AN OVERLAY DISTRICT TO ADDRESS STORMWATER RUNOFF QUANTITY AND QUALITY IN THE DISTRICT OF COLUMBIA: EMPHASIS ON THE ANACOSTIA RIVER

by

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ABSTRACT

This Masters Project (MP) addresses the serious water quality issue of the Anacostia River in the District of Columbia. Focusing on non-point source pollution, the research explores the need for a more unified approach to stormwater runoff policy in DC and how specific examples from across the country can be applied to create a solution. It provides recommendations that will help reduce the burden on the combined sewer overflow (CSO) system that empties into the Anacostia River. Reducing the burden on the CSO system will reduce the number of overflow events during storms. Reducing overflow events and increasing runoff infiltration will have a direct effect on the water quality of the Anacostia River by reducing the quantity of raw sewage, trash, toxicants, and debris that enter the river.

The research questions explored are:

- What are the roadblocks to effective stormwater management in the District of Columbia?
- What are the most effective strategies to eliminate CSO events?
- How can a DC stormwater overlay district improve the water quality of the Anacostia River?

Extensive literature review and interviews were conducted to define the current stormwater management approach in the District of Columbia. The interviews clarified common goals and conflicting objectives for stormwater management, as well as the degree of stormwater management fragmentation in the District. Analysis of the research and interviews led to the identification of gaps in stormwater policy. Further research was conducted to seek successful, model, local government stormwater district policies from across the country. Additional interviews were conducted with representatives of these municipalities (South Burlington, VT, Philadelphia, PA, Pittsburgh, PA, Anne Arundel County, MD, and Portland, OR) to learn about the development and implementation of the specific program, as well as its successes and opportunities for improvement. A cross-case comparison was conducted to compare each program's features and explore its applicability to the District of Columbia. Limited content recommendations were then developed for an Anacostia-specific Stormwater Management Overlay District, and implementation strategies were suggested.

The results of the research, interviews, and analysis indicate that a Stormwater Management Overlay District would be an effective tool to reduce the burden on the Anacostia River CSO system. The overlay district will help to increase stormwater infiltration as runoff passes through the watershed. This tool could be used as a model for urban cities across the country that are facing similar CSO and stormwater management issues.

Keywords: stormwater runoff, CSO, overlay district, District of Columbia, green infrastructure, Anacostia River

TABLE OF CONTENTS

FIGURES

APPENDICES

PREFACE

Although there are many cities in the United States, there is only one District. The District of Columbia is an unprecedented municipality with unique government operations, government status, and government relationships. A special district was created by the US Constitution to serve as the permanent national capital. Although DC is a city, it is neither a state nor is it in a state. Rather, it is directly overseen by the federal government of the United States (Council of the District of Columbia, 2011).

The District is considered a major city and its workday population rises to over one million even though its official resident population is around 600,000 people. The density of DC is approximately 9,800 people per square mile. There is a large migration of people in and out of the city each weekday, as a large number of neighboring Virginia and Maryland residents work in the District. DC has a mayor and city council, but the US Congress has ultimate authority over the city and can overturn laws passed by the local government, or intervene in local affairs. This results in less self-governance than states, as the District does not have a Senator or voting congressional representation (Council of the District of Columbia, 2008). Unlike US territories, DC is subject to federal taxes. These imbalanced rules have resulted in tension between the residents, the local government, and the federal government, and this tension continues to increase.

Congress must approve the city's budget. Also, Congress has imposed many taxation restrictions on the District, which results in a substantial loss in revenue. DC cannot tax the income of nonresidents and about 50% of land in DC is not subject to taxation. However, DC is eligible to receive federal funds, similar to states, and these grants make up approximately 26% of the city's yearly revenue (DC CFO, 2007).

The presence of federal government land, which makes up 23% of the city, presents unique challenges to DC and its ability to regulate development and stormwater runoff. Environmental issues, such as stormwater management, are handled differently in the District than in other cities, which are municipalities located within a state. In DC, similar to states, the United States Environmental Protection Agency (USEPA) is ultimately responsible for overseeing water quality and combined sewer overflow (CSO) issues through the National Pollutant Discharge Elimination System (NPDES) and MS4 Permits. In April 2010, EPA imposed a new NPDES permit on the District of Columbia that requires that 95% of stormwater runoff be captured and retained on site. However, DC is having difficulty collecting certain stormwater fees (that will fund these stormwater management improvements) from federal agencies in the District because the federal government has argued it is exempt from taxation (Stormwater Jobs, 2010).

Because of its complicated government system and key location within the Chesapeake Bay watershed, improved urban stormwater management in DC could serve as a model for other cities. This model policy would have the opportunity to establish an integrated approach to stormwater management that addresses and unifies local and federal government property, private property, and park land.

INTRODUCTION

Background

Stormwater runoff from Washington, DC has a negative impact on the health of the Chesapeake Bay. Nitrates and phosphate contribute to eutrophication of Bay area water bodies, including the Anacostia River. Sediments enriched with hydrocarbons, trace metals, chlordane, PCBs, and PAHs, among other substances, harm foodweb organisms, fish, and potentially human consumers of seafood (Chesapeake Bay Program, 2010).

The Chesapeake Bay Watershed is the largest estuary in the United States, encompassing 64,000 square miles of land in six states. On average, 30.8 billion gallons of fresh water flow per day to the Bay, which amounts to 8.2 trillion gallons annually. Of the 8.2 trillion gallons, approximately 9% is untreated water and waste (Chesapeake Bay Program, 2010). The District of Columbia allows 330 million gallons of untreated water and waste to enter the watershed annually through District–related tributaries (DC Water, 2010). Urban runoff is a serious issue for municipalities within the Chesapeake Bay watershed. As mentioned in the Preface, if the District can perform better, it could serve as a model for other cities within the watershed and across the country.

Figure 1: The Anacostia watershed
Source: www.caringforourwatersheds.com

The Potomac and Anacostia Rivers, with Rock Creek, collect both point source and non-point source pollution from their watersheds that span the District, Maryland, Virginia, West Virginia, and Pennsylvania. Rock Creek and the Anacostia River flow to the Potomac River, which is a major input into the Chesapeake Bay. The Bay ultimately empties into the Atlantic Ocean. The map below shows a holistic overview of the major "plumbing"- the major tributaries and sub watersheds, including that of the Potomac River- of the Chesapeake Bay watershed.

