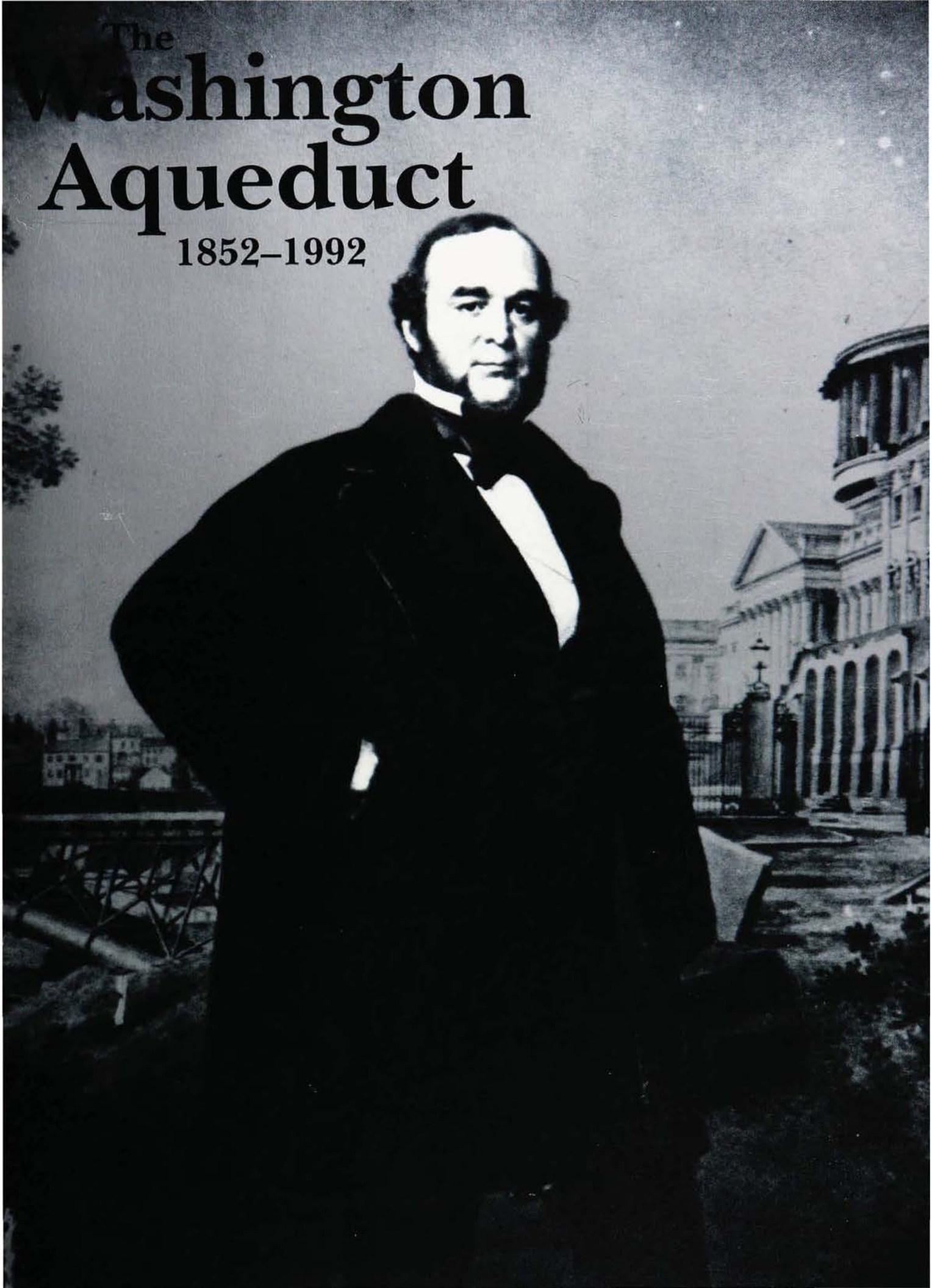
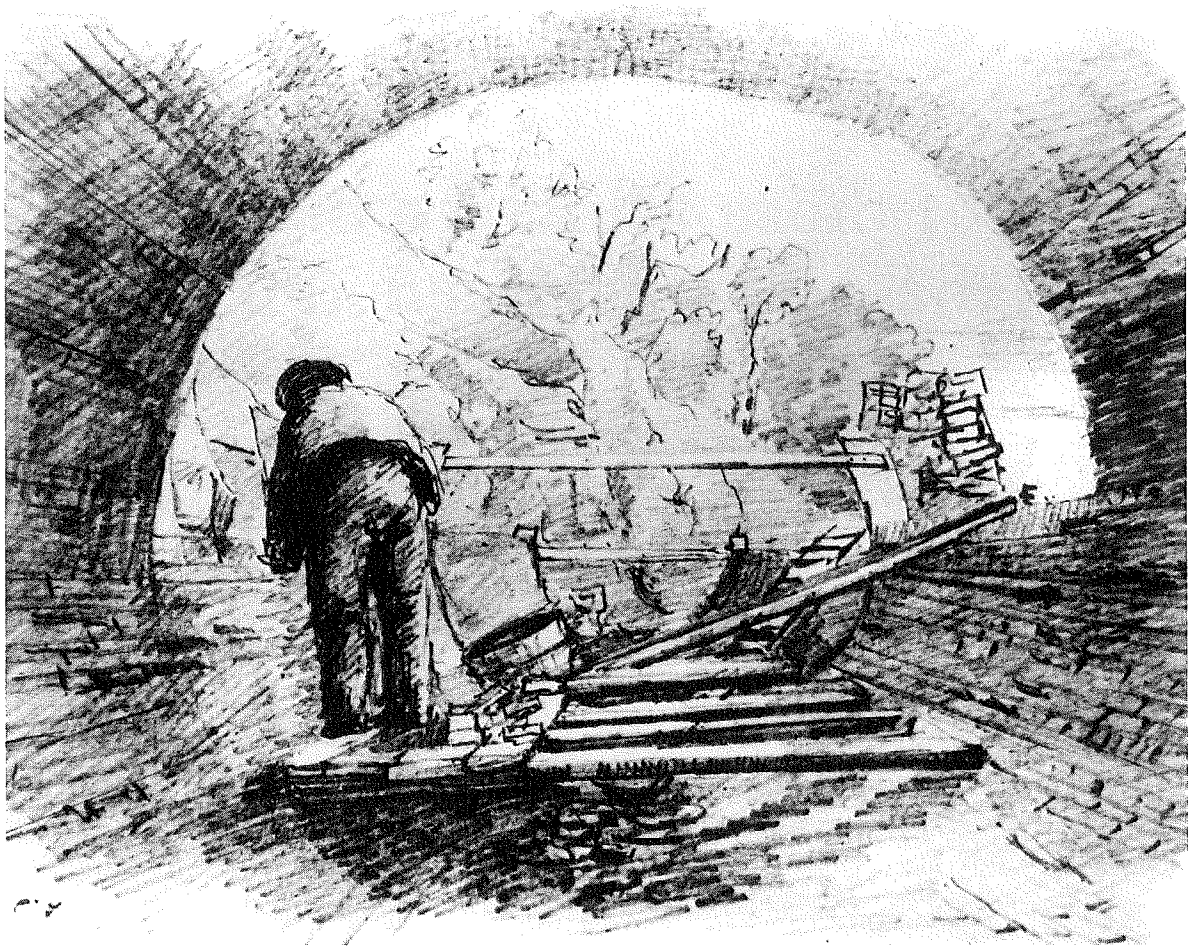
The Washington Aqueduct

1852–1992



Cover: Portrait of Montgomery C. Meigs with projects he was managing in the 1850s, the Washington Aqueduct Rock Creek Bridge and the Capitol Extension. Courtesy of Kunhardt Productions Inc.



Building a trunk of Conduit, Meigs sketch, National Museum of American History, Division of Social History Political Collections, Smithsonian Institution.

To all of those who were there when the Aqueduct needed them.

The Washington Aqueduct

1852–1992

By
Harry C. Ways

The Author

Harry C. Ways was born in Cumberland, MD, in 1926. Following service in the U.S. Marine Corps during World War II, he obtained degrees in engineering from Villanova College and Johns Hopkins University. He joined the Washington Aqueduct in 1952 and served as the Chief of the Aqueduct from 1972 to 1991. He is a Diplomate of the American Academy of Environmental Engineering, a Registered Professional Engineer and a Life Member of the American Water Works Association.

Contents

Acknowledgments

I want to express my grateful appreciation to those who have provided assistance in the preparation of this history, particularly to Brigadier General Gerald C. Brown, U.S. Army, former Baltimore District Engineer and North Atlantic Division Commander, without whose support and encouragement this project may not have been undertaken. Mr. Charles Walker, Executive Assistant, Baltimore District, provided advice and essential support. I am indebted to Perry Costas, my colleague and successor as Chief of the Washington Aqueduct Division, and to Ray Ferrara of that Division, who made available the numerous records, reports, miscellaneous papers, drawings, and photographs in the Washington Aqueduct files.

The late Phillip O. MacQueen, Principal Engineer, Washington Aqueduct, stood virtually alone in stimulating interest in the history of the Aqueduct during the long period of neglect. Dr. Martin Gordon, Office of History, Corps of Engineers reviewed and made helpful comments on the early drafts. Kathleen Richardson skillfully edited the final manuscript. Henry Dunn, Chief of the Baltimore District's Visual Information Section, and his staff were responsible for the layout of the text and photographs and the production of the book.

Dr. Barbara Wolanin, Curator, Office of the Architect of the Capitol, provided advice about and access to the Mohr transcripts of the Montgomery Meigs shorthand journals and other related material in the Capitol Archives.

And finally, my thanks to Mr. William D. Mohr, retired Senate Reporter of Debates, for his painstaking and thorough transcriptions of the archaic version of Pittman shorthand used by Meigs. When completed, this work (being undertaken under a grant from the Senate Bicentennial Commission) will undoubtedly change perceptions of some of the events of the 1850s. As this book was being written, these journal transcripts included the period from late in 1853 to the end of 1857 (in 1800 typed pages). They have provided remarkable insights into the activities and character of Montgomery Meigs. The transcripts for the period 1858 to 1861 will provide even more knowledge and understanding of that turbulent period in Meigs' career.

Harry C. Ways

Introduction

For more than 140 years, the Chief of Engineers has been responsible for providing "the Cities of Washington and Georgetown with an unfailing and abundant supply of good and wholesome water." This authority was interrupted only for a brief period during the Civil War, when the responsibility was transferred temporarily to the Interior Department. The planning for the water supply and the related construction was first directed by Captain (later Major General) Montgomery C. Meigs and continued thereafter under the supervision of numerous civilians and Corps of Engineers officers. Over those years, the system, which Meigs named "the Washington Aqueduct" at the formal groundbreaking ceremony in November 1853, has grown to become one of the largest municipal water supply systems in the nation. It now provides the potable water supply to nearly 1 million consumers in the District of Columbia and in Arlington and Fairfax counties in Northern Virginia.

Since the initial assignment to the Army Chief Engineer, General Joseph Totten, in 1852 by President Millard Fillmore, Congress has maintained that function within the Corps. During the early years, members of Congress objected to the assignment of the Aqueduct and other major public works projects to military men, even though as graduates of West Point the latter were probably the best trained individuals for the task. This resistance soon dissipated. Strong support for and confidence in the arrangement existed over the years, expressed as recently as 1972 in legislation directing that the Washington Aqueduct remain under the control of the Chief of Engineers.

Many individuals, both Army officers and civilians, have made significant contributions to the development of this major utility. If, during the 19th century, the abundance and the wholesomeness fell short of citizens' expectations, the situation was not unique to the nation's capital. And during the 20th century, the residents have fared better than those in many other areas in that regard.

Although staffed entirely by civilians, over the years the Washington Aqueduct has had more than 60 Corps Officers in Charge. Some of these officers played major roles in the development of the water supply system, particularly during

the 19th century. However, because of the unique nature of this municipal water supply function within the Corps and the myriad of other duties of the Corps officers assigned to the post of District Engineer in the 20th century, the civilian "Chief Engineers" have played the dominant role in operating and managing the Aqueduct. The officers remained involved in major policy decisions, particularly those relating to water resources planning and development. Since General Meigs' departure, only 12 civilian engineers have been in charge; their tenures ranged from less than 1 year to over 35 years (in the case of Mr. Edward Dana Hardy). All five of the Chief Engineers who have served for more than one year between 1950 and 1990 have been admitted to the Baltimore District's "Gallery of Distinguished Employees." In addition, hundreds of individuals, doing all types of work, have dedicated their careers to this area of public service. Frequently, as was the case with Captain Meigs, they have foregone more lucrative employment elsewhere because of their pride in and high regard for this beneficial utility. Several are mentioned herein by name, too many others have made similar contributions to be singled out by name.

One individual, however, stands out above all others. Not only was he the planner and builder of the original Washington Aqueduct (nearly all of the major facilities he constructed in the 1850s are still in use today), but he accomplished much in addition to his work related to the aqueduct. Few men have contributed as much to the nation or have been held in such high regard by those at the highest levels of government. The Meigs era is undoubtedly the most interesting and remarkable part of the Washington Aqueduct story. His tomb in Arlington Cemetery bears the tribute "Soldier, Engineer, Architect, Scientist, and Patriot." To these words we might add "Statesman and Politician of Impeccable Integrity." No other water system can boast a founder to match Meigs' accomplishments on behalf of the young nation he loved and served with such distinction.

The benefits to the nation's capital, as exemplified in the Capitol Building and the magnificently executed Washington Aqueduct—which is still providing water for the city today—would justify far greater recognition than Meigs has received. However, the contribution he made to the Union victory in the Civil War is the one most deserving of the nation's respect and gratitude. William Seward, Secretary of State during that conflict and a dominant figure of the time, expressed his appreciation of Meigs' war service in 1867. Seward wrote, "The prevailing opinion of this country sustains a firm conviction which I entertain and on all occasions cheerfully express, that without the services of this eminent soldier the National cause must either have been lost or deeply imperiled in the late civil war."

Historian Alan Nevins, in his extended history of the war, *Ordeal of the Union*, described Meigs as one of the principal architects of the northern victory and a conscientious administrator whose zeal and skill were invaluable. He called Meigs truly illustrious, although long overlooked and neglected by Civil War historians. Nevins wrote of Meigs:

> The quartermaster bureau under Montgomery C. Meigs accomplished a Herculean task with remarkable efficiency, honesty, and expedition no reasonable person could deny...He brought to his office a high reputation as a supervisor of the principal pre-

war undertakings, both architecturally and engineering, for the improvement of the capital. A man of dogged industry, marked reserve, and utter devotion to the nation, he sometimes seemed a mere machine for toil. Yet his papers reveal a kinetic spirit and a warmly emotional nature, sensitive to blame and responsive to praise...Unescapably, Meigs was often violently criticized, for every step he took involved friction.

But Meigs' activities went far beyond those expected of the Quartermaster General. He met regularly with the President, the Cabinet, and the top military leaders to plan the strategy and management of the conflict. And he was a close advisor, friend, and sometime social companion of President Lincoln. Lincoln often dispatched members of the Cabinet or military officers on missions to investigate matters on which he had to make decisions, and Meigs was trusted with his share of those assignments.

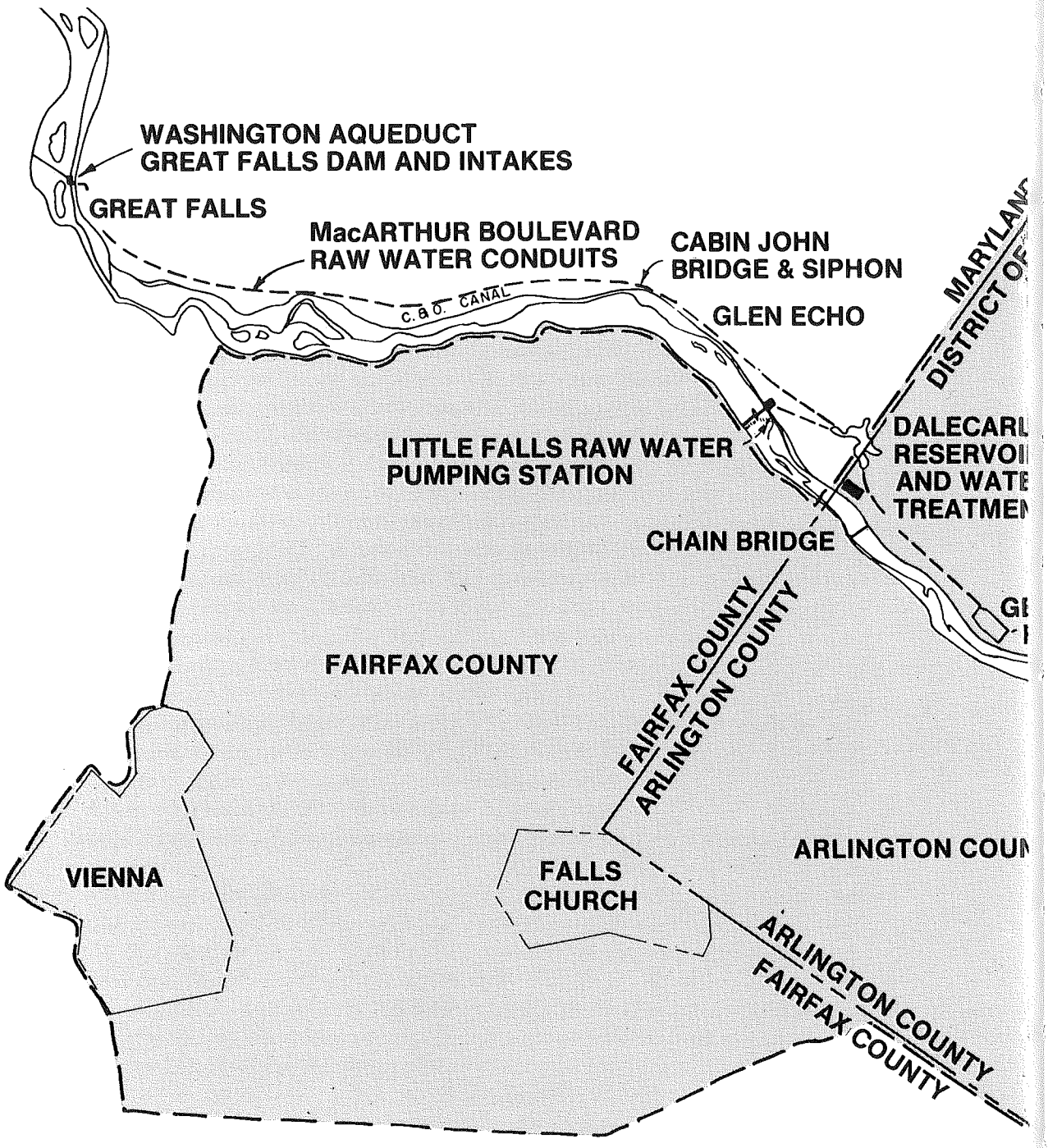
At the time of his death in January 1892, the Army paid tribute to his service and character with the following obituary order:

> General Meigs was personally a man of kind and amiable character, of strict probity and sense of right, and of great breadth of intellect. The army has rarely possessed an officer who combined within himself so many and valuable attainments and who was entrusted by the Government with a greater variety of weighty responsibilities or who has proven himself more worthy of confidence. There are few whose character and career can be more worthy of respect, admiration and emulation.

For those wanting a more detailed accounting of Meigs' life and accomplishments in a single work, there is no better source than the excellent 1959 biography "Quartermaster General of the Union Army", by Russell Weigley. Weigley wrote; "There was in Meigs none of the grasping acquisitive drive which so often marked the new day, no thirst for wealth and material success for their own sakes, but instead a dedication to service and duty as the great ends of life, which bespoke an earlier and perhaps more gracious era."

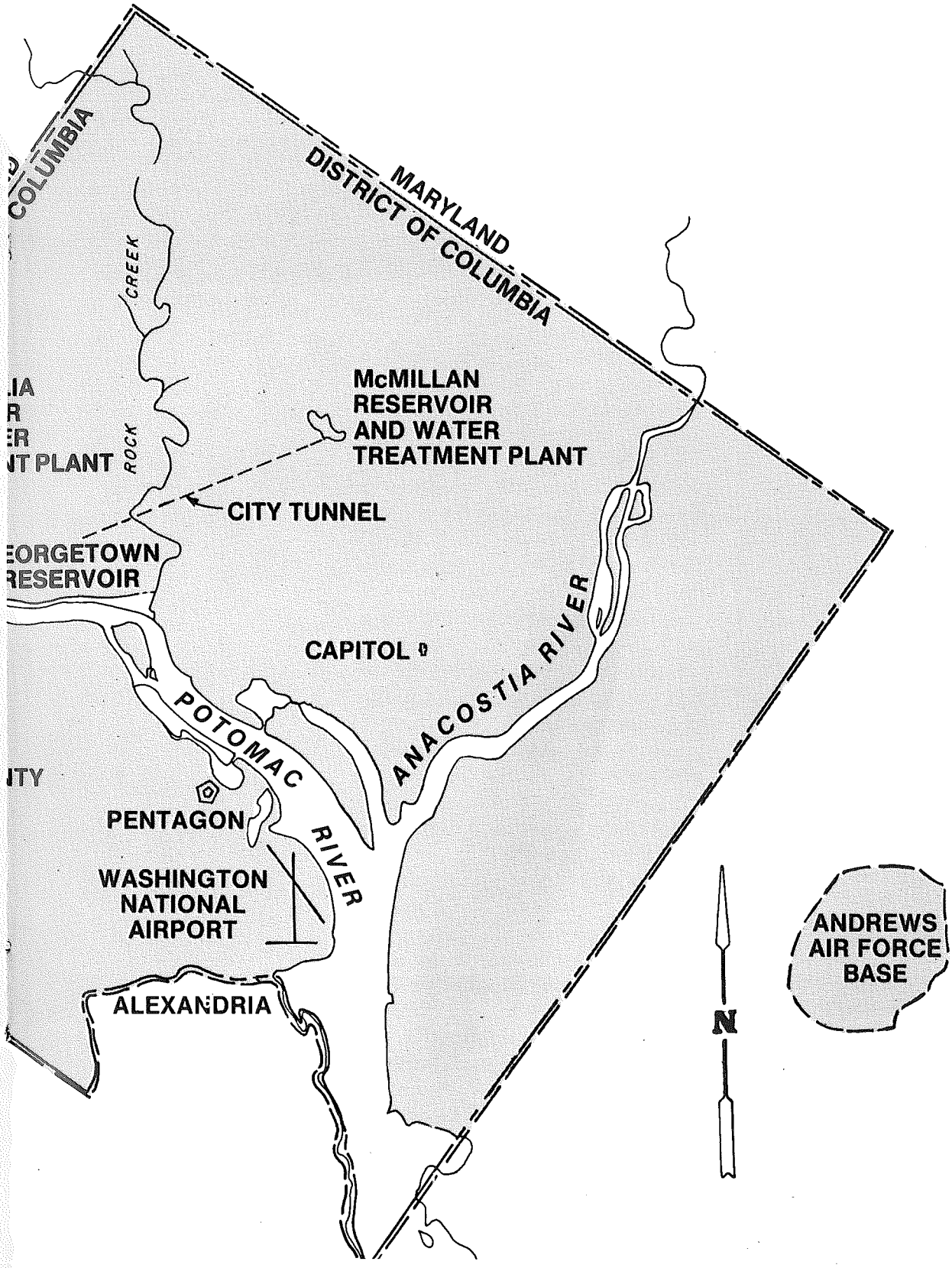
The dedication that Montgomery Meigs exhibited during his management of the Washington Aqueduct has been reflected in the work of many hundreds of loyal employees that followed in his footsteps. This is their story as well.

The Washington Aqueduct — Servi



NOTE: Light blue color indicates service area.

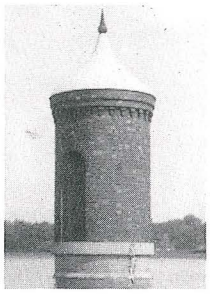
ce Area and Major Facilities



Wooden water pipe from Pennsylvania Avenue, c. 1810

CHAPTER 1
The Early Sources

By the 1850s, the residents of the nation's capital were furnished with water from a series of springs, wells, and cisterns—some privately developed and others provided by the government. The largest and best known of these was the Smith Spring, purchased by the U.S. government in 1833. By 1837, it fed 12 fire hydrants via a 6 inch cast-iron main laid in Pennsylvania Avenue, on its way to the Capitol. This spring was located on land inundated by the McMillan Reservoir around 1900, but it continued to supply the Capitol with drinking water until 1905. In 1884, the Chief of Engineers in anticipation of the development of a new reservoir at the site, recommended that the Smith Spring spring house be encased in a watertight circular housing to prevent the Potomac River water from mingling with that of the spring. (That housing is still visible today in the McMillan Reservoir. If the housing is leaking, which is probable, some water from Smith Spring may now be mixing with the river water in the reservoir that is to be treated and pumped to consumers in the 1990s.)[1]



Smith Spring House in McMillan Reservoir

The other major springs, all located about midway between Massachusetts and Pennsylvania avenues, and extending from the White House to the Capitol, were the Old City Spring (1802–1870), Caffrey's Spring (1809–1870), and the Franklin Park Spring (1816–1904), which was purchased in 1816 for use by the White House and the Treasury. The water was piped to the government buildings, first in wooden pipes made from bored logs, and later in cast-iron pipes. Major Isaac Roberdeau of the Corps of Topographical Engineers supervised the installation of the first cast-iron pipes to bring spring water to the White House and the adjacent executive offices in 1822. These lines were used by the citizens, legally and illegally, which considerably diminished the amount available to the government.[2]

Although water from the Aqueduct system was first available in 1859, the frequently muddy and distasteful nature of the river water resulted in continued use of those sources for drinking and bathing until filtered water was introduced to the system in 1905. Some believed that it was the pollution of the wells and springs by open sewers and pit privies, rather than the unfiltered water from the Potomac, that contributed to the high typhoid fever rates prevalent in the city in the last half of the 19th century. Whether due to the effectiveness of the new slow sand filters, or to the subsequent abandonment of the wells, cisterns, and springs these rates declined significantly in the early 20th century.[3]

Early schemes for a more elaborate water supply included "Skinner's Grand Basin," proposed to Congress in 1830 by Mr. I. K. Skinner, a civil engineer. He suggested a long basin—200 feet wide, 600 feet long, and 5 feet deep—on the Mall between the Capitol and the Washington Monument, to be kept 4 feet above sea level with water from the Chesapeake and Ohio (C&O) Canal. Skinner maintained that this source would provide better quality than water from the springs, a questionable conclusion considering the proposed basin's exposure to pollution. However, the fatal flaw in his scheme was that it would stop up all the drains and flood the basements of many homes on Pennsylvania Avenue.[4]

At the same time, the Baltimore architect, Robert Mills, who at one time supervised the Baltimore Water Works, put forth two schemes. He first cited Tiber Creek as a source, but noted that the supply was limited. (Apparently, he was unaware of the creek's gross pollution.) He then recommended a supply from Rock Creek. But Congress elected to proceed with the supply from Smith Spring instead. Mills, who had prepared the designs for the Washington Monuments in both Baltimore and Washington, had been a protege of Thomas Jefferson and was favored by President Andrew Jackson to design the new War and Navy Department buildings. He also designed the Treasury Building, the Patent Office, and the new Post Office, whose construction Meigs was to supervise. He lost out to Thomas U. Walter in his bid to be the architect for the capitol extension, otherwise he might have played a more visible role in the career of Montgomery C. Meigs.[5]

Montgomery C. Meigs

CHAPTER 2
Congress Addresses the Need

Between 1800 and 1852, the population of Washington and Georgetown increased from just over 3,000 to about 58,000. The District had approximately 50,000 residents living in 7,079 dwellings, over half of which were made of wood. Approximately 8,000 people lived in Georgetown. Water supplies from the wells and springs were proving to be inadequate, particularly for fire protection. On Christmas Eve 1851, fire started by a spark from a stove destroyed the room on the west front of the Capitol (the room housed the Library of Congress). Many irreplaceable files were lost because there was no way to extinguish the flames. The result was a constant fear of fire.[1]

On 30 September 1850, Congress appropriated a meager $500 to enable the War Department to "make such examinations and surveys as may be necessary to determine the best and most available mode of supplying the city of Washington with pure water, and to prepare a plan and estimate of the probable cost of same." Lieutenant Colonel George W. Hughes of the Topographical Engineers was assigned to conduct the surveys. Hughes had worked on several public works projects around Washington prior to serving with distinction in the Mexican War. His report on the survey was submitted to Congress by Secretary of War C. M. Conrad on 25 January 1851 and published as House Document 33, dated 3 March 1853. Although Hughes recognized the Potomac River at Great Falls as a potential source, the limited funds, even when supplemented by an additional $1,000 from the City of Washington, were insufficient to adequately study this option. The study was confined to the use of Rock Creek, which Hughes recommended, stating that it "would supply 8 million gallons per day, a sufficient amount to supply the city for the next 50 years." Hughes had considerably underestimated the future growth of the capital. He concluded by commenting on the lack of sufficient funds and recommending further study.[2]

Apparently, Congress recognized that the meager appropriation had not produced a sufficiently comprehensive report. With a view to providing a satisfactory solution, the 32d Congress in 1852 increased the

amount 10-fold, appropriating $5,000 "to enable the President of the United States to cause to be made the necessary surveys, projects and estimates for determining the best means of affording the cities of Washington and Georgetown an unfailing and abundant supply of good and wholesome water." This bill had been drafted by the Secretary of Interior, Alexander Stuart, assisted by local banker William W. Corcoran and Colonel (Brevet Brigadier General) Joseph G. Totten. President Millard Fillmore turned to Totten, who had been the Chief Engineer of the Army for 14 years and was to remain in that post until his death in April 1864. Totten had distinguished himself in the Mexican War, directing the siege of Vera Cruz. On 14 September 1852, Totten wrote to the President advising him that "Capt. F. A. Smith of the Corps of Engs, who will have principal charge of the investigation, is at present abroad as member of a Court Martial, but will not be delayed many days." Smith, Totten's long-time deputy, soon reported for duty, but died shortly after starting the work. By letter to Secretary of War Conrad, dated 1 November 1852, Totten then recommended the appointment of a young lieutenant, Montgomery Cunningham Meigs, to succeed Smith. This action introduced to the nation's capital a man who was destined not only to gain prominence there but to become a significant figure in U.S. history.[3]

MONTGOMERY C. MEIGS

Who was this Montgomery Meigs, described by an eminent historian in *American Heritage* Magazine in 1989 as one of the most underrated men in American history? Montgomery Meigs was the son of the Charles Delucina Meigs, a prominent Philadelphia physician and professor at Jefferson Medical College. Charles was the son of Josiah Meigs, a graduate of Yale, a professor of mathematics and natural history, and a President of the University of Georgia. At the time of Montgomery Meigs' birth, Josiah Meigs was the Commissioner of the General Land Office in Washington. His mother was Mary Montgomery. She descended from General Richard Montgomery, who died commanding the American forces in the battle of Quebec.

Montgomery Meigs was born in Augusta, Georgia, on 3 May 1816, but he was raised in Philadelphia, where his family had moved when he was very young. After brief study at the University of Pennsylvania, he was appointed in 1832 to the U.S. Military Academy at West Point, at the time the only engineering school in the country. He graduated fifth in the class of 1836 and, because there was no vacancy in the Corps of Engineers, Meigs joined the elite Corps of the Army, the Engineers, in 1837. Until 1853 he had a variety of assignments related to public works and defensive fortifications extending from Detroit to the Delaware River. One of his first assignments in 1837 was as assistant to Lieutenant Robert E. Lee on projects designed to improve Mississippi River navigation and the Port of St. Louis. During these surveys, while he and Lee "paddled about in a dugout canoe" from their base in a small log cabin, Meigs developed an admiration for Lee. This opinion was destined to change dramatically 25 years later during the Civil War.[4]

In May 1841, one day before his 25th birthday, Meigs married Louisa Rodgers, the daughter of Commodore John Rodgers and the sister of Admiral John Rodgers. He chose well. During 1849 and 1850 he was assigned to the Engineer Bureau in Washington as assistant to the Army's Chief Engineer, General Joseph G. Totten. Having been

impressed with Meigs' abilities, Totten recommended him to the Secretary of War as the man to undertake the water supply studies that Congress had authorized in 1852. Secretary of War Conrad approved the assignment, and on 2 November 1852 Lieutenant Meigs was assigned the task of making the survey and preparing the report. Thus began the highly visible public career of one of the most distinguished men in American history.[5]

MEIGS' REPORT TO CONGRESS

Lieutenant Meigs arrived in Washington and reported to the War Department to take charge of the work on 3 November 1852. He plunged into the task in a manner characteristic of this man of remarkable ability. Meigs noted in his journal entry for that date that Captain Smith had only had time "to walk to Rock Creek and ride up to Great Falls . . . and it remained for me to begin and carry on this work." Smith had also engaged an assistant, Mr. William H. Bryan, a civil engineer who remained with Meigs as his principal assistant during most of his work on the Aqueduct. Only nine days after his arrival, on 12 November Meigs submitted his first report to General Totten. By 4 December, Totten had transmitted another of Meigs' preliminary reports to the Secretary of War. The last progress report was submitted on 4 January 1853, and on 12 February three months after assuming the job, Meigs submitted his final comprehensive report to Totten. Two days later, Totten recommended construction as proposed to Secretary Conrad. Conrad forwarded the report to the President, and it was submitted to the Senate on 21 February 1853 (published as Senate Doctrine 48, 32d Congress, 2d Session) as one of President Millard Fillmore's last official acts. This 55-page document far exceeded the expectations of those in charge.[6]

The report, discussed the water supplies of New York, Boston, Philadelphia, Paris and London, and even the ancient and modern Roman systems. Meigs provided estimates of population and the amounts of water needed to meet the increasing demands, including an enumeration of every dwelling and shop in every ward of the city to the present time. He also discussed the great need for fountains in Washington and suggested the following:

> The streets, in hot weather, may be flooded every morning by hose. Every particle of offal prejudicial to health or comfort would thus be washed into the sewers. The most magnificent fountains could be kept constantly flowing; and the city of Washington, unrivaled in grandeur and beauty of plan, would, in a few years, refreshed by living streams, and beautified by sparkling jets and towering columns of water, become a place of summer resort and admiration of our whole people.[7]

Meigs quickly displayed his innate ability to lobby Congress for his projects, a talent that was to serve projects related to the Aqueduct, the Capitol extension, and the Capitol dome—and ultimately the nation—well in the ensuing years. An example from his initial report follows:

> Let our Aqueduct be worthy of the Nation; and, emulous as we are of the ancient Roman republic, let us show that the rulers chosen by the people are not less careful of the safety, health and beauty of their capital than the emperors who, after enslaving their nation, by their great works conferred benefits upon their city which, their treason almost forgotten, cause their names to

be remembered with respect and affection by those who will drink the water supplied by their magnificent aqueducts.[8]

The report contained elaborate descriptions of three possible sources, Rock Creek, and Little Falls and Great Falls on the Potomac, citing the advantages and disadvantages of each source and providing drawings and detailed cost estimates for each of the proposed facilities. The chemical characteristics of the water and filtering also were addressed. Meigs recommended the Great Falls project, which with a 7-foot-diameter conduit, would supply 36 million gallons per day at a cost of $1,921,244. Meigs noted early in his report that:

> The waterworks in this country seem generally to have been designed on an inadequate scale. The growth of cities has been so much more rapid than anticipated, and the quantity of water required for domestic use by each family has gone so far beyond all calculations, that the works designed by engineers, and opposed in their inception as extravagant, have almost invariably failed within a few years after their completion to supply the wants of the builders.

Near the end of the report, he stated, "Were I to recommend any change in this project, it would be to increase the diameter of the conduit. An increase of two feet, making a nine-foot conduit, would nearly double the quantity of water —delivering 67,596,400 instead of a little over 36,000,000 gallons." The cost of this modification was to be only $350,000. General Totten recommended the 9-foot diameter conduit, and it was subsequently built. (Unanticipated population growth produced demands for water that would have exceeded the capacity of the seven foot diameter conduit by 1890. The larger diameter conduit met the requirements of the city until 1927. The nine foot conduit was to prove even more valuable when modifications in the 1930's increased the capacity to approximately 100 million gallons per day.)[9]

Lieutenant Meigs may have been somewhat optimistic in his projections of the time needed to accomplish the work, stating that:

> Should the route from the Great Falls be adopted, and money be appropriated so as to be available early this season, I would advise the immediate commencement of the dam at the Little Falls Branch, and the conduits and mains thence to the Capitol. The water from this stream could then be introduced next winter, and the remainder of the work could be pushed through within the next year or eighteen months.

Water from Little Falls Branch was not introduced to the system until 1859, and not from the Potomac at Great Falls until December 1863. However, Meigs could not be held responsible for the delays, which were caused by difficulties in obtaining needed lands and rights-of-way, sickness among the workers, and the Civil War. Even more significant was the lack of adequate and regular appropriations of funds, caused by vindictive efforts of a few recalcitrant members of Congress. Not even Montgomery Meigs could overcome their hostile opposition to military supervision of civil works projects. His remarkable foresight in all aspects of the report had extended to this eventuality. He stated near the end of his report that "if the work is delayed by meagre appropriations, its expense will be much increased; and I hope, in that case not to be held responsible for its cost above my estimate, which is based upon a steady and vigorous prosecution of the work."[10]

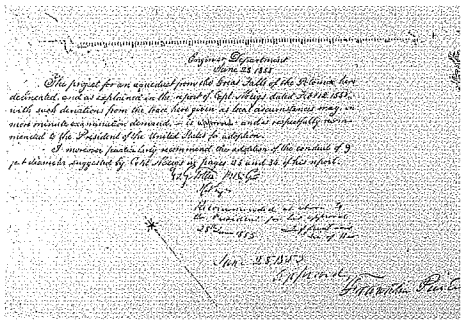
As was characteristic of his attitude throughout his career in public works, Meigs acknowledged and thanked those who helped him prepare the report, particularly William Bryan. He also commented that "In preparing these estimates, I have adopted a simple style, without much ornament, but suitable to the greatness and importance of their object." But some parts of the Aqueduct were to be anything but simple or without ornamentation. At the end of the report, he stated, "I ought perhaps to apologize for the length to which this report has extended." No such apology was needed. The report stands the test of time and has led to the creation of an enduring water supply system. Nearly all of the major elements of the original aqueduct system are in service today and are expected to continue in service for the foreseeable future.[11] Meigs' estimates of the future needs were somewhat conservative, however. He estimated that the city would require 22.5 million gallons per day (mgd) in 1900, and that the nine-foot conduit would provide the amounts needed for almost 200 years. Actually, the consumption had by 1900, exceeded 50 mgd, and the supply had to be augmented with a second conduit from Great Falls in the 1920s. Another interesting note in the original report, in light of current events, was one of Meigs' arguments in favor of the Great Falls site: "The full head, however, has an advantage in permitting the use of much smaller leaden service pipes in houses." Also he noted that "The engineer who bridles and masters the Potomac will achieve fame."[12]

In his letter forwarding Meigs' report to Secretary of War Conrad, General Totten wrote, "Lieut. Meigs has not perhaps dwelt as much as he might have done upon the advantages to the city of dispensing, in a great measure, with the labor of working fire engines, the head being sufficient, in every part of the city, for extinguishing fires by the use of hose alone." Because the threat of fire would be one of the major factors motivating Congress to authorize the project, it seems strange that Meigs did not give it greater emphasis.[13]

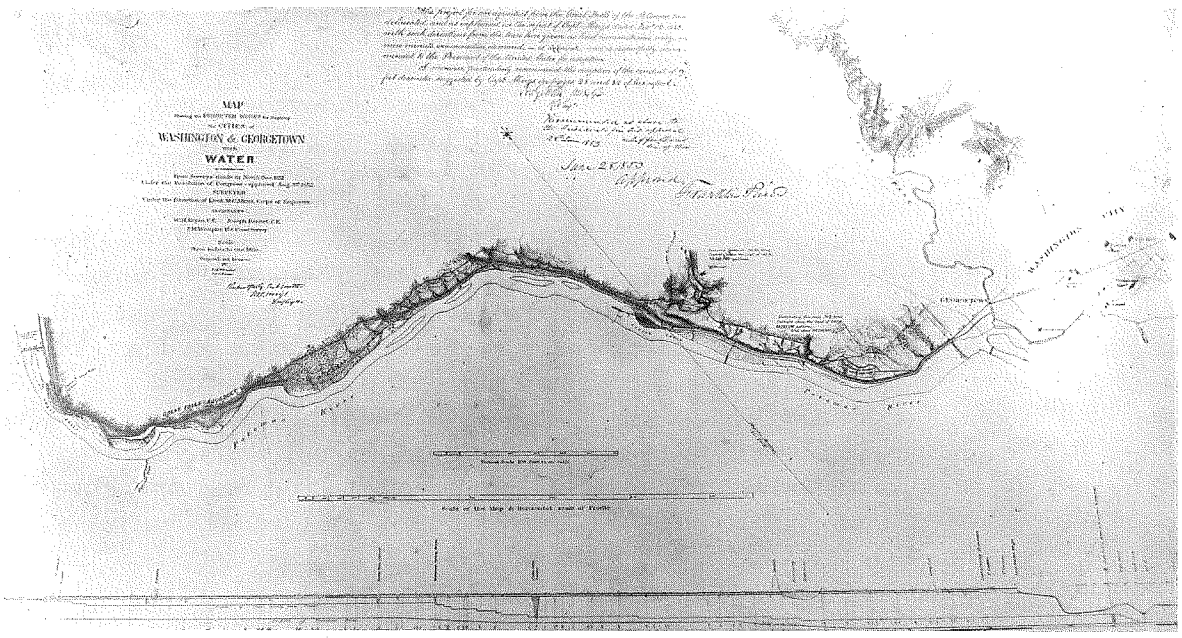
CHAPTER 3
Developing the Plan

After rapid but full consideration of Meigs' report, Congress passed the General Appropriation Bill of 3 March 1853: "For bringing water into Washington, upon such plan as the President of the United States may approve, one hundred thousand dollars; Provided, that if the water shall be taken from any place within the limits of Maryland, the consent of the State shall first be obtained."

Newly inaugurated President Franklin Pierce, a brigadier general in the Mexican War, had roundly defeated his old commander, "Old Fuss and Feathers," General in Chief Winfield Scott, in the recent election. He had appointed Jefferson Davis, a senator from Mississippi, to be his Secretary of War. (Davis had graduated 23d of 33 in the Class of 1828 at West Point, far below his classmate Robert E. Lee. He had served with distinction and



Signatures of Army Chief Engineer Brigadier General Joseph Totten, Secretary of War Jefferson Davis and President Franklin Pierce on Meigs' Plan.



Lieutenant Meigs' February 1853 plan for his yet unnamed Washington Aqueduct.

been wounded in the Mexican War.) Davis then persuaded the President to transfer the authority for completion of major public works, including the new water supply system, from the Department of Interior to the War Department. The opposition at that time became much more vehement a few years later, resulting in considerable obstruction and delay of the work on the Aqueduct. On 29 March 1853, Davis chose Montgomery Meigs to carry out the task of building the Aqueduct that the latter had planned so well. On that same day, he also put Meigs in charge of the work on the Capitol extension. In February 1855, Davis ordered Meigs to superintend the extension of Robert Mills' 1830 U.S. General Post Office building.[1]

The man chosen earlier to be the Architect of the Capitol, Thomas U. Walter, was suspected of peculation. A Senate investigation found no misconduct by Walter, but concluded that he had been a careless administrator. The Deficiency Appropriation Bill passed by Congress in 1853 contained a clause providing that funds for the Capitol extension should be "disbursed through a new agent appointed by the President." President Peirce on 23 March issued an order that went further:

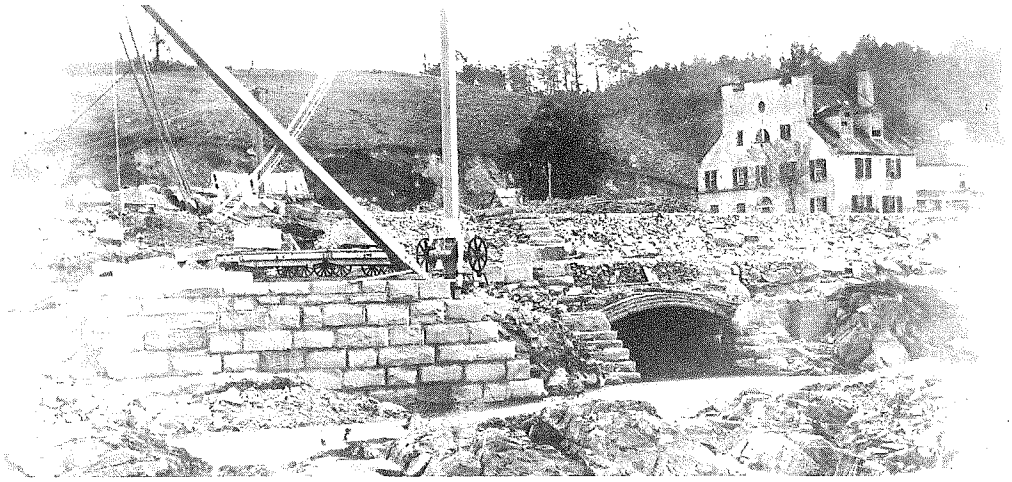
> Believing that the public interest involved in the erection of the wings of the United States Capitol will be promoted by the exercise of the general supervision and control of the whole works by a skillful and competent officer of the Corps of Engineers or the Topographical Corps, as these Corps are more amenable to the Secretary of War, I hereby direct that the jurisdiction heretofore exercised over the said work by the Department of the Interior be transferred to the War Department and request that the Secretary of War will designate to the president a suitable officer to take charge of same.

It would be reasonable to assume that the new Secretary of War had played a strong hand in persuading the President to transfer the work to his department. Davis found Meigs to be the most suitable officer, and he was detailed to the job on 29 March 1853. Five days later, Davis provided written orders to Meigs, citing several subjects he should investigate, including the condition of the foundation and the arrangements for "warming, ventilation, speaking and hearing." One paragraph stands out: "As upon you will rest the responsibility for the proper and economical construction of these buildings, you will consider yourself fully empowered to make such changes in the present administration as you may deem necessary, and to regulate the organization hereafter as your experience may dictate." If Thomas U. Walter was aware of this order, he found great difficulty in accepting it. Meigs was to dominate the work on the Capitol for the next 5-1/2 years, significantly modifying the mechanical design and the interior arrangement and construction. He also selected and supervised the artists who created the paintings and sculpture for the exterior and interior (in the process incurring the wrath of prominent American artists and several members of the House and Senate for using foreign artists). He devised the method of constructing the dome and had the prime role in persuading Congress to provide the necessary funds to complete the dome. Davis was later to state that Walter "failed utterly as a constructor" and that whatever was valuable in the design was the result of Meigs' work. In a letter to Meigs, he said that the success of the project was "mainly attributable to you having been put in charge"

and expressed the hope that the country would appreciate Meigs' services. The unfortunate fact is that this has not yet happened.[2]

In June, Meigs submitted his detailed plan for the Aqueduct to General Totten, having designed the system to include the added capacity provided by the nine-foot conduit. On 28 June 1853, Totten recommended Meigs' plan to Davis, who immediately forwarded it to President Pierce for his approval. The cover drawing, showing the entire system in plan and profile, was signed by Totten, Davis, and President Pierce that same day. The location of this original is unknown, but an exact copy, made in 1885, is now in the conference room at the Washington Aqueduct offices.[3]

With the $100,000 authorized by Congress, Meigs immediately began refining the plan and providing design details for the facilities. The Aqueduct was to begin at a small dam on the Potomac River at Great Falls, Maryland, to divert the river flow into the conduit. Just beyond the intake, a gatehouse building with 20 sluice gates controlled the flow and maintained the proper water levels in the 10-mile brick-lined conduit of 9-feet diameter, with a slope of 9.5 inches per mile. Near the D.C. boundary, the conduit discharged to a Receiving Reservoir created by damming the Little Falls Branch, 5.5 miles west of the Capitol. This 50-acre reservoir was designed to permit sedimentation of the turbid waters and to assure sufficient storage so that the conduit could be shut off during periods of extremely muddy water in the river and for necessary maintenance. The water from this reservoir then traveled through a 2-mile extension of the conduit, terminating at another 36-acre reservoir at Drover's Rest on the Potomac Palisades above Georgetown. Flow to this reservoir, termed the Distributing Reservoir, was controlled by a taintor gate at the outlet of the first reservoir. (This gate remained the flow control device until well into the 1960s.) The Distributing Reservoir provided additional storage and settling capacity. Two cast-iron mains of 30-inch and 12-inch diameter carried the water into the city, crossing College Pond, Rock Creek, and Tiber Creek on bridges and extending to the Capitol and the Navy Yard. The total length of the system from Great Falls to the Navy Yard was 18.6 miles. A brick-domed, 2.5-million-gallon circular storage reservoir—120 feet in diameter and 50 feet high with earthen floor and banks was located on Lee's Hill at High and Road streets (now the intersection of Wisconsin Avenue and R Street). This reservoir would serve the higher areas of Georgetown that could not be reached by gravity flow from the Aqueduct. (That reservoir has since been demolished and the site is occupied by the Georgetown Branch of the D.C. Public Library. The old stone retaining wall still surrounding the site was built as part of the Aqueduct.) Water was pumped up 145 feet to this reservoir by a hydraulic ram installed in the west abutment of the bridge over Rock Creek at Pennsylvania Avenue, taking water from the 30-inch main. As stated earlier, Meigs calculated that the capacity of the Aqueduct system would be 67,596,400 gallons per day and estimated the cost to be $2,271,244.[4]



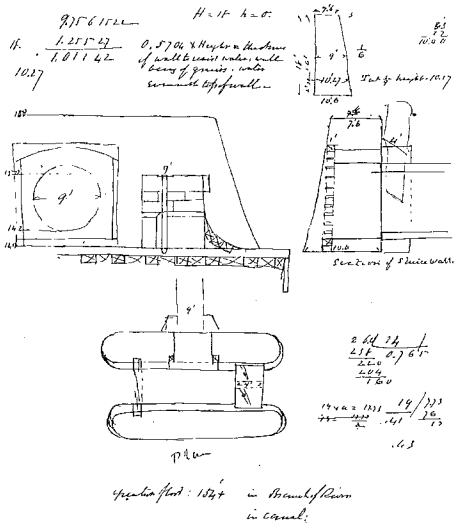
Construction of the Great Falls Intake, at Lock 20 on the Chesapeake and Ohio Canal, Crommelin House to the right.

