House of Representatives as a Democrat from the Altoona area. After serving one term in Congress, he returned to Altoona in 1877

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57. Richard O'Connor, Johnstown The Day the Dam Broke (Philadelphia, 1957), p. 33. Also see, McCullough, Johnstown Flood, pp. 54-55, and John Alexander Caldwell, Illustrated Historical Combination Atlas of Cambria County, Pennsylvania, (Philadelphia, 1890), p. 24.

58. Letter, B.F. Ruff to Daniel J. Morrell, December 2, 1880, printed in Johnstown Daily Tribune, June 18, 1889.

and resumed his former job with the Pennsylvania Railroad. His health failing, Reilly made plans to sell his property in 1879 preparatory to moving to Philadelphia. Throughout his four-year ownership of the land on which the South Fork Dam and Western Reservoir were located, he had done nothing to improve the property.[59]

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59. Deed, The Pennsylvania Railroad Company to John Reilly, March 29, 1875, Cambria County Deed Book, Vol. 38, pp. 56-58; "The Break in the South Fork Dam," Engineering News and American Railway Journal, XXI (June 15, 1889), 555; and Biographical Directory of the American Congress, 1774-1971 (Washington, 1971), p. 1,598.

CHAPTER FOUR

RECONSTRUCTION AND USE OF THE SOUTH FORK DAM AND WESTERN RESERVOIR (RENAMED LAKE CONEMAUGH) BY THE SOUTH FORK FISHING AND HUNTING CLUB OF PITTSBURGH: 1879-1889

A. THE SOUTH FORK FISHING AND HUNTING CLUB OF PITTSBURGH PURCHASES THE SOUTH FORK DAM AND WESTERN RESERVOIR: 1879-1880

In September 1879 there were rumors in the newspapers that Reilly had offered to sell the South Fork Dam and Western Reservoir to the City of Johnstown for $2,500 plus the tax assessments that he had paid on the property since 1875. These rumors were denied since Johnstown had a sufficient supply of water as a result of the recent construction of its waterworks.[60]

During the following six-month period, the status of Reilly's property is somewhat in question. The Johnstown Daily Tribune reported on October 15, 1879, that the dam and reservoir had been purchased by the Western Game and Fish Association of Pittsburgh and were advertising for fifty men to help "Contractor Kaine to go to work on the dam of the old Reservoir, on the South Fork of the Conemaugh River, immediately." It was announced that

> . . . It is the intention of the corporation named to commence rebuilding the dam and putting the extensive grounds in proper shape for the erection of a summer resort, and no better location can be found in Western Pennsylvania for this purpose . . . As soon as the necessary buildings are erected and all the improvements made it will be a formidable rival to Cresson, and in course of time will undoubtedly become one of the best rural resorts in the country.[61]

Later on December 27, the newspaper observed:

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60. Johnstown Daily Tribune, September 30, 1879.

61. Ibid., October 15, 1879.

> The Western Game and Fish Association, some three months since, purchased the old reservoir, and immediately afterward commenced building a dam, proposing to make a boating and fishing basin of the lake, and to build a fine country resort on its banks, from which place visitors could start to scour the woods in pursuit of game animals or fish, as their fancies dictated. From twenty-five to fifty men have been until recently at work on the dam, but the heavy rains of the past week found them unprepared for the flood, and on Christmas the dam was swept away, and the thousands of dollars invested in the work went with the waters-down below.[62]

Despite these newspaper reports and the fact that most secondary works state that Reilly sold his property to Benjamin F. Ruff in 1879, the Cambria County land records indicate otherwise. The land records contain a deed from John Reilly to the "South Fork Hunting and Fishing Club of Pittsburgh" dated March 15, 1880, in which the latter paid the former $2,000 for 500 acres and 54 perches of land in the Adams and Croyle Townships.[63]

The South Fork Fishing and Hunting Club of Pittsburgh was incorporated by a company of wealthy Pittsburgh industrialists, financiers, and businessmen, on May 19, 1879. Organized as a non-profit corporation under the regulations of the "Act for the Incorporation and Regulation of Certain Corporations" of April 29, 1874, the club sought a charter in November 1879. Judge Edwin B. Stowe of the Allegheny County Court of Common Pleas signed the charter on November 17. The charter declared that the purpose of the club was "the protection and propagation of game and game fish

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62. Ibid., December 27, 1879.

63. Deed, John Reilly, et. nx., to South Fork Hunting and Fishing Club of Pittsburgh, March 15, 1880, Cambria County Deed Book, Vol. 43, pp. 319-322.

and the enforcement of all the laws of this state against the unlawful killing and wounding of the same." The place of business was declared to be Pittsburgh, despite the fact that the resort at the South Fork Dam was located in Cambria County. The capital stock of the association was set at $10,000 divided into 100 shares valued at $100 each. Sixteen subscribers were listed for an initial 42 shares, the principal shareholders being Benjamin F. Ruff, a former railroad tunnel contractor and now an occasional coke salesman and real estate broker, with eight and Henry Clay Frick, a millionaire coke industrialist, with six. Ruff, the prime promoter of the club, was the first president; E.A. Meyers, secretary; and W.L. McClintock, treasurer.[64]

The incorporators and Judge Stowe ignored that provision of the Act of April 29, 1874, which provided that the application for a charter had to be recorded in the "office for recording in and for the county where the chief operations are to be carried on." As a result, examination of the proposed club and its plans was removed from the residents of Cambria County and the charter was secured without the knowledge of the Cambria County authorities. This matter, in addition to the Pittsburgh men's efforts to keep the correct name of their organization from receiving public notice, accounts for the wide variety of names used in referring to the club. The Pittsburgh men remained secretive about their project in Cambria County, and by giving false names to their organization in the newspapers, prevented an examination of their plans and concealed the irregularity of their charter.[65]

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64. Charter, South Fork Fishing and Hunting Club of Pittsburgh, November 17, 1879, printed in J.J. McLaurin, The Story of Johnstown (Harrisburg, 1890), pp. 50-52. The full charter may be seen in Appendix L.

65. Shappee, "History of Johnstown," pp. 213-215.

B. RECONSTRUCTION OF THE SOUTH FORK DAM AND WESTERN RESERVOIR (RENAMED LAKE CONEMAUGH): 1880-1881

The South Fork Fishing and Hunting Club of Pittsburgh commenced the reconstruction of the South Fork Dam and Western Reservoir, which it renamed Lake Conemaugh, in the spring of 1880. The first idea that Ruff, who had no experience in waterworks or dam construction, proposed for the rebuilding of the dam was to construct it to a height of about 40 feet and cut the spillway down some twenty feet deeper to handle the overflow. But when he found that this would cost considerably more than repairing the old break of July 1862 and restoring the dam to somewhere near its original height, he chose the latter course. Ruff then employed as foreman and superintendent of the work Edward Pearson of Pittsburgh, an employee in the local freight department of the Pennsylvania Railroad at Pittsburgh and later an employee of Haney & Co., general teamsters for the freight department of the railroad. This was a curious appointment since Pearson had no engineering training and had never been engaged as a contractor on a waterworks or dam construction project.[66]

According to a study by a special committee of the American Society of Civil Engineers in 1889, the work of reconstruction included the removal of the five 24-inch sluice pipes although the masonry on which they were laid and the remains of the culvert were left in place. Other work included the following:

> . . . A sheet piling of plank was put across the lower part of the breach. The original plan of making the

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66. "The South Forks Dam," Engineering News and American Railway Journal, XXI (June 15, 1889), 551-552.

> lower angle of the embankment of stone was adopted, and stone of as large size as could be obtained in the vicinity were dumped into the breach, letting them form natural slopes. This stone embankment was carried up until it reached such a height as to enable a road to be graded down from the crest of the remaining parts of the dam on each side of the breach, so that material could be hauled in carts from the borrow-pits on the hill side. There being no sluices for the discharge of the flow of the stream, the surplus water found its way through the stone embankment, the water in the reservoir rising as the filling on the upper side of the stone embankment proceeded. The washing of the filling through the stone embankment was prevented by covering its face with brush, hay, etc. The material relied on to form the water-tight embankment consisted of clay and shale, which was dumped in on the upper side of the stone embankment, and carried up in layers to the full width of the remaining parts of the original dam. There was no systematic puddling done, but the hauling by teams over the freshly deposited material, which was kept wet by the rising water, made a fairly compact embankment on the upper side of the stone embankment . . . The slopes on both sides of the embankment were covered with a rip-rap.[67]

While the reconstruction work was still in progress, heavy rains damaged the repairs. Daniel J. Morrell, general manager of the Cambria Iron Company in Johnstown, sent John Fulton, a trained geologist and engineer with experience in mining, canal, and railroad works, to visit the site of the dam to report on the quality and management of the repairs. Morrell also had some experience with dam construction, having personally supervised the installation of several small ones put in near Johnstown by the water company.[68]

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67. "Report of the Committee on the Cause of the Failure of the South Fork Dam," 445-446.

68. Storey, History of Cambria County, II, 480-481, III, 14-17.

On November 26, 1880, Fulton reported that he had toured the construction site in company with a delegation from the South Fork Fishing and Hunting Club (which he mistakenly referred to as the Sportsmen's Association of Western Pennsylvania). The men from the club included Colonel Elias J. Unger, C.A. Carpenter, secretary, and N.M. McDowell, a civil engineer from Pittsburgh who had been hired by the club to examine the dam. Fulton's report was as follows:

> This dam is seventy feet high and 884 feet long. It was originally constructed by the State authorities, during the canal epoch, as a reservoir for storing water, for use during the dry season of boating. It is designed to hold a body of water sixty feet deep, covering about six hundred acres of land, and containing at an average depth of thirty feet, nearly six thousand millions of gallons of water.
>
> It was built mainly with rocks and faced with earth on its upper or pool slope, and covered with a riprap of stones. About the middle of the dam a cut stone, arched culvert was constructed, in which a large discharge pipe was placed with connections with a wooden bulkhead. On the north end an ample overfall has been cut through the rock, seventy feet wide, to discharge surplus water during rainy seasons.
>
> After the disuse of this reservoir, the wooden bulkhead was burned down and the dam neglected. The consequence was that the water, under its full pressure, with no repairs to dam, found its way through the masonry of the culvert, and the result was the washing out of a triangular notch of the dam, two hundred feet wide at the top and forty feet deep. The resultant flood past South Fork and down the Conemaugh did some damage, the extent of which I have been unable to learn. The break occurred during a time of low water in the streams, which very greatly modified its action.
>
> During the past season the Sportsmen's Association of Western Pennsylvania, which now owns this property, has put a force at work to repair the breach in the dam, so as to raise the water to its maximum height of sixty feet. The repair force began by placing large rocks in the breach, facing these with hemlock boughs and hay,

and covering the whole with earth and shale. The facing of earth is being made with carts, the material dumped down a slope from the line of the top of the dam, thus gravitating the coarsest materials to the lowest depths-just the opposite of the result demanded in this case.

It did not appear to me that this work was being done in a careful and substantial manner, or with the care demanded in a large structure of this kind.

When this work shall be completed to the full section of the old dam, the entire embankment will contain 262,241 cubic yards, or 316,004 gross tons.

The pressure of water-sixty feet deep-on the slope of this dam is 73,782 gross tons. The weight of the dam, is, therefore, 4 2/10 times that of the pressure of the water against it.

It is evident, therefore, that the water cannot overturn, or slide, the dam, en masse.

There appear to me two serious elements of danger in this dam: first, the want of a discharge pipe to reduce or take the water out of the dam for needed repairs. Second, the unsubstantial method of repair, leaving a large leak, which appears to be cutting the new embankment.

As the water cannot be lowered, the difficulty arises of reaching the source of the present destructive leaks. At present there is forty feet of water in the dam. When the full head of sixty feet is reached, it appears to me to be only a question of time until the former cutting is repeated. Should this break be made during a season of flood, it is evident that considerable damage would ensue along the line of the Conemaugh.

It is impossible to estimate how disastrous this flood would be, as its force would depend on the size of the breach in the dam with proportional rapidity of discharge.

The stability of the dam can only be assured by a thorough overhauling of the present lining on the upper slopes, and the construction of an ample discharge pipe to reduce or remove the water to make necessary repairs.[69]

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69. Letter, John Fulton to Daniel J. Morrell, November 26, 1880, printed in Johnstown Daily Tribune, June 18, 1889. This report was

After Morrell forwarded this report to Ruff, the president of the club responded with a sharp letter on December 2. This rebuttal to Fulton's conclusions read as follows:

> In the first place he was not met by a delegation of the Sportsmen's Association of Western Pennsylvania, nor do they own the property. It is owned by the South Fork Fishing and Hunting Club.
>
> In the second place he is wrong in saying that the dam was originally built mainly of stone; exactly the reverse being true. The face on the lake was not riprapped, but covered with a slope wall.
>
> In the third place the large arched culvert did not contain a single pipe, but three conduits, and, instead of terminating in a wooden bulkhead, were embraced within the base of a wooden tower, which stood out in the lake, standing above the highest water level, to protect rods from ice and drift, connected with valves on the conduits, by which the flow of water was regulated.
>
> He is in error in saying the burning of the wooden bulkhead was the primary cause of the destruction of the dam. Its destruction by fire, while the dam stood, was simply impossible, and it stood many years afterward, and only has been burned a few years. The dam was destroyed by the arch culvert giving way about the center of the embankment. This danger we have avoided by making it solid throughout. He is grossly in error in saying that it resulted in carrying away a notch two hundred feet long and forty feet deep. The fact is that it swept it clear to the bottom, carrying everything before it, slope wall, embankment, and all the arch but a section of about thirty feet long, embraced in the riprap on the lower side. You can have some idea of its extent when I tell you it took over twenty-two thousand yards of material to fill it. We did not put hemlock boughs and hay on the rock. We put them in the notch, but put more than ten thousand yards of material over them, before using the hay, etc.

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confirmed by the findings of A.J. Whitney, a resident engineer of the Pennsylvania Canal Company, and Walter A. Fellows, an engineering assistant to Fulton. Ibid., June 15, 18, and November 9, 1889.

> He objected to our throwing material over the face of our embankment, because the coarser went to the bottom. This is just what we wanted to do, and were putting a riprap of coarse material over our earth face, to protect it from the action of the water direct. We positively deny that there are dangerous leaks in our new work. He makes the amount of water in our lake about 2,000,000 gallons more than it really contains. He says we have ample overfall, also more than four times the weight necessary to resist the pressure it was to sustain. We know we have the first and six times the latter. We consider his conclusions as to our only safe course of no more than his other assertions. I submit herewith the report of our engineer, feeling certain that you and your people are in no danger from our enterprise.[70]

Realizing that he had no legal means of arresting the dam repairs, Morrell suggested in his reply to Ruff on December 22, that the dam should be given a major overhaul and a discharge system should be installed. At the same time, he made it plain that his company considered the current work somewhat shoddy and the situation critical enough to be willing to help foot the bill to set things right. The letter read as follows:

> I note your criticism of Mr. Fulton's former report, and judge that in some of his statements he may have been in error, but think that his conclusions in the main were correct.
>
> We do not wish to put any obstructions in the way of your accomplishing your object in the reconstruction of this dam; but we must protest against the erection of a dam at that place that will be a perpetual menace to the lives and the property of those residing in the upper valley of the Conemaugh, from the insecure construction. In my judgement there should have been provided some means by which the water would be let out of the dam in

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70. Letter, B.F. Ruff to Daniel J. Morrell, December 2, 1880, printed in Johnstown Daily Tribune, June 18, 1889.

> case of trouble, and I think that you will find it necessary to provide an outlet pipe or gate before any engineer would pronounce the job a safe one. If the dam could be securely reconstructed with a safe means of driving off the water in case any weakness manifests itself, I should regard the accomplishment of this work as a very desireable one, and if some arrangement could be made with your Association by which thr store of water in this reservoir could be used in time of great drought in the mountains, this Company would be willing to co-operate with you in the work, and would contribute liberally toward making the dam absolutely safe.[71]

Fulton and Morrell were not the only ones concerned about the quality of the reconstruction work. P.F. Brendlinger, a member of the American Society of Civil Engineers, also visited the dam in 1880 and was dissatisfied with what he observed. He was particularly disturbed by the gap on the center of the dam being filled in simply as an earthen embankment with wagon loads of earth and shale until a level surface was gained. He noted that there was about thirty feet of water in the reservoir and that clear water was spouting out of a number of leaks near the stone culvert, several of which were as large as a man's arm. Later, he reported that:

> there was a large breach in the middle which was being filled by dumping in hard shale blasted from a cut in the side hill in the same way as a railway embankment is made; the dam was faced with loose stone. He had not thought the method of repairing a good one, and had talked to Mr. Pearson...but the latter had stated that the work was good enough. . . . The people at Johnstown

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71. Letter, Daniel J. Morrell to B.F. Ruff, December 22, 1880, printed in Johnstown Daily Tribune, June 18, 1889. Morrell evidently felt that it would be good to have an inside view of operations at the dam and thus he became a member of the club. McCullough, The Johnstown Flood, p. 75, and Johnstown Daily Tribune, June 20, 1889.

and in the valley were indignant at the rebuilding of the dam. There were considerable leaks at the base. . . .[72]

Despite the apparent refusal of the South Fork Fishing and Hunting Club to consider the merits of Fulton's allegations, some efforts were taken to strengthen the dam when the reconstruction work resumed in the spring of 1881.[73] As preparations were getting underway to complete the reconstruction work that year a flood in February caused a small break in the dam. McDowell, who had accompanied Fulton and the club delegation during the inspection of the dam the previous year, was invited to the site to recommend means to stem the leaks in the dam that Fulton had reported as well as the new break. Since he was unable to determine the cause of the leaks, he suggested:

> that they get hay, manure and some brush with leaves on it and cover the slope as much as they could, on the place where they thought the leak might be, then dump clay on top of that, and that work closed the leak entirely.[74]

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72. "Society Proceedings: American Society of Civil Engineers," Engineering News and American Railway Journal, XXI (June 8, 1889), 533. Also see, "The Johnstown Disaster and the Cambria Iron Company," The Engineering and Mining Journal, XLVII (June 8, 1889), 520-522, and New York Times, June 8, 1889.

73. Letter, John Fulton to Editor, Johnstown Tribune, June 15, 1889, printed in Johnstown Daily Tribune, June 18, 1889.

74. "The South Fork Dam," Proceedings of Engineer's Society of Western Pennsylvania, Pittsburg, Pa., V (June 18, 1889), 96. According to J.B. Montgomery, a noted railroad engineer who also inspected the dam about this time, the use of straw and hay was frequently used in the construction of dams to plug numerous leaks. He also observed that the dam was safe provided that no water would run over it.

Accordingly, unpuddled earth was quickly dumped into the break and two loads of hay were thrown in to prevent further leaking.[75] About this time the Johnstown Daily Tribune reported that:

> There is a great deal of apprehension manifested by some of our citizens in relation to the stability of the old Portage Reservoir . . . and fears are entertained that the pressure of water against the dam may cause it to give away, precipatating an inundation which would prove disastrous to property, and probably to life.

However, the newspaper sought to reassure its readers that:

> after the water would distribute itself over the intervening ten miles it would have to course over before it would reach us [Johnstown] . . . there is not much probability its power would be very great here.
>
> The distance around the body of water is about seven miles, the basin being three miles long by, in the widest part, nearly one mile, and as the Association purposes making a drive all the way round, building cottages, hotel, etc., and running a railroad to South Fork, the prospects of it being one of the finest summer resorts in the State are very good.[76]

The reconstruction work on the dam was completed in 1881 by day work. The total cost of the work amounted to some $17,000.[77]

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75. Johnstown Daily Tribune, July 2, 1889, and unidentified newspaper clipping, MG 8, Item 793, Scrapbook, Johnstown Flood, 1889.

76. Ibid., February 11, 1881.

77. "The South Forks Dam," Engineering News and American Railway Journal, 552, and McCullough, The Johnstown Flood, p. 56.

As part of the reconstruction operations, the center portion of the dam was lowered some two feet, thereby creating a convenient roadway over the dam on which two carriages could pass each other comfortably since the lowering increased the top width of the crest by at least ten feet. The lowering of the crest resulted in reducing the maximum flow capacity of the spillway from ten feet to seven to eight feet before water would begin to flow over the top of the dam and down its outer face. Photographs reveal that a telegraph line was carried across the crest of the dam, supported by simple unadorned log poles.

The flow capacity of the spillway was reduced further by a timber roadway bridge (123 feet, 4 inches in length) built over it about 100 feet below the mouth of the waste. The bridge (a drawing of which may be seen on the following page) was supported by seven bents braced with cross supports and spaced 15 1/2 feet apart. Twenty-inch high heavy fish screen grids were placed between the bridge supports on the floor of the spillway to prevent the loss of stocked fish. Above the screens at the water's edge were elevated screens to prevent the fish from leaping on to the bridge or wall. Projecting out into the lake in front of the mouth of the spillway was a log boom, consisting of floating logs hooked together in a V-shape and fastened to the end timbers of the bridge, to keep brush and debris from piling against the screens.[78]

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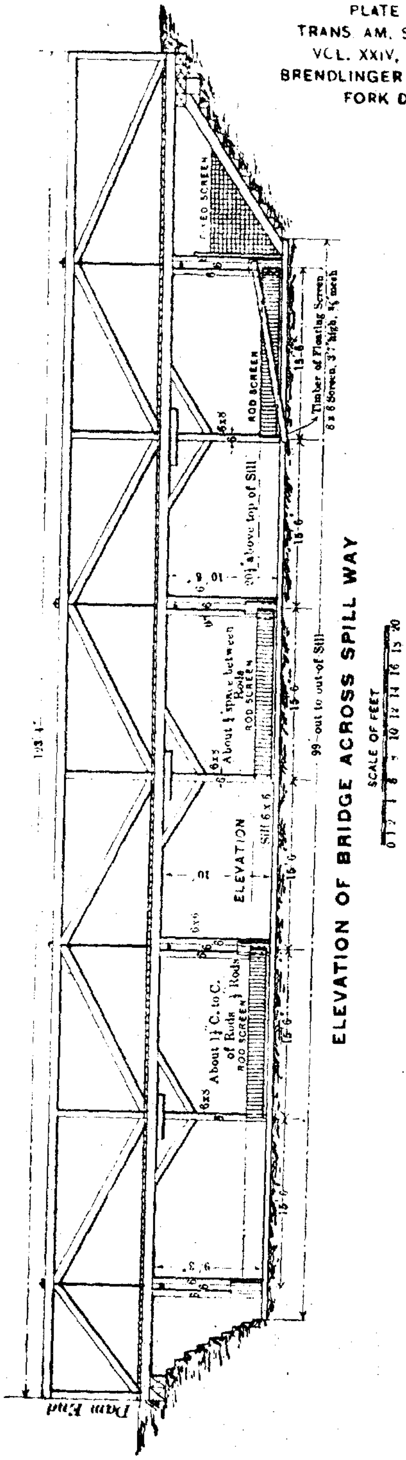
78. Alfred R. Pagan, "The Johnstown Flood Revisited," Civil Engineering, XLIV (August, 1974), 61-62; Nathan D. Shappee, "The Johnstown Flood and Pittsburgh's Relief, 1889," The Western Pennsylvania Historical Magazine, XXIII (June, 1940), 83; Shappee, "History of Johnstown," pp. 215-216; Johnstown Daily Tribune, November 7, 1889; "The South Fork Dam," Proceedings of the Engineer's Society of Western Pennsylvania, 99; and "Pennsylvania Railroad Photographs of Johnstown Flood - 1889," volume in Pennsylvania Room, Cambria County Library, Johnstown. According to McCullough, The Johnstown

PLATE LIII.
TRANS. AM. SOC. C. E.
VOL. XXIV, No. 477.
BRENDLINGER ON SOUTH
FORK DAM.



ELEVATION OF BRIDGE ACROSS SPILL WAY

C. THE OPERATION OF THE SOUTH FORK DAM AND LAKE CONEMAUGH BY THE SOUTH FORK FISHING AND HUNTING CLUB: 1881-1889

While the reconstruction work on the dam and reservoir was being completed in 1881, the South Fork Fishing and Hunting Club commenced plans to operate its new resort, which in many ways was designed to rival the nearby resort of the Pennsylvania Railroad at Cresson. In March it was reported that the club had

> in process of construction a miniature steamboat, which will shortly be launched on their reservoir near South Fork, and which is designed with a view of taking out small pleasure parties on the surface of the large inland lake formed by the rebuilding of the old reservoir dam. During the spring and summer a hotel building will be erected for the accommodation of the stockholders who purchased the property, as well as invited guests, and it is anticipated that fishing will prove one of the pleasureable sports in that body of water the coming season, as it has been well stocked from time to time with bass, etc. . . .[79]

Flood, pp. 40-41, a newly-constructed road which extended some two miles from the Pennsylvania Railroad station at South Fork reached the base of the spillway. From there it crossed a wooden bridge and climbed to the top of the dam, just to the right of the spillway. There the road divided, with the left-hand fork crossing the timber trestle roadway bridge over the spillway and the right-hand fork crossing directly over the dam and following the lake shore about a mile to the main club grounds.

79. Johnstown Daily Tribune, March 22, 1881. The South Fork Fishing and Hunting Club maintained strict secrecy of its plans, operations, and facilities. Most of the known details about the resort at Lake Conemaugh come from scattered newspaper accounts which often provide contradicting or confusing bits of information. Efforts by the author of this report to locate manuscript collections relative to the club were unsuccessful. The National Union Catalog - Manuscript Collections makes no reference to any papers of the club. Discussions with archivists at the University of Pittsburgh, the Carnegie Library of Pittsburgh, the Historical

On March 19, 1881, the club received approval from the Court of Common Pleas of Allegheny County to amend its charter to increase its membership by the issue of 100 additional shares of common stock, thus enabling it to finance the improvements at the resort. The amended charter also permitted the club to increase its membership in the future by the issue of additional shares of stock, not to exceed 400 shares valued at $100 per share.[80]

Only two days before the charter amendment was approved, the club made the first of what would become eight separate land purchases over the next seven years. The land purchases were designed to obtain near-total privacy for the club, provide space for a club house and cottages, and in some cases, acquire portions of land that had been covered by the lake when the dam had been rebuilt. The parcels obtained between March 1881 and January 1887 amounted to about 70 acres at a cost of nearly $2,100.[81]

The club, which by June 1881 had brought the level of the lake up to an average depth of 65 feet, enhanced the fishing prospects of its resort by transporting 1,000 black bass from Lake Erie at a cost of $750. The club chartered a palace railroad car

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Society of Western Pennsylvania, and the Johnstown Flood Museum resulted in the conclusion that no such collection of papers exist. If such a collection did exist at one point, it is likely that it may have been destroyed after the flood of May 31, 1889.

80. Allegheny County Charter Book 6, p. 452, printed excerpts in Johnstown Flood (1889), Collections of Miscellaneous Materials Relating to the Flood, 1 vol., Historical Society of Western Pennsylvania.

81. A list of the land transactions may be seen in Appendix M, and a list of the tax assessments levied against the club may be seen in Appendix N.

containing iron tanks which were attached to oxygen supply air pumps.[82]

Heavy rains and local stream flooding in early June 1881 caused "a great deal of uneasiness" among Johnstown residents. They "were in mortal dread for fear the old Reservoir near South Fork might break, and inundate that entire section below Market Street." Rumors circulated that the dam was breaking on the morning of June 10 and thus the Cambria Iron Company sent two of its engineers, Tatnall and Fellows, to inspect the dam. They reported that the water in the lake was two feet from the top of the dam and the "waste weir on the east side of the embankment" was "carrying off the surplus water as rapidly as it comes down." They observed that the "weir is some sixty feet wide, and the depth of water passing through it is about eight feet." There was "no leakage in the dam" and "the probability" was "that it will be able to stand the pressure." The same newspaper article reported that

> Several of our citizens who have recently examined the dam state it as their opinion that the embankment is perfectly safe to stand all the pressure that can be brought to bear upon it, while others are a little dubious in the matter. We do not consider there is much cause for alarm, as even in the event of the dyke breaking there is plenty of room for the water to spread out before reaching here, and no damage of moment would result.[83]

Robert Pitcairn, the division head of the Pennsylvania Railroad between Altoona and Pittsburgh and a member of the South Fork Fishing and Hunting Club, took several of his engineers to inspect the dam at this time. His primary concern was that the leaks in

82. Johnstown Daily Tribune, June 4, 1881.

83. Ibid., June 10, 11, 1881.

the bottom of the dam would increase. Ruff accompanied the men and claimed that the rumored leaks were actually springs that came from near the ends of the dam. When Ruff promised to take remedial action, Pitcairn was satisfied although he asked his men to keep a periodic eye on the dam.[84]

Heavy rains and high water at the South Fork Dam in February 1883 again led to fears of its breaking. Residents in the vicinity reported that the dam "sustained the immense pressure to which it was subjected without receiving the slightest damage." The Johnstown Daily Tribune reported that men who resided near the dam and "whose judgement is generally sound" observed "that the front of the dam is equal in strength to any amount of water the river will contain and that no fears should at any time be entertained of its breaking."[85]

The Pittsburgh Commercial Gazette carried an article on July 4, 1883, describing the membership, facilities, and regulations of the South Fork Fishing and Hunting Club. It was characterized as the "most ambitious and wealthiest" of the clubs in Pittsburgh. The article went on to relate

> The officers are: President, B. F. Ruff; Vice President, W. A. McIntosh; Secretary, J. B. White; Treasurer, John D. Hunt; Directors, Howard Hartley, C. C. Hussey, E. J. Unger, M. B. Snydam, and Holdship. Among the members are Andrew Carnegie, John W. Chalfant, Charles J. Clarke, Dr. W. F. Fundenberg, John A. Harper, John B. Jackson, Frank B. Laughlin, W. I. McClintock, J. E. Schwartz, Calvin Wells, and Joseph R. Woodwell. This club is the only organization in the city that owns its camping grounds. . . .

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84. McCullough, The Johnstown Flood, p. 175.

85. Johnstown Daily Tribune, February 23, 1883.

The article indicated that the reconstructed dam created

> a lake two and one half miles in length and one mile in width, with a water surface of five hundred acres. Running down to this body of water is a tract of three hundred acres of land. A club house and seven cottages were erected, and here the members pass the heated term. Under the rules a member is entitled to accommodations for two weeks with the privilege of a long stay, if no other member asks for the rooms. Cottages can be built by the members and occupied permanently if they wish. The rules are very stringent. Fishing, shooting, and playing of any games are prohibited on Sunday, the game laws of the state are enforced, and beside this fur, fin, and feather are safe until the Board of Directors authorize the sportsmen to open the season. Members can entertain their families and friends after notification has been given the Secretary, but no person not a member can be given the privileges of the grounds for more than ten days in any one year. The initiation fee is $800, the membership is limited to sixty persons, and the rolls are full.[86]

Trouble erupted between the club and the surrounding property owners in May 1884. The club erected screens or dams at the mouths of four tributary streams that drained into Lake Conemaugh - Rorabaugh's Creek, Muddy Run, South Fork, and Topper's Run - to keep their fish from going up the creeks and thereby getting beyond their control. The surrounding farmers began to tear the obstructions out at night and covertly fish at the mouths of the creeks, thus leading to the club members' announced intention "to shoot the first man caught trespassing on their premises after nightfall." It was reported that the fish in the lake were not "particularly desireable, but many of them are large, and these are very tempting to outsiders."[87]

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86. Pittsburgh Commercial Gazette, July 4, 1883, printed in Johnstown Daily Tribune, July 6, 1883.

87. Johnstown Daily Tribune, May 9, 1884.

From time to time special sporting events were held at Lake Conemaugh. In June 1885 the club hosted the Sportmen's Association of Pittsburgh for a two-day gala with 70 persons in attendance. A shooting match was held with a silver cup as the prize and 240 of the 350 birds that had been provided were killed. A handicap match in which clay pigeons were used and a glass ball contest for a silver medal were also held.[88]

In the summer of 1885 there were rumors that the South Fork Fishing and Hunting Club resort might be opened to the public. On August 10, 1885, the Johnstown Daily Tribune reported this rumor and also described the layout of the existing facilities at Lake Conemaugh:

> The fine body of water and the romantic surroundings of the place, it is thought, would make the resort the most popular on the mountain. The opening of the place would contemplate the erection of a large hotel, and it is said that an architect has already received orders to prepare plans of such a building, and it is probable work will be commenced in the fall.
>
> At present the public is rigidly excluded from the grounds, and the privileged guests, from one hundred to one hundred and fifty in number, seem to be extremely happy in their semi-isolation. But the luxury is an expensive one, the club probably sees a great "spec" in publicity, and it may be that in the near future the beautiful lake will be surrounded by cottages and provided with hotel accommodations sufficient for a thousand persons. There are now about a dozen very tasty cottages and a Club House, which provides meals for all the guests. The seating capacity of the dining room is only ninety, however, so that the guests are greatly inconvenienced and the Club House people nearly driven crazy at each recurring meal time. Then, too, more of the members and their relatives and friends wish to spend the heated term at the lake, and the pressure grows yearly. Under all these circumstances, it does not

88. Ibid., June 20, 1884.

appear improbable that additional accommodations will be provided and that the public will be permitted to bear a portion of the general expense.

