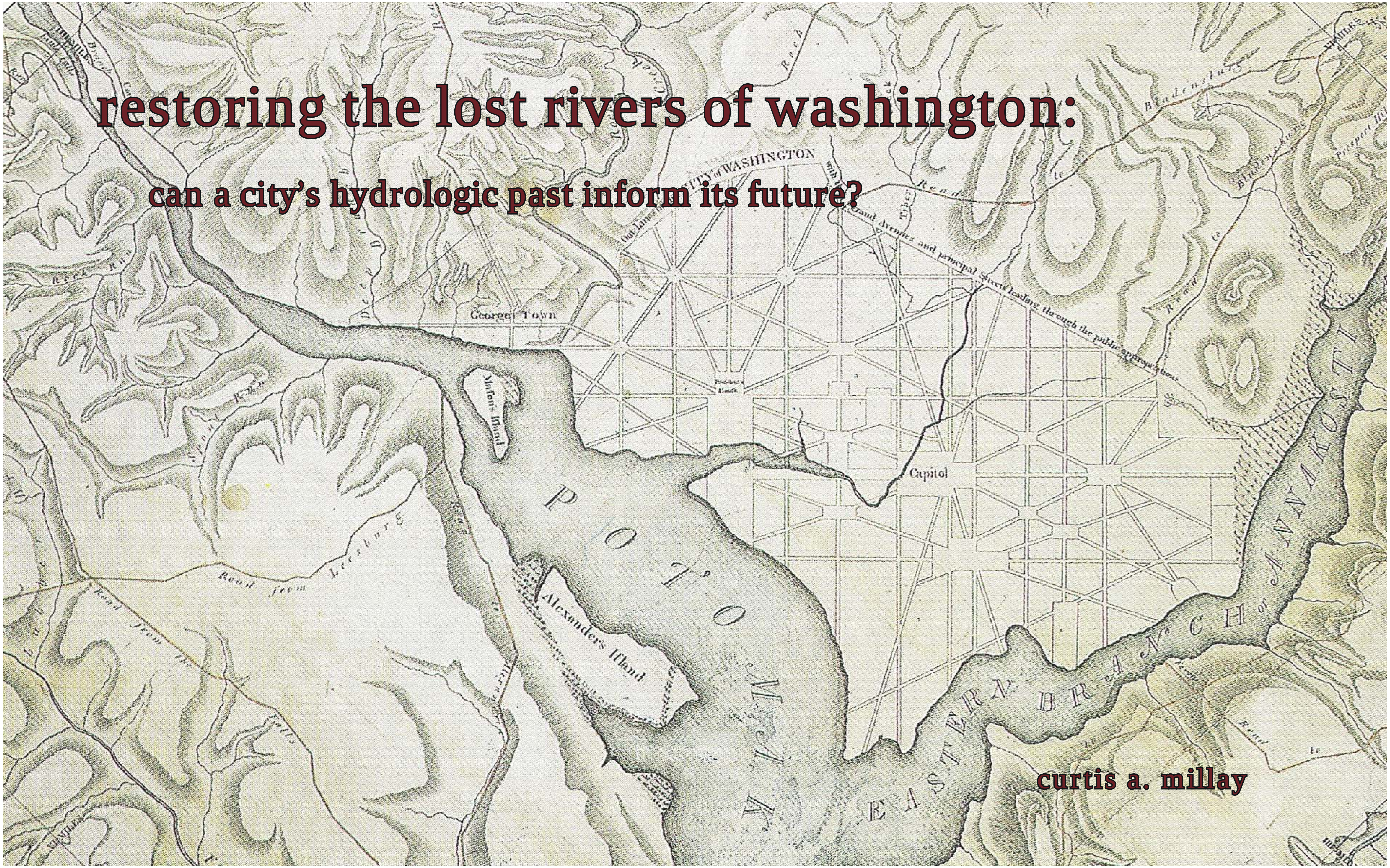
restoring the lost rivers of washington:

can a city's hydrologic past inform its future?



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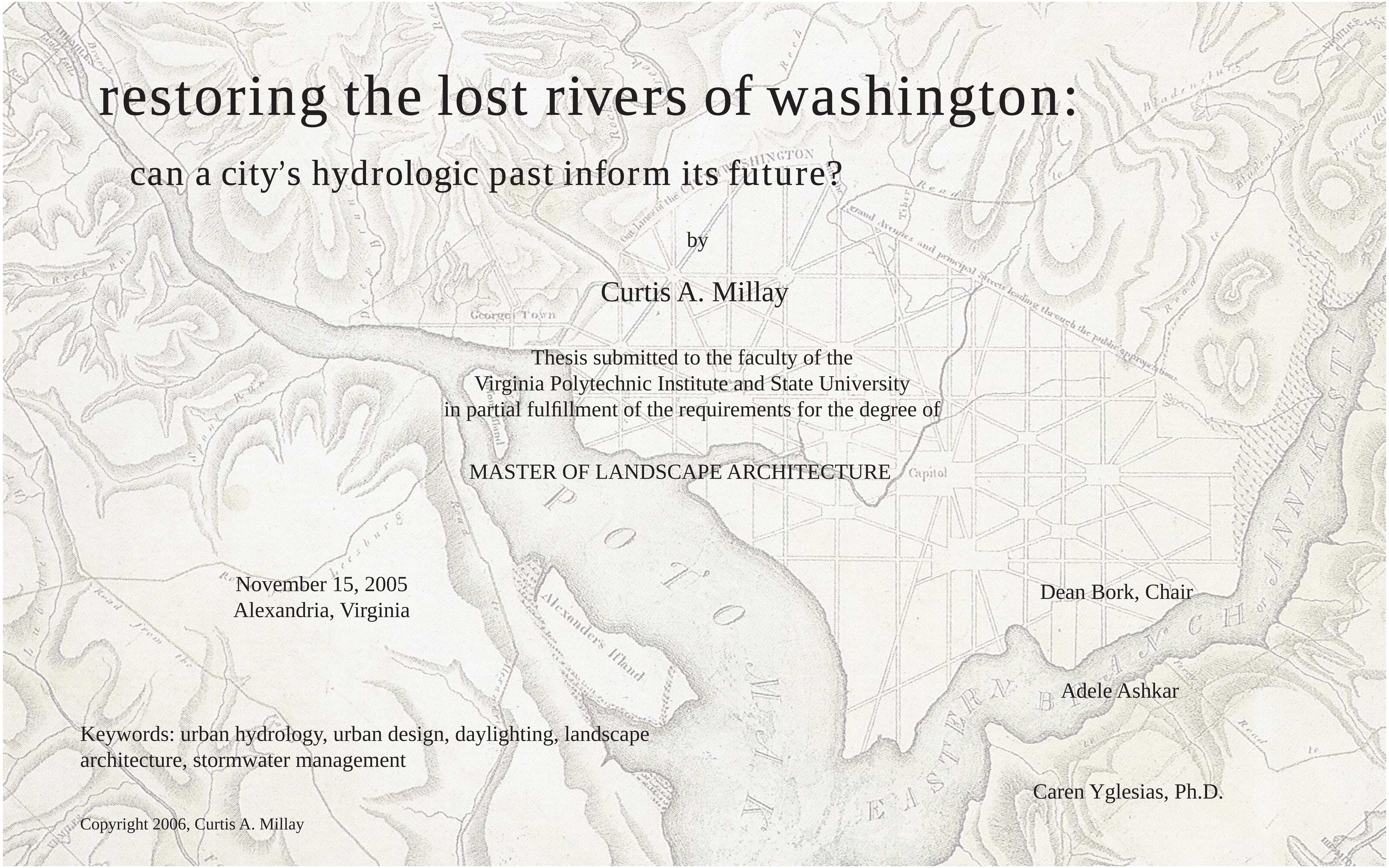

restoring the lost rivers of washington:

can a city's hydrologic past inform its future?

by

Curtis A. Millay

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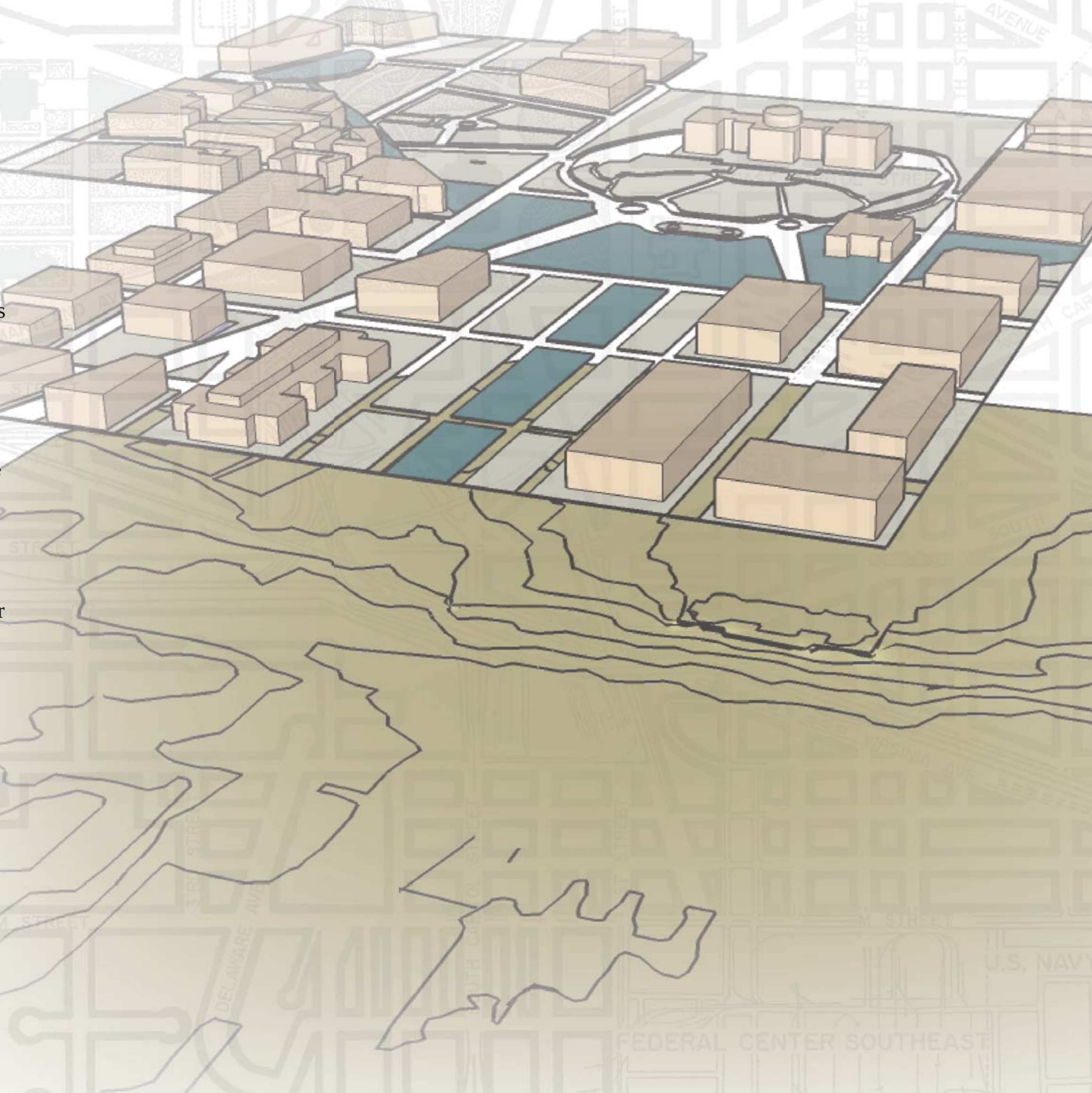
the lost rivers of washington:
can a city's hydrologic past inform its future?

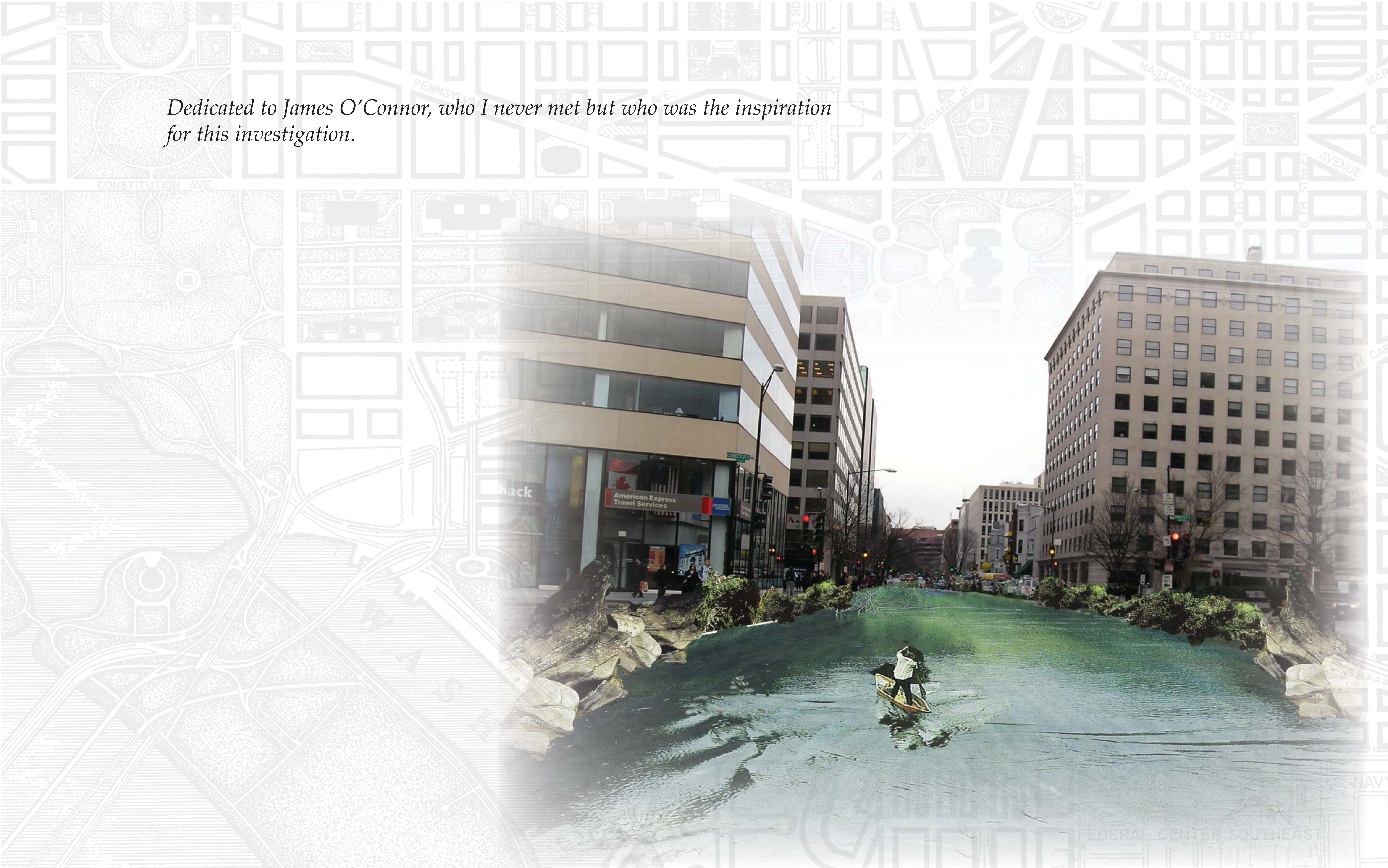
Curtis A. Millay

Abstract

Washington, D.C., like many older U.S. cities, suffers the woes of rapid urbanization and aging infrastructure. The city's combined sewer and stormwater system dumps millions of gallons of raw sewage into the Anacostia and Potomac Rivers over 70 times annually during significant rain events. While many groups, both public and private, attempt to clean the river, billions of dollars are still necessary over several years to remedy the combined sewer overflow (CSO) problem alone. Current plans for a solution include constructing large underground storage tanks that store millions of gallons of wastewater during overflow periods. Washington, however, once had a network of waterways that naturally drained the Federal City. At least three major stream systems—the Tiber Creek, James Creek and Slash Run—and over 30 springs flowed within the boundaries of the emerging capital. The waterways, now buried, were victims of urbanization, and flow now only underground, wreaking havoc on foundations and basements and causing sewer backups and flooding. Can a historically-driven investigation of these buried channels lend credence to the resurrection in some form of a network of surface stormwater channels, separate from the municipal sewage system, to solve the city's sewage overflow crisis? The following study is an initial exploration of the re-establishment of waterways through Washington with the purpose of improving the current storm sewer overflow dilemma and exploring the potential urban amenities that they could provide as part of a stormwater management plan for the year 2110.



Dedicated to James O'Connor, who I never met but who was the inspiration for this investigation.



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I am also grateful to members of the faculty at the WAAC who were insightful and provocative in their reviews and critiques of my work and who would often lead me on a new train of thought and exploration. I would like to thank the landscape architecture faculty: Terry Clements, George Hazelrigg, Paul Kelsch, Ben Johnson, Wendy Jacobson and Brian Katen; and the architecture faculty: Jaan Holt, Susan Piedmont-Palladino, Paul Emmons, Marco Frascari. In Natural Resources, David Trauger helped me keep at least one foot in reality, and Tom Sanchez in Urban Planning assisted me in achieving my sometimes daunting GIS goals. The Center truly allowed me to take advantage of many disciplines to accomplish my work.

Professor Iris Miller, at Catholic University has been a great source of knowledge to me, both in her writings and in her discussions. I would like to thank Dr. Carole Crumley from the Department of Anthropology at The University of North Carolina at Chapel Hill as well for her suggestions and references. In addition I am grateful to Ian Tyndall who took the time to meet with me and go over my project in its infant stages and prompted me to make some of the decisions I made.

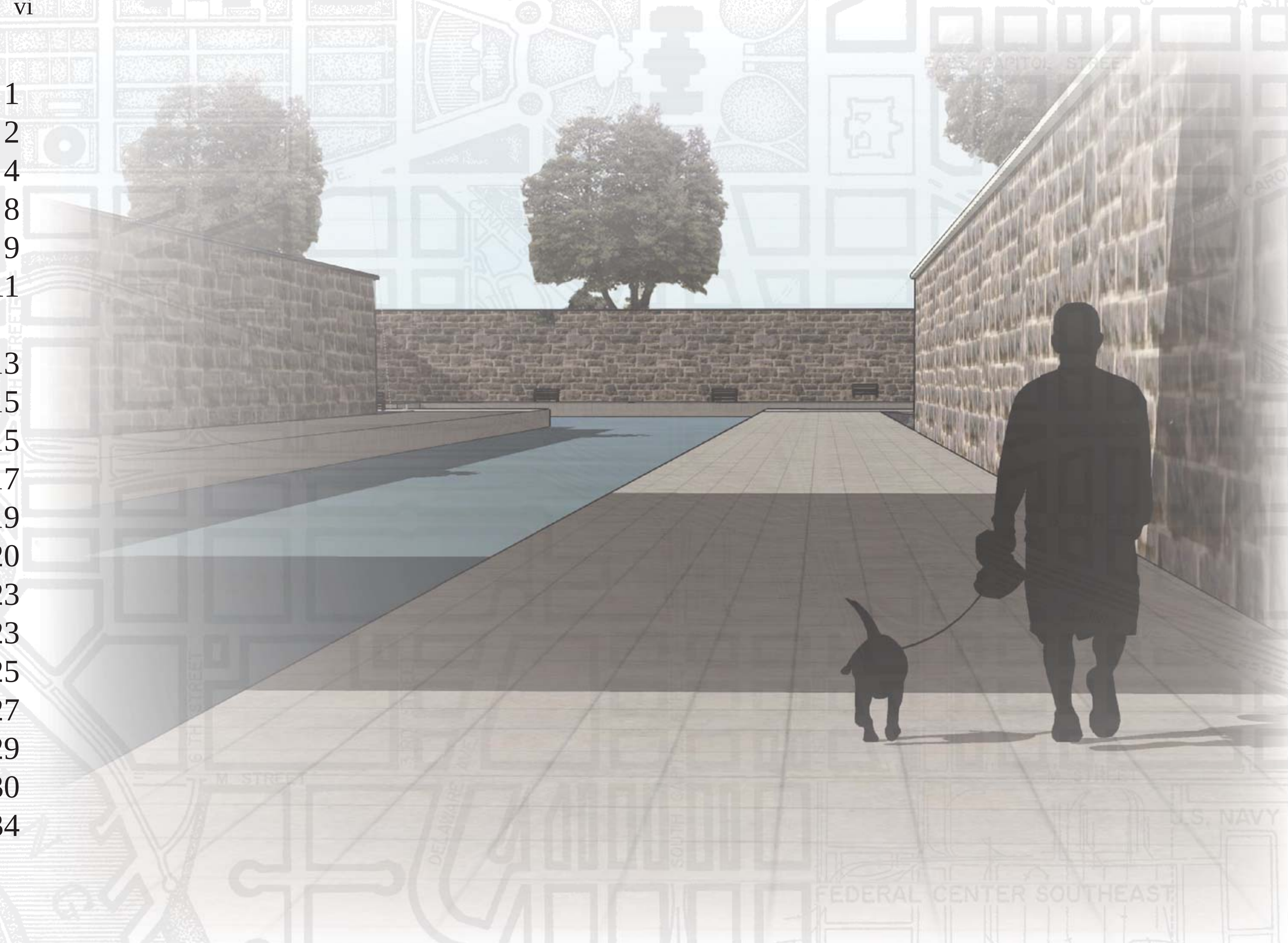
My project turned a corner when I discovered the Don Hawkins topographic map and I would like to thank him for his eagerness and willingness to impart his knowledge to me about all matters topographic, geologic, hydrologic, and historic.

I am appreciative to the staffs of the Library of Congress, Geography and Map Division; the City Museum of Washington's Kiplinger Library and the Martin Luther King Library's Washingtoniana Division. All were helpful and knowledgeable and often introduced me to useful resources of which I was unaware.

In addition to my family who always provides encouragement and support, I would like to thank friends including Ellen Sullivan for her constant encouragement and willingness to help me accomplish my work; Linda Heinrich for her wonderful imagination that makes perfect sense to me; Helen Tangires for her urban hydrology tour of Burgundy and Tim Turner who helped spark my studies in landscape architecture.

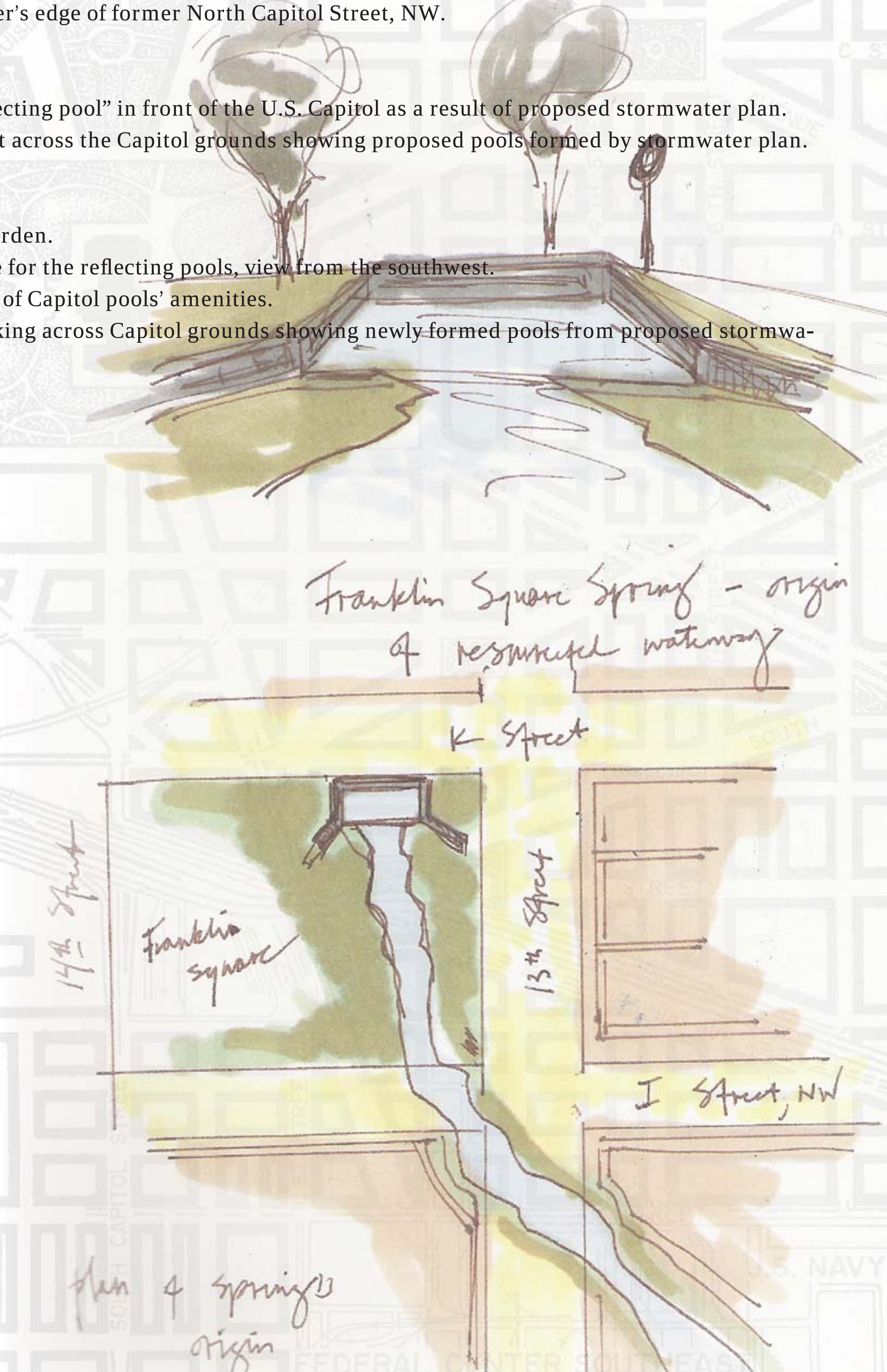
And lastly I would like to thank all the wonderful people that were my fellow students at the WAAC. Over the last few years I have had the pleasure to meet and to work with some truly outstanding colleagues who were always willing to listen, advise or lend a hand.

Table of Contents



List of Figures

All illustrations are by the author unless otherwise noted.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Introduction

Washington, D.C., like many older U.S. cities, suffers the woes of rapid urbanization and aging infrastructure. The city's combined sewer and stormwater system dumps millions of gallons of raw sewage into the Anacostia and Potomac Rivers over 70 times annually during significant rain events. In the Anacostia River the raw sewage and toxic stormwater together with industrial waste and a severely degraded riparian buffer cause it to be one of the most polluted rivers flowing into the Chesapeake Bay [CBF 2006]. While many groups, both public and private, attempt to clean the river, billions of dollars are still necessary over several years to remedy the combined sewer overflow (CSO) problem alone. Current plans for a solution include constructing large underground storage tanks that store millions of gallons of wastewater during overflow periods [DC WASA 2002]. Washington, however, once had a network of waterways that naturally drained the Federal City. At least three major stream systems—the Tiber Creek, James Creek and Slash Run—and over 30 springs flowed within the boundaries of the emerging capital. The waterways, now buried, were victims of urbanization, and flow now only underground, wreaking havoc on foundations and basements and causing sewer backups and flooding. Can a historically-driven investigation of these buried channels lend credence to the resurrection in some form of a network of surface stormwater channels, separate from the municipal sewage system, to solve the city's sewage overflow crisis? The following study is an initial exploration of the re-establishment of waterways through Washington with the purpose of improving the current storm sewer overflow dilemma and exploring the potential urban amenities that they could provide as part of a stormwater management plan for the year 2110.