CHAPTER 4
Building the Projects

By the end of October, just four months after the President's formal approval and less than a year after being appointed to begin his original survey, Meigs had completed the initial details and had assembled sufficient crews and materials to begin the work. A parcel of land was obtained near Lock 20 on the C&O Canal, site of the hotel at Great Falls. Construction started there with the crossing under the canal. Meigs rode to Great Falls accompanied by William Bryan, on 31 October 1853. There he found a small force "waiting for me to strike the first spade, which I proceeded to do, digging the first spadeful." He was followed by the assistant engineers he had wisely selected to assist him in the project. That day, Meigs wrote in his journal:

> Thus quietly and unostentatiously was commenced the great work. Which is destined I trust for the next thousand years to pour healthful water into the Capital of our union. May I live to complete it and connect my name imperishably with a work greater in its beneficial results than all the military glory of the Mexican War.

Meigs was to ensure that his name was connected imperishably



Meigs' first sketch for the Great Falls Intake. It was built as shown, and the two oval piers remain in place today.

with the work many times, in many places, in both stone and iron. And although this initial groundbreaking was quiet and unostentatious, he was that same day planning a "more formal commencement by the President or the Secretary of War." Soon thereafter, he "made arrangements for the formal opening of the work by the President."[1]

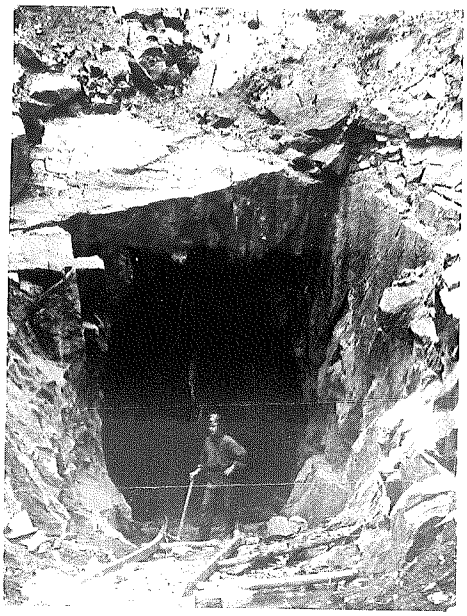
November 8, 1853 marked the:

> Grand Celebration of the beginning of the Aqueduct. The President, Sec. of War Davis, Senator Douglas, Mayor and Councils of Washington...Ritchie, and a

Construction of the gatehouse at Great Falls

number of guests, in all over 100 persons went up to the Falls in our packet and the steam packet which was engaged for the occasion.

The Mayor and Council of Washington provided a cold collation of champagne, which was enjoyed by the company. I was compelled to make the introductory address after the opening prayer by Mr. Pyne (pastor of St. John's Episcopal church, where Meigs was soon to become a vestryman), who fitly commenced this great work for the benefit of mankind by asking the blessing of the Almighty upon it and those engaged in it. I took cause to name it the Washington Aqueduct, and handed the spade to the President of the United States, Franklin Pierce. He made a few appropriate remarks, upon the importance of the work, and then dug a good and honest spadeful of earth, which he deposited in the barrow. Jefferson Davis, Secretary of War, and Senator Douglas followed in hearty speech and deed. The Mayor of Washington, the Engineer (myself), the Mayor of Georgetown, members of councils all filled the barrow, which



Tunnel construction on conduit

was wheeled off at a trot by Purcell, the carrier. At the dinner, success to the work, the health of the President, Sec. of War were drunk, and general good humors prevailed. We returned to town as we came, reaching Georgetown about 7 P.M.[2]

This journal entry is quoted in its entirety, insofar as is possible given the problems in reading Meigs' handwriting. During the Civil War, General William Tecumseh Sherman (another figure whose hand-

Conduit open cut construction

writing presents problems for historians) expressed his confidence in his friend Meigs: "The handwriting of this report is that of General Meigs, and I, therefore, approve it, but I cannot read it." Meigs' illuminating journals covered the entire period that he was assigned to the Aqueduct and extended into the early days of the Civil War. At first they were written in longhand and then, after January 1854, mostly in his modified version of Pittman shorthand, which is being transcribed in its entirety for the first time in the mid-1990s.[3]

Over 200 people were present at the celebration at Great Falls. Senator Stephen A. Douglas, who gave an invocation of the Constitution, was later to gain fame in the Lincoln-Douglas debates and as Lincoln's Democratic Party opponent in the election of 1860. The dinner referred to was held at Crommelin House, the hotel built in 1828 at Lock 20, which was named for the Dutch Banking House that had arranged the loan to build the canal. The building, now known as the Great Falls Tavern, is operated as a museum by the National Park Service.[4]

According to an account of the event in the *National Intelligencer*, "the Hon. Jefferson Davis, Secretary of War, paid a merited tribute to the talent and learning of the engineer under whose management this great design had been so properly placed . . . and insisted that great and magnificent as that design was, it did not exceed the destiny reserved for such a city into which it would eventually provide a tide of prosperity and greatness." He concluded by observing that he had been "in the habit of listening to the engineer for all that related to this undertaking." That reporter noted that the banquet provided welcome relief after a "voyage of fourteen miles, diversified with an occasional promenade on the towing path, to say nothing of half a mile's scrambling over rocks from the hotel to visit the Great Falls." Meigs was pleased that the *Intelligencer* printed a full account of his speech, but noted that "the people of the press are grumbling that more were not invited. The whole town would have turned out if they had been notified."[5]

Nearly two years later Meigs had some difficulty with the clerks at the War Department who refused to pay the expenses he had charged for the "Grand Celebration." Meigs had little patience with the bureaucratic

minions who had the temerity to question his accounts. On one occasion he wrote, "Today I went to the Treasury, where they have got some maggots in their heads about the accounts for the Capitol."[6]

The work proceeded at a much slower pace than Meigs had hoped for, although he had warned in his initial report that problems beyond his control could significantly delay the project. Major factors contributing to the delay were difficulties in obtaining the necessary lands and rights-of-way, failure of Congress to appropriate adequate funds for the work to continue uninterrupted, sickness among the workers, and, later, difficulties in obtaining labor during the Civil War.[7]

In May 1853, based on legislation drafted by Meigs at the request of Jefferson Davis, the State of Maryland consented to the project, authorized the condemnation of lands, and ceded jurisdiction over the Aqueduct lands to the federal government. However, the necessary lands proved to be "hard to come at" (as one of the tracts was designated on the plat). Nearly all of the property had to be condemned, and the authorization approved by the Maryland legislature required that such land be evaluated by a jury of at least 12 inhabitants of the county summoned by the sheriff.[8]

Shortly after agreeing to the plan for the Aqueduct as proposed by Meigs, Congress was petitioned by civil engineer J.C.F. Salomon to adopt a plan he had devised. Salomon proposed pumping from the estuary, either at a site now known as Fletcher's Boat House or from the shoreline in Georgetown, just upstream from the Aqueduct Bridge (now the site of Key Bridge). From there the water was to be pumped to a high service reservoir at an elevation 382 feet above the level in the river. Salomon claimed that his project would be completed much sooner than the Aqueduct and would provide "any amount the District can ever require, ad infinitum." He greatly overestimated the cost of the Aqueduct, at $5 million to $7 million. He made the strange statement that the Aqueduct water would be subject to all sorts of impurities, while claiming that the water taken from the lower reaches of the same river, "driven through pipes and kept in constant motion would be far more pure." This plan was endorsed by the eminent engineer and architect Robert Mills, who favored it over the Meigs plan. But Meigs' efforts to convince the senators that his plan was the best, and should be continued, prevailed. On 1 February 1954, he was able to write, "the Committee on the District in the Senate has rejected Salomon's project and decided to be discharged from the consideration of this petition. Thus we have beaten him in both committees."[9]

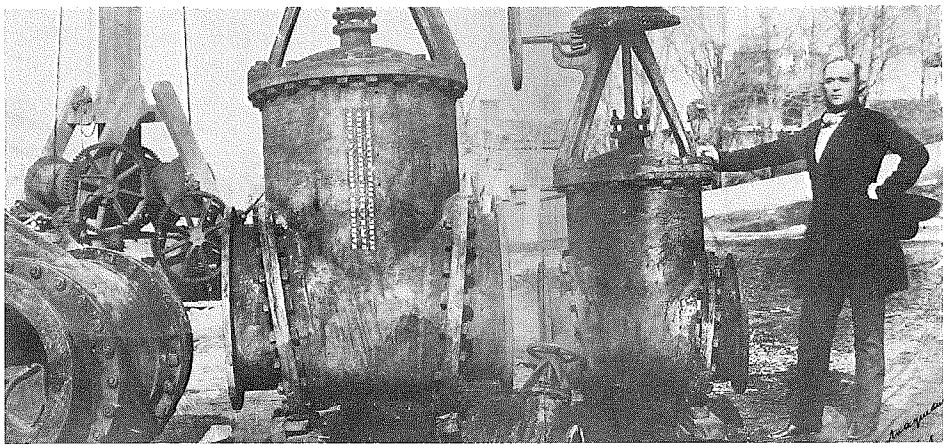
Meigs' journals and *Annual Reports* refer often to the "sickly season," which essentially shut down the work during the summer months and forced him to do most of the work during the winter and spring months. His first *Annual Report* noted that "considerable delay was caused by there being no legally qualified sheriff in the county of Montgomery." The report added that

> The delays occasioned by the procuring of their lands and the want of a sheriff qualified to issue the necessary legal notices prevented our obtaining title to any land before the sickly season set in. All those employed on the surveys were attacked, so that the party was at one time entirely disabled and withdrawn from the field. I considered that it was most advisable, therefore, not to attempt to collect any considerable force until the approach of cold weather should remove all

apprehension of sickness. Preparations have been made in Washington and Georgetown by preparing tools and machinery for a vigorous prosecution of the work as soon as the sickly season is over which will be about the beginning of November.

The Great Falls Manufacturing Company, which was primarily interested in the use of the available water power, became a major impediment to obtaining the lands near Great Falls. As a result, the intake had to be moved 3,000 feet, from the head to the lower end of

Unloading a shipment of cast-iron pipe at the Washington Aqueduct Wharf in Georgetown.



Montgomery Meigs inspecting valves at the Washington Aqueduct Wharf. "Capt. M.C. Meigs, Chief Engineer" cast into valve body.

Quarters for the large force to be employed on the Dam and in the vicinity of the Falls were framed and prepared in Georgetown. The iron work for derricks, etc., the necessary masonry and quarry tools were partly prepared in the machine shops of Washington and partly by the smiths employed in Washington for the Aqueduct. Frames of the quarters, lime houses, etc., have been sent up to the Falls, and though the carpenters employed there have suffered from sickness, they will be ready by the time it will be safe to collect a force there.[10]

Conns Island, which was owned by the company. The company also prevented construction of the dam as far as the island, which reduced the amount of water available at the intake. (To meet increased demands during the Civil War, the Secretary of the Interior, John P. Usher, ordered that the dam be extended to Conns Island despite the objections of the company, which then sued the government. The resulting legal dispute went as far as the U.S. Supreme Court before being resolved. On 22 December 1884, Mr. Justice Harlan delivered an opinion requiring the

United States to pay for the use of the Great Falls Manufacturing Company's land. The subsequent decision to extend the dam to the Virginia shoreline in the 1890s caused even more prolonged disputes over water rights, and litigation continued into the 20th century.)[11]

A large force of laborers and tradesmen had been recruited from around the country as a result of numerous newspaper ads placed by Meigs. In addition, various contractors provided more than 1,000 workers. Meigs preferred to accomplish his task by "days work": work done by men hired directly by the government, and using government-purchased materials. He did reluctantly award contracts for part of the work, which was generally limited to specific small projects such as tunnels, culverts, etc. Later, under orders from Secretary of War John B. Floyd, he was forced to award contracts for nearly all of the work, which he deemed inadvisable. Most of those employed directly by the Aqueduct were housed and fed in facilities built and operated by the government (the cost of the workers' room and board was deducted from their wages). Vegetables and fresh meat were procured from the farmers along the line, until prohibited by order of Secretary of War Floyd in January 1858. These boardinghouse conditions must have contributed to the spread of the "malarious" fevers that predominated. Although his efforts to hire a doctor were at first rejected by the Secretary of War, in the summer of 1855 Meigs "received authority from the Secretary to hire a doctor at a moderate compensation." Meigs complained of excessive drinking among the workers and objected to those who leased land for "groggeries to sell liquor to hands on the Aqueduct," which "has resulted in several deaths already."[12]

However, the most significant factor delaying the work was the failure of Congress to continue funding on a timely basis. By mid-June 1854, the first $100,000 was spent and only one section of the conduit and three tunnels had been started. Much of the land needed in Maryland had been condemned, and the Seneca sandstone quarry had been acquired for $5,000. The stone from this quarry was to be a major constituent of the intake, the gatehouse, the 26 culverts, the four stone bridges, and other appurtenant structures. The Seneca sandstone was beautiful in shape and color, and Meigs expressed regret that so much of it was being used unseen in the rough work associated with the building.[13]

No further funds were available until March 1855, when $250,000 was appropriated. This lasted only until July 1856, at which time the work was stopped again because Congress had stipulated that the funds authorized for that year could be used only to pay for "existing liabilities" and "preserving the work already done." These interruptions not only delayed the completion of the work, but significantly increased the cost. Work crews were recruited, hired, and trained and then dismissed, rehired, and dismissed again. Contracts were let, then suspended, and the contractors suffered considerable loss as a consequence. Meigs expressed his frustration in his 1856 report:

> Besides the loss by interruption of work, depreciation of stock and materials, by injury to contractors who having bid on the faith of the Government are thrown out of work and subjected to heavy losses, thus causing a want of confidence and demand for higher prices in subsequent contracts. The work has laid open so long that opportunity is offered for speculation in lands

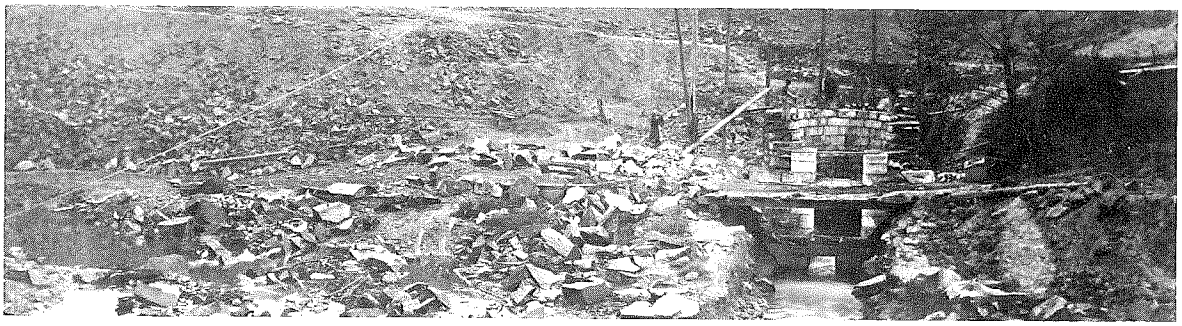
along its line. Favorable points are seized upon and held at high prices.[14]

During these years, Meigs was busy with the massive extension of the Capitol Building, the Post Office extension, and the rehabilitation of Fort Madison, near Annapolis. In addition to lobbying his friends in Congress for money for the Aqueduct, he was also campaigning hard to get authorization to build the new dome on the Capitol. Meigs wanted to have the pleasure of building the dome. He wrote that the mechanical details "would be just the most agreeable study I could have," and that "its construction would be a constant source of occupation and delight to me." But others were seeking to deny Meigs that delight, among them the Commissioner of Public Buildings, Benjamin B. French, who wanted the job himself. He was using Meigs' "enemies," those in Congress who vehemently opposed the involvement of military men in building these public works, to thwart Meigs. The War Department prevailed again, however, probably with the aid of the powerful Jefferson Davis. Captain Meigs must have been pleased with, on 3 April 1885, at Davis's request, he prepared a draft order for the signature of the Secretary of War placing himself in charge of the Capitol dome construction.

The next day Meigs received the order to superintend the removal of the old dome and to install the new one. His work on the Capitol took him on extended trips throughout New England and the eastern United States, including Philadelphia and New York, to review the latest developments in acoustic technology in music halls, to study the current art scene, and to search for the best marble to use in the Capitol. Among those with whom he consulted was John Roebling, the designer of the Brooklyn Bridge (he later purchased wire rope from Roebling's factory in Trenton for the derricks used in erecting the Capitol dome). He selected, hired, and directed the artists doing the paintings and sculpture required to adorn the Capitol. In the process he was criticized for not using American artists for the work. But he had become a familiar and highly respected figure at the Capitol. His attention to accuracy in the work is exemplified by Meigs' examination of a brass rule used to measure the dimension of stone blocks going into the Capitol extension. His investigation revealed that each degree of Fahrenheit changed the length by 0.00023976 inch, and that at 56.184 degrees, the rule was exactly 36 inches long.[15]

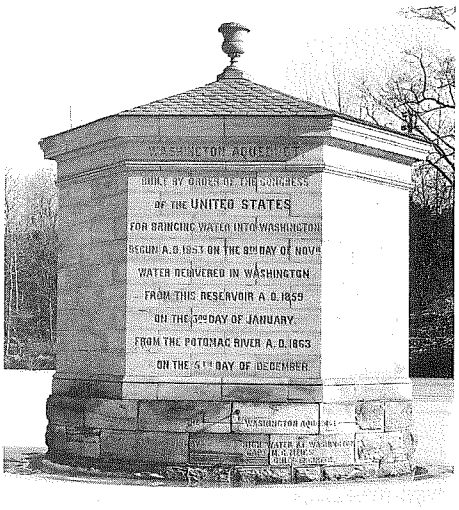
By 1857, the conduit was about 20 percent complete and work had just been started on the bridges and reservoirs. Throughout those early years, the funding delays were not just caused by benign neglect, but also by the active opposition of some members of Congress. Meigs' particular nemesis during the period was Congressman Richard Stanton of Kentucky and, to a lesser extent, his brother Frank of Tennessee. Ostensibly, Stanton's concern was based on his objection to military superintendence of these major public works. But eventually an open and nasty feud developed with Stanton frequently denouncing Meigs and his plan on the floor of Congress and in the local press. During House proceedings on 14 June 1854, Stanton remarked, "if I say that Captain Meigs occupied his position against the expressed enactment of this body, I give utterance only to what any candid man will believe who examines the subject."

The accusations of improprieties were particularly galling to a man of Meigs integrity. Meigs responded in



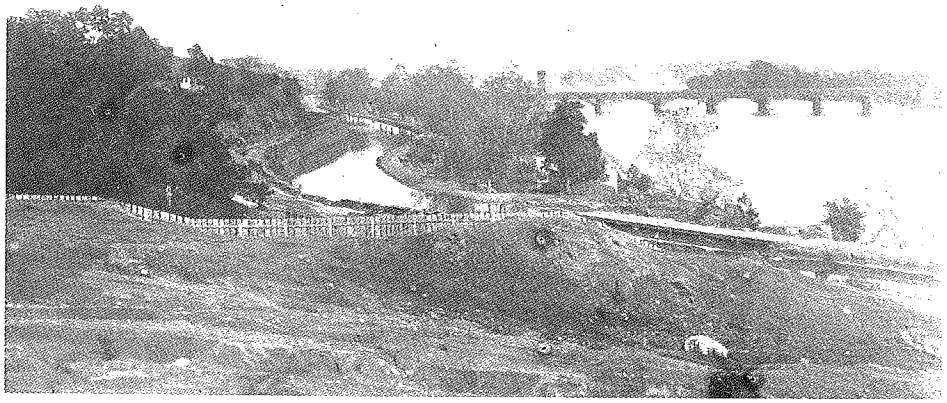
Construction of Receiving Reservoir showing base of sluice tower, May 1858

numerous letters published in the local papers and persuaded supportive members of Congress to counter the false and malicious accusations. After Stanton's refusal to vote for the Aqueduct appropriation, Meigs noted that the congressman had said "that he would be for the waterworks throughout and in full if I (Meigs) had nothing to do with it, but so long as I was superintendent, he would oppose it." At one point Meigs wrote in his journal that "The course of Mr.

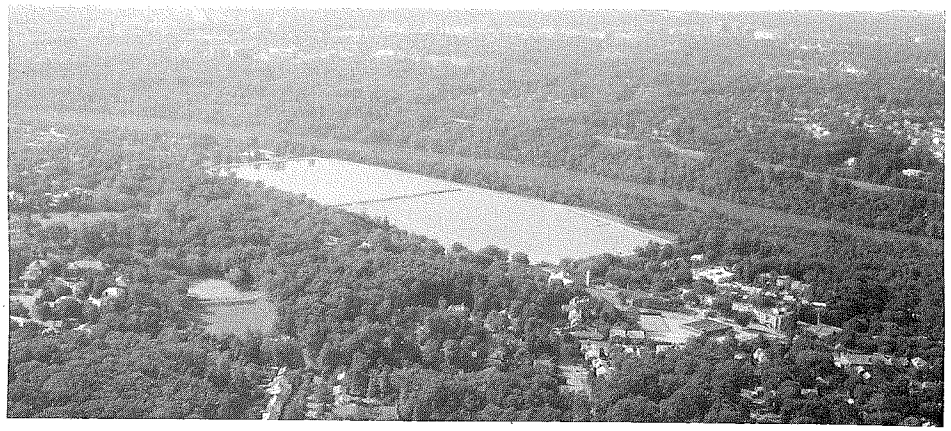


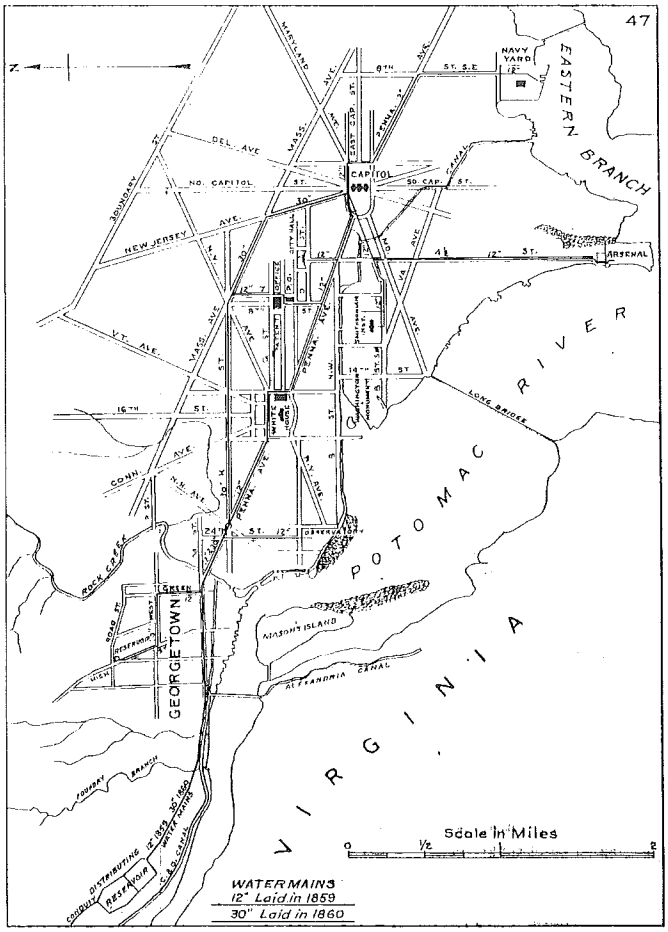
The sluice tower structure as completed and as it is today

Construction of the Distributing Reservoir, showing the C&O Canal and the old Aqueduct Bridge, built to transport barges across the river to the Alexandria Canal. It was later made into a roadway and became an important crossing point in the Civil War.

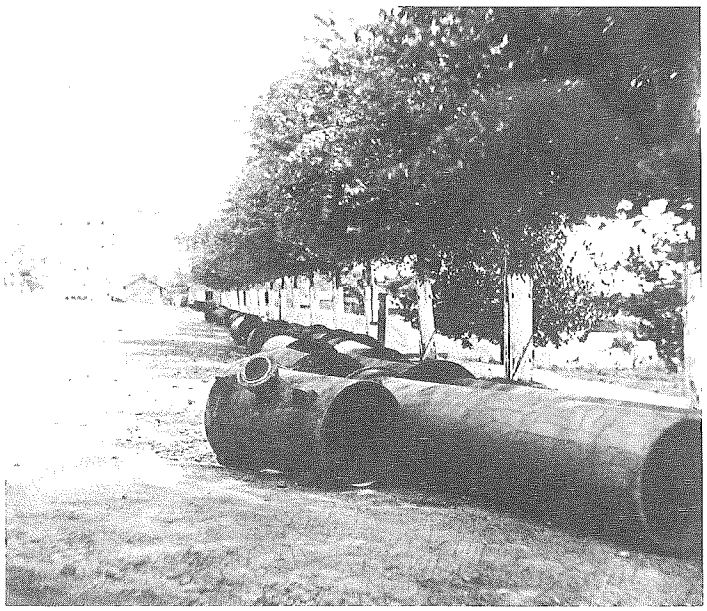


The Distributing Reservoir, c, 1990





Drawing of the pipelines as of 1864, passing the White House and the Capitol and continuing to the Navy Yard, the Arsenal and the Smithsonian Castle.



Thirty-inch cast-iron pipe and fittings awaiting installation along New Jersey Avenue. Note unfinished Capitol dome in background.

Stanton in this great work is such as to merit the contempt and reprobation of all honest men." He later wrote,

> I have been the object of much obliquity from Mr. Stanton and others whose motives I cannot think honest, and yet I have been able to preserve my temper and I feel no animosity toward them. I would do them no harm, though I wish they could be persuaded to leave me in peace and cease from slandering me at the next session

> of Congress or else be deprived of the power to do me harm and obstruct the great work of supplying this city with water, which I have been the fortunate means of devising.

Meigs must have been pleased in May 1854 when he found that "a little paper here, the Star, is out upon Stanton, and threatened him with a complete exposition of the causes of his action in this matter. If it does all it promises, it will doom Stanton forever."[16]

Another opponent of the War Department's involvement in the Aqueduct project was the *New York Tribune* reporter Horace Greeley. In a column regarding the Aqueduct, Greeley conceded that it was badly needed, but argued that the people should be building it without the aid of Congress. Meigs responded with a letter telling Greeley that "he was doing me an injustice and working into the hands of speculators without knowing it."[17]

During the 1850s, Captain Meigs maintained his primary office at the Capitol. Here he kept his records and accounts, supervised the design work and draftsmen, managed the four projects under his supervision, and frequently worked long into the night preparing correspondence. One evening, he concluded his daily journal entry by writing: "It is now one o'clock A.M. I have read tonight 50 letters, and written 15 answers." Some nights extended even later; he once busied himself on Christmas Eve and the next day on such matters as the design of derricks. His office at the Capitol was a convenient central headquarters and was strategically located to give him access to the legislators he so often lobbied for adequate funding to keep the projects moving. From this arena, he also directed the decoration of the Capitol and hired artists to do the painting and sculpture, including the Italian artist Constantino Brumidi, who earned $8.00 per day. Brumidi painted many of the frescoes, including the one in "the eye of the dome." In gratitude Brumidi had included a likeness of Meigs in the frieze encircling the rotunda, but Meigs later had "the blue uniform with my head on it" removed.[18]

Meigs had numerous visitors, including the wives and friends of many highly placed government officials, who came to view the frescoes and the models of the sculpture. One of the visitors who most impressed him was the attractive Creole wife of Senator Joseph Slidell of Louisiana, whom he thought seemed to belong to a new class of women. She was particularly pleased by the idea of having her babies' faces perpetuated in the frescoes of the Capitol. On 2 April 1855, Congressman Richard Stanton came to look at the portrait of Cincinnatus. Meigs remarked that:

> He was very cordial to me in his manner...he took leave of me as if he was one of my best friends and defenders. I do not know what to think of him. It would be a strange thing if he would now give up his hostility and turn out one of my advocates after trying me for so long a time. It would be a great victory to make a friend of him, the leader of the enemies.[19]

Among Meigs' supporters were the mayor and council of Washington, which had presented him with a silver tea set in appreciation of his work. The citizens of Washington wanted the Aqueduct completed as soon as possible, but it was not until the Stantons left Congress that adequate funds became available to again vigorously pursue the work. Richard Stanton's departure, however, coincided with the inauguration of a new administration and the appointment of a man who

proved to be an even greater nemesis, Secretary of War John B. Floyd. On the positive side, the Mississippi legislature elected Meigs' friend, the departing Secretary Jefferson Davis, to the Senate that same year.[20]

Initially, all work on the conduit was done by hired labor under the direction of the Aqueduct engineers, but on 8 May 1855 acceptable bids were received for work to be done under contract. Supervision of the work was divided into three segments: the Great Falls Division under Mr. Charles G. Talcott, the Cabin John Division under Mr. Alfred Landon Rives and the Georgetown Division under Mr. William R. Hutton. A competent assistant engineer had been placed in charge of each division, and the principal assistant, Mr. Bryan, was overseeing them. Meigs managed the work on the Aqueduct by traveling to the Washington Aqueduct Office in Georgetown near the Market House, and by riding around to the various sites. He went frequently to Great Falls, making either a two-hour trip on his horse Corbo, sometimes on the tow path, or riding in the carriage seen in many of the photographs showing the progress of the work in the 1850s. During the hard winter of 1856, he had the carriage equipped with runners so he could ride to the Falls and the other locations in a sleigh. After one of these jaunts, he wrote that he had a good day's exercise: 7 miles on foot and 24 on horseback.[21]

He occasionally took his sons John and Monty along on these jaunts. They sometimes took delight in catching live black snakes and then startling the workers who feared them. Meigs frequently turned the snakes loose in his office at the Capitol in order to note their behavior. One snake coiled around the gas line leading to the chandelier and took up residence near the ceiling. At one point, the box in his office contained three black snakes, a striped snake, four copperheads, and a rattlesnake. Meigs commented, "it looks like Pandemonium." The snakes eventually became models for the sculptors making such ornaments for the Capitol as door rings and handles. One copperhead captured at Great Falls was brought in and given to Casali, one of the artists hired by Meigs to work on the Capitol, to cast. This particular casting so intrigued Jefferson Davis's wife Varina, that Mr. A. Campbell, the Chief Clerk of the War Department, was persuaded to write to Meigs requesting it for her, noting that "she seems to have set her heart upon having it" and that "she spurned the idea of having any but the first cast." Sometime later, after dining at her home, Meigs noted that she had the casting of the snake "upon the center ornament of the table, and passed it around for the examination of the guests."[22]

The Washington Aqueduct wharf at the Port of Georgetown, reached by a bridge built over the C&O Canal at 27th Street, was an important adjunct. Except for the sandstone from Seneca, most of the materials used in building the Aqueduct were delivered to that site by ocean-going ships from various ports on the East Coast. Bricks, cement, cast-iron pipe, valves and fittings, and other materials were unloaded, inventoried, and inspected, often by Meigs himself, at the wharf. The following were some typical deliveries to the wharf, as shown on the bills of lading: On 8 August 1858, the schooner *William Brown* sailed from the Port of New York with 934 barrels of cement purchased from E. D. Nelson & Company, Dealers in Building Materials, for landing at the Washington Aqueduct wharf in Georgetown. This shipment was followed by another on the schooner

C. L. Bayles on the 10th, with an additional 1,162 barrels. These materials were duly received, and the bills were paid by Captain Meigs.[23]

The work on the Aqueduct required not only men and materials, but horse power. Meigs sent William G. Brown, one of his assistants, to Baltimore in September 1855 to purchase "eighteen good stout active young work horses or mules." Fifteen bay, roan, gray, black, brown, and sorrel horses were obtained. The charge for shipment on the Washington Branch Railroad was $18.49, and the charge for livery and shoeing was $19.00. Meigs advertised frequently in the eastern newspapers for bids for contracts and materials, and for mechanics and laborers. "A $3.06 ad appearing in the *Philadelphia Public Ledger* in April 1857 sought "30 good DRILLERS and BLASTERS, 50 LABORERS, and dozen BOATMEN used to handling Canal boats and scows." Meigs urged the Secretary of War to increase the pay of the foremen because of the need to keep them.[24]

Canal boats provided the means of transporting heavy materials, traveling regularly between the wharf and the Seneca Quarry, nine miles above Great Falls, to the stations along the conduit where they were needed. Another packet boat served as an office and as sleeping quarters. Bricks; cement; granite from Quincy, Massachusetts, for the Cabin John Bridge Arch; and other needed supplies went up the canal to the points of use. Rubble and dimension sandstone quarried at Seneca came down for use at the Great Falls intakes and to build the bridges and culverts and the wall around the High Service Reservoir in Georgetown. The Aqueduct acquired several canal boats to carry these loads, which were licensed, according to an Act of Congress for enrolling ships and vessels, to Captain M.C. Meigs (for the United States) as sole owner. One of these was the *Hail Columbia*, a name retained by Meigs, built in 1853 in Washington, D.C. It was described as having a length of 89 feet, a breadth of 13 feet 10 inches, and a depth of 4 feet. It weighed 41 tons, and had a square stern and no figurehead. Another heavier boat built in Cumberland, Maryland, Meigs named the *Mary Louisa*, thus inscribing the names of his wife, mother, sister, and two daughters in Washington Aqueduct lore.[25]

Most of the conduit was constructed in open cut. In addition to the 6 bridges, there were 11 tunnels. The longest tunnel was the first near Great Falls (at 1,427 feet); the shortest was the Bear Den tunnel near Widewater (only 86 feet long). Meigs had been surprised to find that the tunnels were the cheapest part of the heavy work. During Meigs' tenure, five short tunnels were lined with brick. Most of the remaining tunnels were lined from 1914 to 1918. Of the 26 culverts, some had masonry arches with spans longer than some of the bridges. Bridge Nos. 1 and 2 had spans of only 14 feet and 16 feet, whereas the arch at Culvert No. 12 over Rock Run, the largest stream spanned by culvert, was 30 feet. Waste weirs were provided to allow overflow during periods of high water at Great Falls, and the conduit could be drained at several points.[26]

In spite of his intense pride in his assignment, which he viewed as enormously beneficial to the nation, Meigs frequently risked his career by refusing to compromise his principles in disputes with high-level officials or politically powerful contractors. He did, however, frequently complain in his journals about his low pay and his difficulty in supporting his family as he wished. In 1854, he wrote of having

worked 13 years and being paid only $1,600 per year, which was later raised to $1,800. He once complained that he had less money left after meeting his expenses each month than the watchman he had hired for the Capitol. At one point, he suggested that if he could get a commission of 1 percent of the expenditures, he would be making $4,800 per year. He remarked on the large fortunes being amassed by some of his West Point classmates who had left the Army for more lucrative civilian jobs. He did not think he was paid even one quarter as much as he deserved, but that he could take gratification from his work. But he was concerned because his wife was frequently deprived of luxuries. He wrote, "I get praise enough, quite as much as I want, but I don't get much money" and "we never have a dollar to save." But when he was offered higher paying positions, he declined. He rejected an offer to superintend a lead mine in North Carolina at $5,000 per year, and when offered the post of Chief Engineer of the C&O Canal, at $3,500 a year, he also turned that down. His reason for staying was evident from his writing. Once, when complaining of low wages, he wrote, concerning the Aqueduct, "And though I do not expect it will carry my name down to posterity with it, I do feel a satisfaction in knowing that to me has been committed the task of making the plan and preparing the reports which gave birth to this great and beneficial work."[27]

His assignment was not without its perquisites, however, particularly when compared to the assignments of many of his fellow Army officers. He lived at home with his family. He attended fancy receptions and balls, and often dined in Washington at the homes of the Secretary of War or General Totten. He also was a guest of Commodore Perry, at which time he discussed Perry's trip to Japan. He met frequently with the President in his own office or at the White House. On one occasion, while dining at the White House, he had the honor of escorting Mrs. Pierce in to dinner. Meanwhile, many of his fellow officers were facing more arduous duties. During 1853, General Totten sent Brevet Captain George B. McClellan off to construct a military road from Walla Walla to Puget Sound. Ulysses S. Grant, separated from his family, was serving in disease-laden Panama or at an isolated western fort, at a salary far less than that of Meigs. Grant lived in near poverty after being forced to resign from the Army. After failing to regain a commission in the regular Army, he was hastily given command of the 21st Illinois Regiment, replacing an elected colonel who proved to be incompetent. By this time, Meigs was a brigadier general; a member of Lincoln's War Council; and meeting regularly with the President, top Cabinet officers, and the Army commanders.[28]

Meigs was also enjoying his membership in "the Club," a group of close friends recognized for scientific achievements who met regularly at each other's homes to discuss recent scientific developments. The participants included Joseph Henry, the Secretary of the Smithsonian Institution; the influential Alexander Dallas Bache, who was a grandson of Benjamin Franklin, a West Point graduate, and founder of the Coast and Geodetic Survey (and who as such worked closely with the Chief of Engineers on river and harbor and navigation matters); Admiral Charles Davis; Joseph Saxton, the inventor and instrument maker; William B. Taylor, a local scientist; Captain James Gilliss, the brilliant astronomer who President Lincoln appointed as Superintendent of the Naval Observatory

at about the same time he chose Meigs as Quartermaster General; and Arnold Guyot, a pioneer in weather reporting. (Meigs' grandfather, Josiah Meigs, had begun meteorological observations throughout the country in 1817 while serving as Commissioner of the General Land Office.) Another participant was Meigs' fellow officer, Andrew Atkinson Humphreys, who later gained distinction in the Civil War as a division and corps commander and as Chief of Staff of the Army of the Potomac. He was also to serve as Chief of Engineers from 1866 to 1879, and in that capacity would support Meigs 20 years later during a controversy regarding one of the Aqueduct structures. Meigs wrote of this group, "I am pleased with the club which is, if kept up with proper spirit, likely to afford the means of pleasant intercourse with intelligent and scientific men. It will not entail much expense. We are most of us too poor to be likely to run into that fault."[29]

On 7 March 1855, Meigs had a visit from "young Whistler, a son of Major Whistler," who was seeking a job as a draftsman. Major George Washington Whistler was a West Point graduate and a well-known former officer in the Corps of Engineers. He had achieved great success as a civilian engineer in the United States and in Russia, building railroads for the Czar. The younger Whistler had been dismissed from West Point the previous summer by Colonel Robert E. Lee. Jefferson Davis, an old friend of his father, had rejected his request for reinstatement, writing "cadet deficient in conduct as well as Chemistry." However, at the behest of Davis, Captain Henry W. Benham (see more about Benham later in this story) had Whistler hired as a draftsman at the Coast Survey. After only three months, he had been released from that position because of his reluctance to report regularly for work and his penchant for adding whimsical creations such as sea serpents, mermaids, and smiling whales to the official copper plate etchings of charts, maps, and views of harbors. Meigs, perhaps forewarned about Whistler's lackadaisical work habits, did not hire him. Various treasures might have adorned the Washington Aqueduct files if he had. "Young Whistler" was none other than James Abbott McNeill Whistler, the famed expatriate artist whose best known work was the famous portrait of his mother.[30]

Early in May 1855, a blast in a tunnel killed one man and injured three others. Meigs' concern was evident when he wrote, "This is the first really serious injury that has ever happened upon work under my direction. For this, no want of cause rests on me. He was under the contractor's direction." Three days later he wrote, "the work is baptized in blood."[31] On 13 September 1856, near the end of his term in office, President Pierce, accompanied by Secretary Davis, again visited the Aqueduct.[32]

Meigs determinations as to what matters to refer to his superiors was sometimes ambiguous. While making major decisions, such as the modification of the design of the Cabin John Bridge, entirely on his own, he sought written permission for other minor expenditures. He wrote a detailed letter to Davis on 20 August 1855 requesting permission to purchase three engineering textbooks at a total cost of $37.20; other letters to Davis sought approval to subscribe to various newspapers.[33]

During the spring and summer of 1856, Captain Meigs vigorously lobbied Congress on behalf of the Capitol extension, the dome, and, particularly, the Aqueduct. His greatest problem was with the

Aqueduct; some congressmen had been attacking him on the floor regarding deficiencies in both the design and workmanship. Rumors of deficiencies were being spread by contractors in the hope of gaining control of the project for themselves. Meigs wrote, "These people who are opposing are not doing so for any good purpose, but for the hope of profiting by removing me from its management." The rumors were of great concern to Meigs, who feared loss of the appropriations. In addition complaints continued regarding the military control of the projects, probably also motivated by contractors. A more legitimate congressional concern was the fear of constituent reaction to the appropriation of large sums of money for a project that would primarily benefit the citizens of Washington and Georgetown.[34]

Throughout this period, Meigs roamed the floor of Congress, conversing with the members: "It was fatiguing work, this looking at the members, explaining and arguing to them on a subject which they did not understand." If he could not enter the chamber, he would sometimes "call them out during debate to correct erroneous statements." Meigs' opinions of some congressmen appeared in his private shorthand journals: "What a little mind the man must have,: "I do not find them in their talk very much superior to common men," and "I did not find the assembly very brilliant. It was too much composed of Congressmen." Among those opposing Meigs was Congressman Galusha Grow of Pennsylvania. In May 1856, Meigs wrote to Grow about a speech the latter had made charging Meigs with having spent more money than had been authorized. In that letter, he told Grow that he "was under a misapprehension in supposing that I had spent more than the appropriation, that I did not doubt that he would be glad to do me justice, and that he should have the correct information on the subject." Meigs wrote at the time, "Grow wishes to kill the Aqueduct."[35]

To aid his cause, the captain encouraged members of Congress to accompany him on visits to the work sites. He generally could persuade them of the worth of the project and the quality of workmanship. He also garnered some support for himself, but not necessarily for the Aqueduct appropriation. One congressman said that he would not vote for the Aqueduct because it would be "robbing his constituents," but would "not allow slander of the work to go unrebuked." Some legislators felt that, although the Aqueduct was badly needed, the citizens should pay at least one-half of the cost, others felt they should pay even more.

Meigs' boldest ploy in his campaign to win support was to invite 60 members of Congress to accompany him on a trip by steam packet to Great Falls to inspect the work in progress. Mr. Bryan was sent to obtain "a cold collation, to buy wines and refreshments." On 12 April, 1856, 25 people made the trip. Meigs wrote:

> I think the party generally found themselves well entertained. Some of the honorable members used much more wine that I would have liked to take. Several of them had been out on some frolic last night; and drinking now in the day, they slept a good deal on the boat. There was much loud talking, laughing and some unsteadiness of gait. But there was no disorder, and the party was respectable, though merry. They had plenty to drink—whiskey and brandy and champagne and sherry—so that we had an abundance of whatever men might want on such an occasion. The quiet temperate

men from the North had the beauty of the scenery and looked with interest upon the work of the Aqueduct. The rollicking roistering sons of the South had a good entertainment of the wines and the whiskey.

Meigs concluded: "I hope that these gentlemen will be at least so far instructed in the manner as not to make any false statements against it and the work of its author."[36]

The deliberations continued in Congress, and on 9 May Meigs visited Senator Hamilton Fish (the father and grandfather of men of the same name who would later serve in Congress). The senator asked Meigs to prepare "a proviso which I thought would be most acceptable to me and at the same time most likely, if adopted, to get the approbation of the House of Representatives." Accordingly, Meigs wrote a proviso "that the sum should not be made available until the Cities of Washington and Georgetown, one or both, had passed such acts as would pledge the ways and means, after completion of the works, to keep them in good order, and to pay such sums as the Congress might direct for the privilege." In mid-May, Meigs wrote a bill and preamble giving a history of the work. He stated that the appropriation was needed to give confidence to the contractors that the work would be completed. That bill, when introduced would propose $1 million for the fiscal year ending 30 June 1857 and another $1 million for the next year. In 1857, Congress was persuaded to appropriate $1 million, and that was followed by another $800,000 in 1858.[37]

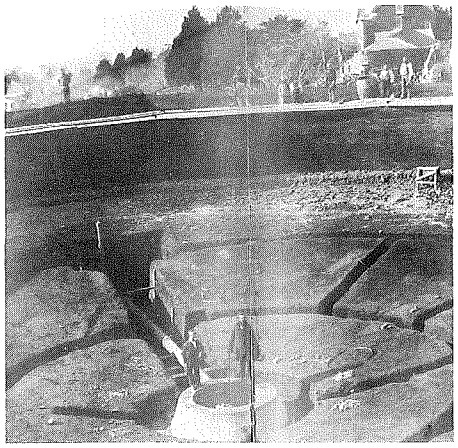
During these years, rumblings of the conflicts that were to rock the nation in the coming years were beginning to be heard. Senator William H. Seward of New York, who originally had opposed the appropriation for the Capitol extension, voted for it, according to Meigs, "to reply to weak and foolish talk by base and weak men talking about the dissolution of the Union." Seward later became the early frontrunner for the Republican presidential nomination in 1860 and then served throughout the war as Lincoln's Secretary of State. He was the man who brought his friend Meigs to Lincoln's attention, and Meigs retained his confidence and support thereafter. Meigs, too, was expressing some opinion. On the boat trip to Great Falls, he compared the "quiet temperate men of the North" to "the rollicking roistering sons of the South." And he explained his reason for awarding a contract to a northern contractor: "Because the North has the enterprise to make the means to execute them well; the South does not."

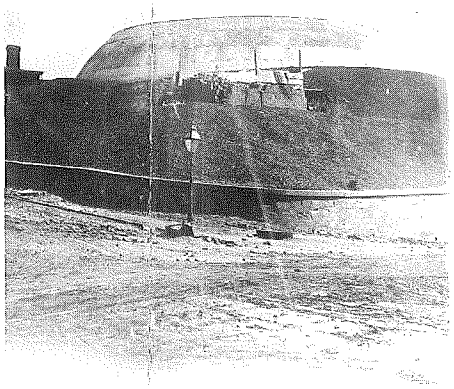
On the issue of slavery, Meigs sided with the abolitionists. Of his November 1854 visit to New York to inspect the Croton Aqueduct, he wrote: "Here the curse of slavery has not come." His opinion on the territorial question also reflected the anti-slavery position: "I think the Kansas-Nebraska Act was a mistake, and a great wrong to the cause of freedom, giving as it does, the entrance of slavery to new regions and thus tending to perpetuate it." These thoughts must have been confined to his shorthand journals, however, as it is unlikely he would have otherwise retained the friendship and strong support of Jefferson Davis throughout the late 1850s. During that time Davis, although deeply attached to the Union, was himself a slave-holder and was the most forceful advocate of the pro-slavery position in the Congress.[38]

The appropriation of large sums for 1857 and 1858 resulted in two years of the most productive work on the entire project. During May 1858, the Aqueduct office employed

Left—
Construction of the High Service Reservoir in Georgetown (inside)

Right—
Construction of the Dome of the High Service Reservoir. Note the sandstone wall, which is still in place today.





5 assistant engineers, 50 surveyors and inspectors, 700 skilled tradesman, 1,100 laborers, 40 teams, 60 cooks and waiters, 30 overseers, 20 clerks, and 12 slaves. (The $1.20 per day earned by the slaves was turned over to their owners.) Various contractors on the job hired an additional 1,000 employees. On 27 February 1858, Meigs paused long enough to have his photograph taken by Matthew Brady. Meigs himself became an adept photographer, and in 1859 produced an excellent portrait of his friend, Jefferson Davis.[39]

In September 1858, Meigs reported that an additional $250,000 would be needed, raising the cost to about 10 percent above his 1853 estimate. He quoted from the language in his original report: "If the work is delayed by meagre appropriations, its cost will be much increased; and I hope in that case not to be held responsible for its cost above my estimate, which is based upon a steady and vigorous prosecution of the work." The money was not forthcoming, and in September 1859 Meigs wrote: "The failure of the appropriation at the last session is much regretted."