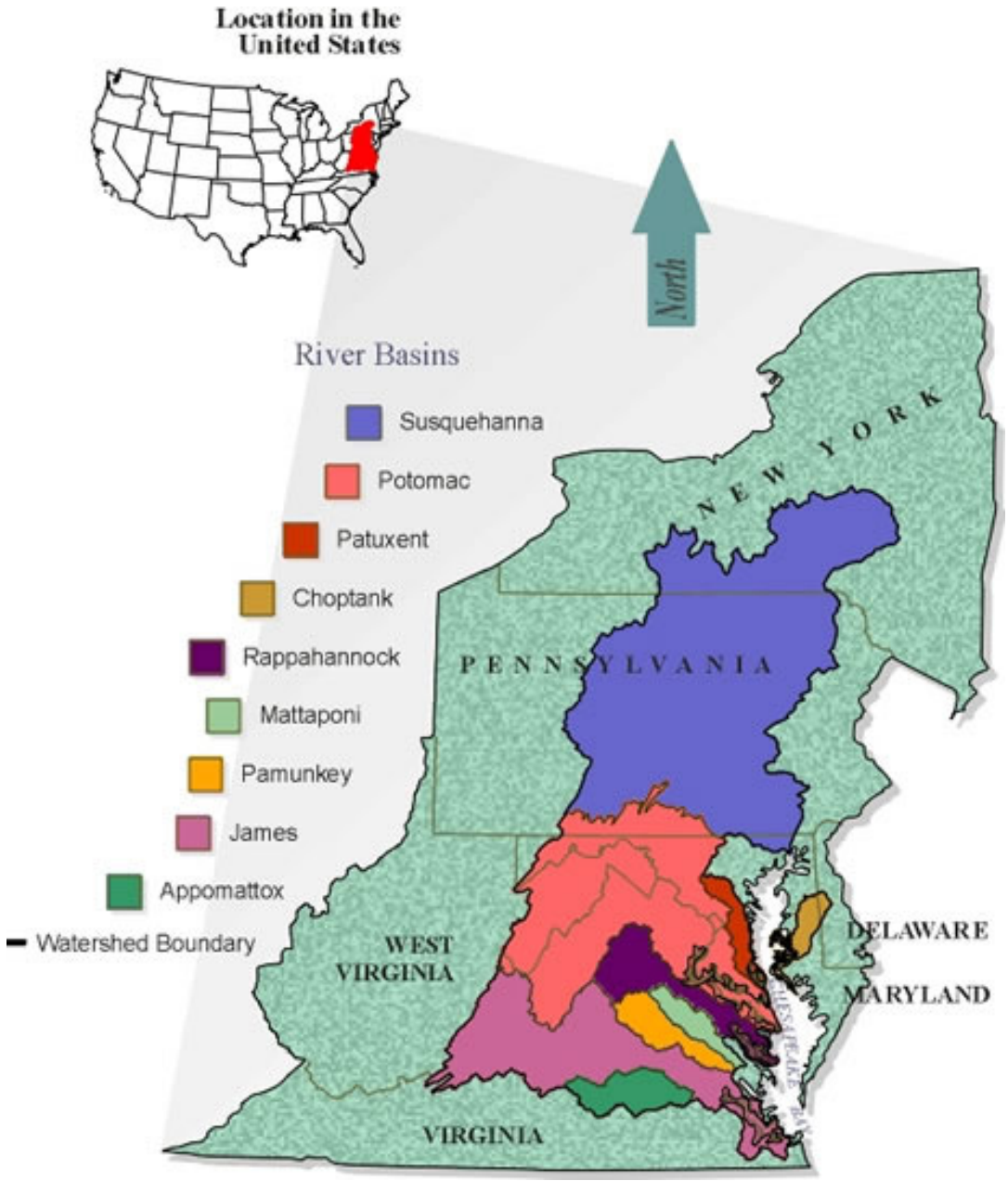


Figure 2: The Chesapeake Bay watershed and its major tributaries
Source: http://ehs.virginia.edu/ehs/ehs.stormwater/stormwater.watersheds.html

The District's urban environment has a high proportion of impervious surfaces with low infiltration rates. Substances include particulates and toxic waste from vehicle tires, exhausts, industry, construction, and residential land uses. In addition, erosion and flooding exacerbate the situation in receiving waters. During storm events, the city's Combined Sewer Overflow (CSO) system allows sewage and stormwater runoff to overflow into the rivers (DC Water, 2010).

Stormwater management policy, implementation, and enforcement in the District fall under the jurisdiction of the USEPA and a number of local agencies, as well as a local water authority:

- The District Department of the Environment (**DDOE**)
- The District Office of Planning (**DCOP**)
- The District Department of Public Works (**DPW**)
- The District Department of Transportation (**DDOT**)
- The District Department of Zoning
- DC Water (with board members from the DC government)

As is mentioned in the Preface, the new permit proposed by the US EPA requires that the District of Columbia do more to improve stormwater management. This includes addressing overall stormwater runoff quantity and quality, and point source and non-point source pollution in particular. Permit goals include further reduction of the amount of direct runoff into the Anacostia River (as well as the Potomac River and Rock Creek), sending all sewage to the Blue Plains Wastewater Treatment Plant, and treating more stormwater on site (in order to reduce entry of pollutants into the rivers) (DC Water, 2010). In response, the District has committed to reducing the pollutant load in the Anacostia River by 98%- a substantial amount that will require a significant change in the way the city's stormwater runoff and CSOs are handled (US EPA, 2011). Although the District's commitment to large CSO events is important, it is the smaller, more frequent storm events (not the 50 or 100 year events) that actually contribute more runoff and toxicants on the whole (DDOE, 2010). The current proposals will address the larger events, but they do not adequately address these frequent, smaller events.