The city of Washington is a fascinating study of changes in water and landmass morphology. Many of the grand monuments and attractions that visitors to the city see today reside on over 600 acres of land created from material dredged from the Potomac and Anacostia Rivers in the late 19th century in order to keep their channels passable. Both the Anacostia and the Potomac have long histories of man's intervention to keep their channels free of sedimentation to provide navigable waterways. The focus of this investigation however, will be on the interior terrain of the original Federal city (hereafter Washington) bounded on three sides by water—the Anacostia River, the Potomac River, Rock Creek, and Florida Avenue to the north (see figure 2).

The Anacostia River

“The Lost Rivers of Washington”

This study of Washington’s buried and forgotten stream systems began as an interest in urban river restoration. The Anacostia River is one of the nation’s dirtiest waterways; ironically, the river is within walking distance of the U.S. Capitol building where lawmakers decide the nation’s environmental policies with regularity. Land bordering the Anacostia has only recently become highly valued economically, and municipal and Federal officials intend considerable development over the next ten years. Originally, this thesis was going to deal with a site directly adjoining the Anacostia and was going to investigate riverside development that could actually benefit the River’s health rather than harm it. During the research on a former canal on Buzzards Point in southwest Washington (see figure 1), however, the author came upon the notes of the now deceased city geologist of the District of Columbia, James O’Connor [Robbins, 2001]. O’Connor talked of a James Creek that once ran into the Anacostia River at Buzzards Point, and how the Creek once connected to a whole network of water systems in the District, now buried and mostly forgotten. He called the network of water “the Lost Rivers of Washington.” Further, the burial of these systems was causing all manner of hydrologic havoc throughout the city – flooding, leaky basements, and rotting foundations. Upon reading his notes, a spark ignited — could the city’s storm sewer woes be remedied by resurrecting these ‘Lost Rivers of Washington’? Could stormwater channels flow above ground while the sewer system

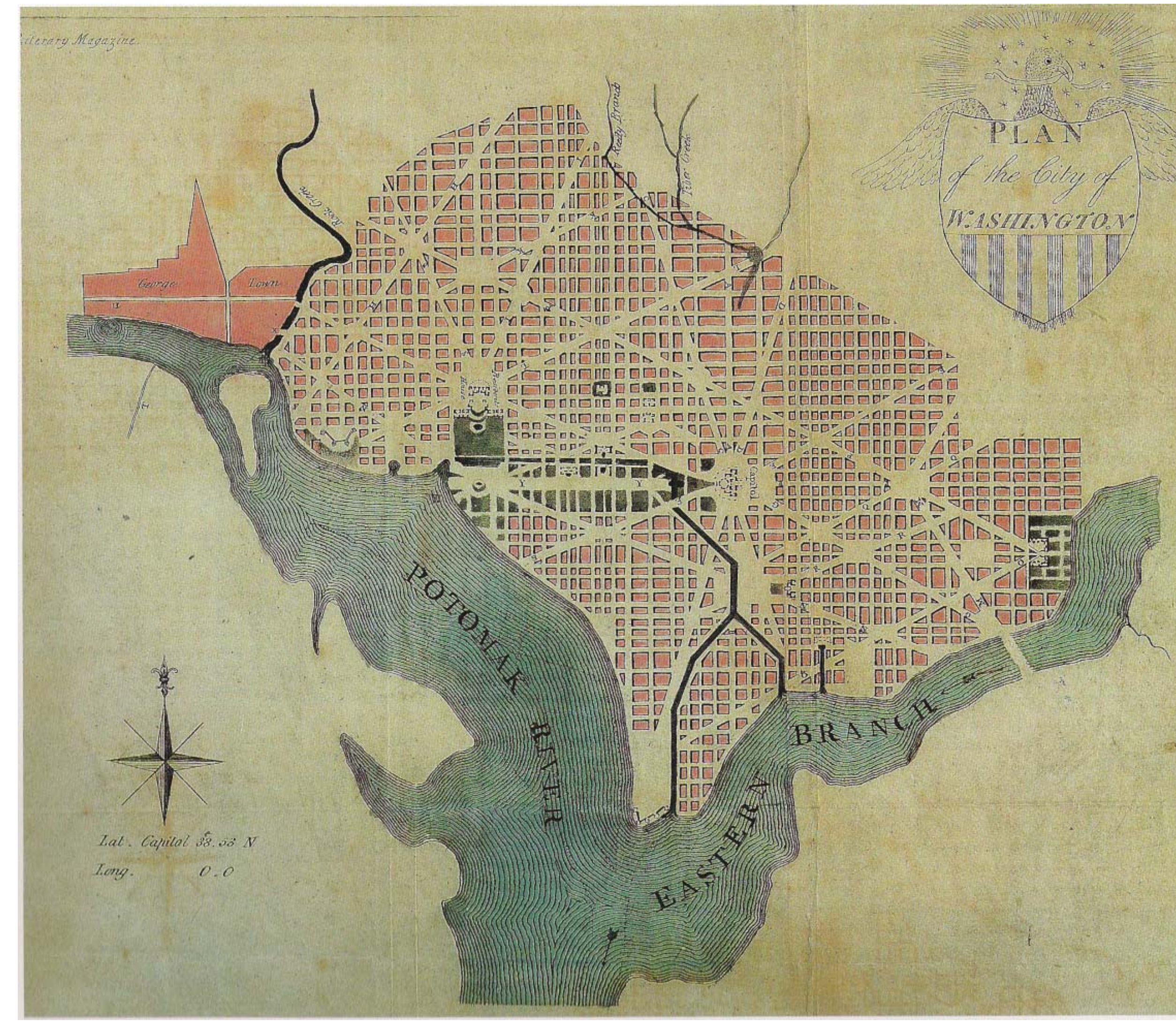


Figure 2. Ellicott, Andrew, based on. *Plan of the City of Washington*, 1793. Library of Congress, Geography and Map Division. This map, though created in 1793, depicts the city as it was not to fully appear for at least another century. The Anacostia was called the Eastern Branch at this time. Florida Avenue or Boundary Street follows the northern border of the city grid.

Figure 1. “Map of Buzzards Point,” *Atlas of Washington*, 1887, plate 23, City Museum of Washington. The map, which shows the James Creek Canal running through the Buzzards Point peninsula, prompted the initial research into the creek and thus led to O’Connor’s notes on the Lost Rivers.

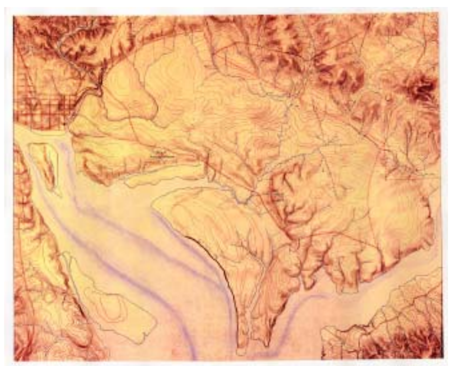


Figure 3. Hawkins, Don. *Topographic Map of Washington in 1791*. 1990. A 20th century reconstruction of what Washington probably looked like around time of founding. Courtesy of Don Hawkins.

flows underground to deal with sewage only? The channels would not only provide storm water management, but would provide public amenities that could possibly rival Amsterdam or even Venice in the Nation’s Capital. Where did the rivers flow? Why were they buried?

A glance at most maps of Washington, DC, around 1800 reveals a projection of the L’Enfant plan—the city neatly laid out in the grid formation with its distinctive diagonal boulevards with Florida Avenue, or Boundary Street as it was originally named, forming its northernmost border similar to figure 2. The image is one so familiar that a viewer would not give a thought to the intent or actuality of the map. In reality, however, Washington in 1800 looked little like these maps. What is surprising to imagine today is that the territory of the Federal City was a lush, well-watered terrain. In 1629, Captain John Smith, on a trip up the Potomac River, described the site of Washington as a “country [that] is not mountainous, nor yet low, but such pleasant plaine hills, and fertile valleys, one prettily crossing another, and watered so conveniently with fresh brooks and springs, no lesse commodious, then delightsome.” [Johnson 1964, p. 42]

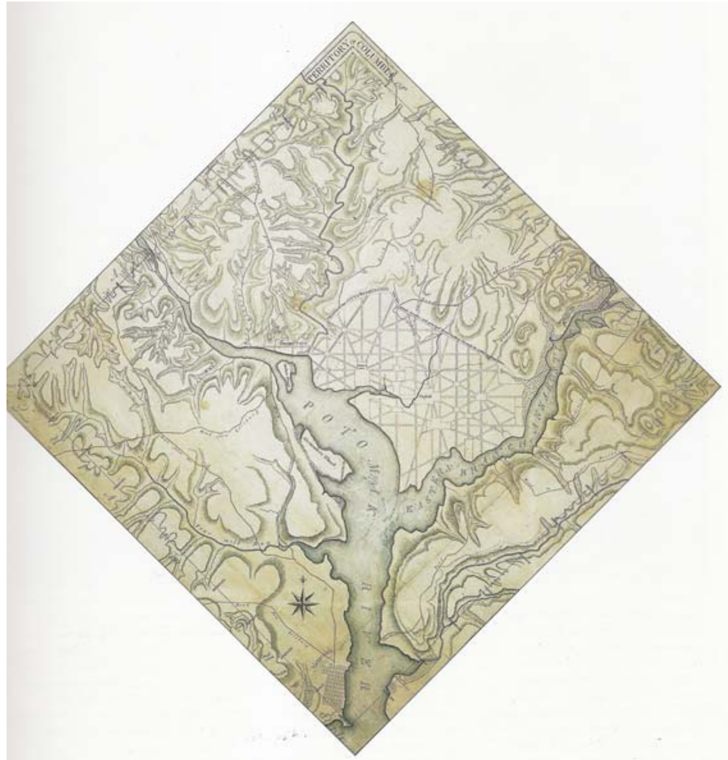


Figure 4. Ellicott, Andrew. *The Territory of Columbia*, 1794 shows the entire 100-square mile territory. Some of the old stream systems are depicted on this map and some are not. Library of Congress, Geography and Map Division.

In 1787 Congress decided to establish a Federal capital—a capital outside any existing state. In addition, they decided that the capital would be 10-miles square. It fell to George Washington to select a site anywhere along the Potomac River because among other reasons it was neutral territory between the north and the south [Cerami 2002, p. 119]. He chose the site where the Potomac converged with the wide, deep Anacostia River and Washington was founded in 1790. The District of Columbia was a 100-square mile territory in the shape of a diamond that took land from the states of Maryland and Virginia (see figure 4). The Federal City lies at the center of the original diamond (in 1846 Virginia's land was returned). Pierre Charles L'Enfant, a French general hired by George Washington, designed the city based on European precedents. At the time of founding, only the port of Georgetown existed to the west of Rock Creek. The terrain for the intended Federal City was undeveloped and made up of large landholdings owned by a few proprietors [figure 7]. The Federal City did not fully develop to its boundaries until the late 19th century and only in the early 20th century did the remainder of the District start filling in. It is difficult therefore to find maps that show stages of actual development. Figure 3 (previous page) is a 20th-century reconstruction by architect Don Hawkins of what the territory of Washington probably really looked like at the time of founding based on his research.

Significance of Washington's Geology

Before identifying the location and nature of the former stream systems, it is important to discuss the geologic location of Washington, D.C. The city of Washington lies on the Fall Line, the point where the Piedmont meets the Coastal Plain. Many East Coast cities settled along the Fall Line for similar reasons—the waterfalls generated by the change in topography powered mills for industry. In addition, the Fall Line provided a head for navigation; therefore, invaders could not attack the city from the interior by water. The hard, crystalline rocks of the Piedmont plateau and the Sunderland escarpment form the ridge or cliffs to the north of Florida Avenue that surround the "flats" of the Federal City which are comprised of soft, easily erodable Coastal Plain alluvial sediments. A geologic map (figure 5) could almost be mistaken for a political map. Compared to Figure 2 Florida Avenue clearly forms a geologic border as well as a political one. The street follows the Wicomico Formation (Qw) of the Coastal Plain.

The District of Columbia rests on a series of at least four, possibly more, distinct old river terraces ranging in height from 40 to 400 feet. The physical terrain for the Federal City played an important role in the selection of the site for the new capital. Pierre L'Enfant and George Washington used this natural amphitheater in their design of the city to enhance the long vistas from the bluffs created by the broad avenues that lead to the water. The combination of crystalline and alluvial formations is important for this investigation because the source for some of the streams and springs in the Federal City began in the bluffs or cliffs from rainwater percolating down through the terrace gravels and then forced out when it hit the hard Piedmont rock. The soft, pliable sediments of the Coastal Plain were receptive to the water and stream valleys formed [Roberson 1989, pp. 58-59].

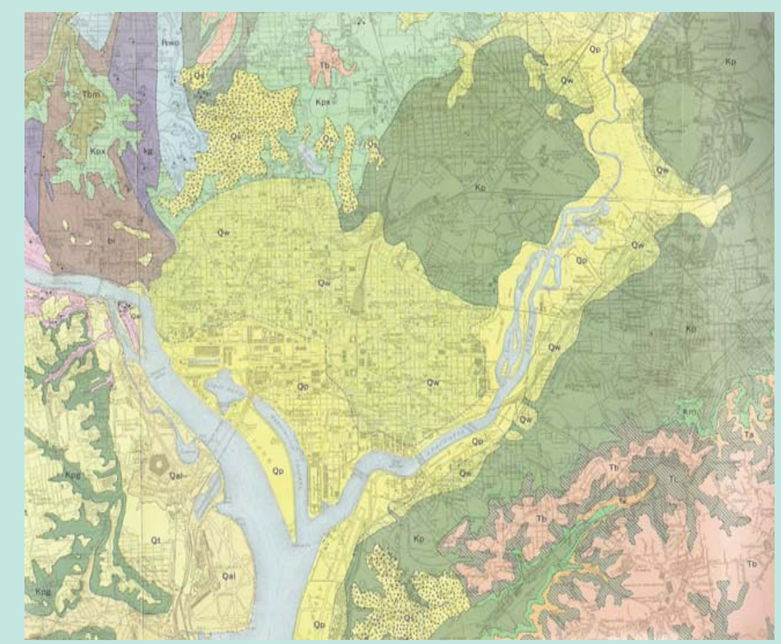


Figure 5. *Geologic Map of Washington, D.C. and vicinity*, 1942. U.S. Geological Survey. Florida Avenue forms a political as well as a geologic border for the Federal city. The avenue roughly follows the northern border of the Wicomico Formation (Qw) of the Coastal Plain.

Locating the Lost Rivers of Washington...

O'Connor noted that the location of the buried waterways is not always easy to find on old maps, possibly because many maps produced at that time were projections for the L'Enfant city plan. Interestingly, even L'Enfant had as early as 1791 planned to erase most of these systems from his plan leaving only Rock Creek and a portion of the lower Tiber Creek and James Creek as a canal (see Figure 2). Further investigation reveals certain maps that indeed illustrate the waterways. As seen in Figure 4 Ellicott included the Tiber Creek in his *Territory of Columbia* (1794) map but did not include Slash Run or James Creek. L'Enfant, though, in a survey map done in 1791 (see figure 6 below) includes all three systems with great clarity. In addition, the map shows the boundary lines for the city and proposed public square parks. *A Sketch of Washington in Embryo* (figure 7 right) is an interesting map that was actually published in 1893 but depicts Washington in 1792 based on research done by a Dr. Toner. The map shows the territory for the Federal City with the major streets of L'Enfant's plan superimposed on it with the major landholders' properties in 1792 delineated [Miller 2002: 56-57]. Tiber Creek, Slash Run and James Creek are clearly illustrated. The aid of the street overlay begins to pinpoint the exact location of the waterways. As becomes evident however

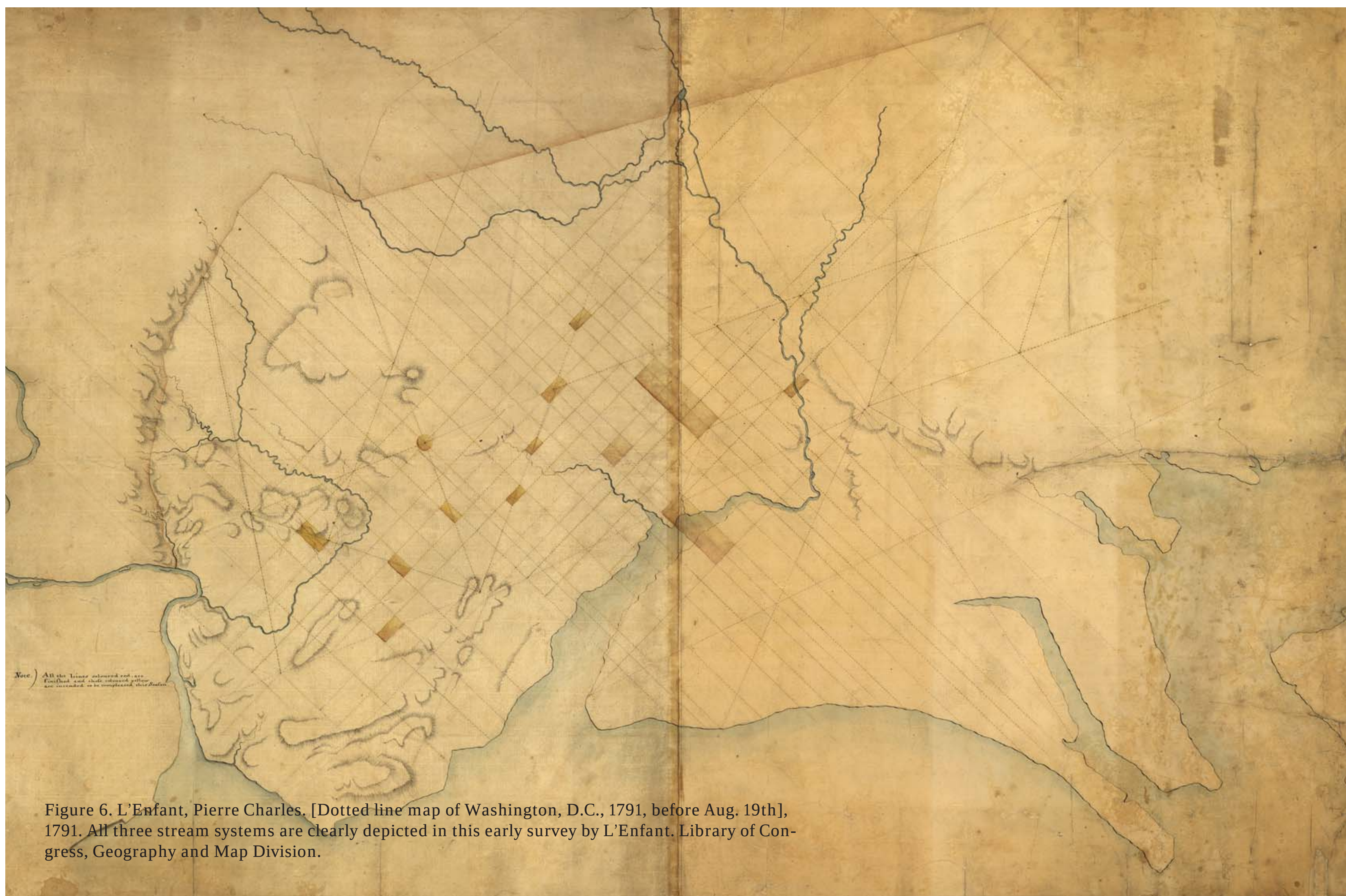


Figure 6. L'Enfant, Pierre Charles. [Dotted line map of Washington, D.C., 1791, before Aug. 19th], 1791. All three stream systems are clearly depicted in this early survey by L'Enfant. Library of Congress, Geography and Map Division.

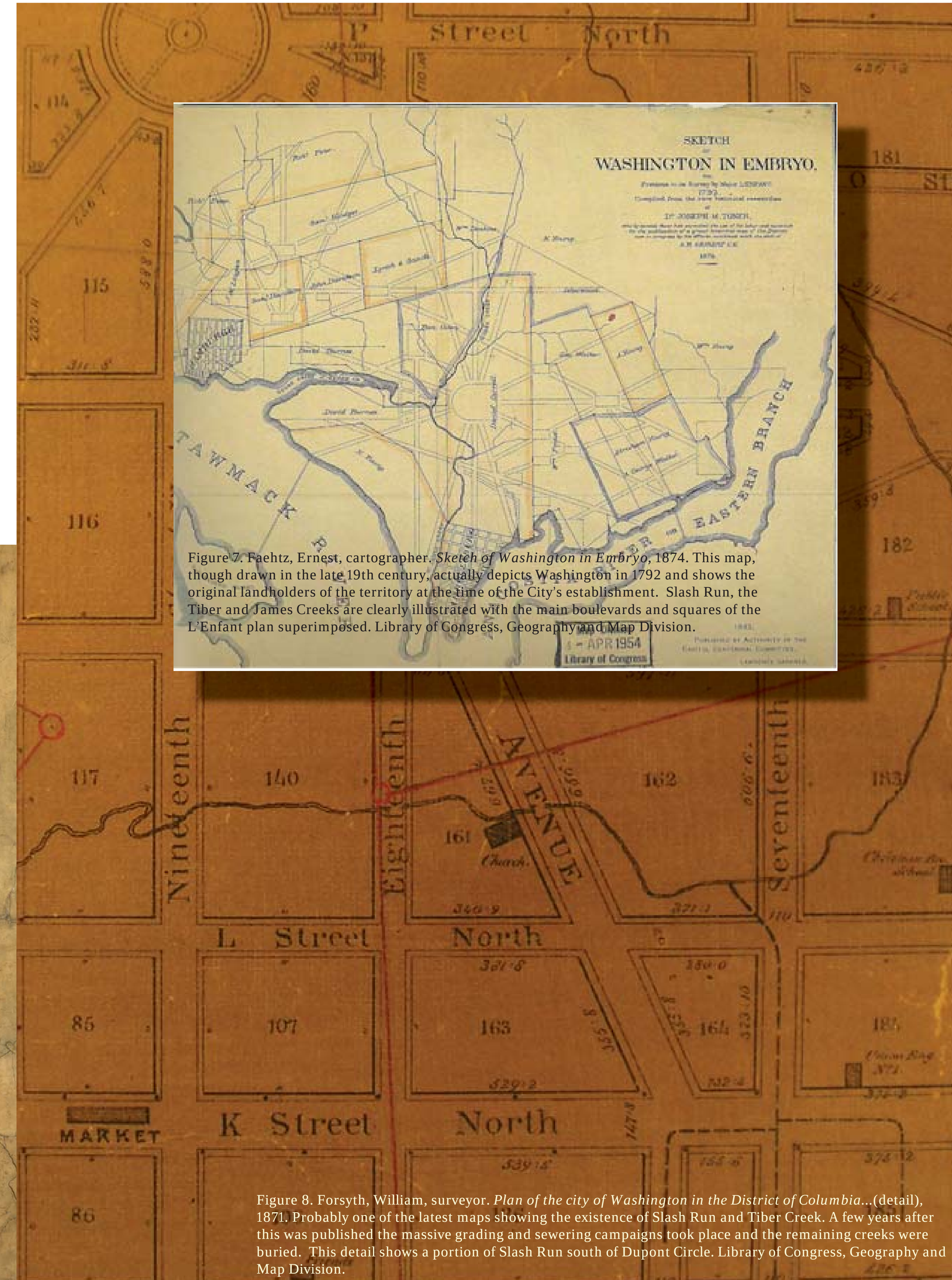


Figure 7. Faehtz, Ernest, cartographer. *Sketch of Washington in Embryo*, 1874. This map, though drawn in the late 19th century, actually depicts Washington in 1792 and shows the original landholders of the territory at the time of the City's establishment. Slash Run, the Tiber and James Creeks are clearly illustrated with the main boulevards and squares of the L'Enfant plan superimposed. Library of Congress, Geography and Map Division.

Figure 8. Forsyth, William, surveyor. *Plan of the city of Washington in the District of Columbia*...(detail), 1871. Probably one of the latest maps showing the existence of Slash Run and Tiber Creek. A few years after this was published the massive grading and sewering campaigns took place and the remaining creeks were buried. This detail shows a portion of Slash Run south of Dupont Circle. Library of Congress, Geography and Map Division.

not all maps agree on the exact location or nature of the stream systems. *A Map of the City of Washington* surveyed by Robert King from 1818 (figure 9, right) is an important document for its accuracy in both topography and position of streets and it shows the Washington Canal as completed at this time but also shows the “ghosts” of the former Tiber and James Creeks along the canal [Miller 2002, p. 72]. Because the former portions are included all three water systems are documented imposed on an existing framework of streets. *The Topographical map of the District of Columbia* drawn by A Boschke and published in 1861 (figure 10, below) shows the actual progress of development of Washington just before the Civil War. Existing individual structures appear along with a network of streets. [Miller 2002, pp.84-87]. Slash Run is fully depicted as is the James Creek. The upper reaches of the Tiber are present but the lower reaches at this point have been fully channelized. *Plan of the city of Washington in the District of Columbia...* surveyed by William Forsyth in 1871 (figure 8, previous page) is significant because of its late date. It is shortly after this, in the 1870s, that the city buries the last of the creeks to make as much developable land as possible. The map shows a detail of Slash Run south of Dupont Circle.

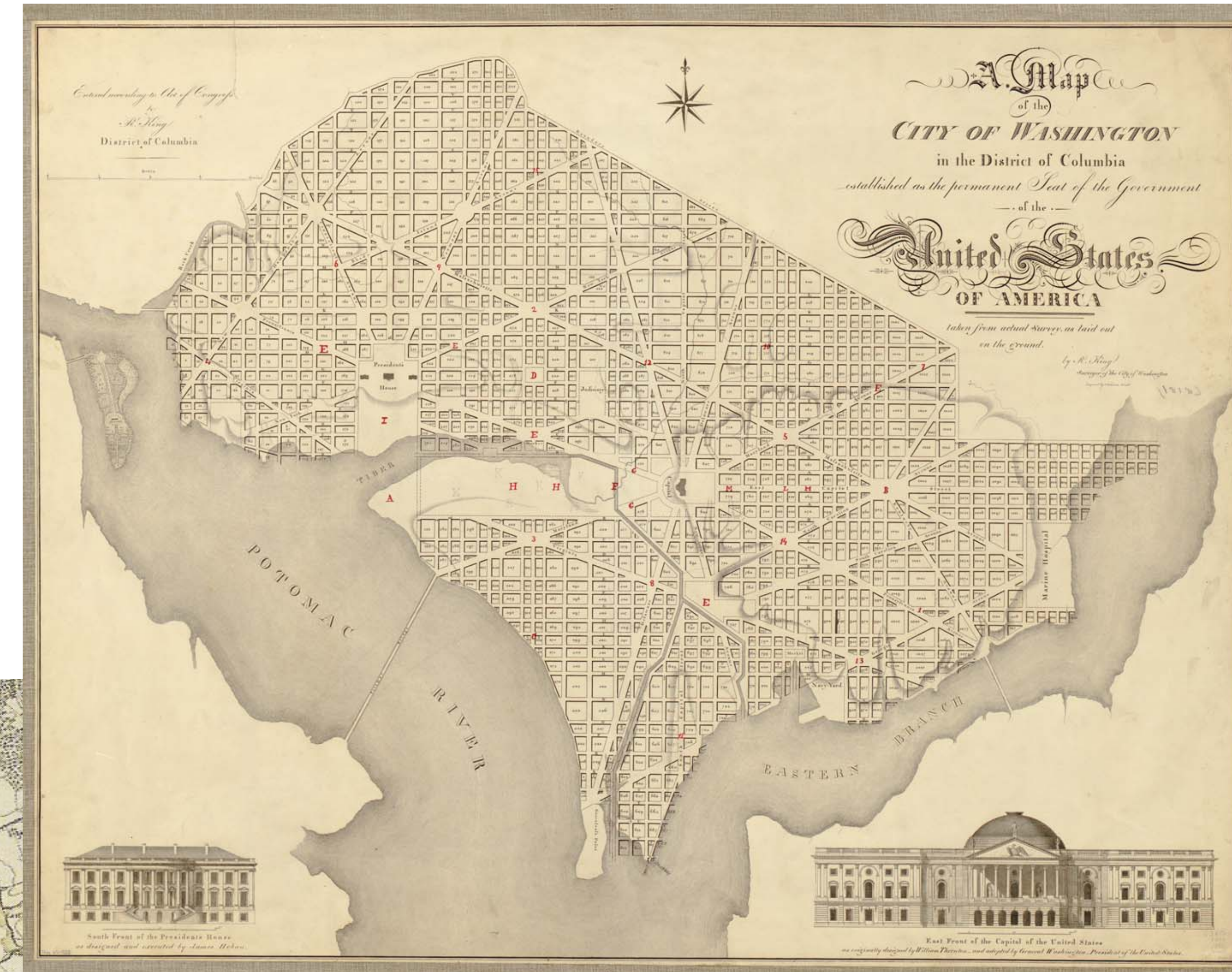


Figure 9. King, Robert, surveyor. *A Map of the city of Washington in the District of Columbia: established as the permanent seat of the government of the United States of America/taken from actual survey, as laid out on the ground by R't King, surveyor of the City of Washington; engraved by C. Schwarz, Wash'n*, 1818. Library of Congress, Geography and Map Division.