The cottages and Club House are on the right hand side of the lake as you enter the grounds from the old Frankstown road and about a mile distant from the breast of the dam or lake. Directly opposite the Club House is the beautiful Rorabaugh farm, sloping gently to the water's edge. The cottages are built in a damp, bad smelling woods. The Rorabaugh farm lies open to the sun and the breeze, and is susceptile of any degree of artificial beautifying. Here would be the place for the great hotel. Col. Ruff, of Pittsburgh, who is a member of the association, also owns individually a fine stretch of dry woodland facing the lake.

But the innovation talked of will not be made for several years, we think. Some members of the club would certainly kick against it to the last. They have been at great expense in the purchase and fitting up of the grounds and are just beginning to reap the benefits.

The lake is stocked with the finest of game fish, now grown almost to full size, and in the season wild ducks and wild geese by the thousand alight upon the water and fall a ready prey to the hunter's fowling piece. The sports of fishing and hunting they would therefore not like to make public, even for a consideration.

Col. Tice, an experienced caterer, is at present in charge of the Club House, and is ably assisted by Clark Higgins. But the house isn't big enough for them to bounce around in to the extent of their ability. They need more room, which the Hotel de Castle in the Air will give them when it materializes.[89]

During the winter of 1886 stories started circulating of a rift between the club members over the real estate transaction of one of its members. The Johnstown Daily Tribune reported on December 33 that the trouble

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89. Ibid., August 10, 1885.

"was caused by the purchase of a large farm, which was bought by a man by instructions of our members, but the land enhanced in value so much that the purchaser now refuses to turn the property over to us, unless he is paid a good fat bonus, and it is very possible that a law suit will be begun and the matter settled by the courts."

The "large farm" referred to by the member of the club quoted above was the Joseph Leahey farm, and the gentleman who bought it, ostensibly for the club but to reality, it appears, for himself, was Colonel Unger, of the Seventh Avenue Hotel, Pittsburgh . . .

Leahey owned a farm of one hundred and three acres skirting Conemaugh Lake on the north. He always claimed that eight acres of his possessions were in the lake, and he used to permit parties to fish in his part in consideration of a small stipend. The members of the fishing club were greatly annoyed in this manner. They denied Leahey's ownership of any portion of the lake and endeavored to keep people from fishing in it.

The club had paid $I,600 to stock the water with fish, and it was somewhat annoying to have outsiders angling them without permission. At first the members of the club tried to bulldoze old Mr. Leahey, but they found that would not work, he only becoming angry and more determined. Then they made inquiry concerning Mr. Leahey's title to the eight acres, and they found that there was a strong probability of his claim being a just one. At all events, it was concluded that it would be cheaper in the long run to buy the eight acres or the entire farm then to go to law about the matter, for old Mr. Leahey had lived there fifty odd years, and if the club began suit for the disputed property twelve men could not be found in Cambria County who would look favorably on the "attempt of the rich Pittsburghers to rob him of a portion of his farm."

It was finally, therefore, decided to purchase the entire farm, if possible, but the negotiations must be conducted in a most delicate manner. Mr. Leahey had become so much incensed at the conduct of members of the club that he declared he would not sell it to the organization for $50,000. An intermediary, therefore, had to be employed, and Judge Thomas, now of the Hotel Brunswick, this city, was chosen. He bought the farm for $4,000 cash, Colonel Unger furnishing the money.

> The Judge and the Colonel went to Ebensburg and had the deed for the farm made in the Colonel's name, and the Colonel has found it convenient to retain the instrument unaltered. The farm has enhanced three-fold in value, and the Colonel, recognizing a good thing when he sees it, clings to it with quite as much tenacity as did old Mr. Leahey.[90]

In June 1887 there was some debate in the Johnstown Daily Tribune over the stability of the South Fork Dam after a flood hit the Stonycreek Valley. Ex-Director of the Poor John Rorabaugh, who lived near the reservoir, stated that the dam was "in an unsafe condition." The foundation of the dam was reported to be shaky and fresh leaks had appeared recently. The newspaper admitted that "should that immense body of water cut loose and sweep down the hillside it would cause considerable damage."[91] On the other hand George Grambling, another local resident, observed that "the dam is an unusually good one" and he considered "it perfectly safe." He agreed with Rorabaugh's assessment that trouble would occur if "a flood should happen there like that in the Stonycreek Valley, as the waste weir" was "not large enough to carry off very much extra water." However, he felt that the dam "would go to pieces very slowly" if it broke and he was convinced that a break would not affect Johnstown "unless it should occur in conjunction with a great flood in the Conemaugh Valley, which is one of the possibilities not worth worrying about." Apprehensions about the dam soon subsided, and nothing was done to strengthen the structure, as some citizens remarked that the rumors were merely a result of the annual freshets.[92]

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90. Ibid., December 23, 1885.

91. Ibid., June 17, 1887.

92. Ibid., June 30, 1887, and McLaurin, The Story of Johnstown, p. 53.

On February 18, 1888, the last known measurement of Lake Conemaugh was made. The length of the lake

> measured down the middle, was 10,188 feet, 1.93 miles. The line was kept out about the middle all the way down. The breadth opposite the lower end of the boat-house was 1734 feet, .32 of a mile.[93]

Later in the spring a freshet appears to have caused minimal damage to the dam. Although the precise location of the damage cannot be determined, it is significant that Herbert Webber, an employee of the club at the lake, later reported that had $5,000 of repairs been applied to the dam after the heavy spring rains in 1887 and 1888, the dam would have been better able to withstand the unprecedented flood in May 1889.[94]

The South Fork Fishing and Hunting Club began its last full summer season in 1888 on an optimistic note. The membership, which now reportedly numbered 68, had decided to establish a "French-style" drainage system for the grounds.[95] The sewer,

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93. "The South Fork Dam," Proceedings of Engineer's Society of Western Pennsylvania, 92.

94. Johnson, History of the Johnstown Flood, p. 47, and Herman Dieck, The Johnstown Flood (Philadelphia, 1889), p. 38.

95. The most complete list of the club's membership was printed in the Johnstown Daily Tribune on June 20, 1889, and contained 61 names. The list was as follows:

F. J. Allen,	A.M. Harnes,	William Mullens,
Dr. W.C. Bidwell,	Durbin Horne,	F.A. Meyers,
James W. Brown,	George F. Huff,	Frank T. McClintock,
Hilary J. Brunot,	Dr. D.W. Rankin,	Oliver McClintock,
John Caldwell, Jr.,	Samuel Rea,	W.L. McClintock,
Andrew Carnegie,	James H. Reed,	James McGregor,
John W. Chalfant,	Marvin F. Scalfe,	W.A. McIntosh,
James A. Chambers,	Jas. M. Schoonmator	H. Sellers McKee,
Charles J. Clarke,	J.E. Schwartz,	H.P. Patton,

which would cost $5,000, would service the club house and cottages and drain over the dam. Three new cottages were to be built that summer at a cost of $5,000 each by Dr. D. W. Rankin, D. W. C. Bidwell, and James W. Brown. The club already had fifteen to twenty cottages built on the grounds, which included between 400 and 500 acres of water and 70 acres of ground. Several of the members owned farms adjoining the club property.[96]

The club opened its summer season on June 27 with 30 members present. The three new cottages were completed, "all the old cottages" had been improved, and the club house had "been entirely refitted." Some 200 ladies and gentlemen were expected for the season which would be highlighted by the annual regatta in which both sexes would participate. Later that summer a scarlet-fever scare ended the vacation season early as everyone left for Pittsburgh.[97]

After postponing the construction of the sewer line the club's directors finally decided in October 1888 to install the water works the following year. The main sewer line, nearly a mile long, was to

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Louise S. Clarke,
A.C. Crawford,
George H Christy,
W.T. Dun,
Cyrus Elder,
J.K. Ewing,
C.B. Shea,
J.S. McCord,
A. French,
H.C. Frick,
John A. Harper,
Henry Holdship,
Frank Semple,
M.H. Suydam,
Lewis Irwin,
P.C. Knox,
Frank B. Laughlin,
J.J. Lawrence,
John G.A. Leishman,
J.H. Lippincott,
S.S. Marvin,
A.W. Mellon,
Rueben Miller,
Max K. Moorhead,
D.C. Phillips,
Henry Phipps, Jr.,
Robert Piteatril,
Benjamin Thaw,
F. J. Unger,
Calvin Wells,
John F. Wilcox,
Joseph R. Woodwell,
William K. Woodwell,
James H. Whitlock.

96. Ibid., March 22, 1888.

97. Ibid., June 27, 1888, and McCullough, The Johnstown Flood, p. 44.

be built from the club house to the dam, running along the shore of the lake. It was to be connected with all the cottages on the grounds by branch lines. The wrought iron sewer system was under construction by April 1889 under the supervision of John Grubb Parke, Jr., a recent engineering graduate of the University of Pennsylvania and a nephew of the superintendent of West Point. The revised cost of the sewer was estimated to be $12,000.[98]

The facilities and accommodations of the Lake Conemaugh resort in May 1889 reveal the exclusive nature of the club. The "commodious" club house had 47 "well furnished" bedrooms, a "nicely furnished office, a pool room, a parlor forty feet square, a dining room 40 x 60 feet, a well-furnished kitchen, bakery, cooling-rooms, milk room, vegetable room, and everything to be found in a well-furnished hotel." It had huge brick fireplaces, billiard tables, and heavy furniture, and a long front porch.

In addition to boathouses and stables, there were at least sixteen cottages (some sources say as many as 23), in one of which lived four families and in another two. The quaint cottages, which were set out in an orderly line among the trees and only a short distance from the water, were substantial residences with up to 17 rooms. Most of them were constructed in the Queen Anne style of architecture characteristic of the 1880's and nearly every one of them was three stories tall, with high ceilings, long windows, a deep porch downstairs, and often a little porch or two upstairs tucked under the sharp-peaked roofs.

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98. Ibid., May 4, June 27, October 19, 1888, and April 9, 1889. A bright student of science and engineering, Parke later became chief engineer of the Pittsburgh Steel Company and an author of several articles in engineering journals. W. J. Maxwell, comp., General Alumni Catalogue of the University of Pennsylvania (Philadelphia, 1917), excerpted in Johnstown flood (1889), Collection of Miscellaneous Materials Relating to the Flood, Historical Society of Western Pennsylvania.

Altogether there were two large steam yachts, four sailing boats, and about fifty canoes and rowboats at the lake. The most unusual craft was an electric catamaran, with a searchlight mounted up front, which had been built by Louis Clarke, a young member of the club.[99]

Despite the accommodations and surroundings at Lake Conemaugh, the "summering" that occurred there was generally less pretentious than the opulence at such wealthy resorts as Newport, Tuxedo Park, Saratoga, and Long Branch. One local historian has written:

> There was no display at South Fork. The young men wore flannel shirts and crush hats, and the girls plain costumes that would not be injured in scrambling over rugged rocks or fishing in turbulent streams. There were a few modest cottages along the borders of the lake and a clubhouse. It was a comfortable home-like place and was as different from the ordinary fashionable summer resort as could well be conceived. The beautiful sheet of water bore upon its bosom in the soft evenings gay parties of young folks, some of whom would strum the mandolin or guitar . . . The club was a happy family party, and nothing more. There was an atmosphere of repose over South Fork Lake that it seemed nothing could disturb . . .[100]

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99. Johnstown Daily Tribune, June 25, 1889; McCullough, The Johnstown Flood, pp. 42-43; Caldwell, Illustrated Historical Combination Atlas, p. 24; and Storey, History of Cambria County, I, 457.

100. Quoted in O'Connor, Johnstown The Day the Dam Broke, p. 34.

CHAPTER FIVE

THE FAILURE OF THE SOUTH FORK DAM ON MAY 31, 1889, AND THE RESULTANT JOHNSTOWN FLOOD

A. THE UNPRECEDENTED RAINSTORM OF MAY 30-JUNE 1, 1889

Beginning on May 30 and continuing through to June 1, 1889, rain fell on the entire Commonwealth of Pennsylvania and extended into Maryland, Virginia, West Virginia, New York, and as far west as Cleveland, Ohio. In its wake a trail of flood and ruin gave mute testimony to the violence of this phenomenal storm. Over an area in Pennsylvania, variously estimated at between 12,000 and 20,000 square miles, an unprecedented eight-inch rain fell.[101]

On May 30 the government forecasters sent warnings of severe storms for the Middle and South Atlantic states. The storm, which had begun in eastern Kansas and Nebraska on May 28 had split into two parts as it entered the Mississippi Valley. One part turned north to pass over the Great Lakes and crossed to New England, while the other part drifted across Kentucky and Tennessee, where, aided by a southeast wind, the rain moved northward to encompass much of the aforementioned six-state area. Winds from the Atlantic and wind from the south forced the storm into a small mountainous area of Pennsylvania where the Allegheny Mountain prevented it from going toward Pittsburgh. So dense was the saturation in this area that rain fell for a period of 32 to 36 hours. The Grampian hills in Clearfield County some 60 miles northeast of Johnstown received six inches of rain in seven hours and 8.37 in 24 hours. Emporium, some 40 miles northeast of the Grampian hills, had 2.5 inches in two hours and 5.85 in 26 hours, and Wellsboro, some 50 miles northeast of Emporium had 9.8 inches in 31 hours. Harrisburg, some 100 miles east of Johnstown, had 6.57 inches in 31 hours, and Blue Knob, some ten miles southeast of the South Fork Dam, had 10.52 inches during the same period. Altoona, some 20

101. Shappee, "The Johnstown Flood and Pittsburgh's Relief," 79.

miles northeast of the dam, had 5 1/4 inches in 10 hours, Huntingdon, some 40 miles northeast of the dam had 7.18 inches in twelve hours, and Somerset, some 30 miles southwest of the dam, had 4.43 inches in twelve hours. Pittsburgh, protected by the mountains of Cambria, Indiana, and Westmoreland Counties, had only 2.3 inches.[102]

The greatest amount of rain appears to have fallen near the summit and just east of the Allegheny Mountains, where the rainfall was reported to have been 8 to 10 inches in 18 to 36 hours. Since there were no official weather stations in the nearly 50-square mile watershed of the South Fork Dam, the amount of rain that fell on that area can only be estimated from the observations reported from other watersheds in the vicinity. To form such an approximate estimate, the American Society of Civil Engineers in 1890 gathered the observations reported from stations within a 50-mile radius of the center of the South Fork watershed for the period of May 30 to June 1. The stations in the northwest quarter of the circle reported an average rainfall of 2.47 inches; those in the southwest quarter, 3.06 inches; those in the southeast quarter, 7.81 inches; and those in the northeast quarter, 5.47 inches. The northeast and southeast quarters included portions of the Allegheny summits and their eastern slopes. The eastern boundary of the South Fork watershed was this summit, which implied that the average rainfall on the watershed was 6 to 8 inches, a fact confirmed by a report that a pail left out during the night of May 30 at the dam contained eight inches of rain water. It was also reported that the heaviest part of the storm was during the night of May 30 when the rain fell at an estimated 2/3 of an inch per

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102. McMaster, "The Johnstown Flood, I," 211; Shappee, "The Johnstown Flood and Pittsburgh's Relief," 79-80; and "The South Fork Dam," Proceedings of the Engineer's Society of Western Pennsylvania," 92-93.

hour on the South Fork watershed. Some mathematicians of the time computed that the average 6-inch rainfall put 4 1/3 billion tons of water on an area of 1,200 square miles in the mountains.[103]

Such a vast volume of water could not be absorbed in such a short period of time, particularly since the ground was saturated from the previous heavy rainfall. The overall rainfall for the month of May in the area between Harrisburg and McConnellsburg ranged from 9 1/2 to 12 1/2 inches. Long before the downpour had ended, the streams were running bank full. Three inches of rain in the mountain area ordinarily produced a flood, and thus many towns such as Johnstown, which was located at the confluence of the Little Conemaugh and Stonycreek, prepared for flooding.[104]

B. THE FAILURE OF THE SOUTH FORK DAM

While Johnstown prepared for another flood on May 31, a small group of men stood at the South Fork Dam and speculated on the effects of the storm upon the dam. Among the group was Colonel Elias J. Unger, who had retired as proprietor of the Seventh Avenue Hotel in Pittsburgh and bought land at Lake Conemaugh the year before and had recently been named president and general manager of the South Fork Fishing and Hunting Club, W. Y. Boyer, Unger's caretaker at the club grounds, and John G. Parke, Jr., the resident engineer who had been hired several months before to install the sewer system from the club house to the

103. Shappee, "The Johnstown Flood and Pittsburgh's Relief," 80, and "Report of the Committee on the Cause of the Failure of the South Fork Dam," 447.

104. Shappee, "The Johnstown Flood and Pittsburgh's Relief," 80-82, and Caldwell, Illustrated Historical Combination Atlas, p. 45.

dam.[105] Unger, who had worked himself up from brakeman to conductor to superintendent of the Pennsylvania Railroad's hotels from Pittsburgh to Jersey City before retiring to live year-round on a 250-acre farm just above the spillway, was in charge of the efforts to protect the dam.

Parke and Unger had been up since 6:30 a.m. and had remained out in the heavy rain to observe the level of the lake which had risen some two feet overnight. After breakfast Parke rode to the head of the lake to see how much water was coming into the lake from the tributary streams. He found the upper quarter of the lake to be covered by debris. At the head of the lake he observed the Muddy Run pouring a large volume of water into the lake and rowed over a four-strand barbed-wire fence and a 300-foot-wide submerged meadow on his way to examine South Fork Creek. This stream, ordinarily 75 feet wide and two feet deep, had overflowed its banks and was stripping branches from trees on its bank at a height of up to six feet from the ground.

Returning to the club house, Parke learned that the level of the lake had nearly reached the crest of the dam. Unger already had a force of some Italian laborers, who had been hired to install the sewer line, and local farmers cutting a ditch through the shale about 25 feet from the western end of the breast of the dam. This work was an effort to excavate a trough that would act as a second spillway and thus relieve the burden of water flowing over the

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105. The events at the dam on May 31 are described in detail in numerous works. Among the best sources are the following: McCullough, The Johnstown Flood, pp. 89-100; O'Connor, Johnstown the Day the Dam Broke, pp. 73-95; McLaurin, The Story of Johnstown, pp. 53-56; David G. McCullough, "Run for Your Lives!," American Heritage, XVII (June, 1966), II, 66-67; David J. Beale, Through the Johnstown Flood by a Survivor (Philadephia, 1890), pp. 88-89; McMaster, "The Johnstown Flood, I," 231-233; and Shappee, "The Johnstown Flood and Pittsburgh's Relief," 82-87.

waste weir at the eastern end. However, the workmen had little success in digging into the tough shale and were able only to excavate a ditch two feet wide and fourteen inches deep. When the impounded water rushed into the ditch, it was soon scooped out to a trough 25 feet wide and twenty inches deep.

While the ditch was being dug, the lake was rising at a rate of nearly one foot per hour. Accordingly, some laborers were plowing furrows along the crest of the dam, thus raising a temporary barrier to prevent the rising water from flowing over the outer face of the dam.

About the same time Parke observed that the waste weir at the eastern end of the dam was carrying its full capacity of seven feet. The spillway was unclogged, and even the timber trestle bridge was offering little resistance to the flow of the water.

By 11:30 a.m. the water began washing over the crest of the dam, first in the center of the breast which was slightly lower than the rest of the dam and soon in many places over a 300-foot distance around the center (i.e., the reconstructed portion in 1880-81) where it had washed away the recently-plowed furrow. After riding to South Fork to give the people warning and to have word telegraphed to Johnstown, Parke returned about noon to the dam and found that Unger had finally ordered the laborers to tear up a portion of the spillway bridge flooring in an attempt to remove the fish screens which were now clogged with debris. They also attempted to remove the V-shaped floating drift guard that projected into the lake. As he crossed the breast of the dam, Parke

> found the water was cutting the outer face of the dam . . . its greatest effect was on some portions of the roadway . . . where the roadway had been widened on

> the lower side by the addition of a shale earth or disintegrated shale, upon which the action of the water was instantaneous, but the heavy rip-rapping on the outer face of the dam protected this wash and the water cut little gullies between each of the large stones for rip-rap. I . . . found that over its entire top it was serried by little streams where the water had broken through our little embankment and was running over the dam.

Parke was convinced that little else could be done to save the dam unless a wasteway was cut "through the dam proper at one end and allowed to cut away . . . towards the center of the dam." As this course of action would mean "the positive destruction of the dam" he refused to consider such action, despite his measurements which indicated that the level of the lake was 7.4 feet above normal and rising.

After lunch he returned to the dam and found a disturbing development. The water on the breast

> had washed away several large stones on the outer face, and had cut a hole about ten feet wide on the outer face and about 4 feet deep, the water running into this hole cut away the breast in the form of a step both horizontally and vertically, and this action went on widening and deepening this hole until it was so near to the body of the water in the lake that the pressure of the water broke through, and then the water rushed through this trough, and cut its way rapidly into the dam at each side and the bottom. . . .[106]

At the time that the dam was giving way, which was about 3:15 p.m., the editor of the Johnstown Daily Tribune, marooned in his

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106. Letter, John G. Parke, Jr., to M.J. Becker, August 22, 1889, printed in "Report of the Committee on the Cause of the Failure of

office by the already serious flooding in the town, wrote a prophetic speculation. It read:

> At 3:15 the Central Telephone Office called the Tribune up to say it had been informed by Agent Decker, of the Pennsylvania Railroad freight station, that the South Fork Reservoir was getting worse all the time, and that the danger of its breaking was increasing momentarily. It is idle to speculate what would be the result if this tremendous body of water-three miles long, a mile wide in places, and sixty feet deep at the breast at its normal stage-should be thrown into the already submerged Valley of the Conemaugh.[107]

The giving way of the South Fork Dam was avidly described by Parke in his aforementioned eyewitness account of the tragedy. He noted that:

> I do not know the actual time it consumed in passing through the breach, but it was fully 45 minutes. It did not take long from the time that the water broke into this trough until there was a perfect torrent of water rushing through the breast, carrying everything before it, trees growing on the outer face of the dam were carried away like straws. The water rushed out so rapidly that there was a depression of at least 10 feet in the surface of the water flowing out, on a line with the inner face of the breast and sloping back to the level of the lake about 150 feet from breast, exactly similar to water flowing through a rectangular sluice-way in the side of a trough with the water level far above the bottom of the sluice-way. When the lake was drained there still remained in the bed of it a violent mountain stream 4 or 5 feet deep, with a swift current, the combination of the two streams already alluded to from the head of the lake and the many little streams from the adjacent hills, which streams were all

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the South Fork Dam," 448-451. The complete letter by Parke may be seen in Appendix O. Also see Appendix P for the eyewitness accounts of the dam's failure by John Rorabaugh, a farmer and neighbor to Unger, and George Grambling, an operator of a sawmill downstream from the dam.

107. Johnstown Daily Tribune, June 14, 1889.

> overflowing their banks, this stream in the bed of the lake showed no signs of diminishing in volume until late in the following day, and was impassable with a boat for several days.[108]

Another eyewitness account of the breaking of the dam was provided by W. T. Boyer, the caretaker of the club grounds under Unger. He observed that during the 45-minute debacle the water

> would wash a kind of a puddle and then some of the earth would give way, and keep on in that way till it had a channel through, when you may know it went with a crash, where nothing could escape that was in the way. Trees four feet in diameter, roots, branches, everything went before it like toys, and before it reached South Fork it was a dam of trees, and not of clay and stones as before. . . .[109]

Just prior to the failure of the dam, Unger reportedly remarked that if it withstood this flood the club "would put it beyond all possibility of danger in the future." When he saw the dam begin to give way, he realized the consequences of the break and "became so ill that he had to be assisted to the hotel."[110]

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108. Letter, Parke to Becker, August 22, 1889, printed in "Report of the Committee on the Cause of the Failure of the South Fork Dam," 448-451.

109. Johnstown Daily Tribune, June 25, 1889. Boyer's full eyewitness account may be seen in Appendix Q.

110. Quotation of John Rorabaugh, printed in McLaurin, The Story of Johnstown, p. 55. Several days later, Unger returned to his home in Pittsburgh and told reporters that "At about 3:15 the dam burst, while we were still at work . . . When the heavy masonry gave-way from the immense pressure of the pent-up waters . . . I was thoroughly exhausted." The Pittsburgh Press, June 5, 1889. During the next several months, Unger continued to insist that:

> The report that the weir or outlet for the water in the embankment was closed or clogged up is not true. It is

The volume of water pouring out of Lake Conemaugh and into the already-flooded Conemaugh Valley was later computed by various engineering authorities. According to the calculations, the estimated 20,000,000 tons of water in the lake would have made a stream 500 feet wide, 20 feet deep, and 12 miles long. The lake more than doubled the water in the channel of the Conemaugh between South Fork and Johnstown. Such a stream flowing over Niagara Falls would take 36 minutes to pass. This vast body of water lost some of its energy due to friction and obstructions in its course, but the 404-foot drop in elevation over the 12 to 14 mile distance between South Fork and Johnstown gave it momentum to roll locomotives for almost a mile and strength enough to bend a locomotive tender around a tree.[111]

C. THE RESULTANT JOHNSTOWN FLOOD TRAGEDY

The 30- to 40-foot high flood wave moved as fast as 40 miles per hour down the narrow mountain valley of the Little Conemaugh, inhabited by nearly 38,000 people. It picked up speed and debris as it swept through the unsuspecting towns of South Fork, Mineral Point, East Conemaugh, Woodvale, and Conemaugh Borough on its

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> about twelve or fifteen feet high and very wide--wide enough to allow all water to flow under ordinary circumstances. A screen was placed in the outlet, but that was a small concern, about two feet high with a pier of timber on each side. The remainder of the space was entirely clean, and the screen was only heavy enough to keep the fish back.

The Nanty-Glo Journal, January 22, 1953.

111. McMaster, "The Johnstown Flood, I," 231-33, and "The Work of The Flood at Johnstown," Engineering News and American Railway Journal, XXI (June 22, 1889), 569-73, 578.

way to Johnstown, portions of which were already underwater from the heavy rains. The wave struck Johnstown about 4:00 p.m. and the devastation of the city itself was over in about ten minutes. More than 2,200 people were killed, thousands were left homeless, and property damage totaled more than $17,000,000, making it the most notable flood of the nineteenth century in the United States.[112]

Newspapers, periodicals, and booklets reported the tragedy to the nation and the world. An article in Harper's Weekly on June 15, 1889, probably summed up best the details of the enormous calamity that had struck Johnstown:

> Johnstown itself has been one of the busiest manufacturing places in the country. It was made, and is largely owned, by the Cambria Iron Company, one of the largest and most flourishing establishments of its kind in Pennsylvania. Conemaugh was near it, and the two together were called Johnstown City. In its various furnaces and mills the company employed about 5000 people. The community consisted largely of working-men, and their houses on the flat were wooden structures built in rows, the property of the corporation. The officers of the company, the merchants, and professional men lived on the hills. There were churches, schools, and a public library, established and sustained by the company. The recent growth of the population had been very rapid. In 1880 the population of the borough of Johnstown was 8380. Before its destruction it had 10,000 and it was estimated that from 25,000 to 30,000 people dwelt thereabout. Other manufacturing establishments had followed the iron-works, and a string of villages stretched up the valley for several miles. There were Conemaugh, Cambria, Millvale, and Woodvale. Most of these, in the descriptive phrase of the sufferers from the great tragedy, have "gone down" in the flood. The buildings are destroyed, and most of the people are dead. Those

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112. Dictionary of American History (New York, 1976), II, 351, III, 37; Harper's Encyclopedia of United States History (New York, 1902), V, 62; and John Stuart Ogilvie, History of the Great Flood in Johnstown, Pa., May 31, 1889 (New York, 1889), pp. 11-12.

> who have escaped with their lives are homeless. Some of them are crazed by their losses and their terrible experience. No one has adequately described this appalling disaster; no one can possibly tell the tale. A whole population has been wrecked within a few hours. Nature has not so exerted its destructive powers on this continent within historic times. We must go back to Herculaneum and Pompeii for the story of a like catastrophe.[113]

Regarding the flood wave as some evil force, the editor of the Johnstown Daily Tribune wrote on June 14, 1889, in the first issue of the newspaper to be printed after the devastation of Johnstown, as follows:

> It came like a thief, and was upon us before we were aware. Already when it reached us it had numbered the victims by the hundreds. Mineral Point and East Conemaugh were gone, a passenger train was engulfed. Woodvale was swept away. Conemaugh Borough was shaved off as if by the sharp surface of an avalanche; in a moment Johnstown was tumbling all over itself; houses at one end nodded to houses at the other end and went like a swift, deceitful friend to meet, embrace, and crush them. Then on sped the wreck in a whirl, the angry water baffled for a moment, running up the hill with the town and the helpless multitude on its back, the flood shaking with rage, and dropping here and there a portion of its burdencrushing, grinding, pulverizing all. Then back with great frame buildings, floating along like ocean steamers, upper decks crowded, hands clinging to every support that could be reached, and so on down to the great stone bridge, where the houses, piled mountain high, took fire, and burned with all the fury of the hell you read about--cremation alive in your own home, perhaps a mile from its foundation; dear ones slowly consumed before your eyes, and the same fate your own a moment later.

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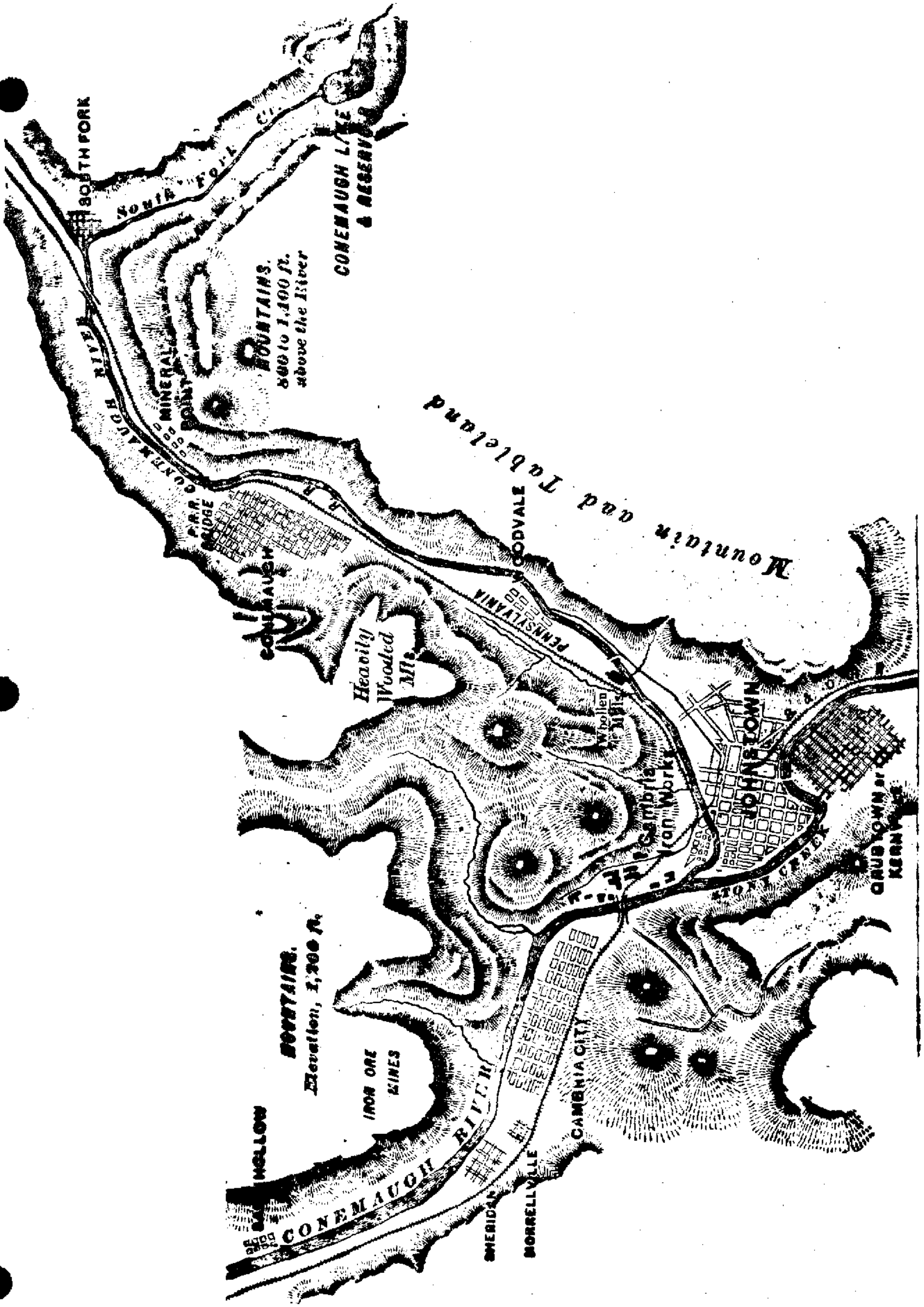
113. Henry Loomis Nelson, "Johnstown and the Floods," Harper's Weekly, XXXIII (June 15, 1889), 478. The article included a map of the course of the flood wave, a copy of which may be seen on the following page.



TOPOGRAPHIC MAP OF JOHNSTOWN AND ITS VICINITY.

