Appendix H

Green Infrastructure Assessment

Phase 1: A Green Print Pilot Program for Richmond

October 2010

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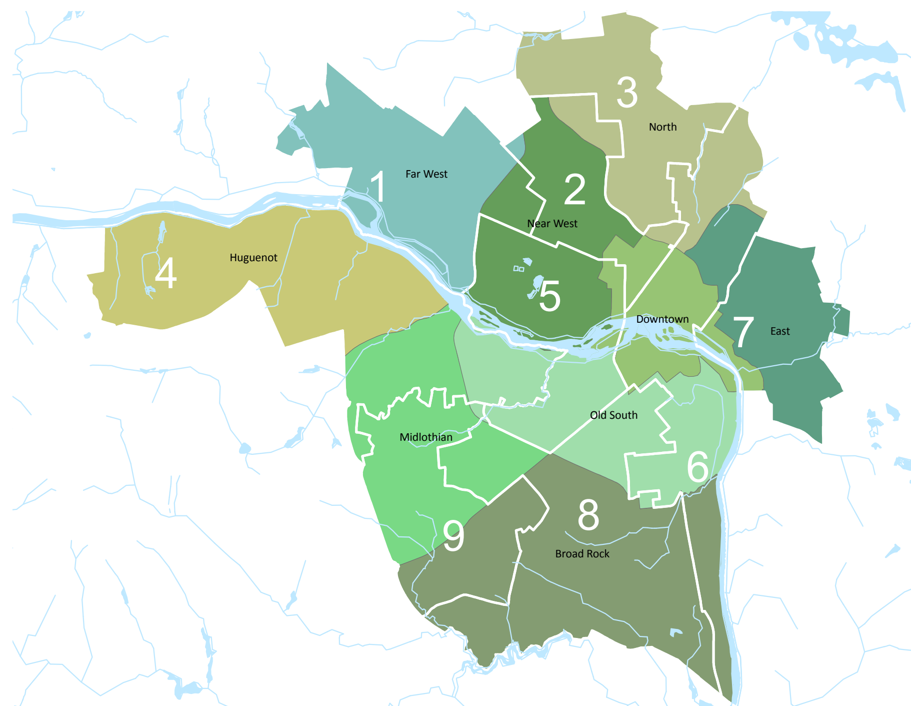
Richmond Planning & Council Districts



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Executive Summary

green infrastructure (n.) -
the interconnected natural systems and ecological processes that provide clean water, air quality and wildlife habitat; green infrastructure sustains a community's social, economic, and environmental health.

Introduction

The Richmond Regional Planning District Commission (RRPDC) joined with the Green Infrastructure Center (GIC) and E² Inc. and the Capital Region Land Conservancy in 2008 to develop a Green Infrastructure Inventory for the Richmond Region identifying green infrastructure assets and opportunities. The goal of the inventory was to illustrate the benefits of green infrastructure at the local and regional and to identify strategies that could be used to implement green infrastrucutre planning practices..

Additional funding was secured in 2009 to develop a Green Infrastructure Assessment (GIA) for the City of Richmond. On January 13, 2010 a group of City of Richmond staff and the Green Infrastructure team discussed the regional project, identified project partners and how the GIA could potentially support the City's goals.

Guiding Principles and Goals

The two phased project first mapped existing green assets and second, will evaluate underutilized properties for their potential to contribute to an enhanced green infrastructure City network with the following goals in mind:

- Inform the City's future decision making and enable the City to proactively plan.
- Identify opportunities to improve the City's urban forest canopy and its stormwater management capacity and function.
- Expand and connect the City's recreational areas.
- Establish alternative transportation connections throughout the City.
- Help create strategies to enhance the economic well being of the City's neighborhoods.
- Help to strategically target lands for restoration and redevelopment funding.
- Serve as a tool and foundation for future fundraising efforts.
- Promote Richmond as a green infrastructure planning model for other municipalities.

This report's focus is on the first phase of the GIA, 'A Green Print Pilot Program for Richmond,' with identification of City-wide green assets including thematic maps depicting:

- Water Resources
- Conservation Lands
- Urban Tree Canopy
- Sustainable Features, Parks and Recreation
- Transportation
- Heritage and Culture

From this larger City view, RRPDC staff worked with the City to provide a more detailed analysis of a smaller, approximately 2,000-acre geographic area, thereby, establishing a pilot project for both recognizing green assets and developing alternative scenarios for quantitative analysis of their enhanced value.

Consisting of the Old Town Manchester, Manchester, Blackwell, Oak Grove, Maury, Bellemeade, Hillside Court and Ancarows Landing neighborhoods, the study area pilot offers the potential to:

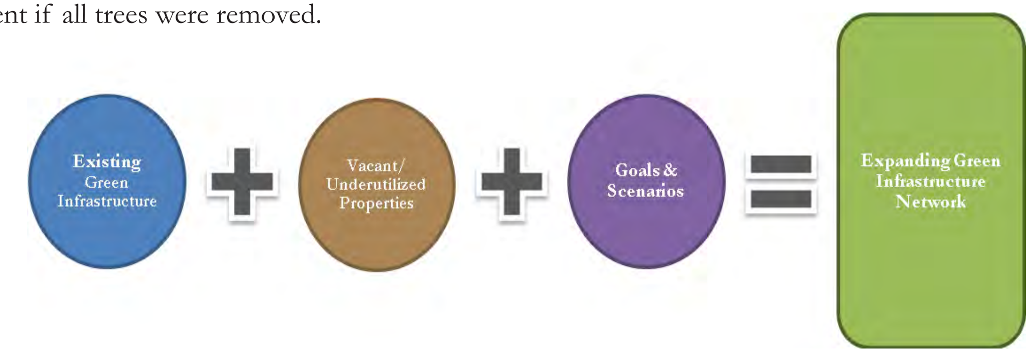
- Identify specific green assets and vacant or underutilized parcels which offer potential to create a natural greener network;
- Assess stormwater benefits to three different watersheds;
- Address the effects of increasing tree canopy in an area characterized by 20% tree canopy and 49% impervious surface coverage;
- Measure the impacts certain land use changes—most dramatically, the conversion of industrial use to mixed-use—could contribute to the green, livability network.

Quantifiable measures for the study area prototype are developed through the application of the CITYgreen© software package created by American Forests which, combined with geographic information systems, can perform land cover analysis for specified areas.

Alternative Scenarios simulate the effects of increased green land cover on a number of factors with the following findings:

- Air pollution: Existing trees remove approximately 35,000 pounds of air pollution with an economic value of more than $100,000 annually; an increase of tree canopy to 20% up to 40% would increase the dollar benefit of such air pollutant removal to more than $250,000 annually.
- Carbon Storage: A 5-year old Willow Oak tree sequesters 6.1 pounds of carbon in a year, meanwhile a 50-year old Willow Oak sequesters 67.8pounds of carbon each year. Carbon serves as a vital participant in the photosynthesis process that feeds tree structure and growth. Existing trees sequester 114 tons of carbon annually; increasing the amount of trees to as much as 40% would have the benefit of storing almost 150% more carbon annually.
- Stormwater Quality: The existing tree and turf cover of the study area serves to filter pollutants from stormwater runoff before it reaches the James River, Goode Creek or Broad Rock Creek. If all tree canopy were completely removed, loading of stormwater contaminants, such as chronium and cadmium, would increase by more than 50% in many of the neighborhoods of the study area.
- Stormwater Quantity: Based on the CITYgreen analysis, the City would be required to spend more than $6.0 million to manage the stormwater resulting from the average 24-hour storm event if all trees were removed.

The Phase I: A Green Print Pilot Program for Richmond concludes with Best Practice examples from other cities across the country and lays the groundwork for Phase II that will outline a city-wide green infrastructure network based on selected vacant lands and natural assests, plus green infrastructure concept plans for select neighborhoods prepared by the GIA team with GIC.



Introduction

Green Infrastructure is defined as "an interconnected network of natural areas and other open spaces that conserves natural ecosystem values and functions, sustains clean air and water, and provides a wide array of benefits to people and wildlife. Used in this context, green infrastructure is the ecological framework for environmental, social, and economic health--in short, our natural life-support system." [Green Infrastructure-Linking Landscapes and Communities, Mark Benedict and Edward McMahon, 2006].

Purpose of Study

The Richmond Regional Planning District Commission (RRPDC), the Green Infrastructure Center (GIC) and the Capital Regional Land Conservancy undertook a cooperative project to document the Richmond Region's [counties of Charles City, Chesterfield, Goochland, Hanover, Henrico, New Kent, and Powhatan, and the City of Richmond] green infrastructure assets in 2009. An outgrowth of the earlier effort, this study brings the generalized nature of the regional approach into focus within the geography of the City of Richmond. Working with the City of Richmond and the GIC, RRPDC staff have completed Phase I of the City-wide Green Infrastructure Assessment, including identifying and mapping existing green assets (the Green Print) and parcels that are vacant and underutilized (the Brown Print) to unlock the potential for creating a greener, healthier city. Phase I also included recognizing the green infrastructure assets and formulating suggestions for changes to unused parcel land use and/or land cover to provide linkages among the assets.

Phase II of the study will evaluate the city-wide vacant land inventory (the Brown Print) for suitability to contribute to the city-wide green infrastructure network and outlines green infrastructure concept plans at the neighborhood scale. Not only would the implementation of green network improvements create opportunities for a more aesthetically pleasing environment, they would support better air and water quality goals of the City.

Study Approach

Using the City-wide green and brown-print inventory, the team defined essential criteria for selecting a smaller study area, including: 1) amount of viable intact habitat; 2) amount of vacant and underutilized properties; 3) existence of the least amount of park land; and 4) highest watershed priorities for the City. Applying these criteria, the team identified both the Broad Rock and Old South Planning Districts (map inside front cover)as potential priority project areas.

As part of Phase I preliminary analysis, RRPDC worked closely with the City staff to select a study area (See Page 15, Map 8) within one of these Planning Districts to refine the analysis through the CITYgreen© software program to quantify alternative scenarios to help in prioritizing key areas, parcels, opportunity sites, and deficiencies that, if improved, could lead to a more effectively functioning green infrastructure system, or Green Print for the area. The study area consists of the neighborhoods of Old Town Manchester, Manchester, Blackwell, Oak Grove, Maury, Bellemeade, Hillside Court and Ancarows Landing. The quantifiable and qualifying analysis of the study area will lead to specific implementation proposals, i.e. tree planting, parcel redevelopment and infill standards, which will be part of Phase II of the larger comprehensive Green Infrastructure Assessment.

City-wide Inventory of Green Assets

Five different thematic maps on the following pages show specific green assets that collectively define the City's existing Green-Print.

Water Resources

Wetlands (U.S. Fish & Wildlife Service) – Sourced from the National Wetlands Inventory mapping of the U.S. Department of the Interior

100 Year Floodplain (Federal Emergency Management Agency) – Based on the 2009 updated DFIRMs (Digital Flood Insurance Rate Maps)

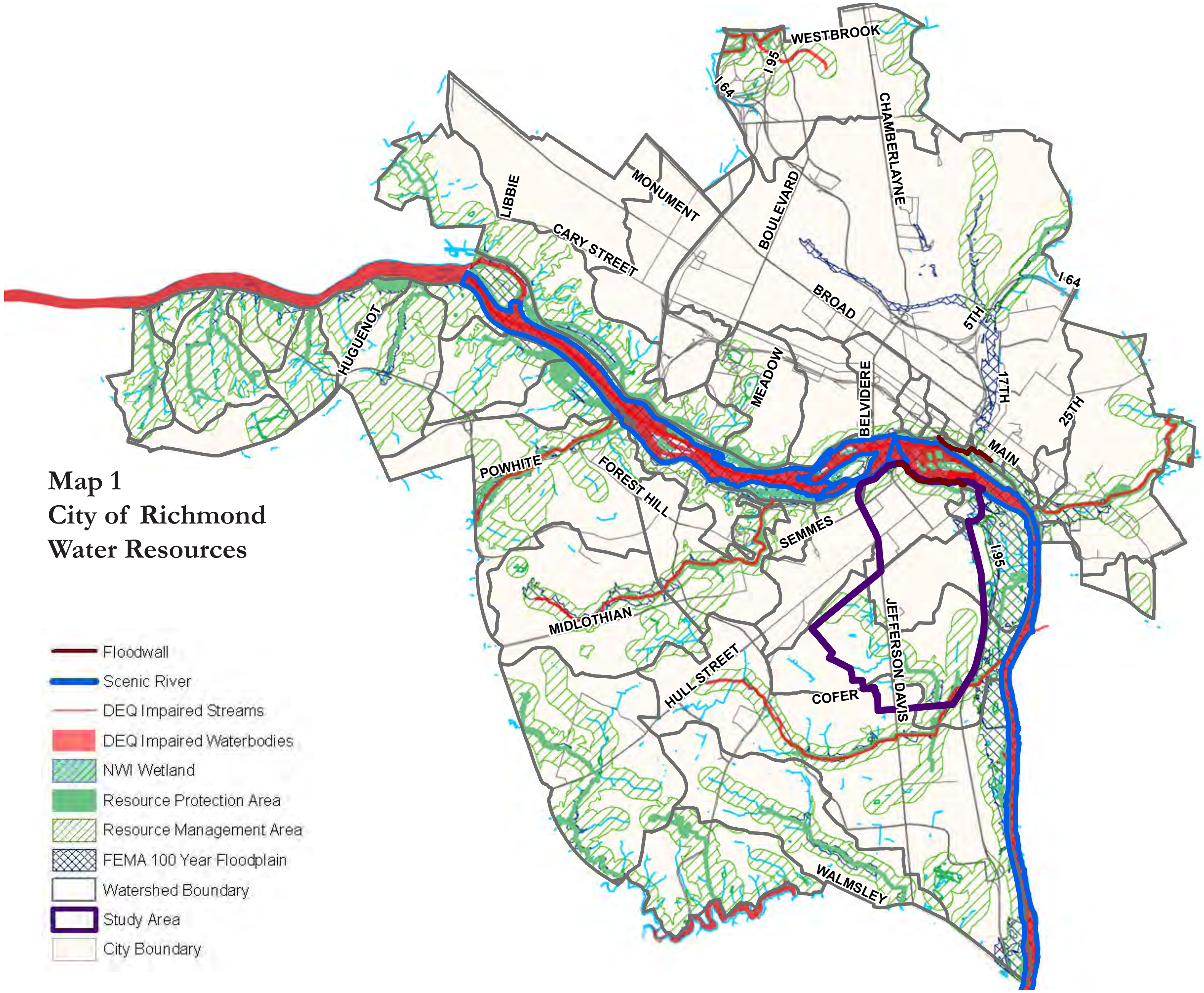
Watershed Boundary (City of Richmond) – Watersheds were developed in conjunction with the Stormwater Asset Management project in the City of Richmond.

Resource Protection Area (City of Richmond) – According to the Chesapeake Bay Protection Act and as applied to the City, the Resource Protection Area (RPA) includes all tidal wetlands; tidal waters; non-tidal wetlands connected by surface flow and contiguous to tidal wetlands or water bodies with perennial flow; shorelines; and a one hundred (100) foot vegetated buffer around each such feature and around all water bodies with perennial flow.

Resource Management Area (City of Richmond) – According to the Chesapeake Bay Protection Act and as applied to the City, the Resource Management Areas (RMAs) include those lands contiguous to the inland boundary of the RPA which have a potential for degrading water quality or diminishing the functional value of the RPA, if not properly managed. The RMA is shown on the Water Resources map (opposite page) and includes, but is not limited to, the following land use categories: floodplains, highly erodible soils, including steep slopes, highly permeable soils; and non-tidal wetlands not included in the RPA.

Impaired Waters (Virginia Department of Environmental Quality) - The data is based on the Final 2008 305(b)/303(d) Water Quality Assessment Integrated Report. Waters impaired due to E. Coli bacteria, PCBs found in fish tissue, Chlorophyll-A, and low levels of submerged aquatic vegetation.

View of Downtown from the floodwall on the south bank of the James River.



Map 1
City of Richmond
Water Resources

Conservation Lands

Cemeteries (Richmond Regional Planning District Commission) – Identified using aerial imagery, City of Richmond parcel GIS data and City of Richmond points of interest GIS data.

Updated Ecological Core Model (Richmond Regional Planning District Commission) – The Ecological Integrity Model of the DCR-Natural Heritage Virginia Conservation Lands Needs Assessment (VCLNA) was "updated", in part, for this project. This "update" was conducted specifically for this project, only in the Richmond Region, and was not integrated into the larger statewide model. This consisted of adjusting habitat cores delineations (i.e. boundaries, and thus areas), which were originally developed using 2001 NLCD (National Landcover Data), based on revised 2007 NOAA CCAP land cover data. A methodology for this "update" was developed by DCR-Natural Heritage, and conducted via collaboration between DCR, PDC, and GIC staff. This adjustment entailed the use of 2007 aerial photography and local building footprint data. This locally adjusted model evaluates and ranks large land areas of forest and natural cover (i.e. cores) based on their ecological integrity, which is measured by factors such as existence of rare, threatened, and endangered species (from DCR and DGIF); diversity and abundance of wetlands; depth and expanse of interior habitat; and stream length.

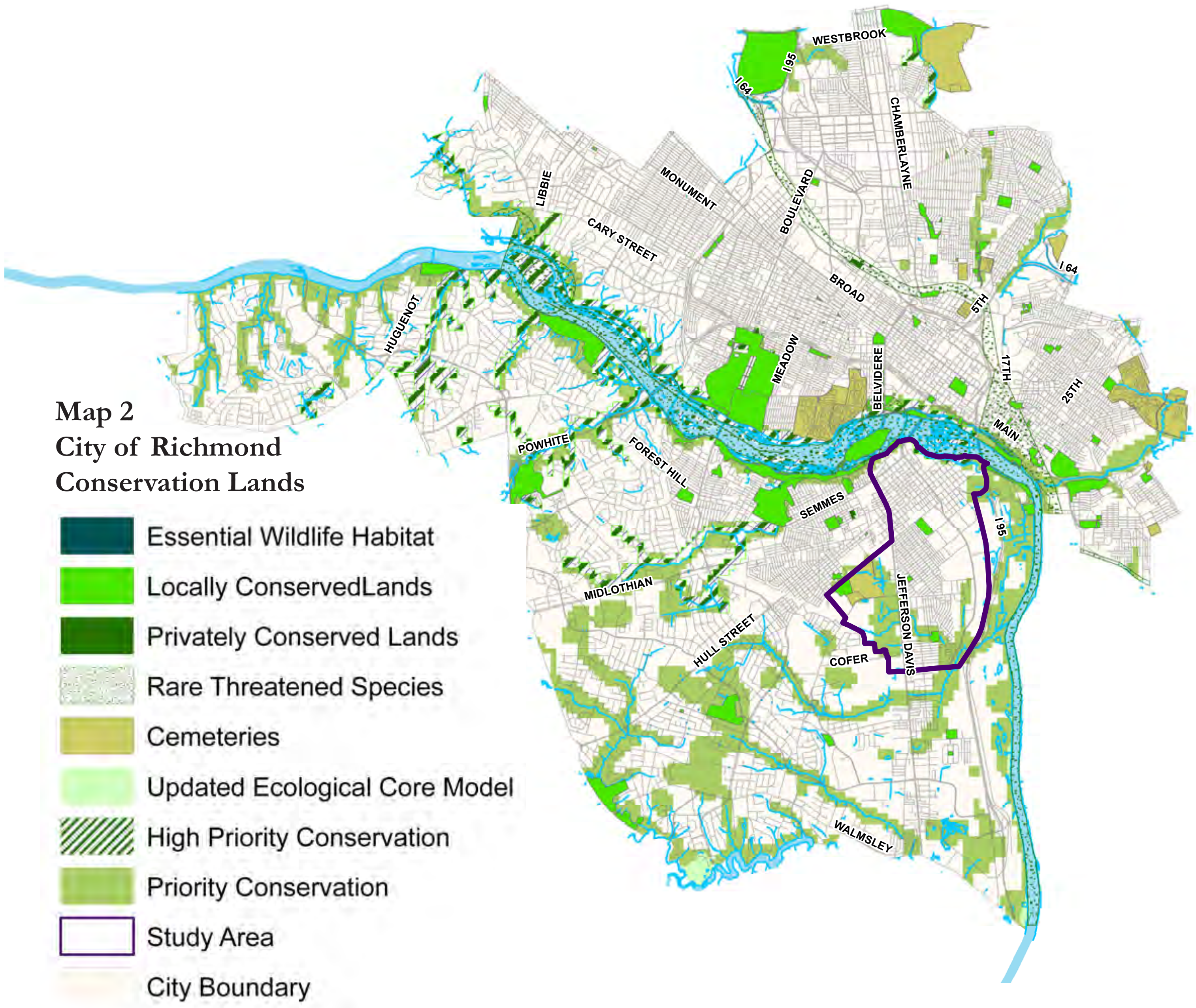
Essential Wildlife Habitat (Virginia Department of Conservation and Recreation) – Depicts the number of Tier 1, 2 or listed species with mapped potential or confirmed essential habitat across Virginia. These habitats were summarized to show areas of habitat conservation opportunity, and created as part of the Virginia Wildlife Action Plan (WAP).