By summer 1859, the work had again been suspended for lack of funds. The confidence that Meigs had in the accuracy of his personal accounting system is shown in his *Annual Report* for 1859, which shows $2.05 as the unspent balance after expenditures. Completion of the Cabin John Bridge was the only remaining obstacle to the introduction of water from the Potomac into the capital. Removing that obstacle took another four and a half years.[40]

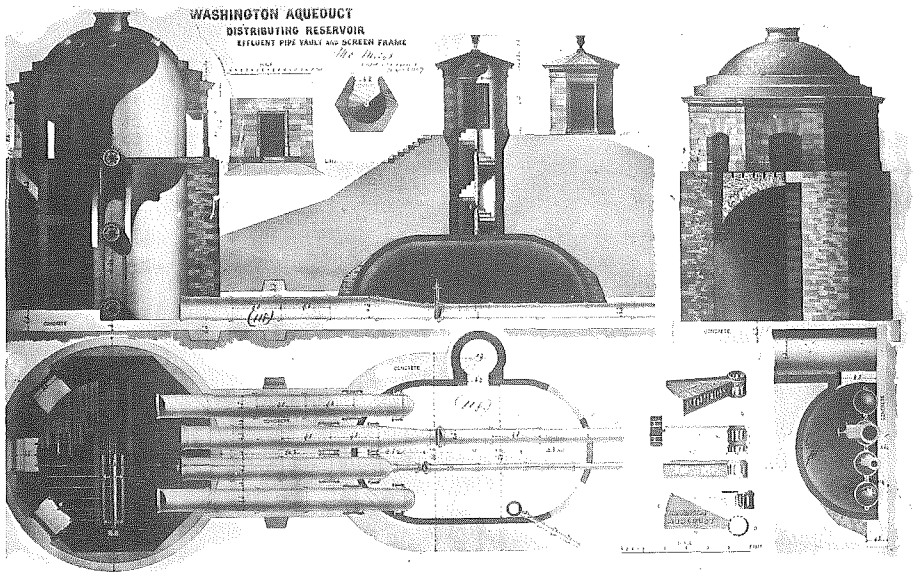
However, the Receiving Reservoir had been completed in 1858 and allowed to fill with water from the Little Falls Branch. A large underground arched brick vault had been built at the south end of the Distributing Reservoir to contain the 12- and 30-inch discharge pipes and the control valves. The vault was reached via a circular staircase with 39 steps. The riser of each of these steps was a casting that displayed the name M.C. Meigs. Eight and one-half miles of 12-inch pipeline had been laid in M Street and Pennsylvania Avenue as far as the Capitol, and from there on to the Navy Yard. A temporary 12-inch main was laid across Rock Creek, and Meigs was now ready to provide water to the city from his system. On 3 January 1859, a group of congressmen and other dignitaries gathered at an elaborate new fountain at the base of Capitol Hill, and the gates were opened. Captain Meigs stood proudly on the wall of the fountain as they cheered the water spurting 100 feet in the air.[41]

Already the demand for water from the pipes was so great that at times the supply would not reach

the Navy Yard. Work on the pipelines continued, and by 1860, after additional funds were authorized, the 30-inch main was completed. It diverged from Pennsylvania Avenue at K Street then ran along New Jersey Avenue to the Capitol. A 12-inch line also extended to the Arsenal (now Fort McNair). The hydraulic ram was pumping to the High Service Reservoir on Lee's Hill in Georgetown, and the supply was more than adequate. But by then, Congress had authorized the city to tap the mains for the use of the citizens, and the smaller pipes laid by the Corporations of Washington and Georgetown allowed increased consumption. These demands soon resulted in complaints about low pressure which was to remain a major concern for the rest of the 19th century as the city's growth outpaced pipeline and reservoir capacities. The Distributing Reservoir had not been completed, and the water simply flowed through the construction, sometimes in a muddy stream.

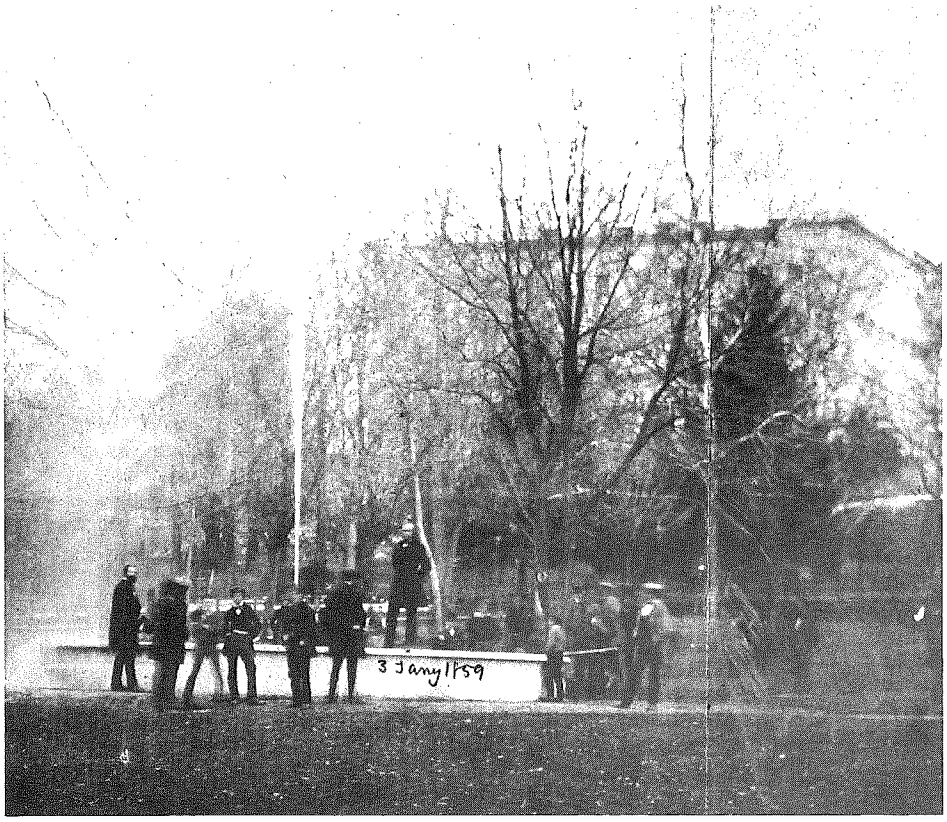
The first expressions of concern about the frequently muddy appearance of the water were beginning to be heard from those accustomed to clear spring and well water. The water from Powder Mill [Little Falls] Branch did not remain "beautifully clear and pleasant to the taste," as Meigs had described it in 1853. Less than a week after the introduction of the water to the mains, the commander of the Washington Navy Yard had written to Meigs asking him to "cause the gate to the water pipes in this yard to be opened so that the sediment may be washed out. It smells badly." The problem of muddy water was not solved for 40 years.[42]

A practice recommended by Meigs, and carried on by others for many years, remained a major health problem for the District of Columbia even in 1993. Writing to the Honorable J. B. Berret, Mayor



Drawing for the pipe vault at the Distributing Reservoir, showing design of circular staircase that had M.C. Meigs cast in every riser.

of Washington, in March 1859, Meigs stated: "Some observations in regard to the introduction of water into houses...Leaden pipes should be used." Meigs apparently had relied on Professor John Dorn's analysis of the Potomac River water. He had sought Dorn's advice earlier regarding his "experiments on lead service pipes to determine whether they would be injurious or not."[43]



M.C. Meigs standing on a fountain near the Capitol watching the water jet rise in the air on January 3, 1859, the first day that water was introducted into the mains.

CHAPTER 5
The Buchanan Years

Throughout the Pierce administration, Meigs enjoyed the support and friendship of both the President, "who spoke very kindly about the trouble given me by the constant attacks in Congress," and Secretary of War Jefferson Davis. At one point, Davis considered Meigs to replace Colonel Robert E. Lee as the Superintendent at West Point, but thought that appointing a mere captain might cause some dissension among the higher ranking officers. Meigs apparently was relieved not to have been selected, writing that he had "a better command here, and was luckily not high enough in rank to be put in charge of the institution." The Meigs and Davis families occasionally dined together. On one such occasion, Mrs. Davis told Meigs that she owed her good health to his father. (At a time when she was in poor health, the elder Meigs had prescribed medication that had cured her, and she had been well ever since.) Meigs was moved by the death of Davis's only child particularly because two of his own children had died at an early age. In one letter, Davis told Meigs: "I hope the country will appreciate your services as fully as I do, and that your good reputation may outlast your durable structures." Meigs had grown to think of Davis as a "great man" and wrote, "he is my superior and my friend." (These feelings were to change in later years. After the war, Mrs. Davis beseeched Meigs to help her obtain permission to visit her husband, who was then a prisoner at Fort Monroe. Meigs, resentful toward those who he believed had deserted their country, and further embittered by his belief that his son John had been murdered by Confederate guerrillas, ignored her plea.)[1]

Meigs had also gained many other friends in Congress because of his work on the Capitol extension, impressing them with his outstanding engineering skills and dedication. He had also earned their respect for the manner in which he took control of the project and for his unimpeachable integrity, even though some would impugn this fact. At one point, Davis expressed concern regarding Walter's attempts to take credit for Meigs' innovations on the Capitol extension. Davis noted that the building as overseen by Walter was imperfect and a failure and that Meigs designed all the important parts. Relations between Meigs and Walter were sometimes

cordial, and they occasionally dined together. At other times, the two were hostile. But Meigs resisted Davis's inclination to remove Walter, saying that to fire him would be an injustice. But nevertheless Meigs considered Walter vain and insincere and felt that Walter "owed his position to my determination to do right and to my influence with the Secretary." He gave Walter credit for devising the dome, stating that "nine-tenths of it was his. He did change some parts to suit me, but the design was his almost entirely." Meigs by then was a well-known figure at the Capitol. Various representatives described him to visitors as "Meigs among the ruins of Carthage" when he was seen inspecting the stone, marble blocks, and building materials strewn over the Capitol grounds.[2]

In March 1857 John Buchanan Floyd's appointment as Secretary of War by newly elected President James Buchanan brought a dramatic change in relations with the executive branch. Meigs' biographer, Russell Weigley, begins his description of this era with the words "Enter the Villain." The fact that the ensuing four years yielded the appropriations needed to complete the Aqueduct was primarily because of Meigs' adroit lobbying in the halls of Congress. His friend Jefferson Davis was now a senator and chairman of the Senate Military Affairs Committee. But Meigs' relations with Floyd were another matter entirely. Their frequent disputes, accompanied by harassment of Meigs and his outspoken responses, eventually led to his banishment from the capital.[3]

Floyd was primarily a politician and was motivated by a politician's concerns for his own success. Both he and his father before him had been governor of Virginia, and he had been on the ballot as one of Buchanan's "electors" in the 1856 election. If not personally dishonest in the sense of benefiting from the spoils of office, he was motivated by base political considerations. Prone to dispensing favors to political cronies and favored contractors, he was a true member of the "Plundering Generation." Historian Margaret Leach wrote that he "administered the affairs of his office with great incompetence." Bruce Catton, the distinguished writer on the Civil War, characterized Floyd as "a bumbling incompetent who had permitted much corruption without being personally touched by very much of it." (Floyd continued to demonstrate his incompetence years later as a Confederate general. He was ultimately censured and cashiered by Jefferson Davis.)[4]

After several unsuccessful attempts, Meigs first met with Floyd on 12 March 1857. Afterward he expressed hope for a relationship similar to that which he had with Davis, but his efforts to arrange another meeting were rebuffed. After General Totten wrote to Floyd regarding Meigs, the two met briefly on 29 April, but Meigs left feeling discouraged. Inevitably, disputes soon arose between Floyd and Meigs. Meigs resisted the Secretary's efforts to have lucrative contracts awarded to contractors he favored and his attempts to have workers removed from the job for purely political reasons on both the Aqueduct and the Capitol extension projects. Events over the next several years prompted an indignant Meigs to write, "I feel as though I was a plug which filthy rats and mice were gnawing at all the time in order to increase the flow from the Treasury . . . Contractors, Architects and Secretaries were all against me."[5]

Early in May 1857, Professor Henry of the Smithsonian introduced Meigs to President Buchanan as "one of the best men in the country." Later that month he had a

long visit with the President and found him to be "a quicker man than Floyd in understanding anything." Floyd had toured the Aqueduct with Meigs on 6 May and a month later ordered him to provide a cost comparison of days' work versus contract work. Meigs' wrote "I must see the President. The fact is the Secretary is not up to his place." The President, on the other hand, was concerned that Meigs did not "get on with the Secretary in harmony and wished to take the bit between his teeth, and that no man could do that in this administration." By July, Meigs was complaining that the Secretary had delayed the work by four months through the latter's involvement in contractor intrigues. Meigs felt that "it was a miserable thing to live in the power of a tyrant" and expressed the hope that "he cannot last forever, he is the smallest cabinet minister I have ever seen."

By November, the dispute over the hiring of a "Know Nothing" had caused Floyd to demand that William Bryan be fired, and he had ordered that Clauduis Crozet be appointed as principal assistant in his place. Floyd did assure General Totten that Meigs would be retained as Chief Engineer, but Meigs remained skeptical. Floyd then ordered that his approval must be obtained prior to all purchases. However, Meigs was able to persuade Floyd to allow expenditures of up to $2,000 without prior approval. Meigs, growing increasingly concerned that he might be relieved of his project responsibilities on the Aqueduct and the Capitol, turned to his friend Jefferson Davis again. Davis spoke to the President on Meigs behalf, telling him that no other man could have matched Meigs' accomplishments. The President promised that he would not dismiss Meigs without first consulting with Davis. Meigs then wrote, "Mr. Davis will bring up his strength to help me." Shortly thereafter, Floyd ordered Meigs to abandon all days' work and put the remaining work on the Aqueduct under contract. Meigs protested that this would interfere with his ability to make on-site modifications he deemed appropriate as the work progressed. His protest went unheeded, and early in March 1858 Floyd ordered that the work be relinquished to contractors immediately after the acceptance of their proposals.[6]

At the Capitol, Thomas U. Walter, the architect whose authority had been removed when Meigs was put in charge over him, saw the opportunity to rid himself of Meigs' supervision and attempted to use Floyd's influence to his advantage. In the summer of 1857, Floyd acted to have Meigs removed from the work on the Capitol. After a meeting with Floyd in August 1857, Walter was heard to boast that Meigs would be "removed by dinner time." This was in spite of the fact that Meigs had protected Walter's position by supporting him when Jefferson Davis had wanted to remove him entirely from his assignment at the Capitol. Floyd was deterred by the intervention of Davis, who wrote to advise him that the significant improvements that had accrued were the work of Meigs, not Walter. Davis added that Walter was Meigs' "subordinate and was only retained in employment by the generous solicitation of Capt. Meigs that he should not be displaced." Davis expressed his conviction that Meigs should be retained. Meigs also wrote to the President on the matter, which "much irritated" Floyd. Nevertheless, Meigs was retained, at least for the present.[7]

Floyd continued his attempts to interfere with the awarding of contracts in an effort to reward his friends and tried to bestow political favors by having unqualified individuals hired. To harass Meigs, he

made unreasonable demands by requesting copies of all records and accounts of the projects. Meigs had no reason to be concerned, because his bookkeeping was meticulous. But this requirement caused much additional and, to Meigs' mind, unnecessary work. Meigs was managing three major public works projects simultaneously and already was working long hours to ensure that they were accomplished efficiently. Meigs, after protesting vigorously, had no choice but to comply, but his reluctance only increased Floyd's annoyance.

By 25 January 1858, Floyd had issued an order that all work be put under contract. With regard to continuing the work in progress, he directed that all provisions as well as hardware, lumber, and groceries must be ordered through Mr. Fitzhugh Coyle. Even the purchase of fresh vegetables from the farmers along the line was prohibited. By March, Floyd was designating the newspapers in which advertisements for Aqueduct contracts should appear. They ranged from the Portland, Maine, *Argus* to the Keokuk, Iowa, *Daily Journal.* His disputes with Floyd even jeopardized the appointment of Meigs' much-loved son John to West Point even though the appointment had been recommended by Jefferson Davis, Stephen A. Douglas, and other senators. Floyd ignored their letters, and the appointment was not forthcoming. At the last minute, after Meigs met with the President, the Secretary agreed to the appointment. Meigs graciously expressed his appreciation in a letter to Floyd.[8]

Floyd still wanted very much to have Meigs removed from all projects. However, President Buchanan, caught in the middle of this dispute, was characteristically reluctant to comply. Buchanan had a tendency to temporize and was slow to act in such situations. He was aware of Meigs' strong support among many powerful members of Congress, having heard particularly from Senator Jefferson Davis, and also knew of the reputation and potential political strength of both Meigs' and his wife's families. Floyd was not without political clout as well, despite growing apprehension concern ing certain questionable activities. Buchanan let the dispute simmer.[9]

By the fall of 1859, Meigs' disputes with both Floyd and Walter regarding designs and contract awards reached the point where Meigs, in strongly worded letters to the War Department, almost asked the administration to choose between him and Walter. For the President, it became a matter of choosing between Meigs and his Secretary of War. On 2 November 1859, Meigs was relieved of all responsibility for the work on the Capitol extension and the dome and was replaced by Captain William B. Franklin. Franklin soon had the same problems with Floyd. But being less defiant than Meigs, Franklin found himself acting as a disbursing agent under Walter's direction. (Franklin rose to the rank of division commander during the Civil War, leading troops in several major battles, including Antietam. But he was later criticized, perhaps unfairly in view of his instructions, for his division's performance during the Union debacle at Fredricksburg. His outspoken criticism of his superiors over the replacement of General McClellan was demoralizing to his command. This caused President Lincoln to reassign him to the West, where he played a relatively minor role during the rest of the war.) Meigs, feeling that his work at the Capitol was substantially complete, did not resist his dismissal from the Capitol. He still had charge of the project he regarded as his greatest work, the Aqueduct, of which he had written, "If I do this I

shall not have lived in vain but will have been the means of doing good in my day and for many future generations."[10]

The *National Intelligencer* on 20 January 1860 reported on a ceremonial presentation that took place at the home of Captain Meigs following a meeting at the Willard Hotel. His subordinates on the great work of the Capitol extension presented Meigs with an elegant silver tea service, which had been obtained for $875 from Messrs. Galt, the same firm that had made the unique tea set presented to him by the mayor and council of Washington in 1854. In the words of the press, the gift was in appreciation "for the exercise of unswerving integrity in a place of high trust and responsibility and for the untiring devotion of his fine talents and varied acquirements to the nation's service and glory." A toast was proposed and it was "appropriately drank [sic] in Aqueduct water." Meigs responded, "I had hoped that I should be permitted to place the capstone on these buildings. It seems to be ordered otherwise... But I throughout have been encouraged...by the clear evidence of large appropriations that I have enjoyed the confidence of the Congress of the United States whose palace we have built." He concluded: "If permitted to finally complete our Washington Aqueduct, I shall feel that a life has been well bestowed in erecting to the Father of his Country this most durable, as the most useful, and therefore the most fitting monument that will ever bear his name."[11]

Perhaps Floyd had underestimated Meigs' influence, for the in power struggle led to a congressional investigation (largely instigated by Meigs) of Floyd's alleged misuse of funds. Floyd also was charged with aiding and abetting the cause of secession by transferring arms and materials to storage areas in the southern states. (The investigation remained unresolved, but Floyd was later forced from office for alleged financial corruption.) The rift was now irreparable. As a consequence, the budget submitted by the War Department for 1860 contained no appropriation for continuation of the work on the Aqueduct. Meigs, foreseeing the possibility that he might not be able to complete his most prized project, took bold action for a mere captain in the Army. He sought the assistance of powerful members of Congress, particularly the chairman of the Senate Military Affairs Committee, Jefferson Davis. Davis spoke in favor of an appropriation of $500,000, the amount Meigs had told him he needed to complete the project. He advised that the work required a person of Meigs' education and background, praised the amendment for entrusting the complete superintendence to Meigs, and suggested that his name be included in the amendment. He also stated that Meigs was entitled "to put the last stone upon this Capitol extension...from which I think he has been unjustly removed." In defending Meigs, Davis said Meigs "has been for five years the hardest working man in the Government." Meigs wrote to Davis "to warmly thank you for your vindication of my conduct on yesterday's debate" and noted that he would preserve the record for his children.[12]

Not only did Congress authorize $500,000 for the Aqueduct in June 1860, but it specified in the legislation that the money "was to be expended according to the plans and estimates of Captain Meigs, and under his supervision." (This was not the last occasion on which Congress was to express such confidence in Meigs. In February 1877, a bill authorizing funds for the Smithsonian's National Museum, now the Arts and Industries Build-

ing, stipulated that it was to be erected in accordance with the plan prepared by Major General M.C. Meigs. The August 1882 Appropriation bill for the new Pension Office Building, now the National Building Museum, specified that it was to be "erected under the supervision of General M.C. Meigs, late Quartermaster General, U.S. Army, retired." Secretary of War Robert Todd Lincoln then appointed Meigs to manage the project.)[13]

President Buchanan approved and signed the Aqueduct Appropriation Act on 20 June 1860, but included a lengthy and strongly worded objection to the language requiring Meigs' supervision of the work. He stated, "I deemed it impossible that the Congress could have intended to interfere with the clear right of the President to command the army and to order its officers to any duty he might deem most expedient for the public interest." He went on to say, "according to my construction of the clause in question, it merely designated Captain Meigs as its preference for the work, without intending to deprive the President of the power to order him to any other army duty." Buchanan stated that he did not believe the act to be unconstitutional, but only because he did not believe that Congress intended "to interfere with my right to order Captain Meigs to any other service which I might deem expedient. My perfect right still remains, notwithstanding the clause, to send him away from Washington to any part of the Union to superintend the erection of fortifications or any other appropriate duty." Buchanan further stated, "It is evident that Congress intended nothing more by this clause than to express a decided opinion that Captain Meigs should be continued in the appointment to which he has been previously assigned."[14]

During July, Meigs was further harassed and persecuted. The War Department held an inquiry into charges regarding his patenting of a fire hydrant that another man claimed was his design. Meigs effectively rebutted all the allegations. Floyd then demanded all of Meigs' plans and estimates that the department did not already have and, on 17 July 1860, issued an order reducing Meigs to the position of disbursing officer and appointing Captain Henry W. Benham Chief Engineer of the Washington Aqueduct. Benham had finished first in his class at West Point, one year behind Meigs. (Ironically, Benham had in 1854 been reprimanded by Jefferson Davis for using intemperate language in a letter to the Treasury Department that Davis had considered an insult to his War Department.)[15]

Meigs immediately protested this reduction in his authority with a long letter to President Buchanan, which he first forwarded to his friend Davis for comment. On 25 July Davis wrote to advise Meigs:

> I have carefully read the enclosed and have marked with brackets and marginal crosses parts which it seemed to me better to omit. My general view is that it is not well to offer in argument the motives of Congress, nor to decide disputed questions of law, nor to arraign the conduct of the Executive; but to present the public question as it would appear to a third or disinterested party.

Meigs, however, had sent his letter to the President before Davis's letter arrived and was thus unable to heed the advice.[16]

Meigs' long and angry letter had asserted that "The orders of the Secretary of War offer me an official indignity, and they directly contravene the purpose of the law." Meigs concluded that "if the President sees fit to continue me in charge of it, I respectfully submit that I must be at liberty to exercise the superin-

tendence according to the plain conditions of the law which this order violates. "Meigs' assertion that the order violated the law contradicted the position the President had taken in his message to Congress a month earlier. He even asserted that portions of the President's message supported his argument. Buchanan immediately responded that he had referred the matter to the Attorney General "for his opinion on the point of law." As frequently happens, the Attorney General, Jeremiah Sullivan Black, fully supported the administration position. He disagreed with Meigs' protestations that by complying with the order he would be violating the law and stated, "I submit whether he [Meigs] is not taking too many branches of the government under his care at one time." The opinion also included a veiled threat: "The words he used are not plain enough to justify the belief that he intended a threat of insubordination under the constitutional shelter of the legislature, and his reputation is too high to allow mere ambiguity of expression to be used against him." (In other words, he had better be a good soldier and do what he was told.) But Meigs' actions over the past several months had clearly challenged the authority of the President and the Secretary of War.[17]

Meigs, incensed by what he believed to be the the Attorney General's misinterpretation of some of his remarks, immediately wrote again to President Buchanan. The President returned Meigs' letter unopened on 13 August, and his curt response left no doubt that he wanted to rid himself of the matter. He directed that Meigs "obey an explicit order" and noted that "it has ended any direct correspondence between us on this subject; whatever else you might say concerning the Washington Aqueduct must pass through the regular and appropriate channel." He did note that "This is done in no unfriendly spirit to you, but from a sense of duty which I owe to my own position." Buchanan was nearing the end of his presidency and was preoccupied with the threat of secession. Meigs had taken his stand at an inopportune time.[18]

Meigs decided to make the best of the situation, but it was only a matter of time before he was confronted with another controversy. He disapproved a voucher to pay a man hired by Benham on the basis that he was not qualified and that "payment of him would be an improper use of the public money which by law is to be expended... under my superintendence. "Citing his "own conscience and judgment," he also refused an order from the Secretary of War to pay the costs of an officer's visit to fortifications in New Jersey, which he said had nothing to do with the Aqueduct. Meigs obviously was not suited to be a mere disbursing officer, as future events were to bear out. (The historian and Jefferson Davis biographer William C. Davis, in his book *The Commanders of the Civil War*, said Meigs was "arguably the most effective department head in the War Department: and that "He was the only Department head to be made a Major General in honor of his services.")[19]

The situation had now reached the point where even the efforts of Jefferson Davis, meeting with the President on Meigs' behalf, could not relieve the tension. Even Buchanan could be pushed too far. In retaliation for Meigs' refusal to allow the officer's expenses, Secretary Floyd, on 18 September 1860 issued an order directing Meigs to assume command of Fort Jefferson, Florida, in the Dry Tortugas. Captain Meigs had been banished, but not for long. His successor Captain Benham was subjected to the same

harassment, and he also had problems with Floyd, as reported in the *New York Times* in November 1860:

> Our friend Secretary Floyd has been unfortunate again in finding a superintendent of the Washington Aqueduct supple enough for his purposes...An "irrepressible conflict" is inevitable between Secretary Floyd and any disbursing officer under him who dares to interpose between the public crib and his faithful friends, and Capt. Benham finds himself in the same predicament from which Meigs was relieved by the high handed act of his removal. I learn from an unquestionable source that the resignation of Capt. Benham has been caused by the same system of intermeddling with his duties which caused the rupture with Capt. Meigs. Floyd insists on his right to give out all the contracts to his friends, and fills every petty office with his favorites without regard to the feelings or the opinion of the superintendent."[20]

Some officers might have regarded this transfer to the Dry Tortugas as a career-ending setback. Meigs, diligent as ever, ultimately turned it to his advantage. He traveled overland to his new post and along the way accurately gauged the attitudes in the southern states concerning the potential for armed rebellion over the slavery issue. His astute assessment of the condition of the existing federal forts was reflected in a letter he wrote to Lieutenant General Winfield Scott, Commander of the Army, on 10 November. He warned that the temper of the South was "excited and dangerous" and of the feeling that "if a struggle was to come, they would prefer it coming now." He also reported on the deplorable state of the federal forts with regard to manpower, armaments, and physical condition, and pointed out that "a few ardent desperate men" could easily seize them. He advised of "What a disgrace such an assault, if successful, would inflict on our Government. How easy to prevent all hostile attempts and how much better than to suppress them." (Four months later, Meigs' warnings prompted the newly elected President Abraham Lincoln to ask him to plan and direct a successful expedition to reinforce Fort Pickens in Florida, as a show of Lincoln's strength and determination to resist southern secessionists. In March 1865 Meigs wrote of this adventure: "This earliest expedition of the war was organized under exceptional circumstances and its records do not appear to have been preserved in Washington. It was an executive act, unknown at the time to any but those engaged therein, including General Scott, the Secretary of State and the President.")[21]

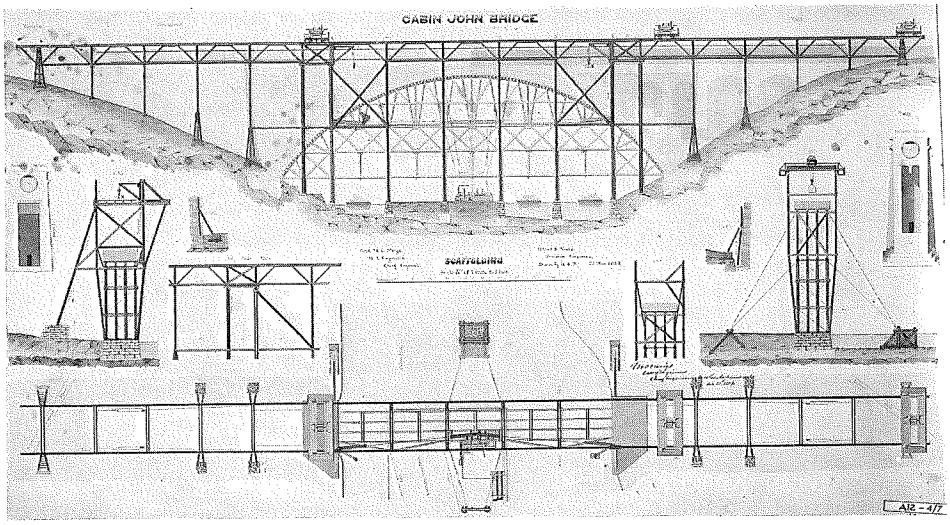
Meanwhile back in Washington, the unsavory aspects of Secretary Floyd's administration of his office had led to his resignation. He was replaced by Secretary Joseph Holt. Edwin M. Stanton, with whom Meigs was to work so closely during Stanton's tenure as Secretary of War in the Lincoln administration, had replaced Black in the post of Attorney General. While Meigs was away, Floyd had convened a Board of Engineers to examine Meigs' work on the Aqueduct. Their November 1860 report fully exonerated Meigs of any improprieties and served to enhance his reputation both as an engineer and a man of high integrity. Throughout the controversy, Meigs had retained the full confidence of the Chief Engineer, General Totten, who himself had a low regard for Floyd. (Totten recently had returned to his post after an extended leave of absence.) On 28 January 1861, Totten issued an order for Meigs' immediate return to Washington. By order of Secre-

tary Holt, on 21 February he was again placed in charge of the Washington Aqueduct relieving Lieutenant James St. Clair Morton (who had succeeded Captain Benham). He also regained his post as supervisor of the work at the Capitol. (Francis Preston Blair, a member of Andrew Jackson's Cabinet, father of Montgomery Blair, and advisor to many high-level officials, including President Lincoln, said of Meigs' exile, "They sent Meigs to gather a thistle, but Thank God, he has plucked a laurel."[22]

(Benham rose to brevet brigadier general during the Civil War, but failed as a leader of line troops and at one point was relieved of his commission. His commission was reinstated by President Lincoln in 1863, and he spend the rest of the war directing the Engineer troops of the Army of the Potomac. Morton was killed in June 1864 while serving as General Burnside's Chief Engineer during the siege of Petersburg, Virginia.[23])

Upon his return, Meigs immediately halted all further work and ordered a full review of the condition of the Aqueduct and an audit of all expenditures during his absence. Believing that those funds had been spent in direct violation of the law, he declined to pay for work done in my absence and not under my superintendence."[24]

Three days before his return to the Aqueduct, Meigs' old friend and benefactor Jefferson Davis had taken the oath of office in Montgomery, Alabama as provisional President of the Confederate States of America. On 22 February, President-elect Abraham Lincoln, on his way to Washington, slipped through Baltimore in the dead of night because of rumors of an assassination plot by southern sympathizers. The next day, Texas became the seventh state to secede from the Union. The fates of Montgomery Meigs and of the nation were destined for dramatic and far-reaching changes during the next several months.[25]



Architectural drawing of Cabin John Bridge showing centering, trestle and hoisting mechanisms.

CHAPTER 6
The Bridges

THE STONE BRIDGES

In addition to the 11 tunnels, there were 26 culverts and 4 stone bridges built to maintain the grade of the Aqueduct between Great Falls and the Receiving Reservoir. The longest culvert was the 30-foot arched structure at Rock Run, the largest stream crossed by culvert. The four bridges were designed and built as stone arches. The first three carried the conduit across smaller streams on the western portion of the line. The longest of these was Bridge No. 3, the Griffith Park Bridge over Mountain Spring Branch. This bridge, which was 200 feet long was built mostly of solid masonry but had an arch spanning 75 feet. Bridge No. 4 was built over the Cabin John Creek.[1]

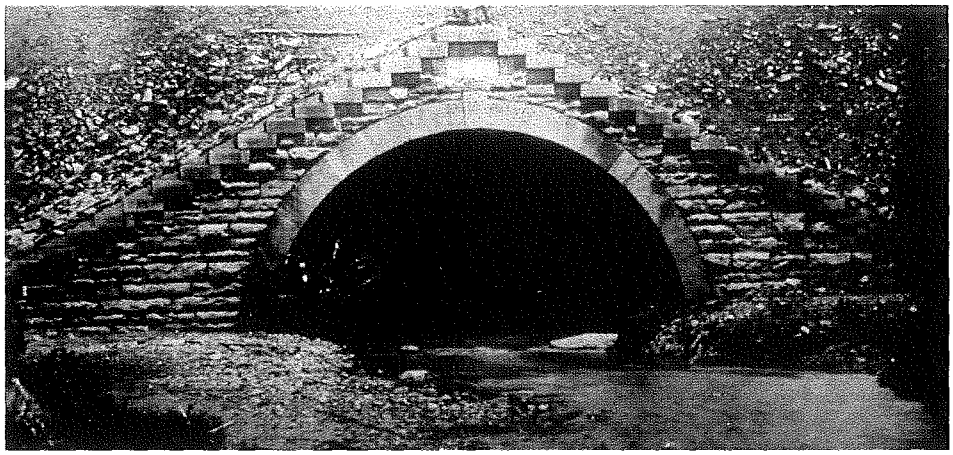
THE CABIN JOHN BRIDGE

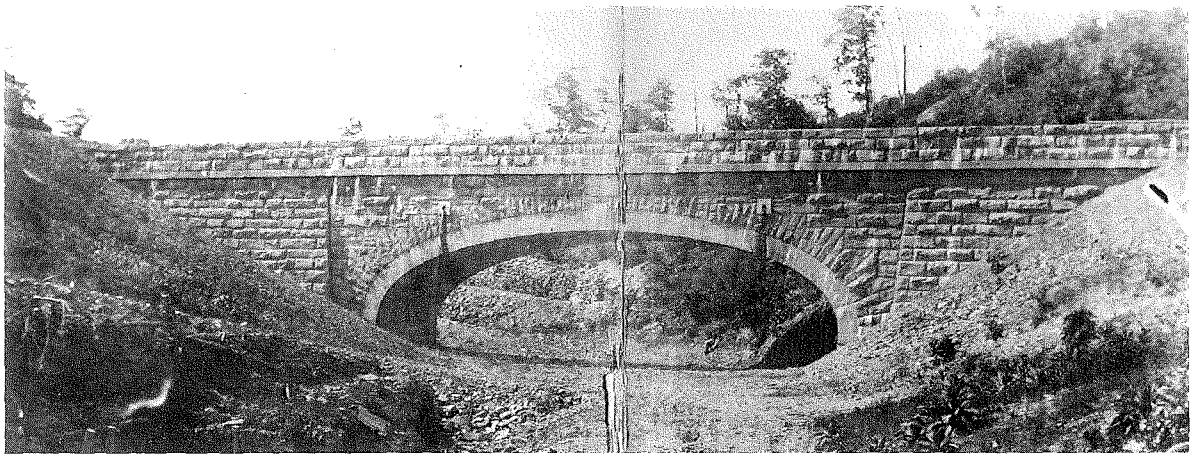
Captain Meigs, in his 1853 report recommending the Great Falls Aqueduct, stated that the project would require "but three bridges, and only one of these large enough to make its erection an object of ambition to an engineer." He also wrote that "the bridge [over Cabin John Creek] would be 482 feet in length; its greatest height 101 ft.; width 20 ft.; and will consist of 6 semi-circular arches of 60 ft. span."[2]

Lack of funds delayed starting work on this major bridge until 1857. By that time, Meigs had decided to modify his original concept. As early as March, 1856, Meigs had concluded that the cost for a single arch bridge might be the same as for the multi-span structure. The result was the pièce de résitance of the Aqueduct, the majestic 220 foot single-span arch known today as the Cabin John Bridge. Meigs made no mention to Congress of the change from his earlier plan. Funds for the Aqueduct were not earmarked for specific items and, even if the longer arch might cost more than the original proposal, the funds could come from savings on other elements of the project. With this change Meigs would be building the longest single-span stone arch in the world. By now his reputation as a builder and manager of public works was such that he probably felt comfortable in creating this monument to his engineering skill.[3]

In November 1854, Meigs had traveled to New York to visit the new Croton Aqueduct, which he wanted to inspect before it was watered. He had some criticism to offer (and noted "Here the curse of slavery has not come," a portent of things to

A typical culvert under the conduit





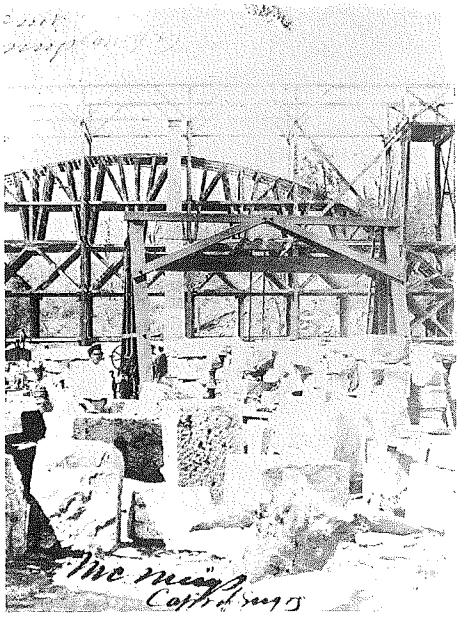
Bridge No. 3 on the conduit.

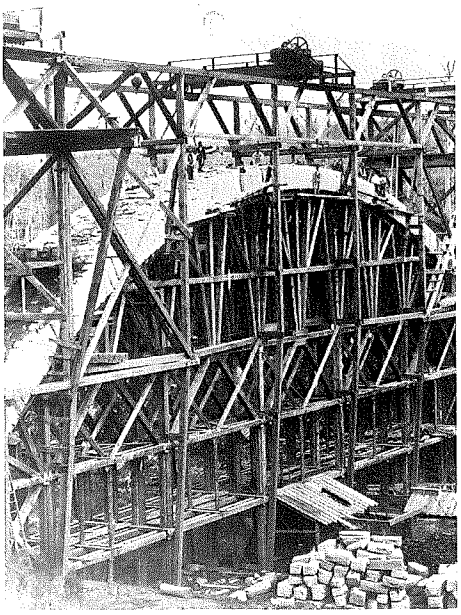
come). Of the High Bridge near Manhattanville, he observed that "This is a noble work, it gives me great pleasure to look at its lofty arches...it is a most imposing site." Perhaps this exposure prompted him to consider an even more impressive work for the Aqueduct system, because the High Bridge had a series of arches similar to those in his original proposal for the Cabin John Creek crossing. He later decided to build the 220-foot span arch, which remained the longest single-span arch in the world for more than 40 years.[4]

The completed bridge had an overall length of 451 feet and a width of 20.4 feet; the deck was 100 feet above the creek. The cut stone arch of Quincy granite, imported by ship from Massachusetts, had a clear span of 220 feet and the height of the key was 57.26 feet. The abutments were of gneiss from a local quarry that Meigs opened about 300 feet upstream from the bridge. The rubble arch and spandrels (and the parapet wall added in 1872) were of sandstone from the Seneca Quarry, which was purchased for $5,000 and operated by the Aqueduct forces. This stone was transported to the site by barge on the C&O Canal. Although the bridge appears to be a solid masonry structure, it actually contains nine interior spandrel arches, five on the west end and four on the east. These are hidden by the sandstone sidewalls. The bids for work on the bridge included the laying of bricks at $6.00 per 1,000 and stone masonry at $5.00 per cubic yard. (The materials were provided by the government.) The total cost of the completed structure, including the parapet walls added later, was

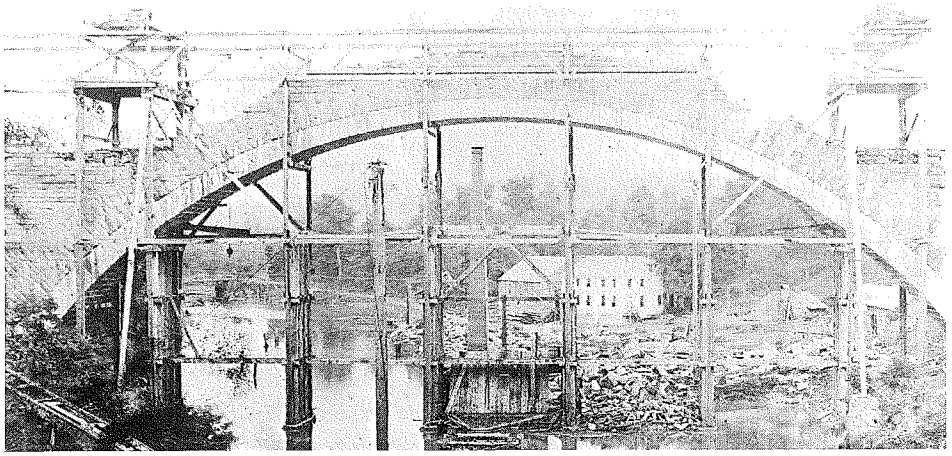
Left—
Cabin John Bridge, centering, trestle and arch stones. May 14, 1858.

Right—
Cabin John Bridge – The arch is keyed December 4, 1858.





Cabin John Bridge The centering is removed August 1861.



Civil War wagon train crossing finished Cabin John Bridge, also showing dam and lock on Cabin John Creek.

$254,000. When completed, it was the final link in the conduit, allowing the first delivery of water from the Potomac River in December 1863. It exists today essentially as originally built. The few modifications include the parapet wall added in 1872 and, in 1912, installation of some steel tie rods and a cement-coated cast-iron lining of the conduit inside the bridge to eliminate leakage. A new cement coating was applied to the iron lining in 1989. The bridge and con-

duit remain in full service, not only to deliver nearly 100 million gallons of water per day, but as an important suburban highway link, carrying as many as 9,000 vehicles a day traveling on MacArthur Boulevard.[5]

BUILDING THE BRIDGE

Obstruction by a few members of Congress, most notably Congressman Richard Henry Stanton of Kentucky, delayed the start of construction until early in 1857. A dam was built on the Cabin John Creek below the bridge location, and the resulting pool under the bridge site was connected by a lock to the C&O Canal 1,000 feet to the south. Materials were loaded on canal barges, either at the wharf in Georgetown or at the Seneca Quarry to the west, and the barges then were floated to a point beneath the bridge. A heavy timber trestle supported derricks and a traveling crane, which were used to hoist the timbers and stone into place. A wooden center arch (the timber structure providing support for the masonry arch during construction) was built to hold the granite arch stones in place. The arch was "keyed" on 4 December 1858. (It would be almost five years to the day before the structure was sufficiently completed to allow water from the Potomac to flow through it to the city.)[6]

On 12 August 1861, when the spandrel arches were nearly complete and the maximum load was resting on the granite arch, the centering was removed. Meigs' last *Annual Report*, dated 30 September 1861 notes: "The centering has been removed, and the weight of the arch rests on its own bearings. During the striking of the center the closest instrumental observation failed to discover the slightest settlement in this, the longest stone arch in the world, 220 feet in span."[7]

More funding constraints and the start of the Civil War further delayed construction. Work was suspended from May 1861 to July 1862 because of the war. Early in the war there was concern that Confederate forces might burn the trestle and the centering, and in May 1861 the trestle was removed temporarily for that reason. However, no such attack took place. The entire project was not completed until late in 1863, permitting the first flow of water through the entire conduit system on 5 December 1863.[8]

In March 1857, Meigs had made Alfred Landon Rives Assistant Engineer in charge of the Cabin John Bridge construction. An 1883 article in *Lippincott's Magazine* claimed that Rives had conceived the single-arch idea. (These assertions probably were inspired in part by the 1877 report of one of Meigs' successors, Colonel Orville E. Babcock, to be discussed later in this chapter.) Another article in the *Washington Star* in 1897 reported that Rives once told his father that he "had conceived the idea of springing a single arch over the Cabin John run." Rives had done some of the structural analysis, and his name appears on some of the drawings, but always as "Ass't Engineer" under Meigs, whose name appeared as Chief Engineer. It was Meigs' practice to assign this analysis to the assistants. The name of Charles G. Talcott appears on the designs and drawings for the shorter stone arches and Bridge No. 3 on the western section of the conduit, which were under his supervision. Talcott's name also appears on the inscription stone located over the keystone of the Griffith Park Bridge as Assistant Engineer, just under that of Chief Engineer Meigs. In addition, William Hutton performed the arch analysis for Bridge No. 5.[9]

"Young Rives" came to work for Meigs in May 1855. He was first assigned to correcting drawings in the office and then to the Post Office project. Meigs' shorthand journals during the early months of

1856 yield significant details regarding the origin of the concept of a single-arch span. Early in that year, Meigs began to develop his original concept of a series of 60-foot arches in more detail and to "make some changes in the simple design so as to give it some balance of design." Meigs and Rives began reviewing the project and found that "an arch of only 1 ft. 4 in. thick would be strong enough to bear the thrust at the ground of this 60 ft. span." The proposed arches were to be semicircular and were to be made of sandstone from the Seneca Quarry. A drawing by Rives in the Washington Aqueduct files shows a bridge of five arches of equal span.[10]

Soon thereafter, Meigs learned of the Grosvenor Bridge, with a 200-foot span over the River Dee at Chester, England. He noted, "this is the greatest span now standing. I should like very much to build such a one." Meigs soon found a full description of that bridge in the *Transaction of the Institute of Civil Engineers.* He was also aware of the single-arch stone bridge that had been built over the Adda, a tributary of the River Po in northern Italy. This single granite stone arch, with a span of 251 feet, had been built in 1380 and destroyed in 1427. By early February, Meigs was "more and more inclined to build a large arch at the Cabin John Bridge." He did "not think it would make much difference in the cost, and it will be so much greater a work in its appearance and effect."[11]

Meigs and Rives continued to work on the Cabin John Bridge. Meigs expressed concern "about leakage from the bridge freezing and causing great damage." (Such freezing did indeed occur, causing some expansion of the masonry and crumbling of mortar and also enormous icicles. The freezing did not, however, cause as much damage as Meigs had feared, and continued until the conduit was lined 1912.) Meigs next learned of the bridges on the Perkiomen Turnpike, north of Norristown, Pennsylvania, built in 1790 with stone arches of 135 feet and then in perfect condition. By 18 February, Rives had worked out the bridge thrusts for the single-arch span, and the two men concluded that it could be built with an adequate factor of safety. On that day, Meigs added a detailed sketch of the bridge to his journal, including all critical dimensions. The sketch depicts the bridge exactly as it was built and as it would look if the sketch were done today. Meigs wrote, "This would make a magnificent bridge, a striking example of the arch, and yet one which is certain of success." He was surprised to find that Bryan, upon seeing the details, "was less adverse than I thought he would be. He seems, like myself, to be taken with the idea of building such a great work."[12]

By 19 March, Rives had "made a rough estimate of the cost of the two bridges and finds a difference of only a few dollars between them. It seems there is less masonry in the larger arch than in the small one, and that the timber needed for the center of the small arches is nearly or quite equal to that in the large one. The length of the soffit of 5 arches of 60 ft. span semicircles is 471 ft. while that of the 220 ft. span, 110 degrees, one arch, is only 261 ft."[13]

As the Senate was approving additional funding for the Aqueduct by a vote of 34 to 5 on 20 March, Meigs and Rives continued their work on the bridge. On 24 March, they redesigned the center (the timber structure designed to hold the arch stones in place until the full load had been placed upon them, at which time the center was to be removed). Meigs' journal for that day includes a sketch of the revised center design, with the comment that "I have altered it entirely. This is much more simple, though

not so open looking as the other, and I do not doubt that it will be much easier to raise and probably cheaper to construct."[14]

On 27 March, Meigs wrote, "I hope to put Rives in charge of the Bridge." This was not to happen until nearly a year later. On 14 March 1857, Meigs wrote to William Bryan:

> I have directed Mr. A. L. Rives to report to you on the 16th for duty on the Aqueduct as an Assistant Engineer, on the same footing as the other two Assistants or Division Engineers—Mssrs. Talcott and Hutton. You will be pleased to give him such instructions as will enable him to carry to the earliest possible completion the works of the Cabin John Bridge. For this purpose he will be placed in charge of a short division of the Aqueduct including that Bridge and so much of the adjoining sections as you think proper. As the Bridge itself, however, will require the most constant attention and vigilance, the section should be a short one, such as to give only work quite near the Bridge.[15]

While Rives' contribution was significant, the single-arch concept was Meigs' own. The drawings signed by Rives are dated after 1856, and Meigs vehemently defended his own authorship of the bridge design. On 21 July, 1883, following the assertions made in the 1883 *Lippincott's* article, Meigs' written statement was that drawings in his diary dated 18 February 1856 gave all essential details, noting the span rise, etc. He stated, "The bridge is my sole work." Meigs also wrote to General H. G. Wright, the Chief of Engineers, and to *Lippincott's Magazine* noting that "It is seldom that an idea of construction comes from the brain and hand of its author so completely and so fully set forth on paper as did this Cabin John Bridge and the Iron Bridge at Rock Creek. Both are entirely my design."

