James River Vulnerability Analysis and Subwatershed Action Plan

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CENTER FOR WATERSHED PROTECTION

JAMES RIVER ASSOCIATION

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Section 1. Introduction

The Center for Watershed Protection (CWP) has been working in partnership with the James River Association (JRA) on a James River Vulnerability Analysis and Subwatershed Action Plan. This project is funded through the 2004 Chesapeake Bay Small Watershed Grants Program. This Technical Memorandum summarizes the methodologies and results from the various technical components of the project.

In essence, the intent of this project was to prioritize restoration and protection opportunities within the James River Basin at different scales. Each section of this memorandum contains a step in the process, as follows:

Section 2. At the **James River Basin** scale, the goal is to divide a very large and complex river basin in manageable watershed units to explore and prioritize restoration and protection at a **planning scale**. The 11-digit hydrologic unit code (HUC-11) was selected as the appropriate watershed unit, and the analysis used a desktop geographic information system (GIS) approach. One priority HUC-11 was selected for further analysis.

Section 3. The **county or jurisdictional** level is still a **planning scale**, but is able to distinguish the growth and environmental characteristics of individual jurisdictions. At this scale, the project classified each jurisdiction based on available data and a desktop GIS analysis, and identified critical watershed planning goals and tools**.**

Section 4. Once the priority HUC-11 was selected, the chosen watershed was divided into appropriately sized **subwatersheds**. At this scale, additional data were used to conduct a **comparative subwatershed analysis**, which is a method to score, rank, and prioritize the subwatersheds based on restoration and protection criteria. The outcome was the selection of priority subwatersheds for further investigation.

Section 5. Within the selected subwatershed, field-level techniques were used to identify potential restoration and protection **projects** within the **stream corridor** and **upland areas** that contribute runoff and pollutants to the stream.

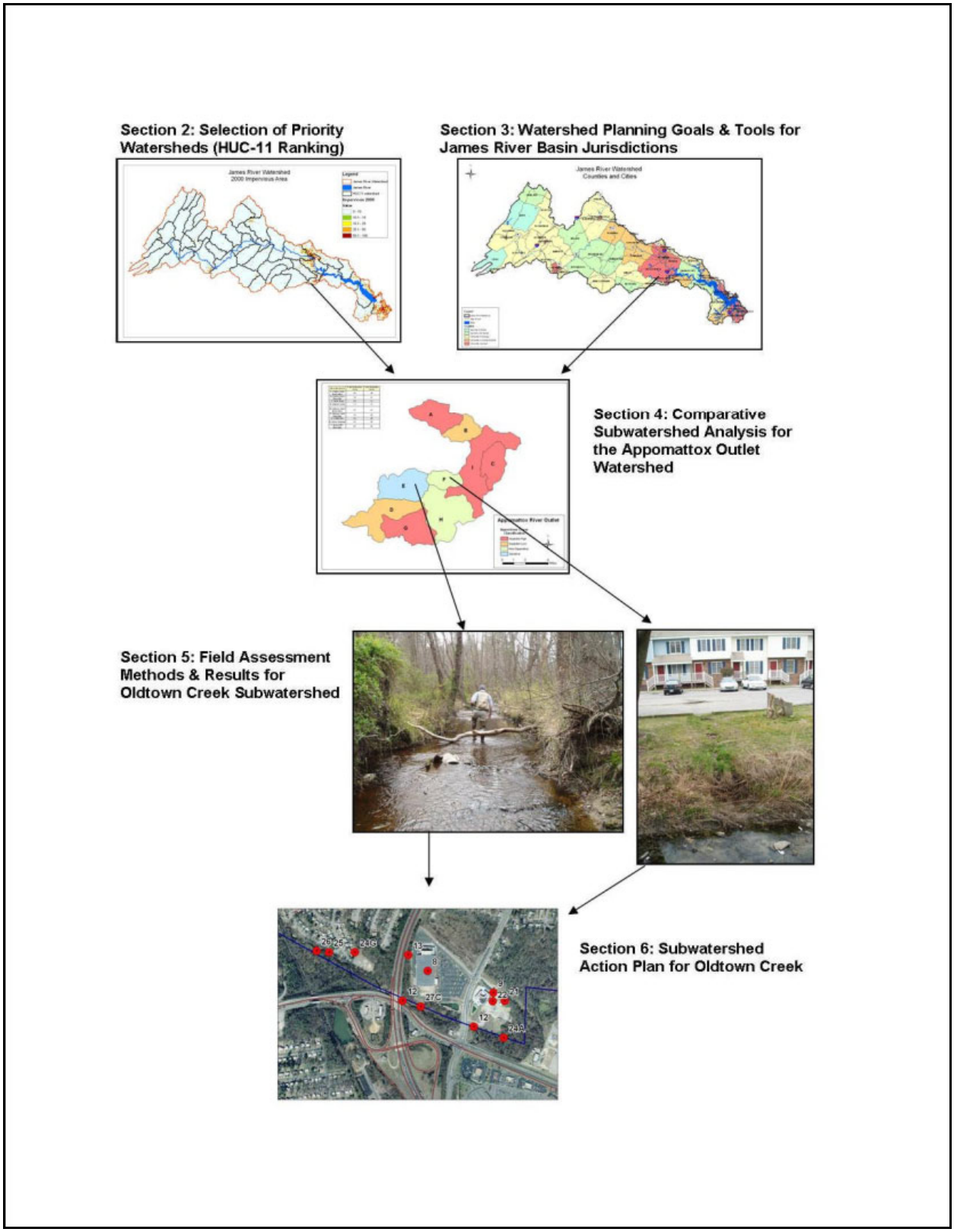
Section 6. Finally, **project evaluation and ranking** was used to evaluate and prioritize the individual restoration and protection projects as part of a **subwatershed action plan (Section 6)**.

In summary, the method employed begins with the entire James River Basin (10,000 square miles), prioritizes restoration and protection needs at the watershed scale (Appomattox River Outlet HUC-11 – 82 square miles), and develops an action plan for a priority subwatershed (Oldtown Creek -- 13 square miles). **Figure 1.1** represents graphically this "scalable" watershed approach. The numbers in Figure 1.1 correlate with the numbered steps listed above.

For the purposes of this project, the terms “Restoration” and “Protection” are used as follows:

- **Restoration** objectives and projects address efforts in watersheds and subwatersheds that already have some development-related impacts. Especially at the subwatershed scale, restoration projects can help restore stream biological, physical, and/or chemical conditions to meet specific subwatershed goals. Example projects include stream restoration, stormwater retrofits, and urban reforestation.
- **Protection** objectives and projects address efforts in watersheds and subwatersheds where the current conditions are good, but need to be preserved and protected due to growth or other threats. Example protection projects include resource inventories, easements, and land use practices (zoning).

Figure 1.1. Scalable Watershed Approach for James River Vulnerability & Subwatershed Action Plan



Section 2. Selection of Priority Watersheds for the James River Basin

Since the James River Basin comprises over 10,000 square miles, the project team was interested in the prioritization of particular watersheds to focus protection and restoration efforts. The eleven-digit hydrologic unit code (HUC-11, or watershed code) was selected as the organizing unit since these watersheds are commonly used for federal and state programs.

A set of scoring criteria was established in order to distinguish priority watersheds for restoration and protection. Restoration criteria were selected primarily to address sediment as a key pollutant of concern for the James River, with other pollutants and sources of degradation serving as secondary considerations. Protection criteria were selected based on the potential to protect land that is essential for water quality and habitats. These areas include protected lands, forest cover, habitat for rare species, and large tracts of forest. Scoring criteria are described in more detail below.

The information is contained in Tables 2.1-2.3.