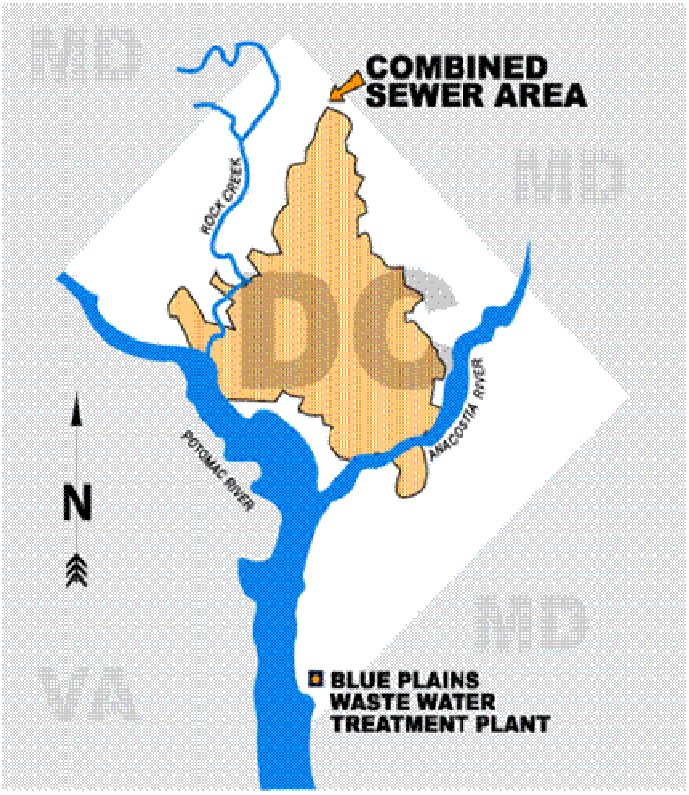


Figure 3: The DC CSO Sewershed Area- 1/3 of DC
Source: www.dcwater.com

The Need for Effective Stormwater Policy in DC

Current obstacles to efficient stormwater management in DC include a combined sewer outfall system, high levels of impervious surfaces, poor enforcement of existing regulations, and a fragmented approach to stormwater management. There are multiple DC agencies that address stormwater but to date no cohesive management structure exists for attainment of common goals. Each agency has its own guidelines, methods and practices. There are also Federal Government agencies that oversee stormwater policy, creating a unique political and regulatory environment in the District. There is oftentimes conflict between the desires of the federal government and the desires of the local government.

OBJECTIVES

The objective of this MP is to develop a comprehensive strategy for the stormwater management of the Anacostia River watershed in order to reduce the burden on the combined sewer system and prevent overflow events. It is equally important that the strategy address smaller runoff events, which happen more frequently and carry pollutants into the river on a regular basis. This project will seek to uncover the origins of the fragmented stormwater management system, current strategies, and what can be done to overcome these. One possible solution is a single DC-wide stormwater overlay district. The project will study the advisability of such an inclusive design and then formulate basic recommendations for its guiding principles.

METHODOLOGY

The process used to develop the recommendations for the District of Columbia's Anacostia River Watershed Stormwater Management Overlay District included the following steps:

1. Literature Review and Research

After extensive review of internet literature, current stormwater periodicals, university reports, NGO studies, and government data, it is apparent that policies have been in a state of constant change for the last 10- and especially 5- years. From this I realized that I needed to determine the most appropriate people to interview regarding current stormwater issues and needs in DC.

2. Interviews: DC Stormwater Management Status and Needs

The agencies that oversee stormwater and water quality were interviewed to ascertain the extent of urban stormwater management in the Anacostia River watershed, and to identify common goals and conflicting objectives for stormwater management. Interviews conducted included representatives from the following groups: **DDOE**, **DCOP**, **DPW**, **DDOT**, **DC Water**, **US EPA**, and the Anacostia Watershed Society. The following questions and topics were discussed:

- The participant's opinion of the water quality in the Anacostia
- What jurisdiction each agency has in the District
- What priorities each agency has
- Current stormwater management policies or programs of the specific agency

- Planned stormwater management policies or programs of the specific agency
- If the participant feels the current policies are effective, and why or why not
- If there are any gaps in the policy and what could be done to bridge these gaps
- What DC needs to do to effectively manage stormwater runoff and pollutants
- What the participant considers model stormwater programs and practices
- What a Stormwater Management Overlay District is
- If a Stormwater Management Overlay District would be effective in reducing urban runoff and improving the quality of runoff that flows into the Anacostia River
- What aspects the participant feels are important to include in the overlay district
- Clarification and discussion of the agency's model program or policy including: date implemented, cost, staff requirements, successes and failures, etc

3. Identifying the Needs of the District of Columbia

After the initial research and interviews were conducted, gaps in policy, technology, communication, etc were identified. Solutions were discussed with those that were interviewed, and suggestions for DC- specifically the Anacostia River watershed- were explored.

4. Identifying Successful Stormwater Policies from Across the Country

Extensive research into the current best practices and future technologies of stormwater management led to the identification of five local government model policies and programs:

- Stormwater Management Overlay District: South Burlington, Vermont
- Land-Water Infrastructure Approach to CSO Control and Watershed Management: Philadelphia, Pennsylvania

- Stormwater Management Overlay District: Pittsburgh, Pennsylvania
- Regenerative Stormwater Conveyance (**RSC**) Systems: Anne Arundel County, Maryland, and
- Stormwater Management Manual: Portland, Oregon

5. Interviews: Successful Policies and Programs

Interviews were conducted with representatives of each municipality listed above to learn about the development and implementation of the specific program, as well as its successes and opportunities for improvement. Conversations with South Burlington, Philadelphia, Pittsburgh, Anne Arundel, and Portland focused on lessons learned and measurable results in stormwater runoff reduction and local water body quality improvement.

6. Cross-Case Comparison

Upon conclusion of the research and interview phases, the essential elements of the model programs/ policies were identified and compared to one another. Research was conducted to determine what made them successful, what was required for implementation, and what applicability each has to DC, specifically the Anacostia River. Specific features compared included: city population and density, cost of program, timeframe for implementation, implementing agency, presence of similar stormwater issues, presence of a CSO system, and proximity to water bodies.

OBSERVATIONS AND RESULTS

The research and interviews resulted in the following observations. These observations were analyzed and compared to develop a series of recommendations described in the next section.

DC Stormwater Management Status and Needs

Research and review of literature revealed that DC is becoming very invested in stormwater, but there are some gaps in policy that prevent effective management of urban runoff and water quality in the Anacostia River. Though there have been efforts to unify DC's stormwater management in the past, much fragmentation and overlap remains. Differing opinions on enforcement, policy modifications, water management techniques, and the importance of urban runoff control in general signal the need for a unifying stormwater management program or policy.

As mentioned in the Introduction, DC is taking steps to address large storm events (50 and 100 year storms), but there is a need for policies and programs that mitigate the smaller, more frequent runoff-producing storms. In the "Clean Rivers Program," DC is currently studying the viability of large underwater tanks to store the CSO wastewater rather than have it empty into the water and flow downstream. The tanks would be buried in the Anacostia River, but also in the Potomac River and the Piney Branch section of Rock Creek. The cost of the Clean Rivers Program solution is estimated to be over $3 billion, and it would take 20 years to implement (DC Water). The cost of the Anacostia tank alone is $35 million (Walker and Hawkins, 2010). The Anacostia tank will be built, but there remains a large- and important- opportunity to address runoff quantity and quality before it even reaches the CSO and tank systems. By intercepting

stormwater close to its source (as it hits the ground), the impacts of urban runoff become less severe and less problematic. For example, less water flows into the CSO system, reducing the chances of an overflow event. Pervious surfaces and soil systems would absorb and filter the water, replenishing groundwater and reducing the quantities of pollutants carried to water bodies.