On 19 July, Meigs took the unusual step of reopening his 1856 shorthand journals to rebut the *Lippincott's* article. At that time, he entered additional handwritten margin notes on the pages containing the 18 February 1856 entries previously referred to. He remarked that he clearly remembered making a drawing and design of the bridge before bringing it to the attention of his office assistants. General Wright responded to Meigs' letter on 20 July 1883, enclosing a copy of Babcock's 1877 report, which had alluded to Rives as the designer of the bridge. Meigs' extensive margin notes on that copy briefly summarized the happenings in 1856. In response to the clear implication that Rives devised the Cabin John arch, Meigs wrote, "This statement is untrue, I designed the bridge." Rives' contribution to the Cabin John Bridge was, of course, well known, but the implication that the concept was his was misleading. The case for giving Meigs sole credit for the single-arch concept remains a strong one.[16]

THE LONG BRIDGE

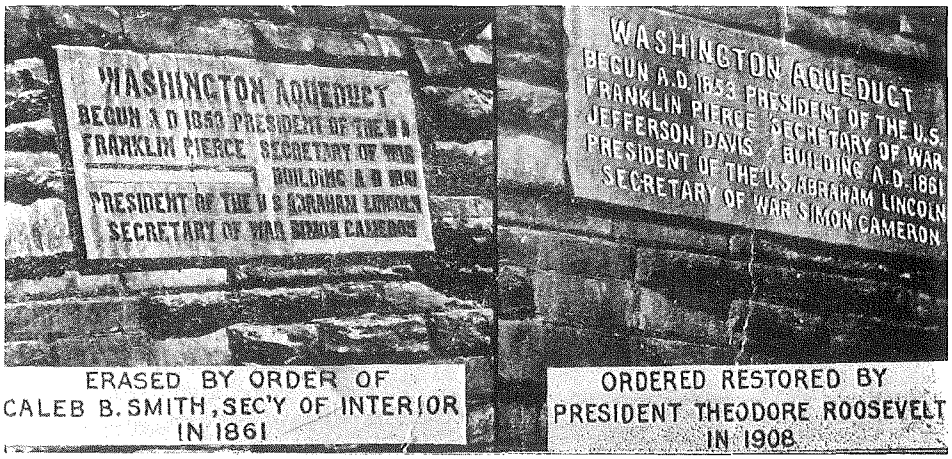
In February 1856, Meigs also became interested in the "Long Bridge." (Although this bridge, which was located near the site of the present 14th Street Bridge, had no direct link to the Washington Aqueduct, the following discussion is included to demonstrate the relationship that existed between Meigs and Rives at the time.) Originally built in 1808, this timber bridge had been rebuilt in 1833 and 1834, during the administration of Andrew Jackson. The project was directed by George W. Hughes, who was later to do the limited water supply study for the capital just prior to Meigs' more elaborate effort. (A structure consisting of a series of masonry arches had been designed for the site in 1833 by Colonel Kearney of

the Corps of Engineers and approved by President Jackson, but it was never built.) The timber bridge had been damaged by the ice floes that accumulated during that severe winter. On 11 February, Meigs and Rives rode over the bridge. While Rives drove the buggy back, Meigs walked over the ice, examining the piers and noting that "the whole structure is in bad order." He later suggested that "indeed, it did not seem quite safe to cross it." Earlier Meigs had written, "I wish the Long Bridge would go away entirely, and they would direct me to build a new one of arches." He observed that the bridge originally was to have been built of stone and that he "hoped to build such a stone bridge." In mid-March, he "set Rives to work on sketches of the arch which would be proper for such a bridge."[17]

In the summer of 1856, the Interior Department took up the matter of replacing the Long Bridge. Meigs wrote to Secretary Robert McClelland, who had earlier entertained Meigs in his home, recommending that Rives be placed in charge of the project for the new bridge across the Potomac. Meigs noted in his journal: "I would be sorry to lose him from my office, but this, if he gets it, gives him the opportunity to advance in his profession." But Meigs soon found that the Secretary did not want "an untried man in whose name the public would have no confidence." The Secretary insisted that Meigs and Lieutenant Colonel William H. Emory do the work. Meigs at first responded that he did not have time in view of his other responsibilities. He later reconsidered, writing: "I know of no work I should prefer to build, besides those which I am now upon, to the bridge at the site of the present Long Bridge." Meigs continued to advocate giving the job to Rives, however, and noted that "if it was put in my hands, I should probably give Rives one of the bridges after studying the general arrangement and nature of the design, and I should feel sure of its being quite as well studied by him as it would be my myself." Secretary McClelland still maintained that he wanted Meigs and Colonel Emory to work on the project. However, Jefferson Davis objected and stood fast even after being assured that Meigs would not be "placed under orders of Interior." Several days later, Davis ordered Emory to Kansas to join his regiment.[18]

Meigs then continued to promote Rives, on one occasion taking him to the White House to meet the President. Finding the President not in residence, Meigs left a letter recommending Rives for the new bridge investigation. At this point, Rives prospects were bright. On 12 September, Meigs accompanied Secretary Davis and his brother Robert on a visit to the Aqueduct project, and that evening he dined at the Davis home. Among the guests was President Pierce, who told Meigs that he had directed Acting Secretary of the Interior Whiting to appoint Rives as Chief Engineer of the bridge survey. Several days later, when Meigs called on Whiting to thank him for the appointment, the Acting Secretary told him it was "his appointment and that they would hold him responsible for Rives' performance of the duty." Meigs wrote, "I have gotten him this appointment, and he ought, in justice to me, make a good work of it." A few days later, after receiving a warm letter of thanks from Rives' father, William C. Rives, Meigs wrote, "This is a compliment and I sent it to my father to read as it will give him pleasure."[19]

A rendering of a metal truss bridge that Rives produced for the site appears in the book *Bridges and the City of Washington* by Donald B. Myer. However, that bridge was never built. Although a parallel tim-



Original inscription stone with Jefferson Davis's name removed (1864) and the restored stone (1909).

ber bridge was constructed in 1863, this occurred many more years before the old Long Bridge was demolished and replaced. But the good news for Meigs was that Rives soon returned to him as a valuable member of his staff.[20]

INSCRIPTIONS ON THE CABIN JOHN BRIDGE

The south side of the bridge shows commemorative tablets (on the east and west abutments); in addition, Meigs' name appears on one of the arch stones. All involved some controversy. The two tablets on the east and west abutments, about 20 feet below the top, were originally specified by Meigs in an order to Rives dated 18 March 1861. The order provided detailed descriptions of the inscriptions and how they were to be installed on Bridge No. 4. The west abutment stone, as specified by Meigs, was to read as follows:

WASHINGTON AQUEDUCT
Begun A D 1853
President of the U.S.
Franklin Pierce
Secretary of War
Jefferson Davis
Finished A D 186-
President of the U.S.
Abraham Lincoln
Secretary of War
Simon Cameron

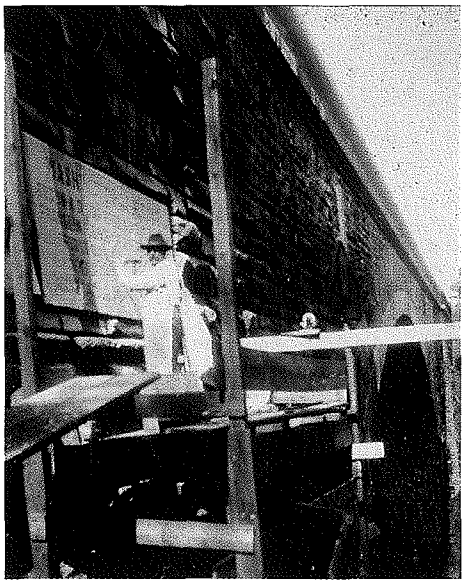
The stone placed on the bridge was slightly different, as shown in the photograph.[21]

In the summer of 1862, Jefferson Davis's name was erased from the tablet, an action Meigs has been unfairly accused of ordering. At that time, the Washington Aqueduct was administered by the Department of Interior, and Meigs was busy as Quartermaster General of the Union Army. Secretary of Interior Caleb Blood Smith gave the order to remove the name Chief Engineer William R. Hutton, after hearing objections from members of Congress, particularly from Galusha A. Grow of Pennsylvania, then the Speaker of the House. (According to Hutton, during a June 1862 inspection tour of the project, Grow said to the Secretary, "Do you know that that damn rebel Meigs has put Jeff Davis's name on the bridge?" This was a strange statement, considering Meigs' current position, but perhaps reflective of an attitude developed some six years earlier. At that time, Meigs had written a strong letter to Grow rebutting the letter's claim that Meigs was spending more money than was authorized.) Secretary Smith gave the order, and Davis's name was erased by stonecutter Joseph Bobinger.

Bobinger was a stonemason from Alsace-Lorraine who had worked on the bridge. His German wife sold food to the workmen and later to

sightseers. This modest endeavor grew to become the famous Cabin John Bridge Hotel, which was built on a 100-acre tract adjacent to the bridge. The Bobingers had purchased the land from the Aqueduct office under the provisions of a Special Senate Resolution. This grand structure included private dining rooms, a "Rathskeller," billiard rooms, and two banquet halls seating 100 each. A large music hall housed the orchestrion, a powerful music box that had been shipped from Europe. Its tones could be heard throughout the hotel and outside in the park. John Philip Sousa introduced his "Washington Post March" at a banquet there. The hotel was a popular place to visit from the time in was built in 1870 until the early years of the 20th century. Guests arrived by canal packets and by horse and carriage to stroll the landscaped grounds and gardens and admire the bridge before dining on superb food and enjoying the wine produced in the adjacent vineyards. The hotel, which had declined in popularity, closed in 1925 and the abandoned building burned to the ground on 6 April 1931.[22]

Appeals to President Theodore Roosevelt in 1908 by, among others, the Confederated Southern Memorial Association, resulted in the restoring of Davis's name to the tablet. This was accomplished by contract for $230. Stonecutter J. B. Horne (ironically, from Moss Point, Mississippi, and named for James Buchanan) subcontracted to do the job for $127.75. Mr. Horne had to first erase the entire stone to a depth of one inch, and then restore the original inscription. This action must have captured the public's attention, because several postcards soon appeared, one showing Horne at work on his scaffold. Another displayed the tools he used to do the job, which were later purchased for $50 by the president of the Confederated Southern Memorial Association, who led the campaign to have the name restored. The tools were then placed in the Jefferson Davis Repository of Memorial Hall in New Orleans.[23]



J.B. Horne re-cutting stone to restore Davis's name.

Captain Meigs' 18 March 1861 directions for the stone on the east abutment specified the following:

UNION BRIDGE

Chief Engr. Capt. Montgomery C. Meigs U.S. Corps of Engrs.

Assistant Engineer Alfred L. Rives C.E.

Meigs also directed that the following letters should appear on the ring stones, one letter to a block:

E. PLURIBUS UNUM[24]

Captain Meigs, having traveled through the southern states and having gauged the temper of the populace, must have suspected that Rives might follow his southern leanings if conflict arose. He was from a politically prominent family of Albermarle County, Virginia. His father, William C. Rives, had recently been the U.S. Minister to France and was an influential member of the Virginia House of Delegates. Nine days before giving him the orders for the inscriptions,

the orders for the inscriptions, Meigs had Rives appear before a Justice of the Peace in the District of Columbia and sign a statement to "solemnly swear that I will support the Constitution of the United States and discharge faithfully and diligently all the duties of the office to which I have been appointed." Meigs' suspicions proved to be correct, however. When Virginia left the Union on 17 April 1861, Rives went south, eventually to become the Assistant Chief Engineer of the Confederate Army.[25]

The tablet, as later installed, read as follows:

UNION ARCH

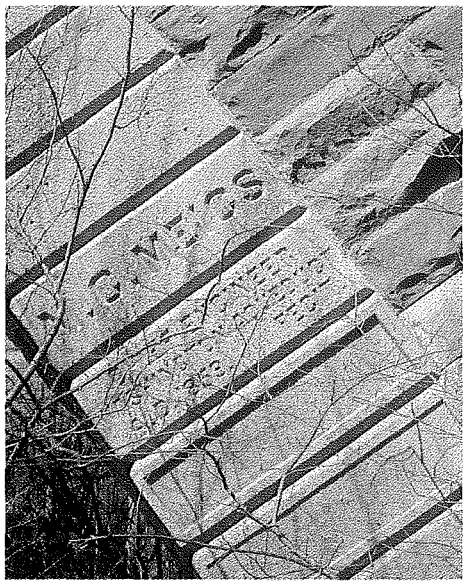
Chief Engineer, Capt. Montgomery C. Meigs, U.S. Corps of Engineers

Esto Perpetua

"E Pluribus Unum" never appeared on the arch stones, a credit to whomever had the good judgment to reconsider that order.

However, on the tenth and ninth granite arch stones on the southeast side of the bridge, the following appears:

M.C. MEIGS
CHIEF ENGINEER
WASHINGTON AQUEDUCT
A D 1859 FECIT[26]
(Fecit means "He made it.")



Meigs' name on arch stones. Note deletions on the two stones below these.

Many years later, Mr. Curtis, one of Rives' assistants, stated that "Captain Meigs, being apprehensive lest some action might be had looking to his removal, and desiring to perpetuate his name as the Chief Engineer of the bridge, caused the inscription to be cut." Had that been so, Meigs would have been correct in his assumption, because he was soon assigned to Fort Jefferson. Another source indicates that Meigs did not have his name inscribed there until after his return from the Dry Tortugas. During Meigs' absence, the names of Captain Henry W. Benham and Lieutenant James Morton, the two officers who had been placed in charge of the work while he was away, were carved into two of the arch stones just below the ones on which Meigs' name and title still appear, also with the designation "Chief Engineer". Upon his return to the Aqueduct project on 21 February 1861, Meigs ordered these names cut out. He believed (rightfully) that they had no valid claim to the title because they had only been carrying out his design during his absence.[27]

The latter version must be correct because recently found photographs indicate that Meigs did not put his name on these arch stones until after his return in February 1861. (Meigs had, however, placed a copper plate on the bridge in April 1858 designating himself as the Chief Engineer.) A remarkably clear photograph of that part of the bridge, dated June 1859, shows no inscriptions. Another, dated 27 February 1861 on the negative, shows the tenth arch stone faintly marked "M. C. Meigs" and nothing on the stone below. The tenth is the stone on which Meigs' name appears today. The photograph also shows that deletions have been made on the seventh and eighth stones.[28]

Bridge No. 5, the pipe arches over College Pond. Note Aqueduct Bridge in background.

THE CAST-IRON BRIDGES

The bridges designated as Nos. 5 and 6 were an integral part of the water mains from the Distributing Reservoir at Drover's Rest to Georgetown and Washington. Both were cast-iron arches, formed by the actual pipes carrying the water to its destination. Bridge No. 5, carrying the mains over College Pond Branch in Georgetown, adjacent to Canal Road, had a span of 120 feet. An arch of this type was not really needed here, because the water could just as well have been conveyed under the stream. It assumed no special significance, and is now covered by earth fill. Bridge No. 6, over Rock Creek at Pennsylvania Avenue, was on the other hand much publicized for its structural innovation. It later became one of the most controversial of all Washington Aqueduct structures.[29]

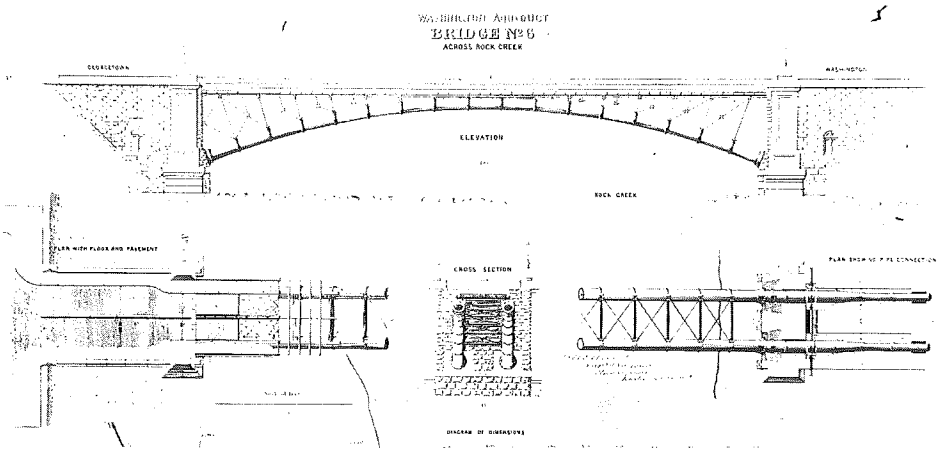
THE ROCK CREEK BRIDGE

Originally, Captain Meigs intended to construct the pipelines under Rock Creek, which at that time was deep enough to allow canal boat navigation. But by February 1855, he had developed the idea of using the pipelines as arches to support the bridge, and the original plan for the rock Creek crossing was changed. The old wooden bridge across the creek at M Street was proving to be inadequate to carry the increased traffic between the city and Georgetown. Meigs designed a new bridge, using the two 48-inch cast-iron pipes for the dual purpose of carrying the water supply and forming a cast-iron arch of 200 feet clear span and 20 foot rise to support the framework for the roadway above. In his last *Annual Report* (for 1861), Meigs noted, "The completion of this work was authorized by the Secretary of War upon urgent solicitations of the citizens of Georgetown and Washington, the bridge being of great importance to the government and to the people in economy of communications between the two cities."[30]

Each arch consisted of 17 sections of 48-inch diameter cast-iron pipe with a thickness of 1.5 inches firmly connected to each other by cross braces and diagonal ties. A framework of H-beams supported two 204.5 feet-long girders, which in turn supported the timber roadway. The abutments, founded on solid rock, were of sandstone from the Seneca Quarry. They contained vaults housing connecting pipes and flow-regulating valves and also, in the western abutment, the Worthington water pressure engine to pump water to the High Service Reservoir described previously. Construction of the bridge began in 1858 and was not completed until 1860, although water had begun flowing in 1859 through temporary

pipes across the creek. Captain Meigs was present on 7 October when the arch was finished by tightening the bolts on the last section or "key pipe" of the arch. A photograph of Meigs standing on a scaffold was at one time thought to be of Abraham Lincoln, but the event occurred well before Lincoln's tour of the Aqueduct in 1861.[31]

In 1876 a controversy arose over whether to rely on this bridge to continue performing its dual role. Colonel Orville E. Babcock had been named Commissioner of Public Buildings and Grounds in 1871 and was now in charge of the Aqueduct. That year Babcock, Chief of Engineers Andrew A. Humphreys, General Meigs, and Frederick Law Olmsted were appointed to an Advisory Committee to the Board of Public Works, then under the control of Alexander R. Shepherd. Shepherd had recently been appointed by President Ulysses S. Grant under the new "Territorial" form of government just enacted by the Congress. This board soon directed major improvements to the city's infrastructure, including grading and paving of streets and roads and adding many miles of sewers. The board also had the unsanitary and unsightly Tiber Creek and Washington Canal covered with arches, turning them into the principal sewer of the District of Columbia and thus draining much of the city into the Potomac Estuary.

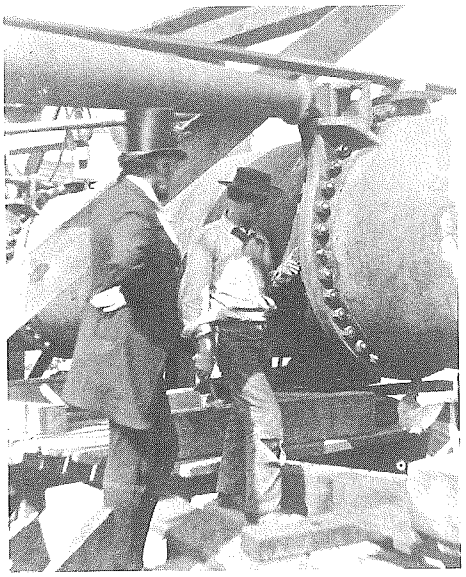


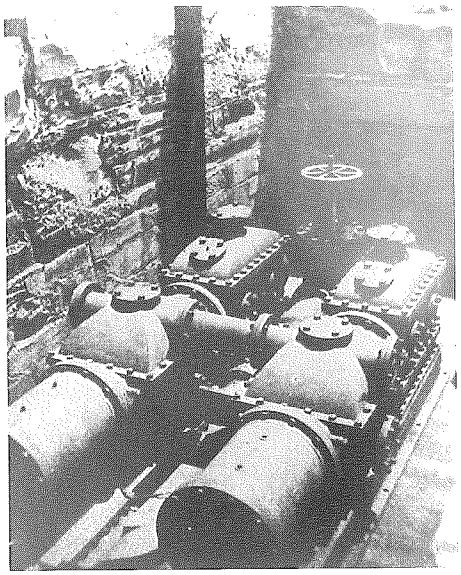
Architectural drawing for Bridge No. 6, the Rock Creek Bridge.

Construction of Rock Creek Bridge #6

Left—
M.C. Meigs on Rock Creek Bridge scaffold, during tightening of last bolt 7 October 1859

Right—
The Worthington pumping engine as installed in Rock Creek Bridge c. 1859





Babcock had in 1875 persuaded Congress to pass an act requiring the removal of the tracks of the Washington and Georgetown Railroad and restricting the Rock Creek Bridge to light loads. In 1876, Babcock, noting that "the entire supply of Potomac water depended on the preservation of this bridge," recommended that the roadway be removed from the arches and that a new wrought-iron truss bridge be erected over the present structure to support the roadway.[32]

Although still serving as Quartermaster General, Meigs was keeping a watchful eye on the Aqueduct, and he took umbrage at this proposal. In letters of protest to both the Chief of Engineers, General Humphreys; and to the Honorable George E. Spencer, chairman of the Senate District of Columbia Committee, Meigs claimed that the bridge was perfectly safe for both uses and that he had been "grieved at seeing a law passed to remove the street railroad tracks from it on the plea of damage to the mains." He also wrote, "to cover over and conceal the bridge, which is now an ornament to the city, would seem to me to be a useless act of barbarism and a clear waste of $70,000." He stated, "I am confident myself that a train of heavy locomotives could be safely run daily and hourly over the bridge, so far as the strength and safety of the Aqueduct mains are concerned." In his letter to the Chief of Engineers, Meigs also unabashedly noted that the proposal "affects the reputation of the engineer and the corps to which he belonged when the work was constructed."[33]

Babcock's 27 January 1877 report in response to Meigs' protest was verbose and sarcastic. He included gratuitous comments about the Cabin John Bridge, stating, "The only act of barbarism I know of was the defacing of the abutments by changing the inscriptions." He also quoted a recent article by a professor at Ecole des Ponts et Chaussees in Paris questioning Meigs' contribution to the bridge design, which noted that "the studies of all its details were made and it was constructed by Alfred L. Rives." Rives had been a recent graduate of Ecole des Ponts when he came to work for Meigs. Including that comment was superfluous and petty. (Meigs' later extensive margin notes on a copy of Babcock's 1877 report disputed his contention, as discussed earlier in this chapter.)[34]

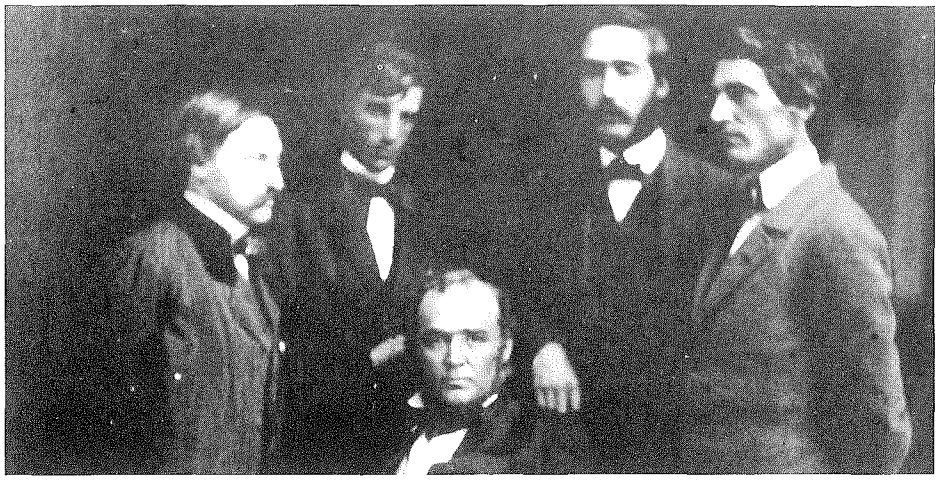
Babcock was not new to controversies. His service during the war had earned him a brevet as brig-

adier, and, as aide de camp to General Grant, he had carried Grant's terms of surrender to Robert E. Lee at Appomattox. He left the Army to become Grant's personal secretary when Grant became President in 1869. Although acquitted, his involvement in the Whiskey Ring frauds forced him out of the White House, but not out of Grant's favor. Babcock was appointed Commissioner of Buildings and Grounds in October 1871, and his service is that assignment was generally regarded as beneficial to the city. But, during the design and building of the new War and Navy Department Building, he was involved in a dispute regarding expenditure of funds appropriated for the building being diverted for other purposes. This new controversy with Meigs, affecting the image of the Corps of Engineers as it did, was of great concern to General Humphreys, whose friendship with Meigs dated from their me'mbership in the Scientific Club in the mid-1850s. Humphreys felt compelled to order the creation of Board of Engineers to review the matter.[35]

In letters to General Humphreys during February 1877, Meigs commented extensively on his design analysis for the bridge. In April, the board, which included Lieutenant Colonel Horatio Gouverneur Wright who later became Chief of Engineers (1879–1884), generally sustained Meigs' position regarding the strength of the structure. (Wright and Meigs had met before when they both participated in the defense of Washington during Jubal Early's raid on the capital in July 1864. Major General Wright, commanding the VI Corps, had been dispatched hastily to Washington by General Grant and was defending Fort Stevens. He was standing beside Abraham Lincoln, urging him to get down, when the President came under Confederate sniper fire. This occasion was the only time that Meigs commanded troops in battle. He had hastily assembled his 1,500 quartermaster troops and marched them out to defend Fort Slocum, adjacent to Fort Stevens. Wright continued to command the VI Corps with distinction throughout the balance of Grant's Virginia campaign.)

After performing its own detailed structural analysis, the board concluded that "the bridge has a superabundance of strength" and that a new "truss over the roadway will be unsightly in such a position." General Humphreys, who had received a preliminary report from the board in late February , relieved Babcock of responsibility for the Aqueduct on 1 March. He was replaced by Lieutenant Colonel Thomas Lincoln Casey, another future Chief of Engineers (1888–1895), on 3 March. In response to the Chief's request to investigate the matter further, Casey on 19 July 1877 reported that he agreed fully with the report of the Board of Engineers.[36]

Meigs' bridge remained intact for another 39 years. In 1916, the superstructure of the old bridge was removed, and a new concrete arch was built over Rock Creek. The 48-inch pipes were left in place, in recesses between the new concrete arches. Although no longer supporting the weight of the bridge, they continue to carry water to the city.[37]



Montgomery Meigs and his assistants, standing left to right, Alfred L. Rives, Edmund D.T. Myers, Charles G. Talcott and William R. Hutton. Montgomery C. Meigs, Papers Manuscript Division, Library of Congress.

CHAPTER 7
The Assistants

The inscription stone at the Great Falls Gatehouse bears the names of Presidents Pierce and Buchanan. Captain Meigs' name appears twice: at the top as "Projected by" and below the names of the two Presidents as "Chief Engineer." This is followed by "the Assistant Engineers have been W.H. Bryan, C. Crozet C.G. Talcott, A.L. Rives, W.R. Hutton, E.D.T. Myers." That Meigs chose to recognize these men in this way indicates his high regard for their contributions to the daily management of the construction of the Aqueduct.[1]

William Bryan was hired by Captain F.A. Smith, who had lived at Bryan's house, just prior to Smith's death. He had for many years been employed as a civil engineer and had been a superintendent on the Chesapeake and Ohio Canal. During most of Meigs' tenure as Chief Engineer, Bryan remained as the Principal Assistant Engineer. Although Bryan was the only assistant Meigs is known to have criticized for his behavior, Meigs also vigorously defended him and fought for his retention when Secretary of War Floyd moved to dismiss Bryan (who had filled a position with someone whose political views had offended Floyd). When Meigs spoke to Floyd on Bryan's behalf, Floyd declared that he considered Bryan an indignity to him and demanded his dismissal. Following Meigs' appeal to Floyd, Bryan was briefly retained, after Floyd had brought in another man as Principal Assistant Engineer. Meigs also lobbied to raise Bryan's salary. At first rebuffed by General Totten, he later succeeded in obtaining a salary of $2,555 per year, which Meigs noted at the time was about $800 more than his own pay. But Meigs was dissatisfied with Bryan's manner of handling the men, which he described as too arbitrary. "If he is left to manage alone he would soon have a strike or get killed," Meigs wrote, just over a month before a strike occurred at Great Falls. And in June 1855, just three days after obtaining a 40 percent raise for Bryan, Meigs was "provoked by his manner of talking to me and the men." Meigs described him as narrow minded, overbearing to subordinates, and obsequious to his superiors. Meigs also commented on his cursing, rudeness, and lack of manners, and noted that "he is the most unpopular man on the line. He has no respect for

his subordinates and has driven away some of the best foremen we have had." In March 1855, Bryan requested two Assistant Engineers for the Great Falls Division and one for the Georgetown Division. He reported that "the best application he had was from Talcott."[2]

Charles G. Talcott, the son of Captain Andrew Talcott, accepted appointment as Assistant Engineer of 16 March 1855 and was initially assigned to work at the Post Office. Soon thereafter he was sent to Great Falls, where his work prompted Meigs to write, "Mr. Talcott pleases me much." Surveys led by Talcott developed a relocated route that eliminated one bridge and saved more than $5,000. During periods when funds were unavailable for work on the Aqueduct, Talcott worked on the Capitol extension. However, his principal duty was supervising the Great Falls Division, and his name is also inscribed on the stone in Bridge No. 3 as Assistant Engineer, just under the name of the Chief Engineer.[3]

On 2 May 1855, the Honorable William C. Rives, recently returned from duty as Minister to France, advised Meigs that his son, Alfred Landon Rives, would accept an appointment under him. Rives, a graduate of Virginia Military Institute, had also just graduated from the Ecole des Ponts Chaussees engineering school in Paris. The French authorities there spoke highly of his proficiency and industry, prompting Meigs to comment, "I trust he may be as good as they say." Rives reported to work on 23 May. He was set to work correcting Aqueduct drawings and then was assigned to the Post Office. He was appointed Assistant Engineer under Bryan, in charge of the construction of the Cabin John Bridge, on 14 March 1857. He remained in that post until joining the southern rebellion, shortly after President Lincoln's unsuccessful personal appeal to his father, William Rives, to keep Virginia in the Union. (Meigs' high regard for Rives at the time was discussed in Chapter 6.) During the war, Rives rose to the rank of colonel and was the Assistant Chief Engineer and for a time the Acting Chief Engineer of the Confederate Army. Following the war, he had a distinguished career with several railroads in the United States and later in Panama, where he posited a plan for completion of the Panama Canal. After the war, he went to Meigs' office to visit. The Quartermaster General refused to see him, commenting, "I could not see any of those gentlemen who had deserted their country and joined the party who murdered my son, with any satisfaction." Rives died in February 1903 at Castle Hill, the family home near Charlottesville, where he had been born in 1830.[4]

William R. Hutton was appointed to a position on the Aqueduct on 1 June 1855, on the condition that he move to Georgetown to be close to work. He reluctantly agreed, but his resentment in being forced to move was manifested at one point in his consistently arriving late for work. When Bryan complained, Meigs wrote a letter of reprimand, advising Hutton that he would be replaced if this tardiness continued. His work habits must have improved, because he was later named Assistant Engineer in charge of the Georgetown Division. Hutton later worked on the Croton Aqueduct and the Washington Bridge in New York. His name appears on the inscription stone at Waste Weir No. 3, between the two reservoirs, under the date December 1858. When jurisdiction over the Aqueduct was transferred to the Department of Interior during the war, Hutton was appointed Chief Engineer and served in that capacity for more than a year. In later years, he pub-

lished a number of articles on the Washington Aqueduct and the Cabin John Bridge.[5]

Edmund T.D. Myers also served as the Georgetown Division Engineer, and it is his name that Meigs placed on the inscriptions dated 1859 on both sides of the Rock Creek Bridge. Myers also joined the Confederacy, and he too was rebuffed when he attempted to visit Meigs after the war.[6]

Of all of the assistants, Claudius Crozet's story is perhaps the most interesting, although he was not selected by Meigs. Colonel Crozet was born in France and graduated from Ecole Polytechnique, the French Military Academy. He served in Napoleon's army as a captain. He fought at the battle of Wagram and later in the ill-fated invasion of Russia. During the retreat from Moscow, he was captured but later befriended by a Russian nobleman, to whose children he then taught French. He was released after the signing of the Treaty of Paris, but continued to serve Napoleon until the defeat of Waterloo.[7]

Crozet sailed for America in 1816 and, upon arrival, was given a professorship at West Point. He was instrumental in revising the curriculum there and later at the Virginia Military Institute. For many years, he worked on various public works projects, including canals and highways; served as President of Jefferson College; and was twice the State Engineer for Virginia. His best remembered project was the Blue Ridge Railroad Tunnel, completed in 1856. Meigs had earlier been quite favorably impressed with that work during a visit to the area in 1855.

Crozet came to the Aqueduct as a result of the dispute between Secretary of War Floyd and Bryan over the latter's failure to fire an employee whose political views offended Floyd. On 1 December 1857, Meigs received an order from Floyd appointing Claudius Crozet Principal Assistant Engineer of the Washington Aqueduct. The next day, Meigs accompanied Secretary Floyd and Crozet on a ride over the Aqueduct.[8] Floyd had served as governor of Virginia, as had his father before him, and was a strong supporter of Crozet. But Meigs had been told by one of the major contractors working on the project, H.S. Galliher, who had also been a contractor on the Blue Ridge Railroad, that Crozet was "intriguing and not to be trusted." Meigs perhaps realized that Galliher might be concerned by Crozet's recollection of the disputes they had earlier on the railroad job. Alfred Rives, the Virginian, told Meigs that he thought Crozet a traitor, and that he had a bad reputation in Virginia. By that he meant that Crozet would serve the man responsible for his appointment, Floyd, rather than his immediate superior.[9]

Crozet wrote to Meigs to inform him that he had been unaware of the circumstances preceding his appointment. Crozet stated:

> I never coveted any office unless vacant, or certainly to be vacated ...If therefore, you think you can by any possibility retain your assistant if I decline, let me know confidentially and I will do it. If on the contrary, a change is decided upon, I will accept...We are all dependent in some way or other, and as an old soldier, I understand the value of discipline, without which no service can be efficiently rendered.

Meigs, who had earlier expressed concern by saying "Floyd is going to give me Crozet, a bitter man," was favorably impressed by Crozet's integrity and came to appreciate the value of his services. Meigs also apparently enjoyed Crozet's company, particularly when he was

telling war stories about his experiences under Napoleon. Meigs temporarily retained Bryan, who shared the Principal Assistant Engineer duties with Crozet. In the summer of 1859, work on the Aqueduct ceased because of funds, and, early in July, Crozet was one of several engineers terminated. He had apparently declined an offer to remain, advising a friend that "It would not suit my views of propriety to remain unemployed nearly a whole year waiting, on pay, for an adequate appropriation to resume the work." Crozet returned to Virginia to work on railroad projects until they were terminated because of the Civil War. He was dismayed by the destruction of many of his works by the opposing forces during the war. He died in January 1864 and is buried at the Virginia Military Institute.[10]

CHAPTER 8
The Lincoln Era

Meigs' last Washington Aqueduct report, for the fiscal year ending 30 September 1861, explained the circumstances of and his actions leading to his banishment. He included a summary of the work done to date and noted that

> Should the return of peace make it proper, a few months will suffice to complete the whole work...and had the work been carried out under my supervision and without interruption, I believe I could have had the satisfaction of reporting it as entirely completed at this time. As it is, it must wait until the restoration of peace enables the country to spare the money from other and more imperative claims.

Meigs was destined to devote his talents and energies to the successful resolution of those "other and more imperative claims: and to do so in a manner that would establish his reputation as a major contributor to the success of the Union cause.[1]

On 4 March 1861, Abraham Lincoln was inaugurated as the 16th President of the United States. Meigs, a Democrat who had supported Senator Douglas, was present. Lincoln's Inaugural Address convinced him that Lincoln was the man to lead the nation in this time of crisis. Within a month, Meigs, at the behest of Secretary of State William Seward, was called to the White House to consult with the new Commander in Chief regarding the condition of the southern forts, now threatened by secessionist extremists. Lincoln felt the need for a show of determination to resist the threatened breakup of the Union. Holding Fort Sumter proved impractical, but on 1 April, Lincoln ordered an expedition to supply men and material to Fort Pickens, in Florida. Captain Meigs planned this effort and accompanied the expedition as commander of the Army forces that succeeded in securing the fort. It remained in Union hands throughout the War. While he was away from Washington, Confederate forces began the bombardment of Fort Sumter on 12 April, and the garrison surrendered the next day.[2]

Meigs returned to Washington on 3 May and was again at the White House, describing his experiences to the President and members of the Cabinet. He also found soldiers from the regiments that Lincoln had called to service living in the

public buildings, and he began to curtail efforts on the public works still under his charge. The confidence that the nation's highest officials had in Meigs was bolstered when Lincoln expressed pleasure with his written advice on the course the war should take in general and the situation in Virginia. (Meigs was to remain Lincoln's friend and one of his trusted advisors throughout the war years. He spent the long night of 14 April 1865 by Lincoln's bedside at the Peterson home on 10th Street were the President died.)[3]

When Postmaster General Montgomery Blair, who had graduated from West Point one year ahead of Meigs, asked if he would accept a major generalship, Meigs replied, "I prefer, in time of peace, the place of Captain of Engineers, to any other on earth. But I am always at the service of the U.S. in any place or position be they ordered."[4]

On 19 May at Lincoln's request, Meigs had the pleasure of guiding the President and Secretary of State Seward on a riding tour of the Aqueduct. Insofar as is known, this tour, and the two visits by Franklin Pierce are the only known visits of Presidents to the Washington Aqueduct. On this occasion, however, the discussions turned to more urgent matters, including Meigs' views on the possible involvement of England and France on the side of the South. A few days earlier, the Cabinet had approved Meigs promotion to colonel. Montgomery Blair and others wanted this to be a step toward his becoming the Quartermaster General. At the same time, some powerful Cabinet members objected, particularly Secretary of War Simon Cameron, on behalf of the many aspirants to the spoils to be gained from control of the massive expenditures of the Department. These officials were aware that Meigs would thwart any such ambitions. But Lincoln wanted Meigs to be his Quartermaster General, as shown in the following:[5]

LINCOLN'S LETTER

PRIVATE

Executive Mansion, June 5, 1861

Lieut. Gen. Scott

My Dear Sir

Doubtless you begin to understand how disagreeable it is to me to do things arbitrarily, when it is unsatisfactory to others associated with me.

I very much want to appoint Col. Meigs Quartermaster General, and yet Gen. Cameron does not quite consent. I have come to know Col. Meigs quite well for a short acquaintance, and, so far as I am capable of judging I do not know one who combines the qualities of masculine intellect, learning and experience of the right sort, and physical power of labor and endurance so well as he.

I know he has great confidence in you, always sustaining, so far as I have observed, your opinions, against any differing ones.

You will lay me under one more obligation, if you can and will use your influence to remove Gen. Cameron's objection. I scarcely need to tell you I have nothing personal in this, having never seen or heard of Col. Meigs, until about the end of last March.

Your obt. Servt,

A. Lincoln[6]

Lincoln, of course, had full authority to make the appointment and needed no one's consent. This was a conciliatory letter to those whose help he knew he would need during the coming conflict. On 13 June 1861, Meigs was appointed brigadier general and Quartermaster General of the Army, effective 10 June. During the discussions of Meigs' future assignment, Francis Preston Blair suggested Meigs as the

best man to lead the Army into Virginia. The course of history may have changed had Lincoln made that choice. At meetings of Lincoln's War Board, Meigs advocated more aggressive action against the southern forces, which he knew were far outnumbered by McClellan's army. The Civil War historian Bruce Catton, writing about Meigs' involvement in planning the earliest strategy during the war, described him as having "a refreshing readiness to behave irregularly in irregular times like the present."[7]

Meigs' work on the Aqueduct and the Capitol was now over, but he was to remain influential in Aqueduct matters for another 40 years. The project, while furnishing water to the city, was incomplete. Work on the dam at Great Falls had just begun, and several tunnels were not finished. Although the arch rested on its own bearings, much work remained to be done on the Cabin John Bridge. The Receiving Reservoir was complete, but the Distributing Reservoir was not built. The Rock Creek Bridge was nearly finished, and the Georgetown High Service Reservoir was in use, but without a dome. The work of completing Meigs' Aqueduct passed to others.[8]

CHAPTER 9
The Civil War Years

On 18 June 1862, President Lincoln approved a joint resolution passed by Congress transferring the supervision of the Potomac Waterworks, as the Washington Aqueduct was still officially called to the Department of Interior, where it was to remain for the next five years. Mr. William R. Hutton, a former assistant on the project, was appointed Chief Engineer and served until 21 July 1863. Silas Seymour, working as a consultant to the Interior Department in October 1862 had proposed a number of changes to the plans as proposed by Meigs. General Meigs on learning of Seymour's report, wrote to the Secretary of the Interior on 27 August 1863 to protest any changes. He noted:

> I have no further connection with the Waterworks other than a natural desire that they should be well and economically completed....None of the work (the proposed changes) need be taken up,...Having made all the designs and plans of this work ab initio, having devoted many years of labor to its construction, I desire to see it completed as designed, and am willing to remain responsible for its success, if so completed....From any change I anticipate ill results, if not to the work, at least to the treasury. (signed) M.C. Meigs, Quartermaster General, late Chief Engineer, Washington Aqueduct.[1]

Silas Seymour was appointed Chief Engineer and General Superintendent on 21 July 1863 and recommended implementation of the changes to the Secretary of Interior the following October. Aware of Meigs' continuing influence, he wisely gave him credit for the work done to date, defended his actions in the dispute with Floyd, and made a point to ensure that the changes reflected no discredit on Meigs. Seymour wrote:

> Before closing this report, I deem it proper, as an act of justice to the gentlemen who have preceded me as engineers in charge of this great national work, as well as a matter of historical interest, to state that the Aqueduct was originally projected, upon its present general plan and location by Brigadier General Montgomery C. Meigs, now Quartermaster General of the United States Army, and that the work, so far as executed, has been done in accordance with the plans and spec-

ifications prepared by him, and generally under his supervision. During the time when the work was being carried on under the auspices of the War Department, this accomplished officer was retained in exclusive charge of the Aqueduct, with the exception of an interval between 11 September 1860, and 21 February 1861, when, either from caprice, or motives of personal interest on the part of the then Secretary of War, he was relieved and ordered on distant service by Secretary Floyd, whose subsequent treason to the government has given reason for the belief that he had never entertained an honest or loyal aspiration in his bosom.

It is proper to remark that the changes in the original plans of General Meigs, already ordered by the department, in the construction of the dam at Great Falls, and the better protection of the banks of the distributing reservoir, as well as the other improvements recommended in this report for the purpose of securing the purest water attainable, are believed to be only the natural results of experience and observation on this and other works of a similar character, during a period of ten years which has elapsed since the commencement of the Aqueduct; and should, therefore, not be regarded as reflecting any discredit upon the plans as originally designed and adopted.

Seymour's comments displayed a shrewd political awareness, particularly those pertaining to John B. Floyd, who was at the time a general, albeit an incompetent one, in the Confederate Army. A similar bon mot to Meigs was included in his next report in February 1864.[2]

The proposed changes were summarized in a 1 October 1864 report from Seymour transmitting an estimate of the increased costs:

The departures that have been made from the original plans, and provided for in the present estimate, may be briefly stated as follows;

1. A dam of solid masonry at Great Falls instead of an embankment of broken stone.

2. A connecting conduit around the lower end of the receiving reservoir, so as to prevent the adulteration of the of the Potomac water with the surface drainage collected in the receiving reservoir.

3. Slope-wall facing for the inner slopes of the distributing reservoir instead of facings of small broken stone.

4. Raising the dividing bank in the distributing reservoir to the full height of the outer banks and the constructing of a central gatehouse therein so as to allow of the independent use of either section for purposes of storage, supply and repair.

5. Excavating the bottom of the distributing reservoir to an additional depth of thirteen feet, so as to increase the purity of the water, and afford twice the amount of storage capacity.[3]

(Upon sighting these five items listed in a subsequent *Annual Report,* General Meigs penciled in a comment beside each item as follows: "much more costly," "not worth its cost," "wasteful," "bad," and "wasteful").[4]

The first of these proposed changes might soon have occurred to Meigs had he remained in charge. The rubble dam that he proposed originally was to be located at the head of Conns Island, where the river bottom was higher, and a relatively shallow dam would have obtained the design height of 150 feet. When problems with the Great Falls Manufacturing Company forced moving the dam 3,000 feet downstream, a much higher dam

was required to maintain that level. Meigs last *Annual Report* for 1861 refers to constructing a "Cut Stone dam". The later construction drawings had shown such a dam at the head of the feeder at Great Falls, but the continuation to the island was shown as a rubble dam. (The dam crest elevation of 150 feet for which the conduit was originally designed was not realized until 1896, and the lower level that existed throughout the last third of the century caused the inadequate flows that plagued the citizens during the period.)[5]

The need for a connecting conduit was occasioned by development on the Little Falls Branch watershed, which caused run-off that muddied the water in the Receiving Reservoir. On many days, the flow to the Potomac was clear while the water leaving the reservoir was muddy. Meigs may have foreseen this also, because his original 1853 plan did provide for a bypass around the reservoir, which was not built during his superintendence. The changing of the stone facing on the slopes was to prevent damage by wave action. The last two recommendations were to ensure the purest (least turbid) possible water, although the fourth probably had the opposite effect.[6]

Work on the Aqueduct continued throughout the war years. But the pace was somewhat slower, primarily because of lack of funds and perhaps materials. The wars effect could be seen in accounts of work during the period. Work was delayed at Great Falls because the workers feared Confederate raiding parties, although no record exists of these ever occurring. In 1863, Company I of the 23d Maine Volunteers was stationed at Great Falls. Although the men were not required to fight any rebels, they themselves did considerable damage to the government facilities. Chief Engineer Hutton was compelled to write to Secretary of the Interior Usher asking him to take action to prevent further destruction. And the intake was the site of "large amounts of floatsome [sic] piled several feet in height and composed of large trees and timbers, some of which appeared to be portions of the Harpers Ferry railroad bridge, in parts of sections firmly bolted together." On 15 September 1861, Confederate troops under Stonewall Jackson had blown up the Baltimore and Ohio (B&O) Railroad Bridge at Harpers Ferry. That bridge had to be rebuilt nine times during the war.[7]

In 1862, the Rock Creek Bridge was completed, and the entablature was installed at the Great Falls Gatehouse. By November 1863, Seymour was able to inform the Secretary of Interior that "on Saturday afternoon, Dec. 5th, we shall be prepared to pass the water entirely through the Aqueduct into the Receiving Reservoir." On that day, a formal ceremony "attended by most of official Washington: was held to celebrate the introduction of Potomac water into the Washington Aqueduct. Visiting dignitaries toured the Aqueduct facilities and visited Cabin John, where they were alarmed to find themselves looking down from the edge of the "parapetless" bridge. As reported in the *Washington Star.*

> It was tacitly agreed that the excursionists should drink nothing but Potomac water throughout the day in honor of the occasion....Such of the more venerable of the pary as claim an exemption from the rule no doubt had considerable justification in the chilly state of the atmosphere and the necessity of protecting the lungs from cold.

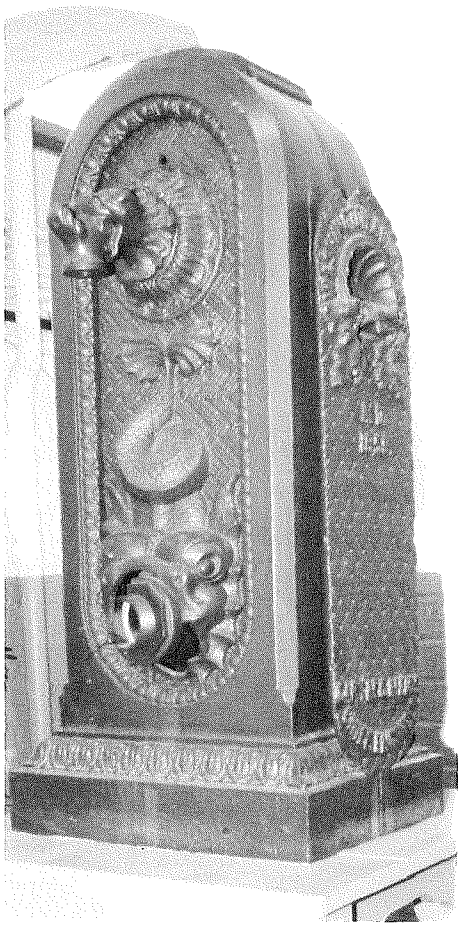
Upon their return to Dalecarlia, "The gate was raised and the waters of the Potomac shot out to join the water of Gunpowder Creek...the crowd then gathered on the green to listen to the speech-making."