Rare, Threatened & Endangered Species (Virginia Department of Conservation and Recreation) – This data includes conservation sites and general location areas for natural heritage resources. Conservation sites are polygons built around one or more of the following elements: rare plant or animal, significant natural community, or geological features. Conservation sites are designed to include the element and, where possible, its associated habitat, as well as a buffer thought necessary for the successful conservation of both the element and its habitat. For rare aquatic species DCR defines Stream Conservation Units, which identify stream reaches that contain aquatic natural heritage resources, as well as upstream and downstream buffer reaches, including relevant tributaries, to act as an aquatic buffer to the species. General locations for natural heritage resources represent approximate locations of documented natural heritage resource occurrences that were not incorporated into conservation sites because they are poor quality, their location was not precisely identified, or they have not been re-verified in over 20 years.

DCR Conserved Lands (Virginia Department of Conservation and Recreation) –From a database of conserved lands in the state of Virginia, the two files depicted on the map represent locally managed conservation and recreational lands and privately owned lands of conservation and recreational interest.

Priority Conservation Areas (PCA) (Virginia Department of Game and Inland Fisheries, Virginia DCR-Natural Heritage Program, and Virginia Commonwealth University-Center for Environmental Studies) – Land and surface waters identified as important for conservation of Virginia's wildlife, plants, and natural communities. Areas identified can be used to identify priority lands and water for preservation or protection. They contain features of conservation importance (e.g.,Priority Wildlife Diversity Conservation Areas, Natural Heritage resources including ecological cores and conservation sites, Virginia's healthy watersheds) along with a protective area around them to ensure their continued existence and ecosystem function. The PCAs may contain areas that are presently developed or otherwise degraded, but if restored and/or better managed would produce conservation benefits. The higher the priority: the greater the potential benefit.

Map 2
City of Richmond
Conservation Lands



City-wide Urban Tree Canopy

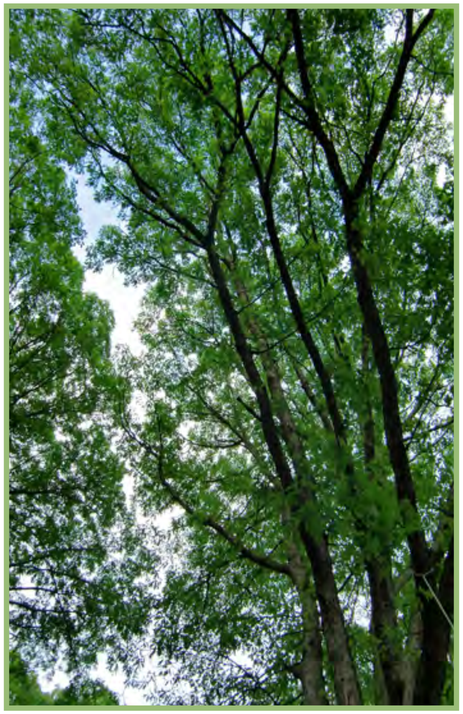
The Virginia Department of Forestry (DOF) in cooperation with the USDA Forest Service and the Chesapeake Bay Program funded an analysis of the City of Richmond's urban tree canopy by the Virginia Geospatial Extension Program at Virginia Tech's Department of Forest Resources and Environmental Conservation. Using the USDA Forest Service's urban tree canopy assessment protocols, an analysis was conducted on year 2008 aerial imagery available from the USDA National Agriculture Imagery Program(NAIP). A report of the analysis is available online at http://www.gep.frec.vt.edu/VA_UTC.html.

Tree canopy consists of leaves, branches, and stems of trees that cover the ground when viewed from above. Urban tree canopy plays a vital role in a city's green infrastructure. Trees clean the air and water, provide wildlife habitat, mitigate the urban heat island effect, and generally contribute to a pleasant atmosphere conducive to work, recreation, and shopping. The urban tree canopy analysis found that slightly more than 40% of the total land area of the City of Richmond consists of tree canopy.

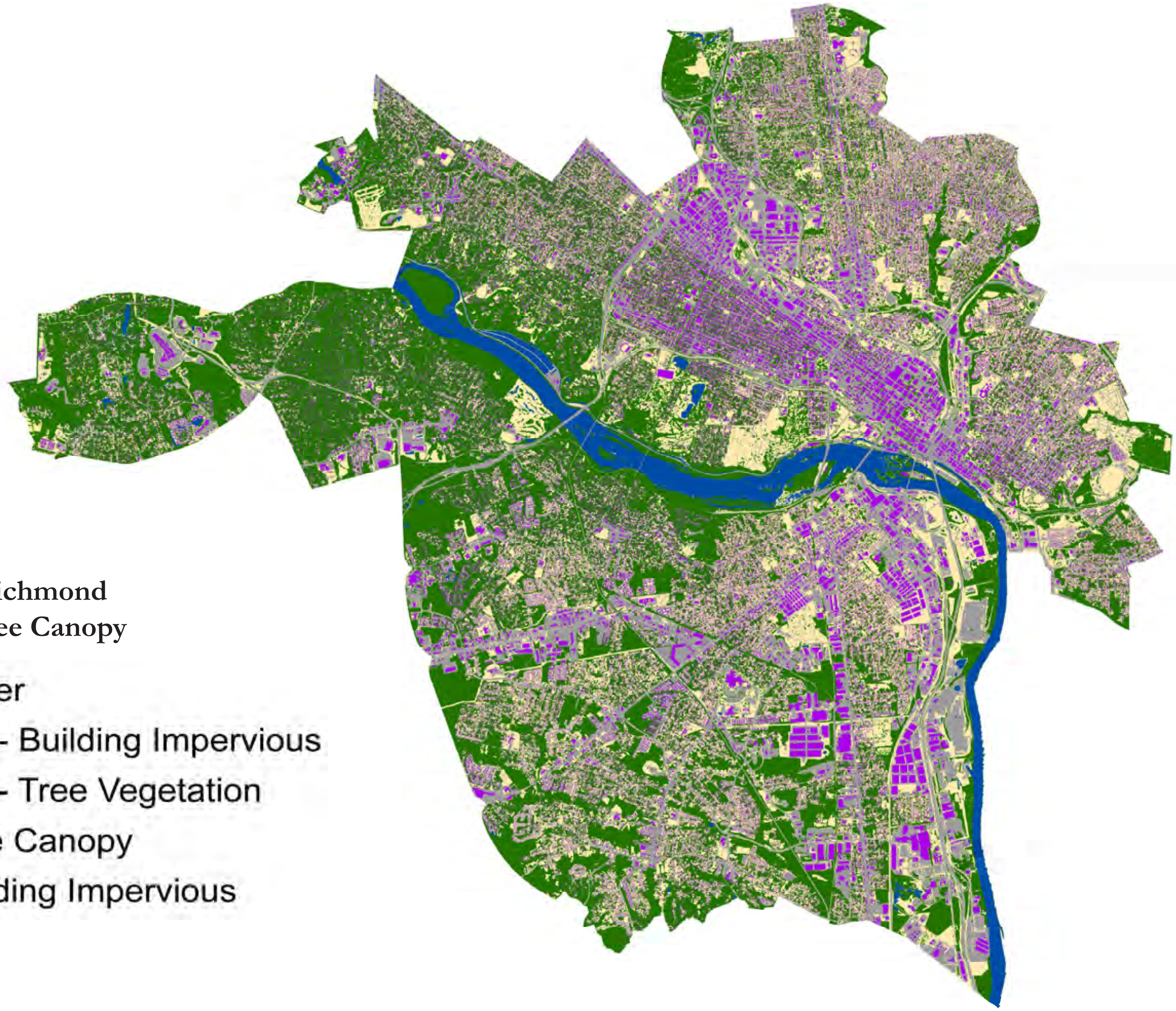
Table 1

City of Richmond Urban Tree Canopy			
Land Cover Class	Acres	Percent Total Land Area*	Percent Land Area
Tree Canopy	16,120.8	40.3%	41.9%
Non-Tree Vegetation	8,916.5	22.3%	23.2%
Non-Building Impervious	9,331.5	23.3%	24.2%
Buildings Impervious	4,138.7	10.3%	10.7%
Water	1,501.6	3.8%	0.0%
Total Area	40,009.2	100%	100%

*Percent Total Land Area includes area covered by water.
Table excerpted from *A Report on the City of RIchmond's Existing and Possible Urban Tree Canopy,* 2010.



Trees in the City of Rcihmond



Map 3
City of Richmond
Urban Tree Canopy

- Water
- Non- Building Impervious
- Non- Tree Vegetation
- Tree Canopy
- Building Impervious

Sustainability Features, Parks and Recreation

Birding and Wildlife Trails (Virginia Department of Game and Inland Fisheries) – Data presents on-road connections between parks and natural areas where wildlife can be seen.

Walking Trails (City of Richmond) – Existing walking/hiking trails in the City of Richmond public parks provided by the City Planning Department.

Parks (Richmond Regional Planning District Commission) – This data set was created by PDC staff as part of a regional parks inventory. It was submitted for review to locality parks & recreation staff for verification, and includes park and recreation lands in the Richmond Region.

Golf Courses (Virginia Economic Development Partnership) – Data from a State map of all golf courses in Virginia

Community Gardens (Richmond Regional Planning District Commission) – This data was collected by PDC staff with help from community garden advocates across the City. The points represent the location of numerous types of gardens in the City of Richmond including learning/school gardens, urban farms, senior gardens, and community gardens.

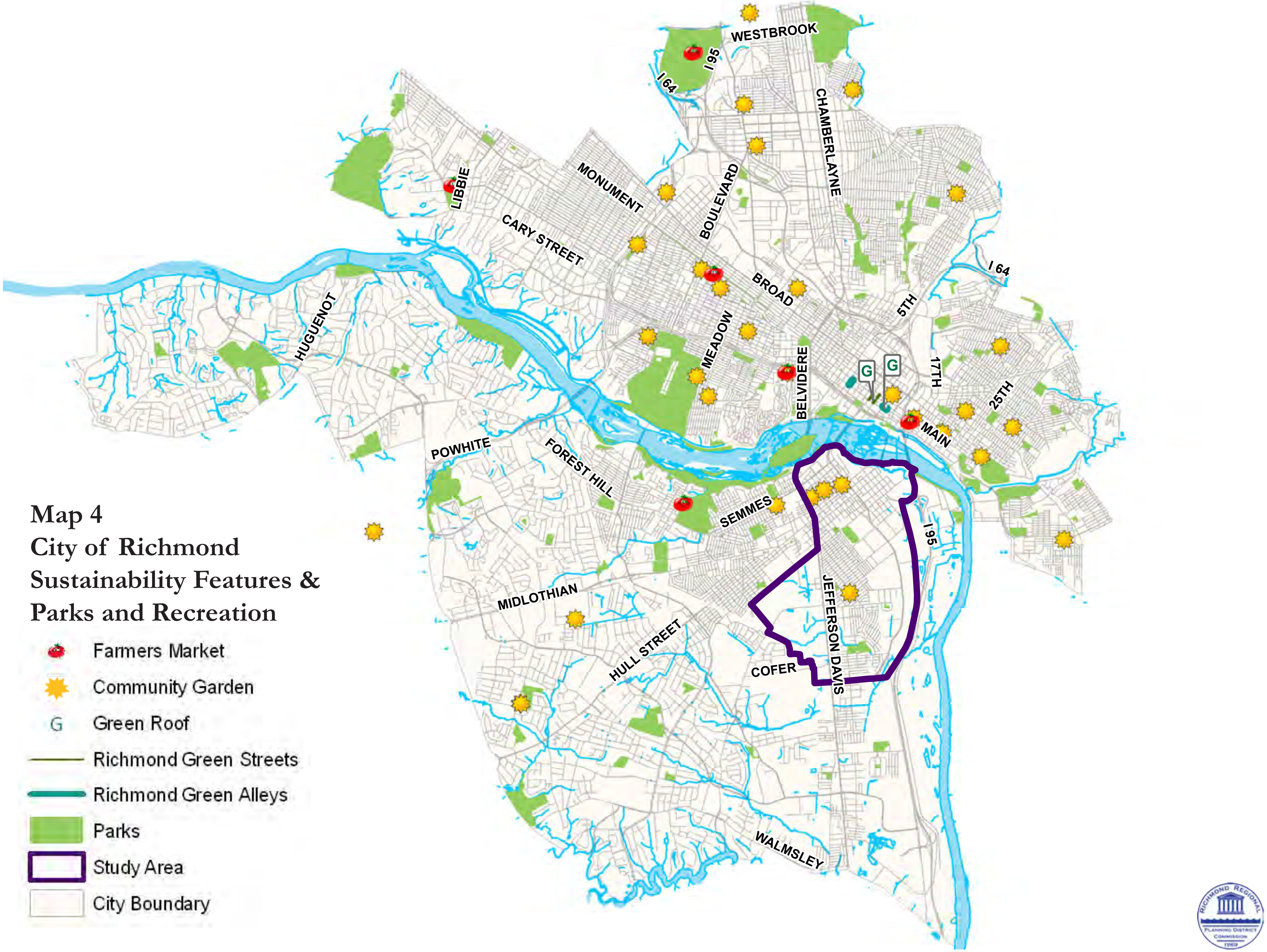
Farmer's Markets (Richmond Regional Planning District Commission) – Represents locations of famer's markets in the City of Richmond.

Richmond Green Alleys (City of Richmond) – This is part of a pilot project in the City of Richmond. Alleys will be retrofitted with pervious pavers to improve storm water management.

Richmond Green Streets (City of Richmond) – Part of the "Greening the Capital" project currently underway by the City of Richmond. The green streets will incorporate street trees and low impact development practices including a curb-less street system with bio-retention rain gardens for storm water filtration.

Richmond Green Roofs (Richmond Regional Planning District Commission) – This data was compiled by PDC staff using a publicly available internet database and 2009 aerial imagery of the City, and verified by City Planning staff.

The proposed James River Branch Trail corridor referenced on p. 12



Map 4
City of Richmond Sustainability Features & Parks and Recreation

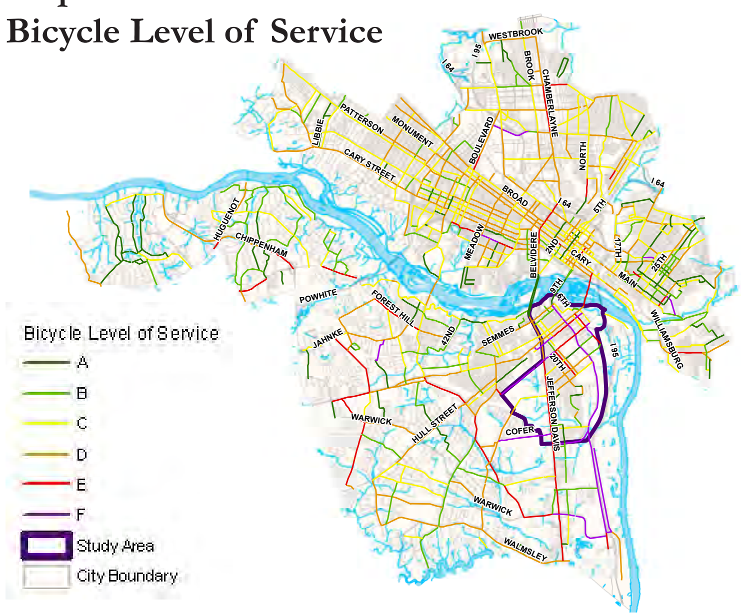
Transportation

Hiking/Biking Trails (Virginia Department of Transportation) – The Virginia Capital Trail that will connect Richmond to Williamsburg upon completion. Many segments are constructed and future phases are fully funded. The proposed James River Branch Trail along an unused CSX rail line; The East Coast Greenway interim on road route; and the Cannon Creek proposed greenway are all in the planning stages.

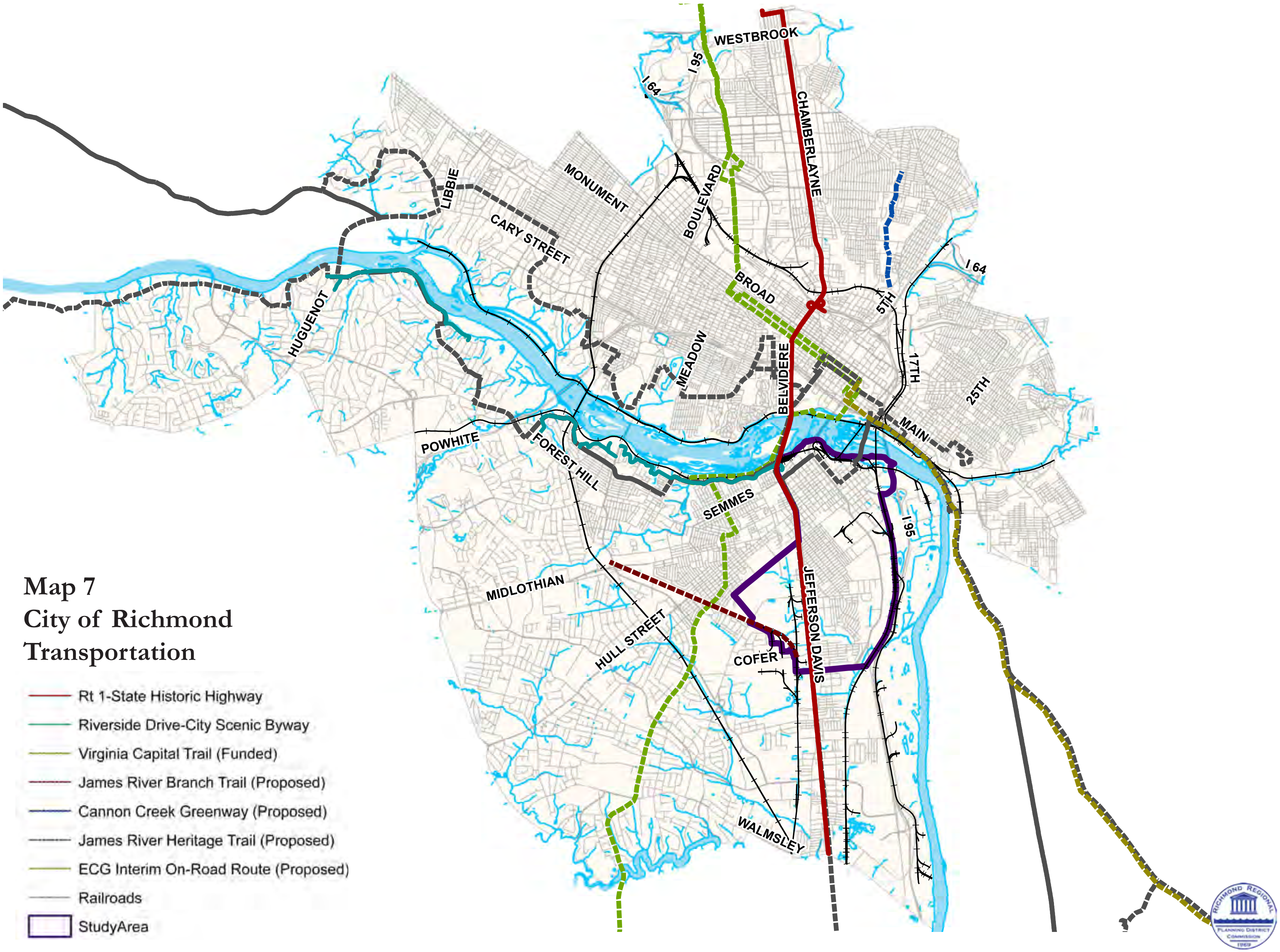
Bicycle/Pedestrian Level of Service (LOS) (Richmond Regional Planning District Commission) – Data prepared for the RRPDC as part of the 2004 Richmond Regional Bicycle and Pedestrian Plan. These data were computed with a specialized modeling technique which evaluates bicycle and pedestrian LOS. The LOS models provide an evaluation of bicyclist and pedestrian perceived safety with respect to motor vehicle traffic and comfort in using the roadway corridor. The models identify the quality of existing service for bicyclists or pedestrians computing LOS values from A (best) to F (worst). Using statistical methods, the model reflects the effect on bicycling or walking suitability due to factors such as roadway width, bike lane or sidewalk width, traffic volume and speed, pavement conditions, parked vehicles and percentage of truck traffic.