In the same edition, the editor concluded:

> All about us there is desolation--not ruin merely, but desolation complete and absolute. The same, reasonable mind fights against fate and will not yield, but there are moments when the strongest merely give way and break under the great load of their own and other's misery.[114]

Meanwhile, the scene at the deserted Lake Conemaugh resort was also one of ruin and waste, and the site quickly attracted a variety of reporters and journalists who filed avid descriptions of what they saw. Witnesses reported observing a vast gravel bar below the dam. Measuring 1,500 feet in length, 5 to 12 feet in height, and 160 feet in width, it contained approximately 100,000 cubic yards of material.[115] A writer for the New York Times described the lake on June 4 as follows:

> At the present time the lake looks like a cross between the crater of a volcano and a huge mud puddle, with stumps of trees and rocks scattered over it. There is a small stream of muddy water running through the centre of the lake site . . . there is but a small portion of the dam left on either side. No damage was done to any of the buildings belonging to the club . . . There are but one or two small streams showing here and there in the lake. A great many of the workmen carried off basketsful of fish which they caught in the mud.[116]

Another correspondent for the New York Sun also provided a glimpse of the dreary scene at the site of the dam as follows:

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114. Johnstown Daily Tribune, June 14, 1889.

115. "The South Fork Dam," Proceedings of Engineer's Society of Western Pennsylvania, 92.

116. New York Times, June 4, 1889.

> Whatever may have been the indirect cause of the giving way of the heap of dirt that dammed upper Conemaugh, the fearful power of the mass of water which was the direct cause of its yielding is evident all about the place. In the centre of the dam is a gap clear down to bed rock in the old bed of the stream, and sloping raggedly upon each side to the top, where it is at least 200 feet wide. Through this huge gap can be seen a vast area of yellowish gravel and mud--a very deep basin in the centre back of the dam, rising at each side in bluffs thirty feet high, and sloping more gradually backward away off until it curves to the left and is cut off from view by a point of land. At the further end of the curve are the big club house and a number of cottages erected for members of the club, gray bits of color in the midst of masses of green trees. This mud valley is not less than a quarter of a mile wide at its narrowest point. It is generally much wider, and is said to average a mile and a quarter.[117]

J. J. McLaurin, who traversed the devastated region soon after the flood and published an account of his observations, described his visit to the emptied Lake Conemaugh as follows:

> It was my fortune, after witnessing the unspeakable horrors at Johnstown, to be the first to traverse the whole length and breadth of the devastated region, from the ruined, emptied Lake Conemaugh to Nineveh. The visit to the dam disclosed how the water carved a highway for itself in its exhaustless rage. Both wings of the dam were standing intact, mute, hoary, moss-grown testimonies to the superior work done by the first contractors. The newer portions had gone, leaving not a particle of refuse, so thorough was the destruction. Masons could not have taken out the stone passage-ways more cleanly. The proud lake had dwindled to a thread winding amid the loose stones and muddy deposits of a petty brook. The cottages looked upon a slimy, oozing gully, no longer the silver expanse that had pleased the eye two days before. Off on the hillside the pretty cottage of Col. Unger, the clubhouse and residences on

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117. Quoted in Dieck, The Johnstown Flood, p. 61.

both banks of the lake seemed to invite the guests who did not come. The mountains with their early foilage, the verdant lawns, the fields carpeted in green and the invigorating atmosphere, which had regaled the mirthful throngs of former years, none were there to enjoy.[118] Laughter echoed not along the peaks and slopes. . . .

118. McLaurin, The Story of Johnstown, pp. 57-58.

CHAPTER SIX

POST-FLOOD ANALYSIS OF THE CAUSES FOR THE FAILURE OF THE SOUTH FORK DAM: 1889-1891

Within several days after the flood newspaper reporters and journalists began descending on Johnstown and the South Fork Dam to obtain stories, photographs, interviews, and eyewitness accounts of the disaster. Many of the resulting newspaper and periodical articles, particularly those written in early June, contained numerous fanciful, inaccurate, and exaggerated descriptions of the events on May 31 as well as the causes and results of the dam's failure. Much of this faulty material was also published in a number of books that were rushed into publication in the months after the flood.[119] It is the intention of the author of this report to concentrate only on the analytical studies of the causes of the dam's failure made by trained engineers and printed in reputable engineering journals.

A. ENGINEERING NEWS AND BUILDING RECORD

One of the first engineering journals to send an engineer to investigate the causes of the South Fork Dam tragedy was the Engineering News and Building Record. H. W. Brinckerhoff, a civil engineer on the publication's editorial staff, arrived at the dam on June 5, and several articles were published in the journal in June as a result of his examination. He observed that the failure of the dam "appears to have been due to overflow, caused by [the] inadequacy of [the] spillway and aggravated by the fact that the dam was two or three feet lower at [the] centre than at [the] ends,

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119. The following books were published within a year of the flood: Beale, Through the Johnstown Flood; Frank Connally and George C. Jenks, Official History of the Johnstown Flood (Pittsburgh, 1889); Dieck, The Johnstown Flood; George T. Ferris, The Complete History of the Johnstown and Conemaugh Valley Flood (New York, 1889); Johnson, History of the Johnstown Flood; McLaurin, The Story of Johnstown; and James H. Walker, The Johnstown Horror (Chicago, 1889). The works by Beale and McLaurin are the most reliable as they used manuscript materials and reputable journals in their research.

causing overflow to take place at [the] weakest point." Details of his examination of the dam were as follows:

> Arriving at the scene of the break, we found an earthen embankment stretching a distance of about 900 feet on the crest, across the valley of the South Fork of the Conemaugh. Its central portion had been completely washed out down to, and even below, the original bed of the stream, the rush of the released water having scooped out quite a basin just below the dam.
>
> The width of the break at the crest was about 350 feet, narrowing to perhaps less than one-fourth of that amount at the bottom. The structure of the remaining portions thus exposed in section showed a tolerably homogeneous mass of stiff gravelly clay, well covered with rip-rap on both slopes, the lower slope having quite a growth of trees and bushes on it. My first look was for the heart wall of puddle or masonry that is usual in large earthen dams, but a closer examination of the material left no doubt in my mind that the omission was due to the fact that the dam was practically all puddle of very good quality.
>
> This had apparently been deposited in pretty uniform horizontal layers, and the exposed portions showed a high resistance to the erosion of the flood, standing with very steep and in some cases perpendicular slopes. The section of the dam, as near as could be estimated with the assistance of a fifty-foot tape, was as follows: height, 80 feet; width at top, 20 feet; width at bottom, 300 feet; inner slope, two to one, length, 100 feet; outer slope, one and a half to one, length, 120 feet.
>
> The rip-rap on the inner slope at least was mostly of irregular quarry stone, such as one or two men could handle, and the toe of the inner slope was of roughly-squared stone carefully set on edge. The inner slope was also slightly concave, or in other words its inclination increased from the toe up, averaging, however, as above. The outer slope was so overgrown as to be less readily examined.
>
> Around the north end of the dam a spillway or waste weir had been cut through the solid rock, of which both sides of the valley at this point appears to be composed, more or less covered, however, with soil. This waste

weir was 65 feet wide at its narrowest point before it commenced to descend materially. It was somewhat wider at its upper end, enough probably to amply effect the obstruction occasioned by a fish screen three feet high or so attached to the posts of a carriage bridge which crossed at that point. The bottom of the waste weir at its inlet is about ten feet below the crest of the dam at its nearest point. This, in the absence of a level, was estimated by measuring up from the bottom of the weir on the posts at the bridge above mentioned, and sighting across. The crest of the dam, some three hundred feet long, between the weir end and the break, sloped uniformily from the former to the latter point, as could be seen by sighting along it, a little from the weir end over the edge at the break falling several feet below the edge of the crest on the opposite side of the break. As near as could be estimated by measuring up from the water mark on the rip-rap, and by sighting across from the bottom of the waste weir to the water mark on the other side of the reservoir the crest of the dam at the side of the break next to the weir was about seven feet above the bottom of the weir.

At the bottom of the break, on the line of the inner toe, were the remains of the foundation of a gatehouse, from which some large iron pipes had originally extended through the dam for the purpose of drawing off the water when the reservoir was used for its original purpose of supplying the State canal. According to the statement of an old resident of the vicinity, sometime after its use for this purpose had been discontinued, a leak along these pipes or the tunnel in which they were laid caused the destruction of the central portion of the dam; the break, however, does not appear to have been so extensive as the present one and caused no serious damage. When the breach was closed to form a lake for its recent use of boating and fishing, the pipes for drawing off were no longer needed and were therefore omitted.

What sort of work was done and what material was used in repairing this break there is nothing now left to show, as far as can be judged from the general appearance of things and the fact that both leaks occurred at the same point. It will, therefore, be understood that all that has been said so far probably applies exclusively to the original work.

The depression of the crest of the remaining portions of the dam toward the centre is most likely due to the settlement of the embankment, which would naturally be greatest where the dam was highest. If, as is probable, the crest of the new work was made fair with the old at the start it would, in course of time, settle to even a lower point, perhaps four or five feet below the elevation of the dam at the ends. This would, in a measure at least, account for the rapid destruction of the dam. The old resident, before mentioned, who saw the dam go, observed no leakage through the dam, but said that the water commenced to flow over the crest of the dam at its centre. This continued a couple of hours or so before the flow became serious, then the lower slope began to eat away rapidly under the increased flow, the sides of the breach falling in from time to time, until in about half an hour the breach was complete.

The overflow was due to a combination of two causes: first, the inadequacy of the waste weir which, however ample it may seem to have been, was plainly unable to carry off the vast volume of water that poured into the reservoir, and, second, to the depression of the crest of the dam at its centre. This depression reduced not only the effective discharge area of the weir, but also the velocity of the discharged water, thus very greatly reducing the weir's capacity for relief.

The position as well as the amount of this depression was a serious matter. Being in the centre, the overflowing water could wash the widest portion of the outer slope and cut the dam to the bottom in the shortest possible time, both sides of the breach caving in at once, while had the overflow occurred at either end, nearly two-thirds of the dam would have had to have been washed away before the reservoir could have been emptied, and, as in addition to this the water could only act on one part of the dam at once, the time required to empty the reservoir would have been increased in a proportion even greater than that of the material to be washed away.

An effort was made in the direction when the water began flowing over the dam by cutting through at or near the end of the dam furthest from the waste weir, but rock was soon met with, and a sufficient outlet could not be made in season to prevent overflow.

Though the section of the dam appears to have been ample to resist overturning or sliding, even with the reservoir full to overflowing, it is easy now to see that an increase in the length of the lower or outer slope, while it would not have prevented the destruction of the dam would have materially retarded its progress, and thus, not only have reduced the volume of the ensuing flood by letting the water out more slowly, but have given more time for those below to escape its coming.

To sum up it may be said that the dam as originally designed seems to have had sufficient stability, and to have been well built. In grading the crest, however, not enough allowance appears to have been made for subsequent settlement, and this defect was probably increased when the dam was repaired, even supposing that no other elements of weakness may not have been introduced. This concentrated the destructive effect of the overflow at the worst possible point, and the disaster followed.

As compared to the volume of the stream when observed, the waste weir appeared to be of simple dimensions, especially if the crest of the dam had been everywhere ten feet above the bottom of the weir.

Whether the size of the weir bore any reasonable proportion to the area of the watershed of the South Fork, especially if denuded of trees, or to any observed flood flow of the stream itself, it is, of course, impossible to determine at present.

It may be added that the dam is straight in plane, and its crest was used for a roadway.[120]

B. ENGINEERING NEWS AND AMERICAN RAILWAY JOURNAL

The Engineering News and American Railway Journal sent two of its editorial staff members to the South Fork Dam on June 6 to examine the structure. A. M. Wellington and F. B. Burt, both of whom were civil engineers, recruited S. T. Miller, a mining engineer associated with the Lidgerwood Manufacturing Company, and made measurements and drawings of the dam and issued a

120. Advance proofs of his report were quoted in the New York Times on June 8 and 9, 1889.

preliminary report that was the basis of an article in the New York Times on June 9. Calling the reconstructed dam "an engineering crime," Wellington stated that it was

> in every respect of very inferior construction and of a kind wholly unwarranted by good engineering practices of thirty years ago. Both the original and reconstructed dams were of earth only, with no heart wall, but only riprapped on the slope.
>
> The original dam, however, was made in rammed and watered layers, which still show distinctly in the wrecked dam. The new part greatly added to its stability, but it was, to all appearances, simply dumped in like an ordinary railroad filling, or, if rammed, shows the evidence of good effect from it. Much of the old part is standing intact, while adjacent parts of the new work are wholly carried off.
>
> There was no control wall of puddle or masonry either in the new or old dam. It has been the invariable practice of engineers for thirty or forty years to use one or the other in building high dams of earth. It is doubtful if there is a single other dam or reservoir in any other part of the United States of over fifty feet in height which lacks this central wall. The reconstructed dam also bears the mark of great ignorance or carelessness, having been made nearly two feet lower in the middle than at the ends. It should rather have been crowned in the middle, which would have concentrated the overflow, if it should occur, at the ends instead of in the centre. Had the break been at the ends the cut of the water would have been so gradual that little or no harm might have resulted. Had the dam been at once cut at the ends, when the water began running over, the sudden break of the dam would have been at least greatly diminished, possibly prolonged, so that little harm would have resulted.
>
> The crest of the old dam had not been raised in the reconstruction of 1881. The old overflow channel through the rock still remains, but, owing to the absence of the crest in the middle of the dam, five feet of water instead of seven feet were necessary to run water over the crest, and the rock spillway, narrow at best, had been further contracted by a close grating to prevent the escape of fish, capped by a good-sized timber, and in some slight degree also by a trestle footbridge. The originial

discharge pipes at the foot of the dam had been permanently closed when reconstructed, and this, while a minor matter compared to the others mentioned, further reduced the possible rate of maximum discharge.

The net effect of all these differences of condition was that the dam, as it stood, was not much safer against excessive floods, apart from its inferior construction, than the original dam would have been with a crest only 3½ to 4 feet high above the bottom of the rock spillway instead of 7 feet. It is impossible to say if the riprapping of the new part of the dam was as good as the old or not, since it has not been wholly carried away. A large amount of the old riprapping and slope wall still remains intact and is of excellent quality. It does not appear that there was any great amount of leakage through the dam before it broke. The destruction came from water flowing over the top.

Mr. Wellington said that no engineer of known and good standing for such work could possibly have been engaged on it, since, in the particulars mentioned, it violated the most elementary and universally understood requirements of good practice. He did not believe that any other dam of equal height had ever been constructed in the country wholly of earth without some kind of protection against leakage or abrasion by water in the centre of the dam. The estimates of the original dam indicate that it was made of about half earth and half rock, but if so there was little evidence of it in the breaking dam. The riprapping was merely a skim on each face. The dam was seventy-two feet above water, two to one inside slope, one-half [sic] to one outside slope, two [sic] feet wide on top. The rock throughout was about one foot below the surface. The earth was pretty good material for such a dam, if it was to be built at all, being of a clayish nature, making good puddle. To this the fact of its standing intact since 1881 must be ascribed, as no engineer of standing would have ever tried to so construct it. The fact that the dam was a reconstructed one, after over twenty years' abandonment, made it especially hard on the older part of the dam to withstand the pressure of the water.[121]

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121. New York Times, June 9, 1889. Also see, Caldwell, Illustrated Historical Combination Atlas, p. 24.

On June 15 the Engineering News and American Railway Journal published the full report by Wellington and Burt. According to their surveys, the two engineers calculated that the watershed of Lake Conemaugh was 56.63 square miles and perhaps nearly 60 square miles if a portion of its extension into Bedford County were taken into account. They computed the size of the reservoir to be between 400 and 440 acres.

The plan and elevation of the dam were measured with tape line, handlevel, and pocket compass only since it was impossible to transport an engineer's transit and level to the site of the dam. However, they were convinced of the accuracy of the plan

> especially in the most important fact of the dishing or sag of the crest line, but for which the dam would have had an excellent 'fighting chance' of surviving intact, since it would have given 1½ to 2½ feet more water in the spillway, and this in spite of the obstructions in it. . . .

The two engineers commented at length on the interior construction of the dam. They noted:

> There was certainly no heart wall of any kind, masonry or puddle, in the dam, and our sketch of probable cross-section, based on the estimates which appeared in last week's issue, was in that respect, incorrect. If the rubble masonry thus estimated was ever intended for a heart wall, that part of the design was changed. Also, so far as can be judged from the evidence of the remnants, the carefully rammed part of the dam extended only to the upper edge of the crest, not to the lower edge. How much better able this part of the dam was to resist wash than the lower part, is strikingly evident from the engravings. Two very heavy benches remain, over all the upper surface and edges, of which the stratification in horizontal layers is still sharp and distinct, the surface being hard, and the brakes in it being nearly vertical down to the next layer. The whole of these benches could be walked over like a flight of steps. Of course the rush of water may have cut away the lower part of this rammed part of the dam; but

> [the] fact that its inner edge is nearly vertical under the upper edge of the crest, and in no part extends beyond it, while at points this edge falls short, indicates that the rammed portion did not extend much beyond the center of the roadway, at least. Most of the upper part of the roadway, however, seems to be new work; and it is possible that the roadway and inner face of the rammed portion was extensively broken down before making the repairs. . . .

Concerning the riprapping on the dam they observed that on both slopes it "was exceedingly well done on the parts now remaining." How well the riprapping had been done on the reconstructed portion of the dam, which was washed out, could not be determined. They inferred from eyewitnesses' accounts "that it was fairly well done."

The men also described the principal materials used to construct the breast of the dam. According to their observations, they noted:

> The original estimates were for half earth and half rock and slate spoil. We can readily understand how this could be, and yet the dam be made practically all of earth. A rotten, slaty shale rock lies close beneath the surface, which for a foot or two disintegrates into earth almost completely after excavation. It was probably contemplated to excavate half the material from this soft rock, and a good deal was so excavated, but the large borrow pits on each side at the bottom of the reservoir indicate that a good deal of material was taken from lower down on the valley slopes, where there was more earth and perhaps a rottener rock. Be this as it may, there was hardly a piece of rock as big as a man's fist in any of the central part exposed to view. The lower edge of the northeast side of the gap showed an interior coating of spalls . . . but while these may be the outer evidences of a similar lining extending along the old work, inside the heavy riprap, it is more likely that it is a mere exterior coating of a few stones, which chanced to lodge there in the washout or fall from above. There is no similar evidence of interior stone in the southwest end.

The engineers were especially critical of the way in which the arched stone culvert was closed during the 1880-81 reconstruction work. They wrote as follows:

> This action would have tended distinctly to safety, had it not been accompanied by the great error of neglecting to be correspondingly more cautious as to the spillway area provided at the upper water level. As a matter of fact, the rebuilders, who were aided by no engineering advice or supervision whatever . . . were greatly less cautious about the spillway area instead of more so.
>
> The wreck bears plain evidence as to the manner of closing the old culvert gap. A row of very flimsy and poorly driven hemlock plank sheet-piling in a double layer, was driven across the opening, under about the middle point of the wet slope. . . .
>
> This pipe culvert, by the way, appears to have been a very carefully built structure, of cut stone, with heavy stone blocks, having five almost semicircular rests cut in them to carry the pipes, these rests being 6 ft. between centers longitudinally.
>
> About 14 of the old hemlock sheet piles still remain. . . . Of these, two or three were 1½ ins. thick and the rest 2 ins. They bore no evidence at the top of having been very solidly driven, and in fact such planks cannot be solidly driven and hold [sic] together. It was through this part of the dam that there was a good deal of continuous leakage. The old Dutch farmer who lives just below the dam told us that there was always a small stream of water coming out below the dam. He apparently spoke relatively to the natural flow, however, which is pretty large, and we should judge that there was always far more water leaking through than was healthy for a dam. We could gather no evidence that this leakage had been increasing until just before the break. During reconstruction and just after it, leakage was heavy and gradually decreased. A large amount of hay and straw was used to stop these leaks, which in itself was not improper. As an evidence of how the reconstruction work was done, however, it is significant. . . .

As to the earth in the rammed benches, they judged it to be fairly good puddling material, "but hardly of the best class, not being clayey enough." The earth appeared to have stood well and had the

> whole dam been constructed and <u>reconstructed</u> in similar rammed layers, the disaster might have been greatly alleviated, but still hardly avoided. If, in addition the lower slope had been 2 to 1 instead of 1½ to 1 with a heavy riprap all over it, as still remains on the end portion which is very heavy and good water might have run over for some little time without destroying the dam, except for the sag in the crest.

Returning to the problem of the sag in the center of the crest of the dam, the engineers concluded that the dip was little more than 4½ feet above the bottom of the spillway. Their examination of the structure led to the following conclusions:

> . . . The crest originally was 8 ft. above the spillway (by which we mean in all cases the bottom of the spillway). The bulk of the earthwork having less done in 1840 ($80,000 had then been expended), and the dam not completed till 1852, it had ample time to settle. From 1852 to 1858, the dam was in care of the State and probably well maintained, but possibly there might have been a slight central settlement even then, in 1862 the break occurred, and from 1858 to 1880, or for 22 years, the dam was wholly uncared for. During this period, by wash alone, the crest would lose considerable height and naturally more near the center than at the ends. We judge that by 1880 the crest had substantially the same dip that it has now, which is about 1½ ft. (7 ft. to 5½) in a distance of 305 ft. The dip would not attract an unprofessional eye: the crest still looks level, and good enough to work to for reconstruction, although the dip is clearly discoverable. . . . Everything indicates that the northeast bank still remains substantially unchanged since original construction. The washed out portion was probably restored in 1880 working to the old top as a grade line. If so, the grade of the old portion, prolonged to the center of the dam, would give less than 4½ ft. above spillway at the center; but allowing this not to have been done, the new work was comparatively carelessly and loosely built. It would, therefore, settle while the old part did not, and its settlement would not be noticed, because the crest line would simply prolong the old lines.

That this was substantially the case seems to be proved positively by another fact. A foreman and 25 men were employed for hours before the break, trying to save the dam. They plowed furrows on the lower edge of the southwest crest, and used the material to raise the crest by a temporary bank. This bank at least would be level, because they had the water to give grade. On the northeast end, there was and still is (if it has not been removed) a remnant of this bank, in a rough little mound, which looks as if it had been made by children playing there. It is about 6 to 8 ins. high and 12 to 18 ins. wide at the largest end, near the break, tapering out to nothing in a distance somewhat over half the length of the remaining bank. It is very irregular, and its total contents, calling it a triangular pyramid with 8 x 18 in. base and 150 ft. long, is less than a cubic yard. It would not take 25 men long to throw up this embankment. . . . What were the gang of men doing with the rest of their time? They now say the mound was 12 to 18 ins. high in the center of the dam, but their memory is evidently not clear; it might have been considerably more or less than this. Be this as it may, the fact remains that <u>water ran over the dam in a broad sheet for two hours before its final and sudden collapse, and in volume sufficient to destroy the dam without hurting or touching this slight mound</u>. Had there been any water running over at a level high enough to cut it away at the end, it would all have gone away by quick abrasion, since it bears no marks of having been solidified or smoothed over by the flood at all, and when wet must have been a mere loose heap of mud.

From this our conclusion is that the top of the sheet of water which destroyed the dam was at one time sensibly higher than the base of this remnant of embankment . . . or about 5½ ft. above the bottom of the spillway. As the sheet of water must have been at least a foot thick to do the work it did in the time it took to do it, the resulting conclusion is obvious.

The report included a detailed description of the spillway. According to their examination, the two engineers reported:

. . . The bridge had been built to carry a driveway over, as also [on] the lower bridge. . . . Attached to the posts of the bridge were, first, a row of iron gratings to serve as fishguards, and secondly a floating 8 x 8 stick, armed on the corners with a double row of nails, to serve as additional fish-guard, and keep fish from jumping over. The fixed grating was 18 ins. high, rested on a wooden sill projecting about 2 ins. above the floor of the spillway, and was made of ½-in, rods 3/4 in. apart in the clear, or 1½ ins. between centers. The floating stick was armed with an iron eye at each end sliding on a vertical rod attached to the bents of the bridge; so that it could rise and fall with the water level, floating in the water cornerwise. Another similar stick of an form, braced across the angle, was arranged in front of the bridge in some way we did not clearly determine; possibly both sticks were all one exterior guard, and during the flood had broken loose or been cut loose, and knocked out one of the posts of the bridge. . . . Some of the fixed gratings have been knocked down since the disaster . . . but they extended clear across. There was also a number of inner wire netting guards . . . which had apparently been placed above the fixed grating to further guard against the escape of fish, but were removed during the flood. . . . There were fewer small obstructions of leaves and brush in front of the gratings than we should have expected. What there was when we examined the dam was insignificant in amount. The normal water stage in the spillway was indicated very clearly by water marks in the grating as 9 to 12 ins. above the bottom. The gratings were fixed and not swinging, as has been stated. We looked with care for some maximum water mark left by the flood, but found none, as is not unnatural, since lake water, even in floods, is clear. Had it been river water, there would doubtless have been clear marks.

We estimate elsewhere the net rise of reservoir level caused by these spillway obstructions at one foot, and we do not think this estimate can be too high when we consider the probable great velocity of 15 to 20 ft. per second.

Concerning the lower part of the spillway and its excavated falls, the engineers observed that:

Just below the foreground there was another and very high fall a little above the lower bridge, the abutment of which had been badly injured. It might have been injured before, but it is more likely this was the severest flood in which it had been exposed, and that its injuries were recent. No part of the spillway . . . has been widened since first built, if the mossgrown rock

> slopes overgrown with bushes and trees, tell the truth. The extreme upper end of the spillway had been bell-mouthed about 10 ft., where the upper bridge crosses, apparently with the idea of counteracting in this way the loss of discharging capacity from the obstructions. In a sense it would do so, but, as we have pointed out elsewhere, not without raising the lake level nearly as much as the same obstructions would have done in a narrower part of the spillway, the only difference being that due to the smaller velocity required at the other point for the same discharge.[122]

A summary article in the same issue of the periodical provided the journal's conclusions relative to the causes of the dam's failure. Uppermost in the minds of the engineering journalists was the fact that

> at no time during the process of rebuilding the dam was ANY ENGINEER WHATEVER, young or old, good or bad, known or unknown, engaged on or consulted as to the work,-a fact which will be hailed by engineers everywhere with great satisfaction, as relieving them as a body from a heavy burden of suspicion and reproach. The precautions taken against failure were only such as an experienced railroad contractor's knowledge of hydraulic engineering indicated were admissible without further increasing a contemplated investment of $3,700, which had to be increased at best by over $10,000.

Information from various sources enabled the engineers to draw certain conclusions about the reconstructed dam, despite the "great difficulty" that the work had been done ten years before and "was not observed at all by any experts in such matters of whom we can now find trace." The reconstructed part of the dam had been executed with "slight care." Moreover,

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122. "The South Fork Dam and Johnstown Disaster," Engineering News and American Railway Journal, 540-545.

> The old material which had caved in, and so lost its compactness, was left untouched; the top of the dam was worked down on to it; the old pipes and culvert, which still remained in somewhat injured condition, were covered with earth and permanently closed, a double row of hemlock plank sheet piling being driven across the dam in a board flume, which was raised from time to time as the work progressed. There was no careful ramming in watered layers, as in the first dam, although some say there was some ramming. There was much leaking during the process, and some tons of hay and straw were filled-in. The dam was finally made fairly tight, but there has always been some leakage at the bottom and of late years this has been increasing. The truth as to the exact amount of leakage is very difficult to ascertain. The original crest height of the dam was decreased from one to three feet, and the spillway was shortly after obstructed with gratings to retain fish, and a trestle bridge was built across the opening.

The engineers observed that there were four primary causes for the failure of the reconstructed dam. These were the: (1) lowering of the crest; (2) central sag in the crest; (3) closing of the bottom culvert; and (4) obstruction of the spillway. Their findings were as follows:

> . . . In the reconstructed dam the length of the crest at the ends of the dam was only 7 ft. above the spillway floor, which was further decreased by a sag in the crest to 5½ ft. at the ends of the still remaining bank, and probably to but little more than 4½ ft. in the middle of the portion washed away. That such further sag existed is inherently probable from the evidence of the remains, but it is proved to have existed by the fact that there is a low, tapering mound of earth about 8 ins. high on the still standing crest, which is known to have increased on the part washed away to a bank of considerable height, on which 25 men were at work for hours before the break.
>
> Again, the five 2-ft. pipes under the dam had an area of 15.7 sq. ft. This would only amount to about 3 ins. depth across the spillway, but the discharging capacity under 70 ft. head was at least 564 cu. ft. per second, as much as a weir 72 ft. wide could discharge if 1.8 ft. below the reservoir water levels.

As for the spillway, it was seriously obstructed, as elsewhere more fully shown: (1) by a sill about 2 ins. high; (2) by an iron-fish-guard 18 ins. high, composed of half-inch rods 11-in. apart between centers, or only 3/4-in. in the clear, which is close enough to readily catch leaves and fine brush; (3) by an 8 x 8 stick floating cornerwise, sliding vertically on a rod at each end, and armed with closely driven nails to keep fish from jumping over it; (4) by the posts of the trestle bridge, equivalent to closing about 6 per cent of the opening; and (5), at the time of the break, by a ragged piece of drift 10 ft. long and 2 ft. in diameter, and some smaller obstructions. These obstructions were placed at the head of the spillway, where it had been enlarged about 20 per cent, in width, apparently with the idea their effect would thus be eliminated; but while it is true that they did not decrease the capacity of the spillway below, if running at a given depth, they did increase the necessary lake level, to give that depth, by an amount which, at the high velocity of nearly 20 ft. per second which then obtained, we should estimate as at least one foot. Various engineers whom we have consulted as good authorities on such matters estimate that the obstructions increased the lake level under the given conditions from 6 ins. to 2 ft. Had the bridge and all its obstructing attachments been cut away in time, the disaster might possibly have been averted. There is no evidence discoverable that the water in the spillway below the bridge was at anytime over 4 ft. deep, and this appears to have been the maximum possible without running over the crest.

Now, if we assume a 2 per cent hydraulic grade line in the spillway proper, after the obstructions at the entrance were passed, and compute the comparative discharge for the given cross-section for varying depths by Kutter's formula [using the coefficient 0.35] we shall find the following striking contrast in conditions of safety:

With the crest of the dam above bottom of spillway	Velocity, ft. per sec.	Area of water section sq.ft.	Discharge in cu.ft.per sec. from spillway and pipes.
10 ft.	24	840	18,330 + 564
8 ft.	22	655	14,300 + 564
4½ ft.	18	375	6,700 + 0

> The first two lines represent (one or the other of them) the conditions which existed in the original dam. The last line represents the most favorable conditions which can have existed just before the dam broke; because it hardly seems possible that the center of the dam can have been much if any higher than 4½ ft. above the bottom of the spillway, and full credit for this height is given without any deduction for the loss of head by obstructions in the spillway, which we have estimated at 1 ft. If we were to allow for this also, it would bring down the discharge to about 4,700 cu. ft. per second; and we very much question if there was much if any more water than that going through the spillway when water began to run over the crest.
>
> Was there this amount of water to be provided for? The ordinary flood discharge of the stream, according to the original reports, is nearly 2,000 cu. ft. per second. This is expressly described as a "moderate estimate." The rainfall appears to have been at least one inch per hour for several hours. To discharge 1-inch per hour from the whole water-shed an enormous but not unprecedented discharge, would require 9,000 cu. ft. per hour, which the spillway in its original condition would have discharged with ease without aid from iron pipes under the dam. About that amount, probably is what had to be taken care of. To raise the whole area of the lake 10 ins. per hour, which is the reported rate before the break, required an accummulation of at least 4,032 cu. ft. per second. Really, it was about 4,500 cu. ft. per second because of the greater area due to the high water. This added to our estimate of 4,700 cu. ft. per second of spillway discharge, gives 9,200 cu. ft. per second coming into the lake when the dam broke--an estimate close enough for all practical purposes to the 9,600 cu. ft. above.

Under the circumstances the periodical investigated reports that the dam had been inspected occasionally by engineers. No evidence was discovered that it was "even once inspected or approved by any engineer . . . who . . .could be regarded as an expert." Local or junior engineers had looked at the dam, but none of them "would carry much weight in the profession." The report that Pennsylvania Railroad engineers "regularly inspected" the dam was proven to be erroneous. Concerning John G. Parke, Jr., the periodical concluded that he was

> an engineer by education; but he is still a very young man, only a year or two out of college, and did about all that could have been done, except to clear away the bridge and its fishguard attachments, which obstructed the spillway. A man of great resolution, self-confidence, and self-sacrifice might have diminished the disaster when he saw it was inevitable by cutting the dam at one end, first sending down warning that he was going to do so. This would have greatly decreased the rate of erosion, since there would have been only one side to erode, and that could have been in the more solid old work.[123]

In an editorial in the same issue as the two aforementioned reports, the Engineering News and American Railway Journal absolved the engineering profession of any guilt in the South Fork Dam disaster. The periodical congratulated the "whole engineering profession" that "no member of it, however humble, has a shadow of responsibility for the grave defects of structure by which the Johnstown dam has suddenly attained a fame second only to that of Vesuvius as a destroyer of life." The periodical found it "truly amazing that there should not have been engaged, for a time at least, some young peg-sticker to set grade stakes, who called himself an engineer, and on whom the dread responsibility could now be shifted. The fact that no engineer had been employed in the reconstruction of the dam led the editors to conclude that:

> . . . No grade stakes were needed, for there was the old crest of the dam to work by; no slope stakes were needed, for there were the old slopes to line by; and no measurements of quantities, because the work was not done by contract, but by a contractor, on his own

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123. "The South Fork Dam," Engineering News and American Railway Journal, XXI (June 15, 1889), 551-553.