Among the spectators were soldiers of the 1st Maine and the 9th New York from nearby Fort Sumter. Speakers included Secretary of the Interior Usher and the mayor of Washington. At 7 PM the celebrants reassembled at the National Hotel for a sumptuous supper. Usher, the mayor, and other city officials were present to hear the featured speaker, Vice President Hannibal Hamlin, representing President Lincoln. A letter was read from Secretary of State Seward, who regretted that "unavoidable cares" prevented his acceptance of the invitation. Many toasts were drunk interspersed with patriotic music played by the Marine Band.[8]

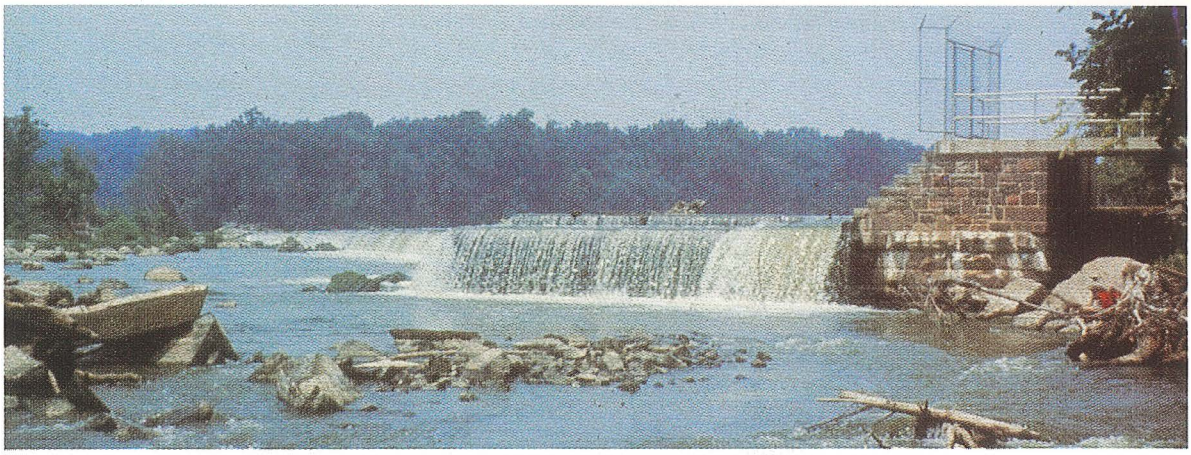
The flow of water through the bridge resulted in several leaks, and the conduit was shut down until repairs could be made. Full service to the city via the Cabin John Bridge did not begin until 29 July 1864. The 14 May 1864 edition of *Harpers Weekly* magazine had included an article on the Washington Aqueduct, complete with "Views of the Great Aqueduct" in the form of drawings of 10 of the prominent structures. In 1865, Theodore B. Samo replaced Seymour as Chief Engineer of the Washington Aqueduct.[9]

During the summer of 1866, drought conditions prompted the Secretary of Interior to ban the use of water from city mains to wash pavements in front of residences. By early September, Meigs noted, "There had been abundant rains, and the water has been flowing freely to waste." But on 13 September, a policeman entered a private residence and arrested and fined a servant for causing the streets in front to be wet during the day. The residence happened to be that of Quartermaster General Meigs. He immediately wrote to the Secretary, suggesting "that the police be notified that the scarcity of water has ceased, and that the necessity for enforcing the ordinance has also passed."

The Meigs' legacy continued in other ways also. On 8 June 1865, the water main in Pennsylvania Avenue broke, and "preparations were immediately made to repair it. The water was shut off from the main, and with the assistance of the steam-fire engine 'M.C. Meigs,' the damage was easily repaired." Meigs had cast his own name on all of the hydrants, but a grateful city had also named the associated pumping apparatus for him.[10]



Meigs' fire hydrants for the city. Note "M.C. Meigs, Chief Engineer" cast into the side.



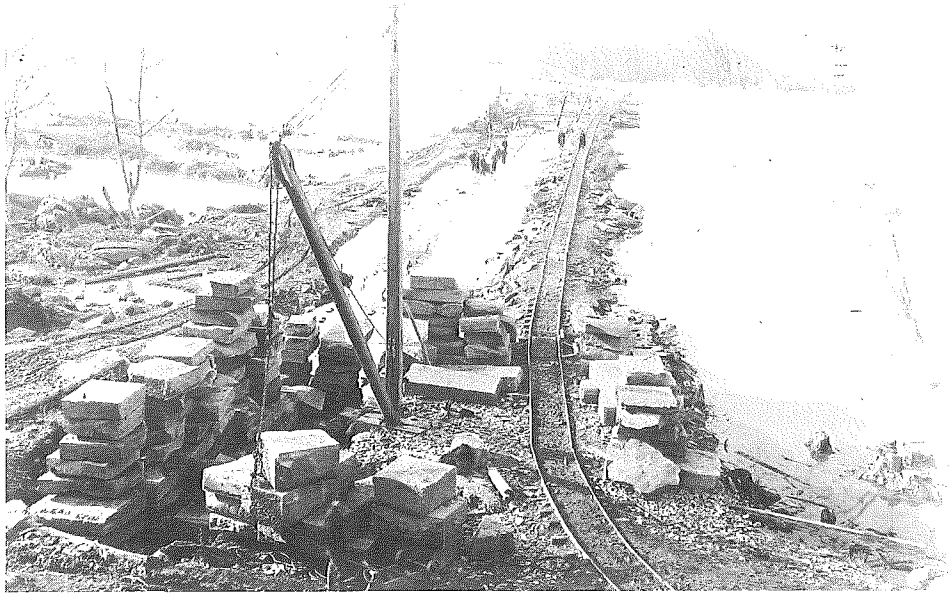
Great Falls Dam

CHAPTER 10
The Latter Third of the 19th Century

The Civil Appropriations Act of 2 March 1867 directed that "the Chief Engineer of the Army shall have the superintendence of the Washington Aqueduct." Congress had returned jurisdiction and management of the Washington Aqueduct to the Corps of Engineers. While there was no immediate change in the work then under way, Interior Secretary O.W. Browning informed Mr. Samo the civilian who had been in charge for the Dept of Interior, that he was "no longer amenable to this department." Major (Brevet Brigadier General) Nathaniel Michler, who had been placed in charge of the Aqueduct by the Chief of Engineers, General A.A. Humphreys, reappointed Samo as Chief Engineer. The work consisted of completing Meigs' projects, including the proposed modifications. The 2,730 feet long and 8 to 9 feet in diameter by -pass tunnel and conduit at the Receiving Reservoir was placed in service in August 1867. Potomac water was diverted around the Receiving Reservoir directly to the Distributing Reservoir, and the first reservoir was then used only for storage. Blockage caused by falling rock necessitated lining this conduit in 1890, and it was returned to service in 1891. The extension of the dam to Conns Island at an elevation of 147 feet was completed during December 1867. Work continued on the bridges and the Distributing Reservoir, which was not finished until 1872. By 1869, the consumption was 12 mgd, serving a population of nearly 130,000.[1]

In 1871, Major George Elliott was in charge briefly. (He later returned and was in charge during the controversial years 1890 to 1895 as a lieutenant colonal and after March 1893, as a colonel.) Elliot proposed that a stone parapet be built on the 20.4-feet wide Cabin John Bridge, 90 feet over the creek, which he said "should not only be strong enough to prevent accidents in cases of horses being frightened on the bridge, but should have the appearance of strength which an iron railing would not have." The parapet, which replaced a low guard rail of logs and timber, was installed in 1872. Over the years, it proved strong enough to resist numerous truck and car accidents. In 1895, Will Robertson, a daring entrepreneur who was well known for riding his innovative bicycle down the

Great Falls Dam extension to Virginia shore



Capitol steps, traveled to the bridge, accompanied by the press, and rode his 51-inch "Star" bicycle the entire length of the bridge on the narrow parapet in three minutes.[2]

As the city government increased the pace of tapping the mains for the use of the citizens, the amount of water available, and the pressure at which it was delivered, diminished. This situation was to be repeated often over the next 30 years despite various schemes to relieve the shortages. General Meigs, in testimony before the House Committee on the District of Columbia on 27 April 1870, advocated increasing the capacity by raising the levels in the reservoirs rather than building new mains, which he said were not needed. However, in August 1872, a new 36-inch main was completed from the Distributing Reservoir to Capitol Hill, in time to meet a demand that had risen to 17 mgd. The maximum consumption came during the winter months, when citizens allowed their pipes to run continually to prevent freezing. The concerns about water quality, which were also to intensify over the next 30 years and eventually result in filtration of the supply, were duly noted: "The placing of screens [at the effluent of the Distributing Reservoir] will materially reduce the quantity of small fish, which, at present, swarm in the pipes and fountains."[3]

During 1874 and 1875, substantial stone and brick dwellings were built for the gatekeepers at Great Falls, the Receiving Reservoir, and the Distributing Reservoir. In 1875, telegraph lines were installed connecting Great Falls and the two reservoirs. And, in 1876, the Worthington Pressure Engine at the Rock Creek Bridge, after being repaired several times, was found to be worn out and it was abandoned. The District Commissioners had erected a new steam pumping station to take its place. General Meigs, on learning of this, commented that it had been running constantly for 16 years.

Attention then focused on the complaints about the condition of the water, which was muddy most of the year, and the inadequate pressure in much of the system. Water consumption doubled from 12 to 24 mgd between 1868 and 1876, and again to 49 mgd by 1898. During the summer of 1876, the water was often 2 feet below the crown of the dam at Great Falls. Furthermore, the consumption exceeded the flow in the Maryland channel.

In 1880, consumption in the fall was 3 mgd greater than the flow on the Maryland side of Conns Island. A temporary rip-rap dam at the head of the island provided some relief, but was vulnerable to washouts during high water. By the end of fiscal year 1880 Congress had appropriated $3,785,157 for the Aqueduct. Of that amount, $3,487,546.72 had been expended, and $610.28 had reverted to the Treasury.[4]

Between 1870 and 1890, efforts to solve the quality and quantity problems produced considerable controversy and debate over how best to accomplish the needed improvements. The citizens, the press, and Congress all became involved in the process. Six major projects were proposed. Each had its proponents and opponents. However with impetus from the three parties concerned, all six projects were implemented by 1905. They were as follows: (1) completion of the Great Falls Dam to the Virginia shore; (2) construction of a tunnel leading to a new large-capacity reservoir on high ground east of Rock Creek; (3) more large-diameter pipelines to the city; (4) diversion of the polluted Little Falls Branch around the Receiving Reservoir so that it could be returned to full service and provide additional sedimentation time; (5) raising the height of the extended Great Falls Dam; and (6) filtration of the entire supply. (Note: The events surrounding the tunnel and filtration projects will be discussed in separate chapters.)

After authorization by Congress on 15 July 1882, work began to extend the dam to the Virginia shore. The work was completed in 1886, with the crest of the dam at an elevation 148 feet above sea level.[5]

General Meigs, now one of the best known and most highly respected citizens of the capital city, was ever watchful over the Aqueduct and city affairs in general. In addition to serving on the Advisory Committee to the Board of Public Works, he shared his ideas with local civic associations. His advocacy of raising the height of the dam and building a tunnel, presented to the Capitol Hill and East Washington Association in a speech entitled "Extension and Completion of the Washington Aqueduct and Its Connection With Washington City," met with frequent expressions of approval by rounds of applause. On 24 January 1879, he wrote to the chairman of the Senate Committee on the District of Columbia, restating the suggestions he had made in a letter published in the *Washington National Republican* on 1 June 1876. At that time, he had recommended that more storage and additional sedimentation be provided by the construction of a second Distributing Reservoir "at some point on the bluffs to the North of Washington." (Seven years later, on 2 August 1883, Meigs wrote that his 1876 letter "has at length brought its fruit.") Such a reservoir had been shown on his original 1853 plan, but at the time it was to be supplied from Rock Creek. He now suggested supplying the new reservoir via a 10-foot diameter conduit from the existing Distributing Reservoir. He suggested that "the best route is as nearly as possible a straight line which would be a tunnel" and mentioned that the City of Baltimore had commenced construction of a direct tunnel 7 miles long and 12 feet in diameter. He proposed a 4-foot-diameter cast-iron main from the new reservoir connecting to the mains near the Capitol and said if that was completed, no additional pipelines would be needed from Georgetown.[6]

In proposing this, Meigs wrote "By now complaints are again rife from those who pay an annual water rent and do not receive the abundant supply of water which is

enjoyed by those who live on the lower ground of the city." Perhaps he had heard from Benjamin B. French, the Commissioner of Public Buildings in the 1850's and 1860's, who had been Meigs' friend, later antagonist, and fellow sojourner at White House socials during the Lincoln era. French had commented on the problems in his diary. In 1870, he wrote of "our wretched supply of aqueduct water," and of how "the constant use at the Navy Yard for mechanical purposes deprived us on Capitol Hill of it." Two years later this man, who had a few years before given up one of the finest wells in the city and turned it into a sewer pit, wrote:

> I'm sorry to say that the water from the Aqueduct is now, on this part of Capitol Hill a d—md humbug, and nothing shorter. Wednesdays, the Navy Yard steals it all away from us, and Sundays of course, every bathing tub is in use all over the city, at our expense, and so we have to pay for what we cannot get; although the Congress promised us 'a bountiful supply of pure water,' we really get only a very meager supply of, at present, the muddiest, dirtiest water that ever went down the throats of human beings! And I much fear it will be worse rather than better.[7]

Congress by the Act of 15 July 1882, mentioned earlier, also authorized the new tunnel and second Distributing Reservoir project, which proved to be the most controversial of the entire Washington Aqueduct era and will be discussed in a separate chapter.

Filtration of the supply was first suggested in 1876, and the *Annual Report* for 1880 gave it detailed consideration in a well-prepared review of the use of filtration in other cities. The events of the next 25 years concerning this matter, also controversial, will be addressed separately.[8]

The 15 July 1882 act also authorized the construction of a fish ladder at Great Falls. As designed by the U.S. Fish Commission, the fish ladder proved to be structurally inadequate and was washed away in 1886 by high water. At the Corps' insistence, the project was then turned over entirely to the commission for design, funding, and construction. The project dragged on for years, and, even when completed, the structure did not function satisfactorily. This was a portent of a problem 70 years later, when the fish ladder built at the new Little Falls Dam in accordance with a design by the U.S. Fish and Wildlife service failed to attract any fish.[9]

Over the many years of its existence, the Washington Aqueduct has maintained a remarkable continuity of employment. An interesting entry in the 1884 *Annual Report* mentioned that "On Feb. 4, Jeremiah Harrington, keeper of the Distributing Reservoir, died, and his son, who was familiar with all the works connected therewith was appointed in his place." His son was Daniel Harrington, who remained with the Washington Aqueduct until his retirement. Ten years later, the *Annual Report* noted that "Thomas Sullivan, John Halloran and Daniel Harrington, the watchmen gatekeepers at the Great Falls and at the reservoirs, in addition to their other duties, have skillfully and energetically acted as foremen of laborers engaged on the works of repair of their respective divisions of the Aqueduct." Daniel Harrington's son George, upon graduation from college, went to work in the Washington Aqueduct Laboratory as a chemist. He retired at age 70 in 1966 as the Chief of the Laboratory Section, then located in the two-year-old chemical building, having worked in the original Dalecarlia laboratory since it was first installed. This three-generation involvement may have been unique, but several

fathers and sons served as career employees. In one case as many as four brothers worked for the Aqueduct at the same time, following other relatives who also worked there.

Thomas Sullivan, the watchman and gatekeeper at Great Falls, died on 11 June 1900. At the time, the Officer in Charge of the Aqueduct wrote that he had been an employee since 1857, except for the years 1861 to 1865, when he had served in the Union Army. He was described as "a faithful, diligent and upright servant of the government." Over the 140-year history of the organization, many other faithful, long-term employees have deserved similar accolades.[10]

Work on the tunnel project, which began in 1873, was suspended in November 1888. Controversy surrounded the project, including proven bribery and fraud as well as massive cost overruns. After its virtual abandonment, it seemed unlikely that it would ever be finished. The reputation of the Corps and confidence in the Aqueduct was at an all-time low. Lieutenant Colonel Elliot, taking charge in July 1889, was determined to remedy that situation. Maintaining that there was no need for filtration, he immediately began several projects to restore the public's confidence, which had been lost as a result of the tunnel episode.[11]

New mains from the Georgetown Reservoir to the city would not have been needed if the tunnel had been completed successfully, but Congress decided to terminate that project. By the Act of 2 March 1889, Congress authorized funds for a new 48 inch main. Elliot heeded the legislators' directive that the new main should be completed in the shortest practicable time. By January 1890, a new 30-inch main was finished. Two months later, a new 5-mile-long, 48-inch main was extended to the Capitol, which, in contrast to the Pennsylvania Avenue Bridge, crossed over Rock Creek on a wrought-iron riveted girder bridge north of the M Street highway bridge. The local press closely watched and frequently reported on the progress of this construction. Elliot succeeded in bolstering the public confidence that had been diminished by the tunnel fiasco. A *Washington Star* article of 17 February 1890 had this to say: "Colonel Elliot has not only added to his already brilliant reputation as an engineer, but he has both the Congress and the Citizens of Washington under lasting obligation for so promptly relieving the prolonged water famine in the city." The press, "prominent in exposing the frauds in construction which led to the abandonment of the most notorious Washington Aqueduct tunnel after it had cost the country and the District of Columbia a million dollars each, kept a close watch on the substitute work, the great 48-inch main." On 20 March 1890, 1 year and 18 days after the funds were approved, the new main was placed in service, as "Miss Elliot, Colonel Elliot's daughter, gave the lever the motions that raised the last valve and water rushed through the gate into the mains." Pressures measured on Capitol Hill that day showed "increases of 8 to 10 pounds." But the *Star* also noted, "There is plenty of water, if it is muddy."[12]

Elliot had also recommended lowering the level of the dam between the two basins in the Distributing Reservoir, noting that the present arrangement forced all the water to pass through a narrow passage in the dam. (The result was a comparatively rapid stream of water.) He pointed out that General Meigs had intended that this dam act as a skimming weir, taking the clear water from the top of the first basin across into the lower one and

thus producing clearer water. This recommendation, which in retrospect seems to have been one of Elliot's best, was never implemented.[13]

Elliot took another step to improve water quality at the Distributing Reservoir. In 1889, the reservoir had to be fenced "to keep cattle off the slopes and embankments." Earlier reports had referred to the need "to clean the long ditch in front of Drover's Rest." Drover's Rest was a livestock market and slaughterhouse located on a triangular five-acre tract at the intersection of Conduit Road and High Cut Road (now MacArthur Boulevard and Reservoir Road). The pens at Drover's Rest might hold as many as 1,000 cattle, 4,000 sheep, and 140 hogs. The potential for contaminating the reservoir was finally acknowledged in 1890, and funds were requested to purchase this tract. Purchase was delayed when Congress refused to authorize funds to pay the exorbitant asking price. Fortunately, the market was closed in 1891 before the necessary condemnation proceedings could be completed, and the problem was eliminated.[14]

By now the population served was more than 232,000, and the daily consumption was 35.5 mgd. However, the inadequate flow available at the intakes kept the levels in the Receiving Reservoir too low to maintain adequate pressure in the higher areas, primarily because of the excessive waste in the lower areas of the city. More water was needed than the intake works could provide, which pointed to the need to raise the height of the Great Falls Dam to increase flows in the conduit.[15]

Colonel Elliot realized that because of the city's large volume of waste, the pressures could be sustained only through increased flow in the conduit. He also maintained that the increased settling time obtained by restoring the Dalecarlia Reservoir to service would eliminate the muddy conditions. Although he consistently recommended solutions other than filtration, by 1891 he realized that ultimately it was the only way to consistently produce clear water. In December 1891, he told a *Washington Star* reporter:

> Some plan [for filtration of the supply] must be adopted if the city is to have a perfect water supply. I want it understood that we must come to filtration. The capital city of the nation ought to set the example—other cities use it—and the results are most satisfactory. It is not an experiment.

The *Star,* well aware of public concern, was by now printing detailed instructions on how to build a home filter, "one that will do good service—and—can be constructed by any man about the house who has a particle of mechanical ingenuity."[16]

Yet, in 1892, Elliot was again advising Congress that the "most practical and least expensive method of improving the quality" was by restoring the long-idle Receiving Reservoir—which was now green, laden with algae, and smelled fishy—to full service. This modification, first proposed in 1885 and recommended by a Board of Engineers later that same year, was authorized in 1893. Work proceeded simultaneously on the dikes, channels, and tunnels to divert all of the Little Falls Branch and the tributaries of Mill and East creeks, which would then permit the refilling of the Receiving Reservoir after it had lain idle for more than 10 years. The project would include four small dams to block flow to the reservoir, 5,000 feet of diversion channels and two tunnels, the longest one of 1,000 feet passing under the conduit and discharging at the west side of the hill carrying

Conduit Road. The 1885 *Annual Report* had noted that this diversion would cut off the only available emergency supply in the event of a conduit failure. Accordingly, pipes were provided to allow creek flow to the reservoir if needed.[17]

By November 1894, the works needed to permit full use of the Receiving Reservoir were nearly complete. The *Star* noted that when the impending reclamation of the Dalecarlia Reservoir was completed, "Our nectar of the Alleghenies will, it is asserted, be as bright and clean as liquid diamond. Every time a Washingtonian holds a glass of redeemed Potomac water to his lips, he will say 'Here's to Colonel Elliott.'" Colonel Elliot retired on 30 March 1895, but by a special provision in the D.C. Appropriations bill of 2 March, he remained in charge of the works in progress for restoring the reservoir. The Dalecarlia Reservoir was filled and returned to service by the end of July 1895, prompting much acclaim from Congress and the citizens. The *Star* described the restored reservoir as "Colonel Elliot's crowning work."[18]

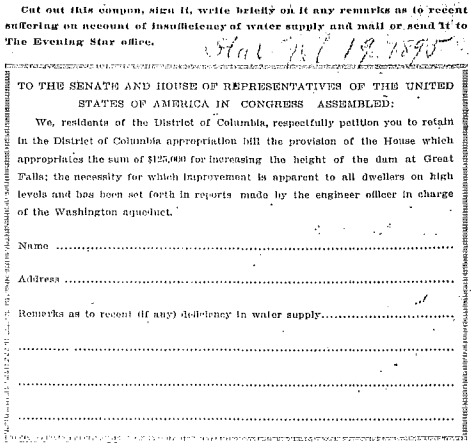
As population and consumption continued to increase, and the waste remained undiminished, the pressure increases that the new mains had produced were lost to those in the higher levels. Elliot, one month prior to his retirement, had begun lobbying for the increased level of the dam at the Falls. He reported, "One Senator, living on Capitol Hill, has to go down into the basement every time he wants to wash his face." Elliot maintained that raising the dam at Great Falls by several feet would provide the additional water needed to enable the reservoirs to be maintained at higher levels. He recommended raising the dam 2.5 feet, but Congress refused to appropriate funds, despite the mounting fury being vented by the press and citizens. Congress feared that the old conduit could not withstand the additional pressure, resulting in the possible loss of the entire supply.[19]

But Elliot had two powerful allies. "The *Washington Star* published a Water Coupon Petition (as shown below) in February 1895 and stated:

> "Already in many parts of the city residents have suffered on account of the insufficiency of the supply of water delivered from the conduit. Something must be done at once, and the *Star* today affords the citizens of the District the means of getting an appeal quickly to the Congress. Let everyone who reads this send at once to the *Star* Office the accompanying coupon petition."[20]

But perhaps more significant to congress was a letter that Elliot produced that General Meigs had written to him in his final year of life. (Throughout his tenure, Elliot, unlike some of his predecessors, had maintained a friendly relationship with General Meigs. Elliot noted Meigs' "frequent notes respecting the Aqueduct...in which, up to his death, he continued to retain the deepest interest.)" On 1 March 1891, Meigs had written the following to him:

> The original design was to set the lip of the dam at the Great Falls at the height of 150 feet above



Cut out this coupon, sign it, write briefly on it any remarks as to recent suffering on account of insufficiency of water supply and mail or send it to The Evening Star office.

Star Feb 19 1895

TO THE SENATE AND HOUSE OF REPRESENTATIVES OF THE UNITED STATES OF AMERICA IN CONGRESS ASSEMBLED:

We, residents of the District of Columbia, respectfully petition you to retain in the District of Columbia appropriation bill the provision of the House which appropriates the sum of $125,000 for increasing the height of the dam at Great Falls; the necessity for which improvement is apparent to all dwellers on high levels and has been set forth in reports made by the engineer officer in charge of the Washington aqueduct.

Name .....

Address .....

Remarks as to recent (if any) deficiency in water supply.....

.....

.....

.....

tide, for which height all the profiles and waste weirs were built. The backfilling over the conduit would now allow a height of water some two feet higher than the dam to flow safely through the conduit, and if needed, another foot or two and corresponding widening of the embankment would fit the Aqueduct to convey with increased height of dam lip, a very much increased flow of water to the city.

With that letter and another written the same month recommending completion of the work on the tunnel project, Meigs continued to play an influential role in the development of the Aqueduct system. This influence was felt until the tunnel project was completed more than a decade after his death.[21]

Funds were authorized in March 1885 to raise the dam 2.5 feet and the work was completed in November 1896, just 10 years after it had been raised to 148 feet and extended to the Virginia shore. Although the plan had been to use stone from the Seneca Quarry, in December 1895 it was decided that it was no longer economical to quarry stone from that site because of the 30-foot-plus depth of stripping required. Granite was purchased and the work continued. The coping stones were removed, the height of the body of the dam was raised, and the coping stones were replaced and bolted down with 2-inch-diameter bolts 7 feet long. The vertical cut stone portion was from 7.9 to 8.3 feet wide, with 15 to 20 feet of rubble extending horizontally behind the stones. This 2,751-feet-long dam was a sturdy structure, which has stood the test of time and the ravages of many Potomac River floods to this day. When the work was completed in 1896, it resulted in the conduit flowing full, thus maintaining higher levels in the reservoirs.

During 1897, extensive gauging was done to determine the flow in the conduit with the increased height at Great Falls. The flow, with the Receiving Reservoir at elevation 144, was 75.544 mgd. With the dam now one-half foot higher than Captain Meigs had proposed originally, this amount was about 8 mgd more than he had predicted 44 years earlier in his initial report. It was noted that consumption (45.267 mgd) was now 60 percent of the maximum available flow, and that "before the consumption equals the maximum capacity of the present conduit, another conduit should be completed and be in readiness to supply the city with an increased supply of water." This was the first suggestion that Meigs' original plan was going to require augmentation much sooner than he had anticipated. This second conduit was not completed until 1927.[22]

The relatively rapid completion of these two major projects restored public confidence, and this in turn spurred resumption of work on the unfinished Washington City Tunnel, which General Meigs had urged in his last written recommendation to the Senate committee on 30 March 1891, just nine months prior to his death on 2 January 1892. The 1896 Corps report recommended that money be appropriated to resume work and complete the Washington Aqueduct Tunnel and the Howard University Reservoir. Congress responded favorably on 30 June 1898.[23] The city tunnel was completed in 1901, and the third reservoir at its eastern terminus was filled and placed in service on 8 January 1902. This increased the storage capacity to more than 600 million gallons. This addition, along with the higher dam and the restored Dalecarlia Reservoir, did much to alleviate the problem of low pressure. Unfortunately, despite the increased settling time provided in

the two additional large reservoirs, the residents still were confronted with muddy water much of the time. Daily consumption was nearly 57 mgd, and the population exceeded 279,000. The frequent requests in the *Annual Reports* for complete metering of water use had gone unheeded.[24]

By now the technology had advanced to the point that filtration was not only feasible, but advisable. The question was no longer whether, but how to better treat the city supply. As long as the river water remained cloudy, the public preferred to use the clearer water from the more than 200 wells and cisterns. But Public Health officials already had suggested, and some had concluded, that the high incidence of diseases, particularly typhoid fever, was likely the result of sewage contamination of these clear waters. The Potomac River water remained relatively unpolluted.[25] A prominent member of the medical community was advising that "analysis of the Potomac water shows it to be a good potable water—though it has its drawbacks, which bear more on the aesthetic and pecuniary line than of the sanitary, but are not injurious to health." He also expressed concern that the "wells and springs in the city are always dangerous and should be constantly and closely watched as they are liable to become disease breeders from the contamination of the water." In an 1898 report on the prevalence of typhoid fever in the District of Columbia, Dr. George M. Kober concluded that "The majority of the persons attacked were consumers of wellwater...while the Potomac Water compares favorably with that of other rivers as regards purity, no water supply from streams once polluted can be considered safe for drinking purposes without filtration or sterilization..."[26]

What She Has and What She Hopes For.

How careless the citizenry could be regarding pollution of their wells can be seen in this notation from the diary of the then Commissioner of Public Buildings, Benjamin B. French: "This week I have had the water from the streets brought into my premises and connected the street service pipes with the pipes in my garden. Have had my well covered and converted into a sewer for the sink drainage in the basement." Ironically, in September 1854, Meigs had visited French's home to see his garden and this same well supply, of which French was quite proud. Meigs was impressed with the system, but pointed out the potential of a problem if French could not get a man willing to pump an hour a day to raise the water to the tank in the stable loft. Meigs also noted that French's pipes were exposed, and that he would have trouble with them in the winter. (Meigs appreciated the grapes that French gave him from his garden. He took them home to Louisa who "relished them right well.")[27]

Finding that refilling the Dalecarlia Reservoir still did not satisfactorily relieve the muddy water problem, Senator McMillan, chairman of the Senate Committee on the District of Columbia stated "It seems to me that we should be able to have our water filtered or relieved of sediment by some other means, and it shall be my endeavor to bring about

such a result." At that time the Potomac River was recorded as being very turbid 120 days of the year and turbid on another 35. The senator's efforts helped spur resumption of the work on the tunnel, authorized in June 1898, as well as construction of the new filtration plant later named for him. The editorial cartoon in the *Morning Times* summarized the situation in 1896.[28]

Meanwhile Congress, ever vigilant over its own water supply, saw to it that its water was clear and sparkling. When the excavation and construction of the Howard University Reservoir threatened to disturb the pipelines bringing water from Smith Spring to the Capital, Congress appropriated $10,000 "For changing the route of the pipeline that supplies the Capitol, encasing a portion of it in concrete and uncovering and examining the entire line." When this work was completed (at a cost of $7,600), the city main was cut off and the spring water turned on, furnishing a generous supply for drinking purposes. Congress then was advised that if the new reservoir was to be filled, "the spring house will have to be encased in a tight wall above the water line, to prevent Potomac water from mingling with that of the spring." That structure still stands in the center of the McMillan Reservoir, but the spring is no longer connected to the Capitol.[29]

During the last three years of the 19th century, the Corps recommended other projects that were later implemented, although in one case it took 76 years. By 1898,

> "Year by year travel on Conduit Road, the most beautiful driveway in the vicinity of Washington increases" [and with it the cost of keeping it in repair, which during the previous two years had consumed 12 percent of the Aqueduct appropriation] It is so extensively used as a public driveway that it does not seem fair to charge the annually increasing cost of repairing it against the appropriation for supplying the District of Columbia with water."

This burden was not shifted until 1974, when transfer of responsibility for maintaining and policing MacArthur Boulevard to Montgomery County was agreed to.[30]

During the flood of 2 June 1889, the dam at Great Falls withstood a flow of water rising 16 feet above the crow. However, considerable damage occurred. Near Conns Island, two dozen coping stones, each weighing about three tons, were washed off and deposited in the pool below the dam. In 1893 the Corps recommended purchasing the land necessary to widen the right-of-way for Conduit Road "for the purpose of parking on it, and with the additional object of controlling the land abutting on the road and excluding the liquor saloons that now exist and are increasing, and to which many of the collisions on the road are doubtless attributable."[31]

The vulnerability of the single conduit system was recognized in 1897: "In view of the state of war existing between the United States and Spain, and on account of the disastrous results that might ensue from an attempt by a hostile individual to cut off the water supply of the city by the destruction of the conduit, precautions have been taken by the officers in charge against such an occurrence." This warning of the city's vulnerability produced the first efforts to provide security. The protection was expanded during World War I, through the use of Army troops and the formation in 1916 of the Washington Aqueduct Police force. This police force patrolled the conduit for nearly 60 years, until Montgomery County assumed the police responsibility for MacArthur Boulevard in 1975.[32]

CHAPTER 11
The Washington City Tunnel

At the point where the Washington City Tunnel passes under Rock Creek, the invert is 29.45 feet below the Washington Aqueduct datum, making it the lowest point in the entire Washington Aqueduct system. The engineering errors and contractual irregularities surrounding the construction of this project caused the Corps of Engineers' reputation as managers of the Aqueduct to also reach its lowest point.

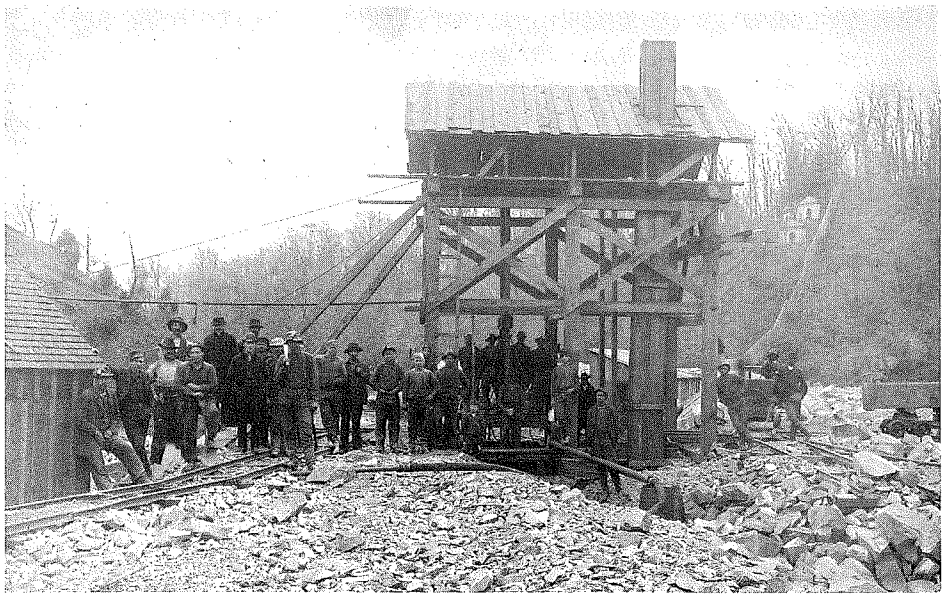
At the outset, Major Garrett J. Lydecker, the Officer in Charge stated that the tunnel's construction would be "a simple piece of engineering work." It proved to be anything but, and Lydecker was later court-martialed for this role in the resulting fiasco.[1]

Major Lydecker served as a Commissioner of the District of Columbia from May 1882 until May 1886. He was also placed in charge of the Aqueduct on 12 August 1882. Congress, by the Act of 15 July 1882, had authorized raising the dam at Great Falls and extending it to the Virginia shore and also expanding the Aqueduct to include a new reservoir to be built on the high ground north of Washington. General Meigs had recommended both of these projects and had in fact advocated the tunnel project during the preceding six years. After his letter to the *Washington National Republican* was published in June 1876, Meigs continued to promote the extension of the Aqueduct system to a new reservoir north of the Capitol as the best way to supply adequate water, rather than building another main from the existing Distributing Reservoir. He wrote letters and spoke to various civic organizations, such as the Committee of One Hundred. Many of these letters and speeches were published in local newspapers. He also joined the District Commissioners in presenting his plan to the Senate District Committee.[2]

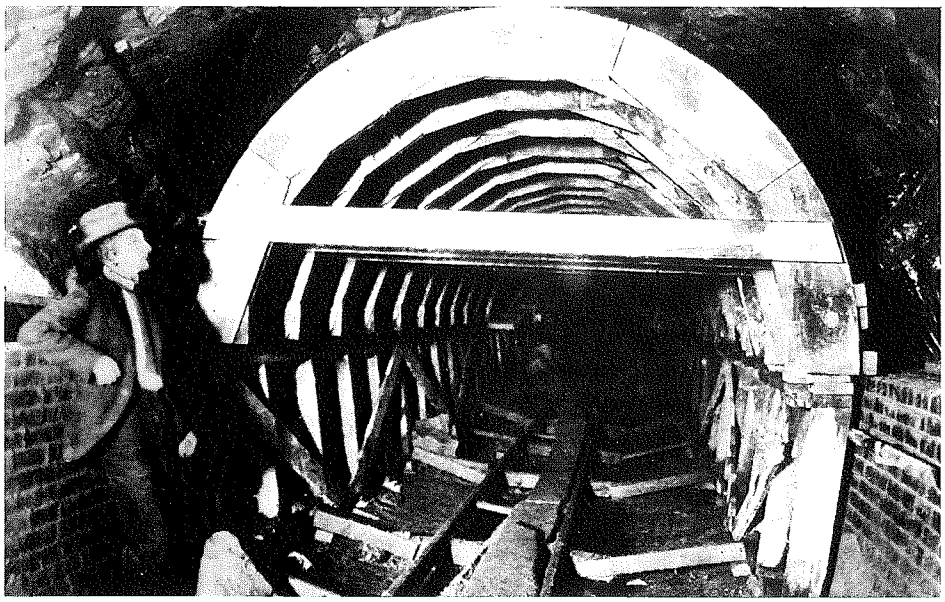
Because Congress had authorized separate and specific sums of money for construction and also for the purchase of land for the Aqueduct extension, the legislators must have expected that the extension would be a surface conduit similar to the prior conduit construction. However, Lydecker rejected the surface conduit and recommended the construction of a tunnel. He stated, "There is no reasonable doubt that this tunnel can be carried through solid rock in a direct line between the terminal points. "Lydecker re-

Construction of Washington City Tunnel at Rock Creek

Workmen about to enter Rock Creek Shaft on City Tunnel



Lining the Washington City Tunnel



commended that the tunnel construction be done by hired labor and estimated "a total cost of excavation of about $530,000, leaving a balanced of the amount appropriated of $70,000 available for contingencies, such, for example, as lining for the tunnel where ever it may be found necessary." He selected a ravine just east of Howard University as the site for the new reservoir, to be built by contractors. The Chief of Engineers approved the tunnel concept, but, aware that Congress preferred the use of contractors on public works projects whenever practicable, held the suggestion to use hired labor on the tunnel in abeyance.[3]

The proposed tunnel was to be 90 feet deep at its west end and 165 feet deep at its eastern terminus. The depth along the line varied, but in some places was more than 180 feet. The preliminary studies leading to the assumption that solid rock would be encountered throughout the length of the tunnel were inadequate. Perhaps Lydecker relied too heavily on Meigs' earlier suggestions in letters to the press that a tunnel would be best. In order to "test the project where the conditions most unfavorable to its adoption were to be found," a shaft was dug at its eastern terminus. Here rock was encountered at elevation 29, a depth of 116 feet. A 4-inch-diameter borehole located 1,500 feet west of that shaft was drilled to a depth of about 70 feet to encounter "gneiss rock, the rock increasing in hardness with the depth." Other than that, the examination relied entirely on the use of data from existing wells drilled previously near the proposed line, on outcroppings of rock found during roadway excavations, and on observation of quarrying operations in the vicinity. This failure to do further underground exploration led to serious problems.[4]

When it was decided not to use hired labor, bids were taken and a contract was signed on 29 October 1883 for the construction of the tunnel at a cost of $548,000. But the contract stated that the prices bid were "exclusive of tunnel lining, the extent of which could not be estimated." Initially, the work proceeded satisfactorily as three working shafts were sunk at Foundry Branch, Rock Creek, and Champlain Avenue. Tunneling operations were to proceed in both directions from each of these shafts. Shafts also were driven at the site of the new reservoir and near the existing reservoir to the west. Here the first rotten rock was encountered. Because this unstable material would not stay in place, much of the tunnel would have to be lined. By 30 June 1884, 1,591 feet of tunnel had been driven, all of it (except a small segment at the west shaft) through solid rock. One worker was fatally injured at the Champlain Avenue shaft, otherwise work seemed to be progressing satisfactorily. However, the solid rock condition was not to last much longer.[5]

Problems with alignment also soon arose. Towers had been set up on a hill 400 feet east of the Distributing Reservoir and on the roof of Miners Hall at Howard University. Another movable tower was used at two intermediate points. Transits were set up, and "the points on the line were fixed by 5-20 observations between them." This had to be done "in the hour immediately before sunrise on calm clear days" because the west tower could not be seen at any other times. These towers were soon blown down and replaced with surface surveys. The line was then transferred to the tunnels by dropping a plumb bob down the three shafts. The *Annual Reports* were failing to tell the whole story. Things were going wrong, and confidence in the surveying techniques

was waning. Mr. George H. Coryell, who had done tunneling work for the Pennsylvania Railroad, was brought in as an Assistant Engineer in October 1884. Five years later, Coryell testified before Congress that when he arrived, the work on the tunnel "was in a perfect state, you might say, of confusion and chaos; I could not ascertain from the records of the office or from other parties the condition of the work."

Coryell's surveys, done the month after his arrival, found that the headings were far out of line, both horizontally and vertically, and that they would never have met. In the worst case, the drifts between the east shaft and the Champlain Avenue shaft would have missed their connecting point by nearly 22 feet horizontally and 16 feet vertically. The *Annual Report* for 1885 states that Coryell had resurveyed the tunnels "to insure the meeting of the long tunnel drifts," but fails to mention the potentially disastrous discrepancies he found in the previous surveys. The report does, however, credit him with rendering "extremely valuable service" in the "difficult dangerous and disagreeable operations connected with the work." He is described as being "most indefatigable, conscientious and painstaking" and having shown "the highest intelligence and judgment throughout."[6]

As the work progressed, the character of the stone began to change. It ranged from gneiss to "the same stone rendered treacherous by clayey seams." Still worse, workers encountered rock that was hard when drilled but turned to clay on exposure to air and that in other cases disintegrated upon contact with water. The original estimate was that only a relatively short portion of the 21,000-foot tunnel would have to be lined. But by 1885, it was obvious that "A much larger portion of the tunnel will require lining than first anticipated." The cost of completing the tunnel was reestimated in October of that year at $993,442; the estimate was described as "to a certain extent hypothetical, being based on what may be encountered in the tunnel headings yet to be driven." It was also noted that "the contractors have been held to the strictest requirements of the contract in the masonry and lining of the tunnel." If true, that condition did not last much longer.[7]

A most revealing comment on the nature of the project's management is to be found in the 1885 report under the heading "Casualties". After describing accidents that killed five men (including deaths caused by falling rock, cave-ins, falling down shafts and two being crushed under the cage), the report notes, "This small number of casualties is evidence of the great care and foresight shown by the contractors in looking out for the safety of the men employed." The contractors were being praised for a record that should have resulted in an investigation of their practices. By this time, about 150,000 pounds of dynamite had been used without accident, but this record was soon to change.[8]

The *Annual Report* of 1886 continued in an optimistic vein, noting that the conduit was "holed" for a total of 16,372 feet, or a little over 3 miles. At the three points where the east and west headings met, the maximum error in the tunnel axis at the connecting point was three-eighths of an inch both vertically and horizontally. Among the expenses listed was Coryell's $200-per-month salary, which was perhaps the best investment made to date on the Aqueduct. That report mentioned three more deaths, two from premature dynamite explosions and one caused by a blow to the head

from a drill that fell from the top of the Champlain Avenue shaft. In addition, heavy rock slippage occurred, filling the tunnel and trapping some workers (who were released without loss of life). And, finally, Congress was advised that "it may be necessary to make still further appropriations to complete the work."[9]

Working conditions in the tunnel must have been difficult, perhaps even worse than those for coal miners at the time. The work was being done by the light of miner's lamps and torches, which gave very poor illumination. The atmosphere was offensive and discomforting to the workers because of the fumes and smoke from blasting and from torches and lamps. These conditions worsened when barometric conditions hindered ventilation. Even the mules used to haul the slag carts to the shafts were mistreated by being forced to live in the tunnel for as long as 13 months at a time. An insensitive *Washington Star* reporter who visited the tunnel in November 1885 wrote, "They seem to have become accustomed to their subterranean habitation, and to rather enjoy it."[10]

The tunnel work was suspended in February 1886 to await an appropriation. Commenting on the failure of Congress to appropriate the funds needed to continue the work, the 1886 *Annual Report* stated, "It became evident that some concealed influences were in operation to delay this important matter, notwithstanding the urgent recommendations of this office, the Engineer Department and the Secretary of War...." Work was resumed only after a prolonged investigation by the House Appropriations Committee regarding the methods and increasing costs of doing the work, reported as House Document 3109, 49th Congress, 2d Session. The committee criticized the work methods and assailed the character of the lining. But the committee resumed funding, directing that a Board of Engineers be appointed to advise on the "plans and methods heretofore pursued." The Board of Engineers appointed by the Chief of Engineers made a number of recommendations in August 1856 regarding the lining and arching of the tunnel. But the board made no direct criticism of the work, nor did it come up with any startling revelations. Work was resumed on 30 August, and the tunnel was "holed through" in July 1887.[11]

Work was suspended just over a year later, in September 1887, because of the lack of funds, and the tunnel was allowed to fill with water. The General Deficiency Act of 30 March 1888 provided funds to resume work, but by 30 June 1888 only 10,100 feet had been lined (10,627 feet remained to be lined). By then, Congress had appropriated $1,354,534, and $1,011,873 had been spent. In addition $504,930 had been spent on the new reservoir. By October 14,617 feet were lined with 6,080 feet yet to go. During these four months, the contractors lined more than 1,000 feet per month. Perhaps the contractors were working faster than was appropriate for the condition of the rock in the tunnel. If so, those managing the project failed to notice. In September, an investigation was made into ex-employees, charges that the lining was not being installed in accordance with the specifications. Work was suspended in November. The new reservoir was nearly finished and the connecting 48-inch main had been laid to the downtown area. Other than that necessary for protection and preservation, no further work was done on the tunnel or reservoir for the next 10 years, and the project was essentially abandoned.[12]

The Chief of Engineers' *Annual Report* for 1889 conceded:

In September, 1888, charges were made that the work was being done in an improper manner by the contractors, and that instead of the portion of the tunnel beyond the brick lining being rubble masonry well packed in cement, large voids had been permitted to remain. An immediate investigation was ordered, and the facts as reported show that systematic frauds had been in progress in the construction, and that numerous and extensive voids existed in the lining of the tunnel. The whole subject has already been carefully investigated by a Congressional committee, and by military courts, and it is deemed unnecessary at this time to refer to it further than to say that from the reports of this investigation the terms of the contract and specifications have been outrageously violated, and in the lining of a portion of the tunnel the contractors' workmen have done the poorest kind of work, leaving numerous voids beyond the brick lining, and that where these voids exist, the lining is utterly unfit for the object in view.[13]

The congressional investigation referred to above was authorized by a joint resolution on 8 October 1888 directing that all matters relating to the tunnel "shall forthwith be fully investigated by a joint select committee of six members, three from the Senate, and three from the House of Representatives." The joint committee's exceptionally thorough report was published as Senate Report 2686, 50th Congress, 2d Session, on 26 February 1889. It had 655 pages of small print, a 293-page appendix, and 31 full-size drawings. It included the report of the three civil engineers that the committee had appointed, the complete transcript of the statements of 28 witnesses, including General Meigs, copies of innumerable documents, and the responses of several Chiefs of Engineers regarding the degree of review and supervision provided. Meigs testified that he had always considered the tunnel to be a better alternative to a surface conduit. He stated that "There is nothing so lasting in human engineering as a tunnel." He noted, however, that he had proposed only a one-acre reservoir rather than building the large reservoir at that site, stating: "I have always been much opposed to the building of that reservoir because it is a very great danger to the city." He cited several instances in which dams had broken and caused many deaths and great damage. "An earthen bank is liable to be perforated by musk-rats...if a musk-rat makes a hole through a dam, that is a tunnel which would enlarge very rapidly and be a source of great danger." Fortunately, he has so far been wrong about that. But when asked about any great advantage of a tunnel over a surface conduit, he answered, "It costs nothing to take care of." He has been proven essentially correct in that regard.[14]

At the outset, the committee had stated that "In view of the alleged failure of the army engineers, and the contractors under them in respect to the Aqueduct Tunnel, the committee thought it best, for the public interest to employ a board of three highly qualified civil engineers." The committee also stated that Congress has never provided for such a tunnel and described it as a radical and unique suggestion: "It was plain to the Committee that such a work for such a purpose would never have been resorted to had the matter been brought under the consideration of a board of engineers at the time the work was undertaken." The committee noted that at the time the tunnel recommendation was approved, no bor-

ings or other systematic examinations of the nature of the rock along the line of the tunnel had been made. The committee added that in contrast to other major public works, the decision to construct a tunnel rather than a surface conduit had been made with no investigation or review by the Board of Engineers. The committee criticized the awarding of the contract, noting that it had not been given to the low bidder. The contract instead had been awarded based on a variable standard for determining the low bid "that would have enabled him [Lydecker], as well as the Chief of Engineers and the Secretary of War, to give the contract to any one of the bidders preferred...which enables them to show favoritism and it really destroys the value and security of competitive bids." As for the work itself, "It appears beyond all question that substantially the whole and every part of the lining of the tunnel is absolutely and enormously defective."[15]

Worse was yet to come. The committee stated that "It appears from the testimony, ...that several of the government inspectors...received, under false names, various sums of money from the contractors." These inspectors were inexperienced for the task and inadequately supervised by Lydecker and his assistant. (The former visited the work site only about every other week and the latter only once a week.) The committee found no evidence that the two men were guilty of any corrupt practices or had received any money from the contractors, but condemned their performance:

> In view of the evidence, the committee feels compelled to say that the officers in charge of the work, as well as the chief inspector, must have been guilty of great negligence in the discharge of their duties...for it seems impossible...that this sham work could have gone on for months of time without being discovered if any one of the engineers connected with the work...had done his duty.[16]

The committee recommended that no more money be spent on the tunnel and that it be left as it was. It suggested that, if the project were to be pursued, surveys should be made as to providing a surface conduit or using large-diameter cast-iron pipes. But more water was still needed in the higher elevations. The committee addressed this need immediately by asking for authorization of a new 48-inch main to the downtown area from the Distributing Reservoir. The committee added that the project should "be done under the direction of the Chief of Engineers in the shortest practicable time."[17]

By War Department order dated 2 March 1889, Major Lydecker was tried by court-martial. The charges were stated in four long pages that detailed with extreme precision the wrongdoing of Major Garrett J. Lydecker. The charge was neglect of duty to the prejudice of good order and military discipline, in violation of the 62d Article of War. On 4 April, the *Star* reported, "The trend of opinion at the War Department is that the Court has found Major Lydecker guilty of neglect of duty, but that the sentence does not amount to a dismissal. A reprimand is the least that could be done, and it is thought that the sentence will lie between the two, something like a suspension from rank and duty." He was fined and transferred to a post far distant from Washington. One reporter wrote, "The sentence was practically no sentence, three chief engineers having been committed directly or indirectly to the scheme" by endorsing the reports and the requests for extra appropriations.[18]

Except for actions taken to protect the work, nothing further

occurred until Congress, by Act of 2 March 1895, directed that a full and detailed report be prepared regarding the feasibility and propriety of completing the tunnel and reservoir. Upon recommendation of the Chief of Engineers and approval of the Secretary of War, an expert commission consisting of two Corps officers and two civilian engineers was appointed in November 1895 to report on the feasibility of completing the tunnel. Colonel Elliot, now retired, gave extensive written testimony at the board's invitation, to which he appended "an abstract from a letter that I received from the late General Meigs in 1891 in which he expressed his views regarding the completion of the tunnel, and which may be interesting to the Commission." On 23 March 1891, Meigs had written:

> I also note that you were making arrangements to measure the daily outflow of water from the unfortunate tunnel, so badly managed in construction, and so foolishly, it seems to me, abandoned....I do not doubt that the day will come when, the panic of the day forgotten, the great bore, though located too low for economy, will be completed and will give the capital an abundant supply of Potomac water. Faithfully your friend, M.C. Meigs.[19]

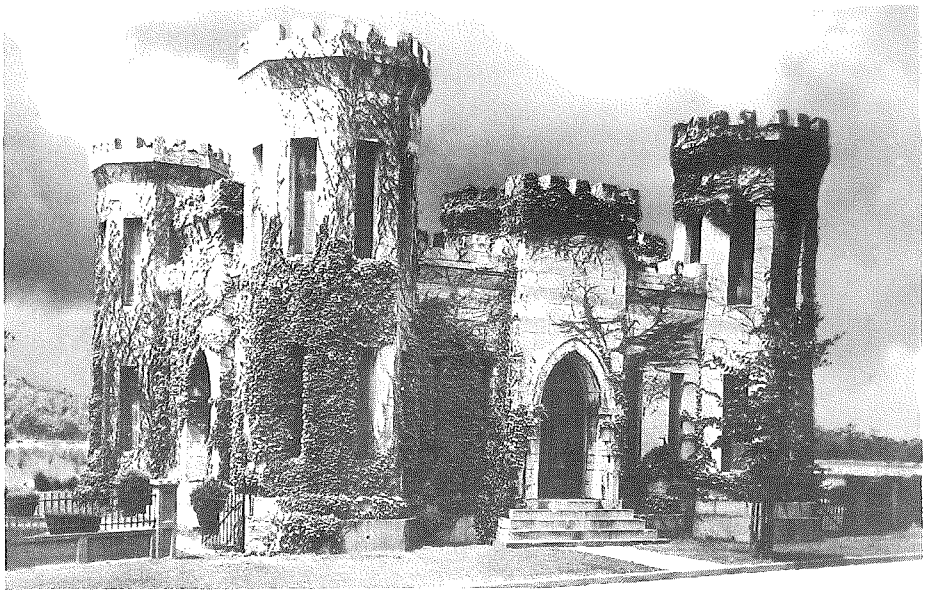
On 17 January 1896, the commission (in House Document 166, 54th Congress, 1st Session) reported:

> It is our unanimous judgment that it is feasible to complete the tunnel conduit with its appurtenances ready for service for the sum of $897,837 as stated in the estimate, and we believe that such completion will not be impractical or too expensive, inasmuch as we know of no more economical method for bringing increased water supply from the reservoir in Georgetown by pipes or otherwise.