The proposed underground tank system is not an ideal solution based on cost, time for construction and completion; and it is not sustainable. Under such a plan, all wastewater would be pumped to the Blue Plains Wastewater Treatment Plant for expensive treatment, requiring additional infrastructure, while imposing additional maintenance burden on the District.

As described in the Introduction, the immediate effect of reducing the need for combined river sewer outfall pipes is that less untreated water will empty directly into the water- and therefore the Chesapeake Bay. Taking the burden off the CSO system, by implementing solutions directed by a master Stormwater Management Overlay District, reduces the need for underwater storage tanks. It will also take additional burden from Blue Plains Wastewater Treatment Plant, increasing groundwater recharge, and assisting the District in meeting the EPA's new permit requirements.

Figure 4: A CSO along the Anacostia River
Source: http://www.anacostiariverkeeper.org/combined-sewer-overflows

Current District of Columbia policies and programs that address stormwater runoff include:

- Comprehensive Plan language:
    - Landscaping: Encourage the use of landscaping to increase water retention (Clarion, Farr, RMLUI, 2008).
    - Reducing Sedimentation: Prevent sedimentation of rivers and streams by implementing comprehensive stormwater management measures (Clarion, Farr, RMLUI, 2008).
    - Maximizing Permeable Surfaces: Encourage the use of permeable materials as a way to absorb stormwater and reduce urban runoff (Clarion, Farr, RMLUI, 2008).
    - Green Engineering: Promote green engineering practices for water and wastewater systems (Clarion, Farr, RMLUI, 2008).
    - Low Impact Development Criteria: Establish criteria for new development, including provisions for expanded use of porous pavement, bioretention facilities, and green roofs. Explore the expanded use of impervious surface limits in the District's Zoning (Clarion, Farr, RMLUI, 2008).
- Incentives:
    - DDOE 2011 subsidies to install green roofs
    - Riversmart Homes: limited money for residential modifications including landscaping, rain gardens, etc.
- DDOE Pilot Programs and Projects:
    - Small low impact development stormwater systems

    - Storm drain stenciling and informational signage
    - Rain garden installations
    - Riparian habitat restoration along water bodies on NPS property
- District of Columbia Code and Municipal Regulations:
    - Chapter 2, Drainage of Lots, requires that all lots drain into the storm sewer.
    - The Water Pollution Control Act includes "waters of the District" and requires that they be protected for future beneficial use (Clarion, Farr, RMLUI, 2008).
    - Title 21, Water and Sanitation: establishes property maintenance regulations that require owners of property where stormwater best management practices have been installed to maintain and repair the systems (Clarion, Farr, RMLUI, 2008).
- Zoning Ordinance:
    - Tree and slope protection overlay district
    - Floodplain and waterfront prohibited uses and overlay districts

Staff from District government described the current stormwater management situation in DC as "in progress" (DDOE, 2011). There is excitement over the direction of stormwater management, but there is also a realization that much is left to be done. Staff generally supports the creation of green infrastructure to address runoff and improve river water quality. However, it was expressed that an overlay district (that identifies locations and techniques for such low impact development) would be harder to fund and would take longer to implement. This is because the effects of such techniques are not immediately evident, in contrast with the CSO tanks. Staff emphasized that a stormwater management overlay district, and accompanying green infrastructure techniques, would save the District money in the long term, by capturing and

treating stormwater early, before it reaches the rivers and sewer system. These opinions align with research findings in the Green Build-Out Model (Casey Trees, LimnoTech, 2007).

Staff from EPA Region III, the region in which the District of Columbia lies, explained that there is deep tension in DC because of the costs of management and retrofits to stormwater infrastructure. The conflict between the local and Federal governments is over who will pay for the management of the aging infrastructure. Staff acknowledged that the District does recognize the need for effective stormwater policy. EPA stated that it is important to require or encourage retrofits of existing development in order to have effective stormwater management. Water quality end points are driving new stormwater policy requirements. In the past, however, the market and current technologies drove stormwater requirements. This should be considered when creating stormwater policies in the District. Staff described the importance of emphasizing stormwater management in new development and redevelopment projects across the city. Finally, the EPA stressed the need to reduce the proposed, expensive infrastructure in order to prevent expensive and unsustainable retrofits in the future.

Citizens expressed mixed feelings towards the current stormwater fees imposed by DC Water and DDOE. On the one hand, residents seem to support DC's attempts to better address runoff and water quality in the Anacostia River. However, they are wary of the size, scale, and sustainability of the proposed underground tanks. There is concern that these tanks will require an unreasonable amount of maintenance over the years. More significantly, there is concern that DC is not addressing the *source* of the runoff, but rather reacting to the runoff. All citizens responded "yes" when asked whether they would support the implementation of strategically-placed low impact development infrastructure to capture and treat runoff before it enters the sewer and CSO system.

Successful Stormwater Policies from Across the Country and Cross-Case Comparison

As described in the Methodology section, a series of local municipality stormwater policies or programs were selected from around the country. Successful policies are defined as those that have been implemented for at least 2 years, have data defining actual reduction in stormwater, and have reduced pollutant load in nearby water bodies. These approaches were also chosen because they are known nationally or internationally for their stormwater management leadership, are undertaking "revolutionary" approaches to urban runoff management, or have key aspects that can be applied and expanded upon in the District of Columbia.

Upon selection of the model policies, interviews of city leaders and staff involved in these policies were conducted to ascertain information about policy successes, failures, history, cost, next steps, what is effective and what is not, implementation, timeline, lessons learned, etc.

<u>South Burlington, VT: Stormwater Management Overlay District</u>

Department: South Burlington Stormwater Services, Planning and Zoning Department

City population: 16,000

Density: 950 people per square mile

Presence of a CSO system: No

Proximity to water bodies: Yes: adjacent to Lake Champlain

As one of the few existing stormwater management overlay districts in the country, South Burlington has shown that effective stormwater management can happen by planning locations of green infrastructure systems and setting infiltration goals for various portions of the watershed. The overlay district, established in 2008, requires that all development within the

district include low-impact design techniques to manage runoff. The overlay district has been successful, and although no numbers exist that specify how much runoff was collected, the city is looking to expand the district to other watersheds. A Low Impact Development Guidance Manual compliments the overlay district, and expands upon the required stormwater management best practices. This policy- both the overlay district language and the overlay map- is very applicable to the District. The approach of requiring LID technologies can be used in DC, as can the establishment of a stormwater quantity to be treated onsite. Also applicable are the alternatives for properties that cannot meet the required stormwater volume treatment on site.