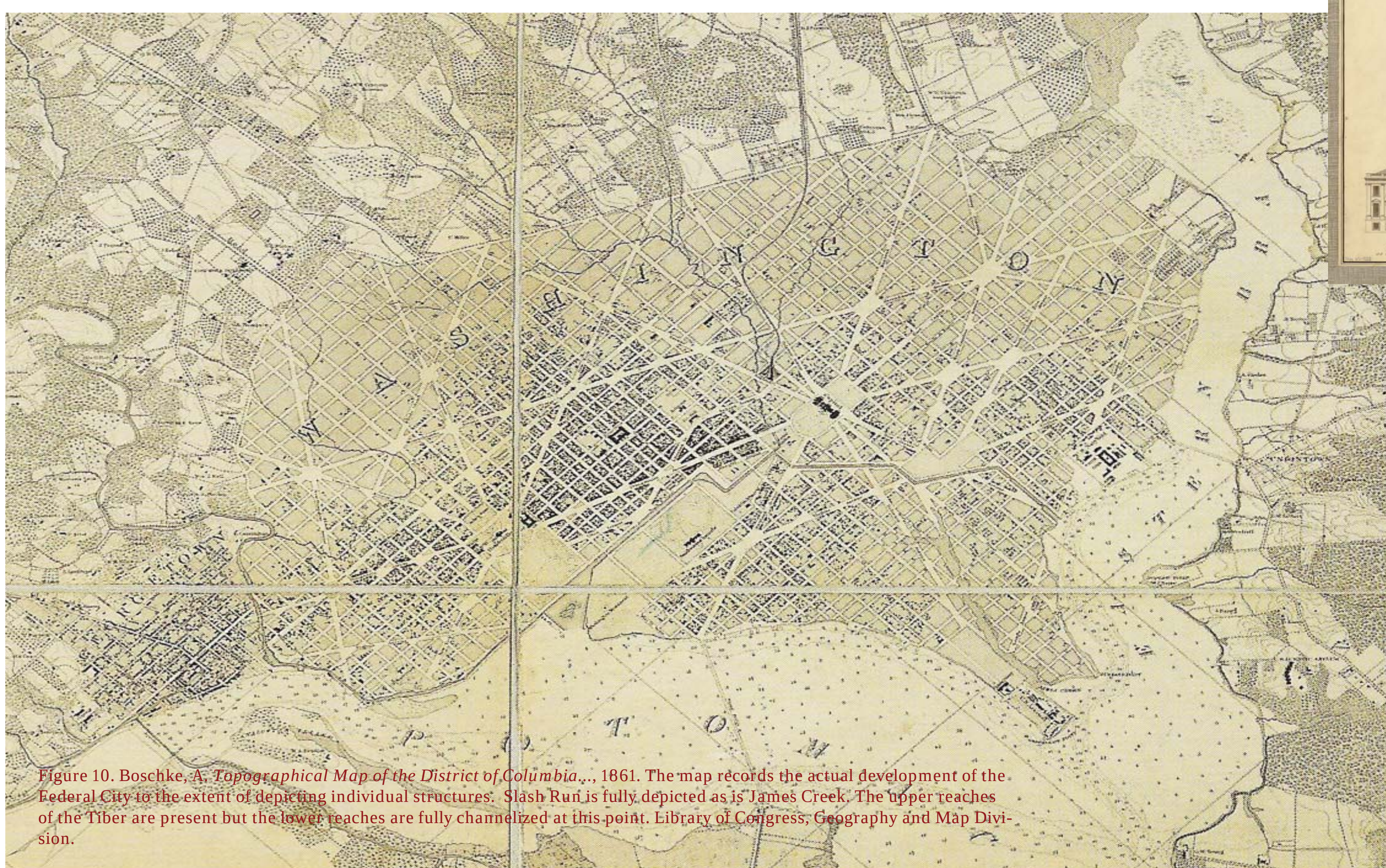


Figure 10. Boschke, A. *Topographical Map of the District of Columbia*..., 1861. The map records the actual development of the Federal City to the extent of depicting individual structures. Slash Run is fully depicted as is James Creek. The upper reaches of the Tiber are present but the lower reaches are fully channelized at this point. Library of Congress, Geography and Map Division.

Slash Run

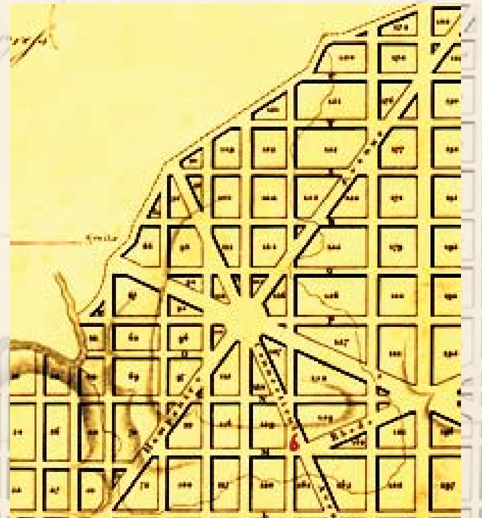
Slash Run, a tributary of Rock Creek, was one of the major stream systems in the District. The stream consisted of two main branches that formed above Florida Avenue between 18th and 16th Streets, NW, the present day Meridian Hill Park area. The channel flowed roughly down 18th Street and skirted around Dupont Circle almost to Scott Circle then headed east between L and M Streets, NW, toward Rock Creek and entered it near 23rd and P Streets, NW. Slash Run ran through what was once swampy areas that were popular for berry picking and bird-watching, and even flat-bottomed boats were used along L Street. Some of the ravines formed by the channel measured between ten and twelve feet deep [Williams 1989, p.84-85].

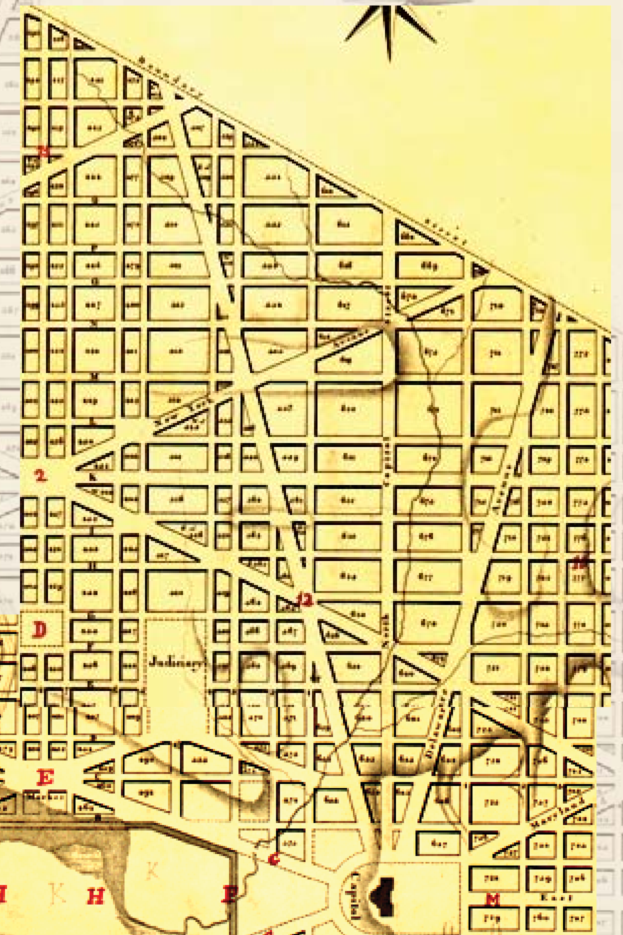
Tiber Creek

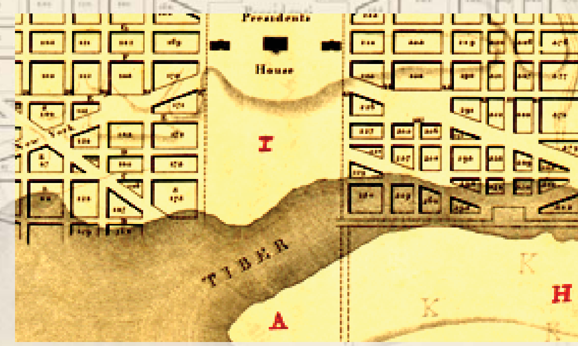
Tiber Creek was the largest stream system in the Federal City. The system began somewhere near the present day Soldiers' Home about three miles north of the Capitol building. By the time the Tiber reached the foot of the bluffs at Boundary Avenue, or present-day Florida Avenue, it joined four other branches to form a substantial stream. The channel flowed south roughly along North Capitol Street, through the site of Union Station, with other smaller tributaries joining it along the way. When the stream reached the point somewhere near the present day Department of Labor and the East Building of the National Gallery, it turned west and ran roughly along the Mall and Constitution Avenue. At that point, the channel started widening dramatically until it reached the base of the White House lawn where the mouth of the system met the Potomac and measured between 700 and 800 feet wide. The Tiber was important to the industry of the early city with various mills established along its banks as well as artificial lakes for fishing, boating and swimming. Anglers caught shad, herring, eels, pike, catfish and perch among others as far upstream as near the Capitol building. The Tiber also played the very important role of serving as a drainage system to almost half of the District of Columbia at that time. [Williams 1989, 81-84]

James Creek

James Creek, in southwest Washington, also plays an important role in this study. James Creek formed just southwest of the Capitol, not far from where the Tiber turned west. The Tiber never joined James Creek naturally, although they flowed closely to each to other. Later the Tiber sewer emptied into the James. Like the other systems, the James gained volume by springs and tributaries flowing into it along the creek's path. The channel flowed southward along South Capitol Street and then broadened greatly through a marshy area and flowed into the Anacostia River between Fort McNair and Buzzards Point. The James Creek had an extremely wide channel. [Williams 1989, p. 84]







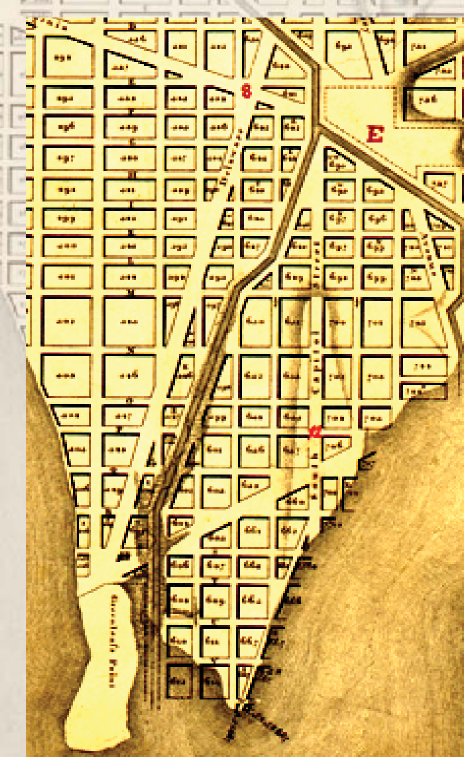


Figure 11. King, Robert, surveyor. *A Map of the city of Washington in the District of Columbia: established as the permanent seat of the government of the United States of America/taken from actual survey, as laid out on the ground by R't King, surveyor of the City of Washington; engraved by C. Schwarz, Wash'n*, 1818. Library of Congress, Geography and Map Division.

Washington Canal

Early in the nineteenth century, as planned by L'Enfant, Benjamin Latrobe transformed the lower portion of the Tiber from the White House to the Capitol into a canal. L'Enfant originally envisioned the canal to be a waterway of great beauty adding grandeur to the Nation's Capital. The path of the canal followed the route of the Tiber from its mouth at the base of the White House to the Capitol building, from there it turned southeast and broke into two branches, one continuing to the Navy Yard and the other joining the James Creek and flowing into the Anacostia. The James Creek, not channelized until much later, was never part of the main Washington city canal.

The canal was not for aesthetic purposes only, the waterway provided transportation of goods into the interior of the city. Boats could enter the canal at the White House from the Potomac and navigate to Central Market near the present day National Archives and to other destinations without negotiating down the Potomac and then against the current up the Anacostia. The canal was three miles long and initally four feet deep. The topography of the canal and the tides from both the Potomac and the Anacostia influenced the canal and heavy sedimentation resulted. Eventually the pollution from the markets as well as raw sewage made the canal an unsightly, stinking mess. The canal, completed in 1810, was mostly disused and filled in by 1871 [Williams 1989, pp. 86-87].

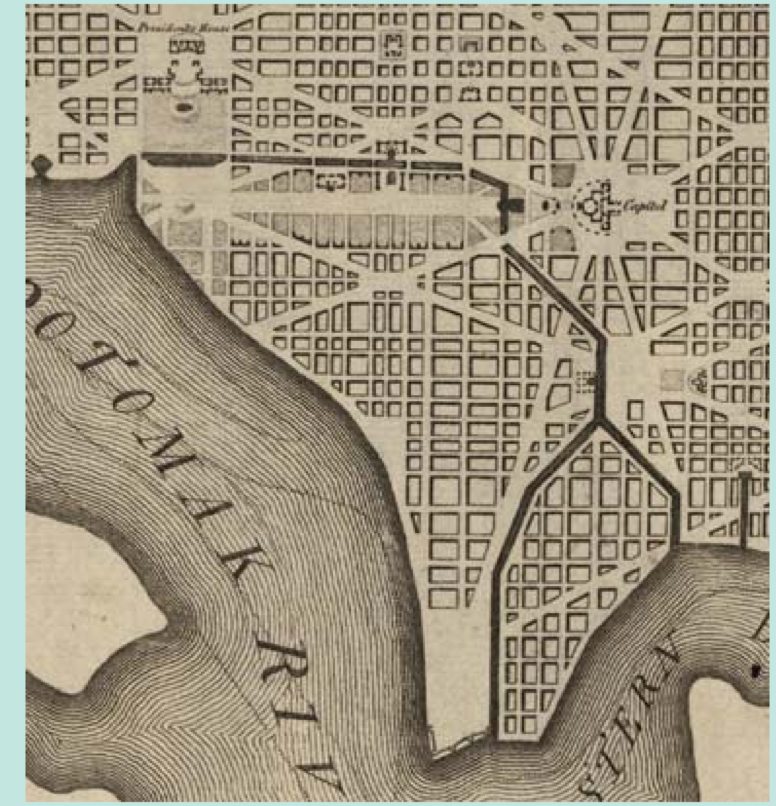


Figure 12. L'Enfant, Pierre Charles. *Plan of the city of Washington/Thackara & Vallance sc.*, detail, Philadelphia, 1792. This detail shows L'Enfant's original plan for the Washington City Canal. Library of Congress, Geography and Map Division.

Degradation of Waterways

Washington: a missed opportunity?

The evidence of abundant waterways suggests a city that could have developed much differently than it did. Figure 13 shows the approximate location of the waterways overlaid on a 1990 map of Washington, D.C. based on maps and writings. Many European precedents exist for using water for transportation and other public amenities. Instead of working with the watery assets in the Federal City, the increasing population led to their degradation.

By the mid-1800s industries that had taken advantage of the stream systems for their livelihood were also leading to their demise. Along the northern reaches of the Tiber, gristmills and other types of mills as well as human sewage fouled the waters. Agriculture and development stripped the creek buffers of vegetation and therefore sedimentation was a major problem. Slash Run also had mills, but even more detrimental were the slaughterhouses that left the once clear waters fetid. James Creek as well had become an open sewer by the 1860s and the city transformed the remaining open portion of it into a canal all the way to the Anacostia. By the early 20th century, they covered the James Creek canal because of its squalid and dangerous condition [Williams 1989, p. 88].

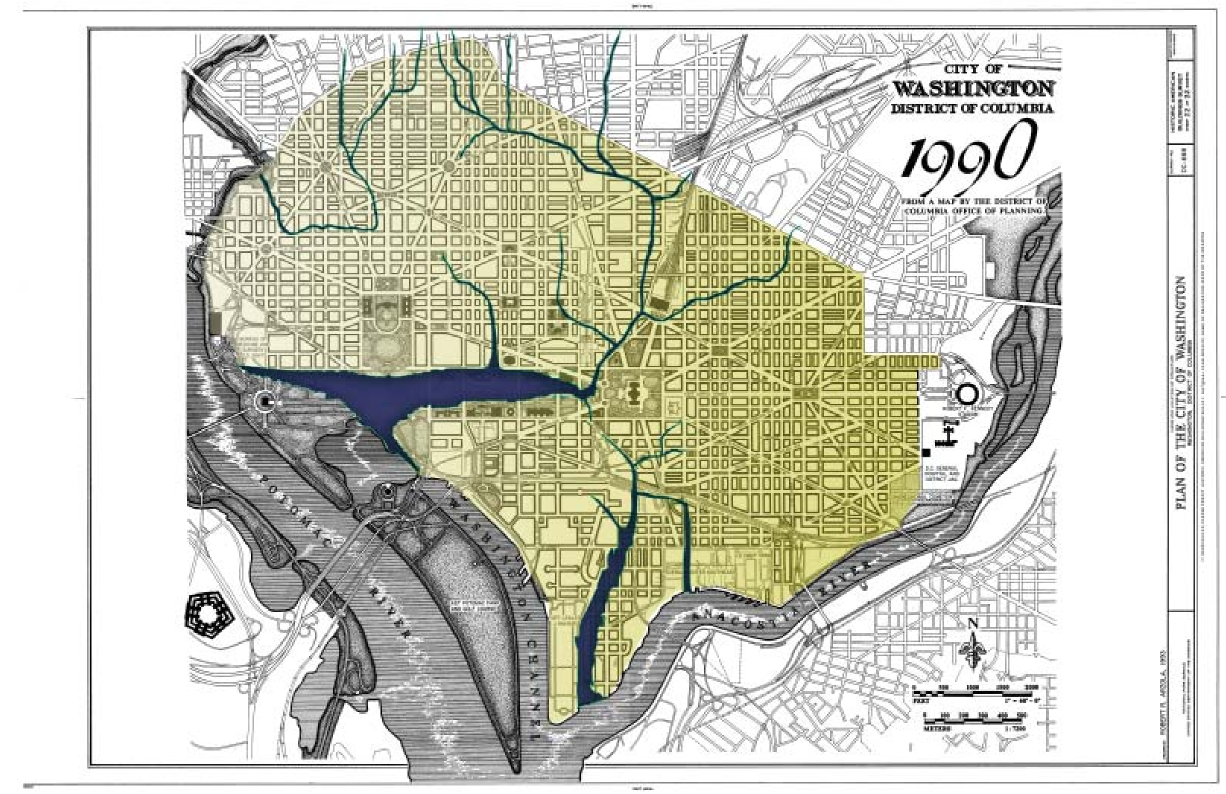


Figure 13. A 1990 map of Washington overlaid with approximate location of past waterways. (1990 map: Library of Congress, Historic American Building Survey)

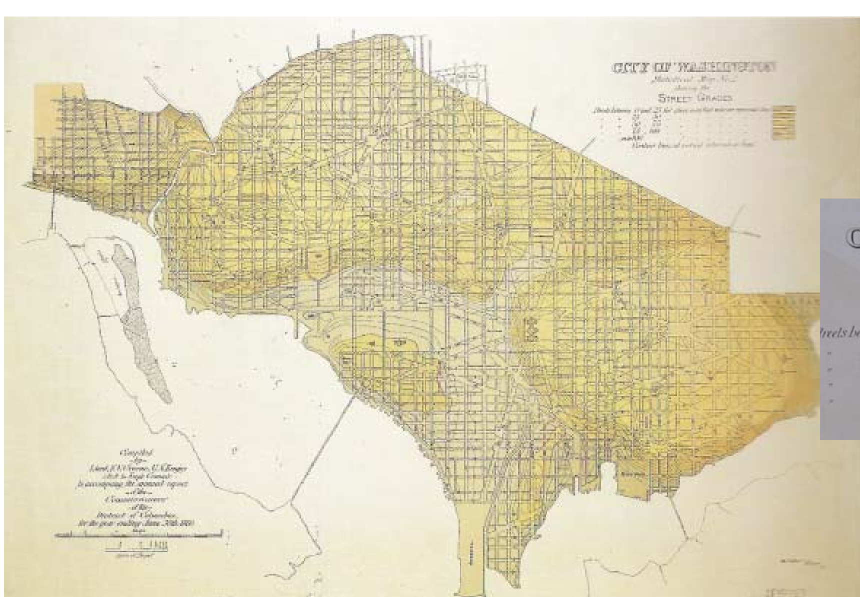
Figure 14. The morning commute could have included a paddle. This view is looking west on M Street, NW, at the intersection of Connecticut Avenue near where the original Slash Run once flowed.

Figure 15. An alley across from National Geographic where Slash Run probably flowed.

Figure 16. 1101 Connecticut Avenue where Slash Run once flowed. Here, sunbathers along the rocks of the Creek seem to be oblivious of the Washington workday around them.

The Sewering of the Creeks

What was an asset to the population of the District became a bane to its existence. The foul smells from the waterways and fear of malaria led the city to fill in many of the streams gradually. By the 1870s, with an increasing population, developable land was a priority and the Board of Governors launched a massive sewer line and grading campaign. The campaign resulted in altering the once dramatic topography, a result of the stream systems cutting through the alluvial soil, to reflect the terrain seen today (see figure 17 below). The Public Works Department converted most reaches of the Tiber Creek, James Creek and Slash Run into sewers. Figure 18 at right shows an 1889 map of the Washington sewer system. The most dominant red line, sewers of 4 feet and greater, is the Tiber Creek, at that time emptying into the James Creek, not into the Anacostia. The sewer system began as simple brick arches with plank flooring constructed over the creeks in the 1860s [Owens 1937] with the Tiber serving as the backbone of the system. The sewering of creeks was common practice in the early days of wastewater treatment to convey sewage away to a larger body of water. Washington, like other early U.S. cities, combined conveyance for sewer and stormwater into one system in an effort to save costs. As the rate of urbanization increased, however, the rate of impervious surfaces also increased. With greater amounts of sewage and stormwater the systems became overtaxed resulting in a tragic dilemma—the combined sewer/stormwater overflow (CSO). Significant rain events produce vast amounts of stormwater that rush into the storm sewer system and because the system cannot handle the volume, it overflows and dumps raw, untreated sewage into rivers. Billions of gallons of raw human sewage finds its way into our nation's rivers annually from such systems.



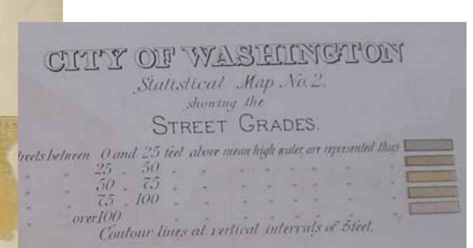
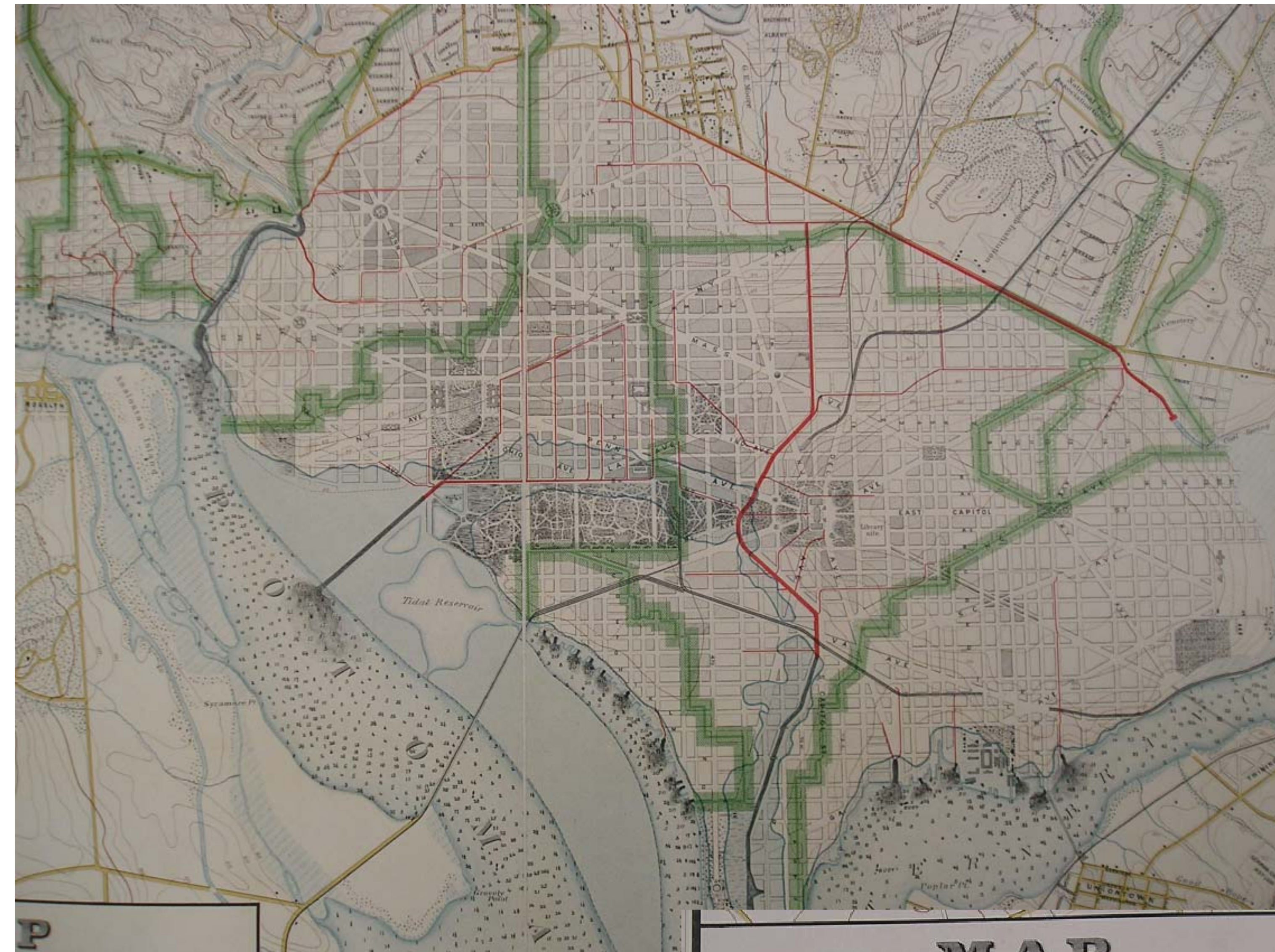


Figure 17. Street grading map from Greene, F.V. *City of Washington, statistical maps*, 1880. Library of Congress, Geography and Map Division.