Special Road Designations (City of Richmond) – Roads designated by the City as a Scenic Byway because of significant historical, cultural, scenic, recreational and environmental contribution to the City, includes Riverside Drive from easternmost intersection at Cowardin Avenue to its westernmost intersection at Huguenot Road. State byways include roads such as Route 6 designated by VDOT as scenic because of views of natural beauty, historic or social significance. The State General Assembly also designated Route 1 as a historic highway in their 2010 session.

Map 5
Bicycle Level of Service



Map 6
Pedestrian Level of Service



Map 7
City of Richmond
Transportation

Heritage and Culture

National Register Historic Districts (U.S. Department of the Interior, National Park Service) – Historic Districts listed in the National Register of Historic Places which enables qualified properties and rehabilitation/renovation in accordance with the Secretary of Interior's standards, to be eligible for historic tax credits.

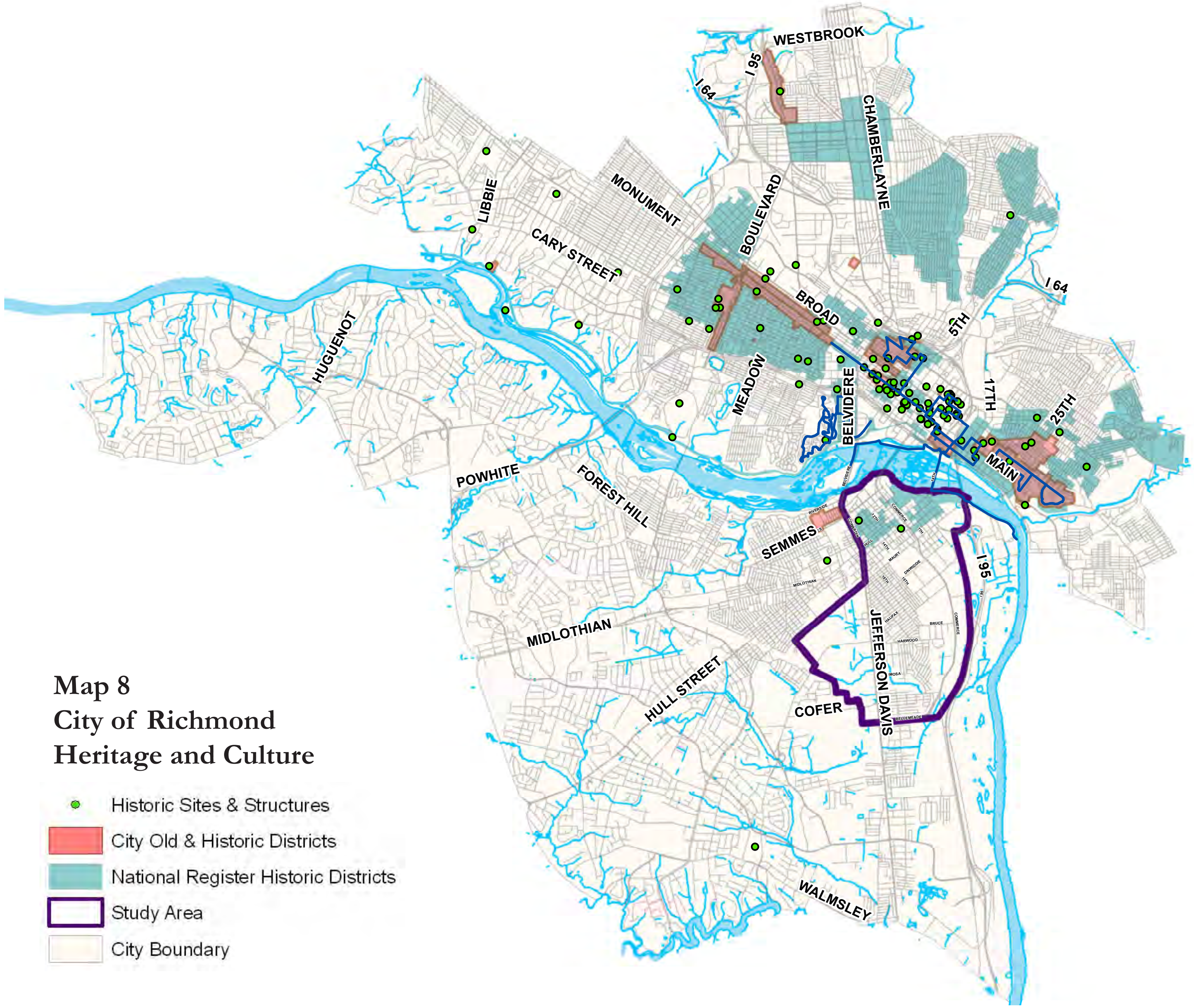
City Old & Historic Districts (City of Richmond) – Old and Historic Districts designated by the City of Richmond which provides for exterior rehabilitation standards, governed by the Commission of Architectural Review.

Historic Walking Tours (City of Richmond) – There are nine (9) designated walking tours throughout the City managed by Historic Richmond Foundation, including Hollywood Cemetery, the Tobacco Warehouse Tour, Belle Isle, the Pump House/Canal Discovery Tour.

Historic Sites and Structures (City of Richmond) - Notable sites and structures indicated on the City of Richmond points of interest GIS file.

Historic building on Bainbridge and 13th Streets

Renovated Manchester Courthouse



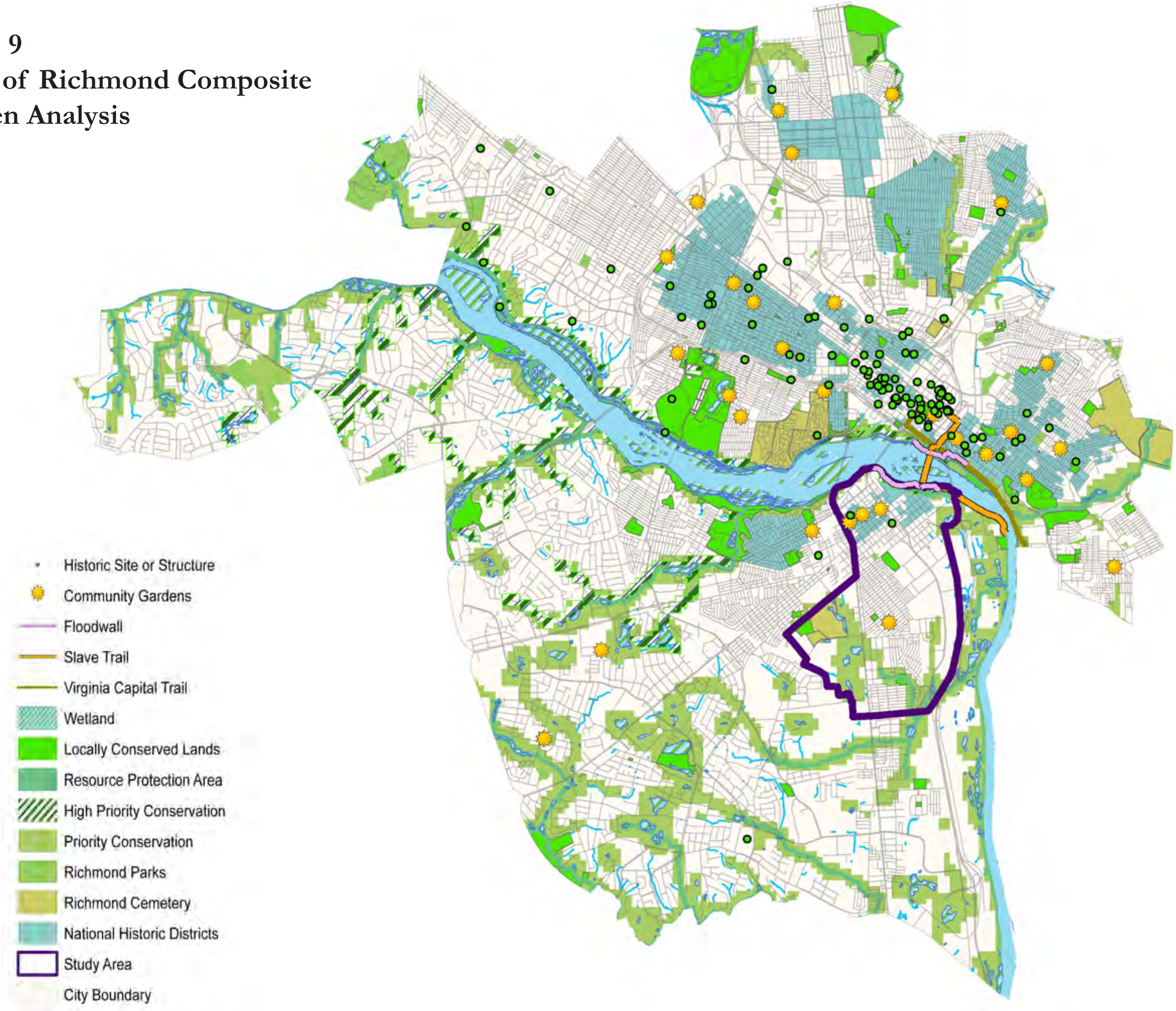
Map 8
City of Richmond
Heritage and Culture

City-wide Composite

Key green infrastructure features identified in the existing asset inventory have been combined to create a green infrastructure composite base map for the entire City of Richmond. This base map unites the most essential green infrastructure features from the separate green asset map layers to illustrate green infrastructure asset clusters along with the major connections between them. Existing green infrastructure assets are extensive along the James River and frequently overlap. Other clusters centered around wetlands, recreation areas, and/or cultural areas are highlighted throughout the north and south banks of the River. Connections between these clusters are naturally created by stream corridors or are culturally instituted by transportation routes. Additional green infrastructure considerations add dimension to this base map for finer scale analysis at a neighborhood level. Similarly, opportunities for enhancing existing green infrastructure assets and providing connections can be discovered with the addition of vacant parcel and building information. Looking at a neighborhood scale, these combined layers with current zoning information and knowledge of development/redevelopment projects will better define the potential for green infrastructure to be conserved or expanded.

Photo top right illustrates an effective use of small ornamental street trees in a narrow space below overhead electrical at Second and Hull Streets (photo credict: Michael Stewart). Photo bottom right features a tranquil greenspace at Maymont, Italian Gardens.

Map 9
City of Richmond Composite Green Analysis



Vacant Parcels

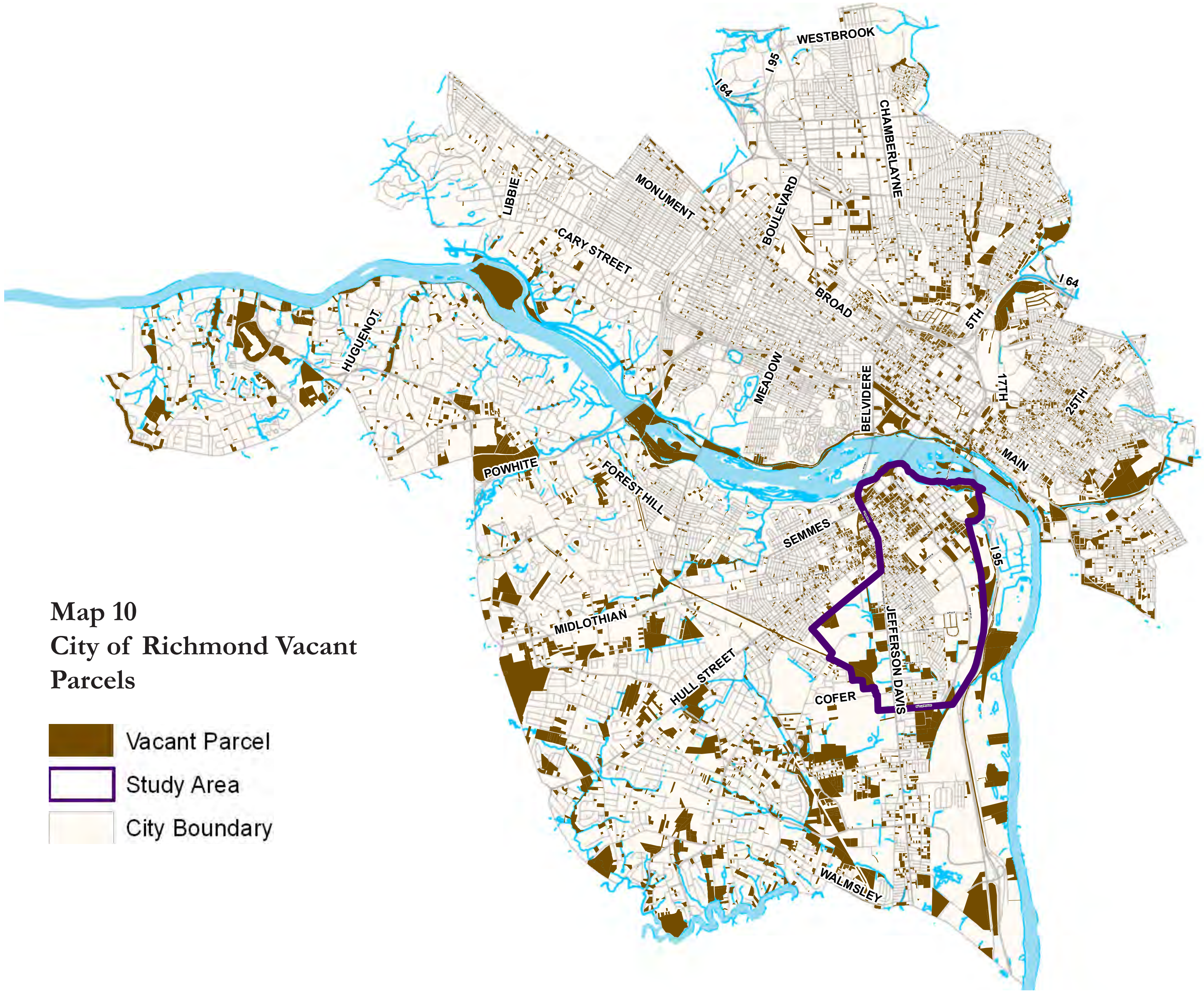
Sensitive reuse of vacant parcels can function to extend and connect existing green infrastructure assets. To identify existing vacant parcels, PDC staff enlisted the help of staff from the City Real Estate Assessor office. The assessor's office maintains a database of all properties in the City of Richmond listing existing status and land use of each property. Upon the advice of assessor's staff, the green infrastructure team identified a property as "vacant" if it was listed in the assessor's database as being a vacant lot, having a vacant building or being a paved surface parking lot, including those identified as follows:

- Single family residential vacant
- Single family residential vacant building
- Condominium vacant
- Condominium vacant building
- Multifamily residential vacant
- Multifamily residential vacant building
- Industrial vacant
- Industrial vacant building
- Commercial vacant
- Commercial vacant building
- Paved surface parking lot

Green Infrastructure Center staff and E^2 staff are currently working to create a comprehensive database of vacant parcels in the City of Richmond. While the assessor's office maintains a high quality database, the accuracy across all land use types, especially industrial uses, varies due to different data reporting and record keeping requirements. Additionally, other departments in the City of Richmond maintain separate vacancy databases that may not correlate with the data provided by the assessor's office. Phase II of this project will detail this comprehensive vacant parcel database and additional analysis about how the vacant parcels can interact with existing green infrastructure assets identified in this Phase of the project.

Vacant lot on the corner of Bainbridge Street& 12th Streets.

Vacant residential building located at Porter & 12th Streets.



Map 10
City of Richmond Vacant Parcels

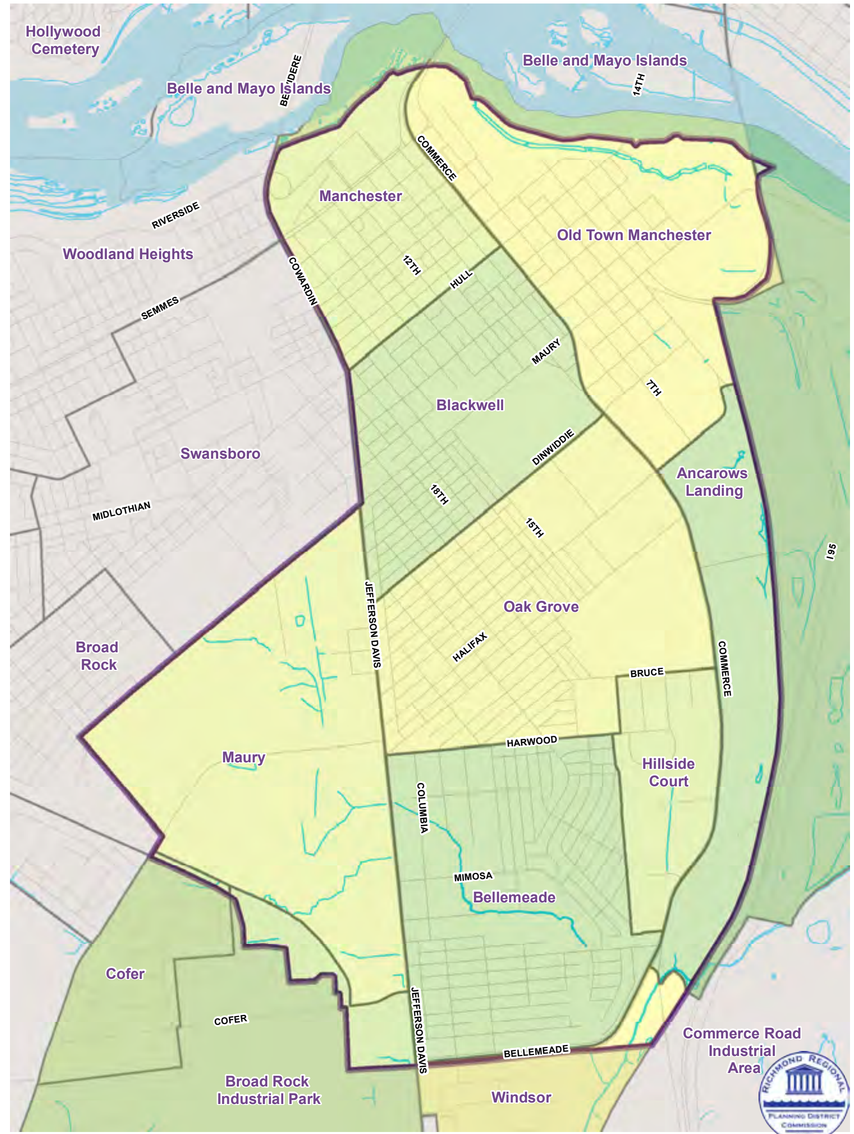
Selection of a Study Area

As referenced in the beginning of this report, both the Broad Rock and Old South Planning Districts of the City were identified as priority project areas. Within these planning districts, the team identified an approximately 2,000 acre study area that offers the following characteristics essential for both measuring existing and potential green infrastructure networks:

- Distinct geographic area with defined watershed boundaries
- Wide range of existing land uses
- Opportunities for redevelopment expressed through the recent City-sponsored rezoning of Manchester
- An aging commercial corridor (Route 1/Jefferson Davis Highway) with significant vacant property
- A potential Southside Rail-Trail
- The Blackwell Hope VI project

The study area is made up of the following neighborhoods: Old Town Manchester, Manchester, Blackwell, Oak Grove, Maury, Bellemeade, Hillside Court and Ancarows Landing.