2.1. Criteria for RESTORATION HUC-11s

Criteria for selection of priority restoration HUC 11's included soil erodibility, incremental yield of phosphorus (used as a surrogate for sediment based on data availability), and the percentages of both agricultural and urban land. These criteria are outlined in **Table 2.1.**

2.2. Criteria for PROTECTION HUC-11s

Priority protection HUC-11s were evaluated using the occurrence of rare, threatened and endangered species and the presence of unprotected conservation areas, including wetlands and large tracts of forest. In addition, the Chesapeake Bay Program's development pressure list was used to ascertain areas that are vulnerable to development and therefore where protection should be a priority. The criteria for priority protection HUC-11s is described in **Table 2.2.**

2.3. Selection of Priority HUC-11 Watersheds

Priority HUC-11s for restoration and protection were identified in a preliminary sense using the data noted above and in **Tables 2.1 and 2.2.** The priority selections were then cross-referenced with other data sources related to development pressure and impaired streams, and, in some cases, selections were modified. Development pressure was estimated by the Bay Program based on proximity to developed cities that serve as hubs for jobs and estimated time of travel for potential commuters. The development pressure ranking was cross-referenced with the restoration and protection criteria and used to help select priority HUC-11 watersheds. The 303d list of impaired waters provides evidence

from a larger state and federal perspective that these waters are impaired for some of their historically designated uses. Both data sets were used to verify (or cross-reference) priority HUC-11s for restoration and protection. Additional information about these data is provided in **Table 2.3.**

Based on the criteria described above, 11 HUC-11 watersheds were identified as priorities for restoration, 13 HUC-11 watersheds were identified as priorities for protection, and 2 HUC-11 watersheds were identified as priorities for both restoration and protection. The data used to select the priority watersheds in presented in **Table 2.4**, and **Figure 2.1** shows the locations.

After a list of priority HUC-11s was developed, JRA and CWP worked together to review and evaluate all of the selected watersheds. Part of this process was selecting one priority HUC-11 to feed down to the next level of analysis – the comparative subwatershed analysis (See **Section 4**). This selection was based on opportunities for both restoration and protection, the size of the HUC-11, the individual jurisdictions included in each HUC-11, and political considerations (e.g., the potential to affect change within the watershed). The outcome of this process was the selection of the **Appomattox River Outlet HUC-11** to continue the study.

Table 2.1. Criteria Used to Select Priority Restoration HUC-11s

Priority HUC-11s meet one or more of the following criteria AND are on the "Development Pressure" list from the Chesapeake Bay Program.

1. Soil Erodibility
    a. HUC 11's with greater than 75% in the high category (≥0.3) plus some overlap with other factors.
    b. Data taken from STATSGO soils layer and broken into three categories (none to slight, moderate and high) based on Chesapeake Bay Program.

2. Phosphorus Incremental Yield
    a. HUC 11's with greater than 0% in the high category (>0.507), or >10% in the medium category (0.317-0.507) plus overlap with other factors.
    b. Data from USGS SPARROW Model.
    c. Classification of data based on 2004 VA DEQ Nonpoint Source Assessment Study http://www.deq.state.va.us/wqa/ir2004.html

3. Agricultural Land
    a. HUC 11's with greater than 20% acres of agricultural land.
    b. Agricultural land includes pasture/hay and croplands from the landuse/land cover data (2000) from the Chesapeake Bay Program.

4. Developed Land
    a. HUC 11's with greater than 6% developed land.
    b. Developed land includes low, medium, and high intensity developed and transportation categories from landuse/land cover data (2000) from the Chesapeake Bay Program.

Table 2.2. Criteria Used to Select Priority Protection HUC-11s

Priority protection HUC-11's meet one or both of the following criteria AND are on the "Development Pressure" from the Chesapeake Bay Program.

1. Rare, Threatened, and Endangered Species (RTE)
    c. HUC 11's with greater than 50% acres of RTE.
    d. RTE includes both Natural Heritage Screening Coverage and Element Occurrence Representations obtained from the Virginia DCR, Natural Heritage Program.

2. Conservation land MINUS Protected land (unprotected conservation land)
    e. HUC 11's with greater than 70% unprotected conservation land.
    f. Conservation land includes forests and wetland from land use/land cover data (2000) from the Chesapeake Bay Program.
    g. Protected land obtained from VDCR includes:
        - National forests
        - Private easements
        - State forests
        - USFW refuge
        - Wildlife management areas
        - Local conservation lands
        - National park boundaries
        - Virginia Outdoors Foundation Conservation Easements
        - VDCR- Virginia Department of Conservation and Recreation

Table 2.3. Data Used to Verify Priority HUC-11s

After being selected based on the criteria in **Tables 2.1 & 2.2**, priority HUC-11's were cross-referenced with the following data sources.

1. Development Pressure
    h. Data obtained from the Chesapeake Bay Program http://www.chesapeakebay.net/rla.htm

2. 303d Listed Rivers and Reservoirs
    i. Data obtained from Virginia Department of Environmental Quality (VDEQ) http://www.deq.state.va.us/wqa/ir2004.html

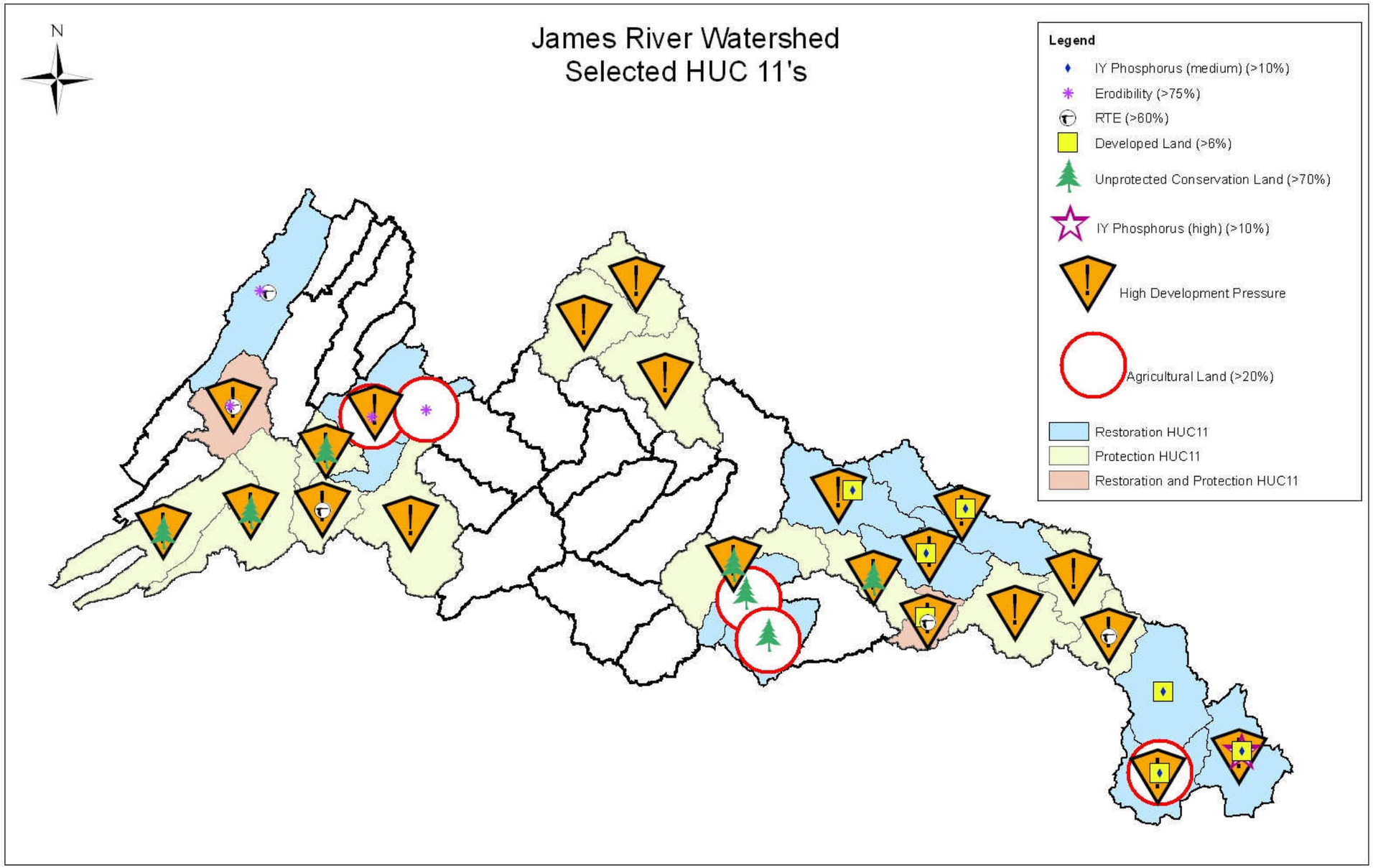
Table 2.4. Data Used to Select Priority HUC-11 Watershed.