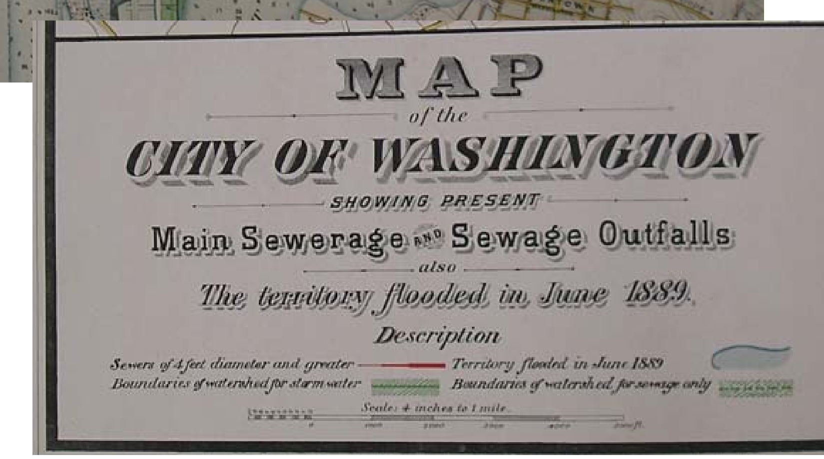
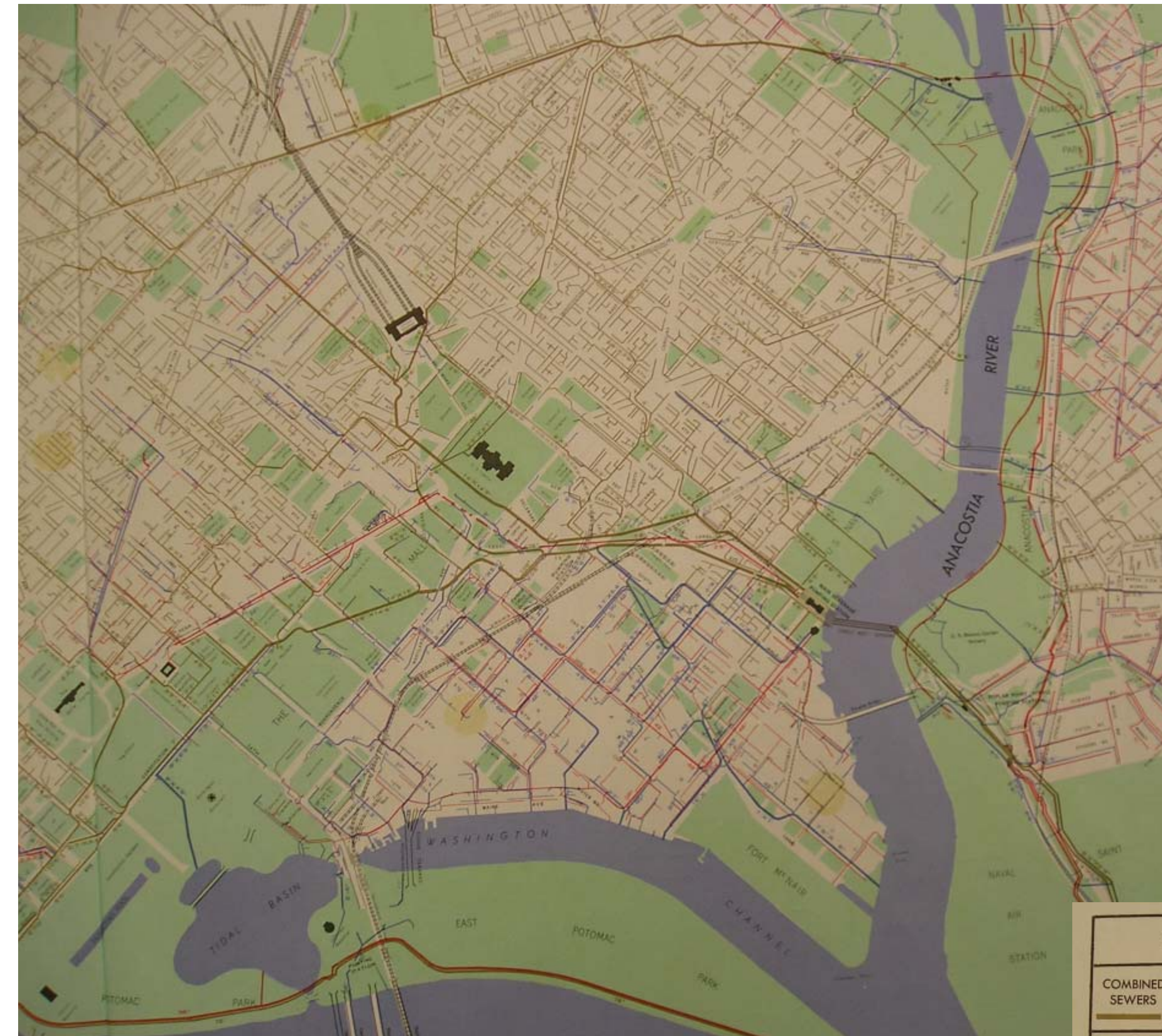


Figure 18. *Map of the City of Washington showing present Main Sewerage and Sewage Outfalls*, 1889. Library of Congress, Geography and Map Division.

By the early 20th century Washington stopped combining sewer and stormwater lines. Today however, the early combined sewer system still accounts for approximately 1/3 of the whole system or 12,478 acres. The combined system occurs in the oldest part of downtown Washington and much of the work done in the early 20th century has not been updated. More than 35% of the sewer lines in this section are at least 90 years old. [DCWRRC, August 1992, p. 60] Figure 19 at right is a detail of a 1986 map of the Washington area sewer map showing the Federal city area. The brown lines are combined sewer/stormwater, blue lines are storm sewers and red lines are separate sewers. There are a total of 60 CSO (combined sewer outfalls) along the Potomac, the Anacostia, Rock Creek and other tributaries that are predicted to dump 2,490 million gallons per year of overflow into these waters. The long term control plan intends, among other things, to implement low impact development measures throughout the system, rehabilitation of pumping stations, storage tunnels holding million of gallons of overflow (a 77-million gallon one alone for the plagued Northeast Boundary sewer area), and outfall consolidations [WASA 2002].



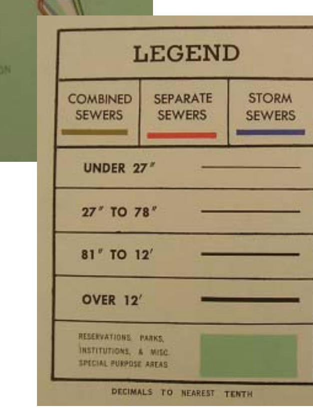


Figure 19. [Metropolitan Washington Council of Governments] *Washington metropolitan area sewer service area*, 1968. Library of Congress, Geography and Map Division.

Figure 20. A typical CSO outfall into the Potomac River. This one is located near the Kennedy Center.

Toxicity of Stormwater

Raw sewage rates highly as a significant health hazard but urban stormwater by itself is also a significant pollutant to the environment. Stormwater is toxic, picking up anything in its path, such as oils from automobiles, pesticides and lawn fertilizers. The stormwater heats unnaturally from contact with impervious surfaces such as asphalt and concrete, and in addition, it moves at a greatly accelerated rate. The outflow of high volumes of toxic, heated, rapidly moving stormwater can be devastating to the ecosystem of a river. The heated water and toxins kill fish and other living organisms in the river, and the rapidly moving water causes erosion. Controlling stormwater runoff is one of the most important issues in the battle to restore the health of urban rivers and environments.

Hydrologic Havoc

By the late 19th century, most of the streams that comprised the natural drainage system for the Coastal Plain region of downtown Washington were buried. Problems other than excess stormwater arise when one attempts to cover up an entity as powerful as a stream or drainage system. One of the most famous examples of such a calamity occurred in the West Philadelphia neighborhood of Mill Creek, the subject of Anne Whiston Spirn's *West Philadelphia Landscape Plan* [Spirn 1991]. Houses and streets built over the long buried Mill Creek fell into large ravines that suddenly appeared along the old stream's path. Assuming buried hydrologic systems disappear has tragic consequences.

While burying streams in Washington provided sewer channels below and developable land above, drainage was not always a consideration during burial for some systems. As a result, hydrologic problems abound in the District today. To locate areas plagued by chronic water problems in the District, one need only overlay a map of the District in 1800. Figure 21 at right is a hydrologic crisis map of downtown Washington based on recorded disturbances.

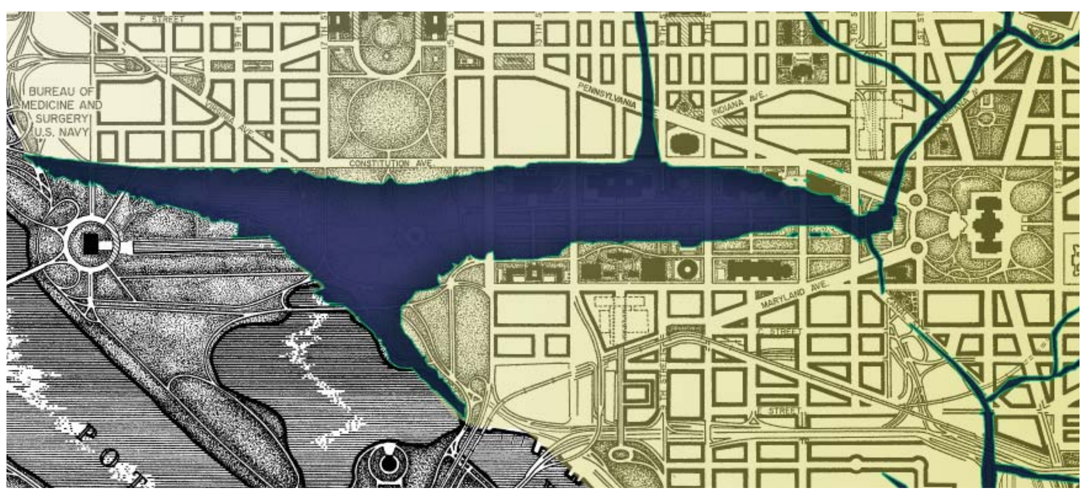


Figure 22. The mouth of the Tiber Creek overlaid on a 1990 map of Washington. This detail shows the White House south lawn, Federal Triangle and Mall areas were once underwater.

The drainage systems of the Tiber and James Creeks strongly molded the topography of downtown Washington. In spite of the filled-in and sewered streams, the groundwater is still migrating toward and flowing through the gravelly deposits of the old river beds infiltrating sewer pipes and the like. The old beds act as conduits for groundwater. [DCWRRC August 1992, p. 29] The territory from the south lawn of the White House along Constitution and Pennsylvania Avenues almost to the Capitol building all rests on the former mouth of the Tiber (see figure 22 above). Eight buildings, including the Commerce Department and the FBI, collectively pump 1.7 millions gallons of groundwater per day from their basements into the storm sewer system. Groundwater makes up 19% of substance processed at the Blue Plains treatment plant daily. [DCWRRC May 1992, p. 55] Buildings on the Mall suffer similar problems. The east wing of the Natural History building is pulling away from the main building because the Tiber Creek is beneath it.[O'Connor 1999, p. 4]. On a visit to the East Building of the National Gallery of Art, the architect I.M. Pei, on a walk through

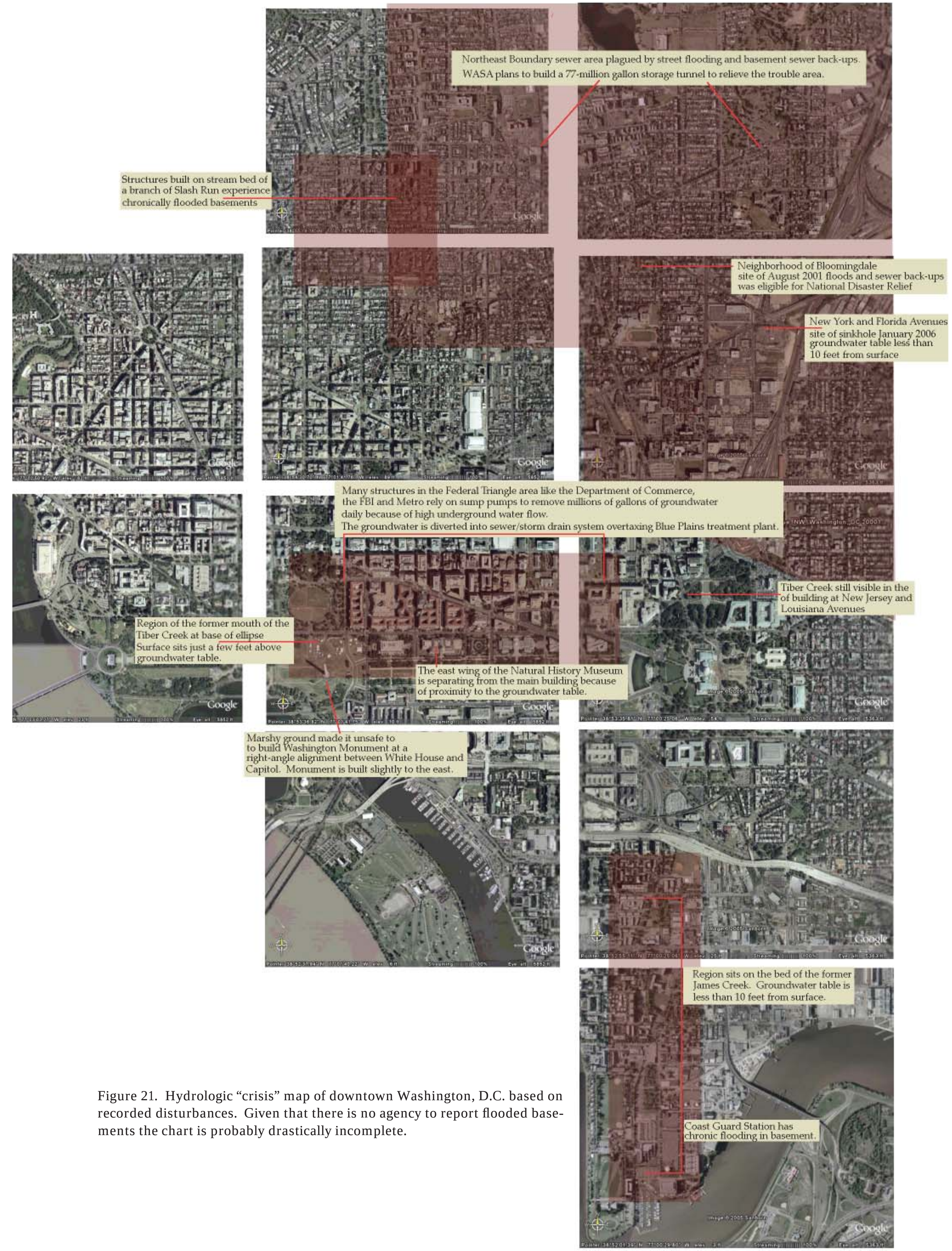


Figure 21. Hydrologic "crisis" map of downtown Washington, D.C. based on recorded disturbances. Given that there is no agency to report flooded basements the chart is probably drastically incomplete.

the building, tapped on the floor by the waterfall in the concourse that links the East and West wings, and reported that this was the most expensive floor he had designed because of the high water table beneath the building [Heinrich 2005, personal conversation]. The Metrorail system likewise pumps 423, 283 gallons per day of groundwater into the sewer system. [DCWRRC August 1992, p. 29]

Large construction projects also can encounter engineering difficulties due to the large volume of water beneath the surface. During construction of the I-395 tunnel under the Mall that crosses the former Tiber Creek bed, groundwater levels were 25 to 30 feet above subgrade. During the dewatering process the amount of water pumped out was nearly 250 gallons per minute. [DCWRRC May 1992, p. 38]

Further north up the Tiber path, the old river still runs in a bricked tunnel in the basement of a building at New Jersey and Louisiana Avenues, NW. [Williams 1989, p.84]. The neighborhood of Bloomingdale, which resides about eight blocks north of Union Station on both sides of North Capitol Street, is just a few feet above the groundwater table. During the intensive rains of August 2001, record flooding and sewer backups plagued the neighborhood with over 2,600 reports of flood damage making the city eligible for Federal Disaster Relief.

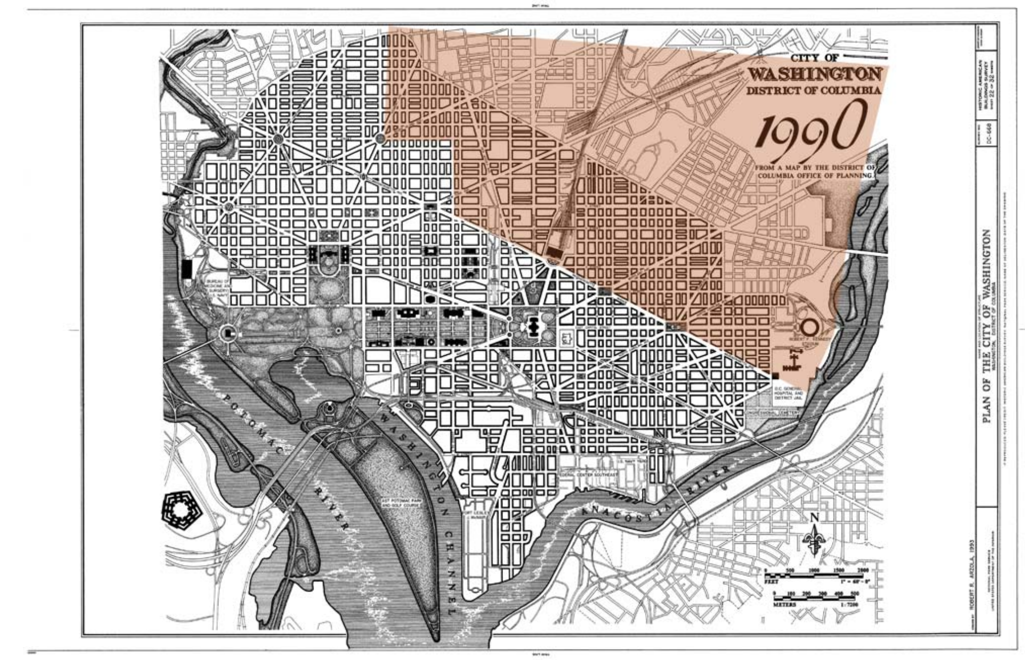


Figure 23. The shaded area is the troubled Northeast Boundary sewer area.

The Northeast Boundary sewer area, plagued by street flooding and basement sewer back-ups, covers a 4,278 acre area (see figure 23). This area is a priority with WASA. The long term plan calls for constructing a 77-million gallon storage tunnel for the region to control overflow.

Residents from 18th to 14th and R to U Streets, NW have chronic flooding in their basements, because developers built the houses on the old streambed of Slash Run (see figure 24 below).

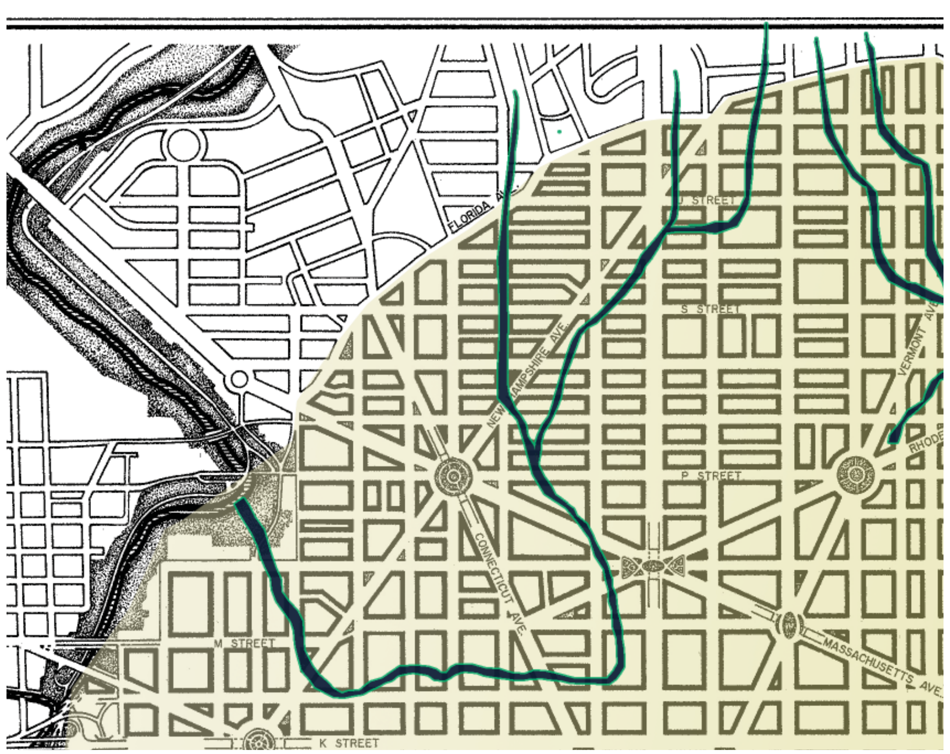
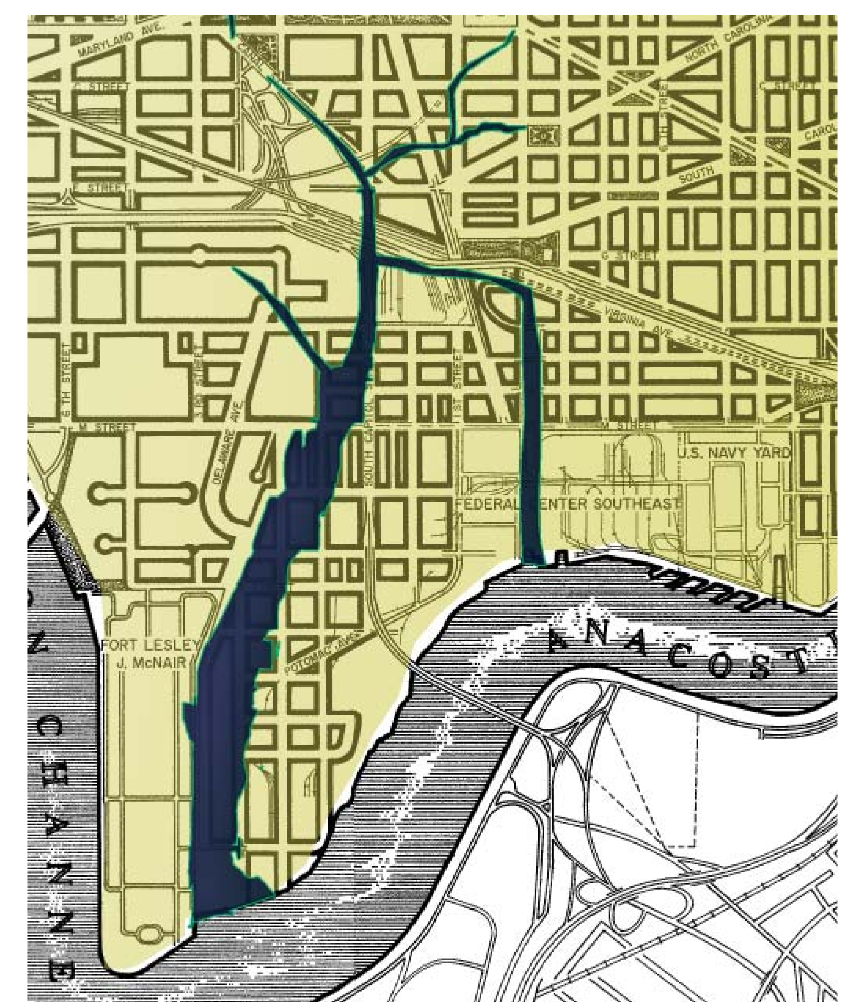
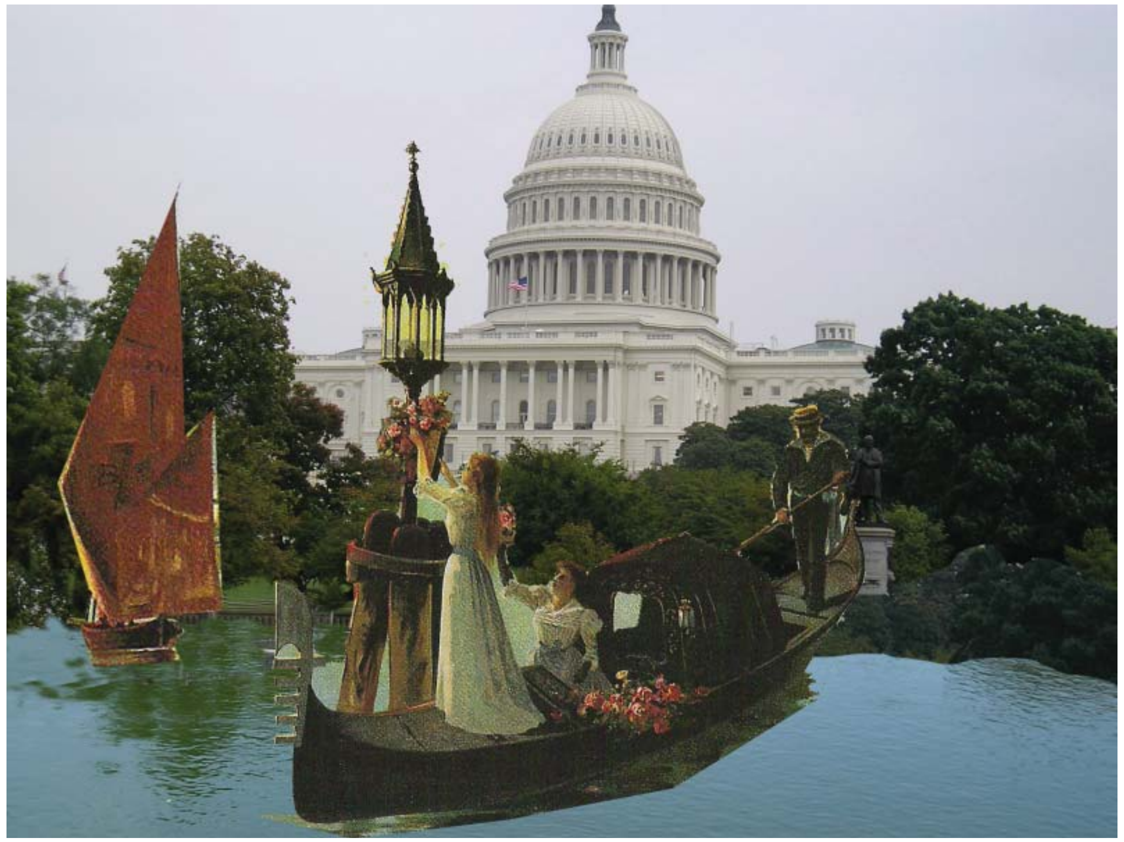


Figure 24. The path of Slash Run overlaid on a 1990 map of Washington. Many residences in the upper right portion of the map report chronically damp or flooded basements. They are clearly built on the path of the old streambed.