Shops located along Hull Street in Manchester



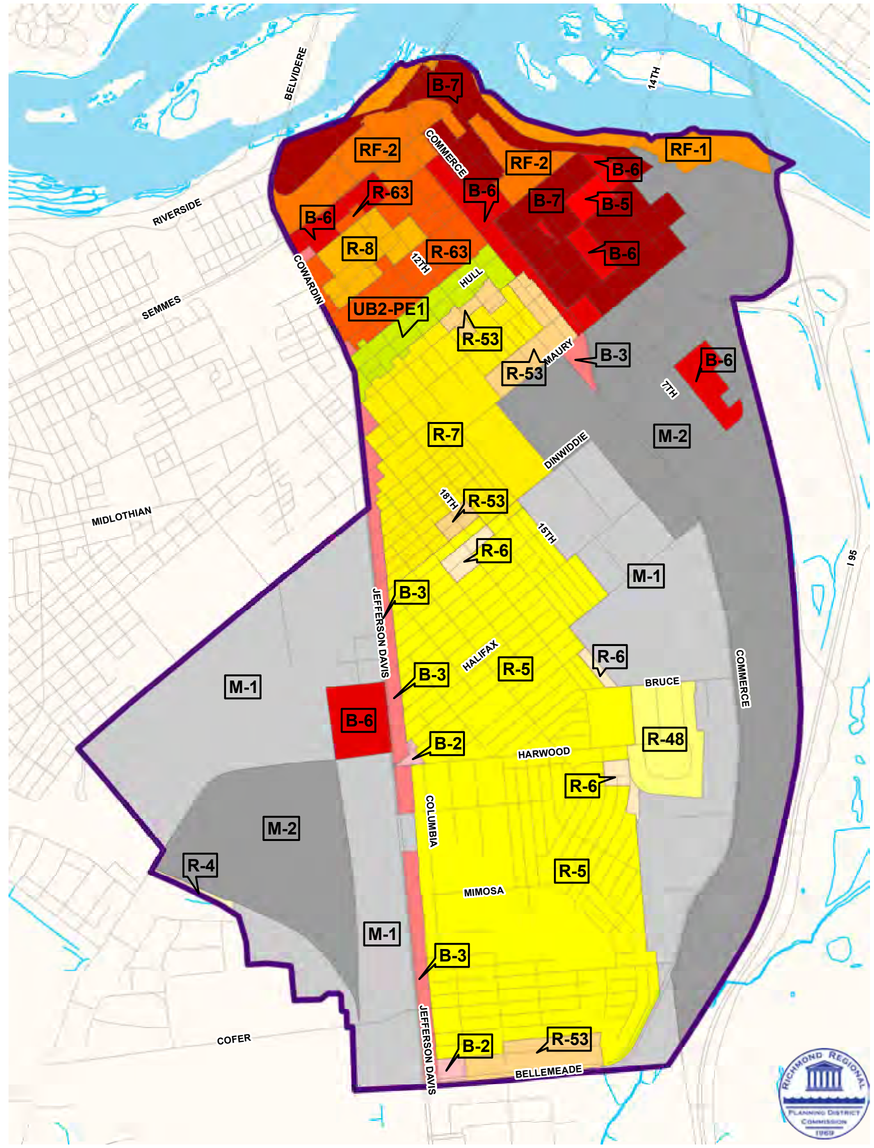
Map 11
Neighborhoods of the Study Area

Existing Zoning

Existing zoning is an indicator of a parcel's readiness to be developed or redeveloped and the regulations that will govern any new or reuse of the parcel. The study area zoning offers a wide array of opportunities, especially with the recent rezoning of the Manchester area. The largest single study area zoning category is Industrial (988 AC) followed by all the Single Family Residential categories (494 AC). The new zoning categories in the Manchester rezoning (R-63, R-8, and B-7) will enable more parcels to be redeveloped as a Mixed Use category and represent a total of 485 acres along with the existing zoning categories regulating Riverfront development. The existing zoning along with vacant parcels together will set the stage for several of the alternative development scenarios to test the impacts that enhanced green infrastructure can have on the study area's water and air quality.

Above: Old manufacturing building at 2nd and Decatur Streets looking southwest on Decatur Street offers opportunityfor conversion toanother use

Left: Plant Zero Lofts located at 3rd and Hull Streets in former industrial building



Map 12
Existing Zoning

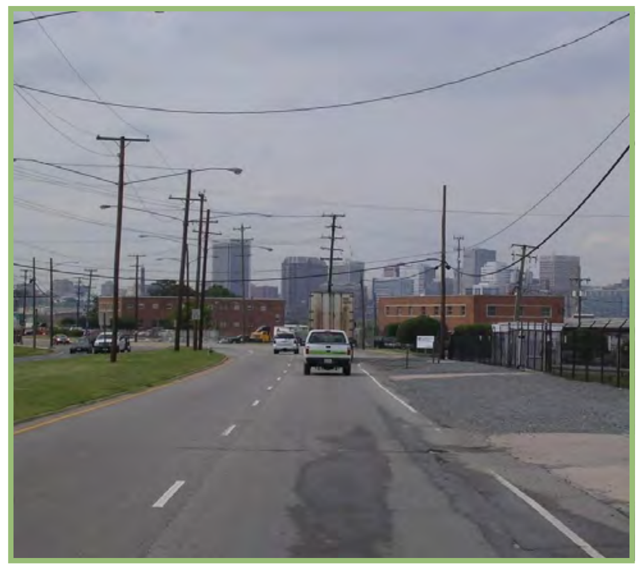
Composite Study Area Analysis

The composite map on the opposite page highlights both existing green assets taken from the City-wide green assets inventory presented in the first part of this report and the vacant parcel inventory from the City Assessor's office. Identification of existing vacant parcels in the study area accessing the City Assessor's data base as of October 2009 shows a total of 806 vacant parcels representing approximately 284 acres, or 13.5 percent of the 2097-acre study area. The average size of the vacant parcel is about one-third of an acre, the largest is 21 acres with the smallest being no more than 220 square feet. The importance of identifying vacant parcels (the "Brown Print") in the context of the green assets is to look for opportunities to strategically enhance the vacant parcels through new development or redevelopment that contributes to a green infrastructure network. Therefore, characteristics such as the location, ownership, property value, and zoning are all factors that contribute to the propensity of individual vacant parcels to be incorporated into the green framework. Looking at the two inventory measures in the composite suggests both obstacles and opportunities for enhancing the study area's green infrastructure, and thereby, the aesthetics, environmental and economic viability.

Natural area on Columbia Street along a tributary of Goodes Creek represents a green network opportunity

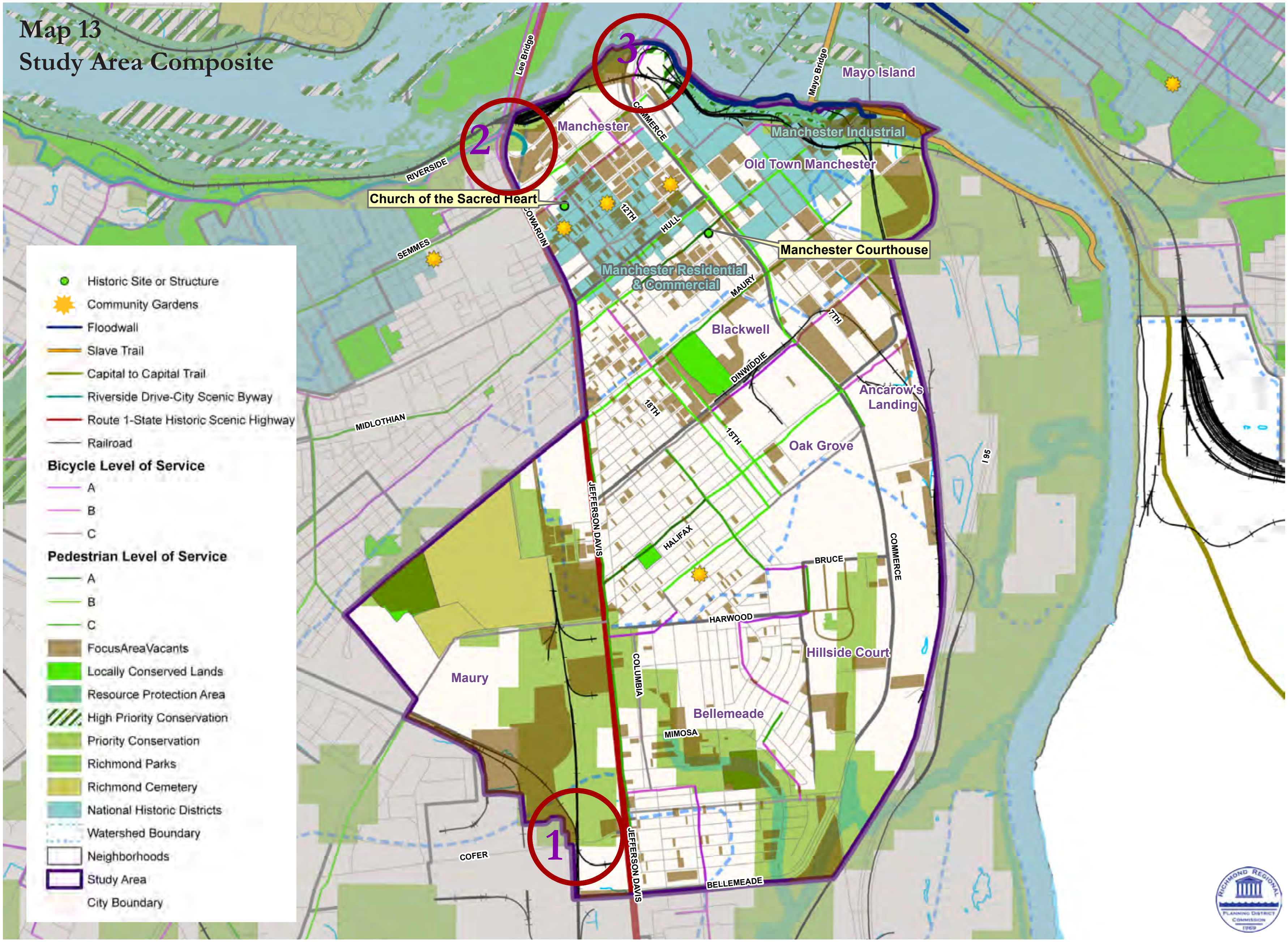
Key existing features indicate potential for green connections through locally conserved lands and stream beds from the neighborhood of Bellemeade to the planned James River Branch Trail. Existing transportation options that intersect with 'green' features offer potential Gateways shown on the opposite map:

1. South at a Cofer Road trailhead for the rail trail
2. North at Cowardin intersection with Riverside Drive at the Lee Bridge
3. North at Commerce Road and the Manchester Bridge and the area along the flood wall to the 14th Street Bridge and the designated Slave Trail



Commerce Road looking north toward downtown also offers a green network opportunity if put on a 'road diet'

Commerce Road and Jefferson Davis Highway (U.S. Route 1) serve as vehicular north-south spines through the study area, each having their own character and challenges. The wide cross-section of Commerce (photo to right) with a healthy median could even be viewed as an opportunity to put the street on a 'road diet' incorporating additional green features, such as a dedicated pedestrian/bike lane. Focus on Jeff Davis revitalization opens up similar opportunities along with parallel neighborhood streets such as Columbia Avenue. The rezoning and concentration of vacant parcels in Manchester will introduce new vitality through the population living and working in the area that should be supported with green infrastructure improvements.


Map 13
Study Area Composite
Historic Site or Structure
Community Gardens
Floodwall
Slave Trail
Capital to Capital Trail
Riverside Drive-City Scenic Byway
Route 1-State Historic Scenic Highway
Railroad
Bicycle Level of Service
A
B
C
Pedestrian Level of Service
A
B
C
FocusAreaVacants
Locally Conserved Lands
Resource Protection Area
High Priority Conservation
Priority Conservation
Richmond Parks
Richmond Cemetery
National Historic Districts
Watershed Boundary
Neighborhoods
Study Area
City Boundary
Lee Bridge
Mayo Bridge
Mayo Island
Manchester
Manchester Industrial
Old Town Manchester
Church of the Sacred Heart
Manchester Courthouse
Manchester Residential & Commercial
Blackwell
Ancarow's Landing
Oak Grove
Hillside Court
Maury
Bellemeade
RIVERSIDE
SEMMES
MIDLOTHIAN
COWARDIN
COMMERCE
12TH
HULL
MAURY
7TH
DINWIDDIE
18TH
15TH
JEFFERSON DAVIS
HALIFAX
BRUCE
HARWOOD
COLUMBIA
MIMOSA
COFER
BELLEMEADE
I 95
1
2
3

CITYgreen© Analysis

CITYgreen is a software package created by American Forests, a non-profit conservation organization. When paired with geographic information systems, CITYgreen performs a land cover based analysis of a specified study area to calculate the value of tree canopy in both economic and ecological terms. The software runs several models to produce quantitative results on the ability of trees to perform air pollution removal, carbon storage and sequestration, and stormwater management. CITYgreen analysis was performed on the green infrastructure study area as a whole and on the individual neighborhoods that form it.

As a source of land cover data to use for the CITYgreen software analysis, RRPDC staff utilized the data produced as part of the City of Richmond's urban tree canopy analysis funded by the DOF. The data was classified into three land cover types for an analysis of the study area: impervious surfaces, tree canopy, and open space/turf. *Impervious surfaces* include building roof tops, sidewalks, streets, and similar surfaces through which water cannot penetrate. *Tree Canopy* includes all areas generally covered by trees when viewed from above. *Open space/turf* includes grassy lawn areas, bare ground, and other spaces that are neither impervious nor covered by tree canopy. The land cover analysis performed for purposes of this exercise does not provide an actual tree count, but instead measures area considered to be occupied by trees.

The Richmond Green Infrastructure study area includes 2,099 acres in the City of Richmond south of the James River. The study area consists of a variety of neighborhoods (see map on page 20) and development patterns from turn-of-the-century, mixed use, urban neighborhoods to blocks of industrial warehouses. In addition, there are lower density, suburban residential neighborhoods and an abandoned rail line planned for a trail through the City.

To the right is a table depicting the acreage of the study area and its' constituent neighborhoods. The smallest neighborhood is the Hillside Court neighborhood which consists of only 4.7% of the study area, while the largest neighborhood is the Maury neighborhood which is 20.3% of the study area.

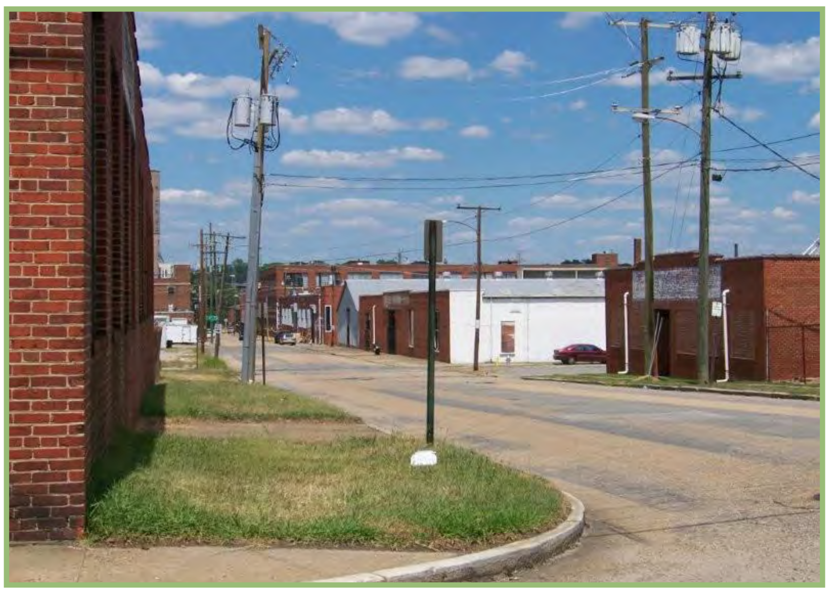
*Numbers and percentages listed in the CITYgreen Analysis section have been rounded.