> account, by "day's work." As for paying for "judgement," the circumstances were peculiarly such as to make the thought of it seem absurd. A man of no experience in public works would not have dared to omit doing so; a man of more experience in hydraulic work, who knew what tricks water is capable of, would have been likely to call in the best advice he could get; but an old experienced railroad ccontractor, who had never (or "hardly ever") been engaged on hydraulic works, was of all men the most likely to have that little knowledge which is proverbially a dangerous thing, and in this case has proved so terribly dangerous. Not all such contractors would have been misled by it, by any means, but a larger proportion of them than of almost any other class would be likely to be so misled.[124]

In the June 22, 1889, issue of the Engineering News and American Railway Journal the enormous amount of water that emptied from Lake Conemaugh through the broken dam was computed. At its normal water level the lake contained some 480,000,000 cubic feet of water, but just before the dam gave way it held nearly 640,000,000 cubic feet or 20,000,000 net tons. Comparing this vast body of water with Niagara Falls, it was pointed out that:

> . . . The discharge over the Falls is in the neighborhood of 18,000,000 cu. ft. per minute. It would, therefore take nearly 36 minutes for Niagara Falls to discharge an equal boay of water. The reservoir was emptied, all but the last harmless drippings, in just about that time, so that, during its continuance, a body of water substantially equal to the vast flood of Niagara Falls was pouring through the . . . gap in the dam.[125]

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124. "Editorials and Editorial Notes," Engineering News and American Railway Journal, XXI (June 15, 1889).

125. "The Work of the Flood at Johnstown," Engineering News and American Railway Journal, 569-573, 578.

Following its studies of the South Fork Dam disaster the Engineering News and American Railway Journal noted some lessons to be learned that would preclude future similar calamities. The editors observed

> that correctly designed, honestly built, and well maintained earthen dams are under certain circumstances the safest of all structures for impounding water; and that the destruction at South Fork was due to causes altogether outside of the fact that the dam was built of earth.

The "one lesson of real value" to be learned from the Johnstown flood was

> the extreme importance of having all such structures, whether of earth, wood, or masonry, at once carefully examined by competent men, wherever these dams now exist. And such examination should be coupled with legal powers to compel repairs where such repairs would make the structure perfectly safe, or to drain the reservoir and cut the dam where its original design is so faulty as to be beyond repair. . . .[126]

C. ENGINEER'S SOCIETY OF WESTERN PENNSYLVANIA

The Engineer's Society of Western Pennsylvania took an active interest in the break of the South Fork Dam and sent a delegation to visit the site of the disaster. Returning from their inspection of the dam, the delegation held an evening colloquium on the subject on June 18. Concerning the sag in the center of the crest of the dam, it was noted by Thomas P. Roberts that:

> In the edition of the Engineering News of the fifteenth of this month, Mr. Wellington, one of the

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126. "Editorials and Editorial News," Engineering News and American Railway Journal, XXI (June 29, 1889), 599.

editors, reports that the top of the dam was 18 inches lower than the end against the bank. This was in a distance of 300 feet, and taken with a hand-level. I am inclined to think such a measurement very uncertain: nevertheless, he has built up quite a theory on that. From his statements it would seem that the amount of water flowing through the waste weir was only about 4½ feet deep. Now, it is positively certain that the lake rose fully 7 feet above the level of its low-water outlet, and, as the weir is at one side of the lake, it must have been 7 feet deep entering that place. The depth of water, so far as I could understand from the testimony of those who were present at the time, overflowing the dam was about 10 inches to 1 foot, and I do not think the sag could have been over 15 inches, or, at greatest, 18 inches, instead of 4 feet. Of course, when levels are taken, my figures may be changed. The width of the break in the dam I made to be 372 feet; it may be somewhat more. . . .

I made a cross-sectional sketch of the dam here, showing the stratification very distinctly, in layers of 6 inches to 1 foot. I do not think there was any place where these layers were over a foot thick. It is a little wavy, but very compact. Then there is a portion on the lower slope which does not seem to have been made with the same care, nor was it necessary. There is a great deal of rip-rap on the lower slope; I suppose 10 or 15 feet deep at the bottom. This part here, in the lower slope, seemed to be shaly earth. The entire upper half was a puddle wall. That puddle wall at the base was not less than 160 feet, rising to the upper edge of the road. I may say that none of the material that was last placed in the dam is remaining there now. I think I can speak positively as to that, because the statement has been made that 22,000 yards were required to fill the old gap, whereas by my rough measurement, I found that about 100,000 cubic yards of material were removed from the dam. The original cost was about $17,000. It would cost now over $50,000 to repair the dam.

This puddle is well made and the dam was certainly intrinsically strong enough to resist any pressure. The trouble was from overflow. I understand from the statements of those on the ground it came over in a distance of 200 or more feet and about 10 inches deep. The washing away continued until only about 5 feet of that road remained, and then the pressure became too

> great for what was left to hold back the water. It is difficult to ascertain the time the water was passing out, because in their excitement they could not tell exactly; the statements vary from one-half to one and a half hours. One reason, I think, it took considerable time to flow out was, that the water was 70 feet deep at the time of the overflow, and the water was not probably over 30 feet deep just below the dam after the break. The section of the break was wearing deeper all the time, of course. So also was its capacity for discharge diminishing.
>
> In regard to this waste weir, it is reported that it was very much obstructed, but I did not find that to be the case.
>
> They told me that the water in the creek was unprecedentedly high all that morning, so I think the weir was discharging very freely. It must be remembered that the reason the marks are not distinct about this weir, is that the water was clear all the time it was discharging.

Although various newspapers and periodicals were laying great stress on the fact that the culvert sluice pipes had been closed, one member disagreed with the conclusion that this had been the cause of the break in the dam. W. G. Wilkins observed that a railroad engineer had calculated that the pipes operating at peak capacity would only have lowered the lake one inch per hour. Since the lake was rising at a rate of 10 inches an hour before the disaster, the culvert pipes would not have made much difference.

Charles Davis, another society member, had visited the dam almost two weeks after the flood. He had taken measurements of the break as well as of the crest of the dam and had made a rather extensive examination of the spillway and spillway bridge. His observations, which are particularly important to the understanding of the problems at the spillway, were as follows:

> I measured out from the right bank. The length of dam is 900 feet. Next to right bank, or next to weir,

there is a stretch of dam still standing 30 feet long, then a space covered by the washout of about 400 feet in length, then a further stretch of dam of 200 feet, connecting with the left bank. The breach extends to bottom of dam and is some 50 feet wide there. The dam is about 70 feet high.

I went down into the weir and took some measurements and levels. (I had a hand level with me.) I found the bottom of the weir somewhat irregular, and finally concluded to take a timber sill connected with trestle bridge as a base, as representing the crest of weir.

Standing on that I took a sight to what I thought at that time would represent the crest of the dam, i.e., a sight on the top surface of road on crest of dam at the breach.

I made the level of crest of dam 4½ feet above this sill. Before leaving waste way or weir I measured the width of opening under the bridge and found it to be about 105 feet; also measured it immediately below and found it 90 feet wide. I looked at the screen and made such measurements as I thought necessary.

I went into the weir also, to see if I could find any marks of the flood. At first I could not discover any. I thought I would see them on this timber trestle, but could not find them. Out in the weir itself I found marks on the shale banks and on the bushes, showing that the water was over 6 feet above the sill. It showed a 6 feet flow there instead of 4½ as mentioned in some of the newspapers.

Now, after going over on the crest of dam and examining the ground closely, I found I was mistaken in taking the sight for level of crest of dam above weir; that there was a sag in the crest in both banks contiguous to the breach, this sag extending back along road or crest some 25 or 30 feet; that the water in pouring through the breach had saturated the ground for some distance in from face of breach, and, of course, the crest had dropped down. Looking at the ground carefully, near the break, I saw numerous cracks. I found there was a sag of some 6 inches there. The crest of the dam was in reality 5 feet and over above the sill in weir, instead of 4½ feet. The top of dam next to weir was slightly elevated above other portions-say about 1 foot. This sill stands 8 inches above the floor of weir.

> On top of it is the screen, composed of vertical iron bars, ½-inch round, spaced 1 3/8 inches between centres and 18 inches high, connected by two horizontal bars 2½ by ½ inch. On top of that, for portion of length of screen, was a square piece of timber 8 inches square, with spikes driven in on the edges, making diagonals to the axis of the timber. These spikes projected out about 4 inches. This timber was probably a portion of boom which stood out in front of screen to keep the drift out of the weir. It was made to float, to rise and fall with the lake. . . . The weir itself is at least 80 feet in length by 6 feet above the sill. . . .
>
> In walking up the road to the dam, on the right bank of the stream, the bushes and tree-tops gave evidence by their inclination towards the dam, that when it gave away (half mile below being the narrows, and the stream making a sharp bend to the right) the water could not vent itself quick enough and had formed a whirlpool; the effect of this could be seen all along this road. The same thing took place at Johnstown when the stoppage occurred at the bridge.

At the conclusion of their discussion, the engineers summarized their views on the cause of the dam's destruction. They concluded that:

> No earthen dam ought to have water allowed to flow over it. The waste weir was not large enough to carry out the water . . . this dam has been in bad condition for years. From the information we can get, the repairing was not done as well as the old (original) work. With regard to this wicker-work at the weir, we all know it would have been an obstruction to a great extent and would impede the flow of the water somewhat. . . .
>
> The general consensus of opinion is that for this kind of a dam this one is about as good as could be made, but . . . some provision should have been made for just such a thing as happened and which destroyed the dam; that is, that it should have had a larger outflow than was possible with the weir or shoot in use.
>
> . . . the dam was constructed well enough, if there had been an outflow large enough to take out the excess water. But there was not sufficient drain for the tremendous flow of water from this 'cloudburst;' if there

had been a means of opening that outlet so as not to have an overflow, it would have been the solution of the whole matter.[127]

D. AMERICAN SOCIETY OF CIVIL ENGINEERS

On June 6, 1889, the American Society of Civil Engineers appointed a special four-man committee to investigate the causes of the failure of the South Fork Dam. The members of the committee were James B. Francis, president of the society, A. Fteley, vice president, William E. Worthen, and M. J. Becker, the latter two having been past presidents of the organization. The impetus for setting up the committee appears to have come from a request of the aqueduct commissioners of New York City.[128]

The first progress report of the committee was presented on June 22. Although the committee was still gathering information, some conclusions as to the reasons for the failure of the dam had been agreed upon. First, "there was no doubt that if the spillway had been of sufficient capacity, the disaster would not have occurred." Second, the main question turned on "the capacity of the overflow, the capacity of the reservoir, and the area of the water-shed." There was much conflicting data on the watershed area of the dam: "if as large as it has been stated, it may not be exceptional; if, however, it is as small as has been stated, the rainfall must have been abnormally great." Accordingly, a complete survey of the watershed would be made.[129]

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127. "The South Fork Dam," Proceedings of Engineer's Society of Western Pennsylvania, 89-99.

128. "Society Proceedings: American Society of Civil Engineers," Engineering News and American Railway Journal XXI (June 22, 1889), 532-33.

129. "Society Proceedings: American Society of Civil Engineers," Engineering News and American Railway Journal, XXI (June 29, 1889), 603.

At the annual meeting of the American Society of Civil Engineers held at Seabright, New Jersey, in June, 1889, William J. McAlpine read a paper entitled "A Method for Determining the Capacity of the Waste-Weir for a Storage Reservoir on a Torrential Stream." In the paper he expressed his views on the proper construction of dams for reservoirs on torrential streams, with particular comments relative to the South Fork Dam, as follows:

> The recent terrible disaster of the failure of an earthen dam at Conemaugh, Pa., has started in the public mind a distrust of all earthen dams similarly situated, which has been heightened by the publication of the alleged opinion of an eminent engineer, "that earthen dams should not be built on torrential streams." I am informed, however, that this distinguished engineer denies having expressed or entertained any such opinion.
>
> On three-fourths of the water and hydraulic works in this country, there are existing dams of earth either for storage or reception. The latter, in most cases, are either within or contiguous to the towns and cities, and all at elevations far above that of the adjacent towns. Are these structures unsafe, or do any of them threaten disasters similar to that at Johnstown?
>
> The foundations and circumstances of each case, if we should, as we ought, have regard solely to the safety of the structure, will determine whether a dam for storage upon a stream should be made of masonry or of earth. The considerations of economy should never enter into the question. It may, however, be remarked that the difference in the cost of such dams made of masonry or of earth is not great, when each one is selected to suit the circumstances of the case.
>
> When the bed of the valley and its sides are as high as the proposed crest of the dam and is of watertight rock, at or near the surface, the dam should be built of masonry, especially if stone of suitable quality can readily be obtained. When the bed and sides of the valley are of watertight earth, suitable material for the artificial bank is certain to be easily obtainable, and then the dam should be built of earth.
>
> When rock occurs, or is accessible on only a portion of the bed or sides of the valley, it will generally be

found that the structure can be most safely made of earth, because in a dam of masonry it is one of the most difficult problems to change the foundation connections with rock to those with earth.

The failures of dams have been chiefly from the following causes:

First. In two thirds of the cases which I have examined, the failures may be traced directly to an improper construction of the outlet pipes or conduits, leading first to leakage, which continually enlarged, ultimately causes a rupture.

Second. To an incomplete connection at the bottom and sides of the valley between the artificial and natural earths, both of which may be impermeable, and yet (not being properly united) may allow small leakages between them, first in films, which take up the firm earthy matter in solution, and thus continually enlarge the leak passage until finally the dam is ruptured.

Third. In earthen dams, from the want of sufficient waterwaste plan, so that great floods fill the reservoirs to overflowing, and cause the sudden destruction of the dam. . . .

Dams of masonry and earth are liable to be ruptured from all of the above cases, though the last mentioned one is peculair to those of earth, as destruction is certain, while in masonry it is rarely destructive.

The stability of a well made earthen dam was remarkably shown at the late disaster at the Conemaugh. The original dam, built by the late W. E. MORRIS, after long years of neglect was ruptured some twenty years or more ago by leakages along the conduit which contained the discharge pipes. This breach was filled up in a moderately good manner, but the height of the dam was lowered two or three feet to provide a roadway on top.

At the great flood of May 31 the water in the reservoir had risen so as to flow over the earthen dam at 10 o'clock, A.M., and continued to flow over for 4½ hours before the whole dam gave way. It then yielded by scouring out only that portion of the earthwork which had been put into the former breach by a railroad contractor, and leaving that portion built by Engineer MORRIS intact. Even this less perfect work resisted the pressure of some 7 or 8 ft. of extra depth of water for 4½ hours before it failed.

I may here remark that if this dam had been maintained at its original height, it is probable that the increased depth of the spillway passage would have discharged the great flood without allowing the water to overflow the dam, and it would probably be now standing. . . .

It is assumed that the greatest quantity of water which will ever be poured into an artificial lake will be when the surface of the ground is frozen and covered with three feet depth of snow, and a rain of four inches depth, with a temperature sufficient to melt the whole of the snow, equal to four inches more of water, say in six or eight hours.

That the dam is of earth, with its crest ten feet above the bottom of the wasteway. The wasteway must have a capacity to discharge the above flood without allowing the water in the lake to rise higher than four or five feet below the level of the crest of the earthen dam.

From a good many observations of floods, I have noticed that the water in the tributary brooks of the valleys flows at the rate of 2 to 6 miles an hour, depending upon their rate of descent, the roughness of the bed, and the sinuosity of the stream; and that the surface water flows over the land to the smaller water channels at from an eighth to a mile an hour, when it is not too much obstructed by trees, bushes, etc., or absorbed in the thirsty earth.[130]

In September 1889 A.Y. Lee, a civil engineer from Pittsburgh, completed the survey of the South Fork Dam watershed for the American Society of Civil Engineers. In his study he concluded that the watershed area was 48.6 square miles. Among his summary

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130. William J. McAlpine, "A Method for Determining the Capacity of the Waste-Weir of a Storage Reservoir on a Torrential Stream," Engineering News and American Railway Journal, XXI (June 29, 1889), 590.

comments on the characteristics of the watershed were the following:

> The general character of this water level is less rugged than might be expected from its location, at the very crest of the Allegheny Mountains. Judging from what could be seen of the watershed from the heights in the vicinity of the reservoir, which was perhaps half of it, it is fully half cleared land, with a gravelly soil, with little or no rocks in place cropping out, and with only a very limited area so steep that cultivation is not readily practicable on it. On the other hand, there is practically no level land on it, - all has sufficient slope to throw water rapidly off it into the streams. . . .

Taking the watershed as a whole, Lee went on to explain that "we should hardly say" that it sheds

> water much more rapidly than others of its size in ordinary hilly country. At least, it tends to safety to assume that it would not, although there may be few such basins not on the side of a mountain range where the water is helped along quite so continuously by unbroken descents.

He concluded by saying that:

> The main fact that we can be sure of is that, with a mountain watershed of this area and a reservoir of this size [he estimated it to be 405 acres at normal operating level], the original spillway provided for the dam was nearly, if not quite, enough for perfect safety, while the obstructed spillway, as it was when the dam broke, was less than half large enough.[131]

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131. "The Drainage Area of the South Fork Basin," Engineering News and American Railway Journal, XXII (September 14, 1889), 241. A copy of the map prepared by Lee, which appears as Plate XLVII in "Report of the Committee on the Cause of the Failure of the South Fork Dam," may be seen on the following page. Lee found that 16 inches of water were running over the dam when it broke and that the slope on the inner face of the dam was 2.75 to 1 in some places. "Editorials and Editorial Notes," Engineering News and American Railway Journal, XXI (June 22, 1889), 575.

PLATE XLVII
TRANS. AM. SOC. CIV. ENG'RS.
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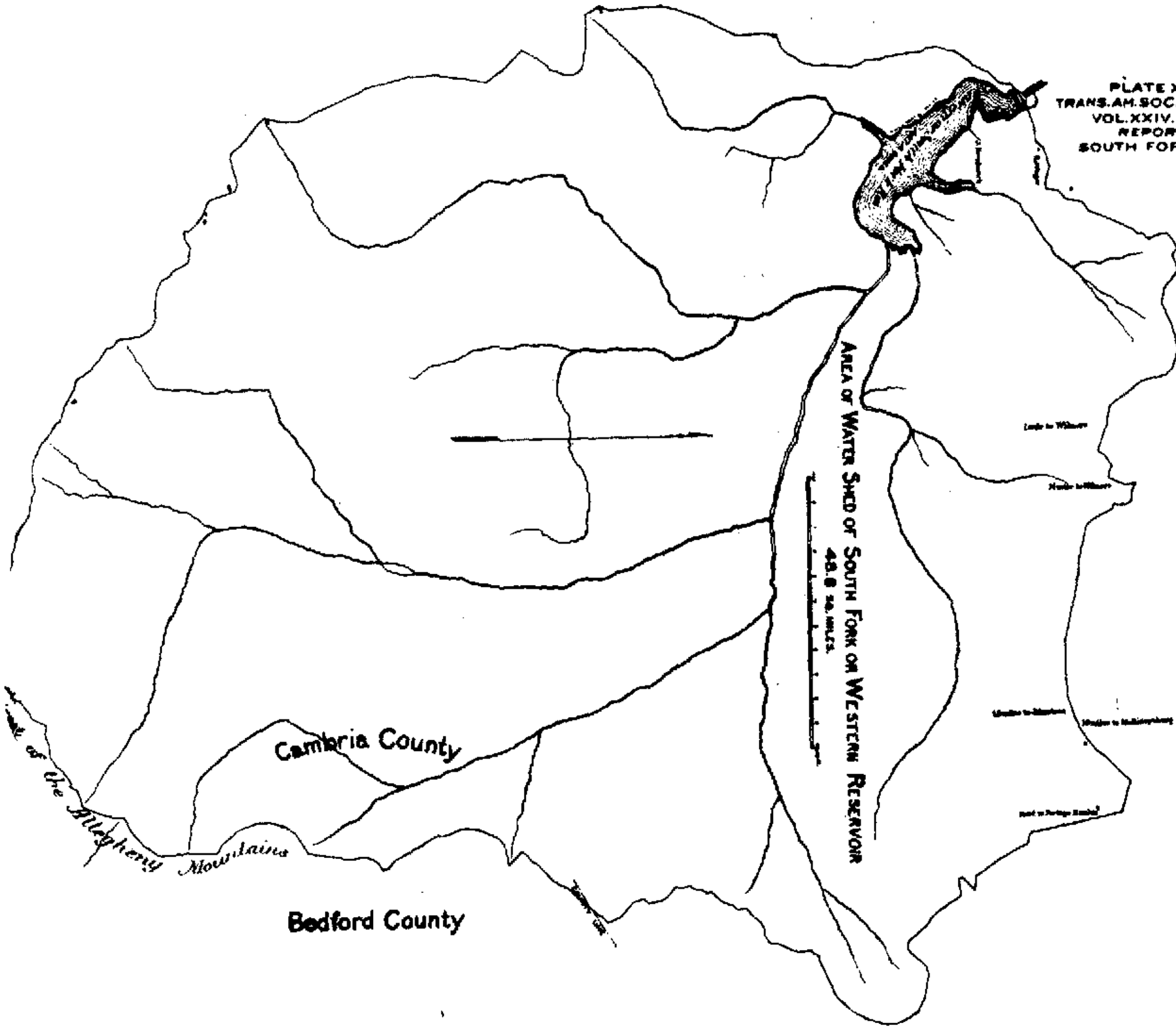
SOUTH FORK DAM.



Finally on January 15, 1890, the four-man inspection committee of the American Society of Civil Engineers released its report on the causes of the failure of the South Fork Dam. According to the report, the engineers concluded that the "failure was due to the flow of water over the top of the earthen embankment, caused by the insufficiency of the wasteway to discharge the flood water." The breach in the dam was "about 420 feet wide at the top and 50 to 200 feet wide at bottom." The amount of earth and stone that had been washed out of the breast amounted to some 90,000 cubic yards. "All the material put in in 1880 and 1881, to repair the breach of 1862" had been washed out "together with part of the old embankment made in 1851 and 1852." Some parts

> of this old work are exposed by the flood, and indicate that it offered great resistance to washing and that it was originally selected and put in with the requisite care to make a sound embankment. The original construction of the embankment as indicated by the plan and specification, and more particularly the mode of repairing the breach, may be objected to as not being according to the best practice; nevertheless, the failure of the dam cannot be attributed to any defect in its construction. . . .

Because of its conclusion that the inadequate waste was the principal cause of the failure of the dam, the committee devoted much of its attention to that portion of the structure and its relationship to the breast of the dam. The committee observed:

> According to Mr. Morris' original plan and specification the top of the dam was 10 feet wide and 10 feet above the ordinary surface of the water in the reservoir, which is understood to be nearly the same as the floor of the wasteway. By our levels the floor of the wasteway for 176 feet from the lake averages 1602.82 feet above tidewater. The elevation at eight points on the top of the remaining parts of the dam, where not affected by the late washout is 1610.78 being 7.96 feet above the floor of the wasteway, or 2.04 feet below its height as originally designed. This accords substantially with the

> statements of parties living in the vicinity, to the effect, that when the breach was repaired in 1880-81, the top of the dam was lowered about 2 feet in order to make a more convenient roadway over it, the remains of which are now 15 to 20 feet wide.[132]

The committee carried out various studies in an effort to compute the area of the lake, the rate of accumulation of water in the lake prior to overflowing the crest of the dam, the rate at which water was flowing out of the lake through the spillway, and the volume of water pouring over the dam just prior to its failure. A survey of the lake bed by William H. Scriven indicated that the area of the lake at its ordinary depth of water was 407.4 acres and at five feet above its normal depth, 456.8 acres. Because of the obstructions at the head of the waste caused by the fishguard and the sill on which it was placed, the ordinary height of the water in the lake was assumed to have been about one foot above the average height of the floor of the waste.

The engineers computed the rate of accumulation of water in the lake just before it began to flow over the embankment, using Engineer Park's observation that the rise of the water in the lake had risen nine inches in an hour and Scriven's calculations about the size of the body of water. To calculate the rate of accumulation, it was necessary to ascertain the rate at which the water was flowing out through the spillway. Using a mathematical formula that had resulted from experiments at Lowell, Massachusetts, they noted that:

> Mr. Parke's observation of the rise of 9 inches in an hour was evidently made when the height in the

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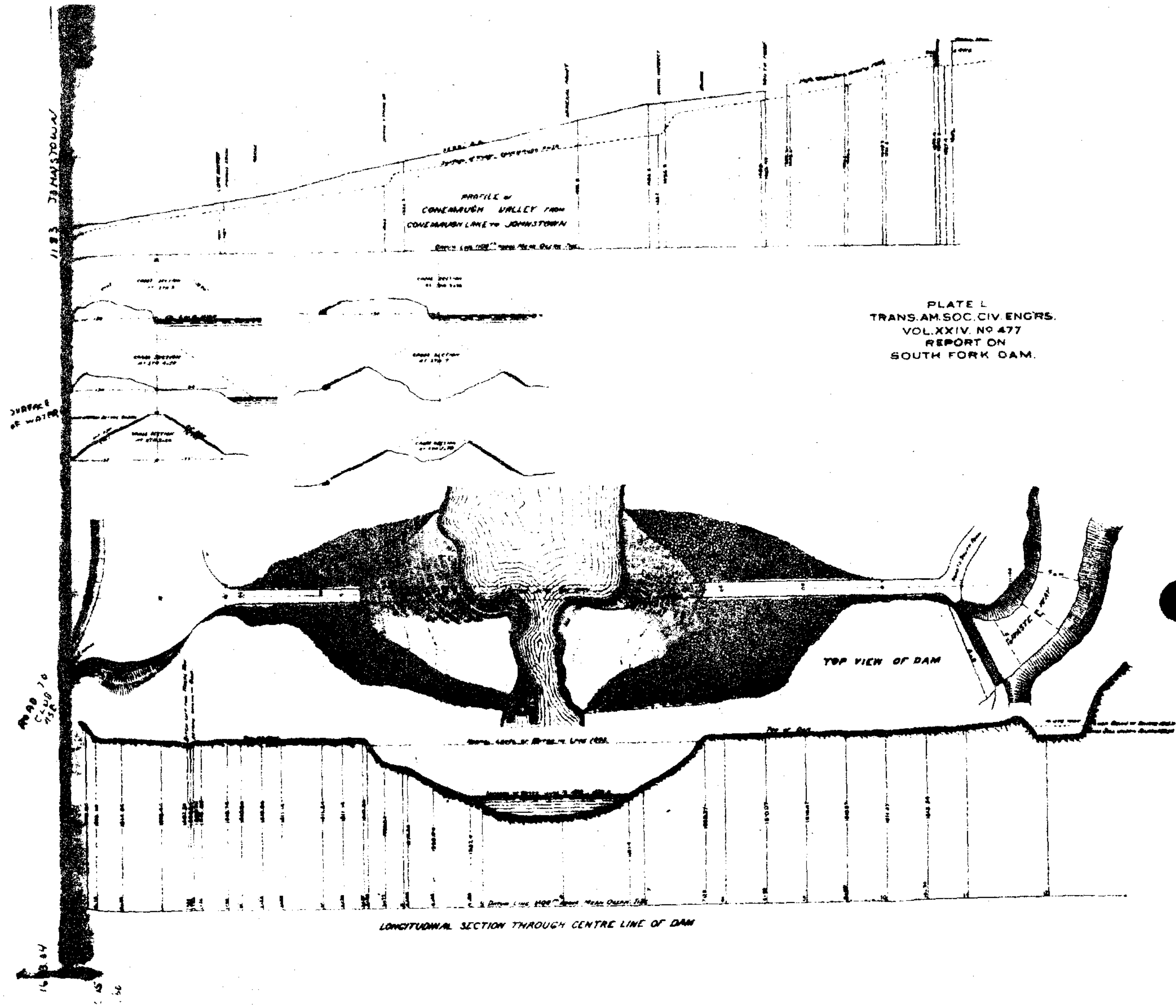
132. The drawing, labeled Plate L in the "Report of the Committee on the Cause of the Failure of the South Fork Dam," illustrates this information. A copy of the plate may be seen on the following page.



JOHNSTOWN
PROFILE of CONEMAUGH VALLEY from CONEMAUGH LAKE to JOHNSTOWN
SURFACE OF WATER
PLATE L
TRANS. AM. SOC. CIV. ENG'RS.
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TOP VIEW OF DAM
ROAD TO CLUB H'SE
LONGITUDINAL SECTION THROUGH CENTRE LINE OF DAM

reservoir averaged about 7½ feet above the floor of the wasteway. At this height the area of the reservoir was 471.62 acres, and the accumulation was at the rate of

$$\frac{471.62 \times 43.560 \times 0.75}{60 \times 60} \qquad 4,280 \text{ cubic feet per second.}$$

By our . . . method the discharge through the wasteway at this height was	3,700 " "
Total quantity entering reservoir at 11:30 A.M.	7,980 " "

Using the same formula, the committee calculated the rate of accumulation of water in the lake at mid-morning on May 31 when it was reported that the level of the lake was rising at a rate of nearly ten inches per hour. At that rate, when the height in the reservoir was five feet above the floor of the spillway, the accumulation would have been at a rate of 5,408 cubic feet per second. At that level the amount of water being discharged through the spillway would have been 1,800 cubic feet per second, thus indicating that the total quantity of water entering the reservoir at that time was approximately 7,208 cubic feet per second.

Just before the break occurred in the dam water was flowing over a large portion of its crest. Based upon eyewitness accounts, the committee estimated that the flow was equivalent to 100 feet in length and one foot deep or to 300 feet in length and nine inches deep. The engineers estimated that the quantity of water flowing over the dam was 991 cubic feet per second. The accumulation of water in the reservoir during the last hour was a rise of six inches or 2,911 cubic feet per second. The discharge through the wasteway when the level of the lake was 8.71 feet above the floor of the spillway was calculated to be 4,780 cubic feet per second.

Thus, the engineers estimated that the flow of water into the lake at the time of the break was 8,682 cubic feet per second.

The calculations of the engineers showed that the flow of water into the lake increased up to the time of the break. The report continued:

> Two-thirds of an inch of rain per hour on the water-shed is equivalent to 20,909 cubic feet per second. The rate of flow caused by a given rain-fall from any water-shed, in the absence of direct measurement is always difficult to estimate; it depends on several conditions:
>
> First. - the length of time during which the rain-fall at any given rate has continued, it being obvious, that the longer it continues the nearer the rate of flow from the water-shed will approximate to the rate of the rain-fall.
>
> Second. - The extent of the water-shed; the larger it is, the longer will be the average time required to reach the reservoir.
>
> Third. - The general inclination of the surface, on which depends the rapidity of the flow from the water-shed.
>
> Fourth. - The character of the water-shed as to its capacity to hold back the water; the favorable conditions for discharging rapidly being rocky and cleared surfaces; and for discharging slowly; ponds, lakes, swamps, large level tracts and woodland.
>
> In this case the extreme length of flow does not exceed 10 miles, and the average length probably is less than 4 miles. The inclination of the surface and the character of the water-shed appear to be generally favorable to a large discharge, and taken in connection with the continuance for several hours of heavy rain-fall, it would appear that a maximum rate of flow into the reservoir of one-half the rate of the rain-fall would not be too large an estimate. This would give a flow into the reservoir for a rain-fall of two-thirds of an inch an hour of $\frac{20,909}{2}$ = 10,454 cubic feet per second.

Although this figure exceeded the estimates of the calculated flow just prior to the break of the dam, the committee observed that it was not inconsistent with it as a maximum. Based on Parke's observation just before the break that "it had been raining most all of the morning and consequently we had more water to expect," and on the strong current of the water in the bed of the lake immediately after the break, the committee concluded that the increase of the flow may have reached such an extent.

After studying the plans and specifications for the wasteway, the committee noted that Morris' plans in 1839 had called for a waste having an aggregate width of not less than 150 feet. However, the waste as constructed in 1853 had an effective width of less than 70 feet. Their measurements had shown:

> The wasteway of the South Fork Reservoir in plan, is about 120 feet wide at the reservoir, narrowing to about 67 feet at 176 feet from the reservoir, the axis being nearly a quadrant of a circle of about 100 feet radius. In profile the average level of the bed of the wasteway for 126 feet from the reservoir is nearly horizontal. . . . The noted elevations varying from 0.14 feet above the average to 0.08 feet below. In the next 50 feet a descent of a foot is noted. This is evidently amply sufficient to maintain the velocity acquired by the water at the end of the horizontal part of the said bed, and consequently the bed beyond this point offers no resistance to the flow over the horizontal part, and this point is therefore taken to be the outfall of the wasteway. (See following page for an accommpanying drawing.)