Figure 25. The bed of James Creek overlaid on a 1990 map of Washington, D.C. Shown is Buzzards Point that rests just feet above the groundwater table. The U.S. Coast Guard station reports chronic flooding in its basements.



Stormwater Management Plan for the Year 2110



Given a constant battle with Mother Nature trying to resurface, could the water be put to better use, especially as the city is grappling to resolve a major storm sewer problem? Could urban design of the future somehow incorporate these natural systems to its advantage rather than to its detriment? The following stormwater management plan for the city of Washington proposes restoring the Lost Rivers of Washington to the surface and incorporating them into the contemporary urban-scape. Water channels could revitalize otherwise mundane and depressed neighborhoods by introducing opportunities for recreation, businesses and green corridors along the new waterfronts. Waterfronts will vary from naturalistic, heavily vegetated buffers similar to Rock Creek Park to a more urban canal experience.

While to some this proposal may seem as outrageous as constructing enormous underground storage tanks to hold filthy water, a different school of thought concerning stormwater has been emerging over the last 40 years. Water is now celebrated and is an asset to a site rather a pariah whisked away in a pipe. Urban development that recognizes natural drainage patterns and allows stormwater to absorb and filter on site results in cleaner water reaching streams and rivers. Is the damage already done to many urban hydrologic systems irreparable? Is there hope for returning “Nature” and its processes to inner cities? The phenomena of daylighting, the action of deliberately exposing some or all of the flow of a previously covered river, creek or stormwater drainage [Pinkham 2000, p. 56], is taking root in the United States and abroad. The earliest projects in northern California began in the early 1980s. Since then daylighting projects abound in all forms. In the early 1990s, the city of Kalamazoo, Michigan, re-exposed five blocks of Arcadia Creek that flows through a dense urban stretch of downtown. Zurich, Switzerland, unearthed at least nine miles of historic streams, and incorporated them into the fabric of the cityscape and plans to daylight many miles more. Kalamazoo and Zurich are wonderful precedents for a highly urbanized environment like Washington, DC. Both projects addressed serious issues like the presence of heavily contaminated soils along the paths of the restored channels.

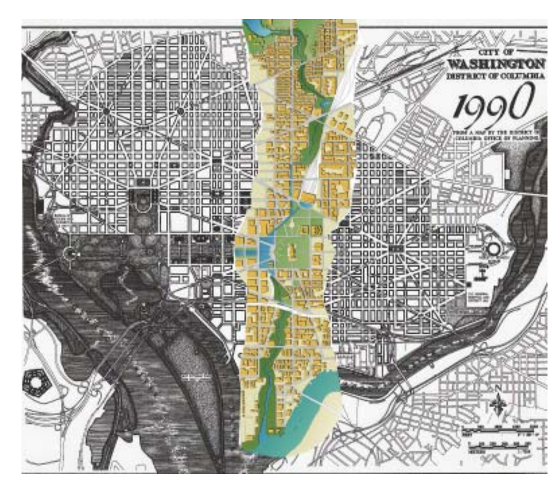
What follows is an initial investigation of establishing and sustaining one channel system with the intent of improving the storm sewer overflow crisis in Washington and, in addition, exploring the potential, and limitations, that arise from the process. The study is not an attempt to daylight the Tiber Creek or Slash Run, nor is it an attempt to recreate one of the stream systems historically. It is an attempt rather to explore whether favorable conditions exist to create an above-ground stormwater channel system that can take advantage of both present and past conditions.

Where could a constructed stream channel fit into the contemporary urbanscape of Washington, DC, and how could it sustain itself? Could the channel operate on gravity and could it take advantage of the high water table in Washington to recharge itself? While the opportunities of selecting routes for study abound, this investigation will explore one channel that could draw on as many resources as possible and benefit as much of the city as possible. Studies of topography, both past and present, groundwater data and current land use lead to a logical path for a pilot stormwater channel project.

Figure 26 at right shows the master plan for the new waterway with its source at the McMillan Reservoir, which is an appropriate symbolic source for two reasons: the old Smith Spring that supplied the Capitol building with water for many decades sits in the middle of the reservoir under a brick hut (see figure 27) and the reservoir is near the original source of the Tiber Creek close to the Soldiers' Home. The new channel follows, roughly, the path of the old Tiber Creek and joins with the James Creek. This path would have more of an impact on the city in areas like the Northeast Boundary sewer area than say would restoring Slash Run. It would also provide other urban design opportunities as it passes through some high profile areas such as Union Station and the U.S. Capitol and Mall grounds and would allow an opportunity to design both naturalistic and urban channels. This path also allows the inclusion of groundwater data that is not readily available for the western portion of the Federal City.

The McMillan Reservoir presents a logical source for the system also because it provides abundant water at the high elevation needed. It sits on one of Washington's old river terraces at approximately 160 feet above sea level. The reservoir serves as a staging point for Washington's municipal water supply. The water in the reservoir, piped in from the Potomac River near Great Falls through the mid-19th century Lydecker tunnel, goes through a partial sedimentation process at the Delacarlia Reservoir in northwest Washington but is otherwise untreated. The beauty of using the Potomac Water as a source for the channel is that it will eventually return to the Potomac via the Anacostia River, filtered and cleansed. The goal of the project is to avoid use of treated city water to sustain the system and to purify the water using phytoremediation. One solution for an initial source involved tapping into groundwater but the use of McMillan Reservoir provides a more reliable supply. The channel taps groundwater periodically for sustenance but not as a main source.

Figure 27. The McMillan Reservoir. The brick structure in the middle is the marker for the original Smith Spring that supplied water to the U.S. Capitol for decades.



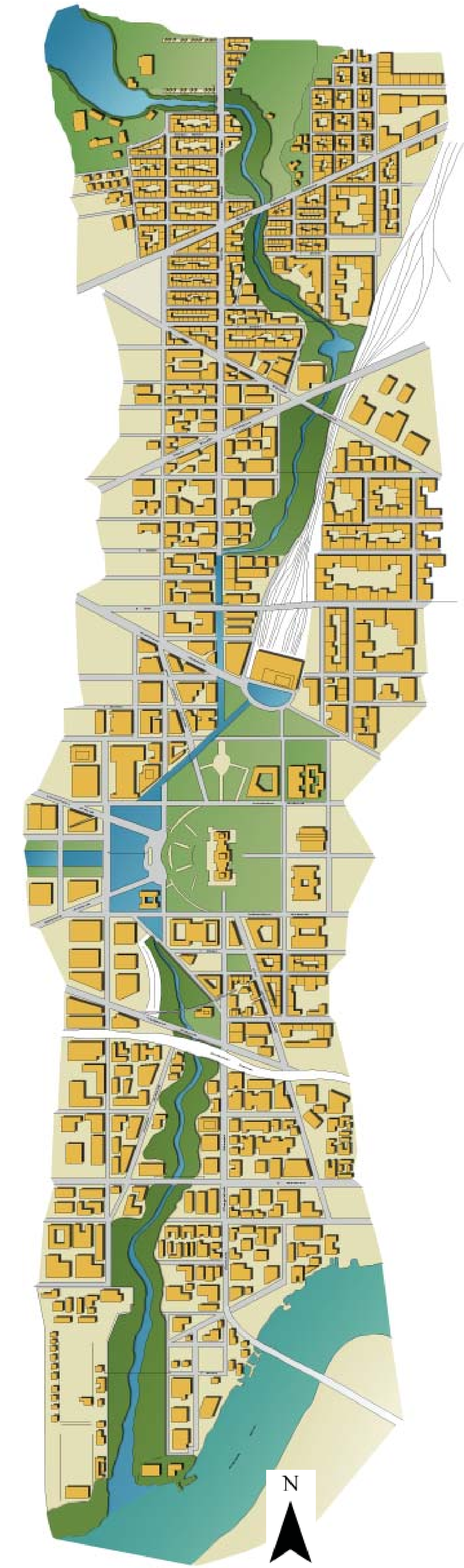


Figure 26. The master plan for a pilot stormwater channel in the city of Washington.

Investigation: Siting the Channel

Topography

Given that a water source exists for the system, could the topography of Washington support a gravity-based flow down the 4.2 miles to the Anacostia River? Does a watershed or drainage basin still exist that would guide stormwater to the channel? To understand the conditions that existed for the original stream it is necessary to look at the past topography.

The paths of the early stream systems are important to this study because trends in the terrain that were conducive to stream channels then could still be extant today. If they are not extant, what would have to change? As mentioned previously, during the 1870s, the Board of Public Works instituted massive grading campaigns to provide more developable land within the Federal City boundaries and, at this time, they buried the last of the creeks. Because the creeks cut through alluvial soil, the terrain was quite dramatic in some locations with ravines as deep as 14 feet. The topography of the city today largely reflects the grading done in the late 19th century. How much of the trends in the original topography exist?

The figures on this page represent a study area of both the present and past topography of Washington. The detail area is approximately from Logan Circle to the west and Union Station to the east and Florida Avenue to the north. The southern border is roughly Pennsylvania Avenue (see figure 28). Figure 29, generated in GIS from a USGS DEM (digital elevation model) for the District, shows the current topography of Washington with the street grid superimposed. Unfortunately due to security reasons the topographical data for the Capitol and White House grounds is not available, therefore the model interpolates from surrounding data and in this case the data created Capitol Hill too far to the east however the configuration at the base of the Hill is accurate, which is what is of concern here.

Since a DEM does not exist for past topography, figure 30 is a 3-D reconstruction using GIS software based on figure 3, the Hawkins map. By tracing contours from the Hawkins map, the author created this 3-D model (both models are TINs [triangulated irregular networks] and have a Z conversion factor of 1.) Note the legend shows that the Federal flats are at highest point about El +90 feet and the lowest point is El +5. While these ranges have not changed, it is evident that the present landscape is more subtle and that the former stream valleys flowed in well-defined channels. From this comparison it is evident that the general trends in the landscape still exist.

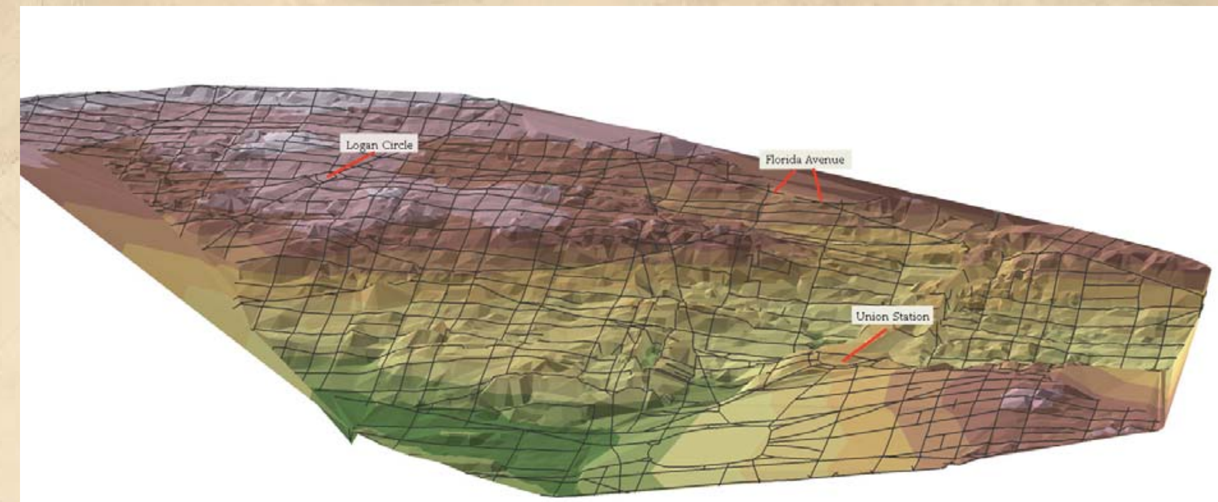


Figure 29. Detail area of a digital elevation model (DEM) for present day Washington, D.C. generated in GIS. Markers label the sites of Union Station and Logan Circle and show Florida Avenue running along the top border. GIS topographic data for the site of the Capitol building is not available for security reasons, therefore Capitol Hill appears as a gradual slope as the system attempts to interpolate available data and places Capitol Hill much further to the east than it is. The configuration below in Figure 30 is a more accurate assessment of Capitol Hill topography even today.

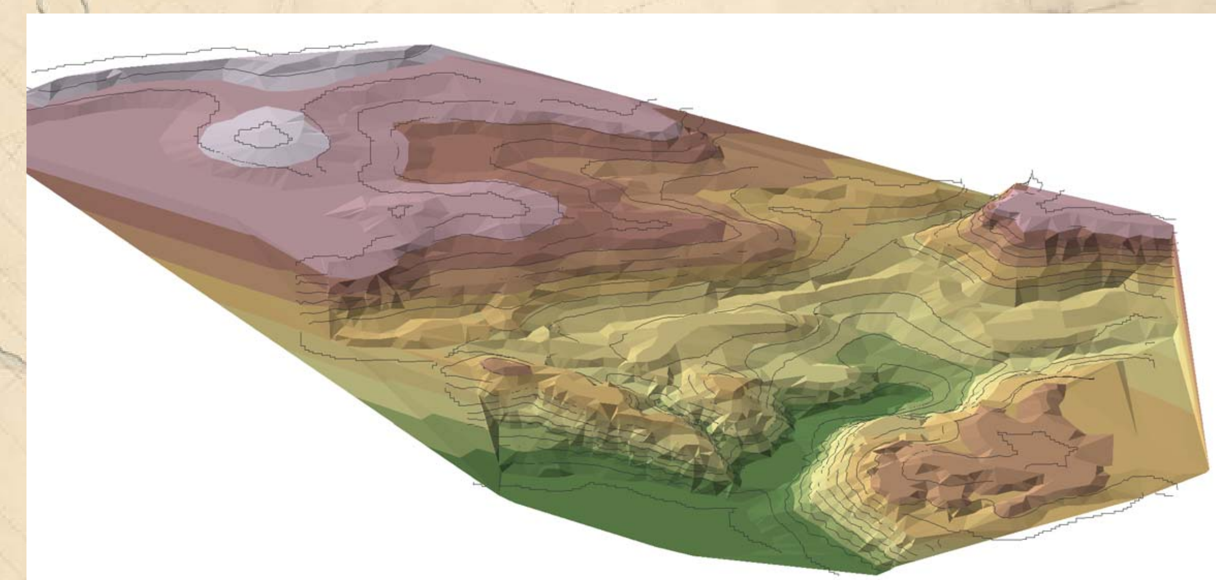


Figure 30. A 3-D reconstruction of the same detail area in Figure 29 though this shows the topography of Washington in 1791 based on Don Hawkin's topographic map (figure 3). The Tiber Creek forms a well-defined valley from Union Station to the base of the Capitol, channels for its tributaries are also evident.

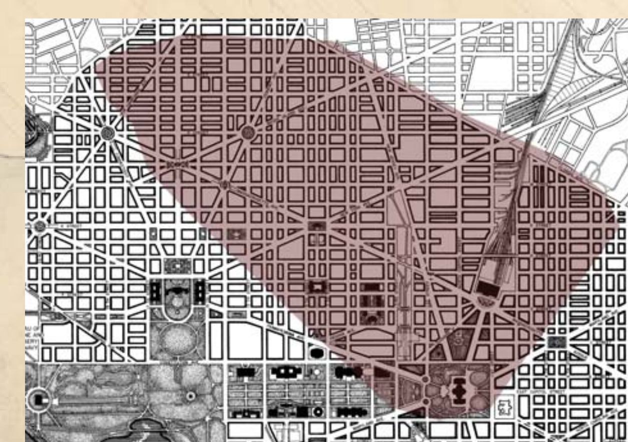
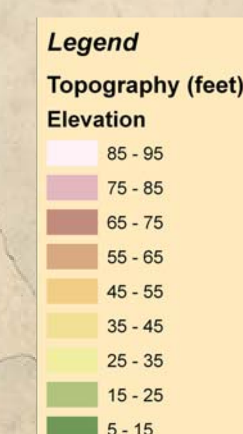


Figure 28. Detail of 1990 map showing the area for topography studies in figures 29 and 30. Area is shaded on this map.

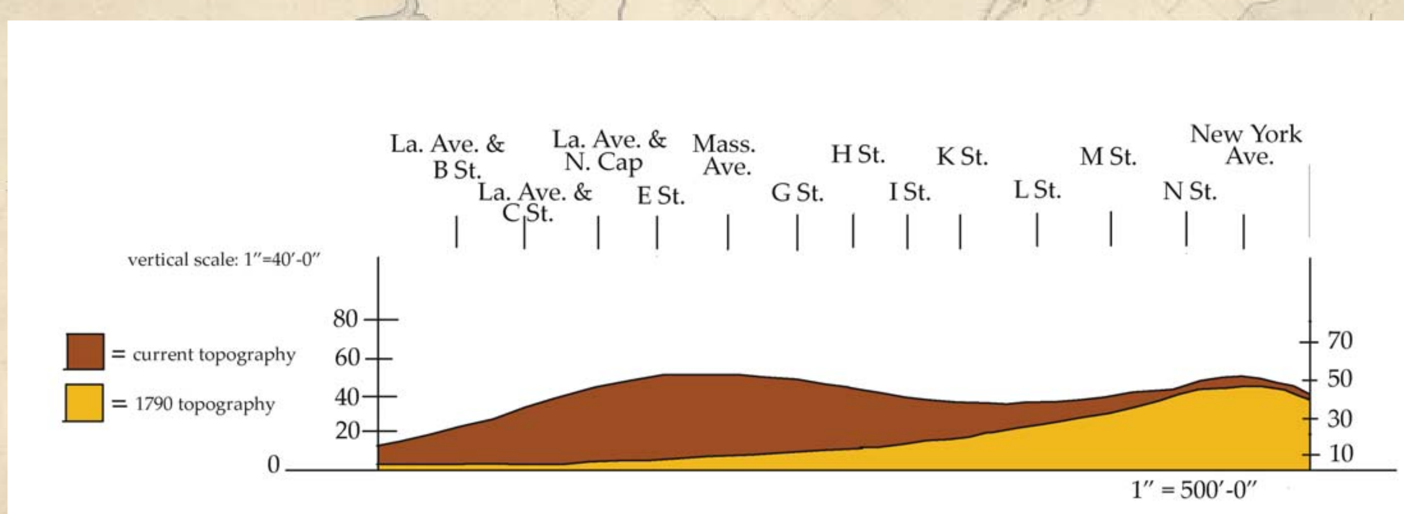


Topography (cont.)

Figure 31, above right, is a detail from the past topography of Washington (figure 30) showing an approximate reconstruction of the Tiber Creek and some of its tributaries. It is evident from the illustration the large impact the Tiber drainage area had on the terrain of the early city. As the Tiber reached the Mall it broadened considerably and flowed toward the White House.

Figure 32, below right, is the same detail of the past topography but with the present topography superimposed in teal green. Areas of fill correspond directly to the stream valleys and other areas with uneven terrain. The changes around Union Station are probably the most noteworthy. In 1910 the builders of Union Station placed 30 feet of debris on top of the old stream bed (i.e. the Tiber sewer at this point) to elevate the site. Ironically it was the weight of the fill from the construction on the old brick sewer arches here that necessitated bringing sewer construction into a new phase by relining them with concrete [Owens 1937]. Washington, D.C. was the first city to line its sewers with concrete. Figure 33 below compares past topography to present topography along the path of the Tiber Creek. While general trends in terrain exist elsewhere, the area around Union Station provides a major challenge to a new gravity-based system.

Figure 33. Profile of Tiber Creek Valley from New York Avenue to Constitution Avenue in 1791 and in present day.



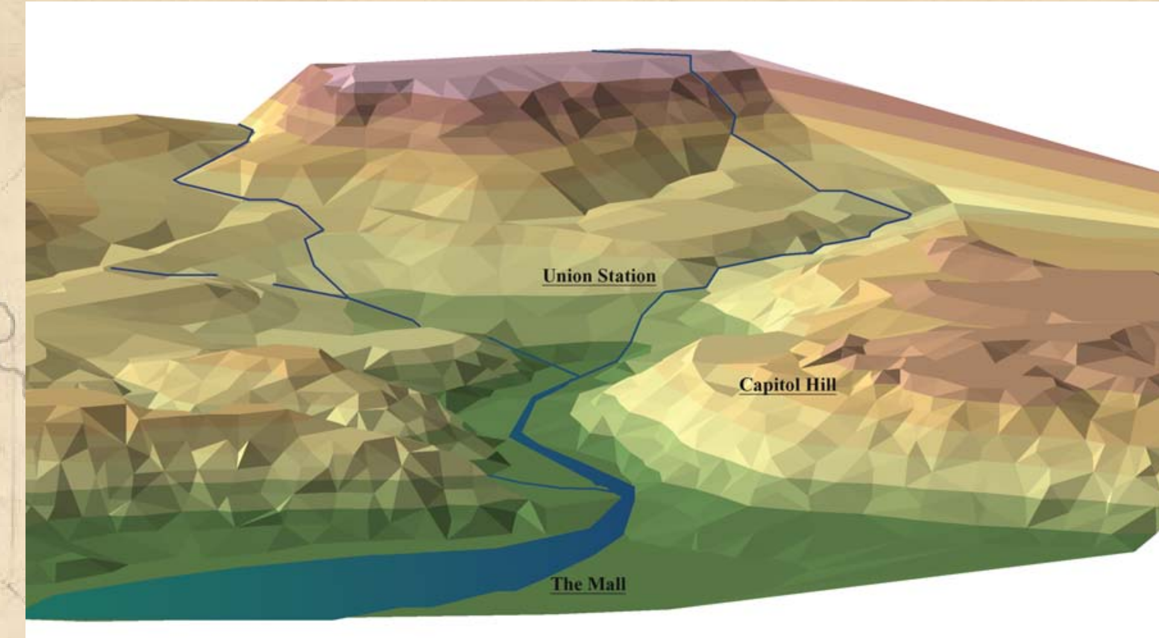


Figure 31. Detail of Figure 30, the lower Tiber Creek valley from Union Station to base of Capitol Hill and onto the Mall showing a reconstruction of the Creek formation. The drainage area for the Tiber obviously had a large impact on the formation of the terrain.

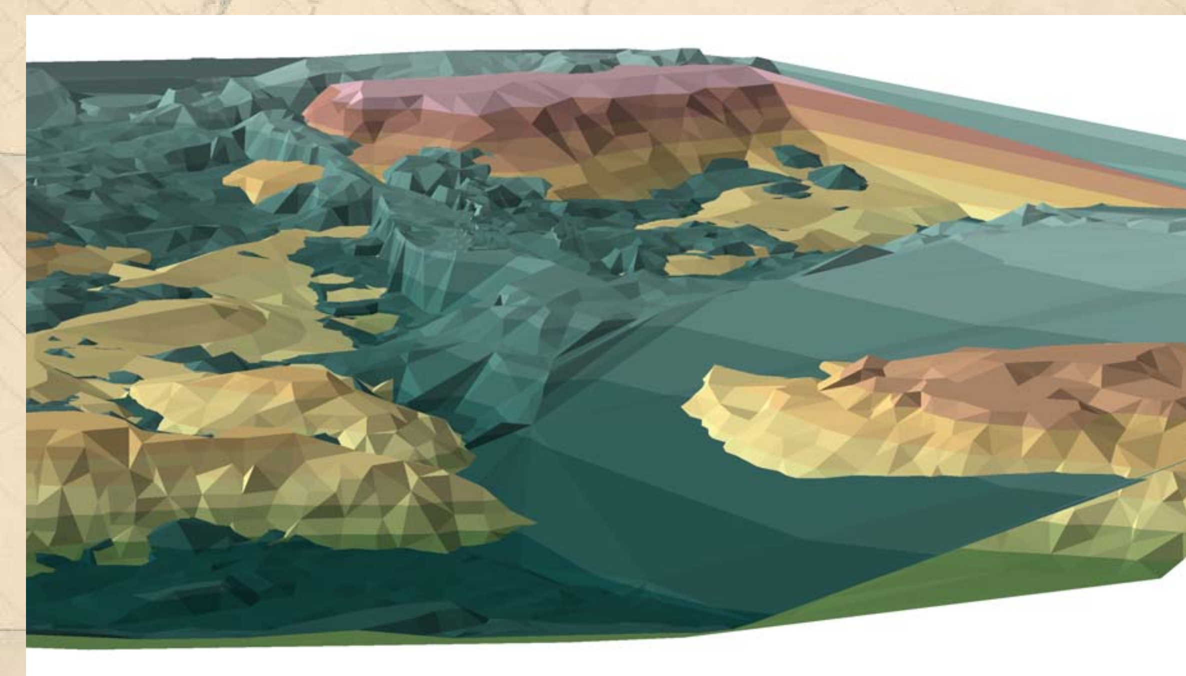


Figure 32. Shows the same detail as figure 31 above but is superimposed (in teal green) with present day topography. Valleys and crevices have been softened but most notable is the Union Station region. In 1910, builders of Union Station put 30 feet of fill on the site.

Groundwater

While studying surface topography is vital to selecting an appropriate path for the channel, it is also important to look at groundwater topography. The contours of the groundwater table could also be a deciding factor in the route of the channel if groundwater is to be tapped to sustain the system. While groundwater once fed the Tiber and other tributaries, where is it flowing now and could the reconstructed channel take advantage of it? Intense urbanization can have devastating affects on groundwater flow.

A study done by the DC Water Resources Research Center in 1995 assessed the impact of urbanization on groundwater flow. The report states, "the construction of buildings with basement sump pumps and paved surface areas has...significantly impacted the surface hydrology, groundwater recharge and general sub drainage basin hydrology throughout the area." [DCWWRC 1995, p. 1&2]. Construction of Metro tunnels, underground storage tanks, underground parking garages and pipelines for utilities (the water distribution system alone accounts for 1,400 miles of pipes, natural gas mains 1,200 miles) all affect the direction and velocity of groundwater flow (especially since the groundwater table for downtown Washington is typically between only 10 and 40 feet below the surface). The study by the DC WRRC was to determine just how much impact urbanization has had. The researchers generated a water table of the Atlantic Coastal Plain Deposits of Washington groundwater contour map. Results for the study show that "despite the sewering of the creeks, old stream channels are still serving as preferred paths for groundwater." [DCWRRC May 1994, p. 20] Most notably is Tiber Creek, which is still following in its original drainage patterns from Union Station along the rail tracks. [DCWRRC May 1994, p. 20] In areas downtown where surface drainage patterns have been altered to send runoff toward the Anacostia, the groundwater is still flowing to the Potomac. The data, then, supports the possibility of groundwater helping to sustain the newly constructed waterway.