Table 2

Area in Acres		
Area	Total Area	Percent of Total Area
Ancarrow's Landing Neighborhood[1]	189	9.0%
Bellemeade Neighborhood	323	15.4%
Blackwell Neighborhood	229	10.9%
Hillside Court Neighborhood	99	4.7%
Manchester Neighborhood	168	8.0%
Maury Neighborhood[2]	427	20.3%
Oak Grove Neighborhood	341	16.3%
Old Town Manchester Neighborhood	326	15.5%
Entire Study Area	2,099	100.0%

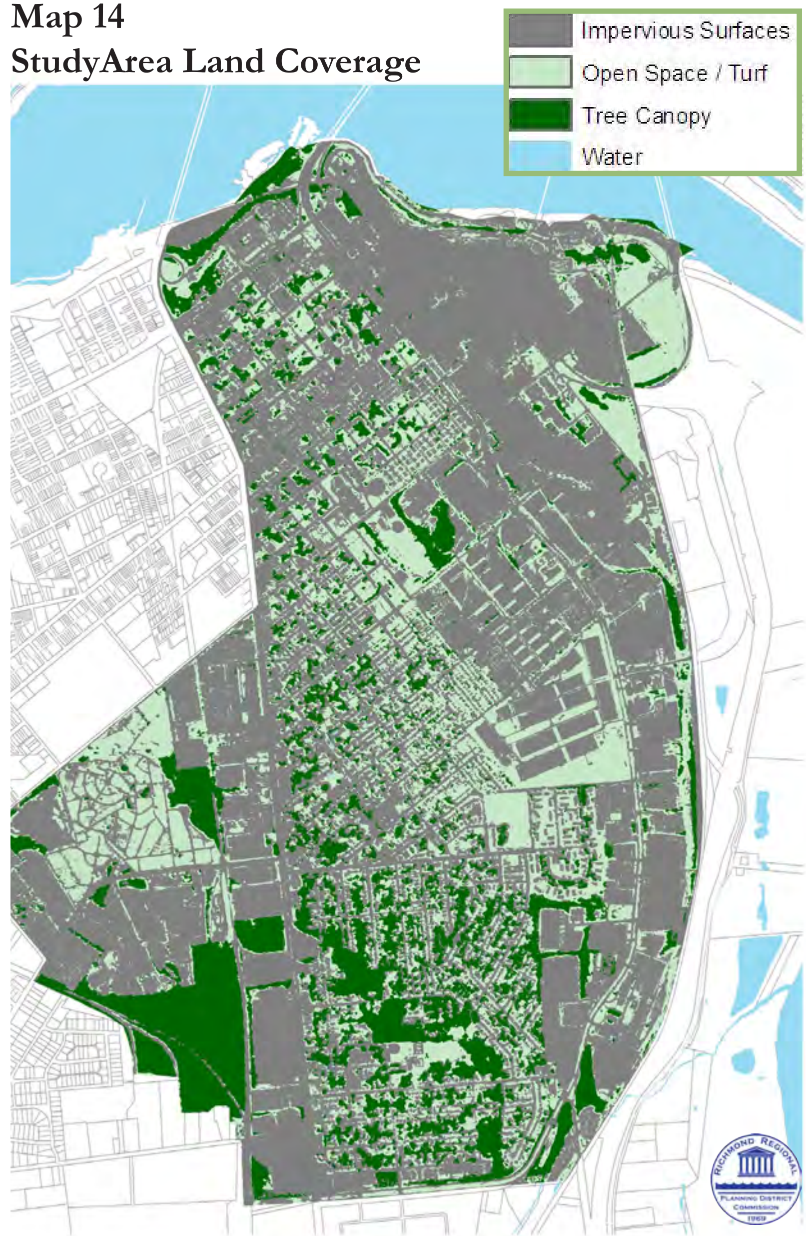
1 - Ancarow's Landing also includes a portion of the Windsor neighborhood.
2 - Maury also includes portions of the Cofer and Broad Rock Industrial Park neighborhoods.
Analysis performed by CITYgreen software

Bruce and Lenmore Streets looking east illustrates large area of open space/turf



Intersection of 7th and Decatur Streets presents an image of urban impervious cover predominant in the area

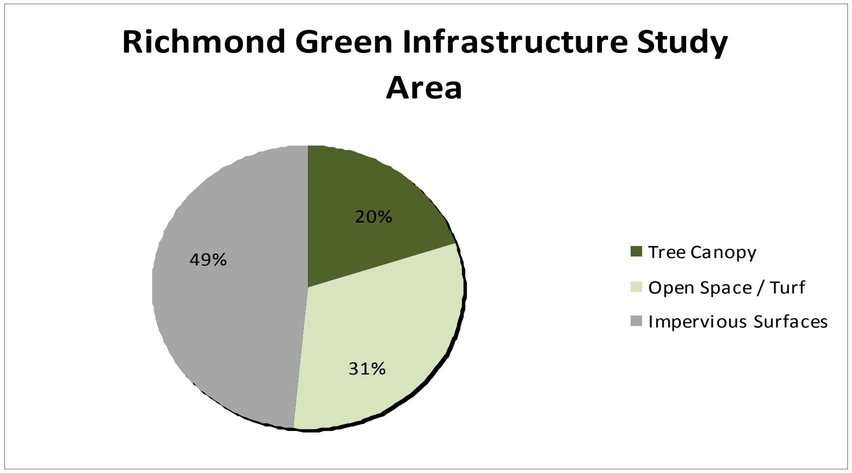
Map 14
StudyArea Land Coverage



Land Cover

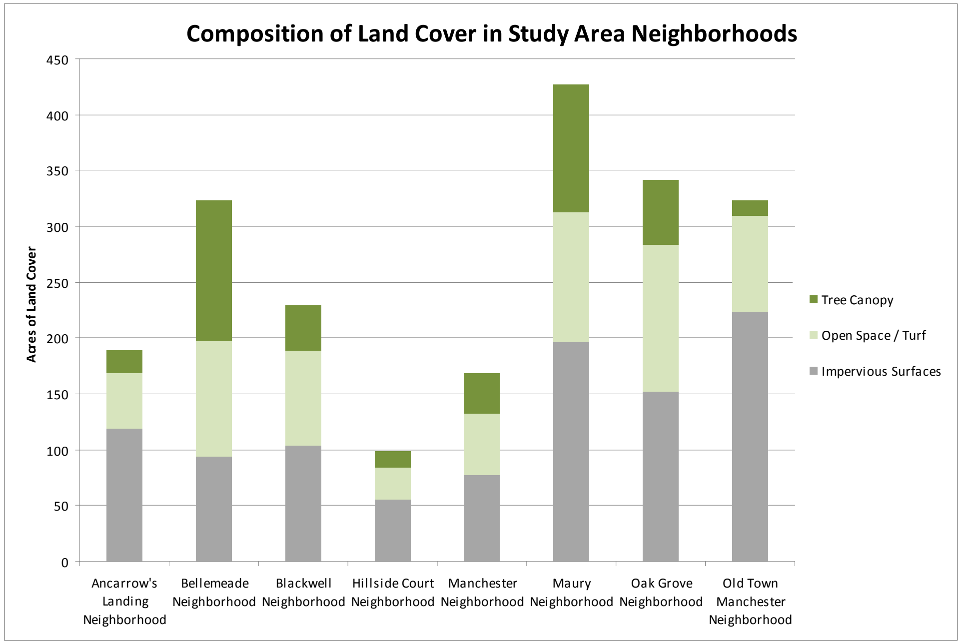
Nearly two-thirds of the study area is composed of impervious surfaces. Impervious surfaces do not allow stormwater to permeate into the ground; and therefore, stormwater runoff generated by new or redeveloped property requires special treatment in accordance with the City's Chesapeake Bay regulations. A quarter of the land area in the study area is in open space and grass/turf. The remainder of land in the study area

The composition of the neighborhoods that form the study area vary, however, impervious surfaces are a majority of all but one neighborhood's land cover. The Bellemeade neighborhood followed by the Maury neighborhood has the most tree canopy land cover. Old Town Manchester has the lowest percentage of tree canopy; not surprising given its industrial past and present uses.



Analysis performed by CITYgreen software

Impervious, unkempt lot located on Jefferson Davis Highway



Analysis performed by CITYgreen software

Table 3

Land Cover							
Neighborhood	Total Acres	Tree Canopy	Tree Canopy Percentage	Open Space / Turf	Open Space / Turf Percentage	Impervious Surfaces	Impervious Surfaces Percentage
Ancarrow's Landing Neighborhood[1]	189	20	10.7%	50	26.4%	119	62.9%
Bellemeade Neighborhood	323	125	38.7%	104	32.1%	94	29.2%
Blackwell Neighborhood	229	40	17.4%	85	37.3%	104	45.3%
Hillside Court	99	14	14.5%	29	29.8%	55	55.7%
Manchester Neighborhood	168	36	21.3%	54	32.4%	78	46.3%
Maury Neighborhood[2]	427	114	26.6%	117	27.3%	196	45.9%
Oak Grove Neighborhood	341	57	16.8%	132	38.7%	152	44.4%
Old Town Manchester Neighborhood	326	14	4.2%	86	26.3%	224	68.7%
Entire Study Area	2,099	420	20.0%	657	24.8%	1,022	48.6%

1 - Ancarrow's Landing also includes a portion of the Windsor neighborhood.
2 - Maury also includes portions of the Cofer and Broad Rock Industrial Park neighborhoods.
*Land Area is in Acres
Analysis performed by CITYgreen software


Manchester Neighborhood: Vacant lots on Bainbridge Street between 12th and 13th Streets

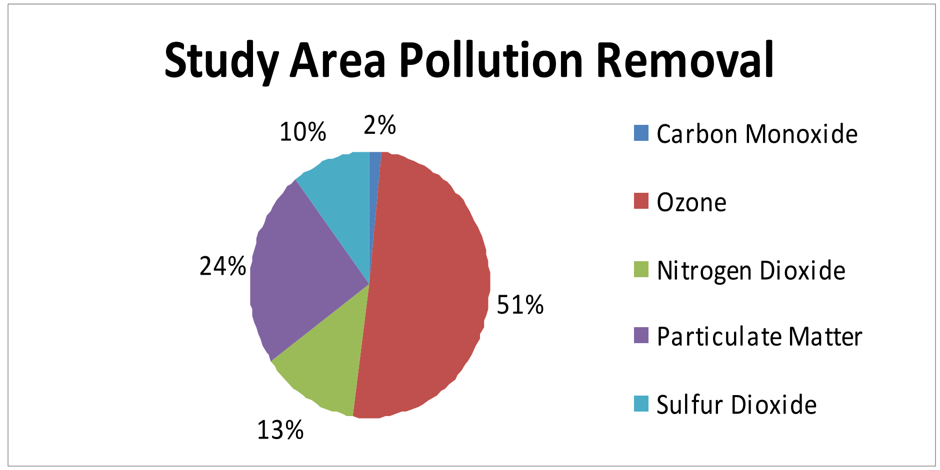

Oak Grove Neighborhood: Residential intersection at 18th and Bruce Streets


Blackwell Neighorbhood: New Construction on 13th Street north of Stockton Street

Analysis Measures

CITYgreen utilizes four different analysis measures:

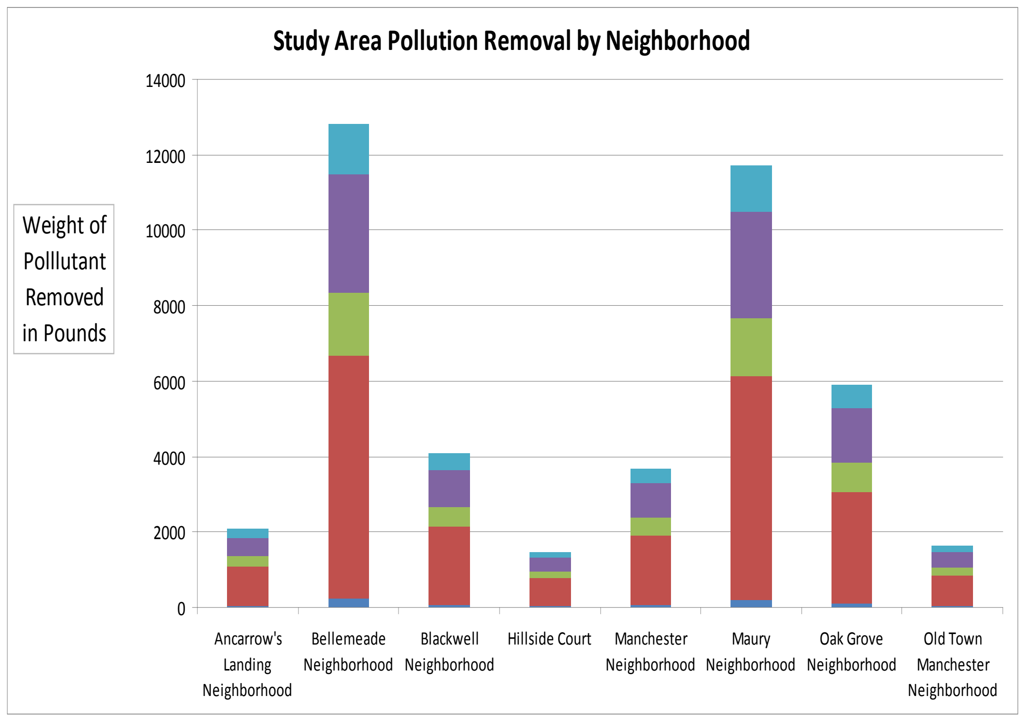
- Air Pollution Removal
- Carbon Storage & Sequestration
- Stormwater Quality
- Stormwater Quantity



Analysis performed by CITYgreen software

Measure 1: Air Pollution Removal

CITYgreen calculates the air pollution removal capabilities of trees in the study area. The calculation for weight of pollutant removed per year is based on the UFORE model, a model developed by the US Forest Service using data gathered from studies measuring the air pollution removal effects of trees in 55 cities across the United States. The calculation for the dollar value of the removal of the pollutants are based on the value of avoided costs caused by pollution, for example, increased public health care costs and reduced tourism revenue. The costs used in the UFORE model analysis are established by the Virginia State Corporation Commission.



The trees in the study area remove 43,357 pounds of the components that make up air pollution each year; that action has an economic value of approximately $126,413. Ozone is the largest component of air pollution removed by the green infrastructure in the study area. Specifically, the green infrastructure in the study area removes 21,867 pounds of ozone each year; that removal equals a dollar value of $77,257.

The neighborhoods that have the highest annual air pollution removal values are those with the largest percentage of tree canopy, for example the Bellemeade and Maury neighborhoods.

Measure 2: Carbon Storage & Sequestration

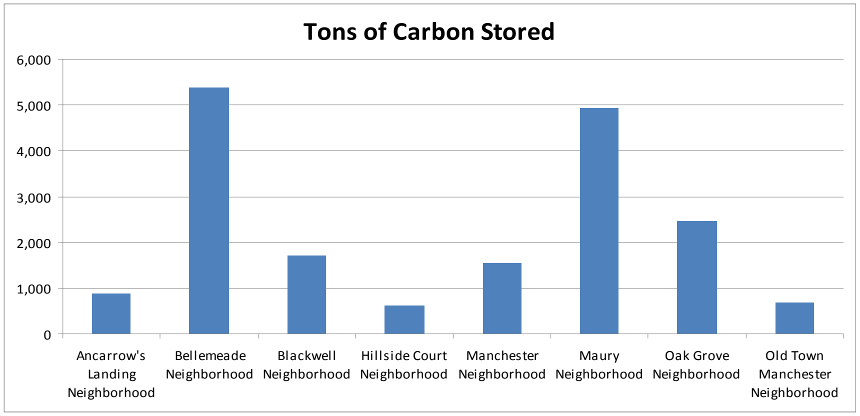
Trees and other plants use carbon dioxide (CO_2) as an input for the process of photosynthesis through which they produce sugars and oxygen. The oxygen (O_2) is released into the atmosphere as a waste product while the sugars act as food for the plant. Trees and plants naturally store carbon in their plant structures as sugars are used to form new growth. The tree canopy in the study area currently stores approximately 18,200 tons of carbon. Each year, the present tree canopy stores an additional 142 tons of carbon.

Table 4

Carbon Storage & Sequestration		
Neighborhood	Tons Stored (Total)	Tons Sequestered (Annually)
Ancarrow's Landing Neighborhood[1]	867	7
Bellemeade Neighborhood	5,377	42
Blackwell Neighborhood	1,714	13
Hillside Court	617	5
Manchester Neighborhood	1,540	12
Maury Neighborhood[2]	4,923	38
Oak Grove Neighborhood	2,473	19
Old Town Manchester Neighborhood	690	5
Entire Study Area	18,200	142

1 - Ancarrow's Landing also include a portion of the Windsor neighborhood.
2 - Maury also includes portions of the Cofer and Broad Rock Industrial Park neighborhoods.
Analysis performed by CITYgreen software

Volume comparison of 1 ton of carbon dioxide
Source: *http://carbonquilt.org/about/carbon*

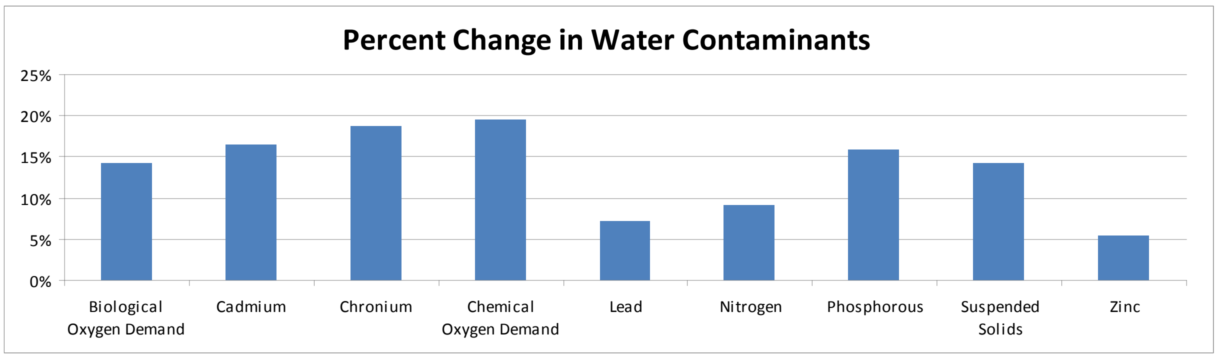


Analysis performed by CITYgreen software

Measure 3: Stormwater – Quality

The study area drains directly into the James River, Goode Creek, and Broad Rock Creek. According to the Virginia Department of Environmental Quality 2008 305(b)/303(d) Water Quality Assessment Integrated Report, the waters that flow along the study area and directly downstream from it are considered impaired due to the levels of certain pollutants and pollutant indicators found in the water and inhabiting wildlife. Waters into which the study area directly drains are considered impaired for recreational purposes, fish consumption, and aquatic life use due to E. Coli bacteria, PCBs found in fish tissue, Chlorophyll-A, and low levels of submerged aquatic vegetation. PCBs, or Polychlorinated Biphenyls, were used in many industrial and commercial applications before they were banned in 1979. PCBs can still be released into the environment through illegal dumping of PCB wastes, leaks or releases from electrical transformers containing PCBs, and disposal of PCB-containing consumer products into landfills not designed to handle hazardous wastes; once in the environment, PCBs do not readily break down. PCBs cause cancer and have adverse effects on the immune system, reproductive system, nervous system, and endocrine system. These water quality impairments are heavily affected by the nutrient pollution which is not filtered out before entering the water bodies.

Tree canopy in the study area helps protect water quality in the James River. If the tree canopy in the study area were completely removed, there would be a marked change in various indicators of water quality. The percentage change in water quality included in the chart and table below is determined by comparing stormwater pollution contamination with the existing tree canopy on the ground to what the stormwater contamination would if all the trees were replaced by impervious surfaces.



Analysis performed by CITYgreen software

The contaminant loading in certain neighborhoods could increase by nearly 50%. The most noticeable increase is in the Bellemeade neighborhood where chromium could increase by approximately 43%, cadmium could increase by approximately 37% and phosphorous could increase by more than 35%.

Table 5

Percentage Change in Contaminant Loading									
Neighborhood	Biological Oxygen Demand	Cadmium	Chronium	Chemical Oxygen Demand	Lead	Nitrogen	Phosphorous	Suspended Solids	Zinc
Ancarrow's Landing Neighborhood[1]	6.8%	7.8%	8.8%	9.0%	3.6%	4.5%	7.5%	6.8%	2.8%
Bellemeade Neighborhood	31.4%	37.1%	43.4%	45.4%	14.7%	19.0%	35.2%	31.1%	10.9%
Blackwell Neighborhood	12.4%	14.4%	16.4%	17.0%	6.2%	7.9%	13.7%	12.3%	4.7%
Hillside Court	9.7%	11.1%	12.6%	13.0%	5.0%	6.3%	10.6%	9.6%	3.8%
Manchester Neighborhood	15.2%	17.5%	20.0%	20.8%	7.6%	9.6%	16.7%	15.0%	5.7%
Maury Neighborhood[2]	20.3%	23.6%	27.1%	28.2%	10.1%	12.8%	22.5%	20.2%	7.6%
Oak Grove Neighborhood	12.1%	14.0%	16.0%	16.6%	6.0%	7.7%	13.3%	12.0%	4.5%
Old Town Manchester Neighborhood	3.0%	3.4%	3.8%	4.0%	1.6%	2.0%	3.3%	3.0%	1.3%
Entire Study Area	14.3%	16.5%	18.8%	19.5%	7.2%	9.1%	15.8%	14.2%	5.5%

1 - Ancarrow's Landing also include a portion of the Windsor neighborhood.

2 - Maury also includes portions of the Cofer and Broad Rock Industrial Park neighborhoods.