The overall conclusions of the committee as to the causes of the dam's failure were included in a final statement. This summation read as follows:

> Assuming the maximum flow into the reservoir to have been 10,000 cubic feet per second, and the wasteway to have been constructed according to Mr. Morris' specification, with a free outfall at the entrance, we estimate that the corresponding height in the reservoir

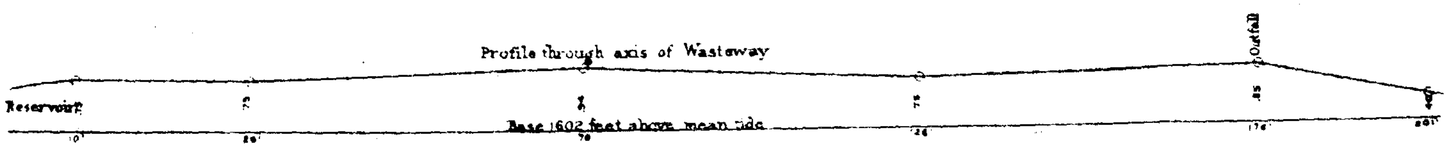

PLATE LI
TRANS. AM. SOC. CIV. ENG'RS
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SOUTH FORK DAM.

would have been 7.80 feet above the crest of the wasteway, or 2.20 feet below the top of the embankment as specified by him. With the five lines of 24-inch sluice pipes discharging to their full capacity at the same time, under 70 feet head, as no doubt was originally designed to be done in an emergency, we estimate the height in the reservoir would be about 7.52 feet or 2.48 feet below the top of the embankment.

The height of the embankment as constructed in 1851-53, was according to Mr. Morris' plan and specification. According to our method of estimating the flow through the wasteway, the discharge through it, when free from obstruction, and the water in the reservoir just up to the top of the embankment as originally constructed, and the sluice pipes discharging to their full capacity, would be 6,923 cubic feet per second. For the wasteways and sluices, as constructed in 1851-53, to discharge 7,980 cubic feet per second, which we have estimated above to have been the flow into the reservoir at the time of the breach, the height in the reservoir under the same conditions would be 10.95 feet above the floor of the wasteway or about 1 foot above the top of the embankment as originally constructed. For the discharge of the maximum quantity entering the reservoir, which we think was not less than 10,000 cubic feet per second, under the same conditions, would require a depth of about 12.63 feet.

The Hunting and Fishing Club, in repairing the breach of 1862, took out the five sluices in the dam, lowered the embankment about 2 feet, and subsequently, partially obstructed the wasteway by gratings, etc., to prevent the escape of fish. These changes materially diminished the security of the dam, by exposing the embankment to overflow, and consequent destruction, by floods of less magnitude than could have been borne with safety if the original construction of 1851-53 had been adhered to; but in our opinion they cannot be deemed to be the cause of the late disaster, as we find that the embankment would have been overflowed and the breach formed if the changes had not been made. It occurred a little earlier in the day on account of the changes, but we think the result would have been equally disastrous, and possibly even more so, as the volume of water impounded was less, and the greater width of the top of the embankment after the change and its consolidation by its use as a road for several years, must have increased its resistance to the formation of a breach and required more time.

In concluding, we must state that, while our deductions are based on the results of observations of rain-fall and of flow which are necessarily approximate, we feel satisfied that they are not far from the truth. There can be no question that such a rain-fall had not taken place since the construction of the dam. But the surface of the water-shed is quite steep, and the consequent rapid discharge of a large percentage of the rain-fall into the reservoir would require a very large outlet to prevent a dangerous accumulation. The spillway, however, had not a sufficient charging capacity; contrary to the original specifications of Mr. W. E. Morris, requiring a width of overflow of 150 feet and a depth of 10 feet below crest, which would have been a sufficient size for the flood in the present case, it had only an effective width of 70 feet, and a depth of about 8 feet; the accumulated water rose to such a height as to overflow the crest of the dam and caused it to collapse by washing it down from the top.

The dam itself, or the parts of it which were left standing, showed undoubtedly that it was well and thoroughly built, and that it would have successfully resisted the pressure of the water. The exposed sides of the breaks show distinctly that the compact layers of which the structure was formed were not obliterated by the wearing action of the flood, and they stand conspicuous witnesses of the value of an earth embankment when well built of good materials, to impound large bodies of water.[133]

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133. "Report of the Committee on the Cause of the Failure of the South Fork Dam," 451-457. At the conclusion of the printed report, there is an eightpage section in which the reactions of various members of the American Society of Civil Engineers may be found. A careful reading of this discussion indicates that various engineers who had examined the dam, spillway, and lake had taken measurements that did not agree. For instance, P. F. Brendlinger had taken measurements which levels differed from those of the committee by "about 4/10 of a foot per hundred, uniformly." His measurements of the spillway bridge also differed from those of the committee by 18 inches. These discrepancies were attributed to the fact that rains may have washed the crest of the dam between measurements and that different points in the spillway may have been used as the proper place for its elevation. At any rate, these discrepancies may help to explain why recent engineering surveys and measurements of the dam and spillway by National Park Service

E. THE NORTH AMERICAN REVIEW

Although not an engineering journal, The North American Review requested Major John W. Powell, Director of the United States Geological Survey, to submit an analysis of what went wrong at the South Fork Dam and of what steps should be taken to preclude future similar disasters. Powell concluded as follows:

> . . . In the construction of the dam there was a total neglect to consider the first and fundamental problem - the duty the dam was required to perform. The works were not properly related to the natural conditions, and so a lake was made at Conemaugh which was for a long time a menace to the people below, and at last swept them to destruction.

He went on to outline the steps that were to be taken to make a precise "determination of the duty of the dam" or "the conditions which it must fulfil or else be destroyed." These steps were as follows:

> When the construction of such a dam is proposed, the first thing to be done is to determine the amount of water to be controlled and the rate at which it will be delivered to the reservoir under maximum conditions of rainfall or snow-melting. The proper method of procedure is to determine, first, the area of the drainage basin supplying the reservoir; second, the declivities of the supplying basin.
>
> The very first thing, then, is a topographic survey.

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engineers do not agree with the levels in the committee report. It is interesting to note that two Pennsylvania Railroad engineers who took measurements of the dam and spillway also disagreed with the calculations of this report as well as with each other. It is recommended that this issue be clarified by undertaking a complete documentation of the elevations in the American Society of Civil Engineers report and those discovered by National Park Service engineers.

The second need is a hydrographic survey.

> The precipitation in rain and snow over the basin must be determined as an average from year to year, and also the maximum precipitation at the times of great flood. This must be supplemented by the gauging of streams to determine their average volume and maximum volumes. All of these factors are necessary and preliminary to the construction of a safe and efficient reservoir system by making mountain lakes. Before a reservoir dam is constructed, it is of prime importance to determine what will be required of it. With these facts ascertained, the engineer can easily plan works adequate to control the forces involved; he can readily determine how much water he can store, and what waste-way will be necessary to discharge the surplus.

Two other factors were necessary in the planning for new reservoirs or lakes. The streams feeding the reservoir should be gauged for the purpose of determining the amount of sediment they carry in order to calculate the "life" of the reservoir and to devise "proper engineering appliances" to discharge the sediment. The rate of evaporation should also be calculated to determine the amount of water loss through that process.

Powell warned that to neglect the aforementioned essential facts in the construction of a reservoir system was "to be guilty of criminal neglect." The

> history of mountain-lake construction, throughout all the countries of engineering enterprise, is full of lessons like that taught at Conemaugh, and the lessons have always been enforced by the destruction of property and life; they have always been emphasized by dire disaster. . . . Woe to the people who trust these powers to the hands of fools! Then wealth is destroyed, homes are overwhelmed, and loved ones killed.[134]

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134. Major J. W. Powell, "The Lesson of Conemaugh," <u>The North America Review</u>, CXLIX (August, 1889), 154-156.

F. THE ENGINEERING AND MINING JOURNAL

The Engineering and Mining Journal, a publication of the American Society of Mining Engineers, did not take an active role in the examination of the dam. However, the periodical did use eyewitness accounts and secondary sources relative to the disaster to draw some conclusions about the failure of the dam. The editors wrote that

> it is seen that the dam did not burst; that its strength was sufficient for the work it had to do; that it was lower than the old dam, and was provided with a waste weir of large, though as events show, insufficient dimensions. The washing out of the dam was not unexpected; for hours the engineer saw that it was inevitable, since the water had risen above the crown of the dam, and was flowing over it, and this, in the impossibility of increasing the waste weirs, made the failure of the dam by washing out merely a question of time.
>
> Insufficient overflow weirs and the material of which the dam was built seem to have been the chief defects in the structure, which was strong enough. No engineer should think of building an earth dam at such a point, and had this dam been built of rock the overflow would not have worn it away.
>
> An earth dam has appropriate places, but one of them certainly is not just above a thickly inhabited valley.[135]

135. "The Conemaugh Dam," The Engineering and Mining Journal, XLVII (January-June, 1889), 517.

CHAPTER SEVEN

THE DEMISE OF THE SOUTH FORK FISHING AND HUNTING CLUB AND NEW DEVELOPMENTS AT THE FORMER LAKE CONEMAUGH RESORT: 1889-1907

A. THE DEMISE OF THE SOUTH FORK FISHING AND HUNTING CLUB: 1889-1904

The South Fork Fishing and Hunting Club suffered from the censure and hatred of the flood days. After the disaster, the members avoided the Lake Conemaugh resort, membership dues declined, and notes fell due. Four days after the flood an angry group of men went to the dam looking for Unger and other club members. When it was discovered that the club men had gone off on horseback to Altoona and Pittsburgh almost immediately after the dam failed, the mob broke into several cottages, smashing windows and destroying furniture. Some time later, several cottages were occupied by six or seven families of Johnstown people, apparently with the consent of the owners. A few of the club members did return to Lake Conemaugh from time to time for short vacations, but the resort never again functioned as it had in the 1880s.[136]

In June 1891 a portion of the club grounds were advertised for sheriff's sale as a result of the suit entered by Henry Holdship and Benjamin Thaw to satisfy the bonds which they held. On July 6 nine parcels of the property were sold to a trustee, E.B. Alsip, for $600.[137]

On the last day of July 1891, the South Fork Branch Railroad, an eight-mile feeder and subsidiary for the main line of the Pennsylvania Railroad, was opened for business, thus facilitating the development of valuable timber, bark, and coal lands in the area, particularly the new Berwind-White Company mines at Windber. Following the South Fork for four miles, the

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136. McCullough, The Johnstown Flood, pp. 243, 264. Elias J. Unger was the only club member to return to the area and establish his permanent residence at his farm just beyond the spillway.

137. Johnstown Daily Tribune, June 11, July 6, 1891.

single track railroad passed through the center of the former Lake Conemaugh and the gap in the dam on a 14.46-acre tract that had been purchased for a right-of-way. From the bed of the lake the railroad turned south and followed Yellow Run to a point near the head of Paint Creek.[138]

In December 1900 it was announced that Dr. S. S. Kring of Allegheny had purchased the club house and about a dozen cottages from the club for $10,000. He intended to turn the club house and cottages into a sanitarium which would be ready for occupancy the following spring. It was observed that some of the buildings were "badly in need of repairs, having been allowed to stand idle since the calamity of 1889." Repairs on the club house were to begin immediately, and by spring it was expected "to be in excellent condition." At that time, it would be opened "as one of the most complete sanitariums in the State and would be filled with people."[139]

In February 1904 the South Fork Fishing and Hunting Club passed "out of history as an organization with the sale of all its personal effects" that had remained at the club house. The entire furnishings of the building were disposed of at a public auction.[140]

B. THE AREA OF THE FORMER LAKE CONEMAUGH RESORT: 1907

A map entitled "Map of Conemaugh Lake Situate in Adams & Croyle Twps, Cambria Co., Pa." was surveyed by the Fetterman

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138. Ibid., August 1, 1891, and Nathan D. Shappee, "Spoilation and Encroachment in the Conemaugh Valley Before the Johnstown Flood of 1889," The Western Pennsylvania Historical Magazine, XXIII (March, 1940), 40.

139. Johnstown Daily Tribune, December 7, 1900.

140. Ibid., February 13, 1904.

Engineering Company in November 1907. This map shows the water line of the lake and the property line of the South Fork Fishing and Hunting Club in 1889. It also shows the status of the former property of the club. There were three significant developments on this land that had taken place since 1889.

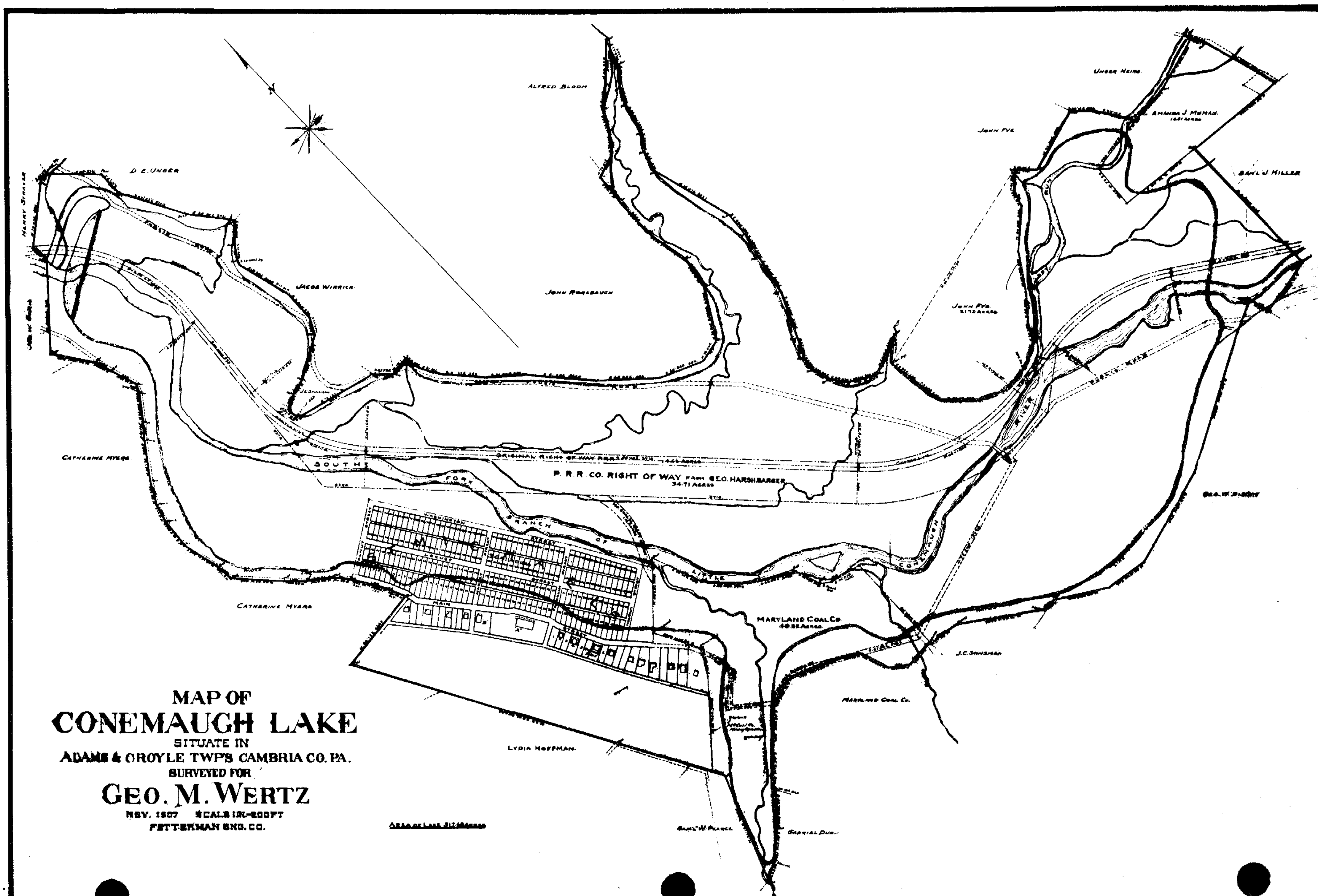
The town of St. Michaels had been laid out on a 30.91-acre tract on the southwest side of the former lake between the South Fork and the former club's cluster of cottages. This tract also included the ground on which the club house and cottages of the club were located. The town was laid out into 204 lots, the majority of which were situated in the bed of the former lake. All of the lots were located on the northeast side of Main Street which ran along the front of the club house and cottages. Apparently, one of the cottages was intended to be used as a school.

The Maryland Coal Company had purchased 40.92 acres of the former club's lands in addition to other surrounding properties. By 1907 the company had installed its main shaft and an air shaft in the bed of the former lake just southeast of the former club's cottages. The company had also purchased 1.18 acres for a railroad spur from its mining operations to the South Fork Branch Railroad line.

The Pennsylvania Railroad Company, through its South Fork Branch Railroad subsidiary, had expanded its right of way in the former lake bed. A tract of 34.71 acres had been added to its earlier acquisition of 14.46 acres.

By 1907 two public roads were in existence on the former club's property. One road generally followed the northern edge of the former lake before crossing the railroad and river near the eastern end of the old lake bed. Just after it crossed the river, the road was joined by another road which extended from Main Street in St. Michaels to the Maryland Coal Company operations and then followed the southern shore of the lake before cutting eastward along the river. From the junction of the two roads a single road continued eastward along the bank of the Little Conemaugh.[141]

141. "Map of Conemaugh Lake Situate in Adams & Croyle Twp's., Cambria Co., Pa., Surveyed for Geo. M. Wertz, November, 1907, Fetterman Eng. Co." A copy of this map may be seen on the following page.


MAP OF
CONEMAUGH LAKE
SITUATE IN
ADAMS & CROYLE TWP'S CAMBRIA CO. PA.
SURVEYED FOR
GEO. M. WERTZ
NOV. 1907 SCALE 1IN.=600FT
FETTERMAN ENG. CO.
ALFRED BLOOM
D. E. UNGER
JACOB WIRRICK
JOHN RORABAUGH
UNGER HEIRS
JOHN FYE
SAM'L J. MILLER
CATHARINE MYERS
P. R. R. CO. RIGHT OF WAY FROM GEO. HARSHBARGER
34.71 ACRES
ORIGINAL RIGHT OF WAY
SOUTH
FORK
BRANCH
OF
LITTLE
CONEMAUGH
RIVER
MARYLAND COAL CO.
MARYLAND COAL CO.
J. C. STINEMAN
GEO. W. DIBERT
LYDIA HOFFMAN
GABRIAL DUBS
MAIN
WASHINGTON

RECOMMENDATIONS

It is the opinion of the author that this report substantially provides the bulk of the basic research data required for the accurate stabilization/preservation treatment and site interpretation of the remnants of South Fork Dam and Western Reservoir (later Lake Conemaugh). It is also the opinion of the author that this report provides an adequate information base for the interpretation of the site.

Research for this report was performed in the following libraries and repositories:

Denver (Lakewood, Boulder), Colorado

Denver Public Library
University of Colorado Library
Rocky Mountain Regional Office Library (National Park Service)
Branch of Micrographics, Graphics Systems Division, Denver Service Center (National Park Service)

Cresson, Pennsylvania

Documentary, cartographic, and photographic files at Johnstown Flood National Memorial

Ebensburg, Pennsylvania

Cambria County Historical Society, Museum, and Library
Cambria County Courthouse

Harrisburg, Pennsylvania

Pennsylvania Historical and Museum Commission, Bureau of Archives and History
Pennsylvania State Library (Law, Government Publications, and General Sections)

Johnstown, Pennsylvania

Cambria County Library, Johnstown
Irving L. London (private photograph collection)
Johnstown Flood Museum

Pittsburgh, Pennsylvania

Carnegie Library of Pittsburgh
Historical Society of Western Pennsylvania

There are four recommendation for further research that conceivably might contribute to a more accurate stabilization/ preservation treatment and a more comprehensive interpretation of the site. First, all of the information on the South Fork Fishing and Hunting Club of Pittsburgh in this report as well as other published works is based largely on newspaper and secondary sources. To my knowledge as well as that of other reputable sources, such as the archivists at the Johnstown Flood Museum, Carnegie Library at Pittsburgh, University of Pittsburgh, and Historical Society of Western Pennsylvania, there is no known collection of papers relating to this club. Hence it would be an interesting as well as profitable exercise if research was carried out in the personal papers of some of the leading members of the club such as Andrew Carnegie, Andrew Mellon, Henry Clay Frick, Robert Pitcairn, and Philander C. Knox in an effort to gather information relative to the formation, organization, and operation of the club.

Second, the restoration of the visual scene of South Fork Dam would require the replacement of the telegraph poles and lines as they would have existed on May 31, 1889. Additional research is needed relative to the date of the installation of the poles and lines, the type of wire insulators used, and the origin of the line.

Third, since it has been generally believed that portions of the north abutment of the dam were removed in order to locate the railroad line that was built along the north shore of the Little Conemaugh in July 1891, additional research is needed to determine if this is true and if so how much material was removed.

Fourth, additional research is needed to determine the reasons for the difference in the elevations of South Fork Dam as stated in the American Society of Civil Engineers report (January 15, 1890) and those discovered by recent National Park Service engineers.

APPENDIXES

APPENDIX A

Report of S. Welch, Engineer, upon a reservoir for the Western Division

Engineer's Office, Johnstown, November 22d, 1834.

To JAMES CLARKE, Esq.
President of the board of Canal Commissioners.

SIR:-In compliance with the directions of the board, I have examined the country along the Little Conemaugh river, and along a portion of stony creek, for the purpose of selecting a suitable site for a reservoir for the western division of the Pennsylvania canal.

There is no point on the main branch of the Little Conemaugh, where a reservoir capacious enough for the purpose required, can be made, without overflowing the railroad. The Ebensburg branch is too small to afford a sufficient quantity of water. The South Fork, which rises in the Cedar Swamp near the summit of the Allegheny mountain, and unites with the main river about eight miles above this place, is the only branch of the Little Conemaugh which drains a district of country large enough to afford an ample supply. This stream discharges a quantity sufficient to fill a reservoir of any desirable extent. In summer it is nearly as large as the main branch.

The most favourable ground for a reservoir on the South Fork, commences about two miles above its mouth, and extends up the stream about two and a fourth miles.

The flat which would be covered with water, varies in width from eight hundred and forty, to about four thousand feet, exclusive of the lateral ravines or valleys which extend out from both sides of the principal valley.

The accompanying map [not extant] shows the extent of ground which would be covered, by a dam which would raise the water sixty feet at bench mark No. 1. This dam or mound of earth and wall, would be fourteen hundred and forty-five feet long. The quantity of water which the reservoir would contain, is estimated at a little more than four hundred million cubic feet, and the surface would cover about four hundred and thirty-five acres of ground.

The ground at bench mark No. 3, is seven feet higher than at No. 1. A dam of the same height at No. 3, would raise the surface of the reservoir seven feet higher, or it would make the water seven feet deeper than the marks on the map represent it. The surface would also be extended on the sides and at the upper end beyond the line represented in the map. A dam at this point would be eight hundred and forty feet long. The reservoir would contain about four hundred and eighty-five millions cubic feet of water, and the surface would cover about four hundred and seventeen acres of ground. This appears to be the most favourable site for a dam. The distance across the valley is less than at any other point above or below it, and it appears from the measurements made, that a dam of the height proposed, placed here, will form a reservoir of greater capacity, than one placed at any other point above or below. The valley increases in width above the upper end of the proposed reservoir, but the inclination of the ground is too great to make it available without a dam of very great height.

The site of the proposed reservoir with the exception of one small field, is covered with timber. The adjacent country for some miles in extent, is principally a forest, and the land is of comparatively little value.

The enclosed diagram [not extant] represents a section, through the centre, of a dam which I would recommend for adoption by the board. The wall and puddle bank should be commenced if practicable upon the solid rock. The slope towards the water should be made of materials that would be impervious to water. The lower slope may be made of coarse heavy materials of any description.

The sluices for letting out the water may be made at any point in the bottom of the dam, where a substantial foundation can be had. A channel sufficiently capacious to discharge the waste water during freshets, should be cut out of the hill, at one end of the dam. The hill at both ends of the dam, with the exception of a thin layer of earth on the surface, is formed of rock. The bed of the channel would therefore consist of solid rock, and not be liable to wear away. The water would not in any event pass over the dam.

Estimated cost of the reservoir, including the building of the dam, clearing the ground of timber, &c.

Clearing a site for the reservoir, 417 acres, at $15,	$ 6,255.00
19,000 perches of rubble wall laid with hydraulic lime, at 2.50,	47,500.00
14,000 cubic yards of excavation in puddle ditch, channel, &c. at 25,	8,500.00
41,000 cubic yards of puddling, at 25,	10,250.00
256,000 cubic yards embankment, at 20,	51,200.00
Contingencies, including gates and sluices,	9,000.00
	$127,705.00

If the wall be taken out, and its place supplied by puddled embankment, the cost of the reservoir would be reduced to eighty-four thousand six hundred and three dollars.

The surveys upon stony creek were made with a view to the construction of a dam across the main river, forty feet high. The most favourable site appears to be at the point marked upon the map, bench mark No. 4, near the head of Vicroy's mill race. A dam forty feet high at this point would overflow about three hundred and sixteen acres of ground, and the quantity of water would be equal to about two hundred and sixty-one and a half millions of cubic feet. A dam of the same height at bench mark No. 1, would overflow about three hundred and fourteen acres, and the capacity of the reservoir would be equal to about one hundred and ninety and a half millions of cubic feet. Neither of these reservoirs would be sufficiently capacious for the purposes required, and either of the dams, with the defences necessary to secure them, would cost as much, or more than the proposed dam on the South Fork.

No examinations have yet been made of the upper parts of Stony creek or its branches. It is probable that favourable sites for reservoirs may be found on these.

In the dryest part of the summer, the quantity of water in the Conemaugh river, at the junction of Little Conemaugh and Stony creek, appears to be nearly the same as it is at Leechburg, where the last feeder is taken into the canal. The water supplied by the tributary streams is not much more than equal to the quantity lost by evaporation. The gradual reduction of the surface of the pools on the upper parts of the river, until they fall to the lowest point that will admit of the passage of boats, keeps up a supply of water on the lower part for three or four weeks, the water in reserve becomes exhausted, and the quantity available for the purposes of navigation, appears to be nearly the same at all points where feeders are taken in. The surface of the Leechburg pool is equal in extent to about four hundred acres. The wear is about one foot higher than the top water line of canal, and the surface may be reduced one foot after the water has ceased running over the dam, without interfering with the passage of full loaded boats. This reserve of water (equal to about 17,264,000 cubic feet) has not been exhausted this season, and the canal from Leechburg to Pittsburg, thirty-five miles in length, has been at all times fully supplied, except when the water was drawn off to repair breaches.

The whole quantity of water required for the supply of this part of the canal in August and September, when the land springs and runs are dry, averages about ninety cubic feet per mile per minute; or $150 [sic] cubic feet per minute for the thirty-five miles. In addition to this, about 1500 feet per minute should be allowed for lockage water, which will be required for an extensive trade, making the quantity required about 4650 cubic feet per minute.

All the other canals on the Western division are much shorter than this-the longest does not exceed fourteen miles-each one is fed from a pool, formed by a dam, built across the channel of the river, and the water at the lower end is discharged into a similar pool which feeds a succeeding canal. All the water which leaks through the bank, &c. except that which is lost by evaporation, regains the channel of the river and passes into the next pool below. There is no absolute loss of water by lockage above Leechburg, nor by leakage, except so far as it augments the evaporation.

The estimated quantity of water required to supply the canal from dam No. 3, to the head of the pool of dam No. 2 of the Ligonier line, (this being the longest canal between Johnstown and Leechburg) and the one which requires the greatest quantity of water, is as follows:

Allowing 200 boats per day, and each lock full of water, including waste, to equal 15000 cubic feet, we have 200 x 15,000 ÷ 1440 minutes = per minute,	2083	cubic feet.
14 miles of canal, at 90 feet per mile, per minute, 14 x 90=	1260	" "
Makin[g]	3343	cubic feet.

Experience has shown that this canal requires a much greater quantity of water than any other on the Western division, except that from Leechburg to Pittsburg. The Conemaugh river at this place, or dam No. 3, above referred to, was at its lowest stage, supply for the canal, about 1700 cubic feet of water per minute, or 2,448,000 cubic feet per day. At Leechburg the Kiskiminetas will probably furnish about 2200 cubic feet per minute, or 3,168,000 cubic feet per day. The quantity of water required for the canal from Leechburg to Pittsburgh, with a trade requiring the passage of 200 boats per day, is estimated at 4650 cubic feet per minute, or 6,696,000 cubic feet per day. The canal between dam No. 3, and the head of the pool of dam No. 2 of the Ligonier line, is estimated to require 3343 cubic feet of water per minute; or 4,819,900 cubic feet per day. There would be required from the reservoir for the last mentioned canal, 1643 cubic feet per minute, and for the first 2450 cubic feet, per minute, or 3,528,000 cubic feet per day. The last mentioned quantity would be that which would be required from the reservoir during each day, while the river continued at its lowest stage.

The reservoir is estimated to contain about 485,000,000 of cubic feet. If the surface is reduced by evaporation during the dry season eighteen inches, equal to about 27,000,000 cubic feet, there will remain for the use of the canal 458,000,000 cubic feet of water. This, at the maximum quantity required for the passing of two hundred boats per day, will, in addition to the water that flows naturally in the river, supply the canal for a period of nearly one hundred and thirty days without any augmentation from rain.

In making the above estimate, the quantity of water lost by evaporation, from the channel of the river and from the canal, is not taken into consideration, as it is supposed the evaporation will not be increased by adding to the quality of flowing water in the stream.

Respectfully submitted.

SYLVESTER WELCH, Engineer.

Pennsylvania House Journal, Appendix to Vol. 2, 1835-36, pp. 54-58.

APPENDIX B

Report of William E. Morris, Engineer.
RESORVOIRS [sic]
ENGINEER'S OFFICE, Hollidaysburg, Nov. 1, 1839.

To JAMES CLARKE, ESQ., President of the Canal Board.

Sir:-Having in compliance with the directions of the board, completed the surveys, necessary for the location of the reservoirs, near "the terminations of the Allegheny Portage Rail Road;" I beg leave to submit the result in the following report:-

The Western termination of the Portage Rail Road, and the commencement of the Western Division of the Pennsylvania canal, are at Johnstown. The canal is supplied by water, taken by feeders from the Little Conemaugh river and Stony Creek, which form a junction at this place. The valleys of both these streams, and their tributaries have been examined for the purpose of selecting the most favorable site for a reservoir.

The first inquiry that presents itself, and upon which, the size of the reservoir depends, is the quantity of water requisite to supply the canal for the most active trade, and during the longest continued drought.

Three months without rain, and a trade that can be passed by two hundred locks full of water per day, are considered safe data for calculation. Under the most favorable circumstances, one lock full of water will pass two boats; under the greatest disadvantages, with a brisk trade, two locks full are sufficient for the passage of three boats. Three hundred boats per day, at an average of thirty tons per boat, would pass a trade equal to nine thousand tons per day.

The greatest amount of tonnage, that passed this season upon the Portage rail road, in one day, was about fifteen hundred tons.

The quantity of water, required for the amount of trade just mentioned, will be as follows: for the canal fed from the dams at Johnstown, which is about six miles in length; and to supply the weigh lock, the waste water from which, is discharged into the Conemaugh, and taken again onto the canal at the next dam below.

Two hundred locks full per day, including waste, would be equal to	2,100 cubic ft.pr min.	
Leakage and evaporation upon six miles canal,	600	do
Weighing three hundred boats,	2,000	do
Greatest demand,	4,700	do
Deduct amount estimated by Mr. Welch, to be furnished per minute, by the Conemaugh and Stony creek in the dryest seasons.	1,700	do
Amount required per minute for the reservoir,	3,000	

Which multiplied by 129,600 the No. of minutes in three months, equals three hundred and ninety millions, nearly the required available contents of the reservoir.

According to the estimate of Mr. Welch, for the same trade, the quantity of water required from the reservoir, to supply the canal between dam No. 3, of the Ligonier line; and the next pool below, a distance of fourteen miles, (being the longest piece of canal above Leechburg, fed from one dam) is 1,643 cubit feet per minute; and for the canal below Leechburg, 2,450 cubit feet per minute; both these amounts are less than that required, as shown above, for the canal at Johnstown.

The valley of Stony creek is not well suited for the construction of reservoirs. Its descent is too great, and the stream in time of floods, by far too large and unmanageable, some of its head water flow from the neighborhood of Berlin, in Somerset county; and from that point to Johnstown, its branches drain almost the whole extent of country between the Allegheny Mountain and the Laurel Hill. Great as may be the importance of securing an ample supply of water; it is no less important to ensure the permanence and stability of the dams, and for this purpose, to avoid streams so powerful as to endanger the safety of the works.

Its branches, with the exception of the Quemahoning are too short, and furnish too small a quantity of water to fill a reservoir of the required size.

This latter stream unites with Stony creek, about ten miles above Johnstown. It is rapid, and the valley narrow, possessing few of the advantages found upon the south fork of the Conemaugh.

Upon the main branch of the Conemaugh, there is but one point at which a reservoir sufficiently capacious could be formed, and its construction there, would flood the village of Jefferson, and cover the rail road for several miles. This site, therefore, is excluded from consideration.

Of the other branches, the south fork is the only one that drains a sufficient extent of country, to render certain a supply of water for the reservoir. The junction of this stream with the main branch, is about eight miles from Johnstown.

There can be no doubt of the sufficiency of this stream, to fill a reservoir, of any desired capacity. It was carefully gauged in September, after one days' rain, and found to discharge in twenty-four hours, sixty millions of cubit feet of water. At the same time, there were flood marks along the stream, two feet higher; it would be a moderate estimate, to suppose a flood of two feet additional height, it would discharge three times as much water; equal to one hundred and sixty millions of cubit feet, in twenty-four hours.