Philadelphia, PA: Land-Water-Infrastructure Approach to CSO Control and Watershed Management

Department: Office of Watersheds

City population: 1.5 million

Density: 11,000 people per square mile

Presence of a CSO system: Yes

Proximity to water bodies: Yes: Delaware River, Schuylkill River

Staff from Philadelphia's Public Works Department emphasized the importance of a multi-faceted approach to stormwater management. The strategy is a comprehensive watershed management approach that utilizes modifications to land, water, and infrastructure-based systems to improve water quality and reduce runoff. By creating pockets of open space and opportunities for infiltration along roadways and within right-of-ways, and prioritizing locations for green roofs, the city has been able to eliminate the need for underground CSO storage tanks. Philadelphia's aggressive approach will create a more cost-effective, sustainable stormwater

management system (City of Philadelphia, 2010). Philadelphia has begun to implement the three phases of the plan: a comprehensive program for Nine Minimum Controls (NMCs), design and construction of capital projects to capture stormwater, and watershed-based planning and analysis. This approach to stormwater management is highly applicable to DC because the District can implement land and water-based improvements to reduce the burden on the CSO system. There is much land throughout DC that can be set aside for stormwater infiltration, and wetlands and riparian habitat can be restored along the banks of the Anacostia River.

Pittsburgh, PA: Stormwater Management Overlay District

Department: Department of City Planning

City population: 300,000

Density: 5,600 people per square mile

Presence of a CSO system: Yes

Proximity to water bodies: Yes: Ohio River, Allegheny River, Monongahela River

This stormwater overlay district is similar to that in South Burlington. It has physically located areas of land that are designated to have low impact development techniques and green infrastructure. Since the guidelines are not enforceable, however, the city is working to upgrade them to criteria that can be placed into the city's building and zoning code. They hope to codify some of the lessons they've learned, including revising the overlay district to address stormwater quantity. For example, if the site is in the lower river basin, the goal will be to get stormwater into the water as quickly as possible. The city is also considering density bonuses in the district as an incentive to construct LID and green infrastructure. The possibility of "trading parcels" is an idea that could be incorporated here, and is also applicable to DC. Parcels of land could be

traded between private owners, between private and government owners, etc. This would allow land critical to stormwater management (such as land close to a CSO outfall) to be controlled by the municipality, allowing for more intense green infrastructure. The cost to design, draft, and implement the overlay district was minimal. It required staff time and salaries to research and write the policy. Implementation involved public comment and city approval. See Appendix 3 for a sample Pittsburgh Stormwater Overlay District.

Anne Arundel County, MD: Regenerative Stormwater Conveyance (RSC) Systems

Department: Department of Public Works

City population: 36,000

Density: 5,400 people per square mile

Presence of a CSO system: No

Proximity to water bodies: Yes: adjacent to the Chesapeake Bay

Regenerative stormwater conveyance systems (RSCs) were implemented by Anne Arundel County to remediate and minimize stormwater impacts on surrounding water bodies and the Chesapeake Bay. This regenerative design approach has been established as the preferred technique to remediate failed stormwater outfalls as well as for stormwater conveyance in new development projects in Anne Arundel County. The approach combines features and treatment benefits of swales, infiltration, filtering, and wetland practices. Monitoring of test installations have revealed that they perform as well as conventional stormwater conveyance systems (sewers, etc). The RSC systems are also able to handle large storms, like a 100-year storm, and they have reduced the need for storm drain infrastructure. These ecosystems enhance pollutant uptake and assimilation and provide a natural and native aesthetic to sites (Berg, 2011). These techniques

can be applied to open and developed land in DC, alongside roadways, and along the Anacostia River. These are cost-saving, performance-based techniques that have proven to be successful in improving the quality of stormwater runoff in a neighboring town.

Portland, OR: Stormwater Management Manual

Department: Bureau of Environmental Services

City population: 580,000

Density: 4,300 people per square mile

Presence of a CSO system: Yes

Proximity to water bodies: Yes: Willamette River, Columbia River

The Portland Stormwater Management Manual outlines requirements for stormwater management in the city. The requirements apply to all development and redevelopment projects within the City of Portland on both private and public property. It establishes a stormwater hierarchy and identifies critical areas for runoff mitigation. The City of Portland's approach to stormwater management emphasizes the use of vegetated surface facilities to treat and infiltrate stormwater on the property where the stormwater runoff is created (City of Portland, 2008). Infiltrating stormwater onsite with vegetated surface facilities is a multi-objective strategy that provides a number of benefits, including but not limited to pollution reduction, volume and peak flow reduction, and groundwater recharge. These benefits play a critical role in protecting stormwater infrastructure and improving watershed health. Portland has learned to revise its submittal guidelines based on feedback from applicants. The design details and calculations in the manual have also continued to evolve as technology and best practices have changed.

RECOMMENDATIONS

The recommendations described below are based on the research and cross-case comparison outlined above.

Recommendations for the District of Columbia and the Anacostia River Watershed: A Stormwater Management Overlay District

Based on research and interviews, the proposed best approach for DC is to build the underground stormwater tank system proposed for the Anacostia, while also creating a **Stormwater Management Overlay District (SMOD)** to establish a strong network of green infrastructure throughout the city that will intercept as much stormwater as possible before it enters the sewer system. Complimentary approaches include promoting and encouraging grass roots change at the individual, residential, and business levels, and also directing more of the stormwater fee to green infrastructure pilot projects, planning, development, implementation, and maintenance. Citizens, including children and teenagers, could be involved in brainstorming ideas for the SMOD and installing some of the pilot projects.