Analysis performed by CITYgreen software

Newly renovated Manchester Courthouse plaza reflects sensitivity to enhancing open space with landscape and pedestrian features

Historic house in the 1100 block of Bainbridge Street illustrates retention of mature trees within historic fabric

9th and Hull Street intersection demonstrates initial effort to add street trees, although canopy trees should be selected for pedestrian comfort at bus stops

Measure 4: Stormwater – Quantity

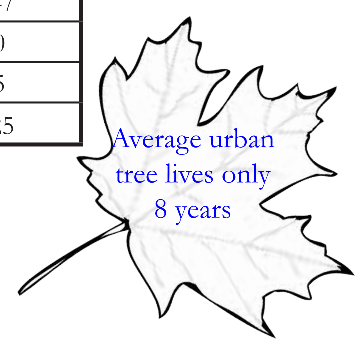
Stormwater can become a problem in urban areas where rainfall runs off repidly and causes higher stream flows that carry contaminants such as oil and grease into waterways. Replacing paved and barren areas with natural land cover, such as trees, can help to mitigate runoff pollution and help to avoid the need for far more expensive, engineered stormwater structures to contain urban runoff. By reducing urban runoff, the City can help contribute to the health of the James River and the Chesapeake Bay.

The CITYgreen software determines the value of trees as they relate to stormwater management by a comparison of scenarios. The dollar values in the following table reflect the additional costs that the City of Richmond would have to assume if the tree canopy in the study area were replaced with impervious surfaces. Through this method, the model estimates the value of the tree canopy related to stormwater management of flow quantity. The City of Richmond would need to spend an additional estimate of $6,035,525 to manage the stormwater from the average 2-year, 24 hour storm event if all trees were removed from the study area. The two neighborhoods with the most valuable tree canopy for stormwater management are the Maury neighborhood and the Bellemeade neighborhood; the tree canopy in each of these neighborhoods is worth over $1,600,000 in total cost savings to the City in stormwater management.

Table 6

Stormwater Quantity				
Neighborhood	2 year, 24 hour rainfall in inches	Additional Cu. Ft. Storage Needed	Construction Cost per cu. ft.	Total Stormwater Value
Ancarrow's Landing Neighborhood[1]	3.3	150,901	$2	$301,802
Bellemeade Neighborhood	3.3	832,157	$2	$1,664,314
Blackwell Neighborhood	3.3	275,073	$2	$550,146
Hillside Court Neighborhood	3.3	104,178	$2	$208,357
Manchester Neighborhood	3.3	251,022	$2	$502,044
Maury Neighborhood[2]	3.3	831,574	$2	$1,663,147
Oak Grove Neighborhood	3.3	394,660	$2	$789,320
Old Town Manchester Neighborhood	3.3	122,332	$2	$244,665
Entire Study Area	3.3	3,017,763	$2	$6,035,525

Analysis performed by CITYgreen software



Alternative Tree Canopy Scenarios

Having established the current benefits that tree canopy provide in the study area, it is worthwhile to investigate what additional benefits are possible with an increase in tree canopy. The following scenarios are based on actual examples of urban tree canopy or expert recommendations.

Scenario A: American Forests: Urban Residential Areas Tree Canopy Recommendation – Tree Canopy 25%

The tree canopy percentage of land cover in the study area was altered to reflect the American Forest recommendation of tree canopy in urban residential areas. Tree canopy was increased from 20% to 25% of total land cover. The percentages for the remaining land cover types were altered. Impervious surfaces were increased from 48.6% to 52.8%; open space/turf was decreased from 31.3% to 22.2%.

Scenario B: Cities Nationwide Average – Tree Canopy 33%

The tree canopy percentage of land cover in the study area was altered to reflect the average percentage of tree canopy in cities nationwide. Tree canopy was increased from 20% to 33% of total land cover. The percentages for the remaining land cover types were altered proportionately. Impervious surfaces were decreased from 48.6% to 47.2%; open space/turf was decreased from 31.3% to 19.8%.

Scenario C: American Forests: Metropolitan Areas East of the Mississippi, Average over all land uses – Tree Canopy 40%

The tree canopy percentage of land cover in the study area was altered to reflect the ideal standard of tree canopy as determined by American Forests for metropolitan areas east of the Mississippi River over all land uses in a city. This is a fairly high goal for the study area, but relevant as a comparison tool for this analysis. Tree canopy was increased from 20% to 40% of total land cover. The percentages for the remaining land cover types were altered proportionately. Impervious surfaces were decreased from 48.6% to 42.2%; open space/turf was decreased from 31.3% to 17.8%.

Tricycle Garden's urban farm located at 9th & Bainbridge Streets illustrates return of vacant parcels for productive use

Measure 1: Air Pollution Removal

Since all the basic land cover change scenarios increase the total area and percentage of the land area with tree canopy, each scenario increases the annual air pollution removal rate of the study area. The increases vary from 24% more air pollution removed in the Scenario A to 99% more air pollution removed in Scenario C.

Table 7

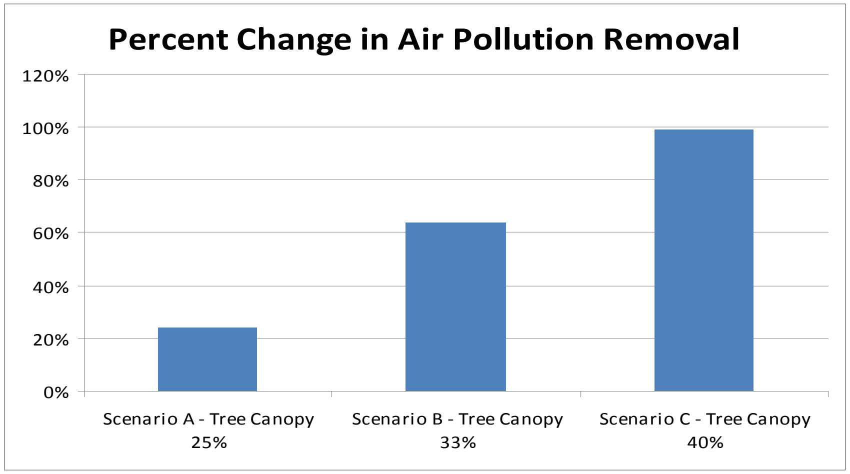
Scenario Change in Annual Air Pollution Removal												
	Carbon Monoxide		Ozone		Nitrogen Dioxide		Particulate Matter		Sulfur Dioxide		Total	
Scenario	Pounds	Dollar Value*	Pounds	Dollar Value*	Pounds	Dollar Value*	Pounds	Dollar Value*	Pounds	Dollar Value*	Pounds	Dollar Value*
Existing - Tree Canopy 20%	754	**$370**	21,867	**$77,257**	5,655	**$19,980**	10,556	**$24,901**	4,524	**$3,905**	43,357	**$126,413**
Scenario A - Tree Canopy 25%	937	**$460**	27,170	**$95,995**	7,027	**$24,826**	13,117	**$30,940**	5,621	**$4,852**	53,872	**$157,072**
Sceanrio B - Tree Canopy 33%	1,237	**$607**	35,865	**$126,713**	9,275	**$32,771**	17,314	**$40,841**	7,420	**$6,404**	71,112	**$207,336**
Scenario C - Tree Canopy 40%	1,499	**$736**	43,473	**$153,591**	11,243	**$39,722**	20,987	**$49,505**	8,994	**$7,762**	86,196	**$251,316**

*This represents a savings of $2.91 per pound of pollutant removed for each scenario including existing conditions.
Analysis performed by CITYgreen software

Table 8

Scenario Percent Change in Air Pollution Removal	
Scenario	Total
Scenario A - (25%)	24%
Scenario B - (33%)	64%
Scenario C - (40%)	99%

Analysis performed by CITYgreen software



Analysis performed by CITYgreen software

Measure 2: Carbon Storage & Sequestration

The percent increases for each scenario are replicated in the increase seen in carbon storage and sequestration in the study area with each scenario. The increase in tons of carbon stored ranges from an additional 4,414 tons with Scenario A to an additional 17,982 tons in Scenario C.

Table 9

Change in Carbon Storage and Sequestration					
	Carbon Storage		Carbon Sequestration		
Scenario	Tons Stored (Total)	Numerical Increase (Tons Stored)	Tons Sequestered (Annually)	Numercial Increase (Tons Sequestered)	Percent Increase
Existing - (20%)	18,200	0	142	0	0%
Scenario A - (25%)	22,614	4,414	176	34	24%
Scenario B - (33%)	29,850	11,650	232	90	63%
Scenario C - (40%)	36,182	17,982	282	140	99%

Analysis performed by CITYgreen software

Measure 3: Stormwater Management – Quality

As stated earlier, the study area drains directly into waters that are considered pollutant impaired by the Virginia Department of Environmental Quality. CITYgreen can be used to predict changes in pollutant loads based on future changes in land cover.

The CITYgreen software used scenario comparison to determine the ability of trees in the study area to mitigate pollution associated with stormwater run off. The existing scenario with tree canopy at 20% was compared to a scenario in which all trees were removed and replaced with impervious surfaces. For the other scenarios listed below, the new tree canopy amount was compared to the existing tree canopy amount of 20%. Therefore, values listed in the table are relative to values for existing tree cover. By altering the land cover in the study area according to the scenarios, the predicted water quality impacts would result.

Highlights of potential impacts include nitrogen and phosphorous reductions in the double-digits for Scenarios B and C; and a reduction of suspended solids of up to 15%. The potential reductions of the heavy metals lead, cadmium, and chromium are particularly noteworthy given the industrial nature of the study area and occurrence of these metals in activities associated with industrial land uses: tire wear, lubricating oil and greases, brake emissions, engine parts, batteries and coolants. Reductions in biological oxygen demand are idicative of potential to improve stream health. Biological oxygen demand (BOD) refers to the amount of oxygen consumed by micro-organisms decomposing organic matter. The greater the BOD, the less the oxygen that is available to higher forms of aquatic life.

Table 10

Scenario Change in Stormwater Quality									
Scenario	Biological Oxygen Demand	Cadmium	Chronium	Chemical Oxygen Demand	Lead	Nitrogen	Phosphorous	Suspended Solids	Zinc
No Trees	14.3%	16.5%	18.8%	19.5%	7.2%	9.1%	15.8%	14.2%	5.5%
Existing - Tree Canopy 20%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Scenario A - Tree Canopy 25%	-5.9%	-6.8%	-7.8%	-8.1%	-3.0%	-3.8%	-6.5%	-5.8%	-2.2%
Scenario B - Tree Canopy 33%	-11.2%	-12.9%	-14.8%	-15.3%	-5.7%	-7.2%	-12.4%	-11.1%	-4.3%
Scenario C - Tree Canopy 40%	-16.0%	-18.4%	-21.0%	-21.8%	-8.1%	-10.2%	-17.6%	-15.8%	-6.1%

Analysis performed by CITYgreen software

Measure 4: Stormwater Management – Quantity

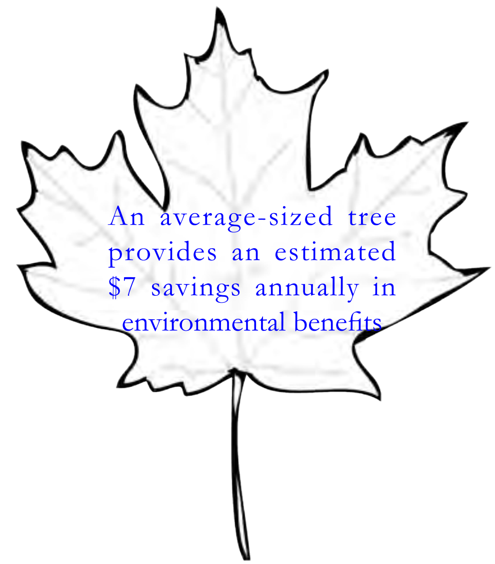
The CITYGreen software uses scenario comparison to determine the value of trees in the study area as they relate to stormwater management. The existing scenario with tree canopy at 20% was compared to a scenario in which all trees were removed and replaced with impervious surfaces. For the other scenarios listed below, the new tree canopy amount was compared to the existing tree canopy amount of 20%. Therefore, values listed in the table are relative to values for existing tree cover. For example, the results for Scenario A in which tree canopy is increased from 20% of land area to 25% of land area indicate that the City of Richmond would reap savings over existing expenditures as a result of the reduction of necessary stormwater treatment capacity required to adequately serve the study area. This increase in tree canopy would account for a reduction of 1,135,268 cubic feet of stormwater run-off which would result in a potential total savings to the City of $2,270,536.

All of the basic land change scenarios result in an allowable reduction of stormwater treatment facility capacity. The analysis predicts that this allowable reduction in stormwater facilities could equate to a potential savings of up to $5.88 million if the study area attained 40% land cover of tree canopy. The annual stormwater savings ranges from $197,956 to $512,785.

Table 11

Scenario Change in Stormwater Quantity			
Scenario	2 year, 24 hour rainfall in inches	Additional Cu. Ft. Storage Needed	Total Stormwater Value of Trees Relative to Existing Conditions
No Trees	3.3	30,717,763	-$6,035,525
Existing - (20%)	3.3	0	$0
Scenario A - (25%)	3.3	-1,135,268	$2,270,536
Scenario B - (33%)	3.3	-2,110,779	$4,221,558
Scenario C - (40%)	3.3	-2,940,801	$5,881,603

Analysis performed by CITYgreen software



Conclusion

The study area has tree canopy coverage over 20% of its land area. Given the intensely developed, urban nature of the study area, this tree canopy coverage is understandable. However, there is room for improvement in increasing tree canopy coverage. The City of Richmond could reap not only aesthetic benefits from this increased tree canopy, but additional environmental and economic benefits as the CITYgreen analysis illustrates. Benefits, both economic and environmental, from increased green infrastructure would accrue to the City most notably through stormwater management, quantity and quality. The savings in reduced demand for stormwater gray infrastructure could potentially save the City from $197,000 to over $500,000 per year. The reduced quantity of stormwater flow could also reduce the combined sewer overflow events into the James River, which would improve water quality in the river and downstream in the Chesapeake Bay. Similarly, the natural treatment and removal of contaminants of stormwater over land as it flows to the River would also improve water quality. Implementing green infrastructure could result in a reduction of BOD, Nitrogen, or Phosphorus of 3 percent to 21 percent below existing conditions.

In the final section of this report we explore ways that other cities have enhanced their tree canopy and green infrastructure network. There are recommendations that could be utilized in the study area, and throughout the entire City, to literally grow the benefits associated with green infrastructure from the aesthetic to the environmental to the economic.

Street tree coverage along Hull Street looking toward Cowardin Avenue

Lack of tree coverage along Commerce Road looking north toward downtown

Opportunities given wider sidewalks for street tree planting on Porter Street

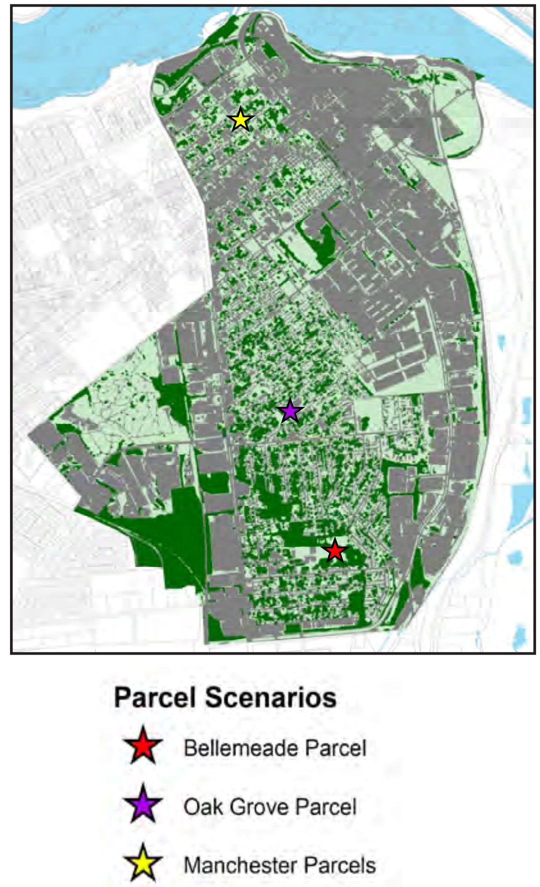
Alternative Parcel Development Scenarios

The CITYgreen software can also be used to analyze the impacts of different land use, landscaping, and site design decisions at a parcel scale. The Green Infrastructure Assessment project team compiled a list of parcels identified as representative for analysis. Criteria factored into the decision included: existing land use, future land use, likelihood of redevelopment in the future, and proximity to existing green infrastructure assets.

A wider variety of land cover types was used for the parcel-based analysis scenarios that follow the analysis of the study area as a whole. Land cover types such as pavement, buildings, etc. appropriate for each parcel are considered. The land cover types used are sourced from the urban tree canopy analysis and were verified using the 2008 NAIP imagery used for the DOF tree canopy analysis.

Table 12

Study Area Parcels for Analysis				
Neighborhood	Location	Acreage	Key Features	Owner
Bellemeade	East of Bellemeade School and Community Center	7.5	open fields on both sides of a stream corridor	City of Richmond
Oak Grove	Current Oak Grove Elementary School site	5	building soon to be demolished and replaced with new construction	City of Richmond
Manchester	City block bounded by Perry Street, Porter Street, 12th Street, and 11th Street	0.4	all but two lots are undeveloped, block included in the Downtown Master Plan as incorporating new development and a small neighborhood park	Richmond Redevelopment and Housing Authority



Bellemeade Parcel Analysis

The 7.5 acre Bellemeade parcel is just east of the Bellemeade Elementary School and Community Center; it is owned by the City of Richmond. The parcel is split by the Bellemeade tributary stream which flows into Goodes Creek and eventually to the James River. The site currently has a landscape of forests and open fields. The parcel is zoned R-5: Single Family Residential. Buildable lots in the R-5 zoning district can be no less than 6,000 square feet or 50 feet in width. In addition, the maximum lot coverage allowed for main buildings and accessory structures is 35%. A series of development scenarios for this parcel was created for analysis with CITYgreen software. The existing conditions of the parcel and the zoning district constraints informed the scenarios. The land cover analysis reveals the parcel is mostly grass meadow and slightly less than one third forested.

Table 13

Existing Conditions	
Land Cover	Percent of Area
Grass Meadow	67.6%
Trees	32.3%

As a first step to developing scenarios, PDC staff determined how a full build-out of the parcel would appear. The parcel was assumed to be developed with the maximum number of single family homes possible at a high 75% land cover ratio, excluding site infrastructure and utility easements. The developable area was divided by the minimum parcel size to determine a maximum yield of 40 dwelling lots. Assuming the primary and accessory structures on each lot would occupy 35% of the lot, or approximately 2,143 square feet of impervious surface, a total of 85,750 square feet of impervious structure area over the entire parcel (26.25%) resulted as the highest possible development scenario for the parcel.

Scenario A: Full Build-Out, Few Trees

This scenario assumes the parcel is fully developed with 40 residential lots. These residential lots have a small amount of tree canopy; existing tree canopy on the entire parcel is reduced by slightly more than half. The residential lots are principally lawn represented by the large percentage of total area identified as turf or meadow. A portion of the lot area is committed to impervious area, consisting of streets, sidewalks, driveways, and walkways.

Bellemeade parcel isoutlined in red above. A transparent land cover layer is over the parcel.

Scenario B: Full Build-Out, More Trees

This scenario assumes the parcel is fully developed with 40 residential lots, but with a greater amount of tree canopy than Scenario A; existing tree canopy is only slightly reduced. The residential lots also have a smaller lawn and less paved impervious area.

Scenario C: Low Impact Development (LID) Full Build-Out

This scenario assumes the parcel is fully developed with 40 residential lots. The key difference between this scenario and the previous ones is that some homeowners have decided to incorporate low impact development practices such as rain gardens, green roofs or porous pavement on their lots. The lots in this scenario are assumed to have much more tree canopy than Scenario A, but with the same tree canopy as Scenario B.

Scenario D: LID with Common Open Space

This scenario assumes a more conservation oriented site design incorporating a neighborhood park or common area in the development. The parcel is subdivided into 30 residential lots, with fewer homes, same tree canopy, and a greater use of LID practices over the total acreage.