The most suitable point upon this stream for the construction of a reservoir, is about two and one fourth miles from the mouth; and is the same recommended in 1834 and '35 by Mr. Welch.

A dam at this point, that would raise the water sixty-two feet, would be eight hundred and fifty feet long on top, would form a reservoir containing, four hundred and eighty millions of cubit feet of water, and cover four hundred acres of ground.

This site combines more advantages for the construction of a reservoir, than any other upon the waters of the Conemaugh, or Stony creek. It is not remote from Johnstown, and is less than two miles from the rail road. It is situated upon a stream that will furnish an abundance of water to fill the reservoir; and from the floods of which but little danger is to be apprehended; if proper channels are constructed for their discharge. The valley is narrow at the dam, and widens immediately above, into an extensive basin. The land intended to be flooded, except a few acres, is covered with timber, and consequently but small injury will result to private property. There is solid rock at both ends of the dam, in which channels may be cut for the discharge of waste water, in time of floods. This fact has been satisfactorily ascertained by a full examination, by means of drifts and shafts sunk for the purpose. Abundance of the best material for the formation of the dam, is found convenient. The "feed water" with but little loss from evaporation will pass to the canal at Johnstown, down the natural channel of the stream, which is narrow and protected from the sun by woods and mountains. Allowing the surface of the reservoir to be reduced two feet by evaporation, there will remain for supplying the canal, four hundred and fifty millions of cubit feet of water; which will yield for three months, three thousand five hundred cubit feet per minute; being sixty millions of cubit feet of water more than the amount required, equal to five hundred cubit feet per minute for three months.

Two plans for the dams, present themselves for consideration, one to be constructed in the usual manner of crib dams, with timber and stone-having a weir upon the top, over which the waste water shall pass, in times of freshets. The other to be formed by a mound or embankment of stone and earth, made perfectly water tight, and raised ten feet above the surface of the pool-having a waste or channel cut in solid rock at one or both ends of the dam, for the passage of the flood water.

To the former plan there are serious objections, great difficulty would be experienced in uniting the body of the dam with the embankments, in such a manner, as to prevent leakage, under so immense a pressure; it would require a large expenditure to secure the base of the dam from undermining; the perishable nature of the material used in its construction, would render early and continued repairs necessary, and thus furnish another constant source of expense to the commonwealth. By the latter plan, both of these objections are avoided, and the dam, when once properly constructed, promises to be permanent and durable, and capable of being maintained at small expense.

The sluice for passing the "feed water" should be placed through the dam, near the surface of the ground, for the purpose of rendering the entire content of the reservoir available.

It may consist of cast iron pipes for about sixty feet next the water, and a cut stone culvert, the remainder of the distance through the dam; a sett [sic] of stop cocks faced with brass, should be placed at each end of the pipes. Those at the lower end for general use, and those at the upper end, as safety gates.

The pipes as laid, should be tested by a force pump, under a pressure, equal to three hundred feet head of water.

The accompanying plans and specifications contain a detailed description of the kind of dam, sluice, &c., which I recommend to the adoption of the Board.

ESTIMATE OF WORK.

400 acres clearing ground covered by water,
8 acres grubbing, base of dam and wastes,
15,000 yards excavation, foundation for dam, puddle ditches, &c.,
40,000 do do rock in wastes,
110,000 yards embankment of dam, good earth,
100,000 do do do slate and stone,
2,000 yards puddling about sluice,
5,000 perches ruble [sic] wall, laid in cement,
6,000 perches slope wall, dry,
3,000 perches cut wall for sluices, laid in cement,
7½ tons wrought iron,
75 tons cast iron for pipes,
10 stop cocks with brass facings, lever and screw,
House for sluice tender.

Estimated cost $188,000.00, exclusive of damages, engineering, and office expenses.

The canal at the Eastern termination of the Portage railway commences at Hollidaysburg, and is supplied by the water of the Beaver dam branch and the south fork of the Juniata. The latter is the only stream upon which a sufficient reservoir can be constructed.

The quantity of water required for the same amount of transportation, assumed as the basis of the calculations for the Western reservoir will be, as follows: for the canal from this place to the new feeder dam at Frankstown, a distance of 3 miles; and the weighlock, the waste water from which flows into the pool of the Frankstown dam.

200 locks full, including waste	2,100	cub.ft.pr.minute.		
Leakage and evaporation upon 3 miles canal,	300	"	"	"
Weighing 300 boats	2,000	"	"	"
Greatest demand	4,400	"	"	"
Deduct natural flow of streams in dryest seasons	2,400	"	"	"
Amount required from reservoir	2,000	"	"	"

Which in three months is 260 millions of cubic feet, the required capacity of the reservoir.

The general features of the valley of the South fork of the Juniata are such as to furnish frequent sites, in some respects favourable for the formation of reservoirs. The descent is moderate, and the width of the flats irregular-abounding in narrow points, where dams could be cheaply constructed; and widening into basins above them.

Two sites were mentioned by Mr. Welch, in his report made in 1835. One at Seth's mills, eight and one-half miles, and the other, one and a half miles, above the head of the present feeder. Into the one at Seth's mills, but a small portion of the water of the South fork, can be collected; it being situated above the junction of the following branches, viz: North Poplar run, Cove creek, Dry run and South Poplar run. These branches at all times contribute at least three-fourths of the volume of the main stream. A dam thirty feet high would form a pool, containing 160 millions of cubic feet of water; and cause one furnace, one saw mill and several dwelling-houses to be overflowed. The capacity of the pool could not be materially increased. These facts, together with the remote situation of this point, induced an immediate abandonment of its consideration.

At the last mentioned site, one and a half miles above the head of the feeder, a dam thirty feet in height; would be 2870 feet in length on top--would cover 450 acres of land; and contain 272 millions of cubic feet of water. By its erection, one grist mill, one saw mill, a tavern, store and distillery, and several dwellings would be flooded; a roofed bridge over the river, and about one mile of turnpike road would be destroyed. The land is nearly all under cultivation and inferior to none in the valley. The hill at western side of the valley, is composed of a light shelly slate rock; an entirely unfit material, in which to construct a waste: That upon the eastern side, is a compact clay, intermixed with stone, and gives little indication of rock upon the surface; nor was the appearance more favourable upon excavating a drift 35 feet into the hill.

The plan recommended for the construction of a waste, at the western reservoir, is much to be prefered to any other. If it be adopted here, <u>solid</u> <u>rock</u>, for the waste is <u>indispensable</u>.

ESTIMATE OF WORK.

150 acres clearing land covered by water.
36,000 yards excavating, foundation of dam, puddle ditches, &c.
310,000 yards embankment of dam, earth and stone.
30,000 yards rock excavation in waste.
10,000 perches slope wall.
1,500 perches wall for sluices.
4½ tons of wrought iron.
60 tons cast iron.
10 stop cocks with brass facings, screw and lever.
House for sluice tender.

Estimated cost, exclusive of damages and office expenses $150,000.00

Three other sites were examined, two of which are worthy of notice. At the third, rock was found suitable for a waste. It is situated near the residence of Judge M'Ewen, one and a half miles below the point, at which Mr. Welch's survey commenced, viz: "the head of the feeder," and one and a half miles from the basin at Hollidaysburg.

A dam at this point 28 feet in height, would be 1230 feet long on top, would form a reservoir, the area of which would be 450 acres, and its available content 320 millions of cubic feet of water.

It may be objected to this location that the surface of water in the feeder is seven feet above the surface of the valley at the dam; and consequently, all that portion of the water of the reservoir, contained below the level of water line in the feeder, cannot be drawn into the canal, and is unavailable. This unavailable portion however, is not included in the above stated "useful content" of the reservoir; it amounts to but 12 millions of cubic feet and would not supply the canal one week, and the capacity of the reservoir is amply sufficient without it.

A more serious objection arises from the fact that the rock before mentioned as suitable for the waste, is upon that side of the valley, occupied by the feeder; a portion of which must be removed in the construction of the waste.

This circumstance renders it necessary to place the sluice for passing the "feed water" on the side of the valley opposite the feeder, and to convey the water, either over the stream by an aqueduct, or beneath its bed in iron pipes.

This structure, properly constitutes an item in the cost of the reservoir at this point, and is therefore included in the estimate.

ESTIMATE OF WORK.

150 acres clearing land overflowed by water.	
5 acres grubbing site of dam and wastes.	
16,500 yds. excavation of foundation of dam, puddle ditches, &c.	
50,000 yds. embankment-good earth.	
55,000 yds. ditto slate and stone.	
2,000 yds. puddling about sluice.	
25,000 yds. rock excavation of waste.	
1,500 prs. masonry of sluices.	
5,000 prs. slope wall.	
4½ tons of wrought iron.	
60 tons of cast do.	
10 stop cocks, with brass facings, screw and level.	
House for sluice tender.	
Conveyance for "feed water" across rises	$15,000.00
Estimated cost, exclusive of damages, office expenses, &c	$100,000.00

In making the foregoing comparison of cost, the corresponding items of work at the two sites were estimated at the same prices.

At the latter site, no manufactories, mills, or other water works, nor any valuable buildings, would be destroyed. The land that would be covered, though principally cleared, is of less value, than at either of the other proposed sites. It is three miles nearer the basin at Hollidaysburg. By its construction at this point, one and a half miles of the feeder would be dispensed with.

Both sides of the proposed pool, are bounded by steep hills, upon which there are few dwellings. At any other part of the valley, one or both sides of the reservoir would be skirted with farms. To the people generally and the owners of property in the valley, in particular, the selection of the lower site, will give far the least dissatisfaction. There would also be a material saving in cost of construction.

Estimated cost of upper site	$150,000.00
" " of site at Judge M'Ewens	100,000.00
Difference in favor of the latter	50,000.00
To this may be added the greater amount of damage at the upper site, equal at least to	15,000.00
Total difference in favour of the lower site	$ 65,000.00

Should rock suitable for a waste be found on the Eastern side of the valley, for which examinations are now being made, the aqueduct will be dispensed with, and thus there would be an increased saving of $15,000 to the commonwealth.

I therefore recommend the adoption of the lower site.

The foregoing calculations are made for a dam, constructed in the same manner, as recommended for the western reservoir, omitting the vertical wall. The accompanying maps, plans, specifications, exhibit the particulars, in detail.

Respectfully submitted.

WM. E. MORRIS, Engineer

Pennsylvania House Journal, Appendix to Vol. 2, 1840, pp. 158-164.

APPENDIX C

GENERAL DESCRIPTION OF ENGINEERING TECHNOLOGY EMPLOYED IN DAM CONSTRUCTION IN THE UNITED STATES IN THE 1830's

"The diagram...of the cross-section of the South Fork dam, as originally built, closely resembles the type of earthen dams which were built in 1830 and anterior by the canal engineers of New York, Pennsylvania, and Ohio. By correspondance, written and oral, a general plan of such dams was agreed upon among the engineers of that day.

The general features of these dams were a top width of 12 or 15 ft. carried up not less than 10 ft. above the bottom of discharge way of the waste, and slopes of 2 to 1 on each side. Where rock was used for the lower section of the dam, the lower slope was often reduced to 1½ to 1. The earth for the upper section, from the waste slope to beneath the rear top angle of the bank, was selected material (clay and gravel), put on in layers of 6 to 8 ins. moistened and compacted by the travel of the teams, as heavy, grooved iron rollers were then unknown.

Almost universally there was put in the center of the dam a puddle wall of clay and gravel, 6 ft. wide at a level 6 ft. above the water line, and increasing in width by steps of 1 ft. on each side of the puddle-wall, for a width of 10 to 12 ft. The tightest material, wet and compacted, was put in, and all of the remainder of the front (or water) slope was made of similar selected materials. Large stones, of more than 5 lbs. weight, were taken out of the front part and placed on the rear slope, over which turf, soil, and light materials were placed.

A gate-chamber of masonry was generally placed just within the front row of the bank, and cast iron discharge pipes were extended from this gate-chamber under the bank to a small gate chamber at the foot of the outer toe of the bank. Sometimes these pipes were carried half way through the bank and discharged into a conduit of masonry, which conveyed the water through the remaining half of the bank. . . The cast-iron pipes which I [William J. McAlpine] used were of 8 to 12 ins. diameter, and connected by flanges, and were always laid upon and enveloped in a supporting wall of masonry with cross cut-off walls. Frequently, however, the pipes were laid upon and enveloped in heavy walls of puddle, and wide cutoffs of sheet iron put in at the pipe joints to prevent the water following the smooth exterior surfaces of the pipes.

The puddling of that period was expensive, costing for the labor alone about 30 cts. per cu. yd. It was made of selected clay and fine double screened gravel in the proportion of one part of clay to two of gravel up to two parts of clay to one of gravel. These materials were throughly mixed, moistened (not wetted) and put on in layers of 6 ins. and cut with spades (not shovels), the cuts an inch apart and then cross cut, the workmen standing upon boards to guide the cutting and the spading extending into the cut puddle below. By measurements made at that time, this process compacted the material from its natural condition in the earth from 20 to 25 percent, and in a month or two the mass became an artificial hard pan, over which water might run for some time without much abrasion.

Mr. JOHN B. JERVIS imported this method of puddling from England, and first used it on the Chenango canal in 1830. He directed me to train some of our inspectors in making the new puddle. One of these trained men, I believe, is now alive and well-known on the Erie Canal (J. HASBROUCK DECKER). Great care was taken to have the spillway of ample capacity, though there was no rule in practice to determine the size. If the hillsides at the dam were of rock, deep and wide trenches were cut as far away from the end of the dam as possible, to where a fall could be obtained, and then a walled channel built to conduct the waste water beyond the outer pool of the earthen dam. If the hillsides were of earth, the channels were walled with masonry and floored with timber and plank.

Frequently waste gates were introduced at these spillways, but no reliance was placed upon them, as their usefulness depended upon uncertain human agency. The crest of the waste weir was usually a hinged plank on top of the masonry, which could be triggered by a blow of a long pole, and thus add a foot to the depth of the discharge.

William J. McAlpine, "A Method for Determining the Capacity of the Waste-Weir of a Storage Reservoir on a Torrential Stream," Engineering News and American Railway Journal, 589-90.

APPENDIX D

APPROXIMATE ESTIMATE OF WORK - DAM FOR THE WESTERN RESERVOIR

Grubbing site of Dam - 8 acres (including ground for waste)
Clearing ground attached to Dam - 5 acres

11,000 cubic yards earth excavation of puddle ditches above walls
1,100 cubic yards rock excavation of puddle ditches above walls
2,000 cubic yards earth excavation of puddle ditches below walls
1,000 cubic yards rock excavation of puddle ditches below walls
109,000 cubic yards embankment of dam-good stuff
97,000 cubic yards embankment of dam-slate and stone
2,000 cubic yards puddling
50,000 cubic yards excavation of earth and rock in wastes
4,500 perches of vertical wall
6,000 perches of slope wall
3,000 perches of masonry in sluices laying 350 feet of pipe

"Specifications, Bills of Materials, Notices, Etc., Exhibited at Letting of Eastern & Western Reservoirs held Nov. 6 & 9, 1839," I vol., 20 pp., RG 17, Map Books, No. 39: 1839, 1846, 1855, a.

APPENDIX E

BILL OF WROUGHT IRON FOR WESTERN RESERVOIR

30 Bars from 8 to 12 ft. long, 1½ by 3/4 square, for Grate
1 Bar (for arch), 24 ft. long, 3 by 1 square, for Grate
2 Bars (for arch), 16 ft. long, 3 by 1 square, for Grate
2 Bars (for arch), 5 ft. long, 3 by 1 square, for Grate
16 wall bars, 15 ft. long, 1½ by 1¼ square, to secure breast plates
5 valve rods, 70 ft. long, 2½ in. diameter
35 Bars with fixtures for brass boxes from 5 to 10 ft. - 2 by 3/4 in.
35 Bars with fixtures for brass boxes from 12 in. long, 2 by 6 in.
8 Bolts for valve rods, 8 ft. long, 1 in. sq. (to secure v. pl.)
18 Bolts, 6 ft. long, 1 in. sq., for breast plates
7 Top Cast, 3 ft. long, 1 in. sq., for suspension path
7 Bolts, in Top Cast, 3 ft. long, 3/4 in. sq., for suspension path
14 suspension, Top Cast, 8½ ft. long, 3/4 in. diameter., for suspension path
2 side, Top Cast, 40 ft. long, 1½ in. by 3/4, for ladder
10 wall bars, 3 ft. long, 1½ in. by 3/4, fastenings for ladder
33 cross bars, 18 in. long, 3/4 in. diameter, for ladder
60 lin. ft. Clamps, 1¼ in. by 3/8, for coping

Total weight of wrought iron - 12,440 lbs.

"Specifications, Bills of Materials, Notices, Etc., Exhibited at Letting of Eastern & Western Reservoirs held Nov. 6 & 9, 1839," 1 vol., 20 pp., RG 17, Map Books, No. 39: 1839, 1846, 1855, a.

APPENDIX F

BILL OF CAST IRON FOR WESTERN RESERVOIR

5 pipes - 75 ft. long - 2 ft. diameter - 1½ inch thick
2 plates for end of pipes - 17 ft. long - 4 ft. by 2 in.
1 plate on stack for valve rods - 15 ft. long - 2 ft. by 2 ins.
5 pipes for passage of valve rods through culvert - 4 ft. long - (3 in. diameter, 3/4 in.)

Total weight of cast iron - 150,495 lbs.

"Specifications, Bills of Materials, Notices, Etc., Exhibited at Letting of Eastern & Western Reservoirs held Nov. 6 & 9, 1839," 1 vol., 20 pp., RG 17, Map Books, No. 39: 1839, 1846, 1855, a.

APPENDIX G

BILL OF LUMBER IN CULVERT FOUNDATIONS

43 pieces	12" x 12"
160 pieces	12" x 12"
12 pieces	12" x 12"
15 pieces	12" x 12"
18 pieces	12" x 16"

TOTAL - 7,036 feet

2 pieces	12" x 12" x 30' put in while foundation was being laid

Field Book, Western Reservoir, 1840, 1 vol., RG 17, Engineering Records, 1825-52.

APPENDIX H

"Reservoirs, Report of Wm. E. Morris, Engineer," November 20, 1840"

The importance to the canal of an abundant and certain supply of water at all times, cannot be doubted by any. Particularly is its importance great upon the main line of the Pennsylvania improvements, a route, considered by the citizens of this Commonwealth, as standing first among those channels of communication opened by the bold and enterprising competitors for the trade of the western world. In this eager contest, interruptions to the navigation, however short, and irregularities of arrival and departure, produced by whatever cause, and though of rare occurrence, are magnified from interested motives, and reported abroad with every possible exaggeration. This is public confidence shaken, the route deprived of its natural and customary traffic, and its business, usefulness and revenue diminished. Where so great an amount of money has been invested, and such vast interests are at stake, it is not the part of wisdom to permit the transporters upon the canals, to labor under these disadvantages, nor the improvements to suffer from these injuries to their reputation. It is to be regretted, that there exists so much reason for complaint upon the part of the forwarding merchants, and that the representations of those interested in rival routes, are not without truth.

Mr. Welch in his report in 1835, states that "Reservoirs on both sides of the mountain ought to be commenced without delay. On the Western Division, the passage of boats was a good deal impeded, in consequence of a deficiency of water, in the latter part of August, and early in September, 1834. On the Eastern Divison, the water began to fail about the 1st of September, 1835, and continued so low in the upper ten miles of the canal, for about two weeks, as to be a serious impediment to the navigation."

The Legislature of 1835-6, directed the Canal Commissioners to place under contract a Reservoir at the Eastern and Western termination of the Portage railway to supply the Juniata and Western Divisions with water.

Mr. Aycrigg, the engineer of the Western Division, in 1838, says: "To supply the upper sections of the canal it is important to have the Reservoirs proposed by Mr. Welch, in 1834, constructed as soon as possible, since the natural flow of the Conemaugh is totally inadequate to the supply of the canal in dry seasons."

The Canal Board, in their report, in 1838, speak of this subject in the following manner, with reference to the Western

Division:-"The water was so low that the levels could not be kept sufficiently full for the passage of freight boats; in consequences of which, goods were detained for sometime at Johnstown, after reaching that place. From past experience, we cannot rely upon the supplies furnished by the Conemaugh, and upper Juniata, in a dry season. Reservoirs will therefore have to be constructed on each side of the Allegheny mountain."

The difficulties that occurred upon the Western Division, in 1838, from want of water, are by no means exaggerated, but on the contrary, are not fully stated. I learn from unquestionable authority that for several weeks the packet boats were unable to ascend to Johnstown, and the only kind of craft that could navigate the canal, was a common flat. The transportation of goods was entirely suspended.

This interruption of navigation upon the Western Division was but little felt at the time, on account of the almost entire cessation of business upon the canal, in consequence of the "big break" upon the Juniata.

Mr. Patton, the Superintendent of the Portage railway, says in his report of 1838: "After the break of the canal, business almost ceased, and there would have been a saving of money to the road by stopping until the canal was repaired."

The supply of water upon the upper levels of the Juniata and Western Division, was equally deficient during the present season. The passage of heavily laden boats was much impeded, from the early part of July, until the 20th of October. During the last six weeks of this time, the weigh locks at Johnstown and Hollidaysburg were closed, and no boats could run with more than half a load.

While the weigh lock was closed at Hollidaysburg, viz: from 1st of September to 20th of October, being fifty days, there were four hundred and seventy-three boats cleared, and of arrivals, about an equal number, being an average of less than nineteen per day. To pass this number, allowing three locks full of water to every four boats, would require about fifteen lock chambers of water per day. The content of chamber, including waste, is 15,120 cubic feet. The distance from basin to next feeder dam below, is three miles. With the levels half filled, eighty cubic feet per mile, per minute, is an ample allowance for leakage and evaporation. From these data, the following calculations will show the quantity of water actually used per day, during the time the weigh lock was closed:

	Cubic Feet.
15 chambers of water, at 15,120 cubic feet each	226,800
3 miles leakage and evaporation, eighty cubic feet per mile per minute,	345,600
Total amount per day	572,400

This divided by 1440, the number of minutes in twenty-four hours, gives the amount used per minute, less than 400 cubic feet.

At this time, every possible effort was made by the Supervisor, to collect and retain the water. None passed over or through the dams, nor was any suffered to escape at the waste weirs, or from leaks through the embankments. The last mentioned quantity may then be set down as the supply furnished per minute, by the natural flow of the streams at Hollidaysburg, in a dry season.

The quantity of water heretofore assumed as necessary to pass the most active trade, is two hundred lock chambers

per day, or per minute,	4,400	cubic feet.
Deduct flow of streams as above,	400	do
Deficit per minute,	4,000	do

It is not probable, however, that a trade of so great activity, will be realized for some years. Let the present capacity of the inclined planes upon the Portage railway be assumed as a basis for calculation, viz: 2,500 tons per day-requiring the passage of eighty-five boats-the requisite supply of water will then be as follows:

57 chambers of water per day,	861,840	cubic feet.
85 boats weighed,	807,500	do
Leakage and evaporation on three miles,	432,000	do
Total per day,	2,101,340	do

Which divided by 1,440, the number of minutes in twenty-four hours, is the required quantity per minute,	1,400	cubic feet.
Deduct supply furnished by streams,	400	do
Amount required from reservoir, per minute,	1,060	cubic feet.

At Johnstown, the weigh-lock was closed forty-three days, during which time about eight hundred boats passed the first lock below the basin; being an average of less than twenty per day.

The same state of facts existed as at Hollidaysburg, and the quantity of water-discharged by the streams, varied but little from that above stated, as furnished by the Juniata.

It is believed by many, whose opportunities of observation have been the best, that the streams in the vicinity of Johnstown and Hollidaysburg have failed much more lately, than in previous years. This is usually found to be the case as the country becomes improved, and the forests disappear, from the branches of the streams. It may therefore be expected that for some time to come, the supply will continue to decrease.

It is very desirable that an appropriation should be made early in the season, to insure the completion of the Eastern Reservoir before winter; and that the work at the Western may be urged with sufficient force and energy to make it available in feeding the canal next summer, and thus an interrupted navigation be maintained throughout the season. For these purposes an appropriation will be required of $150,000.

Provision should be made, without delay, to settle the damages for land flooded by reservoirs. The amount necessary will vary but little from $25,000.

Upon the western side of the mountain, the land within the water line of the pool, with the exception of about eight acres, was covered with timber. The damages will consequently be light. At the Eastern Reservoir, nearly the whole extent of the pool is cleared land, under cultivation, and the damages will be proportionably high. In cases like the present, where the property of individuals is taken for public use, and where no benefit nor advantage results to the party injured, a liberal price should be allowed by the Commonwealth, and prompt payment be made.

<u>Pennsylvania House Journal: Appendix to Vol. 2, 1841</u>, pp. 401-405.

APPENDIX I

WESTERN RESERVOIR.

Report of D. Watson, Superintendent.

To the Board of Canal Commissioners of Pennsylvania:

GENTLEMEN:-The work at the Western Reservoir, was commenced in the spring of 1840, and has been regularly prosecuted since that time.

Having made no report since the commencement of the work, the present may embrace some transactions of the year 1840.

The contracts for clearing have been all completed, with the exception of a part of one section. The work at the dam has also been regularly prosecuted since the time of its commencement, and the contractors are still prosecuting it with more vigor than could be expected, under their long continued embarrassment, arising from the want of funds.

A considerable portion of the embankment has been made, and the masonry is in such a state of forwardness, that the pipes were all laid about a month ago. The principal part of the pipes were delivered last winter, and the balance were ready for delivery, and were furnished during the summer before they were needed. The other iron work necessary has also been delivered.

If the necessary amount of funds were provided at an early period by the Legislature, the whole work could be completed so as to make a supply of water for the canal available by the return of the dry season next year. And I would here suggest, the importance of urging upon our Legislature, the necessity of providing means at as early a period as possible, for the prosecution and completion of this work.- There might be many and important reasons urged for the early action of the Legislature upon this subject, which I do not feel myself called upon to present; but I would merely state, that the experience of the present fall, as well as former seasons, has proved the indispensable necessity of an additional supply of water, in order that the navigation of the Western division of canal may be continued during the dry season. With all the water that could be made available at Johnstown, both from the Conemaugh and Stoney creek, there was not sufficient in the canal for about six weeks this fall, to enable even light packet boats to run regularly.

The loss sustained by the Commonwealth in tolls, occasioned by the trade leaving our improvements and seeking other routes, not subject to similar interruptions, cannot be accurately estimated, but is no doubt of sufficient magnitude, to require the speedy completion of this work. The loss sustained by companies and individuals, engaged in transportation on our improvements, in consequence of low water, has also been great, and is well worthy of consideration.

The contractors for the dam and also for the iron work, who deserve much credit for their energy and perseverance in prosecuting their work without the necessary means being furnished by the Commonwealth, have expended large amounts on their respective jobs, and justice would appear to require early provision to be made for the payment of the amount due them.

For the estimated cost of completing the work, and the amount and description of the work done, I would refer you to the report of Wm. E. Morris, Esq., principal engineer.

I have paid out during the present year on this work, twenty-eight thousand six hundred and ninety-six dollars and nineteen cents, as follows:

Paid Moorhead and Packer for constructing dam,			$17,755.00
Samuel Kennedy for iron work,			1,700.00
James Clarke for clearing lot No. 1,			585.00
Dillion, Wilson and Co., final estimate for clearing lot No. 2,			1,107.33
John M'Gough, final estimate on No.		3,	573.33
Rogers, Marshall & Co.,	do	4,	934.00
John McFarland,	do	5,	2,106.00
Jamison and Bell,	do	6,	799.00
Huber and Hildebrand,	do	7,	2,210.00
For manufacturing cement, as per Jacob Horner Jr's. check rolls,			447.73
Wm. E. Morris, Esq., engineer,			100.00
W. W. Morrison, sub assistant engineer until first May, 1841,			360.00
Wm. and John C. Bargoon, for assisting to measure work, &c.,			6.00
Mahlon Rogers for one skiff for the use of the men engaged in manufacturing cement,			3.50
Shaffer and Davis' blacksmith bill,			9.30
			$28,696.19

Amount of per centage retained, viz:

Per centage retained from	Moorhead and Packer,	$3,130.52
Do.	Samuel Kennedy	300.00
Do.	James Clarke	105.00

There is at present no corps of engineers employed on this work-the duties being performed by Wm. E. Morris, Esq., principal, and John White, Esq., assistant engineer, on the Juniata and Western divisions of canal, aided by W. W. Morrison, since the first of May last, as superintendent of masonry, at a salary of $2 per day.

Respectfully submitted,

DAVID WATSON, Superintendent.

CANAL OFFICE, JOHNSTOWN,)
December 5th, 1841)

Pennsylvania House Journal, Vol. 3, 1842

APPENDIX J

"Bids for Reservoirs and Work Connected therewith Recd., March 10, 1846"

John Snodgrass	$46,280
H. B. Packer	59,585
Campbell, Given & McBride	48,847
John W. Geary	71,090
Giller, Barber & Glover	58,086
Moorhead & Irvin	58,575
Morrisson, Bailey, White & Co.	58,866
James Potts	64,550
Gilliland & Tamary	55,865
J. Gamble & Crane	48,036
J.K. Moorhead	59,014
McFarland & Cummins	60,790

RG 17, Map Books, No. 39: 1839, 1846, 1855, b.

APPENDIX K

NOTES OF PIPES, CROSS WALLS, STACKS, ETC.

Length of each piece of pipe is 7 ft.	
Deduct top	6½ in.
Each piece will lay in work	6'5½"
12 pieces to be in work	12
Whole length of pipe when laid	77'6"

Upper end of pipes to be within face of wall 6 in. Lower end of do. to project beyond face of wall 12 in. (to face stop cock) (or 18 in. to end of pipe)

Whole distance from upper side of upward breast wall to lower side of lower breast wall - 77 ft.

From face of breast walls that is between them - 55.2 in.

Distance from lower side of upward stack to center of 1st pier - 4.9 in.

Distance from center of lower pier to face of lower stack - 5"2½in.

Distance from centre to centre of piers - 6'5½ in.

Field Book, Western Reservoir, 1851, Box 1, 1 vol., RG 17, Engineering Records, 1825-52.

APPENDIX L

CHARTER, SOUTH FORK FISHING AND HUNTING CLUB OF PITTSBURGH

IN THE MATTER OF THE APPLICATION FOR A CHARTER FOR THE SOUTH-FORK FISHING AND HUNTING CLUB OF PITTSBURGH	In the Court of Common Pleas No. 1, of Allegheny County, No._____, Dec. Term, 1879

To the Honorable, the Judges of the said Court:

The undersigned petitioners, Citizens of the Commonwealth of Pennsylvania, having associated ourselves together under the provisions of the Act of General Assembly entitled "An Act for the Incorporation and regulation of certain Corporations," approved April 29th, A.D. 1874, and having made the following Certificate of organization as "The South-Fork Fishing and Hunting Club of Pittsburgh, "do respectfully pray your Honorable Court to approve the same and order the recording thereof and to declare that the undersigned persons and their associates and successors shall be a body corporate under said Articles of Association, in accordance with the above entitled Act of Assembly, and we will ever pray, &c.

C. A. Carpenter,	Howard Hartley,
D. R. Euwer,	Wm. S. Dunn,
W. F. Fundenberg,	H. C. Frick,
B. F. Ruff,	A. V. Holmes.

Personally before me, the undersigned, came Howard Hartley, who being duly sworn says that the statements in the foregoing petition are true, as he verily believes.

HOWARD HARTLEY

Sworn to and subscribed before me this 15th day of November, 1879.

THOS. LEGGETT, Notary Public (Seal.)

Due notice of publication in the <u>Commercial</u> <u>Gazette</u> and the <u>Post</u>, both Pittsburgh papers.

CHARTER OF INCORPORATION.

<u>First</u>. The name and title of this organization shall be the South-Fork Fishing and Hunting Club of Pittsburgh, incorporated

under and in pursuance of the provisions of an act of General Assembly of Pennsylvania, approved April 29, 1874, entitled "An Act, etc."

Second. This association shall have for its object the protection and propagation of game and game fish, and the enforcement of all laws of this State against the unlawful killing or wounding of the same.

Third. This association shall have its place of business in the city of Pittsburgh, county of Allegheny, State of Pennsylvania.

Fourth. This association shall, as such, exist perpetually from the date of its incorporation.

Fifth. The capital stock of this association shall be ten thousand dollars, divided into one hundred shares of the value of one hundred dollars each.

Sixth. The names and residences of the subscribers hereto, with the number and value of the shares held by each, are as follows:

Name	Residence	Shares	Value
B. F. Ruff	Pittsburgh	8	$800
F. H. Sweet	Pittsburgh	2	200
Chas. J. Clarke	Pittsburgh	2	200
Thomas Clarke	Pittsburgh	2	200
W. F. Fundenberg	Pittsburgh	2	200
Howard Hartley	Pittsburgh	2	200
H. C. Yeager	Pittsburgh	2	200
J. B. White	Pittsburgh	2	200
H. C. Frick	Pittsburgh	6	600
E. A. Meyers	Pittsburgh	2	200
C. C. Hussey	Pittsburgh	2	200
D. R. Euwe	Allegheny	2	200
C. A. Carpenter	Allegheny	2	200
W. S. Dunn	Pittsburgh	2	200
W. L. McClintock	Pittsburgh	2	200
A. V. Holmes	Pittsburgh	2	200

Seventh. The number of the Directors shall be five and their names and residences for the first year are: C. C. Hussey, Pittsburgh; W. S. Dunn, Pittsburgh; C. A. Carpenter, Pittsburgh; Howard Hartley, Pittsburgh; W. F. Fundenburg, Pittsburgh.