HUC 11	County	303(d) listed rivers (miles)	303(d) listed reservoirs (acres)	Soil Erodibility (acres)			Phosphorus Incremental Yield (load per area)			Agricultural Land (acres)	Developed Land (acres)	Rare Threatened and Endangered (acres)	Conservation land - Protected land (acres)
				None to Slight <0.2	Moderate 0.2 - 0.3	High >=0.3	Low <0.3165995	Medium 0.3165996 - 0.5065591	High > 0.5065592				
APPOMATTOX RIVER - OUTLET	Chesterfield	16.53	Lake Chesdin (3196)	0.07%	92.47%	7.46%	99.75%	0.00%	0.00%	11.51%	16.62%	69.30%	43.95%
APPOMATTOX RIVER - UPPER	Powhatan	143.36		0.00%	72.07%	27.93%	100.00%	0.00%	0.00%	18.12%	1.46%	5.17%	78.00%
BUFFALO CREEK	Rockbridge	8.33	Robertson Lake (31)	0.00%	0.03%	99.97%	100.00%	0.00%	0.00%	15.79%	1.42%	33.19%	72.19%
CHICKAHOMINY RIVER - LOWER	New Kent	196.73	Diascund Reservoir (1700)	7.62%	60.53%	31.86%	95.18%	0.45%	0.00%	11.64%	2.15%	34.17%	68.06%
CHICKAHOMINY RIVER - UPPER	Hanover		Chickahominy Lake (1500)	13.88%	82.41%	3.71%	86.68%	13.32%	0.00%	12.70%	11.77%	26.67%	57.94%
CRAIG CREEK	Craig	46.34		0.00%	18.92%	81.02%	99.90%	0.00%	0.00%	1.19%	0.94%	29.50%	80.44%
DEEP CREEK - ON THE APPOMATOX RIVER	Nottoway	33.30		0.00%	81.78%	18.22%	99.66%	0.00%	0.00%	20.73%	1.68%	0.24%	76.01%
ELIZABETH RIVER AND HAMPTON ROADS	Chesapeake	24.82		24.66%	75.25%	0.00%	4.63%	57.38%	15.62%	6.19%	25.58%	16.12%	14.78%
FLAT CREEK	Amelia	9.42		0.00%	74.50%	25.50%	99.87%	0.00%	0.00%	24.15%	1.65%	3.36%	73.39%
JACKSON RUN	Highland	11.21	Lake Moomaw (2005)	0.00%	16.47%	82.88%	99.97%	0.00%	0.00%	8.42%	1.24%	51.11%	34.16%
JAMES RIVER - BOTEFOURT COUNTY	Bedford	73.13		0.00%	13.42%	86.58%	99.89%	0.00%	0.00%	15.88%	2.16%	31.55%	70.24%
JAMES RIVER - LOWER TIDAL	Newport News	4.04	Lee Hall (230)	30.58%	44.16%	25.25%	37.01%	31.54%	0.03%	12.22%	6.80%	15.73%	31.12%
JAMES RIVER - LYNCHBURG CITY	Bedford	48.68	Graham Creek Reservoir and Pedlar Lake (165)	0.00%	25.45%	40.97%	96.61%	3.05%	0.00%	9.69%	3.91%	14.83%	54.07%
JAMES RIVER - MIDDLE TIDAL	Surry	7.80		23.62%	54.48%	21.90%	60.37%	14.87%	0.00%	12.89%	5.30%	51.01%	37.80%

JAMES RIVER - NEAR THE TOWN OF COVINGTON	Alleghany	36.61	Douthat Lake (60)	0.00%	10.51%	89.49%	100.00%	0.00%	0.00%	0.00%	3.30%	61.67%	45.78%
JAMES RIVER - NORTH OF HOPEWELL	Chesterfield	78.46	Falling Creek Reservoir (110)	0.89%	87.55%	11.56%	80.30%	19.70%	0.00%	12.79%	17.84%	24.49%	38.62%
JAMES RIVER - PURGATORY TO BIG HELLGATE CREEKS	Botetourt	11.52		0.00%	13.59%	48.31%	99.94%	0.00%	0.00%	7.05%	1.95%	65.35%	66.11%
JAMES RIVER - RICHMOND CITY	Henrico	149.70		7.34%	80.17%	12.49%	88.19%	11.81%	0.00%	16.07%	7.29%	20.31%	56.80%
JAMES RIVER - UPPER TIDAL	Charles City	31.56		12.36%	37.79%	49.84%	97.14%	0.00%	0.00%	17.38%	3.19%	28.65%	60.50%
MAURY RIVER	Rockbridge	69.86		0.00%	12.38%	87.62%	99.89%	0.08%	0.02%	29.43%	3.45%	33.54%	44.24%
NANSEMOND RIVER	Suffolk	6.97		15.60%	84.40%	0.00%	53.82%	38.53%	0.00%	23.82%	6.43%	18.22%	52.50%
NORTHFORK RIVANNA RIVER	Greene	26.85		0.00%	55.64%	44.36%	99.99%	0.01%	0.00%	18.15%	1.85%	9.82%	67.32%
RIVANNA RIVER	Fluvanna	42.65	Ragged Mountain Reservoir (54)	0.00%	25.78%	70.46%	100.00%	0.00%	0.00%	13.61%	3.34%	2.03%	67.62%
SOUTH FORK RIVANNA RIVER	Ablemarle	54.43	Lake Albemarle and Sugar Hollow Reservoir (87)	0.00%	37.24%	43.14%	100.00%	0.00%	0.00%	18.14%	2.08%	5.01%	57.05%
SOUTH RIVER - ON THE JAMES RIVER	Rockbridge	5.44		0.00%	13.90%	86.10%	99.93%	0.07%	0.00%	20.63%	2.49%	29.94%	24.72%
SWIFT CREEK	Chesterfield	29.68	Swift Creek Reservoir (1800)	1.53%	97.71%	0.76%	100.00%	0.00%	0.00%	6.94%	5.35%	30.37%	70.96%

	Protection HUC 11's
	Restoration HUC 11's
	Restoration and Protection HUC 11's

Figure 2.1. Selected Restoration and Protection HUC 11's in the James River Watershed.



Section 3. Identification of Watershed Planning Goals & Tools for James River Basin Jurisdictions

3.1. Data & Results for Classifications

To complement the prioritization of HUC-11's on a basin-wide scale, the project team looked at the next level – individual jurisdictions. This was important since jurisdictional boundaries, while not always following watershed boundaries are the main determinant of land use policies and regulations. The classification process included all major jurisdictions with the James River Basin, including 29 counties and 16 cities. Several of these jurisdictions have only a small land area within the James River Basin.

Several data sources -- including existing urban land, existing forest land, impervious cover, protected conservation areas, development pressure designations from the Chesapeake Bay Program, and population statistics from the Weldon Cooper Center -- were used to sort James River Basin localities into different categories.

General watershed planning goals and tools were identified for each category based on CWP's extensive experience conducting local watershed planning. As one example, watershed planning goals for a county with high development pressure but relatively low existing development may be to focus on watershed based planning to direct development to appropriate or designated areas, while identifying important resource or conservation areas. Watershed planning tools to protect streams and receiving waters in these counties may include enacting strong buffer ordinances, improving stormwater and erosion control programs (including enforcement), and planning code revisions to promote better site design.