The commission also estimated the cost of completing the reservoir as $198,013.

Funds were requested in the *Annual Reports* of 1886 and 1887. Early in 1896, Senator McMillan introduced a joint resolution that provided for completion of the Washington Aqueduct Tunnel, but some members still demanded more information and investigation. Not until 30 June 1898 did Congress appropriate funds and authorize the resumption of work on the Washington Aqueduct Tunnel and the Howard University Reservoir. Work on repairing the faulty lining in the tunnel was resumed in March 1899 and completed in 1901. An innovation was the use of light produced by 300 burners supplied from acetylene gas plants at the Champlain Avenue and Foundry Branch shafts. This not only improved working conditions by eliminating fumes and smoke, but was "especially valuable as enabling good work to be done, and facilitating a thorough inspection of the same. "The tunnel now had a cast-iron lining in the section under Rock Creek. When this work was done, the Foundry Branch shaft was filled, capped, and abandoned. The new reservoir also had been completed, with the elevation of the dam across the ravine raised to 160 feet above datum.[20]

Water was first directed into the tunnel from the Georgetown Reservoir in November 1901. On 8 January 1902, "All connections between the tunnel, the reservoirs and the city mains were opened and the new works placed in service. This addition increased the head throughout the entire gravity system by from 12 to 20 feet." Since the work was resumed in 1899, nearly $1,100,000 had been expended, bringing the total cost of the project



The Castle Gatehouse at Georgetown Reservoir

to more than $2.6 million. Over $2 million had been spent on the 20,696-foot tunnel, originally estimated to cost $545,000.[21]

At the outlet end of the Georgetown Reservoir, sluice gates were installed to direct flow under Conduit Road to the West Shaft from either the reservoir or the bypass conduit. The gatehouse superstructure was described by its builder, Lieutenant Colonel Alexander M. Miller, as brick work "covered with Portland Cement plaster blocked off to represent stonework." He did not mention that it was designed and built so as to represent the Corps of Engineers insignia on all four sides. This building became a well-known landmark now known as the Georgetown Castle Gatehouse.[22]

In retrospect, the decision to build a tunnel was the best one. Tremendous operating and maintenance problems would have resulted in the 20th century had there been a surface conduit across the city. On the other hand, once completed, the tunnel has required little or no additional work or expense. It has been dewatered for inspection several times; the first instance was in 1910. In 1927 the wrought-iron struts originally placed to brace the short elliptical section were replaced with concrete braces. Inspections in 1945 and again in 1967 found the tunnel in excellent condition for its entire length. The section immediately under Connecticut Avenue was heavily reinforced in the early 1970s in anticipation of construction of the new subway just over the tunnel. This construction was entirely paid for by the Washington Metropolitan Area Transit Authority.[23]

CHAPTER 12
Filtration

Lieutenant Meigs' 1853 report had given "some study to the subject of filtration." He had noted that only 1 gallon in 90 would be used for cooking and drinking, and that the other 89 would "clog up the filters and defeat their object." He suggested the use of small filters for drinking and cooking "when needed; and the far greater quantity of water, which is of sufficient purity unfiltered for its purposes, can be allowed to flow without the expense of filtering." His plan had called for shutting off the conduit when the river was turbid from floods and allowing the heavy mud and suspended sediment to be deposited in the large receiving and settling reservoirs. Meigs wrote, "When the water from the Aqueduct shall have been further purified by settling in extensive and capacious reservoirs, as provided in the plan proposed, Washington will be supplied with water unrivaled for purity and salubrity, and which will need, I think, no complicated and expensive filtering arrangements."[1]

But for much of the time during the next 40 years, only one of the reservoirs was available. With increased consumption, flow through the basins was faster and the water often muddy. And with increased population, many more citizens were unable to avail themselves of springs and wells to obtain clear, but not necessarily pure, water. Because of frequent high turbidity in the river and muddy water in the mains, it was inevitable that filtration would be considered again at a later date.[2]

By 1876, Colonel Babcock reported that "The experience of the past year has shown that the Distributing Reservoir is entirely too small for the purpose for which it was built, namely, to afford the Potomac water ample time to deposit its sediment before entering the iron mains." Although this could be interpreted as another round in his dispute with Meigs, he was partly correct in concluding that "in order to have clear water in the mains, the remedy is either to increase the area of the Distributing Reservoir or resort to the more costly process of filtration. The subject was discussed again in the 1880 *Annual Report* of Babcock's successor. This report reviewed the practices in England and in other U.S. cities and noted that "to render it perfectly clear—as clear as crystal—the water in the Potomac, like that of other rivers, must be filtered." The report pro-

vided an estimate of $913,000 to build settling basins and filter beds with capacity to filter 26 mgd, but concluded: "Seeing that the cost of filtration is so great, and that a large quantity of Potomac water used in the cities of Washington and Georgetown does not need to be filtered, it is submitted whether it is not better to leave the filtration of water, as it is now left, to the individual taste of the consumer."[3]

In response to a Senate resolution of February 1886, Captain Thomas W. Symons prepared an elaborate report at the end of March of that year "concerning the advisability and practicability of providing the water supply of Washington with filters and other appliances for the cleansing and purifying of the water." The report reinforced the desirability of filtration and included endorsements from leading physicians and health officials. The processes discussed included coagulation with chemicals, aeration, and the various methods of filtration then available. This report found that filtration was desirable from both a sanitary and an aesthetic point of view and recommended the use of mechanical filters, because filter beds (that is, slow sand filters) would cost twice as much. The proposed 40 mgd plant was to be located on the terrace south of the Distributing Reservoir, above the C&O Canal. Chemical coagulation and aeration were to be included, and the plant would be expandable to 60 mgd. (The current consumption was 25 to 30 mgd.) The cost of construction was estimated at $600,000 and the operating cost at less than 10 cents per year per person, "far less than that at which any other city has ever had a water supply of the same magnitude properly filtered by artificial means." Symons concluded that "The water supply will be greatly improved by filtration and aeration and it is advisable and practicable to do so." [4]

Nevertheless, in the *Annual Reports* of 1890 through 1894, Colonel Elliot, the Officer in Charge of the Aqueduct, continued to maintain that the water supply was not unsanitary and that the improvements under way to divert Little Falls Branch and its tributaries around the Receiving Reservoir, and the return of that reservoir to full use, would relieve the problem of excess suspended matter in the mains. In his 1894 *Annual Report*, he stated: "It seems to be commonly believed that, although our Potomac water is often offensive to the eye as to make it appear to be unfit even for bathing purposes, it does not contain germs of disease and is not unhealthful. I think this belief is well founded." This was followed by yet another long discussion of the types and costs of filtration used elsewhere, particularly in Europe. He concluded, "Under present conditions there appears to be no cause for apprehension respecting the healthfulness of Potomac water as delivered by the river intake of the Aqueduct at Great Falls," and "it seems to me beyond doubt that as long as the present conditions continue the great expenditures that would be required for the first cost of filtration of our water supply and the annual cost of maintenance of these works would not be justifiable and that, for the present at least, reliance should be had on sedimentation."[5]

The dikes, channels, and tunnels needed to eliminate the pollution of the Receiving Reservoir by Little Falls Branch were completed, and the reservoir was filled and returned to full service in July 1885. But muddy water continued to flow in the mains. Early in 1886, a *Star* reporter wrote:

> A person of cleanly habits, who knows he is not as dirty as the

> contents of his tub, hesitates long before he takes his dip....But when it comes to using the stuff as a beverage, the matter takes on even a worse aspect. It is as dark in color as a glass of bock beer, and not nearly as translucent, or anything like as tempting.... Some surprise has been expressed that the use of the Dalecarlia Reservoir has not helped matters to a greater extent than it has....[6]

Notwithstanding the belief of some that completion of the tunnel and the additional sedimentation to be provided in the new Washington City Reservoir would solve the problem, others remained skeptical. While advocating completion of the tunnel and new reservoir and increasing the supply by raising the dam at Great Falls, Senator McMillan in February 1897 suggested that the Potomac water should be subjected to a filtration process. He added that he intended to turn his attention in another year to such a project. The Senate responded on 10 January 1898 with a resolution directing that the Secretary of War report to the Senate any information in possession of the War Department relating to the filtration of the District of Columbia water supply.[7]

The Corps report, submitted only nine days later, discussed the potential for contamination of the supply, suggested that steps be taken to eliminate waste, recommended that a commission of experts be appointed to report on the most suitable method of purifying Washington's water supply and warned that "too much emphasis cannot be given to the necessity for actual tests with the Potomac Water." Yet another act was approved on 30 June 1898 "to enable the proper officer of the government having charge of the Washington Aqueduct....to make an investigation of the feasibility and propriety of filtering the water supply of Washington." The message was clear that filtration was coming; the only questions remaining were what type of facility and how soon it would be built. By now the population had risen to more than 282,000, and consumption exceeded 50 mgd.[8]

Work began immediately on detailed studies. An extensive report entitled "Feasibility and Propriety of Filtering the Water Supply of Washington, D.C." was submitted to the Senate on 28 March 1900. This report included the results of testing done from June 1889 to March 1900 on both mechanical and slow-sand type pilot filter plants erected near the outlet of the Receiving Reservoir (now being referred to as the Dalecarlia Reservoir). Preliminary designs and precise layouts for full-scale plants of both types were presented, along with cost estimates for the implementation of each of the systems. These studies and the preparation of the report and recommendations were directed by Lieutenant Colonel Alexander M. Miller, the Officer in Charge of the Aqueduct. He was assisted by Mr. Edward Dana Hardy. The report stated that during the periods of highest turbidity, the English (slow sand) filters would not furnish a satisfactory effluent. However, the mechanical filters, with proper attention, would furnish an entirely satisfactory effluent both as to turbidity and sanitary conditions.

The report estimated the cost of a slow sand plant of 60 mgd capacity at $2.46 million and the cost for the same capacity rapid sand plant at $1.08 million. (Symon's report 14 years earlier had also indicated that mechanical filters would cost only one-half as much as slow sand filters.) The operating costs, including interest and depreciation, were about the same for either plant.

The report recommended construction of mechanical filters, to be located at the site of the new reservoir. An interesting aspect of this report was the recommendation that a filtered water storage reservoir be created by placing a dam in the large reservoir to separate the filtered water from the untreated water. Near the end of the report, Miller noted that "During the investigation, the Chief of Engineers, United States Army, has, by frequent and personal inspection and examination of the results, as well as by valuable and timely advice and counsel, greatly promoted the work." The Chief at that time was Brigadier General John M. Wilson, a Congressional Medal of Honor winner during the Civil War, who had been the Officer in Charge of the Washington Aqueduct in 1889.[9]

A heated controversy ensued regarding the merits of the two types of filtration, particularly as related to the possible harmful effects of adding a chemical (aluminum sulfate) as a coagulant to enhance the settling and filtration of the water, which would be required with the mechanical (rapid sand) filters. Among those opposing the use of rapid sand filters were the Board of Trade, the D.C. Medical Society, and the Surgeon General of the U.S. Army. On 4 January 1901, the Senate Committee on the District of Columbia, under the chairmanship of Senator James McMillan, held an inquiry into the matter at the Waldorf Astoria Hotel in New York City. Nearly a dozen distinguished medical men and expert engineers provided voluminous testimony, which proved to be inconclusive in deciding which system was best for Washington. Arguments were put forth pro and con. The engineers testifying all agreed that either method would produce an acceptable product. Because the rapid sand system would have cost less than half as much, Miller seemed to have won the day. But following the testimony, the D.C. Medical Society recommended: "In the interest of the people, we urge speedy action on the part of the Congress to supply the city of Washington with a water purified by natural or slow sand filtration through suitable sand beds."[10]

The Senate then appointed a committee of expert professionals, consisting of Rudolph Herring, George Warren Fuller, and Alan Hazen, all of whom had testified at the New York hearings. During his New York testimony, Fuller had noted that mechanical filters were better in dealing with turbid waters and that "The results of the experimental studies already made [Miller's] certainly indicate that the conditions are quite unfavorable for the sand filter [slow sand] in Washington on account of the turbidity which the water possesses, due to the suspended clay of exceeding fineness." But on 18 February, the committee's report to the Senate stated, "In consideration of the full evidence we recommend the construction of a complete system of slow sand filters—and the use of a coagulant for a part of the time. There is no reason to believe that the use of the coagulant will in any way affect the wholesomeness of the water."[11]

On the following day, Senator McMillan recommended to the full Senate "the adoption of the slow sand system of water filtration modified by the use of coagulants whenever the waters of the Potomac are so turbid as to make the use of a coagulant desirable." The matter had finally been decided and, by Act of 1 March 1901, Congress appropriated $500,000 "toward establishing a slow sand filtration plant, and for each and every purpose connected therewith...." When the House rejected later attempts to

add funds for preliminary chemical treatment, the strong and vocal opponents of the use of coagulants had their way, if only for a short time.[12]

Construction began in the spring of 1903 in accordance with a design by Colonel Miller, Mr. Hardy, and the consultant Alan Hazen, who had been one of the select three-member group of experts that recommended slow sand filtration to the Senate. The first filter was placed in operation in August 1905, and soon thereafter the city was receiving an average of 65 mgd of filtered water.[13]

Notwithstanding the wording of the act, the controversy over coagulants raged on. Early in 1903, an amendment was proposed to provide works for the preliminary treatment of water, and more hearings were held. At the conclusion, Colonel Miller recommended "that the matter be postponed until a year after completion of the filtration plant." An experimental plant to test various methods of coagulation was placed in operation in February 1907 and operated for 11 months. On 18 March 1910, after further experimentation, Congress authorized the construction and operation of a plant for preliminary treatment of the water. A coagulating plant was located just below the outlet of the Dalecarlia Reservoir. It fed alum to the water in the conduit flowing to the Georgetown Reservoir to enhance sedimentation of the water in that basin prior to flowing on to the McMillan Filter Plant. The decision to add chemicals validated the original recommendations of Colonel Miller and Mr. Hardy. In another 10 years, planning would be under way to use rapid sand filters in the new water treatment facilities to be built at Dalecarlia.[14]

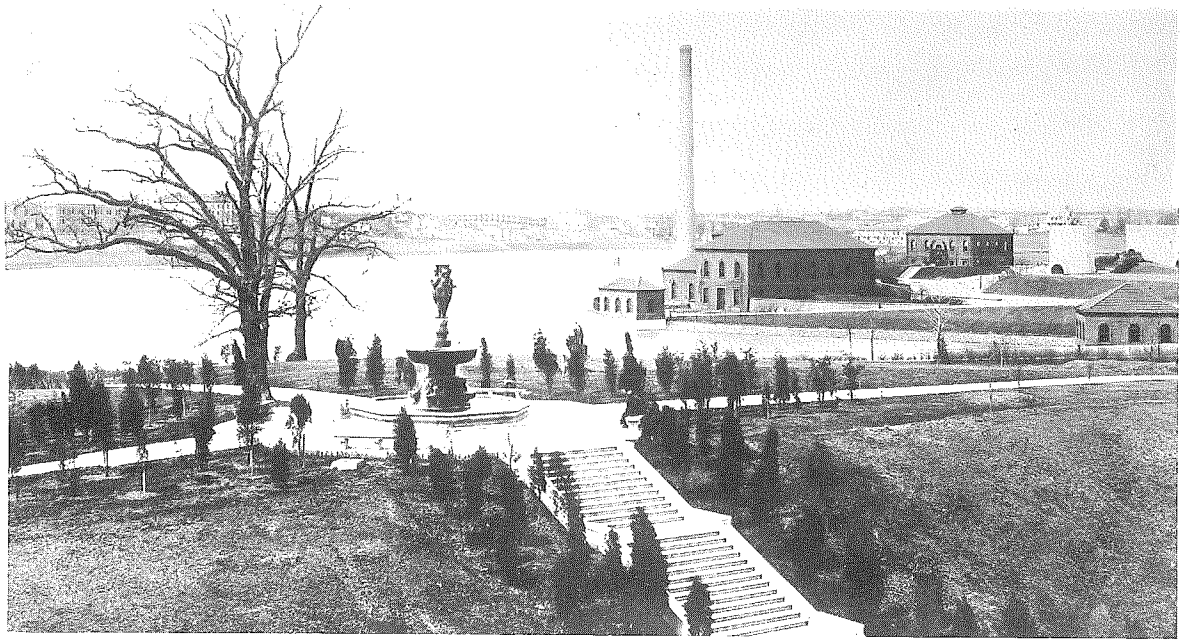
Perhaps it was the aftertaste from the tunnel fiasco that led Congress to reject the recommendations in Colonel Miller's report and yield to the entreaties of interests other than the Corps. During the 20th century, several water resources development projects proposed for the Washington area by other Corps elements would fall to similar opposition. But, during the more than 90 years since the McMillan Filter Plant controversy, Congress has neither disrupted nor meddled in the management of the Washington Aqueduct or its construction program. Mr. Hardy became the superintendent of the new plant when it went into operation in 1905 and remained with the Washington Aqueduct as the Chief Engineer in charge until 1935, the longest tenure of any individual in that post. Colonel Miller died in September 1904, before the plant was completed.[15] The most prestigious award granted by the American Water Works Association is named for George Warren Fuller, one of the experts appointed by the Senate committee, who later became the president of that association. Since its inception, six employees of the Washington Aqueduct have been granted that award by the association, a record unlikely to be matched by any comparable utility.

CHAPTER 13
The McMillan Slow Sand Filter Plant

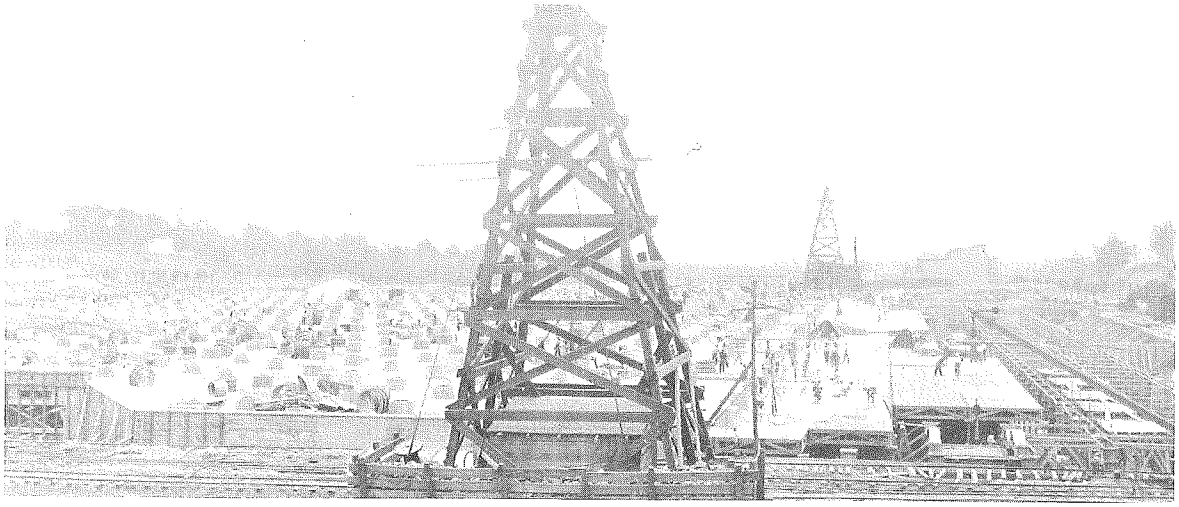
Three sites were considered for the new plant including one near Stubblefield Falls in Montgomery County, Maryland, only 3.5 miles below Great Falls (now the location of the David W. Taylor Naval Research and Development Center). A location adjacent to the new reservoir, then called the Washington City Reservoir, was selected and construction began in 1903. The new slow sand filtration plant was designed by Lieutenant Colonel Miller, assisted by Edward Dana Hardy and Alan Hazen. It was sited and built almost entirely in accordance with the original plan as submitted by Colonel Miller in his March 1900 feasibility report and was placed in full service in October 1905.[1]

Water was pumped up 20 to 30 feet from the new reservoir to the new slow sand filters. Three 36 inch steam-driven centrifugal pumps of 50 mgd capacity each were provided by the Henry G. Worthington Company. (This was not the first or the last time that Worthington equipment was to be installed at the Washington Aqueduct.) The boilers were fired with coal, frequently with Big Vein coal from the Georges Creek area of Western Maryland. Twenty-nine slow sand filters, each one acre in area, and rated at 3 mgd, assured a capacity of 75 mgd, assuming four filters were out of service for cleaning. (Cleaning these filters was always the most expensive item in the plant operating budget.) Following a sustained period of filtration, two inches of dirty sand were shoveled by hand and thrown into movable ejectors, which transferred the sand hydraulically to stationary concrete sand washers outside the filters. Here, reverse currents of water flushed the mud to the city sewer system, and the clean sand was pumped to large cylindrical storage tanks. These concrete storage tanks have been landmarks in the area and have often been mistaken for filters.[2]

About 20,000 tons of sand were washed in this manner each year. Upon return to service, each filter was allowed to run at a very low rate for about 10 days to build up a thin surface film known as a "schmutzdecke." This film did most of the work of filtration, particularly in removing bacteria. When the amount of sand removed from a filter for washing operations had



McMillan Park, the Fountain, the Reservoir and Pumping Station



Construction of the McMillan Slow-Sand Filtration Plant, 1903

The McMillan Fountain

reduced the depth to 24 inches, donkey-powered carts were driven under the storage silos and filled with sand. The carts then were driven to the top of the filters. The sand was dropped through manholes which were located on 20-foot centers through the top of each filter. The sand traveled down a revolving chute, which redistributed the clean sand over the filter bed. At a later date, the sand was returned to the filters by mixing it with water and forcing it under pressure back over the bed. This procedure continued until the Nichols sand-washing machines were introduced during Word War II. These machines replaced the outside sandwashers and the silos. They traversed the beds on caterpillar treads, cleaned the sand hydraulically in place, redistributed the sand on the bed, and sent the waste water to the sewer. Considerable hand labor was still required to prepare the beds for machine operation, however.[3]

The filtered water was collected in tile underdrains and then traveled through regulator houses that metered and controlled the flow to the 14 MG reinforced-concrete filtered water clearwell. The scheme to build a divide wall in the large reservoir to create a filtered water storage basin was wisely discarded in favor of a covered concrete clearwell. Most of the treated water flowed by gravity to the city, with the balance going to the new Bryant Street Pumping Station built by the city for pumping to two High Service Reservoirs. The first Washington Aqueduct Chemical and Bacteriological Laboratory was opened on this site when the plant went into operation.[4]

By 1906, water consumption had reached 200 gallons per capita per day (gpcd) and the monthly average filtered water production ranged from 65 to 70 mgd. In a significant report to the American Society of Civil Engineers, Mr. Hardy, the Chief Engineer of the Aqueduct; and the distinguished consultant, Mr. Hazen, noted that probably half of this was attributable to waste. They suggested that those who make the laws should show "the necessary courage and determination" to carry out reform and reduce consumption: Metering of the water used was needed badly. This report also recommended coagulation of the water destined for McMillan, to be introduced near the outlet of the Dalecarlia Reservoir; placing a concrete bottom in the Georgetown Reservoir; and increasing the capacity of the conduit delivery system by building a booster pumping station at the entrance to the Dalecarlia Reservoir. The first two of these recommendations were soon implemented. The last was to come 30 years later.[5]

By a 1906 order of Secretary of War William Howard Taft (who in three years became the 27th President of the United States and later Chief Justice of the Supreme Court), the site of the new reservoir and plan was officially designated as "McMillan Park" in honor of Senator James McMillan of Michigan. This naming was enacted into law by Congress in 1911. Since coming to the Senate in 1889, McMillan contributed much, not only to the water supply system, but to the overall beauty of the capital city. (His championing of the completion of the city tunnel and the filtration plant were discussed earlier.) As chairman of the D.C. committee, he was responsible for the creation of the 1901 Senate Parks Commission. This commission, consisting of four of the most distinguished architects and artists of the day, developed the concept of the modern Mall, Rock Creek Park, the parkway to Mount Vernon, and the park at the reservoir designed by the premier land-

scape architect, Frederick Law Olmsted, Jr., son of the man who had served with General Meigs on the Advisory Committee to the Board of Public Works 30 years earlier. Senator McMillan died in 1902, six months after persuading the Senate to adopt the Commission Report. Leaders in the House, annoyed at not being consulted regarding the appointment of the commission, ignored the report, thus delaying implementation for several years. To this day, the McMillan facilities remain the only element of the Aqueduct system named for an individual. All other parts of the system are known either by their geographical locations or their functions.[6]

In 1913,, a memorial fountain, paid for by the citizens of Michigan at a cost of $25,000, was erected at McMillan Park. Congress authorized another $15,000 for site preparation. The sculptor of the fountain was Herbert Adams and the architect Charles Adams Platt designed the base of the fountain and the architectural surroundings. (At the same time Platt was designing the new Freer Gallery, the first art museum on the Mall.) The memorial consisted of three allegorical bronze maidens on a small podium. Water flowed from a bowl above the maidens into two larger marble basins below. Gargoyles between the middle and ground-level bowls spewed a single spray of water into the lower bowl. Park benches surrounded the site. This fountain, considered by many to be the most beautiful in Washington, remained in the park until 1941, when excavation for a new south clearwater basin required its removal. At the time, it was carefully crated and delivered to the custody of the National Park Service, with the understanding that it would be re-erected in West Potomac Park. Until the 1990s, it languished in various unprotected storage areas, most recently at Fort Washington, subject to weathering and vandalism. It was later consigned to an ill-fated neighborhood museum near the original site, which was destroyed by fire. Under a recent agreement between the Washington Aqueduct and the National Park Service, the top parts of the statue have been returned to the McMillan site. When the remaining parts are located, the fountain will be re-erected near its original location.[7]

The apparent need for pretreatment during periods of high turbidity resulted in an experimental coagulatant plant being set up at Dalecarlia in 1907, and in 1910 Congress approved application of chemicals to the water supply. After four years of experimentation, a coagulant plant for pretreatment of the water destined for the McMillan filters was built on the line of the conduit just south of the Dalecarlia Reservoir in 1911. A solution of aluminum sulfate was added to the conduit and in the course of the two-mile trip to the Distributing Reservoir (now called the Georgetown Reservoir) was mixed thoroughly with the water to produce excellent sedimentation in the reservoir. Although unknown at the time, the velocity gradient generated during the travel time in the conduit was almost exactly the value recommended later for the design of the mechanical flocculation devices in modern sedimentation basins.[8]

The Georgetown Reservoir was modified in 1913, to include a new earthen dam dividing the north half into two basins. The water was introduced into this new section, then diverted through a sluice gate at the lower end into the other section of the north basin, around a baffle, and on to the south half through another sluice gate, thus tripling the length of passage through the first

half of the reservoir. The reservoir bottom was graded and paved to facilitate flushing of the sediment. This involved modifying the 36-inch piping in the vault at Foundry Branch, which formed a drain to the river.[9]

Recognizing that the water demands were approaching the maximum capacity of the existing conduit, Congress in May 1908 authorized preliminary investigations and surveys to increase the water supply to the District of Columbia. The first investigation was carried out by Mr. F.F. Longley, principal assistant to Mr. Hardy at the Aqueduct, and was published as House Document 347, 61st Congress, 2d Session. Longley studied the advantages and disadvantages of six projects: (1) a second conduit from Great Falls; (2) an additional supply pumped from the river at Little Falls; (3) additional supply from the estuarine portion of the Potomac; (4) a supply from Rock Creek; (5) a supply from Seneca Creek in Montgomery County, Maryland; and (6) the use of deep wells as an additional source.[10]

This report also suggested using the Patuxent River in Maryland, but noted that funds were not available to adequately evaluate that idea. Other actions recommended included installing flash boards to raise the height of the dam at Great Falls, adding a booster pumping station at Dalecarlia, and metering all water use in the city as a means of meeting the demand with the existing conduit. Of the six major projects suggested, all were deemed impractical under present conditions except adding the second conduit and the possible use of the Patuxent.[11]

A followup study in 1913, "Preliminary Investigation and Surveys of the Patuxent River as a Source of Water Supply for the District of Columbia," was presented as House Document 1266, 62d Congress, 2d Session. This study was carried out by the Washington Aqueduct's Chief Engineer, Mr. E.D. Hardy. Advantages of the Patuxent supply were that it was gravity driven, had softer water, and was superior hygienically. The total separation from the present Aqueduct, made simultaneous interruption of supply from both conduits, either by accident or design, most improbable. The cost advantage was in favor of a second conduit from Great Falls, unless it was determined that plan would require additional storage and sedimentation reservoirs and pumping stations. Mr. Hardy's report also put forth the idea that surplus water from the conduit could be directed to a powerhouse at Dalecarlia to generate electricity. The Chief of Engineers recommended that use of the Patuxent be deferred pending further studies.[12]

Except for the groundwater plan and the Rock Creek system, all of the projects suggested in these two reports were eventually implemented. The Rock Creek system had been rejected in 1909 because of "the opposition that would doubtless arise to the submergence of so large an area in Rock Creek Park." The second conduit from Great Falls and the hydroelectric generating station at Dalecarlia were built in the 1920s. Flash boards were installed on the Great Falls Dam, and the Dalecarlia Reservoir Booster Pumping Station was completed in 1935. In 1939, the Washington Suburban Sanitary Commission (WSSC) began pumping water from the Patuxent River and later developed two large impoundments and a filtration plant to develop that watershed to its maximum safe yield. During the 1950s, the Washington Aqueduct completed a dam and pumping station at Little Falls to augment supply. By 1980, the Aqueduct had added an

emergency pumping station located on the estuary near Chain Bridge, and soon thereafter the three major Washington-area water supply utilities were jointly constructing a dam and lake on Little Seneca Creek to provide emergency supply to the area.[13]

Because the maximum daily consumption was nearly exceeding the capacity of the new filter plant, the engineers repeatedly implored Congress to take action to prevent the obvious waste of water that was occurring. The 1909 report had recommended the immediate adoption of metering for both the federal government and the city as the only way to conserve water. Congress adopted that recommendation in 1910 and the work of metering of the federal buildings was initiated by the Washington Aqueduct. At the same time, the city began metering the privately owned buildings. Further consideration of the recommendation to augment the supply, either from Great Falls or another source, was delayed for nearly a decade because of the nation's involvement in World War I.[14]

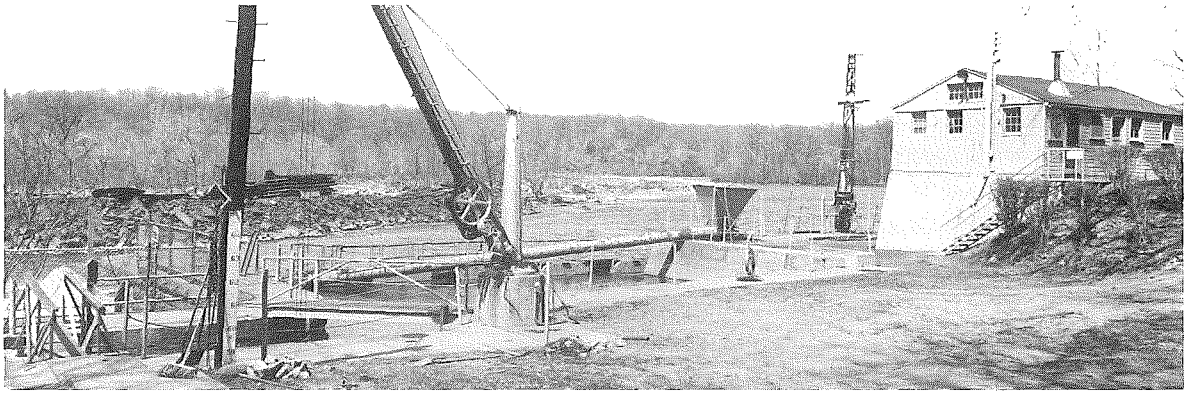
CHAPTER 14
Developing the Dalecarlia Complex

Throughout the decade beginning in 1910, frequent recommendations were made for major additions to meet future requirements. By 1918, maximum daily consumption had risen to more than 78 million gallons per day as a result of the city's growth during World War I. This amount exceeded the nominal capacity of the single conduit and the McMillan filters. Concerns escalated over both the system's adequacy to meet increased demands and its reliability. The urgent need for immediate action was stressed in the *Annual Reports* of the Chief of Engineers.[1]

The System had little, if any, redundancy to counter a failure of any single major element. This led to the preparation of an extensive report titled "Increase of the Water Supply," which was submitted to Congress in February 1921. This report, published as Senate Document 403, 66th Congress, 3d Session, recommended construction of a second conduit from Great Falls to Dalecarlia paralleling the older conduit; a new 80 mgd rapid sand filtration plant at Dalecarlia together with a new finished water pumping station; numerous additional large-diameter transmission mains, and several additional High Service Reservoirs. The Chief of Engineers, Major General Beach, advised President Coolidge that "it is essential that the new conduit from Great Falls...be made available at the earliest possible date in order that the supply of water will not be entirely cut off with attendant sanitary and fire hazards."[2]

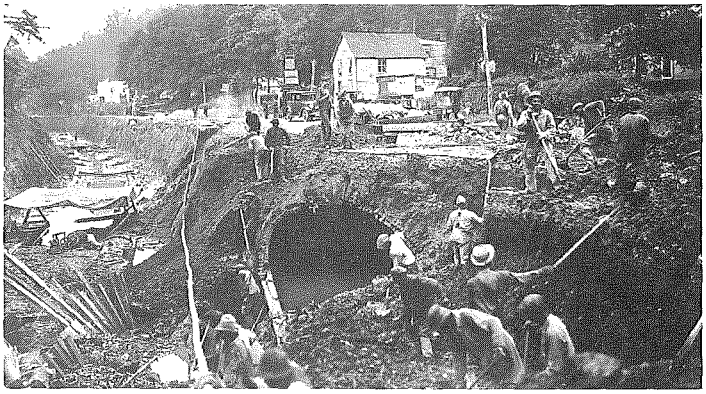
The major works planned were to be constructed on the land holdings of the Washington Aqueduct known as "Dalecarlia" in the vicinity of the original Receiving Reservoir. This name was derived from the name of the major tract of land acquired in that area, a farm called Dalecarlia that had been named for a province in Sweden by a previous owner. In April 1858, Montgomery Meigs had purchased the 281 acre Dalecarlia Farm from a Mr. Jenkins for $37,500.[3]

Congress quickly approved this plan on 30 June 1921. Construction began in 1922 and was completed by 1928. This period saw the most concentrated expansion in the history of the Washington Aqueduct, which doubled the raw water delivery capability and the treatment,



New conduit intake (1928) on right; old conduit intake on left

Construction of new conduit. Note shoring to protect old conduit under Conduit Road on left.

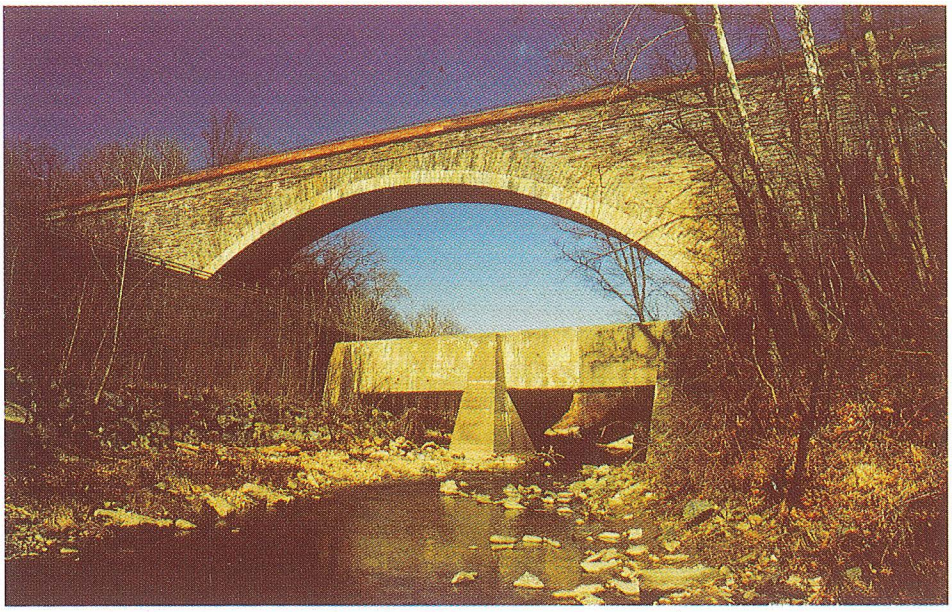


Washout of old conduit during new conduit construction, 12 June, 1924.

pumping, transmission, and storage capacity of the overall system. The work provided backup capability to be employed if any component was disabled or out of service for maintenance and significantly diminished the possibility of a total loss of supply because of the failure of a single element.[4]

An additional intake structure was constructed adjacent to the old intake on the river at Great Falls to supply the new unreinforced horseshoe-shaped conduit. This conduit was built parallel to the 1850s construction, on the river side of Conduit Road (later renamed MacArthur Boulevard). Construction of the second conduit only 30 feet center to center from the old structure was not without problems, however. Although shoring was provided to stabilize the old brick structure, a major washout occurred 12 July 1924. About 40 feet of the old conduit slid into the adjacent excavation. Fortunately, the bottom portion remained undamaged, and, with temporary repairs, flow was restored through an open channel within two days. In the meantime, the entire city had only the reserve

New conduit inverted siphon over Cabin John Creek

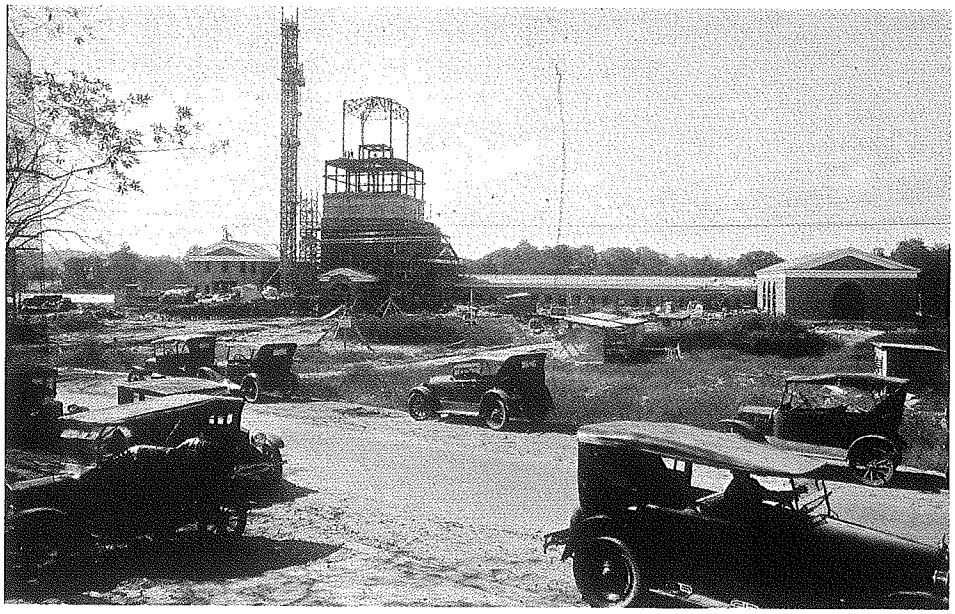


supply in the three reservoirs to sustain it. Even though they had been kept full for just such an emergency, they were nearly depleted before flow was restored.

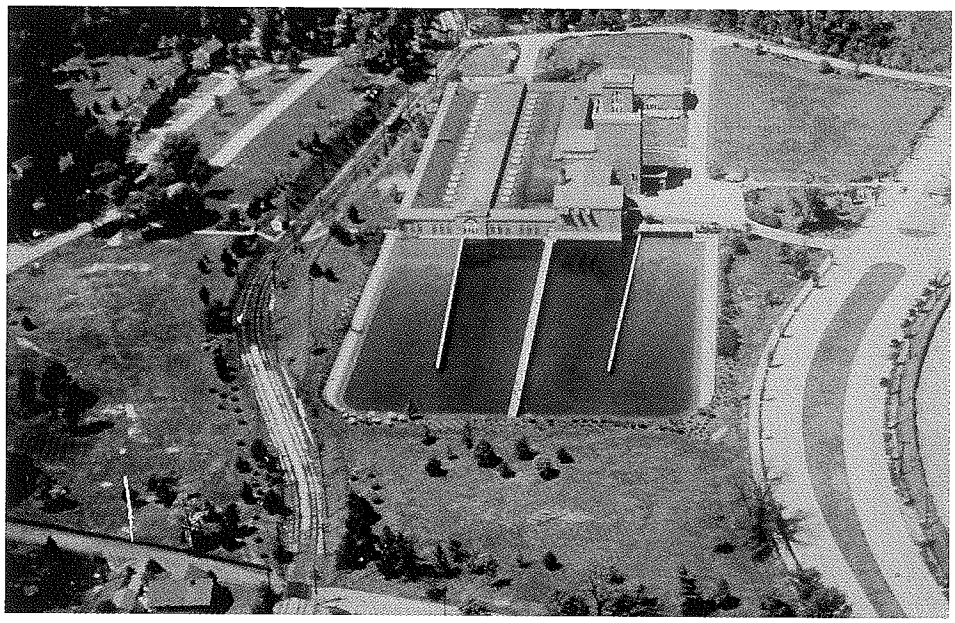
The system was designed to include three interconnections between the two conduits. This arrangement permitted dewatering of one one-eighth of the conduit system when maintenance work was needed in either conduit; the other seven-eighths remained in service to meet demands. The new treatment plant at Dalecarlia consisted of chemical mixing basins, two 40 mgd sedimentation basins, 20 rapid sand filters rated at 4 mgd each, a 15 MG finished water storage reservoir, and chemical storage and feed facilities. Chemical treatment included chlorine for disinfection; liquid aluminum sulfate, which was manufactured at a batch plant on site from bauxite and sulfuric acid; and lime for pH adjustment. Alum treatment of the water destined for the McMillan plant continued from the new plant. A complete waterworks laboratory for chemical and microbiological analysis also was included. And, in 1927, six new brick dwellings were completed behind the Dalecarlia plant to provide on-site housing for key employees.[5]

The pumping station consisted of nine pumps pumping to the First, Second, and Third High Service systems. The three pumps on First High were of 20 mgd capacity each; on Second High, two were of 10 mgd and one of 20 mgd capacity; and on Third High, all three were of 10 mgd capacity. This resulted in a total installed capacity of 130 mgd. The nominal capacity of 80 mgd, with one pump out of service on each level, matched the treatment capacity. The pumps were provided by the Worthington Pump Company. This was the third occasion, but not yet the last, when pumps installed at the Washington Aqueduct carried the name of Henry G. Worthington.[6]

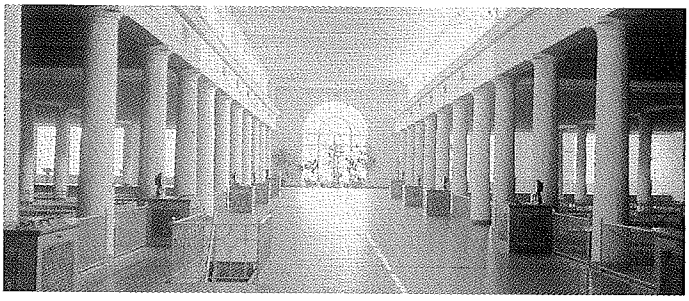
On the First High Service, a 36 inch main was laid down Conduit Road and connected to a new 20 MG storage reservoir on Foxhall Road. Similarly, on Second High Service, a new 36 inch main and another new 20 MG storage reservoir were provided. This main was extended across Rock Creek Park and connected to the existing mains on 16th Street. A new 36 inch Third High Service main and an additional reservoir were tied into the existing system at Fort Reno. Each of these new systems was connected



Construction of Dalecarlia Filter Plant, 1925



Dalecarlia Filter Plant and Pumping Station c. 1928



Interior of Dalecarlia Filter Plant, 1928

into the existing network, so that each could be supplied from either Dalecarlia or from the existing Bryant Street Pumping Station at McMillan. Because the Dalecarlia complex could not yet supply the Low Service area, direct connections from the McMillan plant clearwell were built to provide additional gravity service to that area.[7]

As an adjunct to the new plant at Dalecarlia, a hydroelectric generating plant was built adjacent to the C&O Canal. Two 1500 kilovolt

ampere (kva) generators were used whenever excess water was available from the conduits. This station, which was fed from a penstock connected to the Dalecarlia Reservoir, saved considerably on electrical energy costs over a long period. For some years, these generators provided all of the energy needed to run the treatment and pumping facilities at Dalecarlia during the winter months. They were abandoned in the late 1960s when there was no longer sufficient excess water at any time of the year to justify their continued maintenance.