Eighth. The officers of this association selected for the first year with their residences are as follows: President, B. F. Ruff, Pittsburgh; Secretary, E. A. Meyers, Pittsburgh; Treasurer, E. L. McClintock, who are to serve until the next annual election.

D. R. Euwer,	H. C. Frick,	W. F. Fundenberg,
Howard Hartley,	B. F. Ruff,	H. C. Yeager,
C. A. Carpenter,	Wm. S. Dunn,	A. V. Holmes.

COMMONWEALTH OF PENNSYLVANIA,

County of Allegheny.

Be it remembered that, on the Fifteenth day of November, A. D. 1879, before me, Ralph J. Richardson, Recorder of Deeds, etc., in and for said County, personally came B. F. Ruff, Howard Hartley and A. V. Holmes and acknowledged the foregoing instrument to be their act and deed for the purposes therein set forth, and desired that the same might be recorded as such.

Witness my hand and seal, the day and year aforesaid. (OFFICIAL SEAL)

R. J. RICHARDSON,
Recorder.

And now to wit: November 17th, 1879, the within petition and certificate of Organization having been presented in Open Court and due proof of the notice by publication required by the Act of Assembly entitled "An Act to provide for the incorporation of certain Corporations," approved April 29th, 1874, having been made and the said Certificate of Organization having been perused and examined by the undersigned Law Judge, and the same having been found to be in proper form and within the purposes named in the first class specified by the second section of said Act of Assembly, and the same appearing to be lawful and not injurious to the community, it is ordered and decreed that the said Charter is hereby approved and that, upon the recording of the same and this order, the subscribers thereto and their Associates and successors shall be a Corporation perpetually for the purposes and upon the terms therein stated.

EDWIN H. STOWE,
Prest. Judge Court Com. Pleas No. 1,
Allegheny Co., Pa.

ATTEST: (COURT SEAL)
B. F. KENNEDY,
Prothonotary.

APPENDIX M

LAND PURCHASES BY SOUTH FORK FISHING AND HUNTING CLUB OF PITTSBURGH: 1881-1887

Deed, Jacob Wendell to South Fork Fishing and Hunting Club, March 17, 1881, Cambria County Deed Book, Vol. 44, pp. 830-832.

49 acres; $1,107.34

Deed, Christian Moyer to South Fork Fishing and Hunting Club, December 23, 1881, Cambria County Deed Book, Vol. 46, pp. 461-463.

3 acres, 143 perches; $70.23

Deed, Gabriel Donmyer, et. ux., to South Fork Fishing and Hunting Club, August 4, 1882, Cambria County Deed Book, Vol. 47, pp. 620-622.

3 acres, 118 perches (part of lake); $373.75

Deed, Joesph Varner, et. ux., to South Fork Fishing and Hunting Club, August 4, 1882, Cambria County Deed Book, Vol. 47, pp. 622-623.

31 perches (part of lake); $7.75

Deed, Samuel Miller and Sarah Miller to South Fork Fishing and Hunting Club, April 23, 1884, Cambria County Deed Book, Vol. 52, p. 50.

10 acres, 94 perches; $370.56

Deed, George Fisher & Wife to South Fork Fishing and Hunting Club, September 11, 1885, Cambria County Deed Book, Vol. 54, p. 576.

.57 acres; $20

Deed, Henry Burnett & Wife to South Fork Fishing and Hunting Club, March 4, 1886, Cambria County Deed Book, Vol. 56, p. 82.

Strip of ground 25 feet wide; $25

Deed, Elias J. Unger, et. ux., to South Fork Fishing and Hunting Club, January 20, 1887, Cambria County Deed Book, Vol. 57, pp. 409-411.

4 acres, 128 perches (part of lake); $192

APPENDIX N

TAX ASSESSMENTS LEVIED AGAINST THE SOUTH FORK FISHING AND HUNTING CLUB OF PITTSBURGH IN ADAMS AND CROYLE TOWNSHIPS: 1881-1892

1881

Adams Township

48 acres
$96 valuation of land
$96 aggregate valuation for county rates and levies

1882

Adams Township

48 acres
$96 valuation of land
$96 aggregate valuation for county rates and levies

1883

Adams Township

455 acres
$3,455 valuation of land
2 horses and mules
$100 valuation of animals
$3,555 aggregate valuation for county rates and levies
$53.33 county tax paid

Croyle Township

248 acres
$1,488 valuation of land
$1,488 aggregate valuation for county rates and levies
$22.32 county tax paid

fishery
$500 aggregate valuation for county rates and levies
$7.50 county tax paid

1884

Adams Township

455 acres
$3,455 valuation of land
2 horses and mules
$30 valuation of animals
40 pleasure carriages
$40 valuation of carriages
$3,525 aggregate valuation for county rates and levies
$45.83 county tax paid
$40 state tax paid

Croyle Township

248 acres
$1,488 valuation of land
$1,488 aggregate valuation for county rates and levies
$20.34 county tax paid

fishery
$500 aggregate valuation for county rates and levies
$6.50 county tax paid

1885

Adams Township

455 acres
$3,455 valuation of land
3 horses and mules
$75 valuation of animals
30 pleasure carriages
$30 valuation of carriages
$3,560 aggregate valuation for county rates and levies
$42.72 county tax paid
$30 state tax paid

Croyle Township

248 acres
$1,488 valuation of land
$1,488 aggregate valuation for county rates and levies
$17.86 county tax paid

fishery
$500 aggregate valuation for county rates and levies
$6 county tax paid

1886

Adams Township

455 acres
$2,500 valuation of land
3 horses and mules
$75 valuation of animals
$2,575 aggregate valuation for county rates and levies
$30.90 county tax paid

Croyle Township

248 acres
$1,500 valuation of land
$1,500 aggregate valuation for county rates and levies
$18 county tax paid

fishery
$500 aggregate valuation for county rates and levies
$6 county tax paid

1887

Adams Township

455 acres
$2,500 valuation of land
3 horses and mules
$45 valuation of animals
$2,545 aggregate valuation for county rates and levies
$30.54 county tax paid

improvements
$3,000 valuation by assessor
$3,000 aggregate valuation for county rate and levies
$36 county tax paid

Croyle Township

248 acres
$1,500 valuation of land
$1,500 aggregate valuation for county rates and levies
$18 county tax paid

fishery
$500 aggregate valuation for county rates and levies
$6 county tax paid

1888

Adams Township

455 acres
$5,500 valuation of land
4 horses and mules
$135 valuation of animals
$5,635 aggregate valuation for county rates and levies
$84.53 county tax paid

Croyle Township

248 acres
$1,500 valuation of land
$1,500 aggregate valuation for county rates and levies
$22.50 county tax paid

fishery
$500 aggregate valuation for county rates and levies
$7.50 county tax paid

1889

Adams Township

455 acres
$5,000 evaluation of land
4 horses and mules
$100 valuation of animals
$5,100 aggregate valuation for county rates and levies
$76.55 county tax paid

Croyle Township

248 acres
$1,500 valuation of land
$1,500 aggregate valuation for county rates and levies
$22.50 county tax paid

fishery
$1,500 aggregate valuation for county rates and levies
$22.50 county tax paid

1890

Adams Township

455 acres
$5,000 valuation of land
1 horse or mule
$35 valuation of animals
$5,035 aggregate valuation for county rates and levies
$75.53 county tax paid

Croyle Township

248 acres
$1,500 valuation of land
$1,500 aggregate valuation for county rates and levies
$22.50 county tax paid

fishery
$1,500 aggregate valuation for county rates and levies
$22.50 county tax paid

1891

Adams Township

455 acres
$5,000 valuation of land
$15,000 aggregate valuation for county rates and levies
$75 county tax paid

Croyle Township

248 acres
$1,500 valuation of land
$1,500 aggregate valuation for county rates and levies
$22.50 county tax paid

fishery
$1,500 aggregate valuation for county rates and levies
$22.50 county tax paid

1892

Croyle Township

248 acres
$11,160 valuation of land
$11,160 aggregate valuation for county rates and levies
$119.72 county tax paid

The following volumes were consulted at the Cambria County Courthouse in Ebensburg for the compilation of this information: 1879, Seated Assessments, Cambria County; 1880-84, Unseated Assessments, Cambria County; 1881, Assessments, Adams Township to Jackson, Cambria County; 1882, Assessments, Adams Township to Jackson, Cambria County; 1883, Assessments, Adams Township to Jackson, Cambria County; 1884, Assessments, Adams Township to Jackson, Cambria County; 1885, Assessments, Adams Township to Jackson, Cambria County; 1886, Assessments, Adams Township to Jackson, Cambria County; 1887, Assessments, Adams Township to Jackson, Cambria County; 1888, Assessments, Adams Township to Jackson, Cambria County; 1890, Assessments, Adams Township to Jackson, Cambria County; 1891, Assessments, Adams Township to Jackson, Cambria County; 1892, Assessments, Adams Township to Jackson, Cambria County.

APPENDIX O

EYEWITNESS ACCOUNT OF THE FAILURE OF THE SOUTH FORK DAM BY JOHN G. PARKE, JR.

M.J. Becker, Esq.,
President Am. Soc. of C. E.

Dear Sir,--Being requested by your Committee to give an account of the destruction of the South Fork Dam, I will do so by narrating my experience of the affair and the few observations I made at the time.

On the evening preceding the destruction of the dam, to the best of my recollection, we had many evidences of an approaching storm, and when it grew dark, we had a violent wind storm, and the tree tops about the house were moaning and creaking unusually, but no rain fell. About 9 o'clock, I had occasion to go out of the house a short distance and noticed that the board walk was wet and that there had been a slight rain-fall, but it was not raining at the time, and the sky was much brighter and evidently clearing off, but there was still a high wind blowing. These sudden, violent wind storms, very often accompanied by heavy but brief rain-falls, were customary in that mountainous country, as I had noticed during my two months' location at the lake previous to this time.

I retired shortly after 9 o'clock and slept very soundly, awaking once towards morning and hearing a heavy rain. When I awoke at about 6:30 on the morning of the 31st, I found it very foggy outside, and on going out, found the lake had risen during the night probably 2 feet, and I heard a terrible roaring as of a cataract at the head of the lake, about a mile above the club house where I was staying. After eating breakfast and returning to the shore I found the lake had risen appreciably during our absence, probably 4 or 5 inches, and with difficulty secured a boat, and with a young man who was employed on some plumbing work at the cottage, I rowed to the head of the lake to see the two streams that were pouring into the lake with such an unusual roar. I found that the upper one-quarter of the lake was thickly covered with debris, logs, slabs from sawmill, plank, etc., but this matter was scarcely moving on the lake, and what movement there was, carried it into an arm or eddy in the lake, caused by the force of the two streams flowing in and forming a stream for a long distance out into the lake. The lake seemed very high when I reached the head, for we were able to row over the top of a four-wire barbed fence which stood near the normal shore line and we rowed for 300 feet across a meadow which was covered with water, for it was very flat and a rise in the lake of a foot, covered a large area. I did not get very near to one stream (the Muddy Run) but could see the volume it was pouring in by its current in the still water, but we did go up the shores of the South Fork Creek and found it widely overrunning its banks. In its normal condition it is about 75 feet wide and barely 2 feet deep--many places not that deep, but varying as every mountain stream does. But on this day it was a perfect torrent, sweeping through the woods in the most direct course, scarcely following its natural bed, and stripping branches and leaves from the trees 5 and 6 feet from the ground. We tramped through the fields adjoining the woods in which the stream was boiling, for a half mile above its mouth and could appreciate its volume and force, for I was familiar with the region and saw where the stream covered a portion of the township road for a depth of 3 feet, which is never covered except in floods. Returning to our boat, we found it almost adrift, the water having risen during our absence. We rowed to the club house and found the water had risen at a wonderful rate during our row to the top of the lake. I had been thinking of the dam and was not suprised when landing to be told that the water was nearly over the dam and that men and a plow were needed there. So taking a horse from the stable, I rode to the breast and found Colonel Unger, President of the South Fork Fishing and Hunting Club at work on the dam with a number of Italian laborers (that we had employed on some sewerage work); there were about sixteen of them. Half of them were cutting a ditch through the shale rock at one end of the breast. This ditch was cut through the original ground and about 25 feet from the constructed portion of the breast. The shale was so tough that they could not cut it more than about 4 inches deep and about 2 feet wide, but when it was cut through to the lake, the water rushed in and soon made it a swift stream, 25 feet wide and about 20 inches deep, but the rock was so hard that it could not cut it any larger than this. Previous to this being opened and shortly afterward, I made two observations of the height of the water, and the lake in the hour had risen 9 inches. During the digging of this ditch, I rode back and forth over the dam directing the laborers. We had a plow at work throwing up a furrow, and thus raising a temporary barrier or breast to retard the water flowing over the dam, should it reach that height which it was gradually doing. I noticed that the waste-weir proper was discharging to its full capacity, and that there was no drift or other matter to clog it, except a road bridge supported on small posts which were apparently offering but little resistance as the weir was narrower by about 15 feet at 100 feet from its mouth, and this contraction compensated for the resistance to flow offered by the bridge supports. There was probably 7 feet of water in the weir at the time. There were some iron screens between the foot of each post on the outer row of the bridge supports, but they were about 18 inches high and could not have been removed, had we wished to, owing to the depth and velocity of the water. The water in the lake rose until it was passing over the breast, notwithstanding that the lake had then the two outlets (the waste-weir and the one cut by the laborers). The breast was slightly lowered in the center and the water washed away our temporary embankment thrown up by the plow and shovels, and the water was passing over in many places in a distance of 300 feet about the center of the breast; the men stuck to their task and worked until the water was passing over in nearly one sheet, and then they became frightened and got off the breast. I saw what would be the consequence when the water passed over the breast and rode to South Fork Village and warned the people in the low lands there, and had word telegraphed to Johnstown that the dam was in danger. The people in South Fork heeded the warning and moved out of their houses. When I left South Fork to return it was just twelve o'clock noon, and the water had been flowing over the dam for at least a half hour. I rode back up to the lake 2 1/2 miles through the valley and found the men had torn up a portion of the flooring of the waste-weir bridge and were endeavoring to remove the V-shaped floating drift guard that projected into the lake. It was a light affair and was built to float on the surface of the lake and catch twigs, leaves, etc., and prevent their clogging up the iron screens spoken of above. I crossed the breast at this time and found the water was cutting the outer face of the dam, but not as badly as I feared it would, its greatest effect was on some portions of the roadway which crossed the breast where the roadway had been widened on the lower side by the addition of a shale earth or disintegrated shale, upon which the action of the water was instantaneous, but the heavy rip-rapping on the outer face of the dam protected this wash and the water cut little gullies between each of the large stones for rip-rap. I did not stay on the dam when it was in that condition, but went on to the end of the dam and found that over its entire top it was serried by little streams where the water had broken through our little embankment and was running over the dam. I went on to the new waste-weir we had cut and found it carrying off a great volume of water and at a great velocity. I with difficulty waded it and found that it was up to my knees or 20 inches deep. I felt confident that nothing more could be done to save the dam unless we were to cut a wasteway through the dam proper at one end and allow it to cut away in but one direction, and that towards the center of the dam, but this I would not dare do, for it meant the positive destruction of the dam, and the water at the time was almost at a stand, owing, without doubt, to the large increase of outlet by the overflow on the breast, and I hoped that it would not rise, but yet expected it to rise for it had been raining most all of the morning, and consequently we had more water to expect. I hurried to the club house to get my dinner and to note the height of the water in the lake, and found that it was a little over a stake, that from my level notes of a sewer I was constructing I knew was 7.4 feet above the normal lake level. I returned to the dam and found the water on the breast had washed away several large stones on the outer face, and had cut a hole about 10 feet wide on the outer face and about 4 feet deep, the water running into this hole cut away the breast in the form of a step both horizontally and vertically, and this action went on widening and deeping this hole until it was worn so near to the body of the water in the lake that the pressure of the water broke through, and then the water rushed through this trough, and cut its way rapidly into the dam at each side and the bottom; and this continued until the lake was drained. I do not know the actual time it consumed in passing through the breach, but it was fully 45 minutes. It did not take long from the time that the water broke into this trough until there was a perfect torrent of water rushing through the breast, carrying everything before it, trees growing on the outer face of the dam were carried away like straws. The water rushed out so rapidly that there was a depression of at least 10 feet in the surface of the water flowing out, on a line with the inner face of the breast, exactly similar to water flowing through a rectangular sluice-way in the side of a trough with the water level far above the bottom of the sluice-way. When the lake was drained there still remained in the bed of it a violent mountain stream 4 or 5 feet deep, with a swift current, the combination of the two streams already alluded to from the head of the lake and the many little streams from the adjacent hills, which streams were all overflowing their banks, this stream in the bed of the lake showed no signs of diminishing in volume until late in the following day, and was impassable with a boat for several days.

I need say nothing of the character of the dam, for it is open for inspection of those far more able to express an opinion than I. But there is one thing I want to impress on every one's mind, and that is, that the dam did not break, but was washed by the water passing over it from 11:30 o'clock A.M. until nearly 3 P.M. until the dam was made so thin at one point, that it could not withstand the pressure of the water behind it, and the water once rushing through this trough nothing could withstand it.

Hoping this report will be of some service to your Society, and placing myself at your disposal to answer any inquiries as to the destruction of the dam or any points that I have not developed, believe me,

Respectfully yours,

John G. Parke, Jr.

Americus, Ga., August 22d, 1889.

"Report of the Committee on the Cause of the Failure of the South Fork Dam," 448-451.

APPENDIX P

EYEWITNESS ACCOUNTS OF THE FAILURE OF SOUTH FORK DAM BY JOHN RORABAUGH AND GEORGE GRAMLING

He [John Rorabaugh] said the dam was running over from 12 o'clock until 2, when it broke, and that a trench was dug during the day on the southwest side, to let off the water; also, that the dam was lower on that side than the other, and that there was a dip of one foot in the center. He accounted for this by saying the foundations for the old State culvert were of timber, and that they had rotted and let the center sink. The waste weir, he said, was not deep enough, but plenty wide enough and was not clogged by drift. The club seemed more interested in saving the fish than letting the water out. At the break in 1881 the earth was only dumped in and not puddled, and he put in two loads of hay to keep the dam from leaking. He further stated that the dam was no higher than when the State had it.

George Gramling stated that three-fourths of the dam on the southwest side was inundated at 12 o'clock, and that there was a heavy flow in the center, where the breast was considerably lower than at any other place. At 2 o'clock the dam commenced to go. It worked gradually and then tore the rip-rap from the lower side, after which the inside gave way and it was not fifteen minutes until the dam was empty. "I recommended to Colonel Unger," continued Mr. Gramling, "the necessity of cutting away the bridge over the waste weir and also the building of an embankment on the breast, but neither was done. The place where the dam was patched in 1881 was not as strong as the State dam, the riprapping not being as good, and the red shale was used instead of clay. They simply dumped the earth from the breast of the dam, and it was not even packed, and leaked for several years after, but has not leaked lately. The dam did not have the proper material to withstand a washout."

Johnstown Daily Tribune, July 2, 1889.

APPENDIX Q

EYEWITNESS ACCOUNT OF THE FAILURE OF THE SOUTH FORK DAM BY W. Y. BOYER
THE BURSTING OF THE DAM

Letter from W. Y. Boyer, Superintendent
of the Lake and Grounds.

The Salem (Ohio) End says the following letter was recieved by one of the editors of that paper from Mr. W. Y. Boyer, of South Fork, Pa., who was in charge of the grounds of the Gun Club upon the bursting of the fatal dam that swept the Conemaugh Valley. Mr. Boyer was formerly postmaster at Garfield, Mahoning County, Ohio, and resigned that position for the one at South Fork.

South Fork, Pa., June 10, 1889.

But of course the dam went out, as everybody knows, but in a different way from what most papers report it. The lake had an area of about six hundred acres. The dam on the northwest end of the ravine was built of clay and stones and riprapped on each side and was in the neighborhood of sixty feet high, very strongly built.

On the northeast side of the dam was a waste way through which the water went out and flowed around the dam and down the Conemaugh Valley. In low water the water would be about eight feet below the top of the dam and as it rose, of course, more water would flow through it. The waste way was about fifty feet wide and eight feet deep before it would run over the dam, and in it were beautiful falls. The base of the dam was three hundred feet, and tapered up to thirty feet at the top, over which we had a drive and which had been used daily for nine years, which became very solid.

On Thursday (the day before the breaking of the dam) it commenced raining about 4 P.M., but did not rain very hard until about dark, when it commenced to blow and rain, and all that night it rained very hard. It not only rained, but it poured, and in the morning when I got around I told the guests that I thought the dam would run over that day, of course not being sure at that time. The water rose ten inches an hour.

I left for South Fork shortly after breakfast, and returned about 10 o'clock, when I found that the President of the Club, who was up here at the time, had ordered all the men to help move the dam. Everybody--twenty-two Italians and many neighbors--worked hard trying to save the dam, but in vain; the water finally commenced to go over the dam and began to wash from the outside.

It would wash a kind of puddle and then some of the earth would give way, and keep on in that way till it had a channel through, when you may know it went with a crash, where nothing could escape that was in the way. Trees four feet in diameter, roots, branches, everything went before it like toys, and before it reached South Fork it was a dam of trees, and not of clay and stones as before; and, you may believe, I don't want to see another breaking of a dam, and I never dreamed that I should be an eyewitness to such a thing when I left the quiet little village of Garfield, Ohio. The lake was very nearly two miles long and would average about one-half mile wide and twenty-five feet deep, with beautiful mountain spring water and stocked with the finest black bass, of which there were many.

As far as Johnstown being a wreck, there is no such place anymore. I was well acquainted there and I have seen it twice since, but not the town, only a mud hole, where before it was nothing but houses, stores, and mills of all kinds.

Right below the dam, not more than one-fourth mile, were two farm houses, and ten minutes after it broke nobody could find the exact spot where they stood, nor can it be done to-day: and what was a small stream before the dam broke looks like the Susquehanna River in a dry season . . .

Perhaps it would interest you to know what we had in the way of a summer resort. In the first place there is a very fine club house or hotel with forty-seven bed-rooms, well furnished; a nicely-furnished office, a pool room, a parlor forty feet square, a dining room 40 x 60 feet, a well-furnished kitchen, bakery, cooling-rooms, milk room, vegetable room, and everything to be found in a well-furnished hotel. We also have sixteen cottages, in one of which lived four families and in another two families, two fine steam yachts, four sailing boats, and about fifty sailing canoes and row boats. Of course none of them are of any use up here now.

The draining of the dam was a big loss to the community. Farms that were worth ten thousand dollars the day before the flood are at least 60 percent less in value. The Club had just about completed a sewer system and waste works which cost $12,000, beside the plumbing, etc., and the loss to the club is very great.

I would further add, in connection with what I have already said, that all parties between the lake and Johnstown were notified three hours in advance of the flood that there was great danger of the dam breaking and that it probably would, and warning them to flee. But they would not heed. I could never go through another trial like this. My wife and I are heart-broken at the many lives lost, and by the many threats made to burn down, or blow up the buildings standing here. I have not heard from the Gun Club since the disaster, and do not know what will be the outcome of this affair.

W. Y. Boyer

Johnstown Daily Tribune, June 25, 1889.

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- i. "Dam and Sluice for Western Reservoir, Exhibited at Letting March 10th, 1846, Wm. E. Morris, Civil Engineer."
- l. "Sketch of Piling Iron [for] Western Reservoir," [1839], 1 sect., 12 pp.
- o. "Map of the Western Reservoir for Pennsylvania Canal, Cambria County, Pa., 1853." 4 sects., 15 pp.

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- d. [Bids for Eastern and Western Reservoirs], n.d. 2 sects.

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No. 52: 1841

c. [Maps, Surveys, and Notes on Western Division Canal, 1841].

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MAPS

"Map of Conemaugh Lake Situate in Adams & Croyle Twp's., Cambria Co., Pa., Surveyed for Geo. M. Wertz, November, 1907, Fetterman Eng. Co." Copies of this map can be found at the Johnstown Flood Museum and the Cambria County Library, Johnstown.

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The most important periodical article for this report was the "Report of the Committee on the Cause of the Failure of the South Fork Dam" in the American Society of Civil Engineers, Transactions. This article was valuable in that it provided a documentary history of the preliminary surveys, plans, specifications, and contracts for the construction of the dam and reservoir as well as the details and analysis of the deterioration, reconstruction, and failure of the dam. The articles and editorials in the Engineering News and American Railway Journal, The Engineering and Mining Journal, and the

Proceedings of Engineer's Society of Western Pennsylvania also provided historical data on the dam and reservoir, but, more importantly, they provided extensive data on the post-flood analytic examinations into the causes of the failure of the dam. Other useful articles concerning the history of the dam and reservoir were those by David G. McCullough in American Heritage, John Bach McMaster in The Pennsylvania Magazine of History and Biography, and Nathan D. Shappee in The Western Pennsylvania Historical Magazine.

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The dissertation by Shappee was a valuable source of data for this report since it is the only scholarly and academic treatment of the subject of the South Fork Dam and Johnstown Flood. The planning documents were useful in the assessment of the historical interpretation of the Johnstown Flood National Memorial.

MISCELLANEOUS

Reference research notes on South Fork Dam and Johnstown Flood compiled by Earl P. Heydinger in 1966. On file at Johnstown Flood National Memorial.

These typed reference research notes were helpful in the research phase of this report since Heydinger had gathered data from a variety of sources in the Pennsylvania State Archives and State Library.

NATIONAL REGISTER OF HISTORIC PLACES
INVENTORY--NOMINATION FORM

(Updated, revised, and completed)

As part of this Historic Structure Report the author has updated, revised, and completed two sections of the "National Register of Historic Places Inventory--Nomination Form," prepared by S. Paul Okey, Chief, Visitor Services, Johnstown Flood National Memorial in 1976. The two sections prepared by the author of this Historic Structure Report are No. 7, Description and No. 8, Significance. Accordingly, those two revised sections appear on the following pages.

7. DESCRIPTION

DESCRIBE THE PRESENT AND ORIGINAL (IF KNOWN) PHYSICAL APPEARANCE

At present, all that remains of the historic earthen and rock-filled South Fork Dam (originally about 900 feet in length and 75 feet in height) are the north and south abutments, the spillway cut around the north abutment to carry off excess water, and a few remnants of wood and culvert foundation stones representing the location of the control mechanism. The gap between the two abutments, marking the portion of the dam which gave way in 1889 thus causing the devastating Johnstown flood, is approximately 250-350 feet wide. The South Fork of the Little Conemaugh River passes through the gap as does the track of the Penn Central Railroad.

The earthen abutments (each approximately 150-300 feet in length) are partially overgrown with grass, brush, and trees, and their west or downstream faces are covered with stone rip-rap. The spillway, varying between 60 and 100 feet in width, was cut through the stone embankment to the north of the dam and is now largely overgrown by grass and brush. The remnants of the wood and culvert foundation stones, near the river and at the bottom and center of the original dam, mark the only remains of the original stone arch culvert that carried the sluice pipes used to control the level of the water in the Western Reservoir (later Lake Conemaugh) behind the dam. A wooden control tower, destroyed by fire in the 1860's or 1870's, contained the mechanism that operated the sluice pipes.

Of the original 400-500 acre reservoir or lakebed behind (east and upstream of) the dam, approximately 50 acres are within the authorized boundaries of the Johnstown Flood National Memorial. At present, the former lakebed, which stretched upstream some two miles in length and nearly a mile in width in some places, is largely forested and overgrown with brush. The aforementioned river and railroad traverse almost the entire length of the former lakebed.

8. SIGNIFICANCE

SPECIFIC DATES 1838-1899 BUILDER/ARCHITECT Commonwealth of Pennsylvania
South Fork Hunting and
Fishing Club of Pittsburgh
(reconstruction in early 1880's)

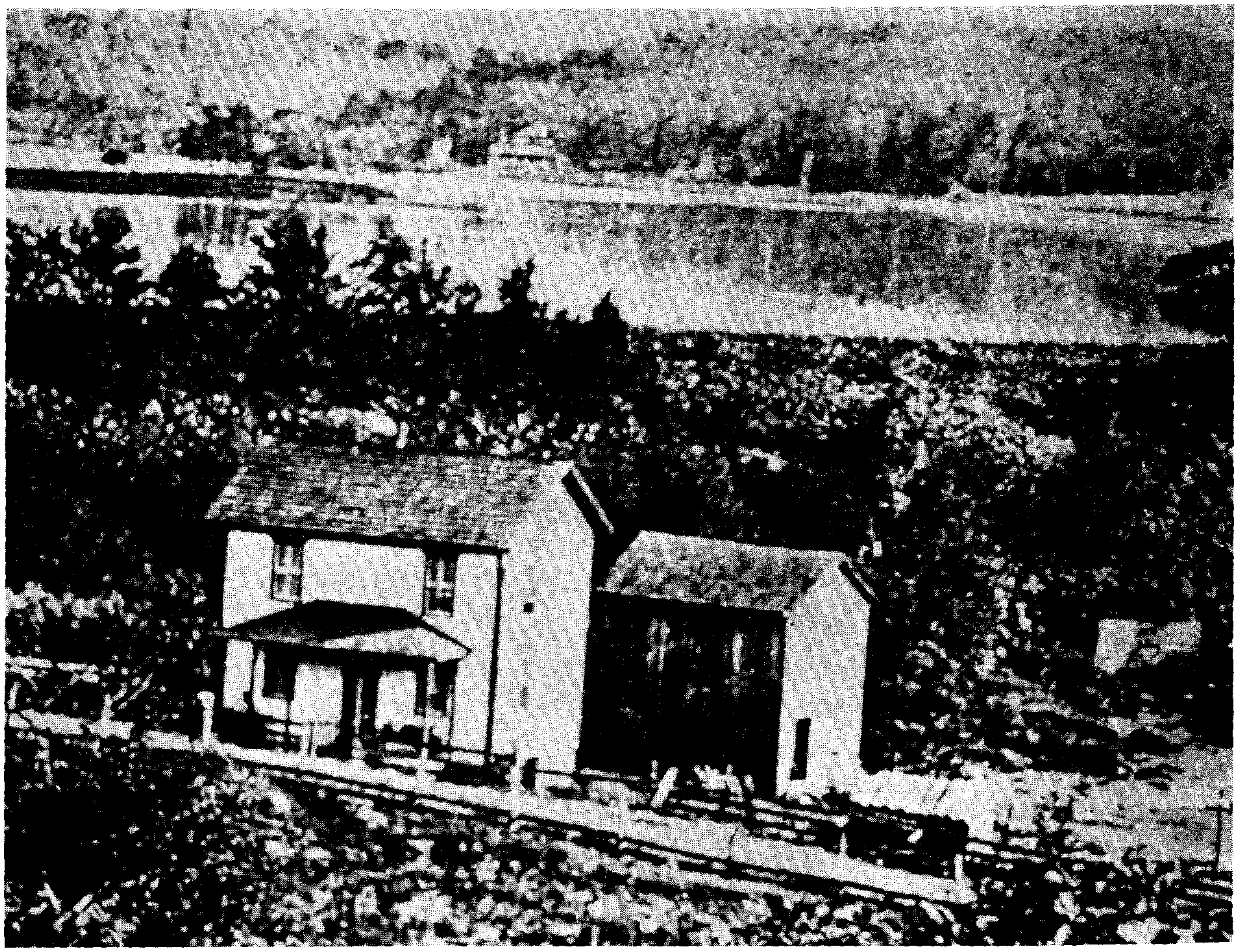
STATEMENT OF SIGNIFICANCE

The South Fork Dam was constructed by the Commonwealth of Pennsylvania between 1838 and 1853 to provide water for the operation of the Western Division of the Pennsylvania Main Line Canal between Johnstown and Pittsburgh, particularly during the summer season when rainfall was often unpredictable and infrequent. Located some twelve miles east of Johnstown, the earthen and rock-fill dam, one of the largest of its kind at the time of its construction, was built to hold the water of the Western Reservoir at a point where the South Fork of the Little Conemaugh River and several mountain streams converged. The dam created what was, at the time it was built, one of the largest artificial lakes in the nation, more than two miles long and nearly a mile wide in some places.

The Pennsylvania Railroad Company purchased the entire Main Line works in July 1857 and left the dam and reservoir virtually unattended until May 1863 when the entire Western Division of the canal was abandoned. In 1879, a group of wealthy Pittsburgh industrialists formed the South Fork Fishing and Hunting Club and purchased the dam and reservoir for a private summer resort. By 1881 the dam, which had suffered its first serious break in July 1862, was repaired and reconstructed, and the reservoir, renamed Lake Conemaugh, was refilled. For the next eight years the summer resort offered fishing, hunting, boating, and other recreational opportunities for the club members, some of which were prominent in the financial, industrial, and political circles of Pittsburgh and the United States in the late nineteenth and early twentieth centuries.