A short summary of the steps in the categorization process is provided below:

1. Identify counties with high, medium, or low development pressure based on CBP vulnerability analysis, in addition to population data from the Weldon Cooper Center.
2. Identify counties with conservation areas (forests, parks, open land) that are either currently protected or unprotected.
3. Identify counties with relatively high percentages of developed land based on land use or impervious cover data.
4. Group counties (and cities) into the following five classifications:
    a. Sensitive Protected
    b. Sensitive Unprotected
    c. Vulnerable Impacted
    d. Vulnerable Developing
    e. Vulnerable Developing Rapidly

Table 3.1 outlines the criteria, goals, and appropriate watershed planning tools for each of the categories listed above. **Table 3.2** lists all the major jurisdictions within the James River Basin by category. **Figure 3.1** displays these results graphically.

Caveats to the categorization are listed below.

- This decision process was based primarily on analysis using the Chesapeake Bay Program vulnerability model and associated development pressure estimates – where growth areas in the Chesapeake Bay were estimated based on travel time to cities and major workforce areas.
- Additional input on 2000-2004 population growth for cities and counties was used via the Weldon Cooper Center at UVA http://www.coopercenter.org/demographics/
- The classifications do not necessarily reflect current on-the-ground conditions (GIS data used to make some assumptions may be 5 years old or older). They also do not reflect the zoning, local political climate, and aspirations of local developers and decision-makers.
- Some counties and cities only have a small portion of their land in the James River Basin; these were often denoted as (small) next to the jurisdiction.

Table 3.1. Jurisdiction Classifications, Goals & Tools			
Classification	**Criteria**	**Watershed Goals**	**Watershed Planning Tools**
Sensitive Protected (SP)	Low Development Pressure + Significant portions of land protected	Continue to preserve and expand important conservation areas, sensitive streams and contiguous forest	• ID of sensitive resource areas • Conservation easements, land acquisition, limit re-zoning, open space transfer • Cluster and use Special Stormwater Criteria (SSC) when development does occur • Consider stream buffer ordinance • Encourage environmentally-sensitive economic development
Sensitive Unprotected (SU)	Low to Moderate Development Pressure + Land Generally Unprotected	Attempt to ensure the preservation of important conservation areas, sensitive streams and contiguous forest Protect agricultural and forest lands and work on the long-term protection and sustainable management of these resources	• Conservation easements • Land acquisition • Consider zoning changes to protect rural and agricultural land and concentrate development areas • ID of sensitive resource areas • Consider stream buffer ordinance • Special Stormwater Criteria (SSC) and strong erosion and sediment control (ESC) measures when development does occur • Better Site Design Principles for new development

Table 3.1. Jurisdiction Classifications, Goals & Tools			
Classification	**Criteria**	**Watershed Goals**	**Watershed Planning Tools**
Vulnerable Impacted (VI)	Fair Amount of Existing Development (or largely built-out) and Some Continuing to Develop (some losing population)	Reduce pollutant sources, restore degraded streams and protect streams from further degradation	• Redevelopment of existing cities • Stormwater retrofitting • Stream restoration • Education and stewardship; source controls • Stormwater controls • Erosion and Sediment Control • Stream buffer ordinances • Appropriate use of Better Site Design Principles with some new development and infill
Vulnerable Developing (VD)	Moderate Existing Development and Relatively High Development Pressure	Carefully target expected growth to most appropriate areas, while protecting and conserving natural resources and land uses that protect water. Prevent significant degradation from occurring in the future from additional new development.	• Smart Growth – designate development & protection zones; implement rural, agricultural, and conservation area zoning protections • Encourage conservation design and Better Site Design Principles • Upgrade codes and ordinances • Upgrade stormwater controls; improve inspection and maintenance program • Improve Erosion and Sediment Control (ESC) standards, inspection and enforcement • Stream buffer ordinances • Watershed stewardship • ID important conservation areas; consider Purchase of Development Rights (PDR) program

Table 3.1. Jurisdiction Classifications, Goals & Tools			
Classification	**Criteria**	**Watershed Goals**	**Watershed Planning Tools**
Vulnerable Developing Rapidly (VDR)	Among highest growth rates in State*	Carefully target expected growth to most appropriate areas, while protecting and conserving natural resources and land uses that protect water. Prevent significant degradation from occurring in the future from additional new development.	• Smart Growth – designate development & protection zones; implement rural, agricultural, and conservation area zoning protections • ID important conservation areas; implement PDR Program • Upgrade codes and ordinances that encourage conservation design and Better Site Design Principles • Upgrade stormwater controls; improve inspection and maintenance program • Improve Erosion and Sediment Control (ESC) standards, inspection and enforcement • Stream buffer ordinances • Watershed stewardship
***** Among top population gainers between 2000 – 2004, Population increase of greater than 10% between 2000 – 2004, or grew faster 2000 – 2004 than 1990 – 2000 (Weldon Cooper Center, UVA)			

Table 3.2. James River Basin Jurisdictions By Classification	
Classification	**Jurisdictions**
Sensitive Protected (SP)	Counties Bath, Craig
Sensitive Unprotected (SU)	Counties Appomattox, Buckingham, Charles City, Cumberland, Highland, Nelson, Nottoway, Surrey
Vulnerable Impacted (VI)	Counties Chesterfield, Henrico Cities Buena Vista, Charlottesville, Chesapeake, Colonial Heights, Covington, Hampton, Hopewell, Lexington, Lynchburg, Newport News, Norfolk, Petersburg, Portsmouth, Richmond, Virginia Beach (small), Williamsburg
Vulnerable Developing (VD)	Counties Albemarle, Allegheny, Amelia, Amherst, Augusta, Botetourt, Bedford, Campbell, Dinwiddie, Greene (small), Hanover (small), Isle of Wight, Louisa (small), New Kent, Prince Edward (small), Roanoke (small), Rockbridge
Vulnerable Developing Rapidly (VDR)	Counties Fluvanna, Goochland, James City, Powhatan, Prince George, Suffolk
(small) – references that only a small portion of the jurisdiction is located in the James River Basin; a number of jurisdictions with very little land area in the James River Basin were not included in the analysis; Rockingham, Orange, Clifton Forge, Giles, York, Montgomery, Charlotte, Lunenburg (most were less than 200acres)	

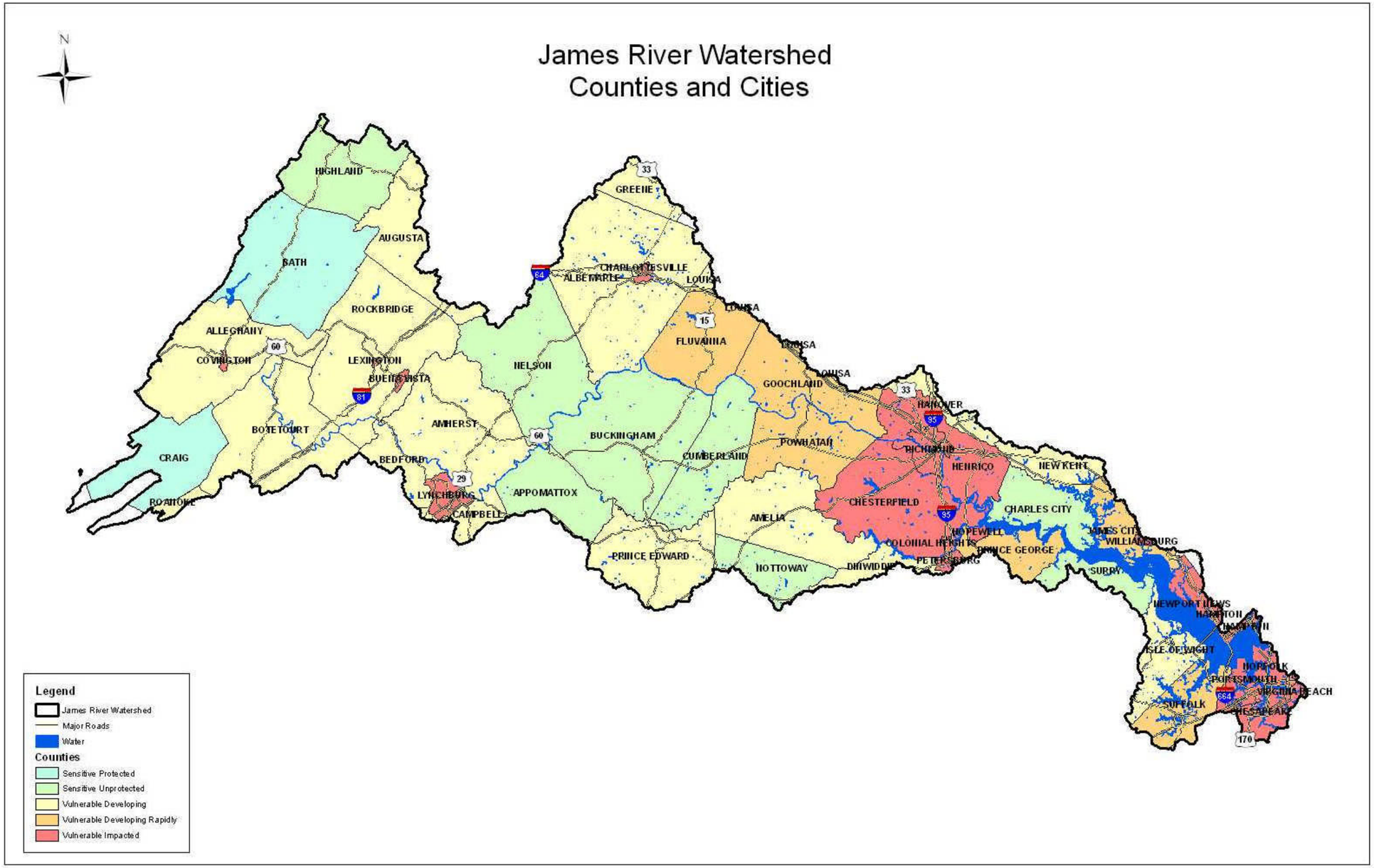
3.2. Observations & Outcomes from the Classification Process