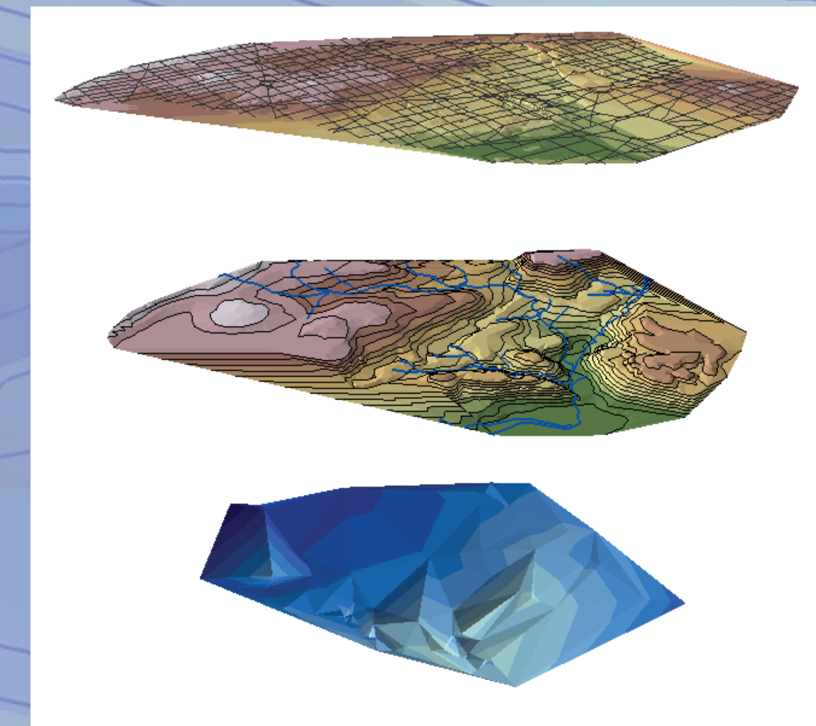
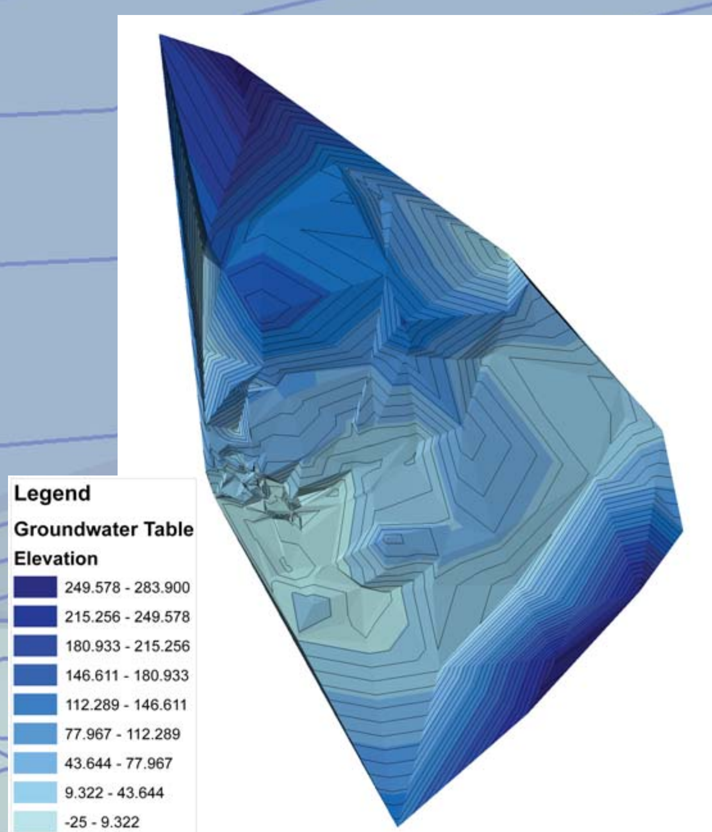


Figure 36. Groundwater table of downtown Washington (below) compared to surface topography of 1791 (middle) and present-day Washington (top). As this illustration points out the groundwater contours are still following the buried channels visible in 1791 topography.

Figure 34 (near left) shows the study area for the DC WRRC study. Figure 35 (far left) shows the three-dimensional rendering of the Atlantic Coastal Plain Deposits of Washington groundwater contour map. The 3-D rendering is the result of transferring the two dimensional data from the DCWRRC study—the x and y coordinates as well as depths to groundwater monitoring wells, surface water data point locations, and soil boring locations—into GIS and creating a TIN of the water table.

When compared with present and past topography (see figure 36 above) the groundwater table visibly reflects and follows the past channels. By placing these layers together in GIS one can then select any point on grade surface and learn how far down the groundwater table resides. The data is of course an approximation and is interpolated based on all points surveyed. The trends are undeniable however. The fact that groundwater is still flowing in the historical channels is significant to this study. If the surface topography still tends to form valleys or drainage basins, the groundwater is close to the surface in these areas and could be used for periodic tapping along the channel for sustenance.



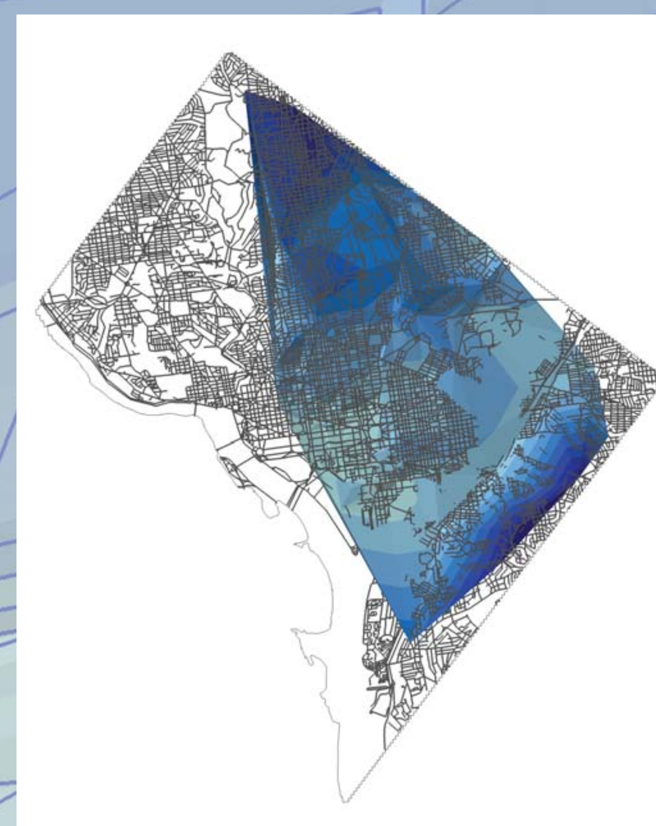


Figure 34 (right). The research area of the DC Water Resources Research Center 1994 study.

Figure 35 (left). Atlantic Coastal Plain Deposits of Washington groundwater contour map generated in GIS from data included in D.C Water Resource Research Center Study (1995).

Based on existing surface topography, land use and groundwater data, figure 37 (below) shows a section of the proposed channel path. The blue mass below grade surface is the groundwater table. In addition, a rough approximation of the geologic formations beneath the city is included—the bedrock formation of the bluff and the river terrace deposits of the flats of the city. The highest point along the path is about El +162.00 and the lowest point is at the shore of the Anacostia, which is about El +3.00. The section reveals certain areas, like Florida Avenue (the Bloomingdale neighborhood of the August 2001 floods) that are amazingly close to groundwater. The areas of high water table can be used to advantage by creating periodic groundwater recharging areas to the channel. Those portions of the channel that do not tap groundwater would have a clay base or non-permeable base so the system would not lose water. Figure 38 at right is a perspective of the same path.

Figure 38. Perspective showing topography and location of channel path.

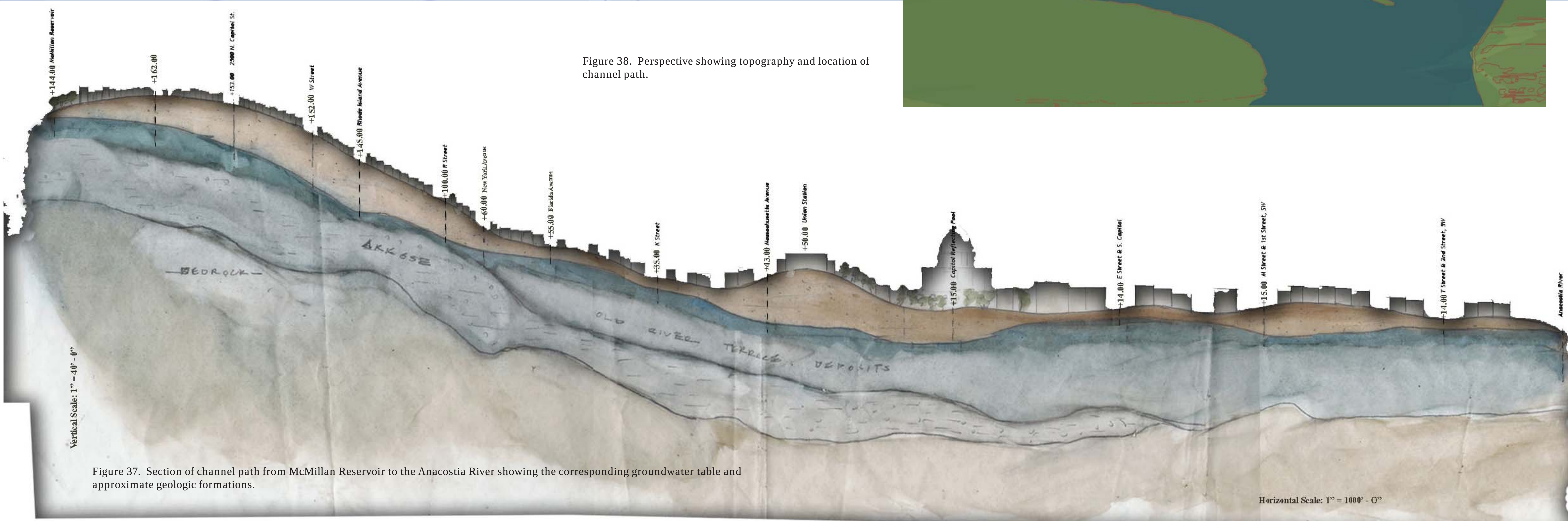
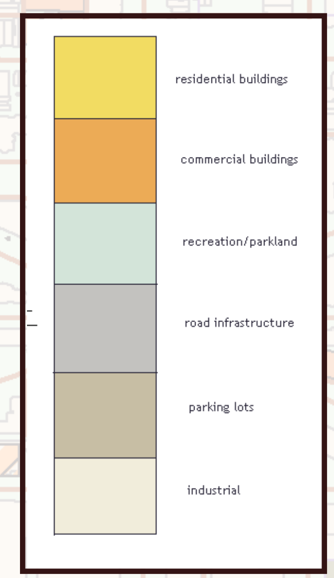


Figure 37. Section of channel path from McMillan Reservoir to the Anacostia River showing the corresponding groundwater table and approximate geologic formations.

Land Use/Demolition

Figure 26 revealed the masterplan of the constructed waterway. Figure 39 at right illustrates what must be removed to accommodate the new system. The chart is coded by industrial, commercial, recreation/parkland, parking, residential use and road infrastructure. Fortunately a relatively small portion is residential use. As much of the territory north of Union Station follows the rail tracks (the industrial section of the city), many vacant lots are evident. Given that this is the 100-year plan many structures in a natural building lifecycle will probably need to be replaced during that span of time. Appendix A shows the demolition plan in detail.



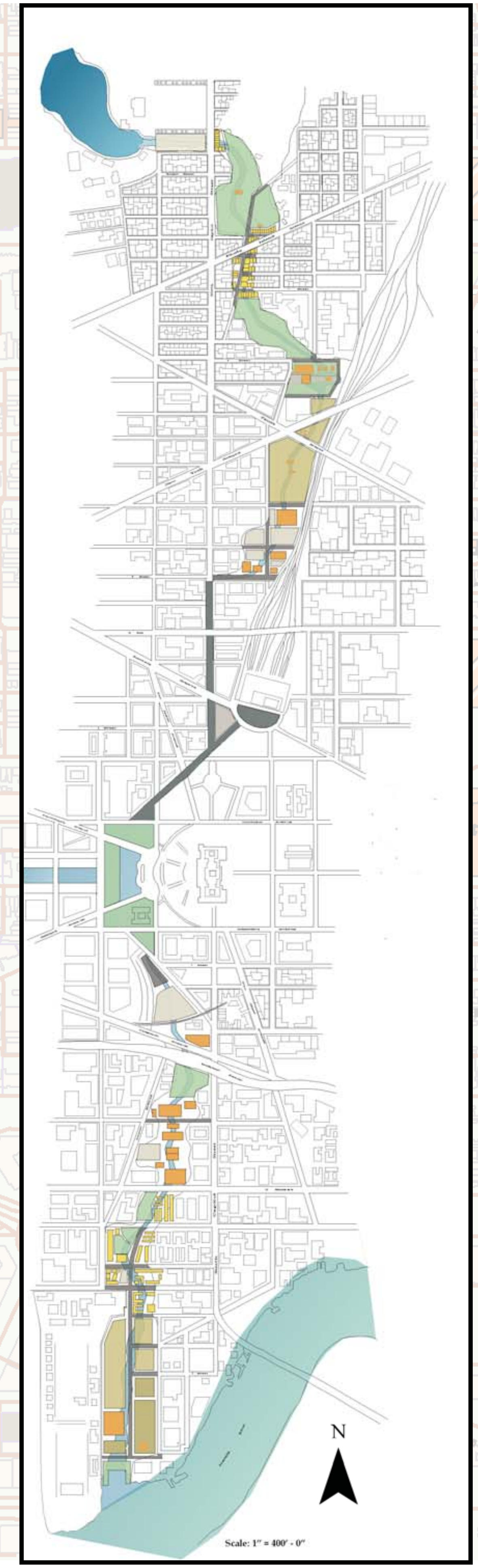


Figure 39. Land use/demolition plan along proposed waterway.

Channel Design

As was evident from the current surface topography section (figure 37, page 18), a constant descending path to the river is no longer possible along the entire path. Figure 40 (below) is a section showing, given the path of the channel, what stream bed elevation is necessary for the water to flow to the Anacostia. The surface of the water source, the McMillan Reservoir is El +142.00 and the Anacostia is about El +3.00. Figure 42 (next page) shows sections of the channel in eight locations to illustrate, given the current topography, how far down over how many feet is necessary to excavate to meet the desired stream elevation and in some cases tap the groundwater. The sections also show the width and nature of the channel and buffer surrounding the system. The initial width of the stream is based on Dunne and Leopold's method that compares geographic location of the waterway in the United States against the size of the drainage area [Rosgen 1996]. The total drainage area for the reconstructed channel is approximately 5.5 square miles (see figure 41, right) so the designed channel is considerably wider than is necessary but as such allows for larger storm capacity and for a generally richer aesthetic experience. The buffer surrounding the system in some instances is as wide as 400 feet. A buffer this wide allows for many opportunities such as an entirely new green corridor that the city did not have before. The buffer could include bike and hiking trails as well as wildlife habitats.

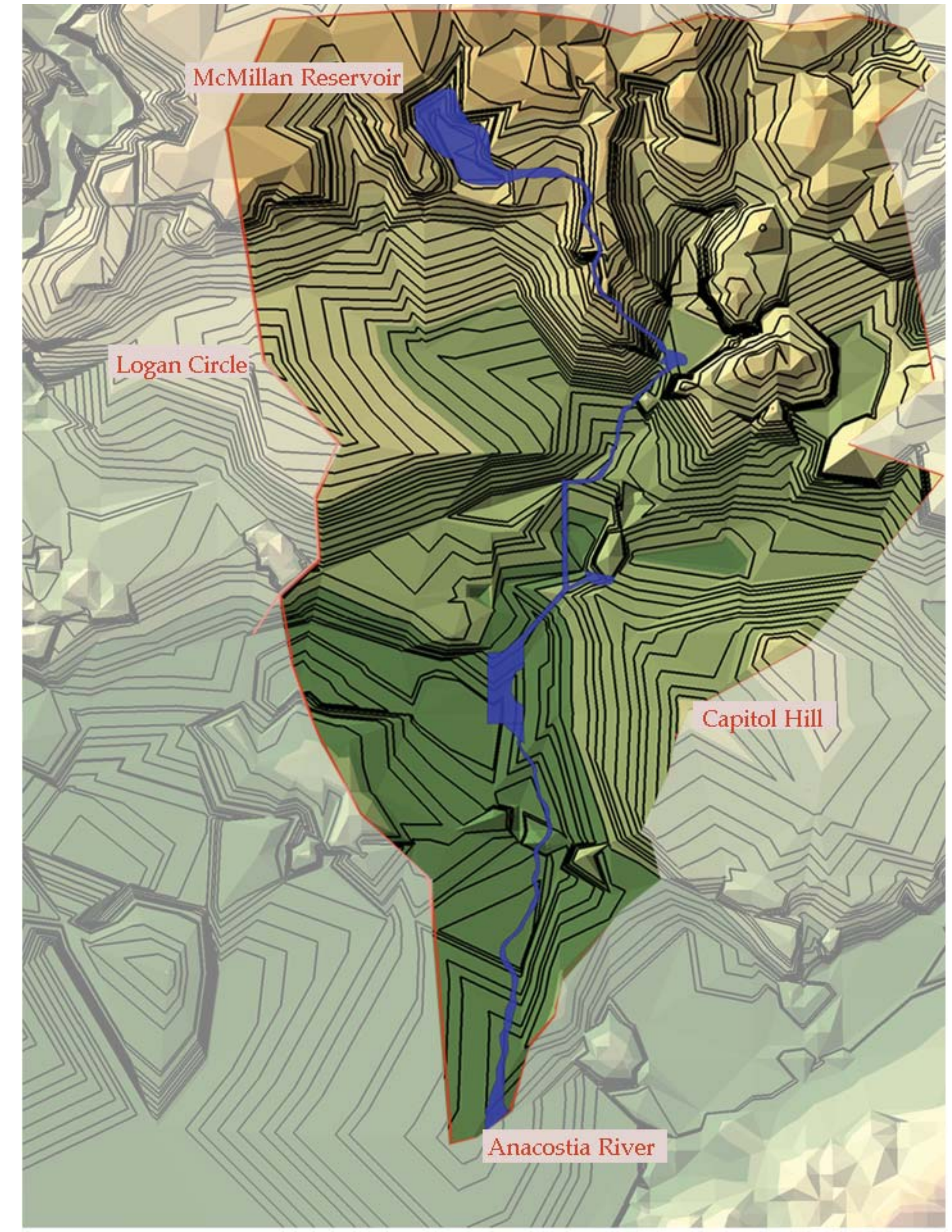


Figure 41. Plan of the drainage area for the constructed waterway. The area measures approximately 5.5 square miles.

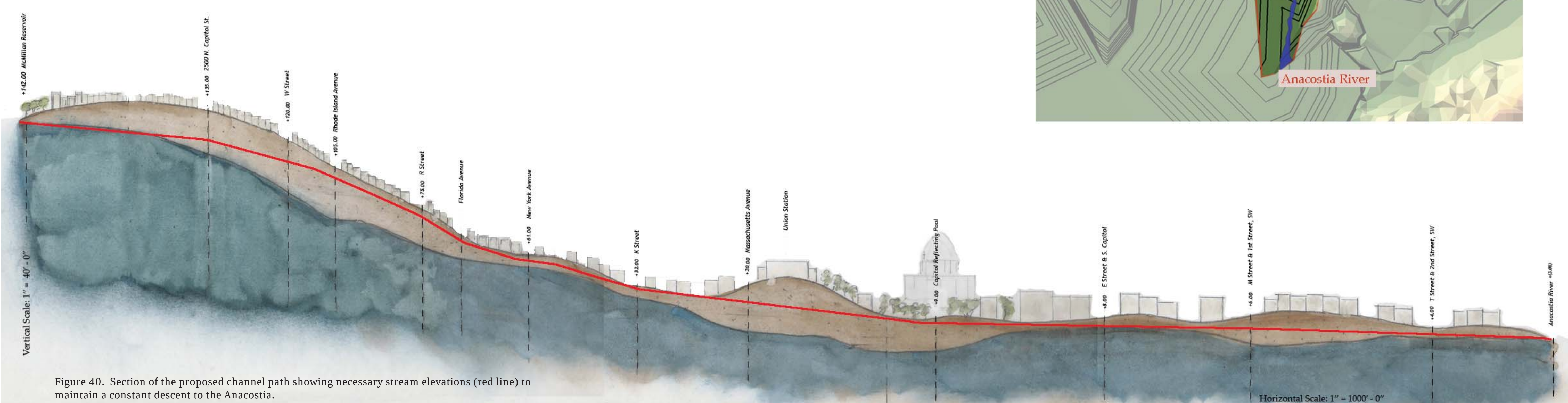


Figure 40. Section of the proposed channel path showing necessary stream elevations (red line) to maintain a constant descent to the Anacostia.

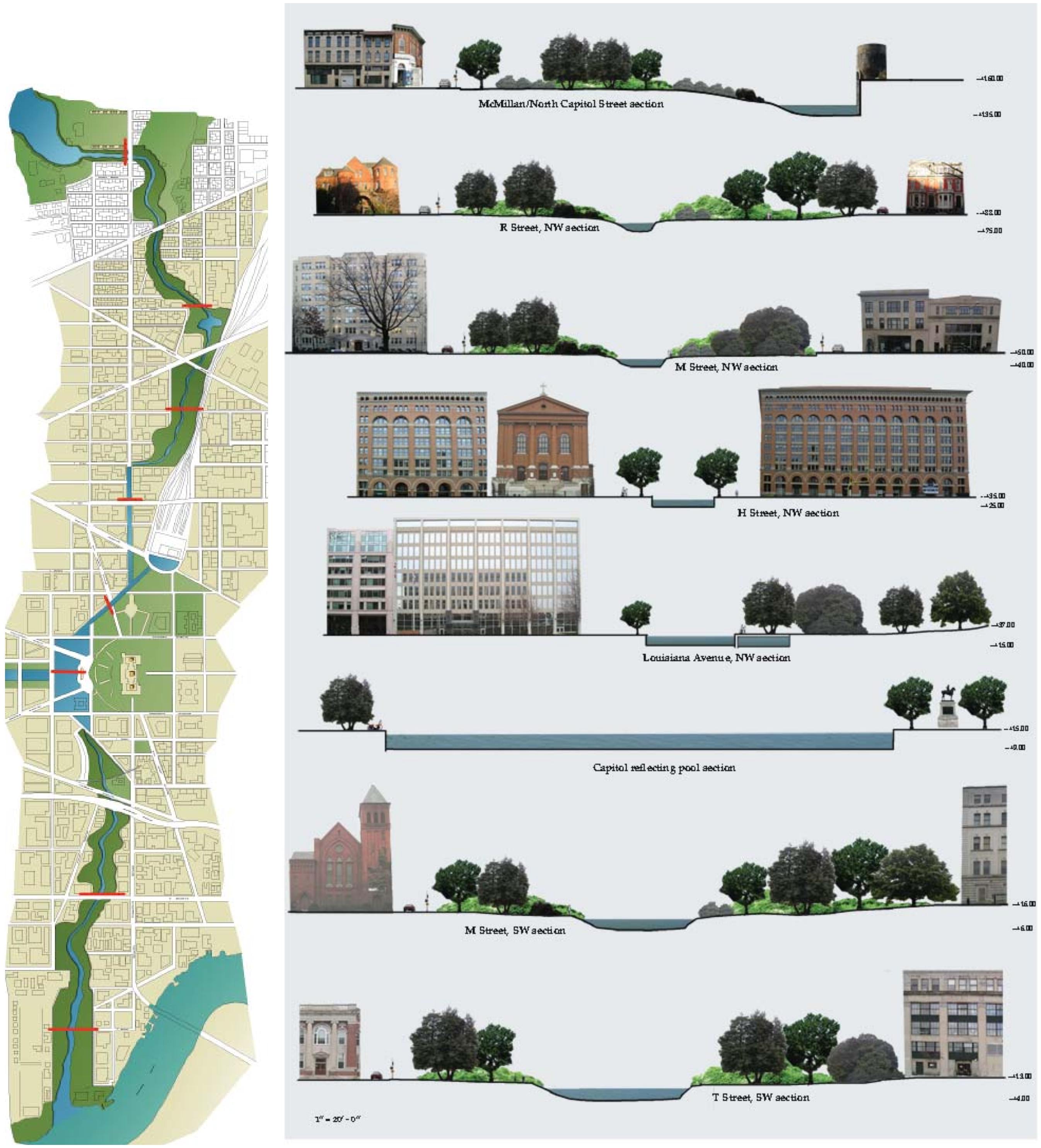


Figure 42. Eight sections along the proposed channel route. Key to sections at left in red.

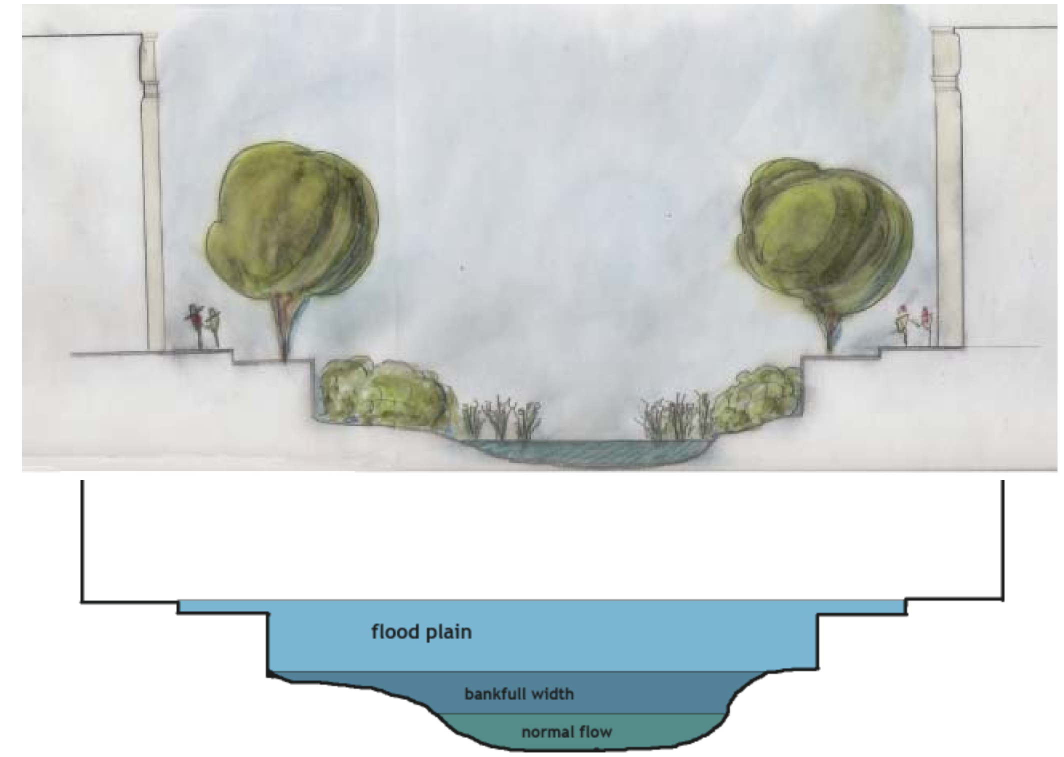


Figure 43. Typical configuration for urban channel sections (above) and stormwater design features (below).