The green infrastructure network will help to reduce the size and scope of the tank system, as well as reduce the quantity of runoff entering the combined sewer during storm events. A strong network of green infrastructure- established by a SMOD- will not only reduce the amount of water entering the tanks during large storm events, but it will also reduce the amount of runoff in minor storms, which happen more frequently. It will reduce (filter) toxins from the runoff passing through the Anacostia River Watershed, thereby helping to improve the water quality of the Anacostia River. An overlay district would be a unifying document

emanating from all departments currently managing stormwater. It would be based in the DC Zoning Ordinance, but all agencies involved with stormwater management (**DDOE**, **DCOP**, **DDOT**, **DC Water**, **EPA**, etc) would also be involved in developing the ordinance. A stormwater overlay district is a broad land use planning technique that is adaptable to specific jurisdictions. It could include:

- Designation of acreage or specific locations to be used for infiltration techniques,
- Description of prohibited, permitted, and required land uses, and
- Requirements for stormwater cleanup prior to release into water bodies

In addition to written language, the Stormwater Management Overlay District should also include a map depicting the following elements overlaid onto the city Zoning Map:

- The boundaries of the proposed overlay district
- Specific parcels of land identified for LID installation
- Federal lands, city lands, and private lands dedicated to stormwater management
- Locations for stormwater infrastructure corridors (underground and above ground conveyance systems)
- Potential conflicts with other overlay districts including: Historic Districts,

Two example "Stormwater Management Overlay District" maps are included in Appendix 3 and Appendix 4. These maps are proposed suggestions of what such an overlay district could look like if it is adapted to a portion of the Anacostia River watershed in DC.

Implementation Strategies

<u>Agencies and Organizations Involved</u>

The agencies and organizations that are critical to the successful implementation of this SMOD include DC Water, DDOE, DDOT, DCOP, DC Zoning, DPW, and the US EPA. Local NGOs, including the Anacostia Watershed Society, Waterkeeper Alliance, DC Environmental Network, and others, should be present at all stages of the planning process. It is also important to involve citizens at an early stage in the planning process and throughout implementation of the SMOD. Residents should be involved in numerous working sessions or design workshops to provide input into the location and characteristics of the proposed stormwater management techniques. It is recommended that a "Stormwater Management Working Group" be assembled that includes representatives from each DC agency listed above, as well as the US EPA, local NGOs, and residents from each DC Ward in the Anacostia River watershed. This working group would spearhead the organization, development, and ultimately a periodic performance review of the SMOD.

Cost and Funding

A greater portion of the existing stormwater fees currently being administered by DDOE and DC Water should be set aside for the design and implementation of the Stormwater Management Overlay District. Currently, funds are set aside for DDOE pilot projects, Riversmart Homes, and green roof installation. By consolidating these three items and adding the planning/design and implementation of the SMOD, the District can make this money go further. It is anticipated that the planning of the SMOD will require an increase in dedicated funds, as will the implementation of the SMOD. These increases in cost could also be funded by redirecting a substantial portion of the funds currently dedicated to the future Potomac and Rock Creek tunnels. Rough estimates show potential annual savings of $5.1 million if a green

infrastructure stormwater management network from the SMOD is constructed in place of a CSO tunnel (Casey Trees, LimnoTech, 2007). The positive effects of the SMOD (and associated green infrastructure) will be realized over a longer period of time, but will ultimately require less maintenance, presenting another cost-saving opportunity for the District.

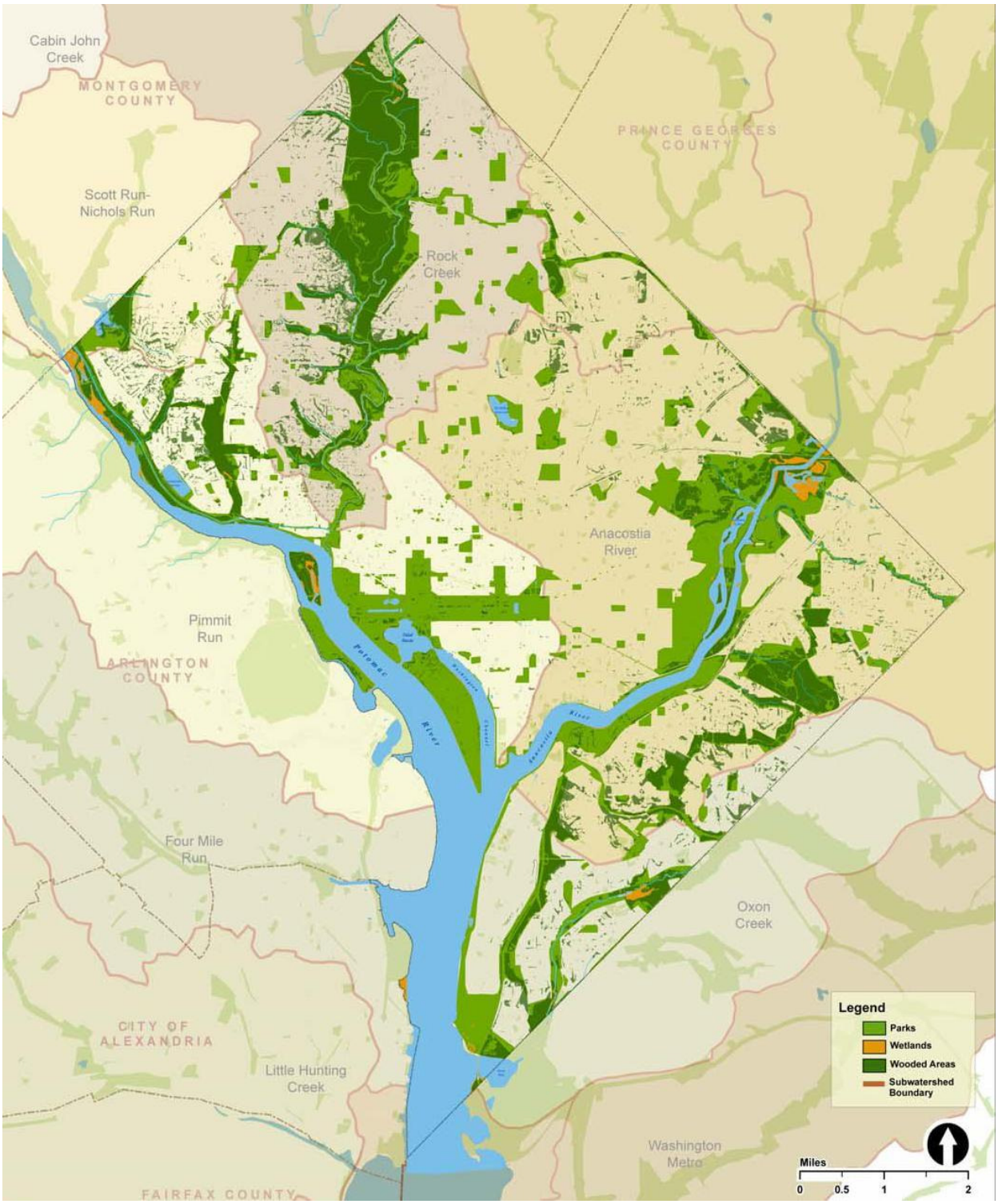
Monitoring Effectiveness

As described in the "Agencies and Organizations Involved" section, the Stormwater Management Working Group would be responsible for setting project benchmarks and criteria for successful performance. Data about runoff quantities and water quality should be collected before construction of the SMOD technologies. Data should be collected at regular, permanent reference points throughout the overlay district. Success should then be monitored on a biannual basis by collecting new data at the same reference points and comparing the runoff volumes to pre-implementation quantities. Data on water quality should also be tested against the water quality information available from the pre-construction condition. Performance should be regularly measured, every two years, for a minimum of 10 years.