The following observations were made based on the classification of jurisdictions:

- Municipalities where the greatest amount of development and hence impact has occurred based on growth (net migration) in the last four years include Chesterfield, Henrico, Suffolk, James City, Chesapeake and Fluvanna. Assuming those trends are likely to continue, good erosion and sediment control, stormwater management, site design and riparian buffer protection are critical in these localities.
- The loss of population in the cities within the James River Basin is alarming and presumably that loss in population is one of the drivers of suburban sprawl in the outlying counties. Stemming population loss in cities is a watershed and water quality impact issue.
- Proactive efforts to manage growth, control stormwater runoff and protect resources are likely to pay dividends in the future in municipalities that have not experienced significant growth.

It should also be noted that these classifications and management strategies were used in the Comparative Subwatershed Analysis (**Section 4**), and were also used directly in a related project – *Building a Cleaner James River*. This project was led by JRA, and included classes at Virginia Commonwealth University, University of Virginia, and Virginia Tech. The codes and ordinances of each major jurisdiction within the James River Basin were evaluated based on the Better Site Design principles (CWP, 1998).

Figure 3.1. Classification of Counties and Cities in the James River Watershed.



Section 4. Comparative Subwatershed Analysis for the Appomattox Outlet Watershed

4.1. Introduction to the Comparative Subwatershed Analysis

As outlined in **Section 2,** the Appomattox Outlet HUC-11 was chosen as the priority HUC-11 within the James River Basin for further analysis. The next step was to conduct a Comparative Subwatershed Analysis (CSA) to identify which of the 9 subwatersheds in the Appomattox Outlet Watershed would be chosen as priorities for detailed field assessment. A CSA is a method to screen the typically large number of subwatersheds in a given watershed in order to find the ones with the greatest restoration or protection potential to work on first (Schueler and Kitchell, 2005). The desired outcome of this analysis was the ranking of subwatersheds within the Appomattox Outlet watershed based on restoration and protection potential. The process for this ranking was as follows:

1. Delineate subwatersheds.
2. Select metrics to rate the subwatersheds based on available data. The metrics should describe restoration and protection potential.
3. Develop weighting and scoring rules for the chosen metrics.
4. Compute aggregate scores and develop subwatershed ranking.

For this watershed study, the following eight metrics were chosen:

1. Impervious Cover
2. County Classification from James Vulnerability Study
3. Forest Cover
4. Non-Forest Pervious Cover
5. Impaired Streams
6. Point-Source (VPDES) Dischargers
7. Protected Land
8. Monitoring Stations

A couple of caveats apply to the CSA:

- The selection of metrics and assigning of scores and weights to each metric is a process that involves professional and value judgments. This process should also be informed by the particular goals of a watershed effort. For the Appomattox Outlet Watershed, the basic judgment was made that subwatersheds with a moderate degree of land use impact had the highest restoration potential. For instance, subwatersheds with impervious cover in the 10 to 25% range are deemed more "restorable" than those with higher impervious cover, where true ecological restoration may have limited feasibility (Schueler, 2004). This reasoning carries through to the other metrics.
- The comparative subwatershed analysis is the beginning of the restoration and protection process, not its end point. The purpose is to gage the relative variation

between subwatersheds, but the quantitative approach should not be used to draw firm conclusions about the absolute condition of a subwatershed. Subsequent field assessments are necessary to confirm on-the-ground conditions (Kitchell and Schueler, 2004).

The following section describes the metrics used in the CSA for the Appomattox Outlet Watershed, as well as the overall weighting and ranking method for the subwatersheds.

4.2. Comparative Subwatershed Metrics

The scoring for each metric is described below.

1. Percent Impervious Cover (IC) Metric

Percent impervious cover was obtained for each subwatershed, and scoring was based on the following categories and point system.

Categories:
Sensitive (ST) = < 10%
Impacted Low (IL) = 10 – 17.5%
Impacted High (IH) = 17.5 – 25%
Non-Supporting (NS) = 25 – 60%
Urban Drainage (UD) = > 60%

Scoring

Category	Restoration Score	Protection Score
ST	1	5
IL	4	4
IH	5	3
NS	3	2
UD	2	1

Explanation

- Impervious cover is one of the most important indicators of watershed health, as noted by Schueler (2004). The categories notes above are based on the Impervious Cover Model (ICM), which predicts that most stream quality indicators decline when watershed impervious cover exceeds 10%, with severe degradation expected beyond 25% impervious cover (CWP, 2003). The ICM defines the Impacted category as including subwatersheds with 10 to 25% impervious cover. However, since most subwatersheds in the Appomattox Outlet Watershed fell into this category, it was split out into High and Low to help distinguish the subwatersheds in the scoring.
- Restoration Scores: Streams within Impacted subwatersheds are generally the best targets for restoration, and thus this category scores highest for restoration scores. Arguably, Sensitive watersheds do not need restoration, thus their low score. Once watersheds reach the Non-Supporting, and especially the Urban Drainage, categories,

restoration is still possible, but likely limited to aesthetic/recreational goals rather than ecological.

- Protection Scores: The goal of protection is to prevent degradation from occurring where existing stream quality is high. Therefore, the highest scores attend to the lowest impervious cover.

2. County Classification (CC) Metric (% of jurisdiction within subwatershed)

The classification of counties and other jurisdictions in the James River Basin summarized in Section 3 of this report was used as a metric in the CSA. The percent of each jurisdiction within each subwatershed was used to attain a classification for each subwatershed. The method for scoring each subwatershed is described below.