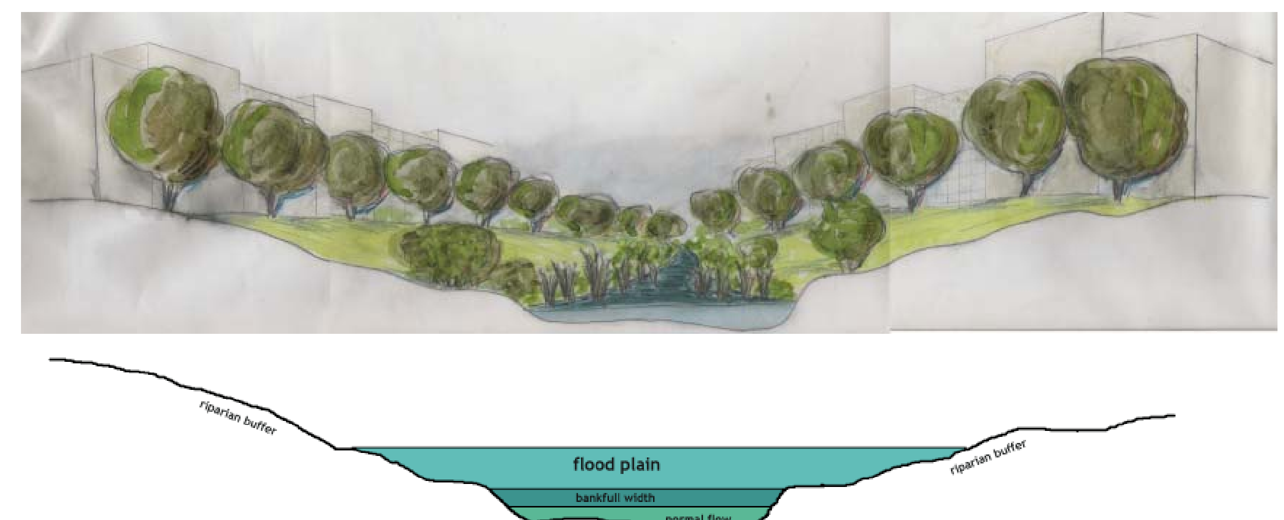
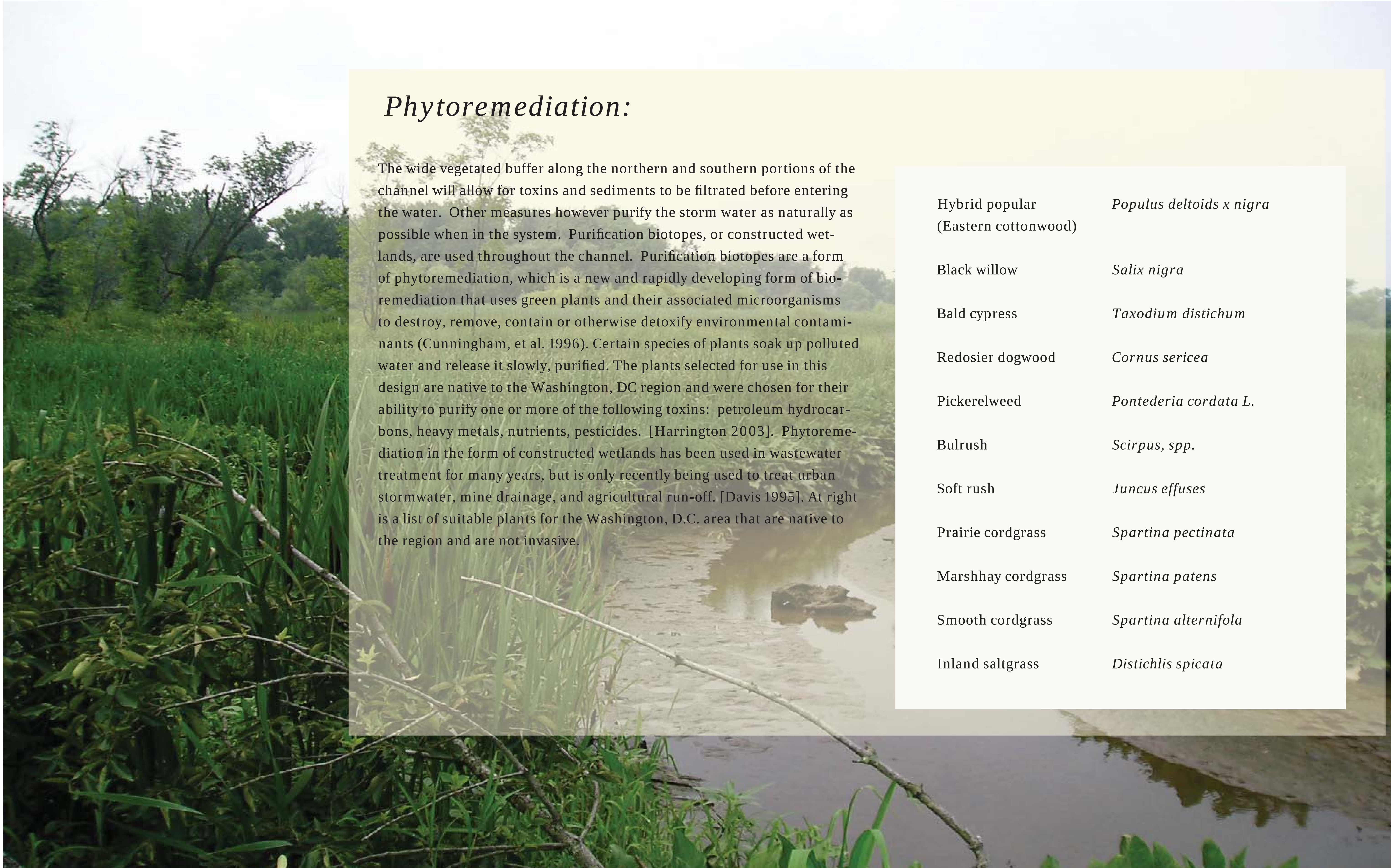


Figure 44. Typical configuration for naturalistic channel sections (above) and stormwater design features (below).

The ideal water depth for the channel is approximately 2.5 feet during normal flow. Figures 43 and 44 show how the design of the channels accommodate larger than normal volume of water. Each channel configuration, naturalistic or channelized, allows for bankfull width capacity and flood plain measures. While during normal flow, the design allocates space for a hiking trail or canal walk, during severe storm activity the space doubles as a flood plain.

The channel design also mimics the natural meanders and riffles that a natural streambed has. Far from an aesthetic concept, channels that meander prove to be more stable and maintenance-free systems than straightened channels. The construction of pools and riffles help the system maintain more natural sediment loading, and therefore helps the stream purify itself and control flooding [Rosgen, 1996].



Phytoremediation:

The wide vegetated buffer along the northern and southern portions of the channel will allow for toxins and sediments to be filtrated before entering the water. Other measures however purify the storm water as naturally as possible when in the system. Purification biotopes, or constructed wetlands, are used throughout the channel. Purification biotopes are a form of phytoremediation, which is a new and rapidly developing form of bioremediation that uses green plants and their associated microorganisms to destroy, remove, contain or otherwise detoxify environmental contaminants (Cunningham, et al. 1996). Certain species of plants soak up polluted water and release it slowly, purified. The plants selected for use in this design are native to the Washington, DC region and were chosen for their ability to purify one or more of the following toxins: petroleum hydrocarbons, heavy metals, nutrients, pesticides. [Harrington 2003]. Phytoremediation in the form of constructed wetlands has been used in wastewater treatment for many years, but is only recently being used to treat urban stormwater, mine drainage, and agricultural run-off. [Davis 1995]. At right is a list of suitable plants for the Washington, D.C. area that are native to the region and are not invasive.

Hybrid popular (Eastern cottonwood)	*Populus deltoids x nigra*
Black willow	*Salix nigra*
Bald cypress	*Taxodium distichum*
Redosier dogwood	*Cornus sericea*
Pickerelweed	*Pontederia cordata L.*
Bulrush	*Scirpus, spp.*
Soft rush	*Juncus effuses*
Prairie cordgrass	*Spartina pectinata*
Marshhay cordgrass	*Spartina patens*
Smooth cordgrass	*Spartina alternifola*
Inland saltgrass	*Distichlis spicata*

Design Focus: K Street

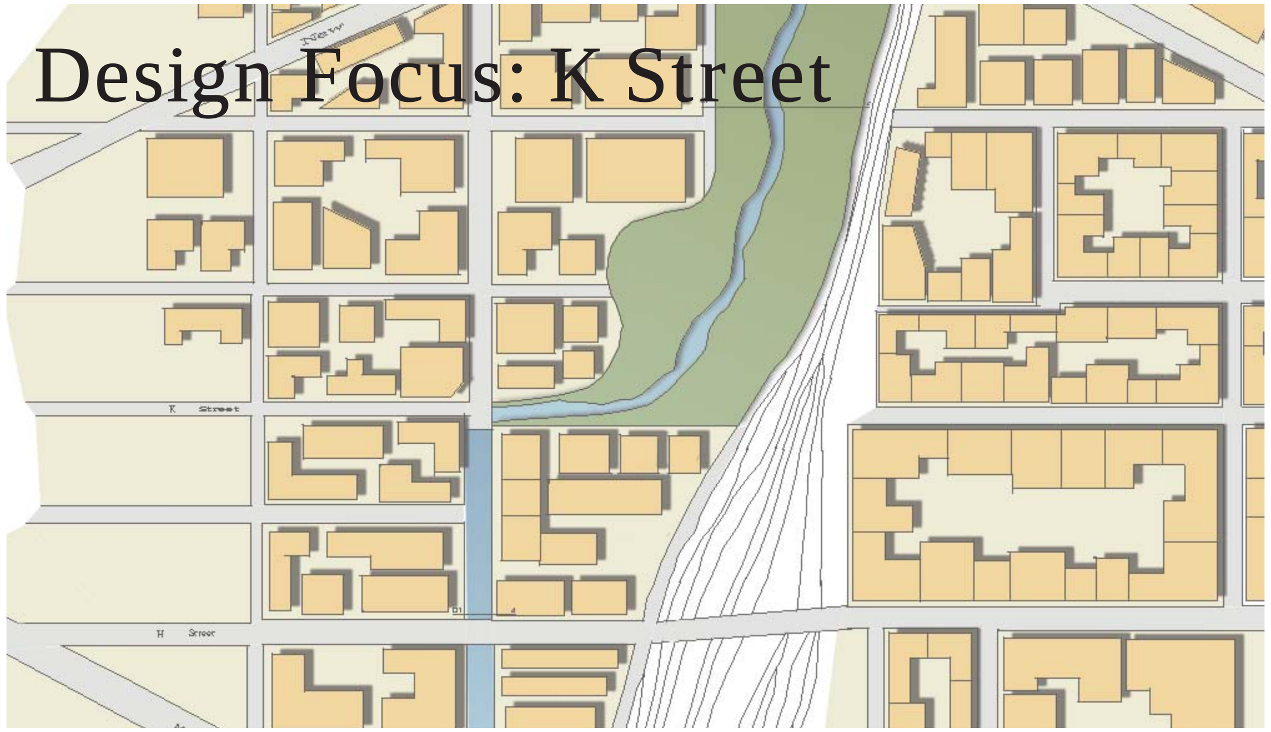


Figure 45. View from the southwest of the proposed intersection of K Street, NW, and North Capitol Street. The naturalistic waterway from the east becomes channelized at North Capitol. Figure 46. North Capitol Street traffic veers to the west on K Street and the remainder of the intersection becomes a pedestrian plaza.

Three areas along the constructed channel present interesting design dilemmas. The first is where the channel intersects K Street, NW, at North Capitol Street. From the north until this point the system accommodates a wide, heavily vegetated buffer. Upon reaching this intersection however the existing urban infrastructure cannot incorporate a naturalistic configuration and the waterway needs to be channelized until it flows south of the Capitol grounds into the southwest sector of the city. The transition from naturalistic to urban is challenging but not unprecedented in Washington. The edges of Rock Creek and Federal parkland, for example, offer some interesting prototypes.

The existing intersection of K Street, NW, and North Capitol Street could not be considered a focal point of Washington life—social, political or corporate. It lies a few blocks north of Union Station in the heart of the old Irish neighborhood called Swampoodle (so named because of the Tiber). All that exists from former days are a couple of 19th century structures—on the northeast corner, an old church and on the southeast corner, the campus of Gonzaga High School. Otherwise the building stock is either nondescript recent office structures or cheap, delapidated commercial structures. The northwest corner of the intersection is actually a large vacant lot. A waterway running through this area could actually revitalize the area, making it a neighborhood, a destination.

The design calls for taking advantage of the naturalistic channel as it eases into North Capitol Street from the eastern portion of K Street. Any hiking or biking trails from the north gradually become more urbanized and transform into sidewalks in front of shops, restaurants. Businesses on K Street

Figure 47. View from intersection of K Street, NW, and North Capitol Street looking east toward former K Street into the waterway coming from the north.

are able to take advantage of not only the water channel but also the naturalistic feel that the large vegetated border affords them. North Capitol Street is a major transportation route from Maryland into downtown Washington. Before reaching these last few blocks before the Capitol however motorists have the opportunity to feed into downtown via New York Avenue or Florida Avenue or others. The intersection with K Street therefore would only allow drivers from the north to veer west (see figures 45 and 46). Half the intersection therefore becomes a pedestrian plaza. North Capitol Street south of K Street becomes the new channel that flows toward Union Station and the Capitol. The section from K Street to Union Station has the opportunity to become one of the most vibrant sections because it is one of the few locations along the canal with existing businesses and structures directly fronting it.

Figure 50. View looking west or "downstream" toward intersection of K Street, NW, and North Capitol Street.

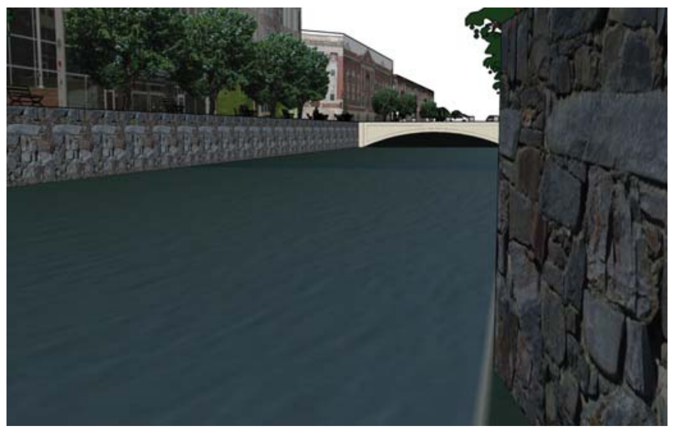


Figure 48. View from the canal toward North Capitol Street. Gonzaga High School is in the background.

Figure 49. A transformed North Capitol Street below K Street looking northwest.

Figure 51. North Capitol Street near Gonzaga High School transforms into an active urban desination.

Figure 52. View down North Capitol Street toward the Capitol building from the K Street, NW, pedestrian plaza.

Design Focus: Union Station

Union Station provides a major topographic challenge for the constructed waterway. The modern-day landscape configuration of Washington along the proposed route is receptive to water flowing toward the Anacostia except for this section of the city. As mentioned, builders placed 30 feet of debris on this site in 1910. The surface grade elevation at G Steets, NW, and North Capitol is El +26.00 and the surface grade elevation at North Capitol and E Streets is El +37.00. While the entire channel could have skirted Union Station altogether and gone to the west along New Jersey Avenue where a valley still exists to the Mall, running the channel through the site of the station is important for a few reasons. First is the high profile nature of the region around the station and the opportunities that its revitilization affords. Secondly, the plaza in front of the station marks almost exactly the confluence of the main branch of the Tiber and a large tributary coming from the northeast. As seen on the masterplan (figure 26) the plaza in front of Union Station will be flooded to mark this confluence but also to provide another periodic reservoir. In a more comprehensive plan for the city the tributary from the northeast could also be reconstructed and water would be supplying the reservoir from that direction.

In order to overcome the topographic change and maintain a steadily decreasing stream bed elevation, the channel flows through open 'qanat' or stepwell-like structures that will afford pedestrian access above and below.

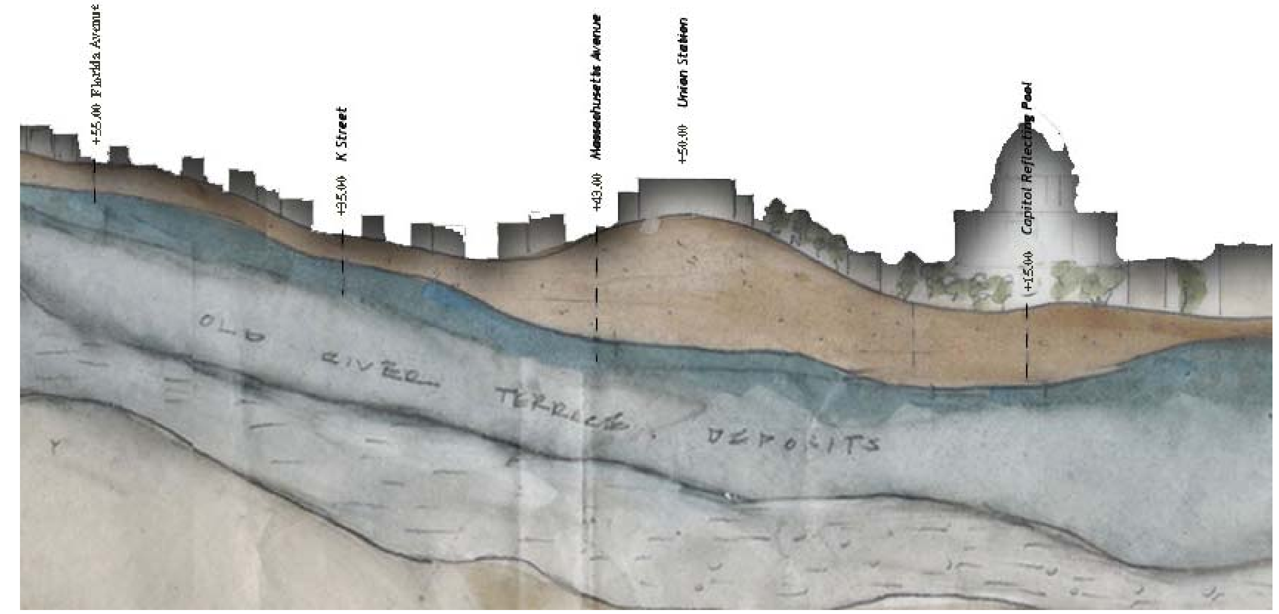


Figure 53. Detail of figure 37, an elevation showing the topography of channel path through Union Station area.

Figure 54. View of waterways through Union Station from the southwest. Waterways replace the intersection of North Capitol Street and Louisiana Avenue, NW. Union Station appears in the background.

Stairwells provide periodic access from the street to walkways along the water. The channel follows North Capitol Street to Louisiana Avenue, NW where it joins the “tributary” from Union Station reservoir and eventually reaches grade near the intersection of New Jersey Avenue, NW.   The most important transportation routes remain open to vehicular traffic by means of bridges. The water channels through the station site enhance the beauty of the surrounding Capitol grounds. Currently the parcels to the east of Columbus Circle (Union Station plaza) are vast parking lots surrounded by chain link fencing. The structures on North Capitol facing the station are insipid, unmemorable buildings that could take advantage of a new waterfront. The area is unsightly and deserves rejuvenation in a more appropriate fashion.

Figure 55. View from the north looking down former North Capitol Street, NW, to intersection at Louisiana Avenue, NW.

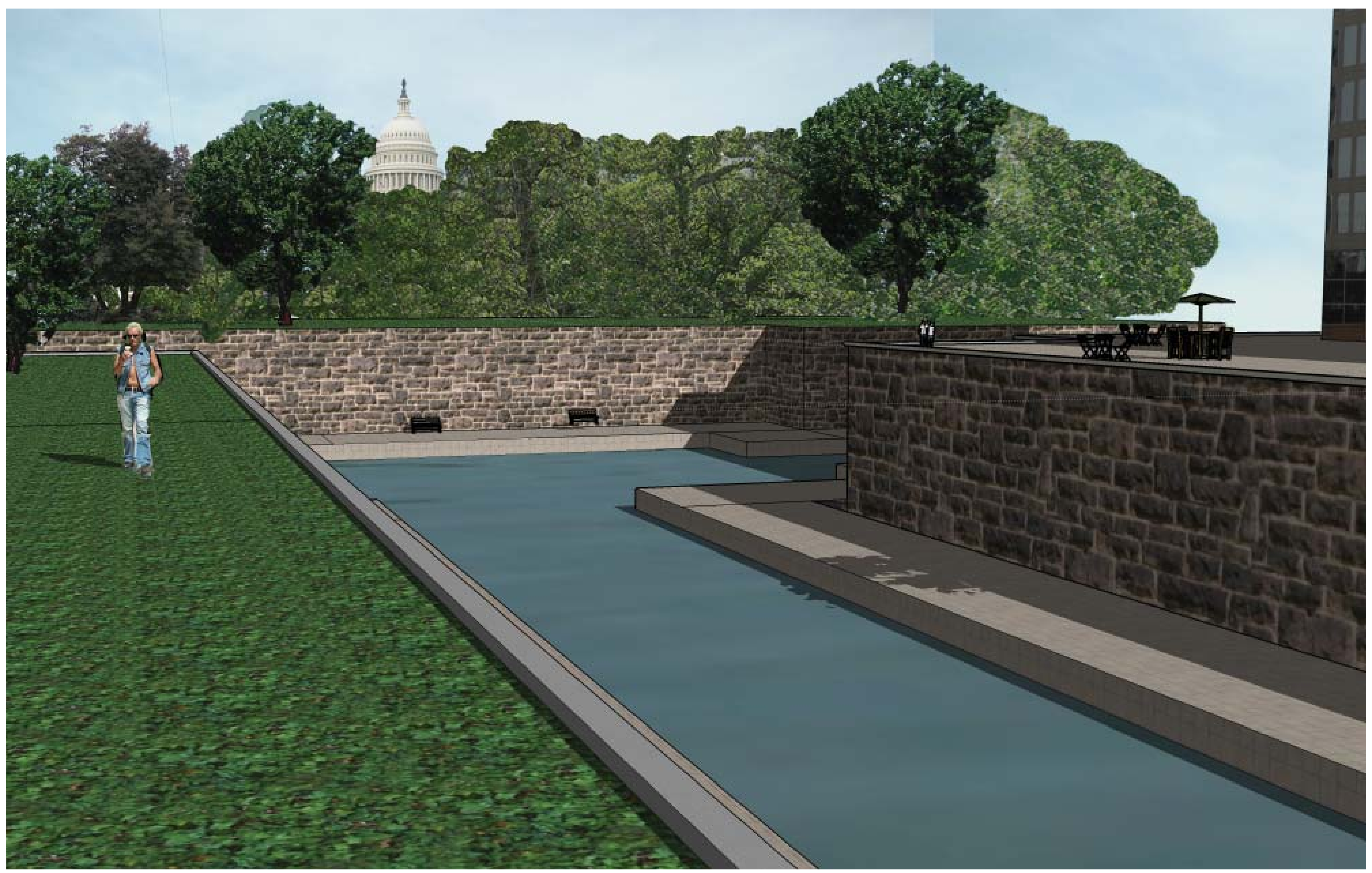
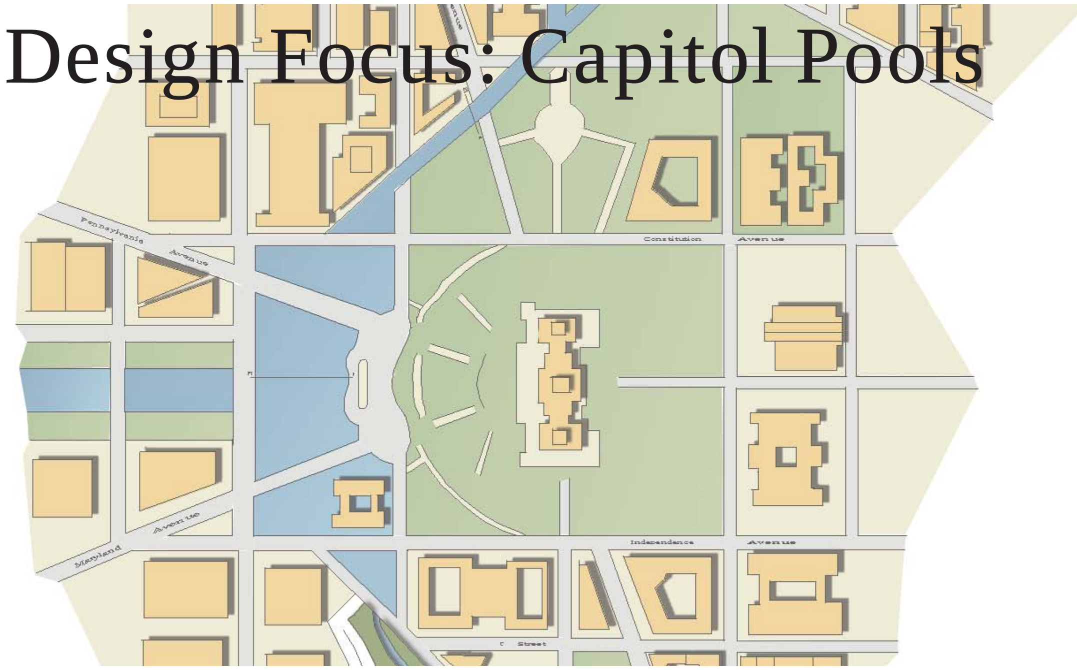


Figure 56. Walkway along the water's edge of former North Capitol Street, NW. The Capitol building is straight ahead and Union Station is to the left.

Design Focus: Capitol Pools



Figures 57 and 58. The vast space in front of the Capitol becomes an urban lake when flooded.