Torrential rains sent the level of water in the lake beyond the danger point on May 31, 1889, causing the poorly-reconstructed dam (rebuilt without the supervision of an engineer) to break and engulfing the valley below and Johnstown in a wall of water that resulted in the loss of over 2,200 lives and more than $17 million in property damage. It was the most notable and devastating flood of the nineteenth century in the United States and the greatest national catastrophe in the post-Civil War era, and it provided a humanitarian cause for the entire country. Thus, it emerged as an example of man's disregard of natural and engineering principles and has provided a source of vast literature with important lessons for environmental and engineering management today.

PHOTOGRAPHS

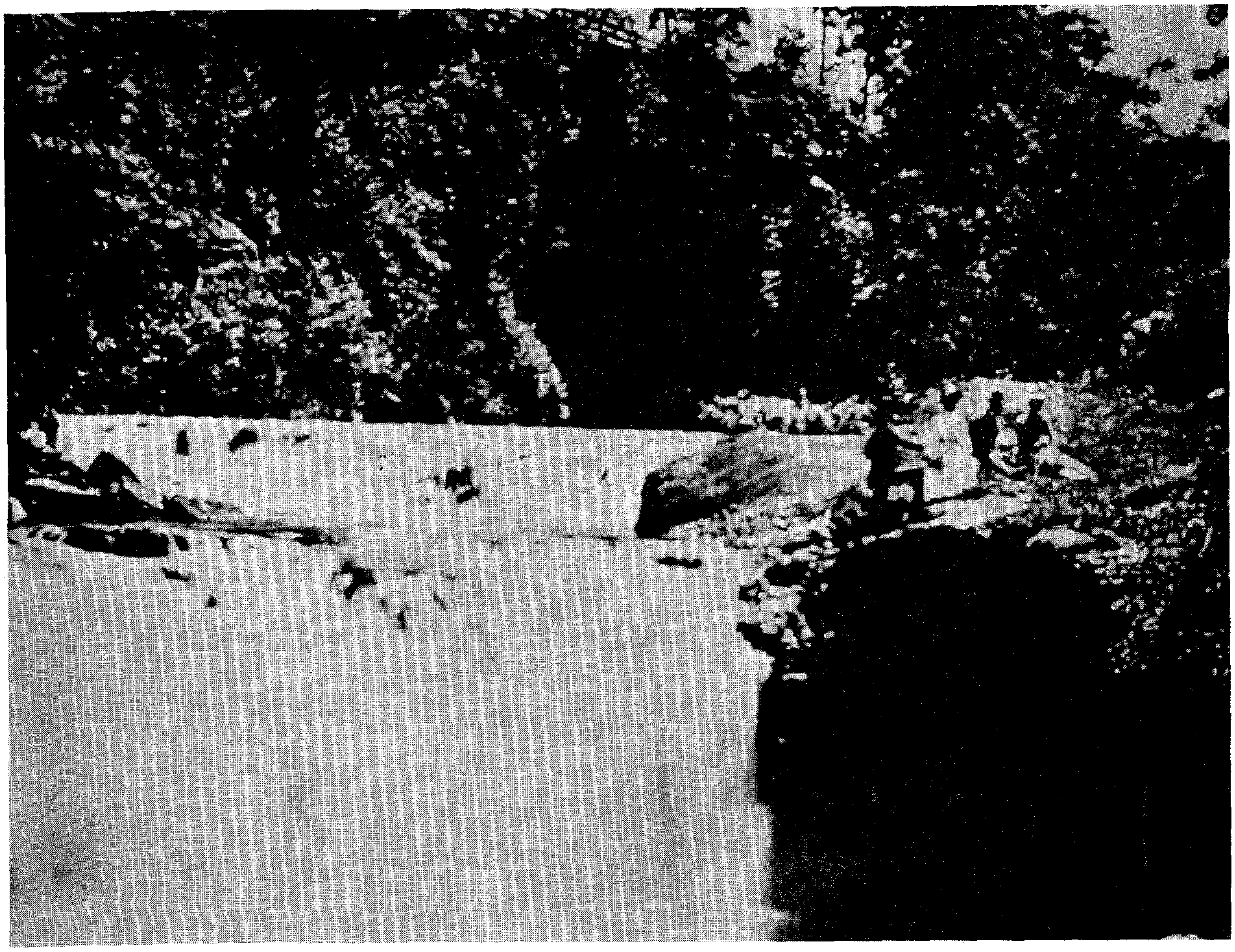


Photograph No. 1

Photograph of South Fork Dam looking generally south toward Lake Conemaugh with resort cottages in background. The arched stone culvert is in the lower right hand corner. Note that trees are growing at each end of the dam but that there is no foliage in the center. This was due to the fact that the center of the dam was patched in 1880-81.

Photograph taken ca. late 1880s.

Irving L. London Collection.

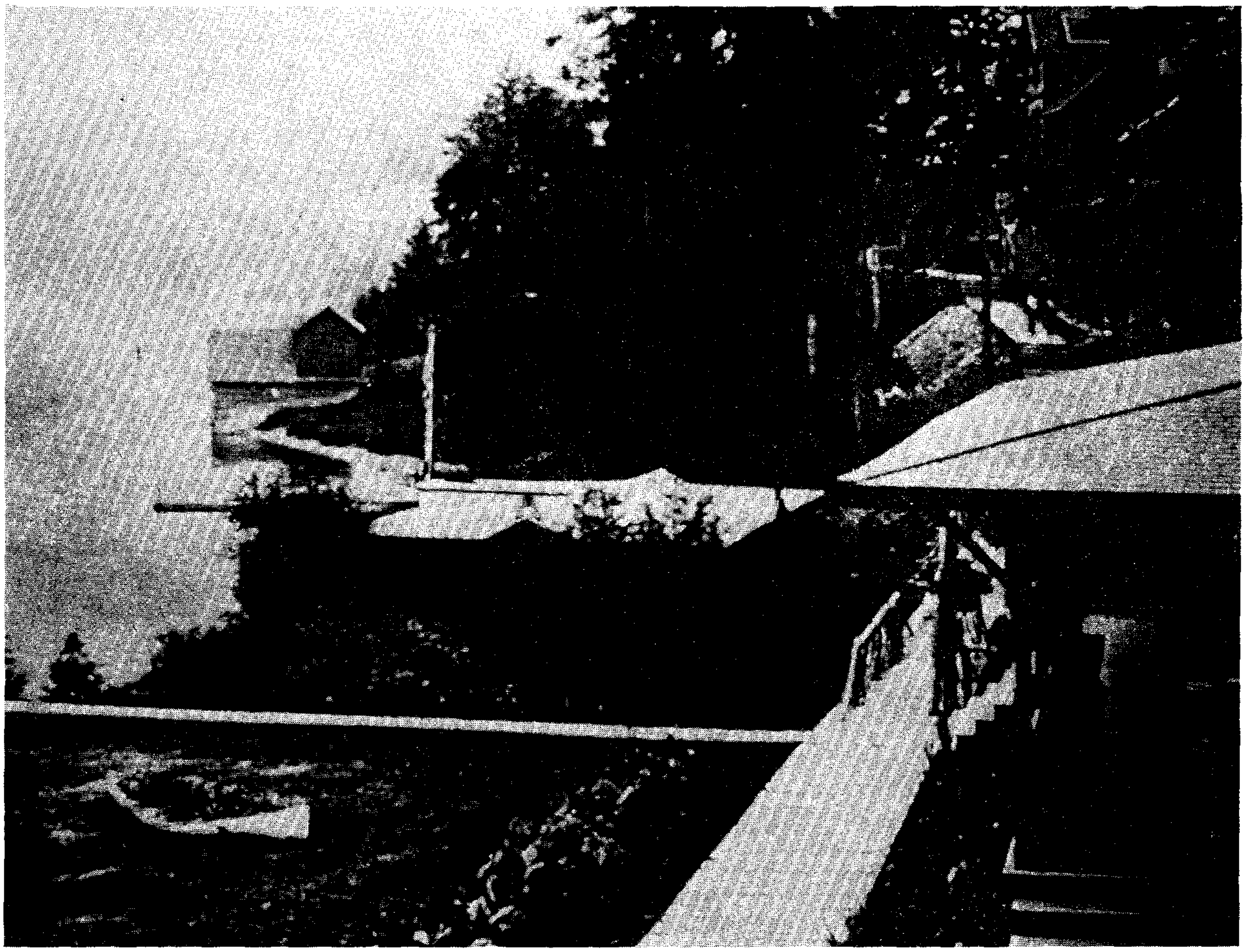


Photograph No. 2

Photograph of spillway showing large volume of water pouring through it. Vacationers are seated at its rim to the right.

Photograph taken ca. late 1880s.

Irving L. London Collection.



Photograph No. 3

Photograph showing cottages along Lake Conemaugh.

Photograph taken ca. late 1880s.

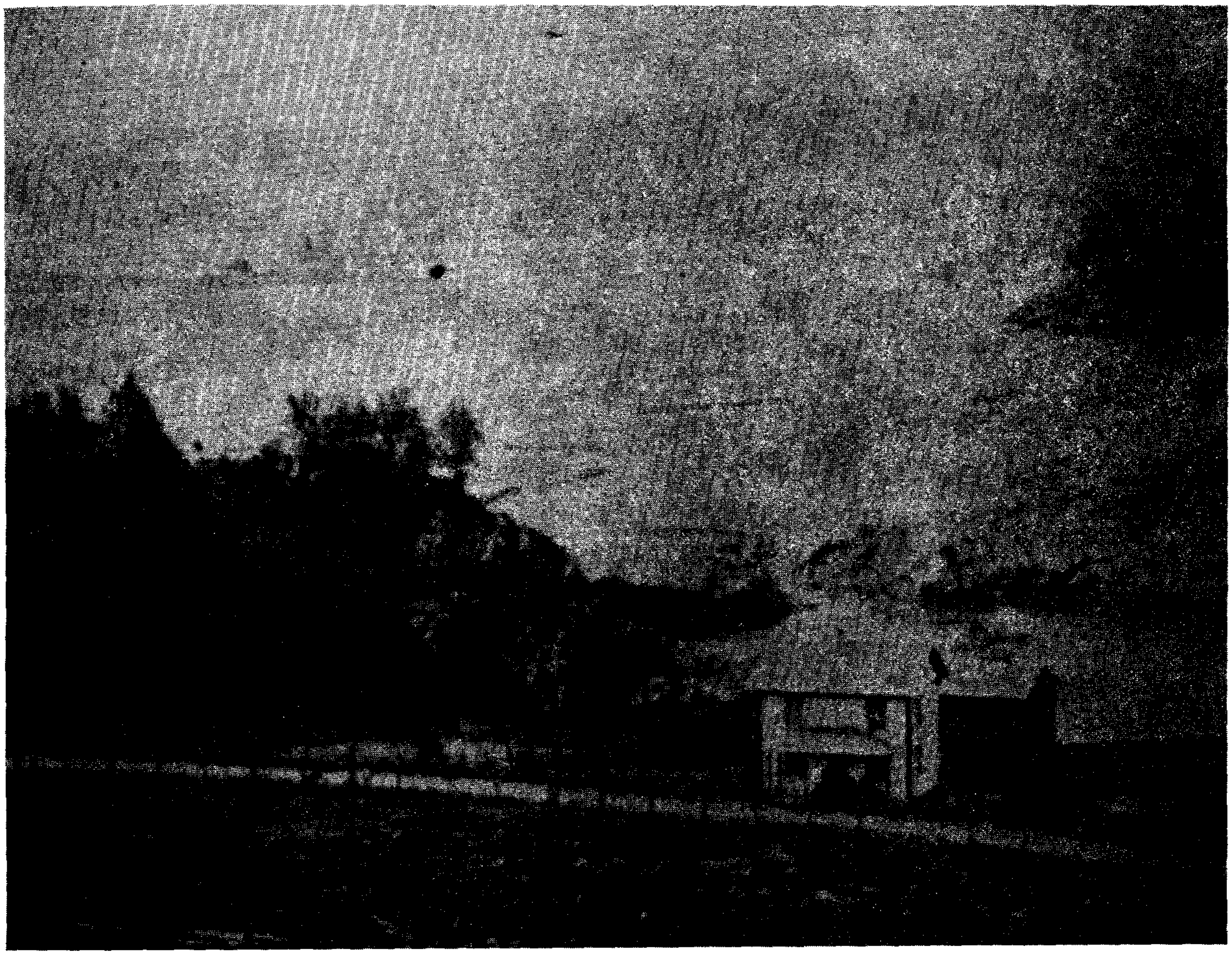
Irving L. London Collection.

Photograph No. 4

Photograph of the broken South Fork Dam after the 1889 flood looking south. The emptied Lake Conemaugh and the club house may be seen in background.

Photograph taken ca. 1889-90.

Pennsylvania Historical and Museum Commission, Division of Archives and History.

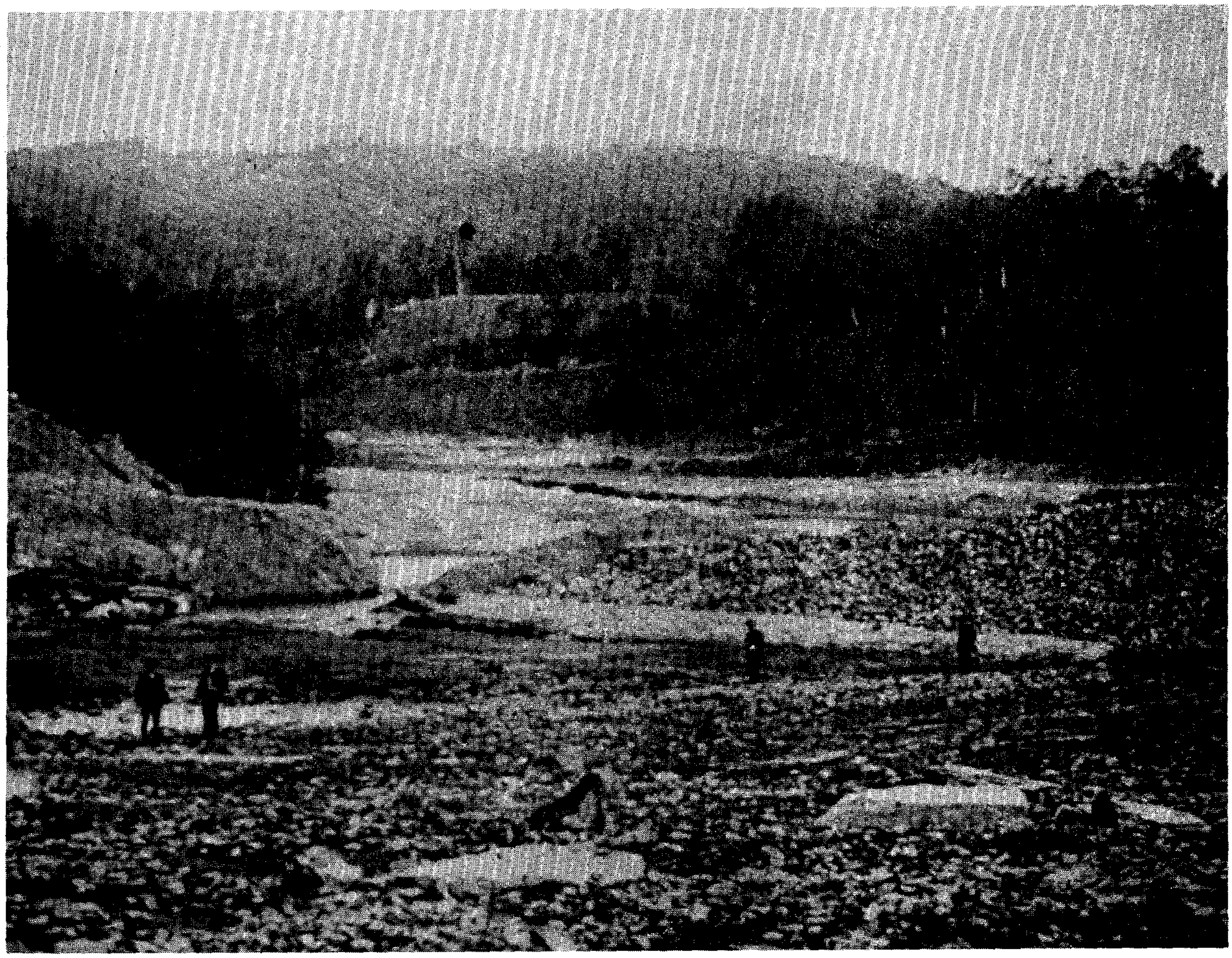


Photograph No. 5

Photograph of the broken South Fork Dam after the 1889 flood looking south toward the emptied Lake Conemaugh.

Photograph taken ca. 1889-90.

Irving L. London Collection.



Photograph No. 6

Photograph of the broken South Fork Dam after the 1889 flood taken from the emptied bed of Lake Conemaugh.

Photograph taken ca. 1889-90.

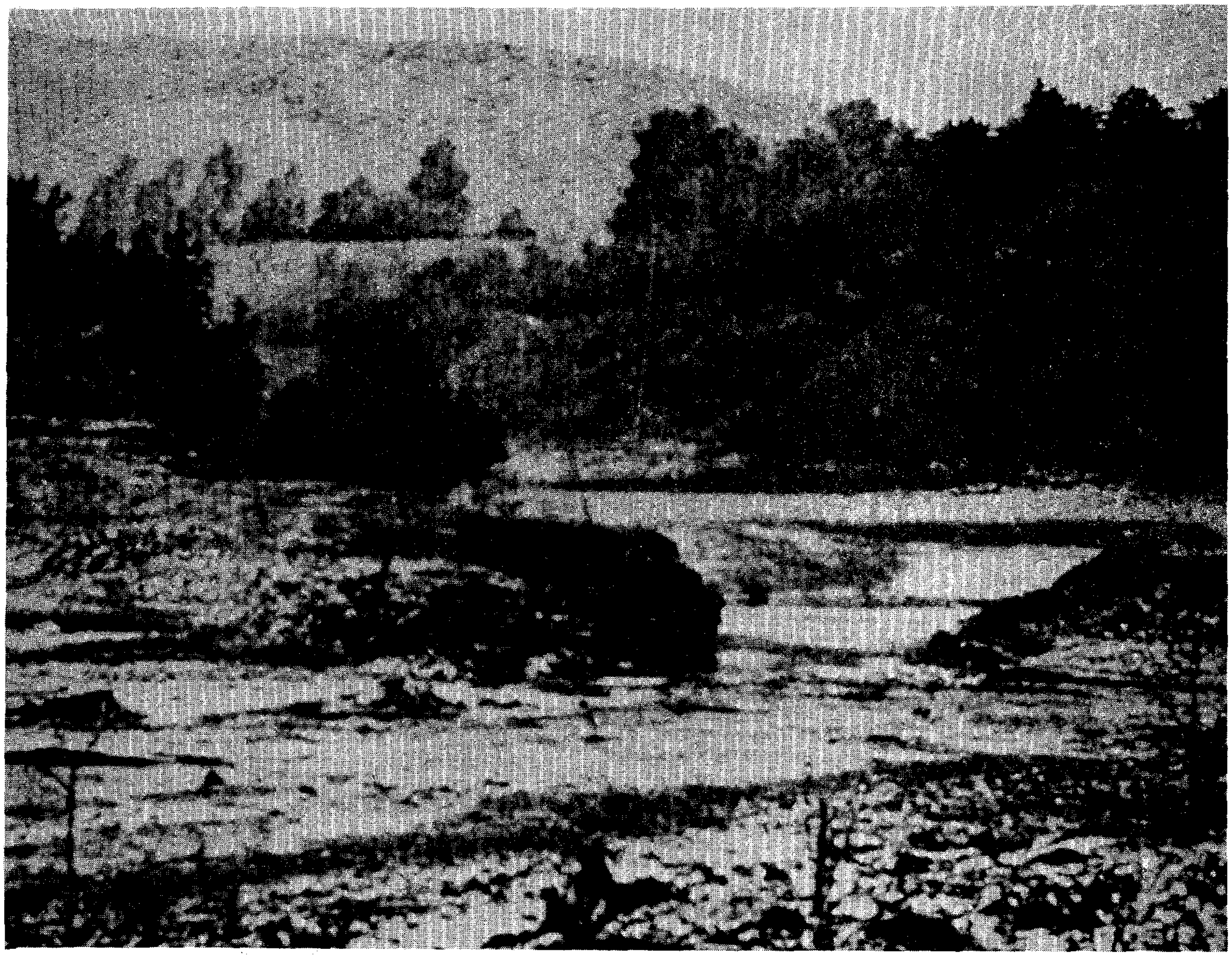
Irving L. London Collection.

Photograph No. 7

Photograph of the broken South Fork Dam after the 1889 flood looking across the emptied Lake Conemaugh toward the club house.

Photograph taken ca. 1889-90.

Irving L. London Collection.

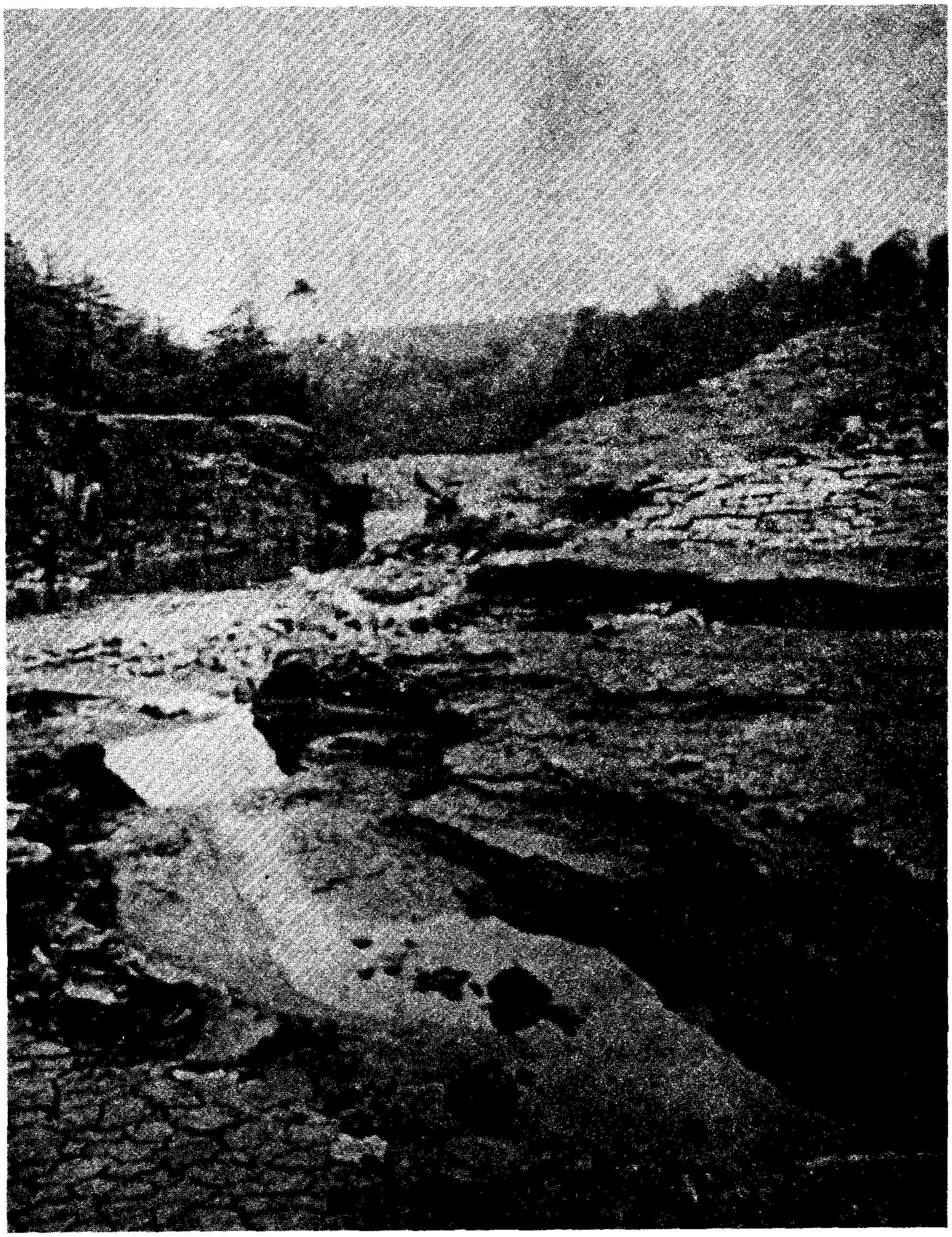


Photograph No. 8

Photograph of the broken South Fork Dam after the 1889 flood taken from the emptied bed of Lake Conemaugh.

Photograph taken ca. 1889-90.

Irving L. London Collection.



Photograph No. 9

Photograph of the broken South Fork Dam after the 1889 flood taken from the emptied bed of Lake Conemaugh. The remains of the arched stone culvert are at the left.

Photograph taken ca. 1889-90.

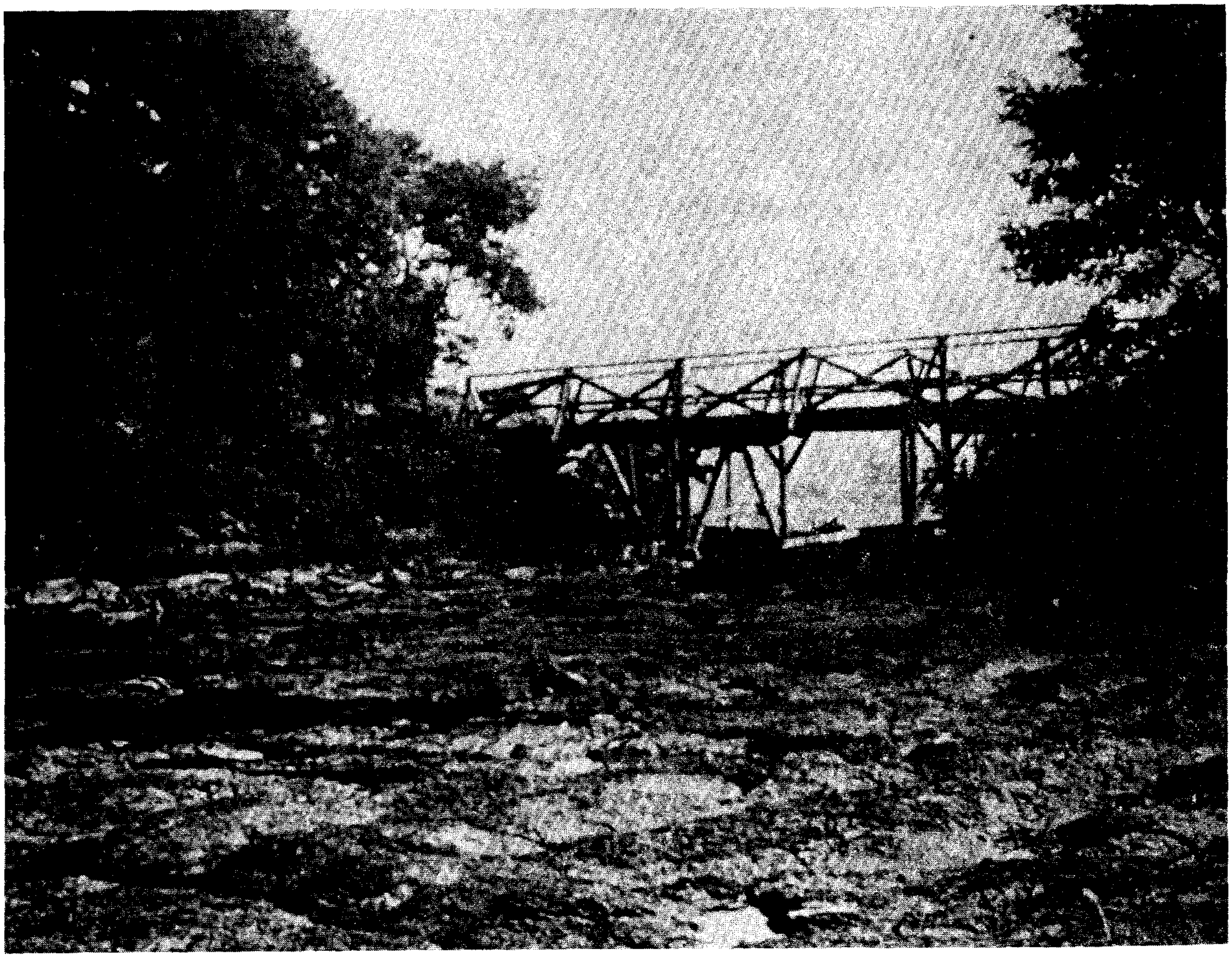
Irving L. London Collection.

Photograph No. 10

Photograph of emptied Lake Conemaugh after the 1889 flood with the resort cottages in the background.

Photograph taken ca. 1889-90.

Irving L. London Collection.



Photograph No. 11

Photograph of the spillway and the spillway trestle bridge after the 1889 flood.

Photograph taken ca. 1889-90.

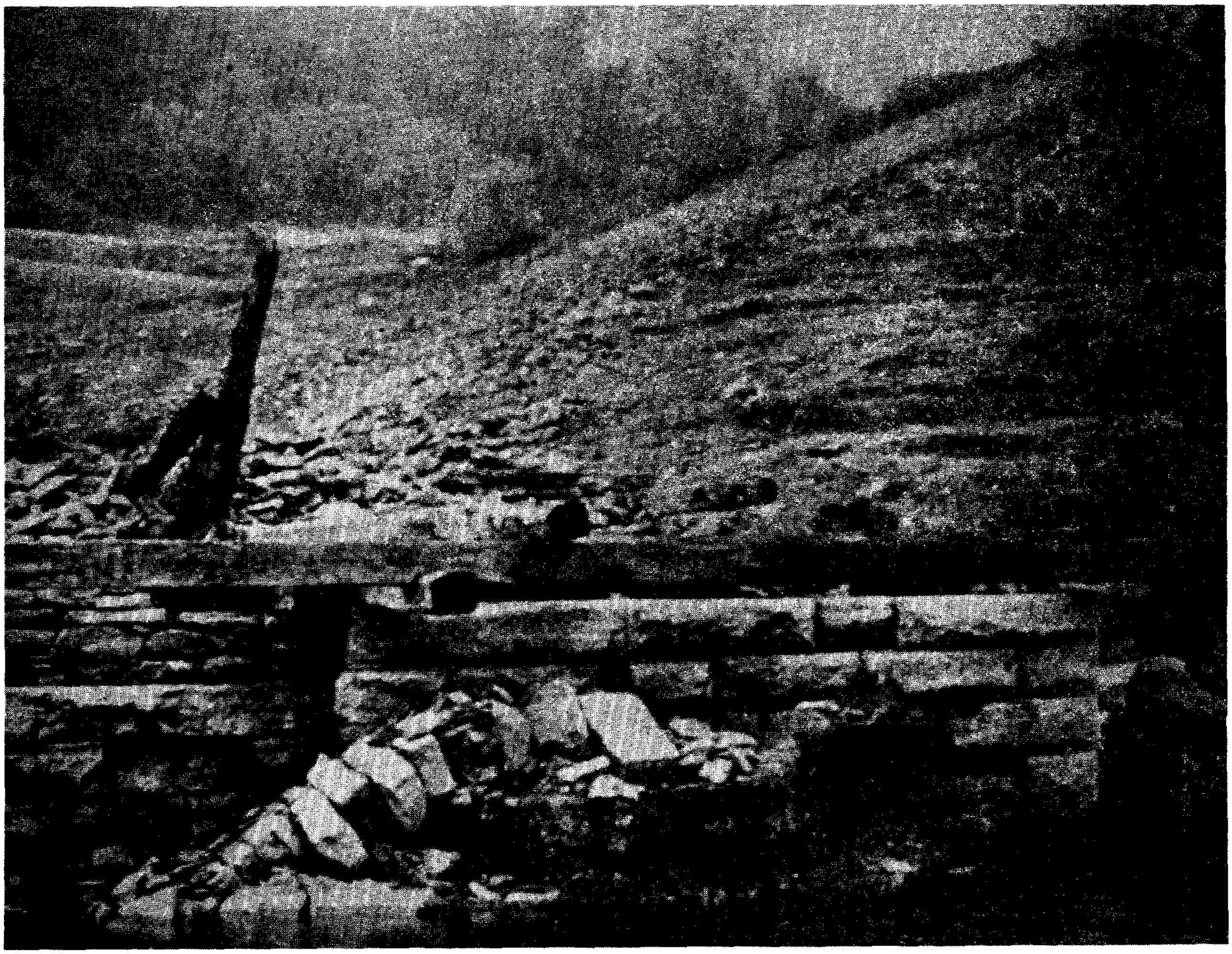
Irving L. London Collection.

Photograph No. 12

Photograph showing the remains of the arched stone culvert after the 1889 flood with the emptied Lake Conemaugh in the background.

Photograph taken ca. 1889-90.

Irving L. London Collection.



Photograph No. 13

Photograph showing the remains of the arched stone culvert and the east end of the dam after the 1889 flood.

Photograph taken ca. 1889-90.

Irving L. London Collection.

As the nation's principal conservation agency, the Department of the Interior has basic responsibilities to protect and conserve our land and water, energy and minerals, fish and wildlife, and parks and recreation areas, and to ensure the wise use of all these resources. The department also has major responsibility for American Indian reservation communities and for people who live in island territories under U.S. administration.

Publication services were provided by the graphics staff of the Denver Service Center. NPS 1607