Scenario E: Twice the Tree Canopy

This scenario assumes no residential development on the parcel. Instead, the area of the parcel devoted to tree canopy has been doubled. The purpose of this scenario is to illustrate the significant impact greater tree canopy can have on a relatively small parcel of 7.5 acres.

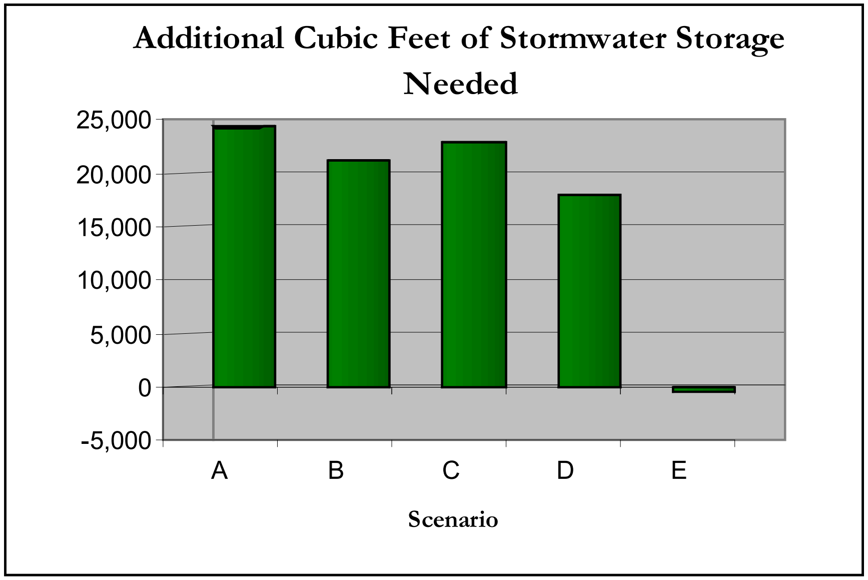
Table 14

Bellemeade Parcel Land Cover Scenarios					
	Land Cover Percentage				
Scenario	Trees	Grass Meadow	Buildings	Paved	LID
A: Full Build-Out, Few Trees	15%	34%	26%	25%	0%
B: Full Build-Out, More Trees	30%	23%	26%	21%	0%
C: LID Full Build-Out	30%	19%	26%	20%	5%
D: LID Common Open Space	33%	23%	19%	15%	10%
E: Twice the Canopy	64.6%	35.4%	0%	0%	0%

Bellemeade Parcel Analysis Conclusions

Scenario E in which the parcel's tree canopy coverage is doubled, provides the greatest benefit in all measures studied through the CITYgreen software. All the remaining scenarios involve the construction of structures and a resulting increase of impervious area. Given these similarities, the questions become: which scenario has the most positive impact on the performance measures in question, and how?

Scenarios A and B provide an indication of the impact of increased tree canopy on a fully built-out, single family residential neighborhood. Scenarios C and D bring low impact development techniques into consideration.



In general, Scenario A had the smallest impact on improving air quality through air pollution removal and carbon sequestration. Scenarios B and C provide similar impacts on improving air quality since these two scenarios have the same amount of tree canopy coverage over the parcel. Scenario D provides a better impact on improving air quality as it has the largest amount of tree canopy coverage of the scenarios with development.

The ability of trees to mitigate the negative impacts of urban land development on stormwater quality and quantity also becomes evident through the parcel scenarios. Similarly, the ability of low impact development techniques to improve stormwater quality and quantity is illustrated through the scenarios.

Scenario C which adds tree canopy and LID techniques allows for a reduction of more than 1,300 cubic feet (or almost 6%) of required stormwater treatment capacity. As Scenario D illustrates, even larger impacts can be realized from increased canopy and LID practices. These results suggest that small changes in tree canopy coverage and development techniques applied City-wide could make a significant difference. Achieving balance in translating these considerations into ordinance or site plan standards without adding to the initial construction costs and reducing the economic yield from a project is the challenge. Some examples from other cities are suggested in the final "Best Practices" section at the end of this report.

Oak Grove Parcel Analysis

The second parcel chosen for CITYgreen analysis is located in the Oak Grove neighborhood. The five (5) acre parcel is the current site of the Oak Grove Elementary School. Richmond City Public Schools plans to consolidate Oak Grove Elementary School with Bellemeade Elementary School, leaving the Oak Grove Elementary School vacant.

The City of Richmond's current Master Plan depicts the parcel as being designated for public and open space uses. Currently the parcel is zoned R-5: Single Family Residential District. A series of development scenarios for this parcel was created for analysis. The existing conditions of the parcel, its intended future land use, and the current zoning informed the scenarios. Currently, a land cover analysis reveals that the parcel is mostly grass meadow, with a notable distribution of trees and nearly one-third impervious cover.

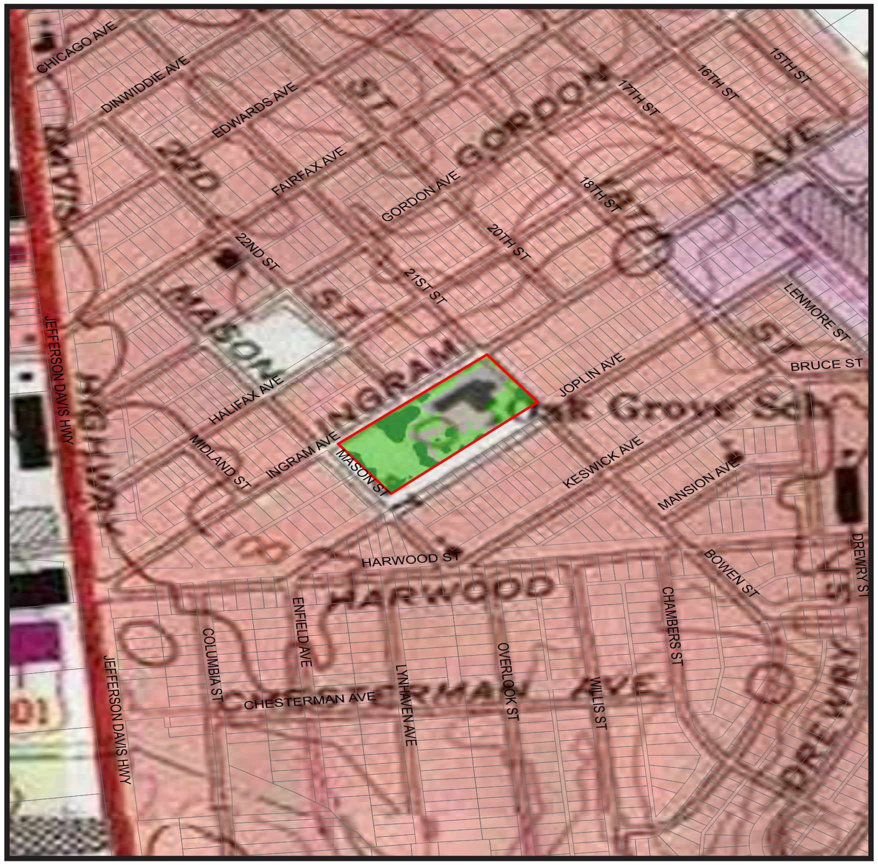
Table 15

Existing Conditions	
Land Cover	Percent of Area
Grass Meadow	50.2%
Trees	17.3%
Paved	20.1%
Buildings	12.4%

In a similar manner to the first parcel analyzed using CITYgreen, PDC staff determined a full residential build-out scenario for the parcel making assumptions based on zoning and site development requirements. The parcel can potentially be subdivided into 26 single family dwelling lots. At a maximum lot coverage of 35%, 57,172.5 square feet of impervious area over the five (5) acres would be attributed to building footprints and related hard surfaces. For scenarios corresponding to the designated future land use of the parcel, it was assumed the existing school structure, or a portion, would remain.

Scenario A: Maintain Structure & Increase Trees, LID

This scenario assumes that the parcel is maintained as a community facility in its current form. Tree canopy is increased throughout the parcel; however, playing fields are also still maintained. As well, low impact development practices are retrofitted around the structure.



The Oak Grove Parcel is highlighted in red above. A transparemt land cover layer is overlaid.

Scenario B: Minimize Structure & Increase Trees, LID

This scenario assumes that the parcel maintains its use a community facility, however, a portion of the existing structure is demolished. Tree canopy is increased across the parcel and LID practices are implemented. Finally, some grass meadow is added to the parcel through increased playing field space.

Scenario C: Build-Out

This scenario assumes that the patcel is fully built-out with 26 residential lots. Tree canopy has been maintained at the original amount present on the parcel before construction. This scenario allows the reader to envision the impacts to water and air quality if the parcel were constructed under current zoning without any special consideration for tree canopy or other environmental qality of life features.

Scenario D: LID Build-Out

This scenario assumes that the parcel is fully built-out with 26 residential lots. Tree canopy has been increased while impervious areas have decreased. LID practices have been followed by some residents. These differences from Scenario C are meant to suggest the potential effects of increased appreciation of trees and low impact development practices by citizens from outreach efforts by the City and community groups.

Scenario E: Park

In this scenario the existing school structure is fully demolished and the parcel is converted into a public park. The park depicted in this scenario would be a demonstration project for sustainable park development. A large percentage of the park would be covered by tree canopy, providing shade to residents while recreating. The notable amount of grass meadow provides ample space for playuing fields. LID practices are spotted throughout the park, for example, pervious pavers or porous pavement replace traditional, impervious pathways.

Table 16

Oak Grove Parcel Land Cover Scenarios					
	Land Cover Percentage				
Scenario	Trees	Grass Meadow	Buildings	Paved	LID
A: Maintain Structure & Increase Trees, LID	35%	27.5%	12.4%	20.1%	5%
B: Minimize Structure & Incresae Trees, LID	42%	33%	8%	15%	2%
C: Build-Out	24.4%	24.4%	26.2%	25%	0%
D: LID Build-Out	35%	18%	24%	13%	10%
E: Park	50%	40%	0%	0%	10%

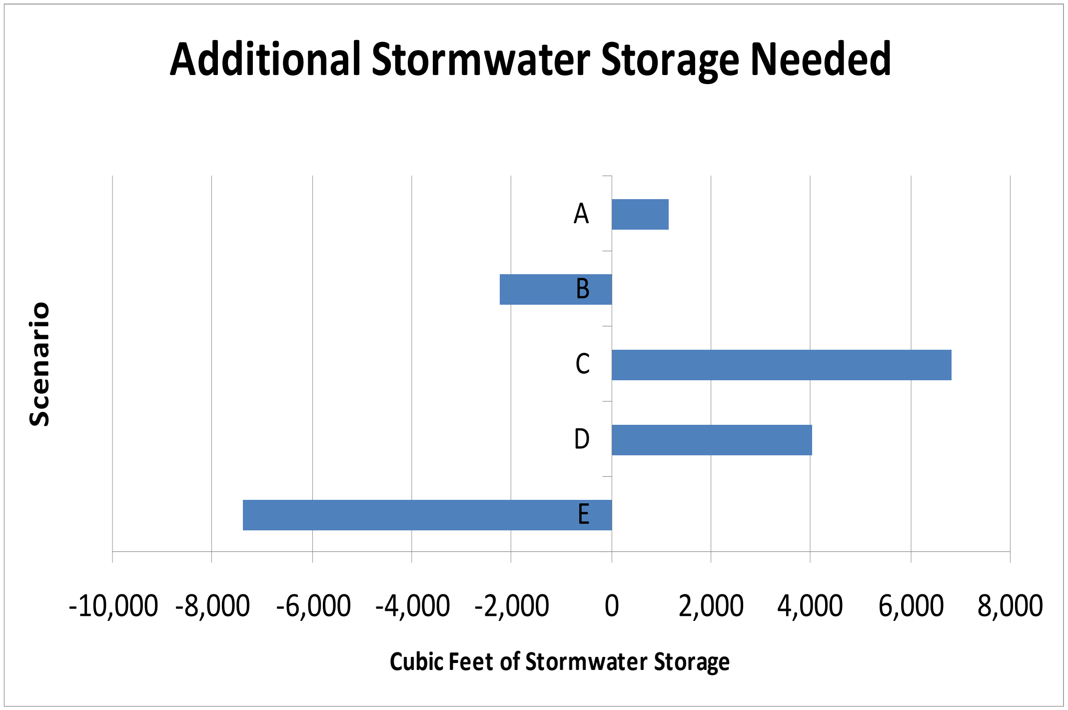
Oak Grove Parcel Analysis Conclusions

As with the Bellemeade parcel, the scenario in which tree canopy is increased and no additional impervious area is developed provides the greatest benefit in all measures studied through the CITYgreen software. For the Oak Grove parcel the park scenario, or Scenario E, provides the greatest benefits. As before, however, the other scenarios provide insight into what the City can expect from other form of redevelopment on the parcel in question.

Scenarios A and B indicate the outcomes of maintaining all or part of the existing school building on the site and incorporating LID techniques and increased tree canopy. Scenarios C and D allow for complete redevelopment of the parcel into a single family residential neighborhood as allowed by current zoning.

Scenario C, Build-Out, had the smallest effect on improving air quality. Scenarios A and D have essentially identical impacts on air pollution removal given the fact that they have the same amount of tree canopy coverage. This similarity in outcomes illustrates that land can be developed in a variety of manners for an array of uses and still maintain similar beneficial impact on air quality. Scenario B performs slightly better in air pollution removal than scenarios A and D given the increased tree canopy and incorporation on LID techniques.

The impacts on air quality are mirrored in the impacts on water quality and stormwater runoff. Other than Scenario E, Scenario B is the only other scenario to reduce both pollutants and quantity of stormwater. Scenario C is likely to produce the greatest negative effects on stormwater. With Scenario C, stormwater runoff is projected to contain approximately 30% more Chronium and Cadmium and 10% more lead. Meanwhile, Scenario C woud likely require an increase in stormwater treatment capacity of almost 7,000 cubic feet at an approximate additional cost to the City of Richmond of more than $13,000.



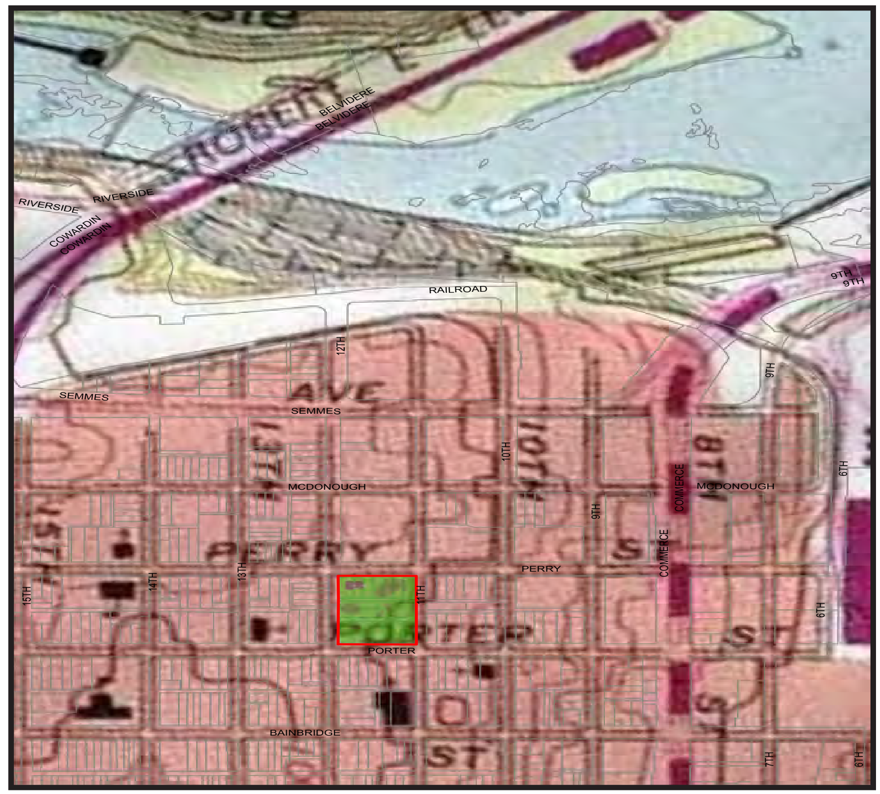
Manchester Parcels Analysis

A total of 354 acres made up of 765 parcels, including the neighborhood of Manchester, was rezoned in 2009. The rezoning instituted zoning categories consistent with the Downtown Master Plan which was approved in 2008. The Manchester parcels are situated on the block surrounded by Perry Street, Porter Street, 11th Street, and 12th Street. The block is depicted in the Downtown Master plan as being three-quarters public park and one-quarter mixed use development. As a result of the rezoning, the parcels are zoned R-8: Urban Residential District.

A series of development scenarios was developed for the parcels reflecting development situations as depicted in the downtown master plan for the subject parcel itself and surrounding parcels. The scenarios include a range of development densities including different combinations of park land and urban residential development. Currently a land cover analysis reveals that the block of parcels is approximately three-fourths grass meadow. The remaining land cover is mostly tree canopy with only two buildings and associated paved area completing the final quarter of the block's land cover.

Table 17

Existing Conditions	
Land Cover	Percent of Area
Grass Meadow	76.3%
Trees	21.0%
Buildings	2.4%
Paved	0.4%



The Manchester parcels are highlighted in red above. A transparent land cover layer is overlaid.

PDC staff determined the parcel development scenarios by looking at surrounding blocks in the Downtown Master Plan. By using thse surrounding blocks to inform the development scenarios for analysis using CITYgreen, it is possible to anticipate the effects on water quality and air quality each of various development patterns as depicted in the Downtown master plan may produce.

Scenario A: Block 3/4 Park

This scenario assumes the block will be developed as depicted in the Downtown Master Plan. Three-quarters of the block is maintained as public park space. The remaining northwest quarter of the block is developed as urban residential.

Scenario B: Block 1/2 Park

This scenario assumes the block is developed similarly to the parcel to the north as depicted in the Downtown Master Plan. The southern portion of the block is developed with urban residential dwellings, while the northern portion of the block is maintained as a small public park.

Scenario C: Block 1/4 Park

Added to this scenario, the southeastern portion of the block is maintained as a small public park area while the remaining portion of the block is developed as urban residential.

Scenario D: Block Fully Developed

This scenario assumes that the block is fully developed with urban residential development and there is no public park land located on the block. This scenario is based on future development as depicted in the Downtown Master Plan for the block to the immediate northwest of the subject block.