Categories & Scoring

Category	**Restoration Score**	**Protection Score**
Sensitive Protected (SP)	1	2
Sensitive Unprotected (SU)	2	3
Vulnerable Impacted (VI)	5	1
Vulnerable Developing (VD)	3	4
Vulnerable Developing Rapidly (VDR)	4	5

Total Restoration CC Score = (%SP)(1) + (%SU)(2) + (%VI)(5) + (%VD)(3) + (%VDR)(4)

Total Protection CC Score = (%SP)(2) + (%SU)(3) + (%VI)(1) + (%VD)(4) + (%VDR)(5)

Where:
% = percent of subwatershed within category expressed as fraction (e.g., 50% = 0.5; 100% = 1)

Explanation

- One component of the James River Vulnerability Analysis was to classify all jurisdictions within the watershed into various categories based on existing development, growth pressure, and the current levels of land protection (See **Section 3**). These categories are linked with specific watershed planning goals and tools. This metric is important to link the Basin-scale HUC-11 priorities with the comparative subwatershed analysis.
- Restoration Scores: Some areas in the VI category are largely built-out and have very high existing impervious cover, limiting their restoration potential (see Metric #1). However, the VI jurisdictions score the highest for this metric because they represent the greatest need for restoration work. Also, they are likely to have parts of the jurisdiction that are excellent candidates for restoration (e.g., within the "Impacted"

category for impervious cover). After the VI category, the VDR and VD jurisdictions are facing dual challenges of restoration and protection through land use controls.

- Protection Scores: As noted above, the VDR and VD jurisdictions still have rural and high value natural resources areas to protect if they can get ahead of the growth curve. Due to the urgency of land protection issues, they receive the highest scores for this metric. The SU category is ranked next because of excellent protection opportunities with a little less urgency for their implementation.

3. Percent Forest Cover (FC) Metric

The percent forest cover was obtained for each subwatershed for use as a metric in the CSA. Scoring was based on the following categories and point system.

Categories & Scoring

Category (%)	Restoration Score	Protection Score
0 – 22.5%	4	1
22.5 – 45%	5	2
45 – 65%	3	3
65 – 85%	2	5
> 85%	1	4

Explanation

- Several studies have found that watershed forest cover may be as important as impervious cover in predicting stream health. One Puget Sound study found that watersheds with at least 65% forest cover usually has a healthy aquatic insect community (Booth, 2000), while a Maryland study correlated stream health ratings of excellent with at least 65% forest cover in the riparian zone (Goetz et al, 2003). For this metric, total forest cover was derived as the sum of deciduous and evergreen land use categories from the Chesapeake Bay Program data. Restoration scores were assigned based on forest cover thresholds of 40 to 45% as a suitable target for most urban areas (American Forests, 2003), and 65% as an ideal forest cover goal to maintain excellent stream health, based on the above-noted studies. The median value for the Appomattox Outlet watershed is 40%.
- Restoration Scores: The highest restoration potential is for subwatersheds with some forest cover that may be able to be expanded through urban forestry practices. Subwatersheds with very low forest cover share some of the same restoration constraints as those in the Urban Drainage category.
- Protection Scores: The highest scores attend to subwatersheds with relatively high existing forest cover. It is likely that most of this acreage is not protected in any formal sense, so opportunities exist to enhance and protect these lands.

4. Impaired Streams (IS) Metric (# of listed streams/subwatershed)

The number of streams in each subwatershed that are included on the State of Virginia DEQ's listing of impaired waters (the 303d list) was used as a metric. Scoring was based on the categories and point system described below.

Categories & Scoring

Category (# listed)	Restoration Score	Protection Score
0	3	5
1	5	4
2	4	3
3	2	2
4+	1	1

Explanation

- The number of occurrences of 303(d) listed streams was used instead of stream miles because the absolute number may be a better indicator of overall subwatershed conditions for water quality.
- Restoration Scores: It is fully expected that there will be some 303(d) waters in a subwatershed with good restoration potential. However, as with the Impervious Cover (IC) and Forest Cover (FC) scores, too much existing degradation can limit restoration potential. Due to the vagaries of the TMDL program, this metric was not given too much weight in assessing restoration potential.
- Protection Scores: The best subwatersheds from a protection standpoint will have no or very few impaired waters.

5. VPDES Discharger (VP) Metric (# dischargers/subwatershed)

The number of point source dischargers in each subwatershed, as permitted by the Virginia Pollutant Discharge Elimination System (VPDES), was obtained for use as a metric. Scoring was based on the categories and point system described below.

Categories & Scoring

Category (# dischargers)	Restoration Score	Protection Score
0	3	5
1	5	4
2	4	3
3	2	2
4+	1	1

Explanation

- Presumably, if VPDES-permitted facilities are meeting their permit standards, then water quality will not be degraded in a particular subwatershed. However, cumulative impacts are possible with multiple dischargers, and even one discharger

that is not in compliance can impact drastically the condition of the subwatershed. The number of VPDES dischargers is also a proxy for commercial and industrial land uses.

- Restoration Scores: This scoring follows the same logic as for the Impaired Streams metric – some dischargers are expected, but too many may limit restoration potential from a water quality standpoint.
- Protection Scores: The best subwatersheds from a protection standpoint will have no or very few point source dischargers.

6. Protected Lands (PL) Metric (acres)

The acres of protected land in each subwatershed were estimated for use as a metric, based on the categories and scoring described below.

Categories & Scoring

Category (acres)	Restoration Score	Protection Score
0 – 30	1	1
30 -- 100	2	2
100 -- 500	3	3
500 -- 1000	4	4
1000 +	5	5

Explanation

- Protected lands present an opportunity for both restoration and protection. These lands are likely not in their optimal ecological condition, so there are management measures that can improve overall subwatershed health. Additionally, protected lands generally cannot be converted to other land uses, so they are prime candidates for restoration and enhancement projects. Thirty acres was chosen as a cut-off because it is close to the median acreage for subwatersheds in the Appomattox Outlet watershed.
- Restoration Scores: Following with the logic above, greater acreage of protected lands represents more opportunity for restoration.
- Protection Scores: For protection goals, protected lands may already be "in the bag," but, again, management practices can be improved to include ecological targets.

7. Monitoring Station (MS) Metric (# stations/subwatershed)

The number of water quality monitoring stations located in each subwatershed was derived for use as a subwatershed metric. Scoring was based on the categories and point system described below.

Categories & Scoring

Category (# stations)	Restoration Score	Protection Score
0	1	1
1	2	2
2	3	3
3	4	4
4+	5	5

Explanation

- The number of monitoring stations (flow and/or ambient) does not have a direct correlation with subwatershed health. However, it does represent an opportunity to gage changes through time in response to restoration and protection efforts (or, changes associated with continued land use change).
- Restoration Scores: More stations mean better coverage across a subwatershed (e.g., main stem plus tributaries).
- Protection Scores: Same as above.

4.3. Overall Weighting & Scoring of Metrics and Selection of Priority Subwatershed

Weights were assigned to each subwatershed metric based on relative contribution of a particular metric to overall subwatershed health. The weighting process is a value judgment based on the best professional opinion, and is subject to revision through stakeholder input. Weighted scores for both restoration and protection had a maximum score of 100.

Table 4.1 summarizes the scoring and weighting for the metrics, and is followed by the equations used to calculate a total restoration score and a total protection score for each subwatershed.

Error! Not a valid link.Table 4.1. Summary of Scoring & Weighting for Subwatershed Metrics

Metric	Max Score	Weight (Restoration)	Max Weighted Score (Restoration)	Weight (Protection)	Max Weighted Score (Protection)
1. IC	5	6	30	5	25
2. CC	5	5	25	4	20
3. FC	5	3	15	3	15
4. IS	5	3	15	2	10
5. VP	5	1	5	1	5
6. PL	5	1	5	4	20
7. MS	5	1	5	1	5
			100		100

Total Restoration Score = (IC)(6) + (CC)(5) + (FC)(3) + (IS)(3) + (VP)(1) + (PL)(1) + (MS)(1)

Total Protection Score = (IC)(5) + (CC)(4) + (FC)(3) + (IS)(2) + (VP)(1) + (PL)(4) + (MS)(1)

Preliminary Ranking of Subwatersheds

Table 4.2 presents the aggregate scores for restoration and protection for each of the Appomattox Outlet subwatersheds. **Figure 4.1** shows these results graphically along with the impervious cover category for each subwatershed.