However, this facility would serve a reverse function in future years. The first occasion was in 1942, when one of the generator blades was converted to a pump impeller and the generator was rewired to be a motor. The purpose was to provide a reserve supply from the C&O Canal during World War II. Equipment was on hand to convert the second unit, if necessary. When the raw water pumping station at Little Falls went into service in 1958, the generator was returned to full service for another decade. Still later, because of the concerns raised by the drought conditions of the late 1960s, the penstock became part of an emergency pumping station system capable of pumping 100 mgd to the Dalecarlia Reservoir from the Potomac River estuary near Chain Bridge.[8]

This major expansion program at Dalecarlia was accompanied by a significant increase in the water supply responsibilities for the Washington Aqueduct. In 1926, Congress approved the sale of water from the Aqueduct to Arlington County. As part of the construction program then under way, the Corps built a 24 inch watermain from Dalecarlia to Chain Bridge, which was then connected to the Arlington system. Water was first pumped through this main in 1927. (These events are discussed in greater detail in the section on water supply to Northern Virginia.) The new facilities were coming on line none too soon. During the preceding 10 years, the annual average consumption had increased to 74.87 mgd, with a peak day of over 90 mgd. The population served had jumped to 552,000. Without the significant reduction in water waste resulting from the long-sought authority to meter both federal and private consumption, the resulting demands might not have been met during the 1920s.[9]

At about the same time as men were being killed and maimed by chlorine gas in the trenches in France, Professors Lynn Enslow and Dr. Abel Wolman were developing a method of applying chlorine to disinfect public water supplies. This accomplishment is now recognized as one of the most significant advances in public health during the 20th century. The Washington Aqueduct engineers and scientists were among the first to implement this new treatment technique. From 7 March to 11 April 1922, 3,600 pounds of chlorine was applied to the water leaving the McMillan filtered water reservoir at a dosage of 0.3 parts per million. After a successful trial period, equipment was acquired and regular chlorination of the supply has been standard operating procedure since 1923. This new treatment technique finally eliminated the remnants of the scourge of typhoid fever as a waterborne disease in the nation's capital, long after the advent of filtration at McMillan.[10]

CHAPTER 15
The Events of the 1930s

The 1930s may have seemed to be a period of relative inactivity. However, two projects were complete that were to have a significant effect on the system's ability to meet the burgeoning demands imposed by the population increases during and after World War II. In May 1930, the height of the dam at Great Falls was raised one foot by installing flash boards on top of the dam. These were held in place by 2 inch iron pipes in holes drilled into the coping stones. At the time, the purpose was to increase the flow to make more water available for generation of electricity at the new hydroelectric plant. However, this addition proved to be even more valuable in providing the water needed to meet the dramatic increase in consumption during the late 1940s and early 1950s, prior to the addition of the Little Falls Pumping Station.[1]

Prior to the mid-1930s, the capacity of the two conduits was limited to the amount that could be obtained by maintaining the Dalecarlia Reservoir at elevation 144 or higher. This level was necessary to provide sufficient head to permit operation of the Dalecarlia plant at or near its design capacity of 80 mgd. To increase both the flow in the conduits and the flow from the reservoir to the plant, a booster pumping station was built in 1935. This idea had first been put forth by Mr. Hardy and Mr. Hazen in their 1906 paper on the McMillan plant. Ironically, this was Hardy's last project as Chief Engineer of the Washington Aqueduct prior to his retirement in 1935. Average day consumption was now 93 mgd, with maximum day usage at 122.7 mgd.[2]

An earthen dam was built across a narrow section of the Dalecarlia Reservoir about 750 feet from the conduit discharge gates, and a 230 mgd pumping station was constructed in the dam. Continuous operation of this station lowered the average elevation on the suction side of the pumps, an area designated as the forebay, to 141.0, and increased the level in the larger portion of the reservoir to 148.0 or higher. This not only dramatically increased the flow in the conduits, but enabled the relatively new Dalecarlia plant to take in enough water to operate at rates higher than its nominal design capacity. Even more important was the ability to significantly increase the flows to the Georgetown Reservoir and to maintain higher levels there. This

not only increased the storage capacity, but also permitted the passage of much greater quantities of water from Georgetown to McMillan. Without the increased flow available to the two treatment plants, it is unlikely that the Aqueduct would have been able to meet the rapidly increasing demands imposed during the World War II years. In 1941, the population served was 800,000, and the Washington Aqueduct peak-day production was 155 MG. By 1953, the peak day had risen to more than 266 MG.[3]

The second significant project during the 1930s was the improvement of the McMillan Pumping Station, which was also a contributing factor in meeting those larger demands. In 1937, the obsolete steam-driven pumps were replaced with three modern electrically driven units with rated capacities of 50 mgd each.[4]

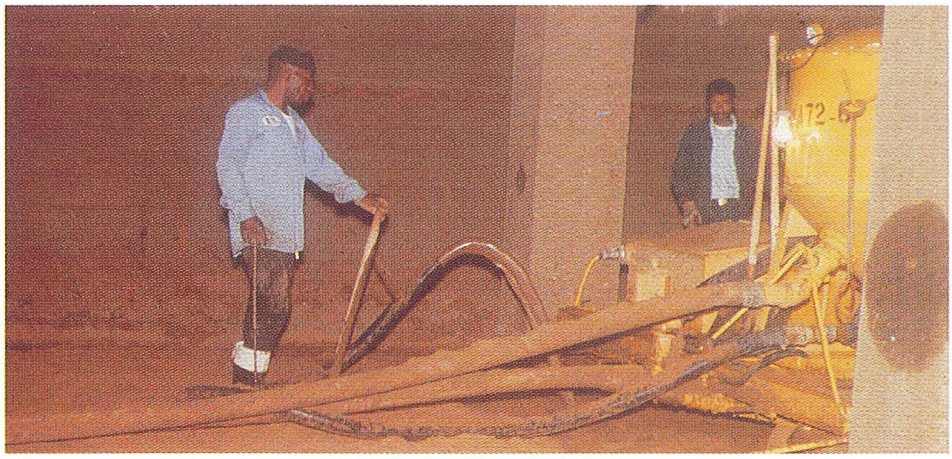
At Dalecarlia, the finished water pumping capacity was increased by installing new pumps. By the start of the war, pumping capacity at Dalecarlia included 60 mgd on First High, 40 mgd on Second High, and 40 mgd on Third High, plus 10 mgd from the Arlington Low Lift Station.[5]

CHAPTER 16
The World War II Years

The remarkable demands placed on the nation during this most challenging and glorious period of the 20th century were shared by the Washington Aqueduct. Protective measures included troops to patrol the conduits, special police guards, additional protective fencing, the acquisition of hypo-chlorinators for emergency disinfection, and a changing of the name of Conduit Road to MacArthur Boulevard.[1]

In 1940, the population of the Aqueduct service area was nearly 720,000, and the average summer-day consumption was 106.2 mgd. The maximum-day consumption was 141.7 MG. Just after the end of the war, the population served had climbed to over one million and the average-day consumption to 158.2 mgd, with maximum-day consumption at 194.2 MG. The maximum-5-day average was 186.3 mgd. Meeting this unprecedented increase in demand under the adverse conditions imposed by wartime mobilization and priorities required innovative and imaginative management and operation of the system. The Dalecarlia Reservoir Booster Pumping Station, as discussed in the preceding chapter, figured prominently in providing sufficient water.[2]

Because the Dalecarlia plant was operating at close to the maximum capacity of its intake facilities and at the associated pumping station, the job of picking up most of the additional load fell primarily on the McMillan plant. Three innovative modifications during World War II produced the capability to meet the higher demands. They were (1) conversion of one of the generating units at the Hydroelectric Station into a raw water pump taking water from the C&O Canal, (2) installation of a makeshift booster pump at the outlet of the Georgetown Reservoir, and (3) upgrading of the McMillan Filter Plant.[3] To alleviate concern over the possibility of losing all or part of the conduit supply because of accident or sabotage, one of the turbine blades at the Hydroelectric Station was replaced with a specially designed pump impeller blade, the generator was rewired to convert it to a motor, and an intake crib was built in the C&O Canal to collect water for pumping up the penstock to the outlet of Dalecarlia Reservoir. This single pump could supplement the conduit flow by as much as 65 mgd. An additional impeller and other necessary materials were kept on hand



The Nichols sand washing machine in operation in McMillan slow-sand filter.

to permit rapid conversion of the second unit within 48 hours if needed, increasing this source to 120 mgd.[4]

At the Georgetown Reservoir, an open impeller-type pump, fabricated in the Washington Aqueduct shops from discarded dredge machinery, was installed just below the water level at the entrance to the gatehouse leading to the city tunnel. The appearance and the commotion created by this mechanical monster earned it the nickname the "egg beater." This device, built to increase the flow from Georgetown to the McMillan Reservoir, consisted of a single pump built on a movable ladder frame with a capacity of 100 mgd at 5 foot head. The operation of the egg beater raised the water level in the West Shaft and increased the flow to McMillan by about 25 mgd, although the resulting turbulence must have created the impression that much more was happening.[5]

The modification with the most long-term significance was the upgrading of the McMillan Filter Plant, "the Sleeping Giant," to increase output to amounts far greater than its nominal design capacity of 75 mgd. The first step was to improve the quality of the water going onto the filters. Coagulation, which previously had been introduced intermittently, was instituted on a full-time basis, and the alum dosage was significantly increased. This modification reduced the average turbidities going on to the McMillan filters from between 10 and 20 units to 2 units, significantly decreasing the amount of material to be deposited in the filters and allowing higher rates and longer runs.[6]

During the previous 40 years, sand had never been cleaned to its full 36-inch depth, and, as a result, suspended silt was found as deep as the gravel layer. To speed up the outmoded filter-cleaning process, self-propelled sand-washing machines were acquired. These Nichols sand-washing machines were electrically driven and moved forward on caterpiller treads. A screw conveyer on the front spiraled the sand into the machine, where it was hydraulically ejected into a separator mounted on the top. Here the turbulence cleaned the sand, which settled to the bottom. The muddy wash water was drawn off at the top, much the same as happens during rapid sand filter backwashing, and the sand settled to the bottom. The fluidized sand then was redistributed over the filter through a spray hose.

Because more frequent washings were now possible, the full 36-inch depth was no longer needed, and the top 12 inches were removed permanently. About 1.25 million cubic feet of discarded filter sand

was now lining the bottom of the McMillan Reservoir. Between washings, the filters were mechanically raked four or five times to break up the film on the surface. This, coupled with the lower turbidity and the lower head loss because of the reduced depth, resulted in longer filter runs at higher rates. With these improved procedures, 25 of the 29 filters could be kept operating during the summer months at rates as high as 5.5 mgd, and averaging more than 4 mgd. By the end of 1944, the plant delivered a maximum daily output of 112 mgd and a maximum hourly rate of 152 mgd. With minor modifications to the collecting mains and the method of flow control, the existing plant had the hydraulic capability to handle this additional flow and much more, as it was called on to do over the next 20 years.[7]

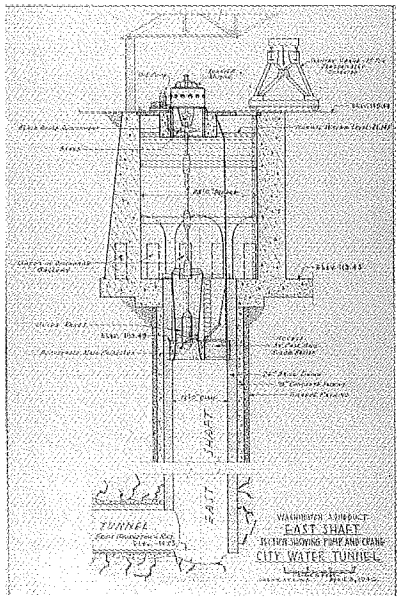
In the pumping station, the three 50 mgd pumps were replaced with 75 mgd adjustable blade pumps. These pumps operated at higher heads to allow drawdown of the McMillan Reservoir to meet the peak hourly and daily demands. To further assist in meeting peak loads, a new 20 MG South Filtered Water Reservoir was built on the McMillan Park site, necessitating the removal of the McMillan Fountain. Further upgrading of the plant after the war enabled it to continue to serve far in excess of its original capacity until 1964, when completion of the new intake facilities at Dalecarlia allowed that plant to make full use of the additional filter and pumping capabilities previously installed there.[8]

The McMillan Park site was now fenced and, at the outset of the war, had been the site of a battery of anti-aircraft guns. On 11 March 1944, Conduit Road was renamed MacArthur Boulevard by an act of Congress, ostensibly to mask the fact that the water supply conduits were located directly underneath, but more likely to honor General Douglas MacArthur.[9]

As the war was coming to a close in 1945, installation of a significant new addition was under way. The new booster pump placed in the East Shaft of the city tunnel was, in its way, as significant in meeting the postwar demands as the booster pumping station at Dalecarlia had been during the war. As the demands increased throughout the 1950s, the Dalecarlia plant was forced to operate at the maximum capacity available under the hydraulic limitations of its intake conduit. The Washington Aqueduct would not have been able to keep up with the demands placed on the system between 1950 and 1964, when the new Dalecarlia intakes were placed in operation, if the McMillan plant had been limited to the flows previously obtainable through the city tunnel from Georgetown. During this period, the McMillan plant consistently produced over 160 mgd during peak summer periods. The egg beater could not have provided the necessary flow, but the East Shaft pump did the job.[10]

This installation was the first of its kind in the United States. The variable-pitch impeller blades were placed nearly 50 feet vertically below the 1,000 horsepower motor, which was mounted at the top of the 165-feet deep shaft. The pump output was varied by changing the pitch of the impeller blades by way of a hydraulically operated piston inside the 50-foot shaft. This pump was designed to deliver up to 150 mgd. During some periods, fortunately brief, that was not enough, and the reservoir had to be drawn down to meet demands. Without this remarkable machinery, there probably would have been occasions between 1950 and 1964 when the Washington Aqueduct would have

had to ask consumers to restrict their water usage. This machinery functioned efficiently until 1988, when the impeller blades failed in place and damaged the shaft. Fortunately, an exact replica, was obtained and installed in time to enable the McMillan plant to ensure adequate supply during the period when the Dalecarlia plant output was reduced by the demolition and replacement of the two original sedimentation basins there.[11]



Drawing of East Shaft Pump installation.

CHAPTER 17
The 480 Report

The war years dramatically demonstrated the need for significant additions and improvements to the system. Aqueduct authorities foresaw these needs, and appropriation acts of 1941 and 1942 each provided $20,000 to develop a plan to ensure an adequate future water supply for the District of Columbia, with the same amount to be available until 30 June 1943. Subsequent authorizations added another $100,000, and, in response, an in-depth report was submitted to Congress on 18 February 1946. The report was completed later than anticipated because of intervening wartime priorities and cost more than initially specified by Congress. This report, titled "Adequate Future Water Supply for the District of Columbia and Metropolitan Area," was published as House Document 480, 79th Congress, 2d Session. It was prepared jointly by the Washington Aqueduct and the D.C. Department of Sanitary Engineering. The report included a comprehensive review and tabulation of the existing system and provided detailed estimates of future population and consumption. It fully addressed the need for additions and improvements to the collection, purification, pumping, transmission, and treated water storage and distribution systems managed by those two agencies. It did not attempt to discuss or plan for water resources development on the Potomac River or consider other sources of supply. That was not its intent, because that aspect of water resources development was to be addressed by other elements of the Corps of Engineers.[1]

In its comprehensiveness and the subsequent adherence to the plans and recommendations, the 480 Report, as it came to be known, was a masterpiece. In addition to detailed cost estimates, the document included 39 full-size drawings detailing the size, equipment, capacity, and proposed locations of the needed improvements. The projects were to be constructed in four stages over the next 55 years, to assure that adequate capacity would always be available to meet the growing demands. The extent to which implementation conformed with the 1946 master planning was remarkable. (The elements of the plan and the individual projects will be described in greater detail in the discussion of the implementation over the ensuing 45 years.) The plan was con-

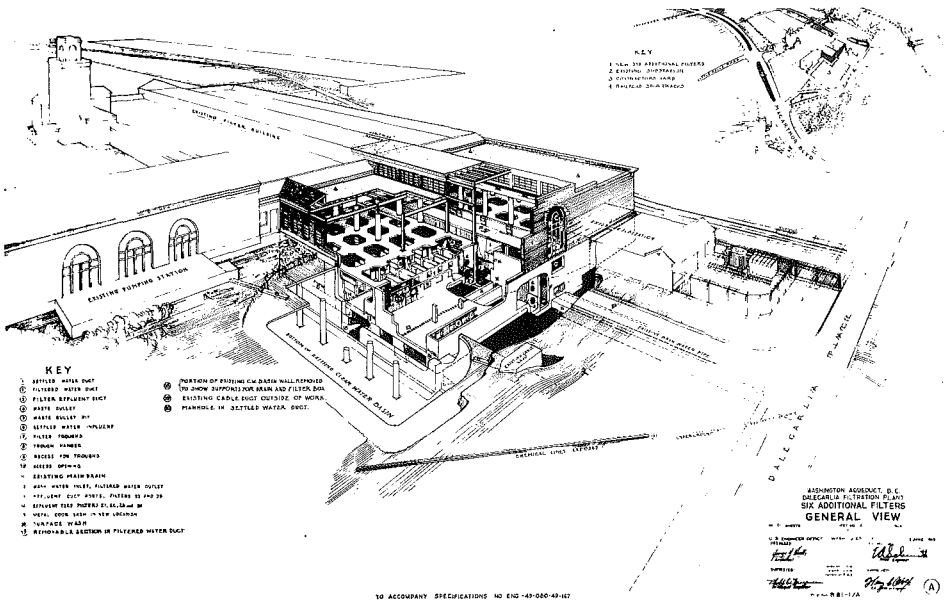
ceived to safely and adequately meet the demands until the year 2000. Except for any new facilities required to meet the more stringent environmental regulations of the 1990s, requirements not visualized in 1946, the completion of the projects as recommended in the 480 Report shall meet the needs of the areas served well into the 21st century.

CHAPTER 18
The Post-World War II Construction Bridge

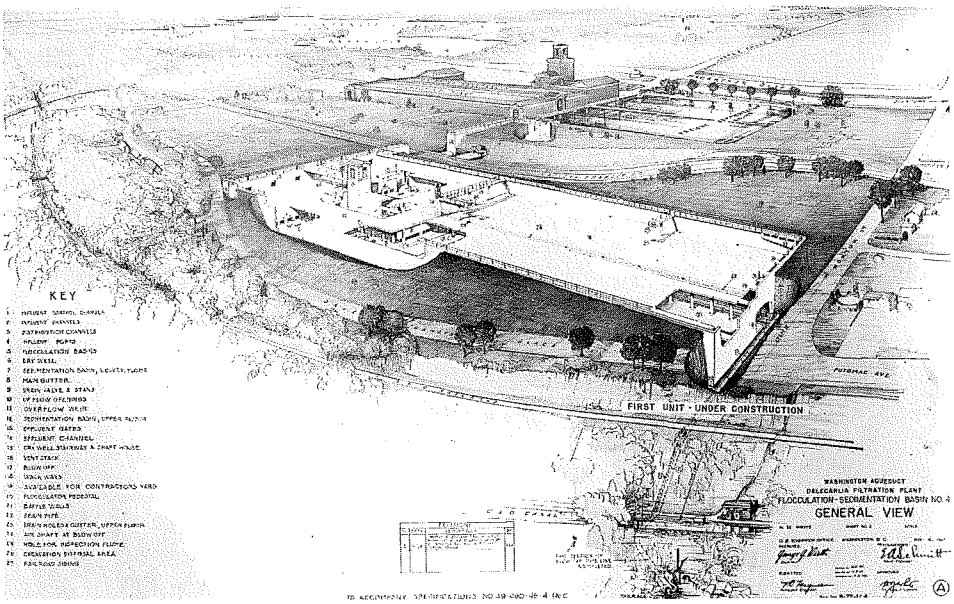
By 1946, the Aqueduct's maximum daily production had risen to 190 mgd, and the average day was 155 mgd. The effects of the war had increased the population served by 44 percent and the utility was serving more than 1 million consumers in the District of Columbia and Northern Virginia. The publication and acceptance of House Document 480 provided the impetus for the much-needed massive improvements and expansion of the system. Washington Aqueduct officials and their counterparts in the District of Columbia Department of Sanitary Engineering wasted no time in beginning the work on their respective facilities. The needed appropriations were requested and approved, and by 1948 work was well under way. The three new 75 mgd capacity pumps had been installed in the McMillan Pumping Station, which enabled that plant to produce 150 mgd with one pump in reserve. The adjustable-blade impeller pump installed in the East Shaft had increased the available supply from Georgetown to over 150 mgd on a sustained basis.[1]

Additional improvements included new rising mains from the McMillan Pumping Station to the filters, several more sand-washing machines, and continued filter renovation. Over the next 18 years, this plant would be called on to produce at these higher rates consistently. More than 160 mgd were provided in the peak summer weeks during most of those years (reaching a maximum day of 172.4 MG on 21 July 1953), until the bottleneck limiting the intake to the Dalecarlia plant was eliminated in 1964. Further modifications to increase the capacity begun after Word War II included the construction of a reshaped soil cement bottom in the northern half of the Georgetown Reservoir to facilitate cleaning of the settled material. The hard bottom permitted the use of snow-plow blades to scrape deposits from the bottom of the reservoir into gullies, which discharged through a new drain directly from the north basin to the Potomac River. An intricate system of baffle walls was placed in the reservoir to improve sedimentation, but the walls were later re-

Drawing showing six additional filters

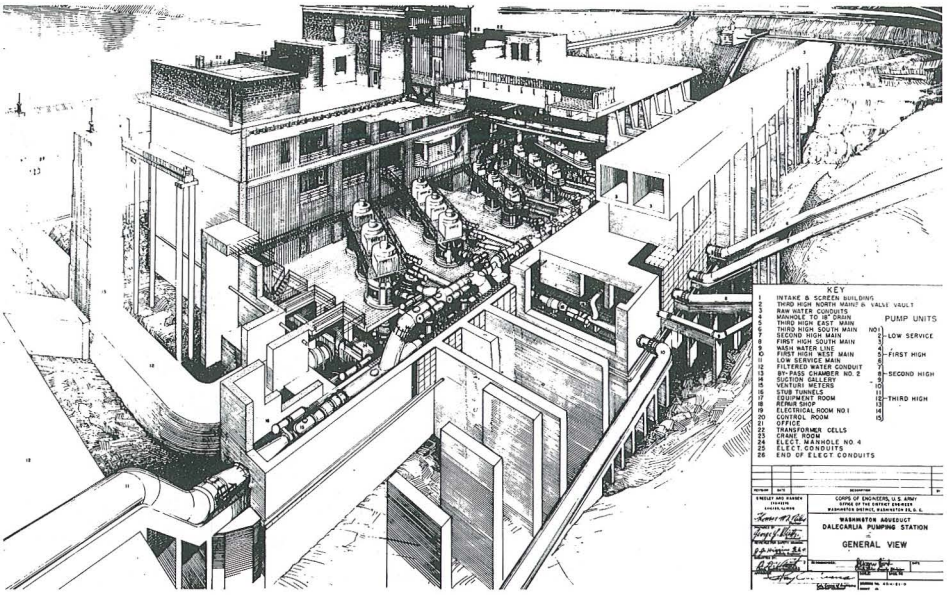


Drawing showing Flocculation–Sedimentation Basin #4

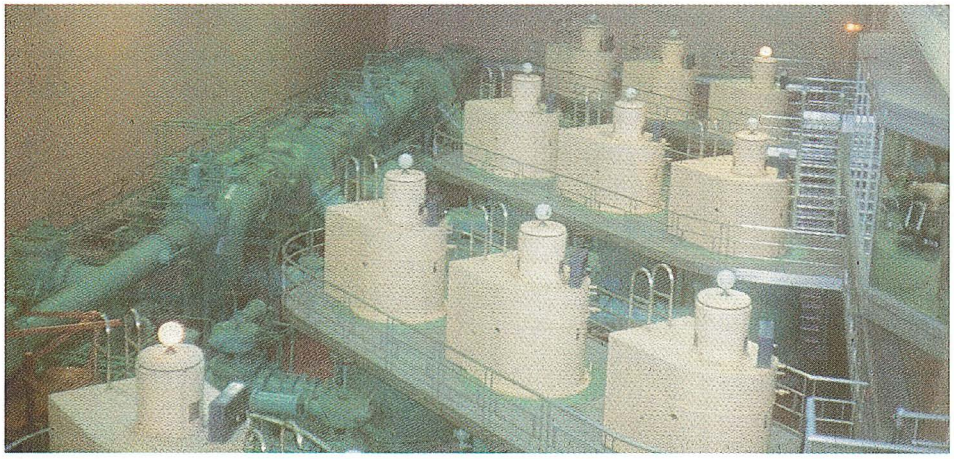


moved. This reservoir renovation, together with the pump and filter modifications at McMillan, would be all that was done to improve the McMillan plant for another 35 years.[2]

Because of the excellence of the Master Plan for expansion of the Dalecarlia complex, implementation proceeded at a remarkable pace. In 1950, the purification facilities were improved by installing vertically rotating flocculator paddles and baffle walls in the first 96 feet of the two original sedimentation basins. The old mixing basins then were abandoned, and sedimentation efficiency was much improved. Six additional rapid sand filters were added in a northward extension of the filter building, increasing the nominal capacity to 104 mgd. Although this project was finished in 1951, the litigation related to alleged failure to comply with the specifications and the contractor's claims for extras was not resolved until well into the 1980s. At that time, the original decisions of the Washington Aqueduct construction manager, Dan M. Watt, who in 1962 became the Chief Engineer of the Aqueduct, were essentially sustained by the court. These new filters used



Drawing of Dalecarlia Pumping Station completed in 1958 showing underground portions of structure.



Interior view, Dalecarlia Pumping Station, 1958

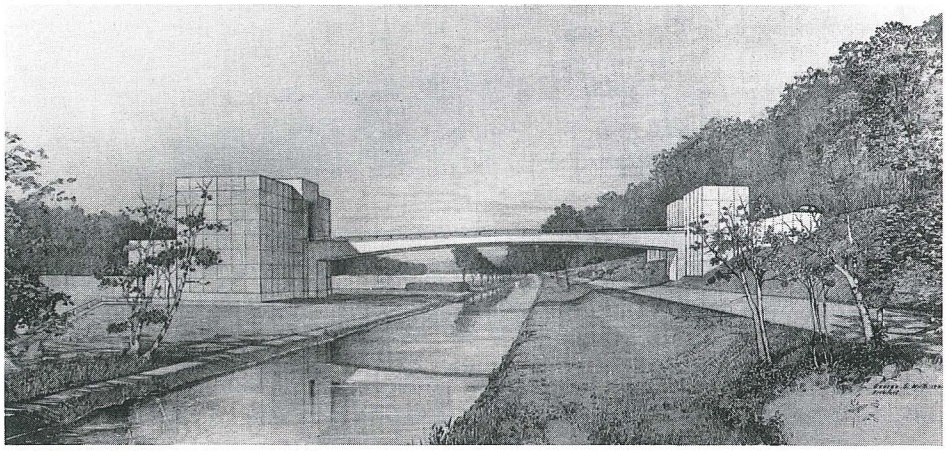
crushed anthracite coal as the filter medium, and during this period several of the original 20 filters were also converted to "Anthrafilt." Because of the lower specific gravity of this medium, a larger effective size could be used, which permitted longer filter runs and more efficient use of backwash water.[3]

Early in 1948, work began on the first of four proposed new sedimentation basins. This flocculation-sedimentation facility, designated as Basin No. 4, was built just west of the Cabin John streetcar line tracks. (Basin No. 4 was built before Basin No. 3, because the streetcar line was still operating regularly on the tracks passing through the proposed location of No. 3.) While not unique to Dalecarlia, the new basin did incorporate an innovative concept. The two original basins were the "around the end" type, with the flow through the basin making a 180 degree horizontal turn at the south end to return to the filter gallery. To make maximum use of the available, and valuable, real estate close to the plant, the new basins were designed as two-story structures 420 feet long and 120 feet wide. Water enters the 120 feet-long flocculation section on the bottom, then moves south through the remaining 310 feet of the lower deck, where most of the sedimentation normally takes place. The water then makes a 180 degree vertical turn and returns to the filter gallery, with continued settling during the 420-feet traverse back to the fil-

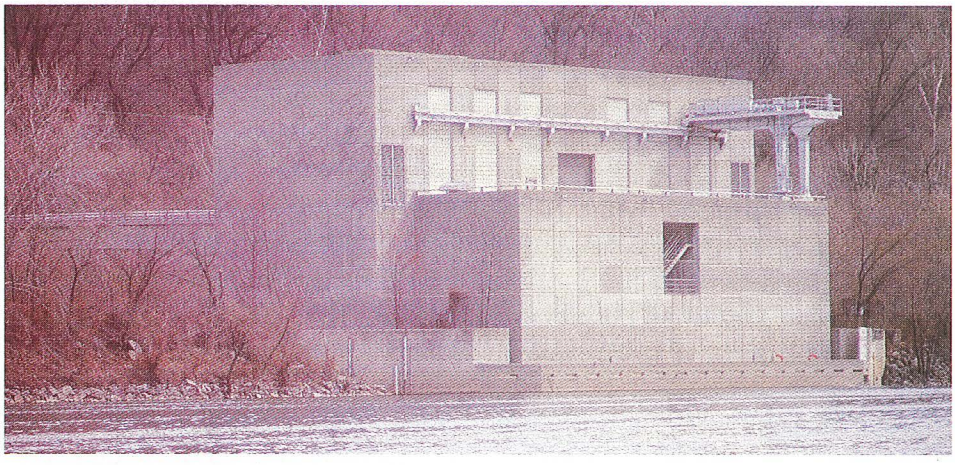
ters. The 34-feet overall depth of this basin provided a volume of 14 MG, 175 percent greater than the total volume of the two existing basins. This new structure was rated at 90 mgd, but was capable of producing more if necessary when the other basins were out of service for cleaning or maintenance. The demands on the system were still increasing fast enough to cause concern. To meet the maximum demand during 1949, the two plants had to produce more than 238 MG and, by 1953, more than 266 MG.[4]

While these projects were under construction, final design was proceeding on major pumping station and transmission system improvements. At the Bryant Street Pumping Station, the D.C. Department of Sanitary Engineering completely renovated the station, which included replacing the remaining steam pumps and doubling the pumping capacity. When completed, the station had an installed capacity of 310 mgd, pumping to all service areas, including Low Service. In 1959, the city completed construction of a 25 MG Filtered Water Reservoir on the Low Service system at Brentwood, permitting the first pumped storage serving this extensive area of the city (which previously had been served only by gravity flow from the McMillan clearwells).[5]

At Dalecarlia, construction of a new 30 MG clearwell to provide additional filtered water storage and improved treatment for pH adjustment was well under way by 1952. When this was completed, work could proceed on the massive new Dalecarlia Pumping Station. This station, housed in a 200-feet-by-101-feet building, 82-feet deep and extending six stories under ground, proved to be one of the jewels of the Washington Aqueduct system.



Little Falls Pumping Station and pre-stressed concrete access bridge over C&O Canal.



Little Falls Pumping Station as seen from the river side.

In addition to all of the needed electrical switch gear, transformers, and supervisory controls, it included 15 large pumps with installed capacity, at their total nominal rates, of over 480 mgd; on Low Service, three units at 50 mgd; on First High, three units at 40 mgd; on Second High, three units at 20 mgd; and on Third High, six units at 27 mgd. The pumps were manufactured by the Worthington Pump Company, which had supplied the first pump installed by the Washington Aqueduct in the 1850s and nearly all of the others acquired since then.

Both the electrical and water flow paths were arranged so that one-third of the system could be isolated for maintenance and repair. The central control room, which is staffed 24 hours per day, was designed not only to control all pumps, motors, valves, and electrical gear in the new station, but also to provide remote control and monitoring of the Hydroelectric Station, the Dalecarlia Booster Pumping Station, the soon to be completed Little Falls Raw Water Pumping Station, and the new Great Falls Intake Building to be constructed 15 years later.[6] In addition to the connecting conduits to the clearwells, and the piping connections to the existing High Service pipelines, this project included a new screenhouse and intake at the Dalecarlia Reservoir and two new raw water conduits from there to the soon-to-be-built new chemical building. The new pumping station was placed in service in 1958, and the old station and the Arlington booster station were abandoned.[7]

In 1952 there was a significant addition to the water treatment process. During that summer equipment was installed to feed powdered sodium silico-fluoride. This procedure was implemented on 23 June 1951 to reduce the incidence of decay in the teeth of children in the area served. In contrast to the McMillan Filter Plant controversy 50 years earlier, this modification had the enthusiastic support of the medical community and public health authorities. The maintenance of a fluoride ion residual of one part per million in the finished water has proved effective in reducing dental caries since 1952.[8]

In 1957 the water supply of the District of Columbia was certified by the U.S. Public Health Service as "Approved for Use on Interstate Carriers." Prior to 1972, this was the only mechanism by which the government could evaluate and regulate water supply systems. This certification followed an extensive survey of the Washington Aqueduct facilities and operations, as well as a review of the District of Columbia's Water Operations Division and Department of Regulatory Affairs. The chemical and microbiological standards required for this certification were the precursors of the standards later promulgated by the U.S. Environmental Protection Agency (EPA) under the Safe Drinking Water Act.[9]

The offices of the Washington Aqueduct Engineering and Construction branches were busy places during the 1950s. Concurrent with the pumping station construction, a new 48-inch Third High Service pipeline was built from Dalecarlia to Fort Reno, and an additional storage reservoir of 20 MG capacity was completed at that site in 1955. Although the 480 Report called for a companion 20 MG reservoir at that site, the need has not yet been established, and the old 5.5 MG reservoir remains in use beside the new larger one.

As these major improvements and additions were being built at Dalecarlia, another major project was under way at Little Falls on the Potomac, just upstream from the old C&O Canal feeder dam. The need for an additional raw water

source had long been obvious, and this site had been mentioned by Lieutenant Meigs more than 100 years earlier. Not only was the existing conduit system likely to become inadequate to meet demands, but it was extremely vulnerable. A conduit failure would reduce the available supply to an amount lower than the demand. Furthermore, the failure of one conduit could result in the washout of the other, totally disrupting the supply as had happened in 1924. (Captain Spencer Cosby, the Officer in Charge of the Aqueduct in 1906, had advised against building the new conduit alongside the old one for that reason, but his advice went unheeded in the 1920s.) The available water storage could have been inadequate to meet the demand required during the restoration. An electrically driven pumping station at Little Falls was the logical answer to the dilemma.[10]

Elements of the Little Falls project included a low dam across the Potomac, with a fish ladder designed by the U.S. Fish and Wildlife Service at Snake Island in the middle of the river and a 30-inch pipeline encased in the dam to provide additional supply to the City of Falls Church service area. The major structure, located on a strip of ground between the river and the C&O Canal, consisted of an intake section with bar racks, sluice gates, and traveling screens; and the pumping section, housing four 100 mgd and one 50 mgd electrically driven pumps, together with their associated motors, valve appurtenances, and electrical switch gear. This 143-feet-by-91-feet structure, 109 feet high, was built so that there was no entry to critical areas below the level of the maximum anticipated flood. It was reached from the George Washington Memorial Parkway (now the Clara Barton Parkway) via a 266-feet-long prestressed concrete access bridge spanning the canal 34 feet above the tow path. At the time of its construction, the bridge was purported to be the longest prestressed concrete bridge ever built. (This was the second time that the Washington Aqueduct had established a record length for a particular type of bridge. The first record was set with the building of the Cabin John Bridge.) At the parkway, two 69 kva to 4.16 kva transformers were located on either side of the bridge. The station discharges to a 4,600-feet-long, 10-feet-diameter horizontal tunnel blasted through rock 220 feet below the Army Map Service (now the Defense Mapping Agency) buildings at Brookmont. A 104-foot vertical shaft with a 66-foot semicircular overflow weir discharges directly into the main section of the Dalecarlia Reservoir.[11]

The need to supplement available flow during the high summer demands and to provide adequate backup in the event of conduit failure fully justified the $7 million cost of this project. The installed capacity at the station was based on the consideration that all water might be pumped from this station and the conduits placed in a standby status. This action seemed advisable at the time, because electric service rates were low and the costs of repairing the conduits, as well as maintaining and policing MacArthur Boulevard, were rising rapidly. However, the conduit repairs held up well, and the MacArthur Boulevard maintenance and policing responsibilities were later transferred to Montgomery County. Those factors, coupled with greatly increased operating costs at the Little Falls Pumping Station because of the unanticipated significant increases in the costs of electric power, have ensured that General Meigs' conduit system will remain in use and continue to prove economically advantageous for many years to come.[12]

CHAPTER 19
Construction After 1960

The Washington District Office of the Corps was abolished in June 1961, and the Washington Aqueduct then became a division of the Baltimore District.[1] Ten months earlier, on 18 July 1960, to the accompaniment of a military howitzer salute fired by gun crews from Fort Myer, ground was broken for the new filter and chemical buildings at Dalecarlia. The ranking officer at the ceremony was Brigadier General Alvin C. Welling, a former Baltimore District Engineer who was then the Engineer Commissioner of the District of Columbia. This project not only contributed additional long-range chemical treatment and filtration capability, but, of more immediate significance, eliminated the influent bottleneck that had greatly limited production from this plant. Four separate Parshall flumes were connected to the influent conduits from the reservoir built earlier during the construction of the pumping station. Measured flow from each flume was directed to the sedimentation basins (each flume eventually would be connected to its own separate basin.) These flumes served both as flow meters, pacing the feed of the chemicals being added, and as mixing devices. The agitation at the hydraulic jump at the end of the flume proved sufficient to provide adequate mixing of the aluminum sulfate solution being fed ahead of the flume. The chemical building provided increased chemical handling, storage and feed capacity for alum, chlorine, lime, hydrofluosilicic acid, and sulfur dioxide.[2]

The new plant was equipped to handle and feed granular alum, and the old liquid alum manufacturing and feed equipment was abandoned. The fluoridation system, which had been introducing powdered sodium silico-fluoride, was converted to feed hydro-fluosilicic acid. These changes eliminated the two most hazardous and obnoxious jobs at the plant. The alum boiling vats created conditions akin to those in steel mills, and there was always the hazard of splashing acid. Hazardous dust from handling the powdered sodium silico-fluoride had been a continuing problem during the 12 years of its use.[3]

In the chemical building, water treatment is controlled from a central operating room, staffed 24 hours per day, which provides visual indication of flow rates, chemical feed rates, and various water quality

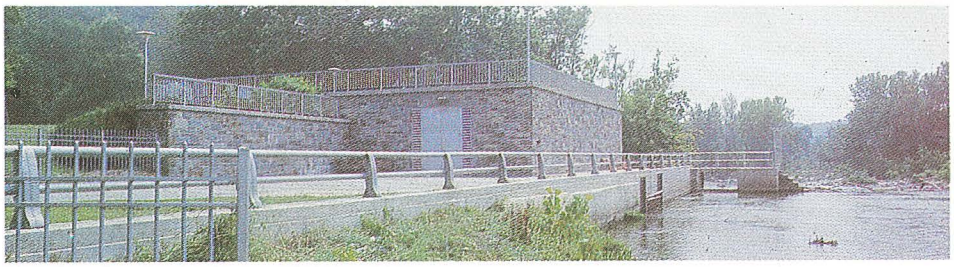
parameters to guide the operators. The second story of this 202-feet-by-137-feet building houses offices and the expanded chemistry and microbiological laboratories. In the highest portion of the building, large cylindrical storage tanks hold several hundred tons of alum and lime. The building has been sized for expansion, with room available for doubling the chemical storage and feeding capability. The coagulant for the water destined for McMillan is still fed to the Georgetown conduit from the Dalecarlia plant.[4]

The 450-feet-by-180 feet west filter building houses 22 more rapid sand filters. Although all 22 were built in 1964, only 10 were fully equipped and operational. The remaining 12 need only filter bottoms, media, valves, and the associated piping and appurtenances to provide additional capacity. The 10 operating filters are rated at 6 mgd each, on the basis of 2 gallons per minute per square foot, adding 60 mg of nominal capacity. This rating, used to specify the overall nominal plant capacity of 164 mgd, is quite conservative by modern standards. With proper pretreatment, the filters will easily handle double that amount and more. Actually, the hydraulic limitations in the associated piping and conduits determine the maximum capacity of the plant, which is estimated at 300 mgd, without resorting to equipping the remaining 12 filters.[5]

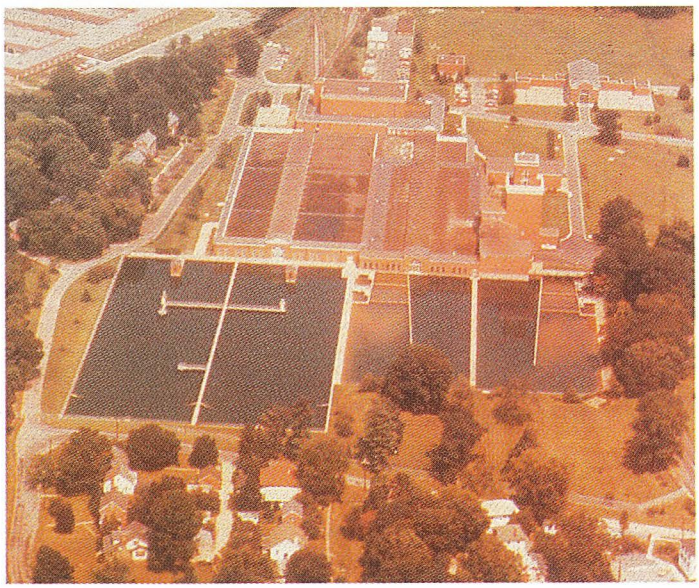
With the improved influent conditions, this plant could now meet most of the increasing demands. By July 1966, the Dalecarlia plant was producing nearly 150 mgd, and the peak day had risen to 278 mgd. On 30 August 1973, the all-time peak day was reached. The two plants produced 279.54 MG: 156.84 MG from Dalecarlia and 122.70 MG from McMillan. Since that time, the rapidly declining population of the District of Columbia (a decrease of 20 percent between 1970 and 1990) has resulted in decreased output.[6] While the design of a new intake structure at Great Falls was under way, the City of Falls Church completed a new 36-inch pipeline from Dalecarlia to its Virginia service area, using the 30-inch line that had been embedded previously in the Little Falls Dam. The use of Falls Church's connection from Arlington was discontinued and the main placed in standby status.[7]

Construction of the present Great Falls intake structure was begun in 1967. This improvement combined the intakes, bar racks, traveling screens, sluice gates, and control devices for both the old and the new conduits in a single facility. Completed in 1970, this addition eliminated the need for 24-hours-per-day staffing of the intakes, because it was monitored and controlled remotely from the control room in the Dalecarlia Pumping Station. Architecturally, the new intake was designed to be compatible with the heavily visited C&O Canal Great Falls Park in which it is situated. The low-lying building rises only a few feet above the tow path, has walls of native stone, and has a flat roof that serves as an observation platform overlooking the wide expanse of the river behind the dam at this point. Although not designed for that purpose, this roof deck also serves as a helicopter landing pad during emergency river rescue operations on this hazardous stretch of the Potomac River.[8]

Because of the dense development of the 6.6 square mile watershed of Little Falls Branch the increased runoff had for some time been exceeding the capacity of the diversion system built in 1885 to eliminate overflow to the reservoir, resulting in intermittent overflows. To eliminate this potential for pollution from the increased business, industrial, and residential develop-



New Great Falls Intake Building for both conduits – 1970



The Dalecarlia Water Treatment Plant, Pumping Station and Maintenance Shops, 1982

ment in northwest Washington, Bethesda, and Chevy Chase, the Dalecarlia Flood Protection Project was completed in 1973. The dikes on Mill and East creeks were raised and widened, and the spillways raised. The two tunnels had been the major bottlenecks causing the backups and overflows. The shorter of the two was replaced by an open cut ditch, and the tunnel under MacArthur Boulevard was enlarged from 7 feet to 12 feet in diameter. During the enlargement, rotten rock was encountered, which added to the project cost.[9]

The need to replace and relocate the Washington Aqueduct maintenance shops had long been apparent. These facilities were made up of old World War II quonset huts and even left-over Civilian Conservation Corps (CCC) buildings from the 1930s. They were located on the Dalecarlia Reservoir watershed, across MacArthur Boulevard on the hill behind the old caretaker's house. In addition to threatening to pollute the reservoir, they were inefficient and inaccessible. By 1974, nearly 700,000 cubic yards of fill material from the Metro construction had been placed and compacted, at no cost to the Aqueduct, in the old Little Falls Branch valley behind the Dalecarlia plant to prepare the site for the new shops and maintenance building. This conveniently located building, completed in 1977, houses expanded facilities for carpentry, painting, plumbing, and pipefitting; automotive and heavy equipment repair; electrical and electronic maintenance; and an extensive machine shop. The building includes a section for materials storage, locker rooms, and modern offices for the Maintenance Branch personnel.[10]

Attention turned again to the McMillan plant, which, with only routine maintenance, had contributed so significantly to meeting demands while the Dalecarlia ex-

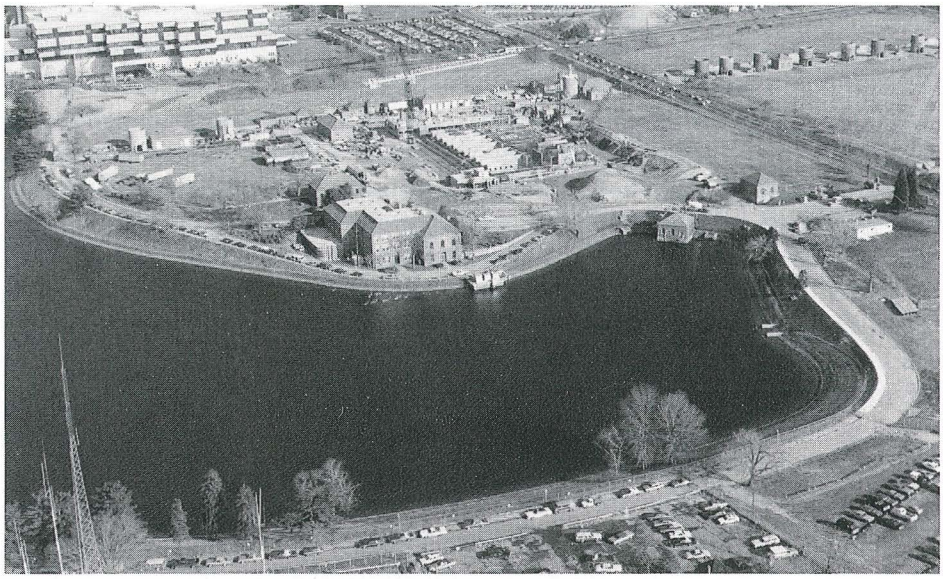
pansion was under way. Although the 480 Report had considered replacing the slow sand filters with rapid sand filters, this had not been recommended. The upgrading of the plant, together with new chemical storage and feed facilities, was considered to be adequate in meeting future requirements. During the ensuing years, several factors dictated reconsideration and the ultimate decision to construct new rapid sand filters and abandon the 29 acres of old slow sand filters. Structural failure of the old filters was a major factor in the decision. By 1972, three of the filters had been declared unusable because large chunks of the roofs had collapsed onto the filters below. Safety considerations precluded placing men and machinery into these structures to carry out the needed cleaning operations. And even with the mechanical sand washers, the filter-cleaning procedure was somewhat primitive. It was so labor intensive that two sandwashing crews worked for three weeks to wash a single filter. First, trenches had to be dug by hand on either side of the columns for the entire length of the filter to permit the sandwashers to operate properly. Abrasion from the sand caused rapid deterioration of the mechanical equipment, and parts had to be replaced frequently. The Nichols Sand-Washing Machine Company had long since gone out of business, and the parts had to be specially fabricated from the patented drawings that Mr. Nichols' widow generously granted the Aqueduct permission to use. The sand-washing operation was not only costly, but had to be carried out in working conditions that were very cold and damp in the winter and hot and humid in the summer. Finally, unexplained decreases in the flow from some of the filters raised the suspicion that some parts of the miles of underground pipe and drainage systems beneath the filters had deteriorated.[11]

In 1982, construction began on the new McMillan Filter Plant, which included replacing the three pumps in the McMillan Pumping Station with variable-speed units having pumping capacities ranging from 60 to 90 mgd each and operating at the higher heads needed to permit the use of filter bed levels above those of the old filters. Although the plan had been to replace these pumps during a 90-day shutdown of the McMillan plant (and to temporarily shift all of the demand to Dalecarlia), this plan was discarded as too risky. Instead, a temporary pumping station was installed using three 50 mgd submersible pumps. This enabled the plant to remain in service throughout the full construction period.[12]

Three of the old slow sand filters were demolished to make room for the new filter and chemical buildings. The 60-feet-by-196-feet chemical building houses the equipment for storing, feeding, and monitoring the lime and chlorine fed to the McMillan filtered water, as well as a prefilter polymer application that may be required from time to time to sustain the higher nominal design filter rates. The building also contains electrical switch gear, and a state-of-the-art central control room, where all functions of the facility are monitored, controlled, and recorded by a computerized system.[13]

The 260-feet-by-165-feet filter building includes 12 high-rate dual media filters, rated at 11 mgd each, based on a nominal design rate of 4 gallons per minute per square foot (twice the design rate used previously at Dalecarlia). The total surface area of all 12 rapid sand filters is only about one-half the area of one of the original 29 slow sand filters. The plant has an overall nominal rate of 120 mgd, but is hydraulically capable of handling up to 180 mgd.