Table 18

Manchester Parcels Land Cover Scenarios					
	Land Cover Percentages				
Scenario	Trees	Grass Meadow	Buildings	Paved	LID
A: Block 3/4 Park	40%	48.7%	5.3%	1%	5%
B: Block 1/2 Park	30%	30%	25%	10%	5%
C: Block 1/4 Park	27%	25%	30%	13%	5%
D: Block Fully Developed	21%	19%	37%	18%	5%

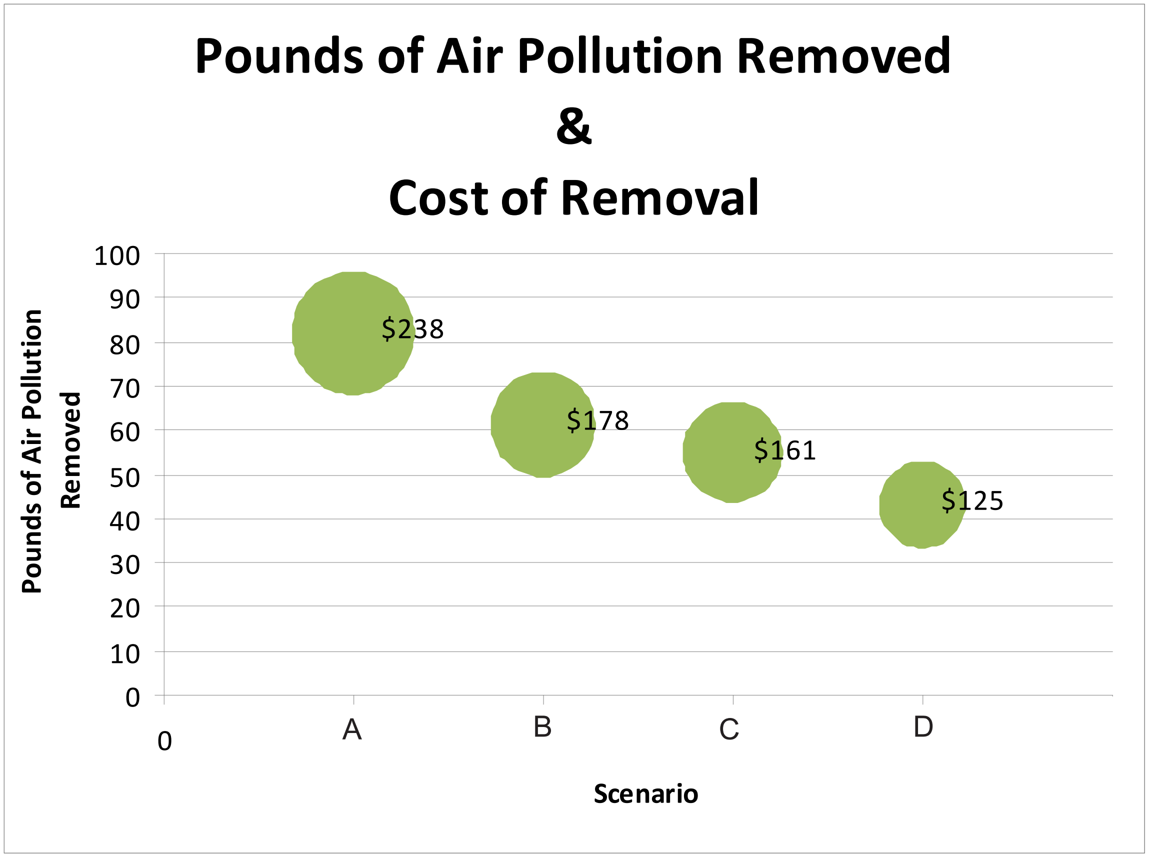
Manchester Parcels Analysis Conclusions

As with the previous two examples, an increase in tree canopy over the subject area results in positive benfits for air and water quality. This set of development scenarios is particluarly important as it allows the City of Richmond to better predict the results of newly adopted future land use planning and zoning changes can have on air and water quality. These scenarios illustrate and quantify the importance of maintianing public park land and healthy tree canopy in denser, urban neighborhoods. Not only do these aspects of urban green infrastructure greatly contribute to quality of life, but they also account for a substantial amount of savings in air pollution mitigation and water quality treatment.

All of the development scenarios analyzed with CITYgreen result in an increase of air pollution and water pollution removal because the tree canopy cover has been increased from existing conditions. The question answered through these scenarios is to what extent does development increase pollution and how can it be mitigated by tree canopy and LID techniques?

Scenario A, with the largest land area maintained as a publ;ic park and with the greatest percent of total area maintained as tree canopy, removes the greatest amount of air pollution and savings is worth the most for that removal. Scenarios B and C are very similar in the amount of air pollution they remove and the cost savings of that removal. This similarity reflects the amount of tree canopy coverage represented in the two scenarios with a difference of only 3%.

The cost of additional stormwater treatment necessary under the scenario changes in land cover from the present result in additional costs ranging from $2,247 for Scenario A to $14,693 for Scenario D. This span of stormwater treatment costs illustrates money-saving value of trees. In this scenario, which represent an urban residential block in the City, for each 1% increase in tree canopy, the stormwater treatment costs are reduced by more than $655.



Best Practices for Green Infrastructure

The simplest way to increase or enhance green infrastructure assets in a community would be to dedicate more land to recreation, parks and open space. If a city is to grown and accommodate a healthy living environment for an expanding population, complete set-aside of open space is often difficult and impractical. The appropriate integration of open space into a development plan however takes into consideration the obvious benefits both aesthetically and environmentally as the CITYgreen analysis of the previous section suggests. The purpose of reviewing Best Practices from a national, state or regional level is to first identify how the City of Richmond compares overall to other similar areas, and second, to look for innovative ways to build in good practices for improving green infrastructure benefits through the incremental development or redevelopment of parcels within the City's boundaries.

National Standards

National Standards provide one way to measure the City's existing land cover relative to other cities as a starting point for analysis and consideration of improvements that will lead to the most effective ways to enhance the environment, reduce stormwater run-off and improve air and water quality.

Urban Tree Canopy

American Forests is a national non-profit conservation organization whose mission is to protect, restore and enhance the natural capital of trees and forests in the United States. They developed the software (CITYgreen) used as an analysis tool in this study, allowing for the analysis of land cover from satellite and aerial imagery, and have established some general urban tree canopy goals based on geographic and climate conditions as well as land use categories which can help communities to establish benchmarks and craft policies for promoting urban forestry priorities to help meet environmental and quality of life goals, including federal and local clean air and water regulations. The opposite table provides recommended tree cover goals for different land use categories.

Table 19

American Forests® Tree Canopy Standards by Land Use*	
Land Use	**Tree Canopy Goal**
Overall	40%
Suburban Residential	50%
Urban Residential	25%
Central Business District	15%

*For those metropolitan areas east of the Mississippi River and in the Pacific Northwest.

God's Garden Community Garden in the 1200 block of Porter Street

Parks and Recreation Standards

The Virginia Outdoors Plan provides level of service guidelines for parkland acreages. These standards, in use in Virginia since 1999, are based on national standards developed by the National Recreation and Parks Association, and recommend the following:

Table 20

National Recreation and Parks Association Standards				
		Service Radius		
Park Type	Acres/1,000 people	Urban/Suburban	Rural	Minimum Size (Acres)
Neighborhood Park	3	2 miles	1-1 ½ miles	5
Playground or Playlot	-	2 miles	-	-
Community Park	3	1 mile	3-7 miles	20
District Park	4	5-7 miles	10-15 miles	50
Regional Park	*	25 miles	25 miles	100
State Park	10	1 hour	50 miles	600

Greenways and Trails

There are no national standards for the number of miles greenways or trails that a community should have. The National Recreation and Park Association, which sets national park space standards and some years ago dispensed with trail standards in part due to significant variability in climate, geography and demand for greenways and trails from one community to another. The City of Richmond's recently completed Parks Recreation and Community Facilities Master Plan does provide the following data with respect to greenways and trails in the City of Richmond:

Table 21

City of Richmond Greenways and Trails	
Total Current Inventory	25.0 miles
Recommended Standard	.2 miles/1,000 persons
Additional trail miles recommended	14 miles

Model City Initiatives

Surveying green infrastructure practices adopted by other US cities is one way to generate ideas for innovative and effective approaches, and may, moreover provide caveats with respect to less than effective measures. The following cities were chosen for study based on their having some similarity to the City of Richmond, either in land area, history, population, climate, geography, political system (independent cities) or based upon their recognized leadership in sustainability planning and implementation.

It is often difficult to determine the full extent of green infrastructure measures in localities because these efforts are undertaken by multiple departments, often without coordination or communication between them. A local Sustainability Office can offer green infrastructure measures, from the largest stormwater management retrofit to the planting of a tree, along with metrics, time frames, responsible departments and staff, and results. Also, some localities may find it beneficial to separate 'green' stormwater expenditures from traditional stormwater expenditures, making cost/benefit assessment easier to calculate. Many green infrastructure practices are new, and as such, economic assessments of their effectiveness and other performance data are, as yet, unavailable. The decentralized nature of green infrastructure practices makes it difficult to measure results. Coordination of these measures will be critical to their future implementation as elected officials typically base funding decisions on the economic cost/benefit ratio of new initiatives.

Best Practice Examples

Table 22

Green Infrastructure Model Cities	Land Area (square miles)	Water Area (square miles)	Total Area (square miles)	2000 Population	Tree Canopy	Year founded	River(s)	Sustainability Ranking *
Arlington County, VA	25.87	0	25.87	189,385	41%	1846	Potomac	**
Baltimore, MD	80.8	11.3	92.1	651,154	27.4%	1729	Patapsco/Chesapeake Bay	10
Lynchburg, VA	49.4	0.4	49.8	65,269	58%	1757	James	**
Pittsburgh, PA	55.5	2.8	58.3	334,563		1758	Allegheny, Monongahela, Ohio	**
Portland, OR	134.3	11.1	145.4	529,121	26.3%	1851	Columbia, Willamette	1
Raleigh, NC ★	142.8	2	144.8	276,093		1792	Neuse	**
Richmond, VA ★	60.1	2.5	62.6	197,790	40.3%	1737	James	**
Roanoke, VA	42.9	0.04	42.9	94,911	32.0%	1852	Roanoke	**
Virginia Beach, VA	248.3	249	497.3	425,257	39.0%	1906	Lynnhaven, Chesapeake Bay	45
Washington, DC	61.4	6.9	68.3	572,055	21.0%	1790	Potomac, Anacostia, Rock Creek	12

* SustainLane 2008, http://bit.ly/zLvG1

** Not listed on SustainLane's Sustainable City Rankings

★State Capitals

Sources: Land Area: *http://www.census.gov/statab/ccdb/cit1010a.txt (Cities with 100,000 or More Population in 2000), http://quickfacts.census.gov/qfd/states/51/5157000.html* Population: *http://www.census.gov/statab/ccdb/cityrank.htm, http://quickfacts.census.gov/qfd/states/24/2404000.html*

Portland, Oregon

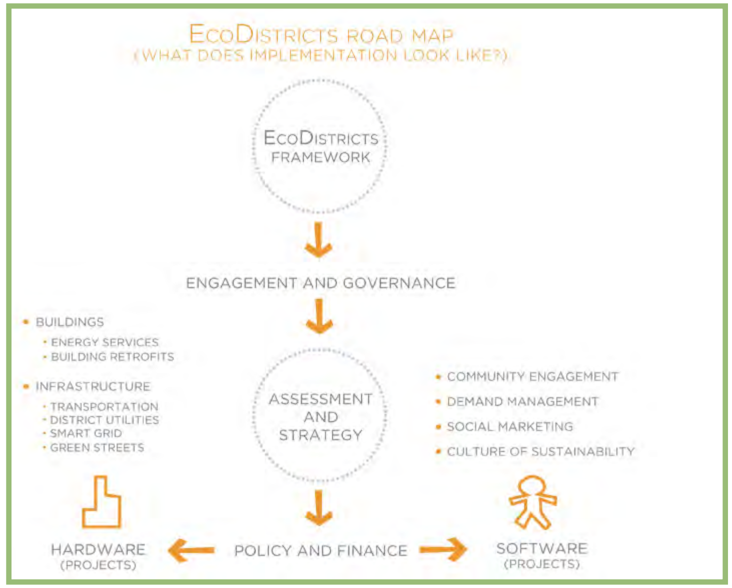
Eco Districts. In Portland's new 'eco-districts', buildings, streetscapes, landscaping, and infrastructure work together to cut greenhouse gases, reduce waste, and improve energy and water efficiency. Part of Portland's Climate Action Plan, Eco-districts look at things in a broader, more systemic way, an approach that includes sharing resources among buildings, including everything from bikes and cars to the heat generated by a computer server room. A crucial element of 'eco districts' is the goal of achieving hydrological equity. Currently, four pilots are planned, with development expected to begin in 2012.

Depave. Depave is a Portland-based non-profit organization which, in partnership with Carfree Portland, has been organizing volunteer work parties to remove thousands of square feet of concrete pavement to reduce stormwater pollution and increase the amount of land available for habitat restoration, urban farming, trees, native vegetation, and beauty; restoring residents' connections to the natural world.

Baltimore, Maryland

Adopt-A-Lot Program. Residents and neighborhood groups are invited to create gardens and generally beautify their communities by adopting one of Baltimore's 10,000 vacant city-owned parcels. Citizens and neighborhood groups enter into a Adopt-A-Lot license agreement with the city to create a community garden, pocket park, flower garden, tree lot, or natural area. As of 2009, 200 such lots had been adopted in Baltimore.

Baltimore Green Space (BGS). City-owned land is sold to BGS, a land trust, which enters into a long-term management agreement with a community partner organization or site manager, who maintain and manage the property. As of the end of 2009, three such 'community-managed open spaces had been protected.



Portland's Eco Districts Roadmap
Source: http://www.pdxinstitute.org/index.php/ecodistricts

Baltimore's Duncan Street Garden, part of the Adopt-A-Lot Program.
Source: http://www.baltimoregreenspace.org/pages/how-neighborhoods-benefit.html

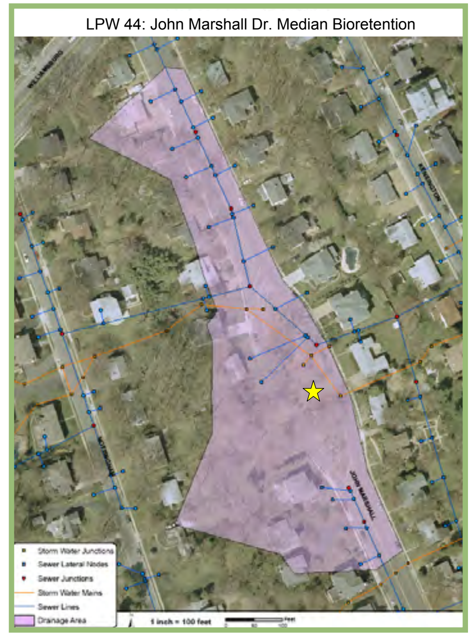
Arlington, Virginia

Watershed Retrofit Studies. Arlington County is working with the Center for Watershed Protection, the premier watershed planning organization in the country, to develop watershed retrofit plans for the watersheds in Arlington County. This effort is part of the County's Stormwater Master Plan update and is intended to create stormwater management facilities where none have existed previously. Objectives of retrofitting watersheds include decreasing peak flows and runoff volumes of stormwater, remove pollutants, alleviate existing drainage problems, provide outdoor learning and community outreach opportunities, create wildlife habitat areas, support existing greenway, trail and stream corridor naturalization efforts and identify potential land acquisition opportunities for new BMPs. Sites for potential retrofit were assessed and ranked based on a selection matrix, included as an appendix to this document.

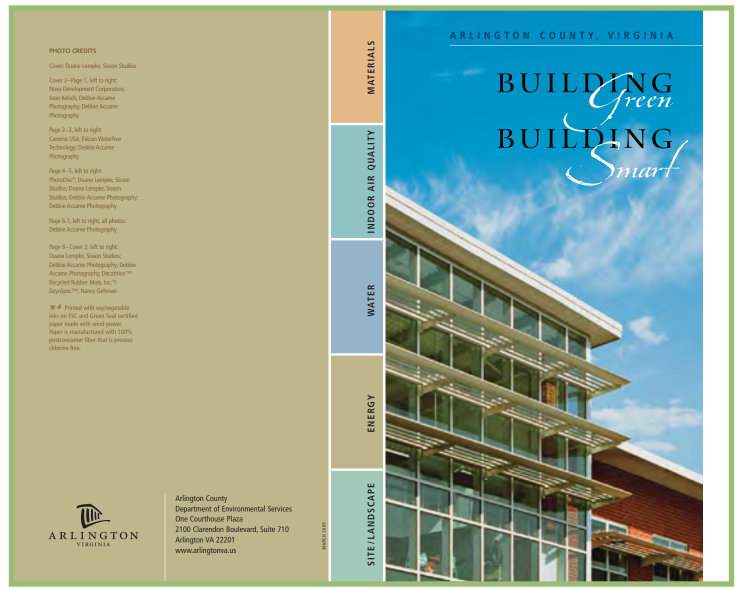
Green Buildings Program. An interdepartmental team of staff from the Department of Environmental Services, the Arlington Economic Development, the Department of Community Planning, Housing and Development, the Office of Support Services, the County Manager's Office and the County Attorney's Office was convened to develop the original policy in 1999.

Through this program all site plan applications are required to include a completed LEED™ scorecard. The scorecard allows the developer to assess the options for including green components in a project. It also allows the County to measure a project's overall performance and to collect data on the environmental status of all site plan buildings in the County. The County offers a density bonus to developers who design green buildings as outlined by the LEED™ rating system. The developer may be granted additional density up to 0.25 floor area ratio (FAR) and/or additional height up to three stories if the project meets the silver LEED™ rating or higher.

Green Building Fund. Developers who do not commit to achieving a LEED rating from the U.S. Green Building Council (USGBC) contribute to this Fund. A builder's contribution is calculated at a rate of $0.045 per square foot, which is based on the fees assessed by the USGBC for registration and evaluation of a formal LEED application. The fund is used to provide education and outreach



John Marshall Dr watershed retrofit proposed to begin construction in the near future.
Source: http://www.co.arlington.va.us/departments/EnvironmentalServices/cpe/documents/file75633.pdf



Arlington County's green building program brochure.
Source: http://www.arlingtonva.us/departments/EnvironmentalServices/epo/PDFfiles/Green_Building.pdf

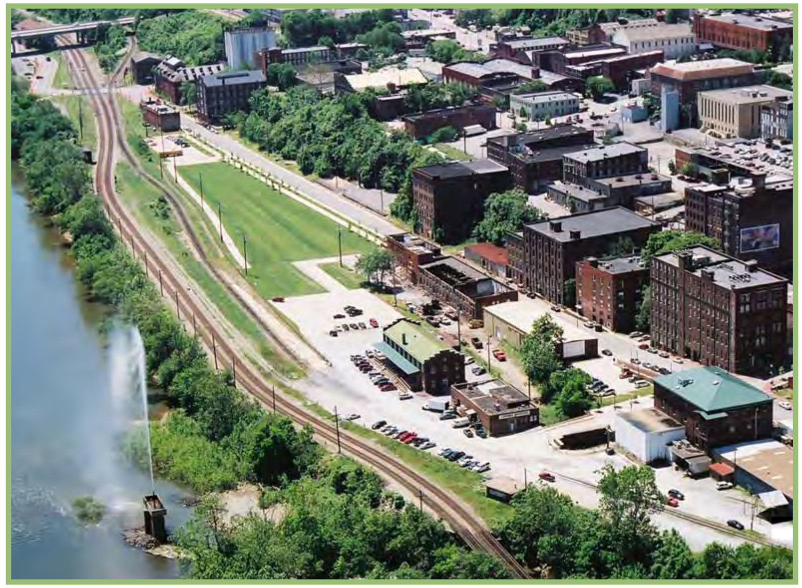
to developers and the community on green building issues. If a project receives LEED certification from the USGBC, the Fund contribution is refunded upon receipt of the final LEED certification

Lynchburg, Virginia

Riverfront Park. The City of Lynchburg has implemented a triple bottom line approach to stormwater management in its downtown area; green infrastructure has been incorporated into a site that covers seven acres. Three acres of parking consists of large-block pavement with oversized joints allowing for infiltration of stormwater into a system of gravel and perforated pipe below the parking. Stormwater is filtered by the system to remove sediment, pollutants, and contaminants before making its way to the James River.

Tree wells in the park are configured to direct stormwater toward the tree roots where it nourishes the trees and is filtered and absorbed by the soil below.

Rain gardens have been installed along Jefferson Street. In addition to providing a beautiful native plant area with trails and wooden footbridges, the rain gardens are underlain with a special soil mix of sand and organic matter that filters and absorbs stormwater. Designed to allow for collection of stormwater ponds of up to six inches during rain events, a system of perforated pipes direct stormwater that is not infiltrated, absorbed or evaporated to the sewer system for treatment and release into the James River.



Lynchburg's revamped Riverfront Park with sustainable modifications
Source: http://www.nbwla.com/portfolio/public_gardens/parks/lynchburg.html

Randolph Macon's new rain garden project part of groundbreaking partnership with City of Lynchburg
http://www.randolphcollege.edu/Images/magazine/2010_1_2/raingarden_1_400.jpg