As the channel leaves the Union Station site, it flows into another high profile site in the city, that of the U.S. Capitol grounds and the Mall. As the Tiber originally flowed here, it is entirely appropriate to do so again. To incorporate this newly created channel into a high-designed urban form is appropriate. The plan takes advantage of the existing reflecting pool in front of the U.S. Capitol building by expanding it to its boundaries and transforms it into a reservoir. In addition, the two parcels to the north and south also join the reservoir. Great precedents for this exist, Le Notre used the same concept at Vaux-le-Vicomte. There, the Grand Canal is actually part of a dynamic stream system that flows in a formal structure through the chateau's grounds and then returns to its natural state upon exiting. Given that the Capitol reflecting pool area is so monumental, the stormwater should not be turbid at this region. In addition, special flood measures need to taken. In order to purify the water before entering the reflecting pools a purification biotope (i.e. constructed wetland) would occupy the large triangle directly to the north of the reflecting pool (see figure 61). The triangle measures 150 x 150 x 160 feet and provides an interesting visual contrast to the formal pools that follow. The existing avenues, Constitution, Pennsylvania and Maryland, act as causeways or bridges over the moving water. As a flood control measure for the reflecting pools, conduits capture some of the water from the channel above the purification biotope near New Jersey Avenue and send it to a location below the reflecting pools on the other side of the Botanic Gardens where the water rejoins the open system (see Louisiana Avenue, NW, section of figure 42). The transformation results in a city space more reminiscent of a lake than a static urban pool. In a more compre-

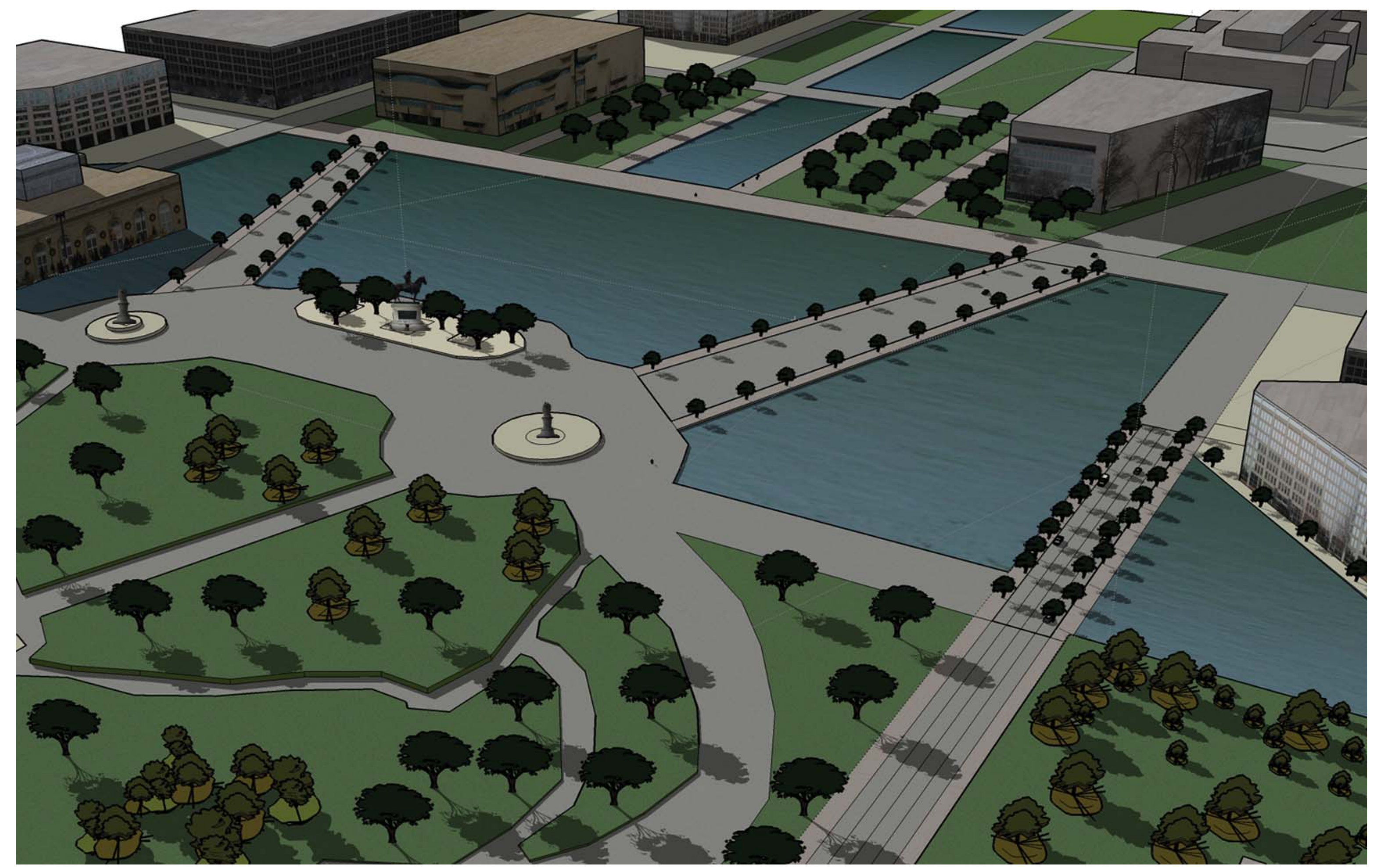


Figure 59. View from the northeast across the Capitol grounds towards the Mall. The Capitol building is beyond the frame to the lower left. The image shows a full perspective of the possibilities of the Capitol reflecting pools as part of the larger channel system. The large pools double as stormwater management.

hensive city plan, the central squares of the Mall provide overflow retention. To heighten the design excitement, the parcel housing the Botanic Garden floods and the building appears to float on the water.

The channel south of the Botanic Garden gradually returns to its more naturalistic state as it flows into southwest Washington along the former James Creek bed. The proposed channel runs just to the west of South Capitol Street as it flows toward the Anacostia River.

Figure 60. The Botanic Garden floating in the Capitol pools and taking advantage of water gardening opportunities.

Figure 61. The purification biotope (or constructed wetland) purifies stormwater before reaching the reflecting pools. View from southwest looking toward Union Station.

Figures 62 and 63. Close-up views of the amenities that the pools as part of a large dynamic system provides such as fishing.

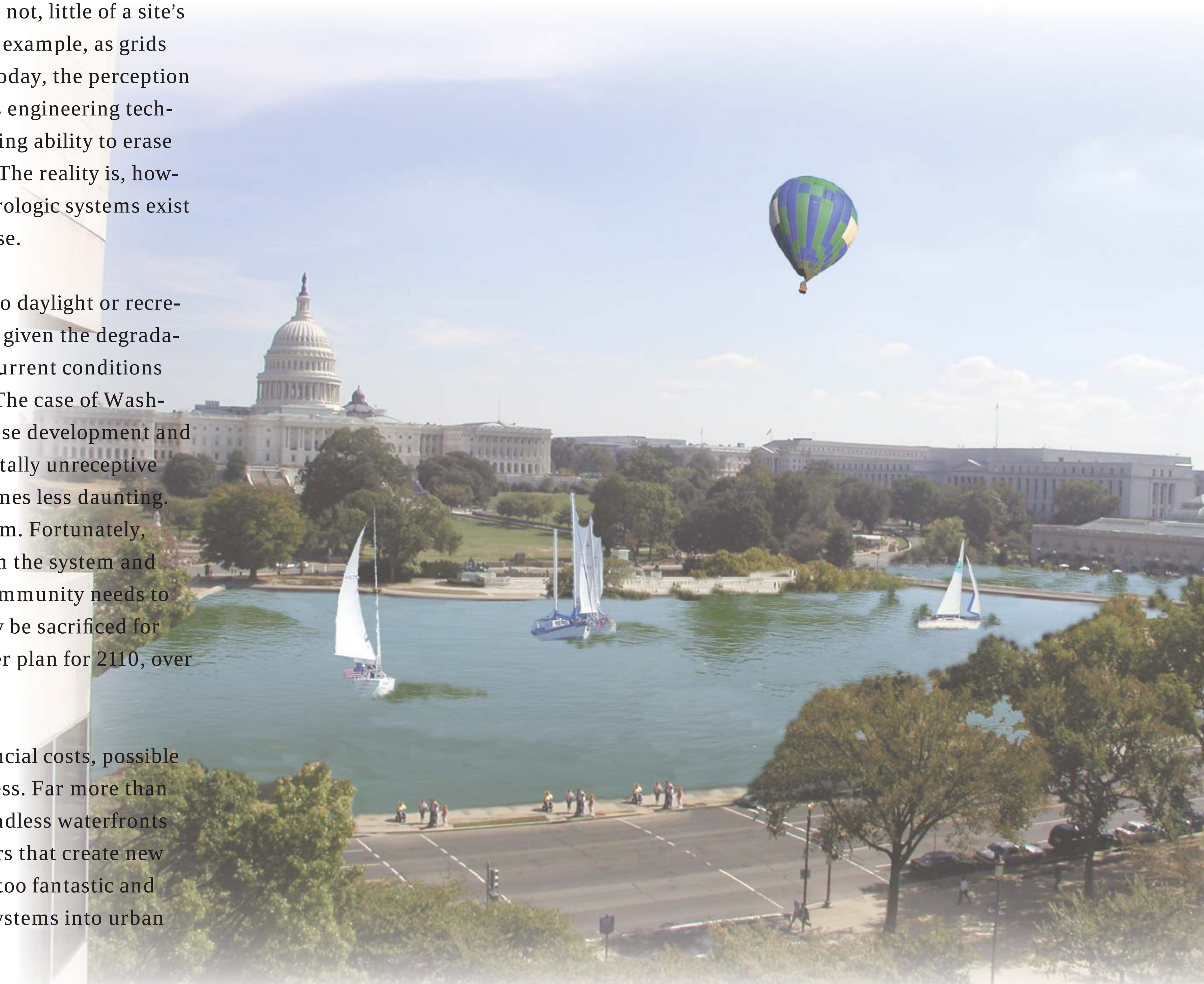
Figure 64. View from the west looking toward the U.S. Capitol building showing newly formed pools. At lower left begins the central portion of the Mall that could also be utilized for stormwater management.

Conclusion

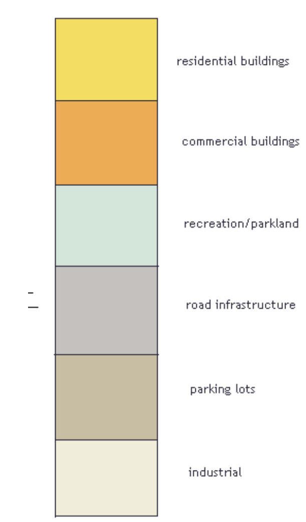
Urban design over the last century in the United States reflects, more often than not, little of a site's existing physical conditions. Designers planned New York and Washington, for example, as grids placed over a seemingly flat, perfectly receptive terrain. In metropolitan areas today, the perception of "Nature" or natural systems among the urbanscape is almost non-existent. As engineering technology advances, a sense of final triumph over Nature results and with it a seeming ability to erase natural systems, creating a manmade dependence on the urban infrastructure. The reality is, however, that under highly structured and engineered landscapes, geologic and hydrologic systems exist that need to perform essential functions, such as drainage, just like anywhere else.

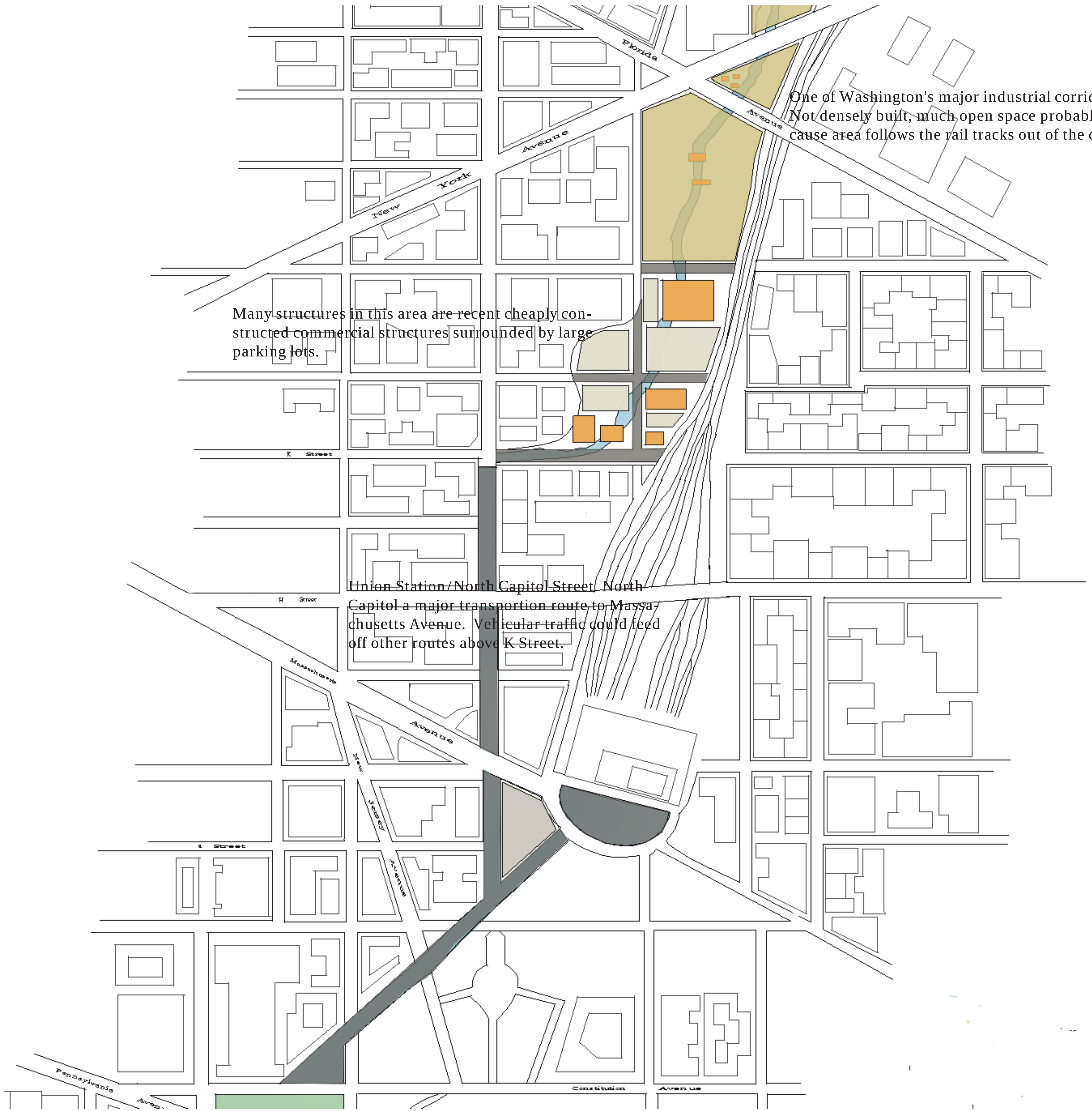
The concept behind the new stormwater channel through the city attempts not to daylight or recreate any of the historic waterways that once flowed through Washington. Rather, given the degradation of the urban environment, the study looks to historic data for solutions to current conditions that would allow the region's former natural processes to return to the surface. The case of Washington, D.C., presents possibly the worst case scenario—altered topography, dense development and rerouted surface drainage patterns. While a dense, urban environment seems totally unreceptive to reclamation, when explored through the context of the past the mission becomes less daunting. Based on historical precedents, such as topography, a channel begins to take form. Fortunately, groundwater flow, despite intense urbanization, is still able to potentially sustain the system and one more piece of the puzzle is solved. Land use can be a trickier question. A community needs to set its priorities. Can a four mile long and four block-or so-wide swath of the city be sacrificed for the good of the whole? Is it worth the cost and the benefits? A master stormwater plan for 2110, over one hundred years from today, allows long-term planning and action.

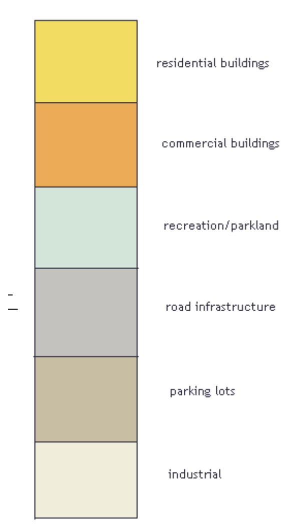
A project of this magnitude is not without its limitations—land use for one, financial costs, possible groundwater contamination. The potential for such a project, however, is limitless. Far more than solving a stormwater overflow crisis, the city transforms into a wonderland of endless waterfronts and all the amenities that that brings—recreation, businesses and green corridors that create new transportation routes through the city. If the creation of a new waterway seems too fantastic and incomprehensible to imagine then how simple it seems to incorporate natural systems into urban design from the beginning.



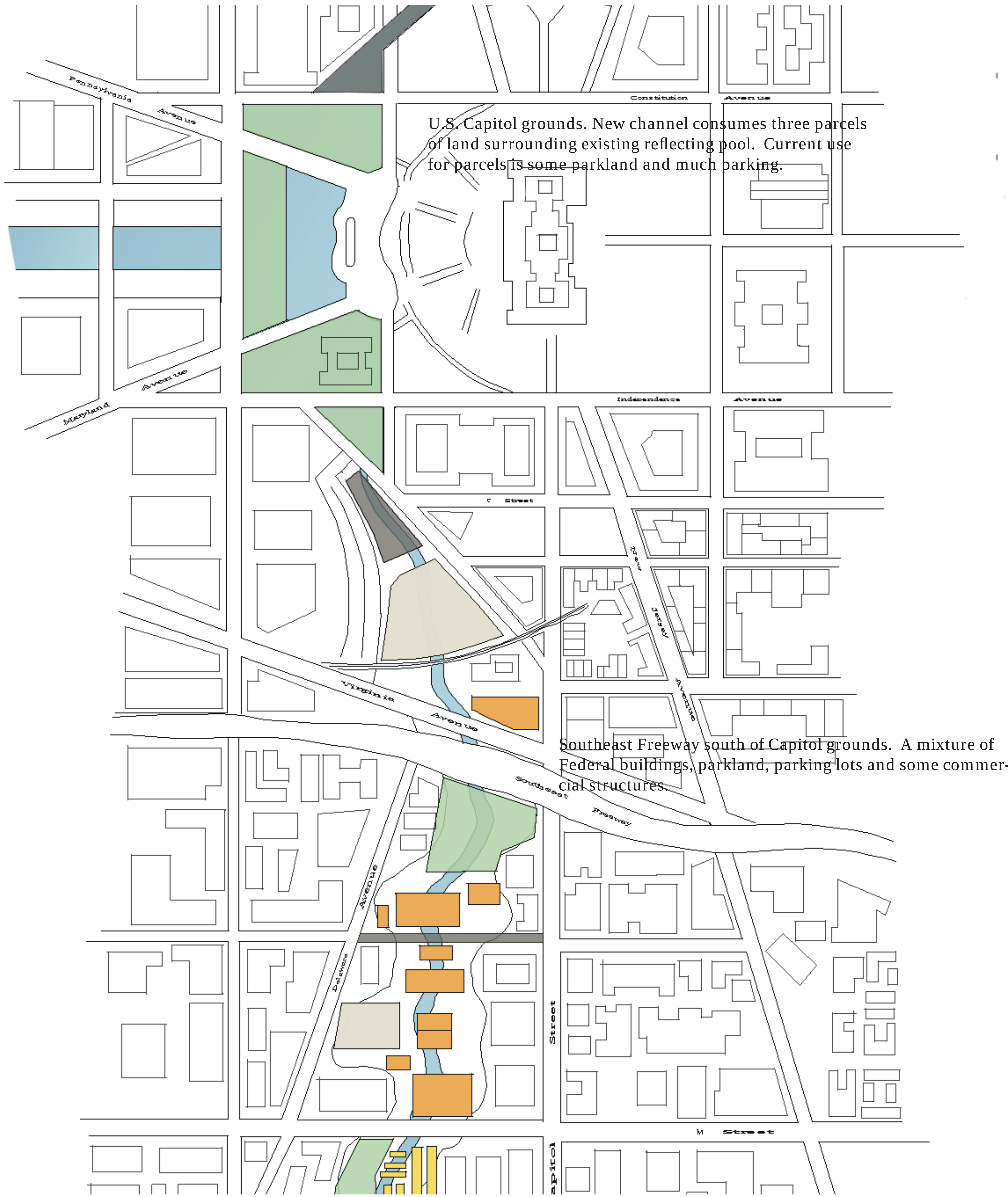
Appendix A: Demolition Plan

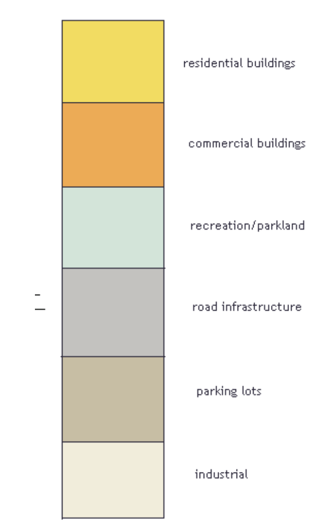



One of Washington's major industrial corridors. Not densely built, much open space probably because area follows the rail tracks out of the city.
Many structures in this area are recent cheaply constructed commercial structures surrounded by large parking lots.
Union Station/North Capitol Street. North Capitol a major transportion route to Massachusetts Avenue. Vehicular traffic could feed off other routes above K Street.
Florida
Avenue
New York
Avenue
K Street
H Street
Massachusetts
Avenue
New Jersey
Avenue
Constitution
Avenue
Pennsylvania
Avenue


residential buildings
commercial buildings
recreation/parkland
road infrastructure
parking lots
industrial

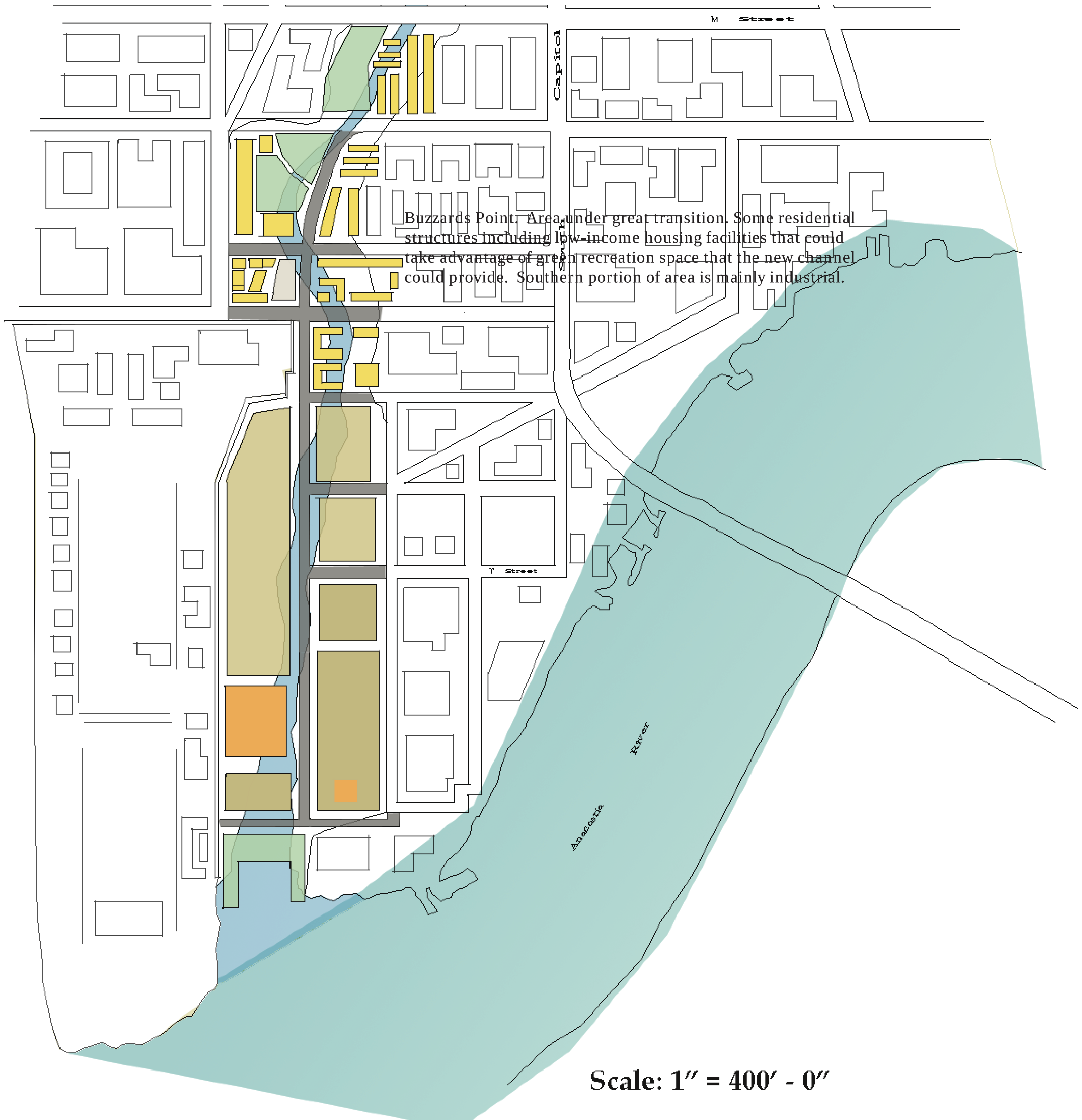

Scale: 1" = 400' - 0"

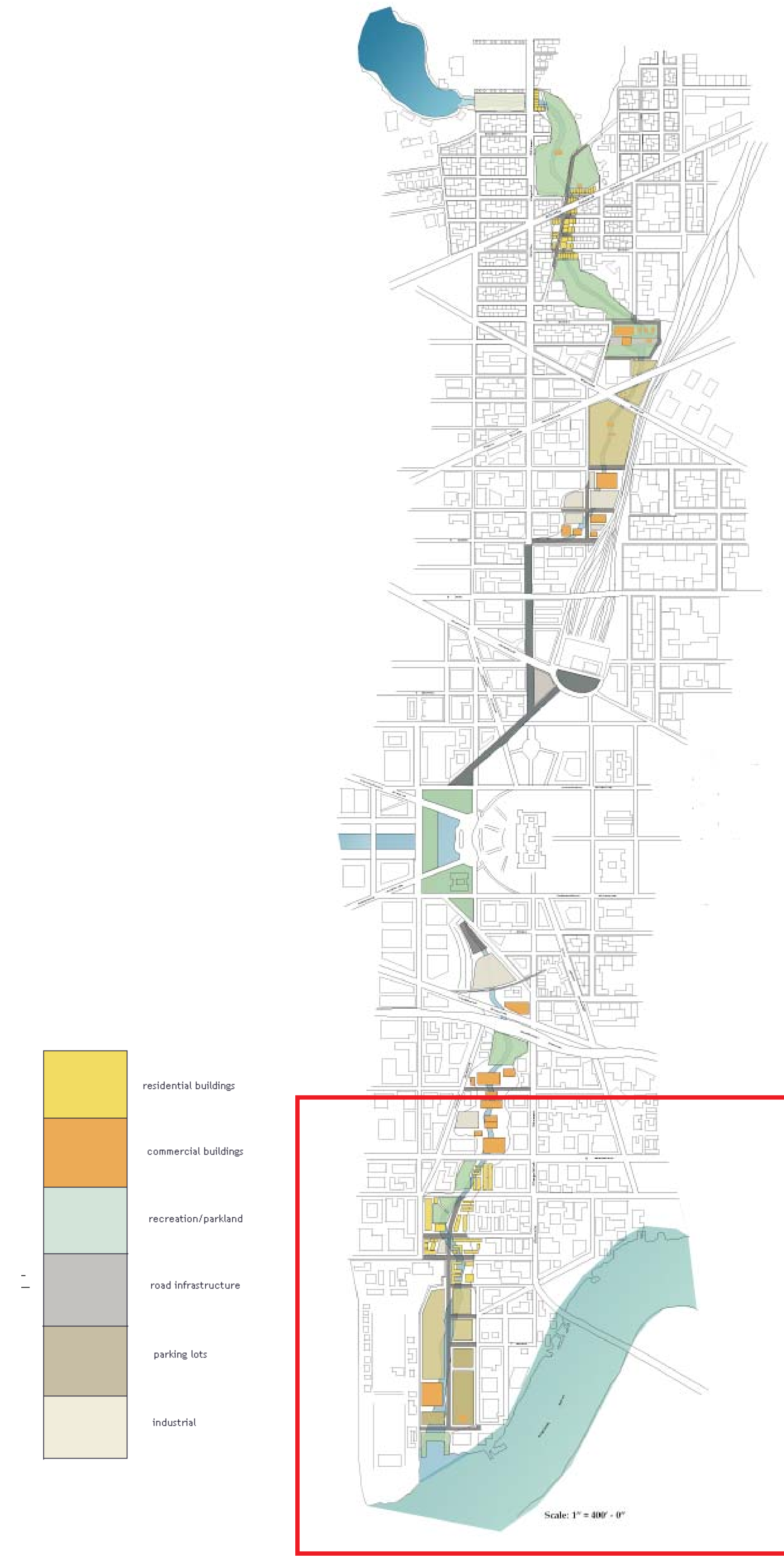

U.S. Capitol grounds. New channel consumes three parcels of land surrounding existing reflecting pool. Current use for parcels is some parkland and much parking.
Southeast Freeway south of Capitol grounds. A mixture of Federal buildings, parkland, parking lots and some commercial structures.
Pennsylvania Avenue
Constitution Avenue
Maryland Avenue
Independence Avenue
C Street
Virginia Avenue
Southeast Freeway
M Street


residential buildings
commercial buildings
recreation/parkland
road infrastructure
parking lots
industrial


Scale: 1" = 400' - 0"

Buzzards Point: Area under great transition. Some residential structures including low-income housing facilities that could take advantage of green recreation space that the new channel could provide. Southern portion of area is mainly industrial.





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