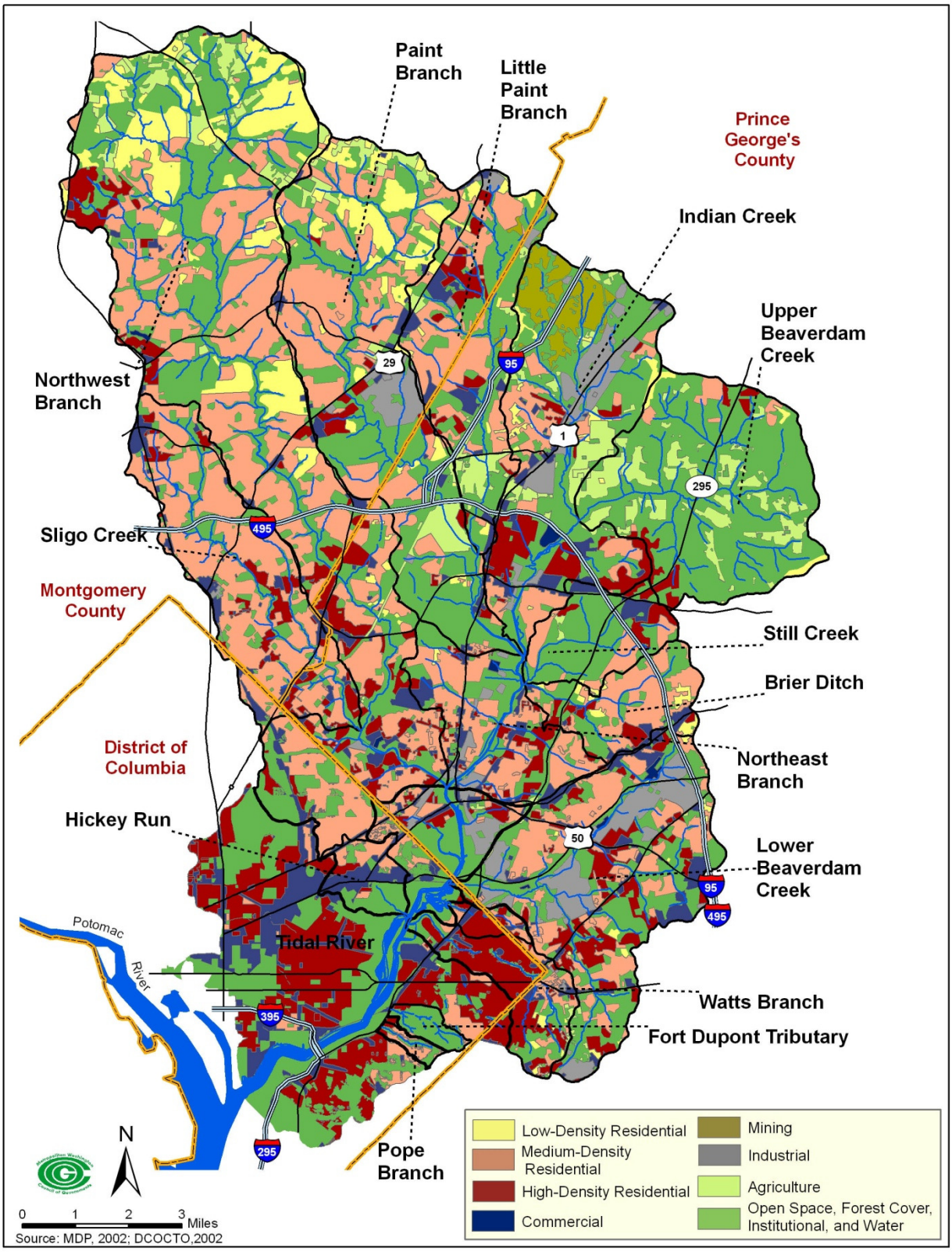
CONCLUSIONS

In conclusion, the District of Columbia is aware of the importance of improving stormwater management in the city. There is motivation to change, and excitement about making stormwater management better. There is a desire to save money, reduce the need for maintenance of the proposed tunnels, and improve the water quality of Rock Creek, the Potomac River, and the Anacostia River. There are barriers present, but they are not insurmountable. Modifying its stormwater management approach will require learning a new way to approach a big problem. Much of the proposed tunnel infrastructure can be eliminated. Green infrastructure required by a SMOD will take slightly longer to implement, but the solutions will be sustainable and require less maintenance. The 95% reduction in stormwater runoff, required by the USEPA, is achievable. Most importantly, modifying its approach to stormwater management will poise the District of Columbia to serve as a role model for other cities in the United States.