Table 4.2. Aggregate Scores for Subwatersheds

Subwatershed ID	Total Restoration Score (Max = 100)	Total Protection Score (Max = 100)
A-Ashton Creek Headwaters	86	44
B- Ashton Creek Mainstem	73	57
C- Cabin Creek	82	51
D- Wallace Creek	71	61
E- Oldtown Creek Headwaters	57	61
F- Oldtown Creek Mainstem	76	36
G- cattail run	85	56
H- urban drainage	81	50
I- Appomattox mainstem	93	60

To move the project into the next phase (stream corridor and upland assessments), it was necessary to select a priority subwatershed for further analysis. Based on a variety of factors -- including the comparative subwatershed analysis, opportunity for improvement, and willingness of the localities -- JRA selected **Oldtown Creek Mainstem and Headwaters** as the priority subwatershed.

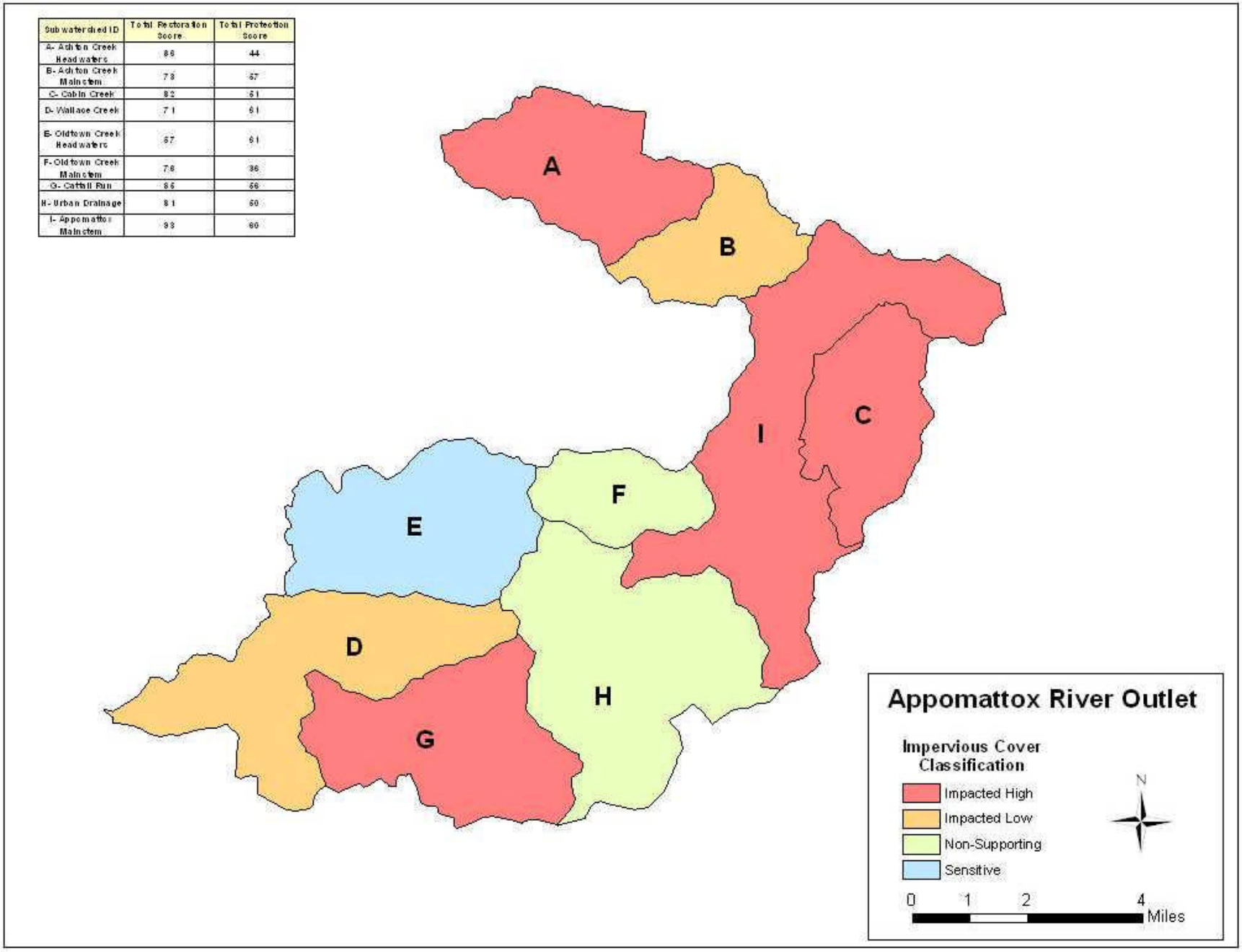
The Oldtown Creek subwatershed presented several attractive opportunities for restoration and protection. The headwaters of the subwatershed are in Chesterfield County, and are largely comprised of forested flood plains and low-density residential development. In stark contract, the bottom half of the subwatershed is within the City of Colonial Heights. Oldtown Creek and its tributaries traverse through single and multi-family neighborhoods, small commercial areas, and major commercial and industrial corridors, such as Boulevard and Conduit Road. Interstate 95 crosses the mainstem in the City, and a major shopping mall is located near the bottom of the subwatershed. The lower section of Oldtown Creek is tidal.

During the planning process, staff from both Chesterfield County and the City of Colonial Heights were contacted and consulted. Staff in both localities expressed interest in the project and willingness to support and participate in the field assessment activities.

The Oldtown Creek subwatershed was selected based on its diversity and opportunities for both restoration and protection.

Figure 4.1 Appomattox Outlet Subwatershed Classification

Subwatershed ID	Total Restoration Score	Total Protection Score
A- Ashton Creek Headwaters	86	44
B- Ashton Creek Mainstem	78	57
C- Cabin Creek	82	51
D- Wallace Creek	71	61
E- Oldtown Creek Headwaters	67	61
F- Oldtown Creek Mainstem	76	36
G- Cattail Run	86	56
H- Urban Drainage	81	50
I- Appomattox Mainstem	93	60



Section 5. Field Assessment Methods and Results for Oldtown Creek Subwatershed

The next phase of the James River Vulnerability Analysis included conducting detailed stream and upland assessments to identify actual on-the-ground restoration and protection projects in the Oldtown Creek subwatershed. At this point, the project moved from a desktop GIS analysis at the James River Basin and HUC-11 scale to a variety of field assessments at the subwatershed scale. Stream and upland assessments are designed to identify specific locations within the subwatershed that can be restored and/or protected to help meet subwatershed goals (Kitchell and Schueler, 2005).

The assessments conducted as part of the project include:

- The **Unified Stream Assessment** involves walking the stream corridor and identifying impairments and restoration potential within urban stream corridors.
- The **Unified Subwatershed and Site Reconnaissance** entails a variety of investigations in upland areas to identify sources of pollution and potential source controls and upland BMPs.
- **Stormwater Retrofit Surveys** investigate the existing storm sewer infrastructure (e.g., drainage areas, inlets, pipes, ditches, existing basins, and outfalls) and identify opportunities to build in storage and/or water quality treatment.

The following sections describe the methods used in Oldtown Creek, and the key findings of the field work.

5.1. Unified Stream Assessment

Overview

CWP and JRA staff and volunteers conducted a stream corridor assessment. Teams documented stream corridor conditions for approximately 6 linear stream miles in Old Town Creek on March 27 and 28, 2006. Teams used the Unified Stream Assessment (USA)—a comprehensive stream walk protocol for evaluating the physical riparian and floodplain conditions in small urban watersheds. A detailed description of the USA protocol can be found in Kitchell and Schueler (2004).

The USA integrates qualitative and quantitative components of various stream survey and habitat assessment methods. The USA is used to assess reach conditions and to identify locations of suspected illicit connections (illegal discharges to the storm drain system), impacted buffer, severe stream bank erosion, excessive trash accumulation and dumping, and impacted stream crossings. These stream impacts are assessed and recorded using eight impact assessment forms described in **Table 5.1**. While the USA helps to identify high quality streams for protection, its main benefit is to identify restoration opportunities for discharge prevention, stream restoration, storm water retrofits, and riparian reforestation.