The McMillan Slow Sand Filter Plant in operation during construction of the new rapid sand plant – 1983



The new McMillan rapid sand plant and chemical building surrounded by the abandoned slow sand plant, 1985

McMillan Reservation with new plant in the center, 1985

At the old slow sand plant, all sand-washing discharges had been disposed of through the District of Columbia sewerage system. However, the District of Columbia Water and Sewer Utility Administration expressed concern that the higher backwash flow rates required to clean the rapid sand filters would overload the local sewers, and also utilize too much of their limited allocation at the Blue Plains Waste Treatment Plant. This led to an innovative backwash recovery system. The filter backwash water is discharged directly to a pool at the north end of the reservoir created by stretching a membrane dam across a narrow part of the reservoir. A small dredge was provided to periodically pump the material which settles behind the dam into the sewer.[14]

At the Dalecarlia plant, concern was growing over the frequent discharges of filter backwash water, which sometimes occurred as often as 15 times a day, into the Potomac River. These discharges were being made in compliance with existing laws, under the terms of National Pollution Discharge Elimination System (NPDES) permits issued to the Washington Aqueduct by the U.S. Environmental Protection Agency. Although no detrimental effect on the river was proven, aesthetic concerns led to elimination of these discharges in 1982. A backwash water recovery facility, consisting of a very deep storage tank and an associated small pumping station, recirculates all of the filter backwash water to the main Dalecarlia Reservoir. The sediment removed in the four sedimentation basins is discharged to the river, under the terms of the NPDES permit, during periods of high flow and turbidity in the river. This material represents less than one-half of 1 percent of the silt load carried by the Potomac at Washington and is material that had been in the river in the first place. Recent scientific testing of the estuary bottom has determined that discharging this material into the river has no detrimental effect. The Aqueduct has always met all requirements of the environmental laws and the permits it holds in this regard and will continue to do so in the future.[15]

The requirements for testing and maintaining water quality were greatly strengthened through rules promulgated by the EPA under the provisions of Public Law 93-523, the Safe Drinking Water Act. These regulations, which went into effect in 1974, led to a major expansion of the Aqueduct Laboratory facilities and the creation of an Organics Section. Here high-technology equipment such as computerized mass-spectrophotometer-gas-chromatographs and atomic absorption spectrophotometers are used regularly to analyze for the many complex chemical components for which standards have been established. The water produced by the Washington Aqueduct meets, and in most cases surpasses, the required standards. However, more stringent future requirements, particularly with regard to methods of disinfection and removal of the byproducts thereby produced, may dictate the need for extensive and costly modification of the treatment processes.[16]

Late in 1990, bids were received on the last major construction project to improve and expand the system as proposed in House Document 480. The two original sedimentation Basins Nos. 1 and 2, nominally rated at 40 mgd each, were by now badly deteriorated, and the Aqueduct engineering staff prepared plans to replace them with two new basins. Because of the high cost of excavation into solid rock that was required for two-story basins at the location, these new

structures were designed as single-story basins, with a capacity of 60 mgd each. These two 490-feet-long-by-135-feet-wide basins are 18 feet deep and have a volume of nearly 9 MG each, more than twice the size of the ones they replaced. Although initially built for batch discharge similar to that from Basins Nos. 3 and 4, they were designed to permit the installation of flight collector mechanisms for continuous sediment withdrawal, if they were required in the future. An additional 120 mgd was sufficient to meet anticipated requirements, but provision was made to add a micro-flocculation system to increase the capacity if needed at a later date. The new basins are wider and larger than the ones they replaced and provide a single flow path from the south end to the plant, rather than around the end baffle arrangement used in all previous basins at Dalecarlia. Flow control and chemical treatment to these basins will be through Parshall flumes Nos. 1 and 2 in the chemical building.[17]

With the completion of this project, the only remaining elements of the original Dalecarlia plant that are still in service are the 15 MG clearwell and the original 20 rapid sand filters. Replacement of the piping, valves, and rate controllers for these filters is now under way. When completed, the old filters can be monitored and operated from the chemical building control room, as are the 10 new filters added in 1964. The next step in this complete renovation program will be replacement of the filter bottoms, media and surface wash systems, and rehabilitation of the building superstructure.[18]

Further increases in capacity should not be required until far into the future, because the 1992 estimate finds population in the District of Columbia continuing to decline (to 589,000). For the near future, the scheduling of any major construction projects that might be needed for the Washington Aqueduct system will most likely be the result of the more stringent environmental regulations likely to be imposed on the nation's water utilities.[19]

CHAPTER 20
Water Supply to Northern Virginia

ARLINGTON COUNTY SUPPLY

Congress authorized the sale of water from the Washington Aqueduct pumping station at Dalecarlia to Arlington County on 14 April 1926. The Secretary of War was authorized, at his discretion and subject to the approval of the Chief of Engineers, to permit the delivery of water provided that "All expenses of installing said connection and its appurtenances, and any subsequent changes therein, shall be borne by said Arlington County." That provision for approval by the Chief of Engineers may be the only instance in which a Cabinet Secretary was required to obtain the Chief's approval before proceeding with an action. The law contained another interesting provision: "that the Secretary of War may revoke, at any time, any permit for the use of said water which may have been granted."[1] The act also provided that the Secretary of War was to determine the charges for the water, and all payments were to be "deposited in the Treasury of the United States as other water rents now collected in the District of Columbia are now deposited."

The Secretary of the Army delegated the authority to establish the charges to the Baltimore District Engineer in 1983. The rates to be charged are determined by the Washington Aqueduct Staff, based on the annual operating costs and the costs of the Capital Improvement Program required to meet the peak demands imposed.[2] A simple contract was signed by the Secretary of War, the Chief of Engineers, and the Chairman of the Arlington County Board of Supervisors on 10 January 1927, and that same contract remains in effect today. The bottom line said, "This agreement is to continue at the pleasure of the Secretary of War." This cut-off authority, similar to the statutory authority of the Chief to shut off the water to the citizens of the District, will also never be implemented.[3]

As part of the major expansion program then under way at Dalecarlia in the 1920s, the Corps built a 24-inch main from the soon-to-be-completed Dalecarlia Pumping Station to Chain Bridge and two 8-inch mains across the bridge. The supply of water to Arlington County began on 26 September 1927, from the Third High Service. During December 1927, the consumption was 4.6 MG, an average of 153,000 gallons per day. By July 1928, the

single-day consumption had risen to a maximum of 734,000 gallons per day. In 1931, a 10 mgd auxiliary booster pumping station located at the Dalecarlia 15 MG clearwell was completed and began pumping directly into the Arlington mains. As the county population increased, more facilities were required to meet the demand. Two 20-inch mains were built across Chain Bridge in 1931, to be joined in 1938 by two more 20-inch lines and in 1994 by a new 36-inch main from Dalecarlia to the bridge.[4]

By 1950, Arlington County had 298 miles of distributing mains supplying an average of 12 mgd to 135,000 people. After a new and vastly expanded Dalecarlia Pumping Station went into service in 1958, the small booster station was abandoned, and the 36-inch main was connected directly to the existing Third High Service transmission main. A new 48-inch main was built under the Potomac River in the 1960s near Chain Bridge. The Arlington County Department of Public Works has recently completed the design of a new 48-inch main from Chain Bridge to Dalecarlia. During 1991, the average consumption by Arlington was 24.6 mgd, and the maximum daily demand was more than 34 MG.[5]

FALLS CHURCH SUPPLY

Early in 1945, the Aqueduct received inquiries from Arlington County regarding supplying parts of Fairfax County from the Arlington County connections to the Aqueduct. The Chief Engineer of the Aqueduct advised Arlington County that such delivery was not authorized by existing statutes and that proper enabling legislation would be needed. That legislation came on 26 June 1947 in Public Law 118, 80th Congress, which authorized the Secretary of War, on the recommendation of the Chief of Engineers, to permit delivery of water from Dalecarlia "to the Town of Falls Church...or any other competent State or local authority in the Washington Metropolitan area in Virginia." After agreements were reached in 1947, the Town of Falls Church began taking water from the Arlington system at a connection on Chain Bridge Road. Arlington was billed for this water and was reimbursed by Falls Church. When the new raw water pumping station on the Potomac River at Little Falls was built in 1957, a 30-inch diameter main was embedded in the concrete dam across the river, at the expense of the City of Falls Church. By January 1962, 36-inch mains on either side of the river were connected to this 30-inch line, providing a direct supply from the Third High Service at Dalecarlia to Falls Church. At the time, the supply from Arlington was discontinued, and the connection was placed on standby status. By this time, the City of Falls Church had obtained a charter from the Virginia State Corporation Commission to serve approximately 50 square miles of Fairfax County, including the communities of Vienna and McLean and the Tysons Corner area.[6]

When increased consumption by Falls Church began to overtax the pumping capacity on the Third High Service, the Aqueduct directed that city to provide the necessary facilities to switch to Second High, where adequate pumping capacity was available. A new Falls Church Pumping Station built in 1978 near Chain Bridge Road, served that purpose. In 1991, the average consumption by Falls Church was 17 mgd, and the maximum-day use was nearly 25 MG. The Aqueduct now supplies an average of 42 mgd, or more than 15 billion gallons per year, to the Northern Virginia jurisdictions.[7]

FEDERALLY OWNED WATERMAINS

Another Washington Aqueduct responsibility in Northern Virginia is the operation and maintenance of a system of water mains connected to the District of Columbia First High mains in Georgetown, which cross the Potomac on the underside of Key Bridge and extend to the Pentagon and Washington National Airport. These mains serve the Pentagon, Fort Myer, Arlington Cemetery, and other federal installations in the vicinity and also the airport. They were constructed during World War II by the various agencies they served. Today the system consists of 16-inch and 30-inch mains extending from the District side of the Potomac to the Pentagon and a 24-inch line from there to National Airport. The 16- and 30-inch lines are interconnected at several points, and there are smaller mains of from 6- to 18-inch diameter, including a 16-inch loop around the Pentagon.[8]

Originally, the responsibility for maintaining the mains was assigned to the Military District of Washington. Because these mains were outside the District of Columbia, it was considered advisable that the maintenance responsibilities be duly authorized by law. The 79th Congress, 2d Session, enacted Public Law 374 to provide for "Maintenance and operation of certain Federal water mains outside the District of Columbia." The law provided funding "to be expended at the direction of the Secretary of War, including supervision by the Chief of Engineers." This responsibility was assigned to the Washington District Engineer by the Chief on 15 January 1943, and immediately was delegated to the Washington Aqueduct, where it has remained ever since. For nearly 50 years, funding for operation and maintenance was from military appropriations. However, these mains are now maintained with funds from the District of Columbia Water and Sewer Enterprise Fund. The District Government is reimbursed for the water used from these mains, as it is for all water produced by the Aqueduct that is used by other federal Agencies.[9]

Ownership of these mains was never transferred to the Corps, but remained with whichever agency originally built them. However, as to protecting the system, the Aqueduct has always functioned as if it were the owner, demanding that the work done on the numerous relocations required by the Virginia Department of Highways and the Washington Metropolitan Area Transit Authority not only be done in a manner that guaranteed the integrity of the system, but that it also be done at their expense. Over the years, this system has also served as a valuable interconnection to meet the needs of either Arlington County or the federal government in emergencies or during planned shutdowns of either system for repairs.[10]

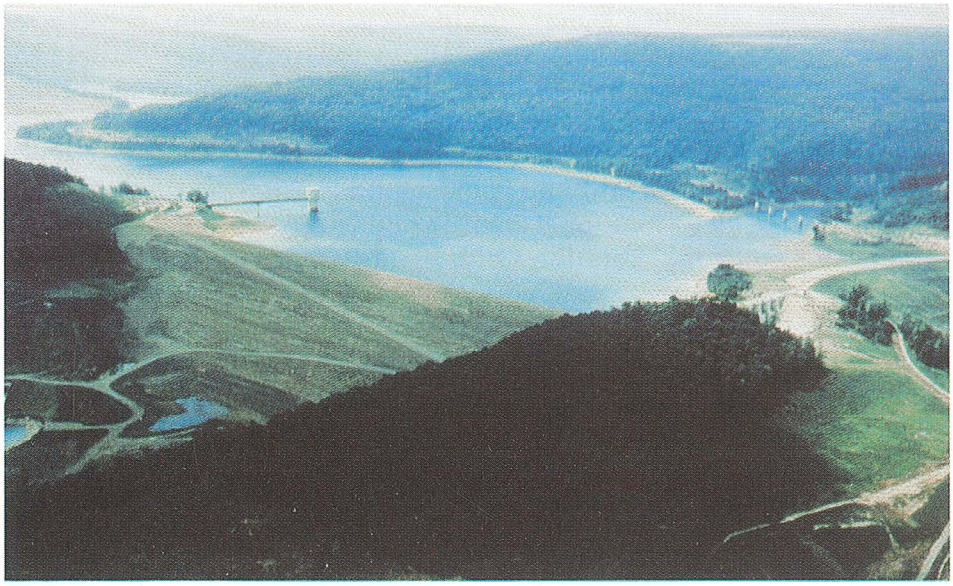
An additional federally owned line is the 20-inch main extending from the District of Columbia Boundary to Andrews Air Force Base in Maryland. This main is also operated and maintained by the Washington Aqueduct Maintenance Branch.[11]

CHAPTER 21
The Regional Water Resources Solution

Except for the 1913 Patuxent River Study done by Mr. E. D. Hardy, additional river water resources development planning for the Washington, D.C., area was carried out by elements of the Corps of Engineers other than those responsible for the operation and management of the Washington Aqueduct. That 1913 study recommended use of the Patuxent River, which was later developed to its maximum yield by the Washington Suburban Sanitary Commission. Later, major impoundments were proposed for such unlikely locations as Chain Bridge and River Bend.

Early in the 1960s, Corps water resources planning had produced a development plan calling for 16 multipurpose upstream impoundments. Because of opposition this plan was reduced to the "Six Pack." Ultimately, only one upstream reservoir, the Bloomington Lake Project, was built. It was authorized originally under the Flood Control Act of 1962. The project became operational in September 1981, providing 30 billion gallons of storage for

Jennings Randolph (Bloomington Lake)



water supply and other purposes. It proved to be the single most important factor in ensuring dependable flows to meet water supply demands during future droughts.[1]

When equitable distribution of available raw water supplies in the Washington area and optimum operation of all existing facilities became significant factors, the Washington Aqueduct assumed a significant role in developing solutions to the Washington metropolitan area water supply crisis. During the drought of 1966, river flow fell to 388 mgd on 10 September. This was the all-time low flow in the Potomac River. At about that same time, the two major suburban water supply utilities, the Washington Suburban Sanitary Commission (WSSC) and the Fairfax County Water Authority (FCWA), were planning long-range expansion of their facilities, including new enlarged intake structures on the river upstream of the Washington Aqueduct intakes, which would be capable of pumping more than the record low flow. The implication were ominous for the Aqueduct customers; namely, the potential of no water at the intakes on the river. Between 1971 and 1982, the Washington area daily water demand exceeded 388 mgd on 41 occasions. Fortunately, the Corps of Engineers held a trump card in this game and played it wisely. Under existing authority granted in 1899 by the Rivers and Harbors Act, any structure proposed on the "navigable" portion of the Potomac River could be built only after obtaining a permit from the Corps. The Potomac was considered to be navigable as far upstream as Cumberland, Maryland; thus, the Corps was able to block any additional intakes until adequate and equitable solutions to the potential water supply problems were developed.[2]

Both the Corps and Congress remained insistent that a legally enforceable agreement for equitable distribution of flow during droughts be in place before any further facilities for withdrawing water from the river were allowed. On 11 January 1978, the Potomac River Low Flow Allocation Agreement (LFAA) was signed by representatives of the Corps of Engineers, the State of Maryland, the Commonwealth of Virginia. the District of Columbia, the Washington Suburban Sanitary Commission, and the Fairfax County Water Authority. Based on a formula developed by the Washington Aqueduct staff, in time of drought all available water, including that available from the WSSC Patuxent River impoundments and the FCWA Occoquan system, would be allocated so that all jurisdictions received a share based on their percent of the normal winter-time consumption by all parties. No disproportionate shortages would be suffered by any jurisdiction.

However, because rapid growth in the suburban areas posed the threat of unacceptably low allocations to the Washington Aqueduct in the future, the Corps insisted that the agreement contain a provision freezing allocations based on the 1988 winter demand of each utility at any time after that year. Including this "freeze" provision proved to be wise, because removal of the freeze later became an important bargaining chip in realizing the cooperative Water Supply Coordination Agreement (CO-OP). This agreement included the provision that payment for raw water supply development needed to meet future long-range requirements would be based on incremental growth ratios rather than total needs of each utility. The Low Flow Allocation Agreement, although it did not provide any additional water, paved the way for subsequent unprecedented regional cooperation in the development and use of water resources.[3]

Shortly thereafter, at a meeting in Cumberland, Maryland, in December 1979, the Federal Interstate Regional Advisory Committee (an advisory group to the Baltimore District's ongoing Metropolitan Washington Area Water Supply Study), recommended that the local governments and utilities form a Metropolitan Washington Regional Water Supply Task Force to address the long-range water supply problem. This Task Force was led by retired Brigadier General Robert S. McGarry, a former Baltimore District Engineer who was then the General Manager of the WSSC.[4]

A long-range plan was developed for solving the water supply problem through local action. The plan embodied the purchase of the water supply storage available in Bloomington Lake from the Corps of Engineers, at a cost of $65.5 million; the development of additional readily available storage on Little Seneca Creek in Montgomery County, at an estimated cost of over $30 million, to provide immediate augmentation, because releases from Bloomington Lake would not reach the area for 7 days; sharing operating costs and supervising the management of the Savage River Dam storage; and a formal Water Supply Coordination Agreement to ensure optimum operation of all facilities to provide the maximum benefit to all users.

An essential element of this plan was the development of an equitable method of sharing the capital cost of nearly $100 million and the subsequent long-range operation and maintenance costs required to implement the plan. Acceptable cost-allocation ratios were developed by a Technical Advisory Committee consisting of the General Manager of the WSSC, the Engineer Director of the FCWA, and the Chief of the Washington Aqueduct. The eight separate legal documents necessary to complete this remarkable plan were signed by all parties on 22 July 1982. The Cooperative Agreements are administered by the CO-OP Section of the Interstate Commission on the Potomac River Basin, under the direction of a managing committee consisting of the top operating officials of the WSSC, the FCWA, and the Washington Aqueduct.[5]

During the CO-OP negotiations, the 1988 freeze provision in the LFAA and its effect on the "regional" philosophy underlying the work of the Task Force was discussed. The argument was made that it was unfair to retain the right to freeze allocations at the 1988 level when the concept of the "regional" cooperation plan involved sharing of all water supply facilities and agreeing to manage them to maximize the benefits to all. It was also argued that a freeze was not needed because the regional operating plan would be adequate to provide all of the future needs of the area for the next 50 years. The Corps had no objection to eliminating the freeze, as long as the future interests of its customers were protected. As a result, all parties to the negotiations agreed that the freeze provision could be removed, provided that the following conditions were met: (1) that the freeze would be waived only when the WSSC, the FCWA, and the Washington Aqueduct had an agreement in effect providing for regional management of all of their water supply facilities for the benefit of the Washington metropolitan area (the CO-OP) Agreement), and the proposed Little Seneca Lake was constructed and operational; and (2) that if any additional water resources development projects were required beyond Little Seneca Lake, the signatories mutually agreed to provide them and to share the cost of any such facilities in proportion to the incremental increases

in water consumption by each jurisdiction during the intervening period, rather than as a percentage of the current rates of consumption.[6] (The costs of the first project undertaken under this provision, the Bloomington Lake (now renamed for Senator Jennings Randolph of West Virginia) Water Supply Reformulation Study, are being paid for by the WSSC and FCWA with no contribution required by the Washington Aqueduct, because the consumption on the latter system has declined in the intervening period, while the use by the others has increased.)

These provisions were then embodied in a revised LFAA. Insofar as ensuring an adequate water supply for the Washington Aqueduct users, these revisions accomplished the purposes of the freeze provision in the original LFAA and, in fact, improved and extended them. It is unlikely the 1988 freeze provision would have been allowed to stand indefinitely. At some future time, it might have been overturned by a court decision, leaving none of the desired safeguards. The modification, on the other hand, was unlikely to be judged unreasonable by anyone, because it ensures both that adequate facilities will be provided to meet all future needs and that the costs of such facilities will be shared on an equitable basis.[7]

The Metropolitan Washington Area Water Supply Study, authorized by the Water Resources Development Act of 1974 and produced by the Planning Division of the Baltimore District, assisted and encouraged this historic regional cooperation. This massive 10-volume report formulated most of the solutions eventually reached, but ultimately concluded that:

> In light of the significant advances in regional cooperation among the major users, the region's recent commitment to act on high priority water supply programs, and the creation of local institutional mechanisms to implement these water supply programs, the District Engineer recommends that no additional projects or programs be undertaken by the Corps of Engineers at this time....

This radical departure from the 16 dams that had been proposed just 20 years earlier was a model of enlightened public participation and bureaucratic cooperation.[8]

CHAPTER 22
The Estuary

The water here flows back and forth with the tide, over the extensive flats between Georgetown and the Long Bridge, collecting and retaining the sewage water of the cities; and, as these cities increase in size, the water will become less and less fit for domestic use.

Montgomery C. Meigs
February 1853

The mid-1960s drought heightened concern over the effects of future droughts, particularly in view of the rapid growth in the Washington Metropolitan area. As an adjunct to the studies and efforts undertaken to alleviate these concerns, the Washington Aqueduct undertook two significant projects involving the use of the water from the estuarine portion of the Potomac below Little Falls. These projects, which are frequently confused with each other and sometimes regarded as the same project, were actually unrelated and designed to serve different purposes.[1]

The first of these projects was the Emergency Estuary Pumping Station constructed just above Chain Bridge. There were concerns about the suitability of the water in the estuary for use as drinking water. The estuary was far less desirable as a source than the free-flowing portion of the Potomac. The water quality in the estuary below Chain Bridge was degraded as a result of the discharge of both treated and untreated sewage, along with storm water runoff. In addition, tidal effects caused periodic mild salinity. Several studies of the feasibility of using this source were done, included simulations in the dynamic estuary computer model at the Annapolis field office of the Environmental Protection Agency.

At Chain Bridge, the estuary water was normally well diluted with fresh water from upstream. But during severe drought conditions this flow would be diminished significantly, or eliminated entirely, by the withdrawals at the upstream water supply intakes. A determination was needed as to how much water could be withdrawn at the upper end of the tidal area before the intrusion of polluted water drawn up from below caused the water quality to fall below acceptable limits. The belief was that 50 to 100 mgd of this water could be treated adequately, at least for a limited period, and that the use of the estuary water was preferable to allowing portions of the service area to "go dry." The results of going dry would be loss of fire protection and a public health

The "camouflaged" Emergency Estuary Pumping Station as seen from Chain Bridge

hazard posed by major sanitation problems.[2]

By the late 1960s, confronted with unpredictable delays in implementing the proposed plans to alleviate Washington's potential water shortages, officials in office of the Director of Civil Works, Office of the Chief of Engineers, became concerned about the Corps' ability to carry out its mandate to ensure an adequate water supply to the nation's capital. Consequently, the Washington Aqueduct was directed to construct a pumping station that could draw water from the estuary if and when insufficient amounts were available at the Great Falls and Little Falls intakes. Delays occurred in obtaining funds, preparing Environmental Impact Statements, preparing plans and specifications, and obtaining the necessary permits for the proposed construction site. Construction was not completed until 1979.[3]

The project was designated as "temporary," to remain available only until the water shortage potential had been resolved by other means. Stipulations were that (1) this pumping station would be used only after the determination that the water could be suitably treated by existing facilities and (2) it was not to be used until after mandatory water use restrictions had been called for by the Metropolitan Washington Council of Governments and put in place by all local jurisdictions.[4]

The station was designed with 100 mgd capacity, pumping directly to the Dalecarlia Reservoir via the old Hydroelectric Station penstock. Because the station was located in the flood plain, the five 800 horsepower motors (one for each 20 mgd pump) were stored at the Dalecarlia site, to be installed at the station if and when required. As it turned out, they never were installed, except for the initial test period. The station provided valuable backup assurance for a brief period, but the water supply problem was solved much sooner than anticipated. Because the station was frequently flooded, and access was extremely difficult, maintenance costs were relatively high. It was abandoned in 1985 because it was no longer needed.[5]

This station had interesting architectural features. The site was on the shore of the Potomac, within the C&O Canal National Park and visible from Chain Bridge. The public and especially the National Park Service, which had jurisdiction over the park, did not want another "Corps Castle" at that visible location. The resulting low-lying struc-

ture was designed to blend into the existing terrain and was surrounded by native stone from the excavation, piled randomly against the sides of the building, to make it unnoticeable from Chain Bridge. It now functions as a river overlook point, or "belvedere," similar to the roof over the intake at Great Falls Park.[6]

The other major estuary-related endeavor was the Potomac River Estuary Pilot Water Treatment Project. During the period when the Corps was proposing numerous dams in the Potomac River Basin to supply the needs of the area, the opponents of these dams demanded that consideration be given to use of the billions of gallons available in the estuary. This slightly brackish water, heavily polluted by sewage discharges from the metropolitan area, had never been considered seriously as a major source of water for the Washington area. However, Congress, in Section 85(b)(2) of the 1974 Water Resources Development Act, which also authorized the Metropolitan Washington Area Water Supply Study, directed that

> The Secretary of the Army, acting through the Chief of Engineers, shall undertake an investigation and study of the use of estuary waters to determine the feasibility of using such waters as a source of water supply and is authorized to construct, operate and evaluate a pilot project on the Potomac estuary for the treatment of such waters at an estimated cost of $6,000,000. The Secretary of the Army, acting through the Chief of Engineers, shall report to the Congress on the results of such project within three years after commencement of operation of such project and such report shall include the results of two years testing at the pilot project for the treatment of water from the Potomac Estuary.

In addition, Section 85(b)(3) directed the Secretary of the Army to request the National Academy of Sciences–National Academy of Engineering (NAS-NAE) to review and provide written comment on the scientific basis for conclusions reached in both the Metropolitan Washington Area Water Supply Study and the Experimental Estuary Water Treatment Plant (EEWTP) testing program.[7]

Overall management of the EEWTP project was assigned to the Washington Aqueduct. It was considered advisable that NAS-NAE review and agree on plant design and operating protocols prior to construction. Numerous meetings were held to reach these agreements. Plans proceeded only after NAS-NAE was convinced that the Corps was limited by both fiscal and time constraints to testing state-of-the-art treatment methods and techniques rather than doing basic research in toxicology, and using previously untried or undeveloped treatment methods. The 1-million-gallon-per-day prototype plant was constructed on the site of the Blue Plains Waste Water Treatment Plant in 1980, at a cost of about $10 million. The objective of the project was to develop, operate, and demonstrate water treatment processes that would consistently produce an acceptable finished water suitable for use as a public water supply and to determine the costs. Locating the plant at this site permitted simulation of the worst case scenario by testing a blend of estuary water and secondary sewage effluent from the plant.[8]

The facility included the conventional treatment methods of coagulation, sedimentation, filtration, and chlorination currently in large-scale use by the local utilities. The advanced treatment processes included use of equipment for microscreening; reverse osmosis; ion

The Experimental Estuary Water Treatment Plant at Blue Plains

exchange and electrodialysis treatment for removal of dissolved solids; granular activated carbon filters and packed tower aeration for removal of synthetic organic compounds and disinfection byproducts; and ozone and ultra-violet light for disinfection. The testing program, done under a cost-plus contract costing more than $9 million, used timed periods operating under various treatment trains, as well as simultaneous side-stream evaluation of other techniques. The program, including testing, evaluation, review, and preparation of the final report to Congress, was completed within the specified three years. The overall cost of the project, including design construction, testing, reporting, and administration, was about $21 million.[9]

The final report on the operation of the plant concluded that water meeting all standards, and of comparable quality to that currently being delivered to area consumers, could be produced from the estuary water. But the report also concluded that the costs to develop such a source would be far higher than those for using the more conventional fresh-water source. The cost of building a more complex treatment facility would be greater, and the processes would be high energy users. In addition, major new pumping stations and transmission mains would be needed to deliver the water to the existing storage reservoirs and distribution system, and the costs of pumping from a much lower level would be considerably greater. That the area will ever use the estuary as a major source of water supply is unlikely.[10]

CHAPTER 23
The District of Columbia Water Department

In June 1854, Captain Meigs recommended that the cities of Washington and Georgetown be required to pay for the distribution pipelines he was planning to lay, which he said would be about one-fourth of the total Aqueduct cost. Congress rejected his proposal, and the first mains were laid at federal expense. Up until the mid-20th century, many of the large-diameter primary transmission mains were built by the Corps of Engineers, beginning with Captain Meigs' mains to the Capitol and the Navy Yard in the 1850s. The service mains and the connections thereto were built and maintained by the District of Columbia government. After 1880, the District was paying partially, or in full, for the large mains, and many of those that were built by the Washington Aqueduct were later turned over to the D.C. Water Department.[1]

When the city was first given permission to tap the mains for the benefit of the citizens, the D.C. government became responsible for getting the water to the customer's homes. During the next 100 years, as the system spread throughout the city, large mains, pumping stations, and storage reservoirs were required to accomplish this. An Act of 3 March 1859 gave the corporations of Georgetown and the District of Columbia authority to tap the Aqueduct mains for the use of the local citizens. The act provided that "the rates levied by the cities of Georgetown and Washington shall never be a source of revenue, other than keeping up to the said cities a supply of water." The act also specified that the Chief of Engineers could shut off the supply to the citizens at any time that the supply was insufficient to meet the needs of the federal government. This law remains on the books, but it has never been invoked and, obviously, never will be.[2]

An Act of 11 June 1878 established the form of government that was to prevail in the District of Columbia for the next 89 years. That act authorized the President, with the advice and consent of the Senate, to appoint two people, who, with an officer of the Corps of Engineers, should serve as the Commissioners of the District of Columbia. The act specified that the Engineer Commissioner must have

at least the rank of captain. A later modification required that this person have at least 15 years service in the Corps of Engineers. Three Assistant Engineer Commissioners, lower in rank than the commissioner, were also to be detailed from the Corps. An Act of 1 July 1882 reorganized the District of Columbia government, created the Water Department, and directed that this department be under the jurisdiction of the Engineer Commissioner. (It was the only D.C. department designated to be under a specific commissioner.) This department then became primarily responsible for the construction and operation of the distribution system, although the Washington Aqueduct continued to design and construct many large transmission mains and reservoirs throughout the first half of the 20th century.[3]

When the increasing population in the higher areas created demands beyond the capacity of the hydraulic ram at the Pennsylvania Avenue Bridge, the ram was replaced by a steam-operated pumping station on Volta Place, and a new High Service area was supplied from a stand pipe at 16th Street and Florida Avenue. As the demands increased ever more, the Volta Place station was replaced by a new larger station constructed on U Street, which pumped to both the old Georgetown High Service Reservoir and to a new 4.5 MG reservoir built on the highest ground in the city at Fort Reno. The Georgetown High Service Reservoir was taken out of service 17 November 1897, at the request of the District Commissioners, when the Fort Reno Reservoir and the pumping station rendered its further use inadvisable except in case of emergency. This 1.5 acre tract became part of the D.C. park system through an Act of 1 July 1916, and a major Public Library was later constructed on the site.[4]

The status of the system at that time was described in the Corps' *Annual Report* for 1899:

> In addition to the three reservoirs (Dalecarlia, Distributing and Georgetown High Service) already mentioned, which form a part of the Aqueduct system, there is another reservoir, built and controlled by the Commissioners of the District of Columbia, called Fort Reno Reservoir with a capacity of 4.5 MG, the reference of its water surface when full being about 420 feet. This reservoir is supplied with water taken from the supply mains by the U Street pump.
>
> The Dalecarlia and the Distributing Reservoir's supply that part of the District which lies below 100 feet above datum. The areas lying between the levels of 100 and 210 feet above datum are supplied by pumping from the U Street Pumping Station directly into the distributing mains, the Georgetown high service reservoir being held as a reserve supply. The areas above a greater elevation than 210 feet above datum are supplied from the Fort Reno Reservoir.[5]

In 1889, a plan establishing five service areas—Low, First High, Second High, Third High, and Fourth High—was implemented. These five service areas still exist today, although with somewhat different boundaries. The Second High Service was supplied from a new 30 MG reservoir at 16th Street north of Colorado Avenue, Third High from Fort Reno, and Fourth High from water pumped to an elevated tank at Fort Reno. The first pumping station to supply the area east of the Anacostia River was also built at this time, taking water from the Low Service system.[6]

The completion of the new Washington Aqueduct Distributing Reservoir near Howard University altered the patterns and, to meet the growing demands, another new pump-

Fourth High Service Storage Tank at Fort Reno

ing station was built. During September 1904, a new steam-driven station was placed in service on Bryant Street, just below the dam that created the new reservoir. The Low Service was fed by gravity, but all pumping to the First, Second, and Third High areas was from that station until the Dalecarlia Pumping Station was completed in 1928. When the McMillan Slow Sand Filtration Plant went into service a year later, the mains to the city from the Georgetown Reservoir were capped and all water was diverted to the new treatment facilities. It was recognized that the mains had become an integral part of the city distribution system, and by mutual agreement they were now operated by the City Water Department.[7]

In 1913, a new pumping station and three elevated tanks were added to provide increased service to the Anacostia area. The first supply of water to an area outside the District occurred in 1917, when Congress authorized the sale of water to the new Washington Suburban Sanitary Commission, established to serve the adjacent Maryland counties of Montgomery and Prince George's. The rates charged were to be based on the actual production and distribution costs. The interconnections between these systems at various points along the D.C. boundary are still in place today, but only for emergency use.[8]

The major construction program to expand the system completed by the Corps of Engineers in 1928 had a dramatic effect on the system. The new electrically driven pumping station at Dalecarlia took over all pumping to the First, Second, and Third High systems and also to the newest outside customer: Arlington County, Virginia. Low Service was served by gravity from the McMillan plant, and the Bryant Street station was placed on standby service. It was partially converted to electrical service in 1931, when several of the pumps were replaced.[9]

The Corps built new underground reservoirs at that time: 20 MG on First High at Foxhall Road and 20 MG on Second High at 44th and Warren streets. Another 5.5 MG reservoir was added at Fort Reno to meet the increased needs caused by placing Arlington on Third High Service. Long mains of 48-, 36-, and 24-inch diameter connected the pumps to these reservoirs. Extensions of the mains from the reservoirs to distant connecting points in the distribution system were also built by the Aqueduct, but were transferred to the District in the 1930s. When the new Second High Reservoir was completed, the Brightwood Reservoir at 16th and Kennedy streets was abandoned and removed. Another First High Reservoir was built by the District on the grounds of the U.S. Soldiers' Home just north of the McMillan plants in 1939.[10]

Additional facilities called for in the 1946 480 Report resulted in

another round of significant changes. The construction projects assigned to the D.C. Water Department included numerous large-diameter trunk mains and restoration of the Bryant Street station to full service as an electrically driven station, which was completed in 1950. The station now assisted the Dalecarlia station by pumping to the First, Second, and Third High Service areas, and also provided partial pumping on Low Service to a new 25 MG reservoir at Brentwood, on New York Avenue, completed in 1959.[11]

The new Aqueduct pumping station completed at Dalecarlia in 1958 was built with added pumping capacity on the three High Service areas to match the greatly increased treatment capacity planned for the site. It also had three 50 mgd pumps to deliver water to Low Service via a proposed new 84-inch main. Responsibility for building this main was transferred later from the Aqueduct to the District of Columbia. When completed for most of its length as a 78-inch main in 1985, it was designated as the Crosstown main. The largest main in the system, it provides valuable redundancy because it is linked to the Bryant Street station in such a way that water produced at Dalecarlia can be pumped from Bryant Street to all of the areas served in the event of the loss of the city tunnel or the McMillan plant.[12]

The Corps retains ownership and jurisdiction over the three High Service Reservoirs built in the 1920s and the transmission mains leading to them, and is responsible for their operation. The jurisdiction generally passes to the District at the point where the water leaves these reservoirs, except on Low Service, where it changes at the connection of the 78-inch main to the Dalecarlia Pumping Station. At McMillan, the Aqueduct jurisdiction ends as the water leaves the south clearwell. The Aqueduct also maintains the lines to Arlington County as far as Chain Bridge, and the mains serving the Pentagon and National Airport.

CHAPTER 24
Funding the Aqueduct

Prior to 1 July 1880, all expenses for the Washington Aqueduct were paid by the federal government. At that time, Congress directed that thereafter the District of Columbia would pay one-half of all expenses incurred for construction and operation of the Aqueduct. That relationship continued until modified in 1916, when Congress required that the city be responsible for all operating expenses, to be paid from the water revenues of the District of Columbia; and one-half of the construction costs, to be paid from the D.C. General Fund. After 1927, all costs for both operating and construction were paid from revenues derived from the sale of the water produced by the Aqueduct.[1] After World War II, the District was authorized to borrow from the federal Treasury to finance the massive construction programs then being undertaken by both the Washington Aqueduct and the District of Columbia Department of Sanitary Engineering. These loans are amortized over 30 years at the federal interest rate prevailing at the time of the loan. The authority to borrow from the Treasury was rescinded in the 1980s.[2]

In 1916, Congress established a "Water Fund" for the exclusive use of the Washington Aqueduct and the D.C. Water Department. It was specified at the time that this fund could be used only for the operation, repair, and improvement of the water facilities. All moneys derived from the sale of water are now deposited in that fund, including proceeds from sales to private and commercial customers in Washington, the money collected by the Aqueduct from sale of water to Northern Virginia, and reimbursements from the federal government for the water used by the various agencies. Under this arrangement, all Washington Aqueduct operation, maintenance, and construction expenses, as well as debt service on prior construction loans, were paid from the District of Columbia Water and Sewer Enterprise Fund.[3]

The Act of 11 June 1878 providing for a government for the District of Columbia also directed that the Washington Aqueduct budgets be included in the annual estimates submitted to Congress by the District Commissioners each year. For that reason, the budgets for this Corps of Engineers function are re-

viewed and approved by the House and Senate Committees on Appropriations for the District of Columbia, rather than by the committees that handle the other Corps civil works project budgets. Because both the Aqueduct and the D.C. Water Department were supervised by Corps officers at the time of that act, this was a logical procedure. However, language was included in subsequent D.C. Appropriation Acts providing that "Nothing herein shall be construed as affecting the superintendence of and control of the Secretary of War over the Washington Aqueduct, its rights to appurtenances and fixtures connected to the same, and over appropriations therefore as now provided by law."[4]

The various laws existing at the time were summarized by Colonel Elliot in 1895:

> "Under existing laws, the Chief of Engineers, U.S. Army has immediate superintendence of the Washington Aqueduct and everything connected with the same belonging to the United States. His authority is required to tap all water pipes laid by the United States. He is in no way responsible to the authorities of the District of Columbia, though the estimates relating to maintenance and operation of the Aqueduct are required by law to be submitted to the Secretary of the Treasury by the Commissioners of the District. The responsibility for the care, storage and distribution of the water supply of the District lies severally upon the Chief of Engineers and the District Commissioners."
>
> These statutes remain in effect today.[5]

This unfettered authority was preserved when Congress passed Public Law 93-198, the District of Columbia Self-Government and Governmental Reorganization Act, in 1973, which directed that "Nothing in this act shall be construed as vesting in the District government any greater authority over the...Washington Aqueduct...than was vested in the commissioner prior to the effective date of title IV of this Act."[6]

To understand the relationships between the Washington Aqueduct office and the various governments of the District of Columbia over the years, one must remember that almost continuously from 1878 until 1967 all public works activities of the District of Columbia were directed by Corps officers, as mentioned previously. Initially, the city was managed by a mayor and council members who were satisfied to have the Corps of Engineers available to resolve the water supply problems. As mentioned earlier, the mayor and council presented a silver tea set to Captain Meigs for his dedicated service to the city. The mayoral system of government ended when the Washington City Charter expired in 1868 and was not restored for more than 100 years. It was replaced briefly by a territorial form of government under a governor and council appointed by the President. An Act of 20 June 1874 established a three-member commission, to be appointed by the President. The President was also directed to appoint an officer of the Corps of Engineers to manage the city's public works under the supervision and direction of the commissioners. The act of 11 June 1878 reestablished the three-commissioner government, but specified that one be an officer of the Corps of Engineers, who would be the Engineer Commissioner. This form of government lasted until 1967. The D.C. Appropriation Act of 1882 specified that the Water Department should be under the direction of the Engineer Commissioner. Although the organizations were separate, during the

19th century the Engineer Commissioner was sometimes the same officer who was in charge of the Aqueduct. And the D.C. Water Department was at times directed by a junior officer of the Corps.[7]

Although distinct jurisdictional boundaries remained, a close working relationship was always in place with regard to the development of the D.C. system. Construction and operations have been coordinated to balance the supply and distribution of water and the funding of mutually beneficial projects. The best example of the extent and effectiveness of this cooperation was the plan for "Adequate Future Water Supply for the District of Columbia and Metropolitan Area," known as House Document 480. The outstanding cooperation in carrying out the interrelated responsibilities for construction and operation of the facilities has continued unchanged as elected officials and their staffs have changed over the years. A recent opinion by the D.C. Corporation Counsel's office has verified the continued full control of the Chief of Engineers.

APPENDIX A
Inscriptions on the Original Washington Aqueduct Structures and Facilities

Many permanent inscriptions appear on the original Washington Aqueduct facilities built under the supervision of Montgomery Meigs. Even before these permanent remembrances were carved in stone, or cast in iron, and in some cases well before the structures were completed, Meigs had copper plates installed naming the principal persons involved. At Great Falls, the plate in the gatehouse had the names of the Presidents, Meigs, and his assistants, similar to the inscription on the stone placed in the building later. At the Cabin John Bridge, a copper plate was placed on an abutment on 4 April 1858 designating Meigs as Chief Engineer; this plate was similar to the carving placed on an arch stone three years later. The copper plate at the Distributing Reservoir gatehouse was salvaged when that building was destroyed in the 1960s.

The permanent inscriptions are shown below.

On the wall in the old stone gatehouse at Great Falls:

Washington Aqueduct
Projected by Captain Montgomery C. Meigs
U.S. Corps of Engineers, Chief Engineer
Begun Nov. 8, 1853 by Franklin Pierce
President of the United States
This stone is erected in the unfinished gatehouse
at the Great Falls of the Potomac
June 10. A.D. 1858, James Buchanan
being President of the United States
Captain M. C. Meigs, Chief Engineer of the Washington Aqueduct
The assistants have been
W.H. Bryan, C. Crozet, G.C. Talcott, A.L. Rives,
W.R. Hutton, E.D.T. Myers
Cost of the work as estimated in 1853, $2,300,000
Actual cost when finished $
Deo gratia
Esto perpetua

On Waste-weir No. 1:

Waste-weir No. 1
Washington Aqueduct
Captain M. C. Meigs, Chief Engineer

On Bridge No. 1:

Washington Aqueduct
Captain M. C. Meigs, Chief Engineer
Anno Domini 1857
Bridge No. 1

On Bridge No. 2:

Washington Aqueduct
Captain M. C. Meigs, Chief Engineer
Anno Domini 1857
Bridge No. 2

On Culvert No. 12:

Washington Aqueduct
A.D. 1856
Captain Montgomery C. Meigs, Chief Engineer
No. 12
May, 1856

On Bridge No. 3:

Washington Aqueduct
Chief Engineer
Captain Montgomery C. Meigs
U.S. Corps of Engineers
Division Engineer
Charles G. Talcott C. E.
Bridge No. 3
June 9,
A.D. 1858

On Bridge No. 4:

The inscriptions on the Cabin John Bridge and the deletions and restorations thereto are detailed in Chapter 6, "The Bridges".

On the sluice tower at the Receiving (Dalecarlia) Reservoir:

Washington Aqueduct
Built by order of the Congress of the United States for
bringing water into
Washington
Begun A.D. 1853 on the 8th day of November.
Water delivered in Washington
from this reservoir A.D. 1859,
on the 3rd day of January.
From the Potomac River A.D. ____on the ____day of ____
151 feet above 0 of the Washington Aqueduct, or 150
feet above ordinary high

water at Washington. A.D. 1858
Captain M. C. Meigs, Chief Engineer

On Waste-weir No. 3 between the two reservoirs:

Washington Aqueduct
Waste-weir No. 3
Dec., 1858
Captain M. C. Meigs, Chief Engineer
W. R. Hutton, C. E., Division Engineer

At the Distributing (Georgetown) Reservoir:

The riser on each of the 39 steps of the cast-iron circular staircase leading to the pipe vault shows the name M. C. Meigs.

On both sides of Bridge No. 6 at Rock Creek:

Washington Aqueduct
A.D. 1859
Chief Engineer, Captain M. C. Meigs
U.S. Corps of Engineers
Division Engineer E. D. T. Myers, C. E.
Iron Founders, A. & W. Denmead & Sons

On many of the brass and iron parts of the derricks and other machinery and on the valves and sluice gates:

Washington Aqueduct, M. C. Meigs

On the many hydrants throughout the city, the casting;

M. C. Meigs, Chf. Engr.

MORE RECENT INSCRIPTIONS

At the Dalecarlia Water Treatment Plant there is a bronze plaque containing the names of the officers, civilians and the contractor associated with the construction of the original plant in 1927, and another similar plaque naming those associated with the major addition in 1964.

At the McMillan Water Treatment plant, there is a plaque with the names of the persons associated with the construction of the New Filter and Chemical Building in 1985.

APPENDIX B
Civilian Chief Engineers of the Washington Aqueduct

William R. Hutton	1862–1863
Silas Seymour	1863–1865
Theodore B. Samo	1865–1880
R.C. Smead	1880–1900
Edward Dana Hardy	1900–1935
Edwin A. Schmitt	1935–1953
Byron Bird	1953–1956
John C. Smith	1956–1962
Dan M. Watt	1962–1971
John E. Kester	1971–1972
Harry C. Ways	1972–1991
Perry Costas	1991–

APPENDIX C
Officers in Charge of the Washington Aqueduct

Montgomery C. Meigs	1852–1860	Henry C. Newcomer	1915–1915
Henry W. Benham	1860	Charles W. Kutz	1915
James St. Clair Morton	1861	Harry F. Hodges	1915
Montgomery C. Meigs	1861	Clement A. F. Flagler	1915–1917
Nathanial Michler	1867–1870	Walter L. Fisk	1917–1919
George H. Elliot	1870–1871	Max C. Tyler	1919–1923
Orville E. Babcock	1871–1877	J. A. O'Conner	1923–1926
Thomas L. Casey	1877–1882	Brehon B. Somervell	1926–1930
Garrett J. Lydecker	1882–1889	Joseph D. Arthur, Jr.	1930–1934
John M. Wilson	1889	Leland H. Hewitt	1934
George H. Elliot	1889–1895	John C. H. Lee	1934
John G. D. Knight	1895	Frank O. Bowman	1934
Charles E. L. B. Davis	1895	Robert W. Crawford	1934–1935
Davis D. Gaillard	1896	William J. Matteson	1935–1937
Charles J. Allen	1896	Robert J. Guyer	1935
Edward Burr	1898	Walter D. Ludlow	1937–1938
Theodore A. Bingham	1898	Robert S. Thomas	1938–1940
Alexander M. Miller	1898–1904	William J. Barden	1940–1942
William P. Wooten	1904	Donald A. Phelan	1942
Smith S. Leach	1904–1905	Clarence Renshaw	1942–1944
Richard L. Hoxie	1905	John M. Johnson	1944–1945
Spencer Cosby	1905–1908	Donald G. White	1945–1948
Elliot J. Dent	1908	Henry C. Wolfe	1948–1950
Jay J. Morrow	1908–1910	Alan J. McCutchen	1950–1953
Warren T. Hannum	1910	Ray Adams	1953–1956
William C. Langfitt	1910–1914	George B. Sumner	1956–1961

Warren B. Johnson	1961–1962
Roy S. Kelley	1961–1965
Frank W. Rhea	1965–1968
William J. Love	1968–1971
Louis W. Prentiss, Jr.	1971–1973
Robert S. McGarry	1973–1976
George K. Withers	1976–1979
James W. Peck	1979–1982
Gerald C. Brown	1982–1984
Martin W. Walsh	1984–1987
Bernard E. Stalmann	1987–1990
Frank R. Finch	1990–1992
J. Richard Capka	1992

Note: Many of the officers listed prior to World War II served short terms of only from 6 weeks to 6 months.

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The resources at the Library of Congress Manuscript Division, specifically the papers of Montgomery C. Meigs, were equally important in preparing the history. This collection includes diaries, journals, letters, family papers, drawings, sketches, maps and plans, photographs, scrapbooks, and studies from 1849 through 1892. Between 1853 and 1861, the journals were written in Meigs' version of Pittman shorthand and thus, until recently, remained an untapped source. The transcriptions of the Journals provided much new information about the construction of the Aqueduct and the Capitol extension and were used extensively in preparing this document. The Office of the Curator, Architect of the Capitol, is the current repository for the continuing transcriptions. The work is being done by Mr. William Mohr for the U.S. Senate Bicentennial Commission. The author has been asked to state that this source is an unedited and unverified transcript of a work in progress. All references to Meigs' Journal in the following notes are cited by date of the original entry. The Archives of the Architect of the Capitol also contain much information about Montgomery C. Meigs and numerous original documents dating from and regarding the con-

struction of the Washington Aqueduct and the Capitol extension, as well as many related articles, reports, and photographs.

The files in the offices of the Washington Division contain a wealth of drawings, reports, plans and specifications, photographs, letters, newspaper clippings, published articles, scrapbooks, and other miscellaneous material from the 140-year history of the Aqueduct. The unpublished *History of the Water Supply of Washington* written in 1934 by Philip O. Macqueen was most helpful.

The library of the Washington Historical Society, the Washingtonia Room at the Martin Luther King Library in Washington, and the Montgomery Meigs material at the National Museum of American History, Smithsonian Institution, all provided useful information.

The fine biography *Quartermaster General of the Union Army* by Russell F. Weigley aided significantly in this project, particularly with regard to Meigs' work and family history. The extensive descriptions of his accomplishments following his work with the Washington Aqueduct are also excellent. Volumes 5 and 6 of *The Papers of Jefferson Davis* by Christ and Dix provided valuable insights into the political relationships from 1853 to 1860.

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