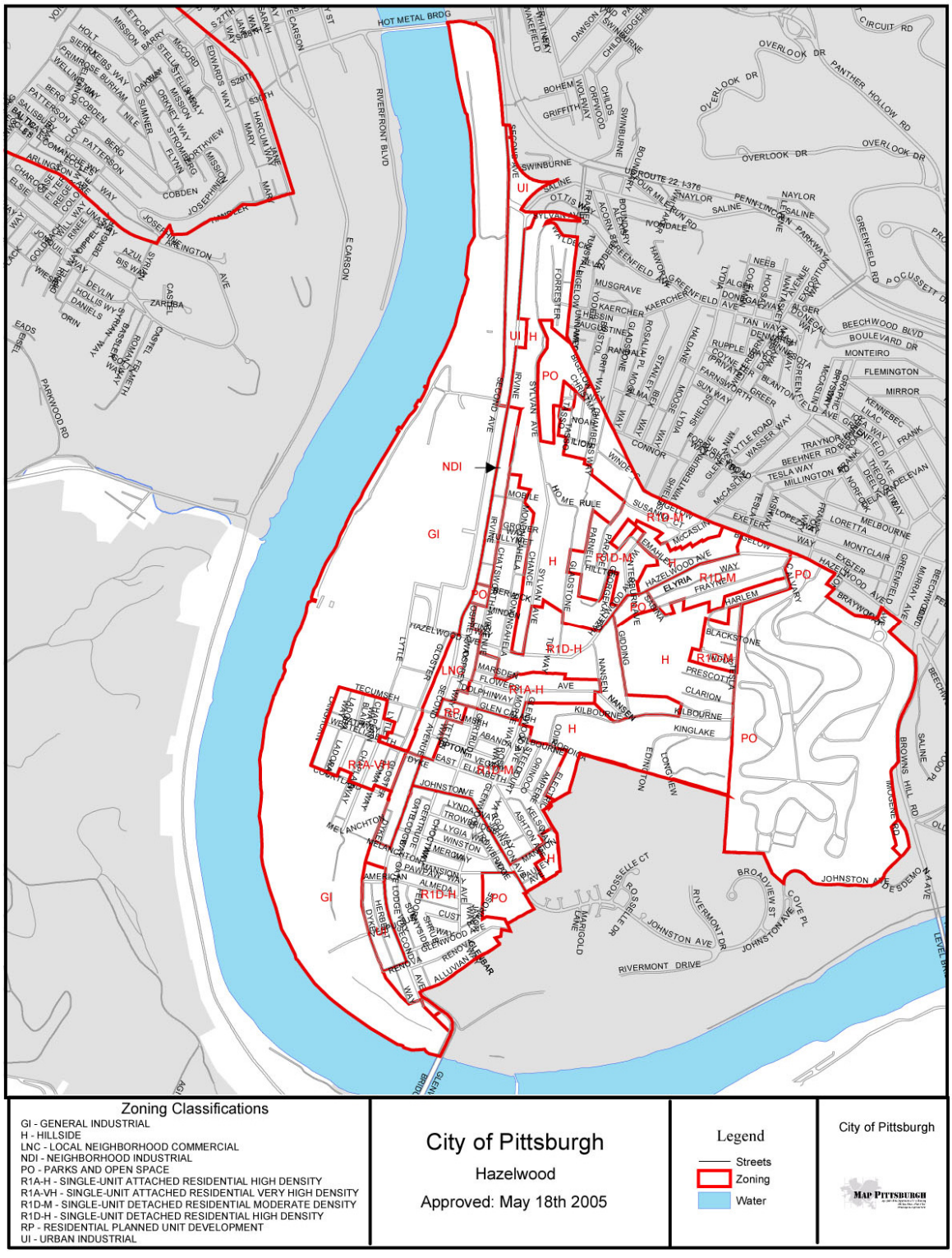
APPENDIX 1: Open space in the District of Columbia



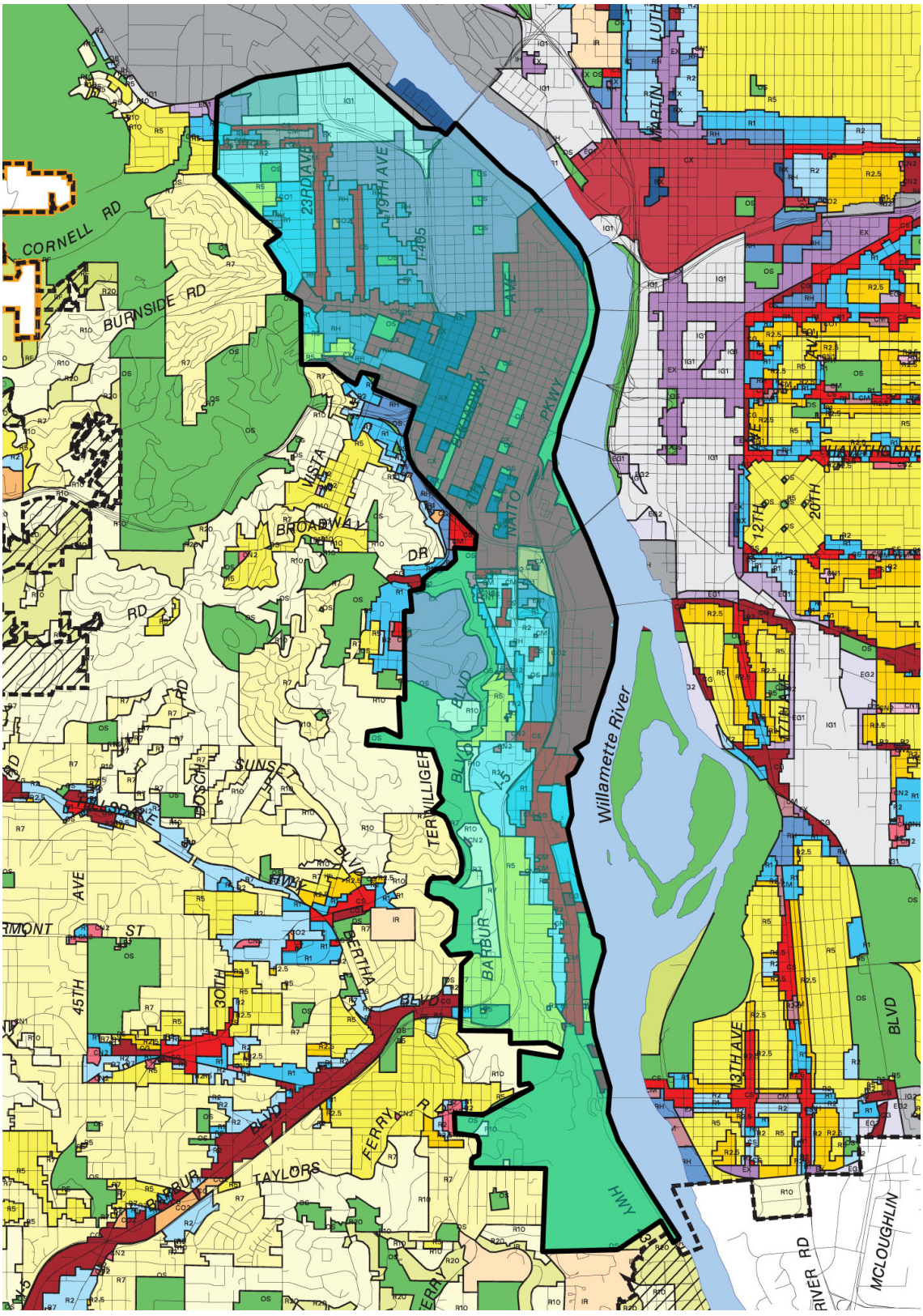
APPENDIX 2: Land use within the Anacostia River Watershed



APPENDIX 3: A sample Stormwater Management Overlay District
Pittsburgh, PA



APPENDIX 4: A sample Stormwater Management Overlay District
Portland, OR



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