Table 5.1. Components of the USA
Impact assessments are site-specific and record data on condition and "restorability" at each problem site. Impact forms comprise an initial inventory of restoration opportunities. The eight impact assessment forms are: **Outfalls** (OT)—*all storm water and other discharge pipes* **Severe erosion** (ER)—*bank sloughing, active widening or incision* **Impacted buffer** (IB)—*lack of natural vegetation, width* **Utilities in the Stream Corridor** (UT)—*leaking sewer, exposed pipes susceptible to damage* **Trash and Debris in the Stream Corridor** (TR)—*trash and illegal dumping* **Stream Crossing** (SC)—*culverts, dams, natural features, etc.* **Channel Modification** (CM)—*straightening, channelization, dredging, etc.* **Miscellaneous** (MI)—*unusual features or conditions*

Reach Conditions

The USA uses stream reaches as the basic organizational tool for creating management recommendations. Each stream reach represents a relatively uniform set of conditions along the stream corridor and is used to characterize average bank stability, in-stream habitat, and riparian vegetation. Within each reach, teams evaluated overall reach habitat using a scoring system that measures habitat and physical parameters in the stream. The habitat scores from the USA in Oldtown Creek were rated as shown in **Table 5.2.**

Table 5.2. Stream Assessment Scoring Criteria	
Score	**Rating**
123 - 138	Excellent
95 - 122	Good
65 - 94	Fair
0 - 64	Poor

Reach scores for Oldtown Creek are shown in **Table 5.3**. The majority of stream reaches in Oldtown Creek rated as fair or good.

Table 5.3. Old Town Creek Reach Scores		
Reach ID	**Score**	**Rating**
RCH-TB-08	**4**	Poor
RCH-TB-06	**30**	Poor
RCH-TB-07	**37**	Poor
RCH-TB-05	**65**	Fair
RCH-OTC-4	**68**	Fair
RCH-OTC-2	**69**	Fair
RCH-BL-02	**72**	Fair
RCH-TB-03	**78**	Fair
RCH-TB-02	**83**	Fair
RCH-OTC-3	**87**	Fair
RCH-BL-01	**88**	Fair
RCH-WP-3	**95**	Good
RCH-BL-06	**95**	Good
RCH-BL-04	**97**	Good
RCH-BL-07	**97**	Good
RCH-OTC-1	**98**	Good
RCH-BB-02	**107**	Good
RCH-BB-01	**108**	Good
RCH-BL-03	**109**	Good
RCH-WP-1	**109**	Good
RCH-TB-04	**109**	Good
RCH-BB-05	**114**	Good
RCH-BB-03	**118**	Good
RCH-WP-2	**123**	Excellent
RCH-HK-02	**125**	Excellent
RCH-BB-04	**125**	Excellent
RCH-HK-01	**127**	Excellent
RCH-BL-05	**128**	Excellent
RCH-BL-08	**138**	Excellent

Key Findings

In addition to determining the reach condition, one of the goals of the USA is to identify sites where improvements can be made to the stream. The types of improvement activities identified in Oldtown Creek include: outfall investigations, trash removal, and utility investigations. The types of impact and improvement activities identified in Oldtown Creek are summarized in **Map A-1: Unified Stream Assessment and Table 5.4**. **Table 5.4** lists each impact, its associated reach, recommended project and a summary of field observations. **Section 6** contains a list and description of priority projects within the subwatershed.

Table 5.4 USA Results for Oldtown Creek Subwatershed			
Reach	**Impact ID**	**Recommended Project**	**Summary of Field Observations**
BB-01	ER-1	N/A	Bank erosion occurs during large storm events.
BB-01	SC-1	Fish barrier removal	Triple barrel concrete culvert with partial blockage.
BB-02	OT-1	Investigate outfall	Outfall closed, concrete pipe with algae odor and excess trash.
BB-03	OT-1	Investigate outfall	Outfall draining neighborhood, potential illicit discharge.
BB-04	ER-1	N/A	N/A
BB-04	MI-1	Protection of area	Beaver dam / wetland area
BB-05	ER-1	N/A	N/A
BB-05	MI-1	Investigate structure	Old circular concrete structure - possibly part of WWT system?
BB-05	OT-1	Investigate ponds	Outfall filled with sediment
BB-05	OT-2	N/A	N/A
BB-05	OT-3	N/A	N/A
BL-01	OT-1	Investigate outfall	Existing Outfall concrete, rip rap, etc. - poorly constructed
BL-01	SC-1	Utility inspection	N/A
BL-02	MI-1	Protection of area	Beaver dam
BL-03	OT-1	Repair outfall	Cracked Outfall
BL-03	OT-2	Discharge Investigation	N/A
BL-03	TR-1	Trash removal	Plastic, tires, yard waste, metal material at illegal dumping site
BL-06	OT-1	Investigate outfall	Outfall about to fail, algae growth in pipe
BL-06	OT-2	N/A	N/A
BL-07	OT-1	Investigate outfall	Fecal odor, deposits & stains (pet waste)
BL-07	OT-2	Discharge investigation	Outfall connected to house, possibly laundry
BL-07	TR-1	Trash removal	Large amount of dumping on right bank; wooden slabs, plastic.
HK-01	OT-1	Investigate outfall	Residential runoff
HK-01	OT-2	Investigate outfall	Needs regular maintenance; repair end section of OT (collapsed)
HK-01	TR-01	Trash removal	Illegal dump, local outfall
HK-01	UT-1	Utility inspection	Exposed stable, concrete manhole in middle of creek.
HK-02	OT-1	Investigate outfall	Concrete outfall buried
OTC-1	CM-2	Fish barrier removal	rip rap
OTC-1	OT-1	Stormwater retrofit	Excess trash; excessive sedimentation
OTC-1	OT-2	Inspection and Maintenance	Sanitary sewer
OTC-1	OT-3	Discharge investigation	N/A
OTC-2	ER-1	Stormwater retrofit	Downcutting, headcutting, bed scour, bank failure
OTC-2	IB-1	Active reforestation	Lack of vegetation
OTC-2	MI-1	Discharge investigation	N/A
OTC-2	UT-1	Utility inspection	Exposed pipe
OTC-3	CM-1	N/A	Concrete channel
OTC-3	OT-1	N/A	N/A
OTC-4	ER-1	Bank stabilization	Banks are downcutting, widening, and headcutting.
OTC-4	MI-1	Stream restoration	N/A
TB-01	SC-1	Possible removal	N/A
TB-01	UT-1	Utility inspection	Pipe corroding
TB-02	ER-1	Bank stabilization	Bank scour
TB-02	ER-2	Bank stabilization	N/A
TB-02	TR-1	Trash removal	A lot of trash from residential area (bottles, glass, plastic, tires) from flooding
TB-03	MI-1	Remove or repair dam	Old stone dam serving in present condition to stabilize water table for upstream reach.
TB-04	ER-1	Bank stabilization	Bank scour
TB-04	SC-1	Fish barrier removal	Evidence of cracking/chipping/corrosion and sediment deposition

Table 5.4 USA Results for Oldtown Creek Subwatershed			
Reach	**Impact ID**	**Recommended Project**	**Summary of Field Observations**
TB-04	TR-1	Trash removal	Illegal dump
TB-04	TR-2	Trash removal	Illegal dump instream
TB-05	MI-1	Stabilization	N/A
TB-06	UT-1	Utility inspection	Exposed concrete pipe, possible leak.
TB-06	CM-1	Stream restoration	Evidence of sediment deposition
TB-06	IB-1	Buffer planting	Lack of vegetation
TB-06	OT-1	Outfall maintenance	Outfall chipped, some benthic growth (brown).
TB-06	UT-2	Utility Inspection	Exposed concrete pipe on stream bottom with joint failure (pipe cracking)
TB-07	CM-1	N/A	Dredged stream
TB-07	IB-1	Buffer planting	Lack of vegetation
TB-07	OT-1	Investigate outfall	OT chipped, moss/benthic growth
TB-07	OT-2	Investigate outfall	N/A
TB-07	OT-3	Investigate outfall	Entire street drains to outfall
TB-07	OT-4	Investigate outfall	Bank erosion
TB-07	OT-5	Stormwater retrofit	Outfall broken in half at end; excessive sedimentation
TB-07	OT-7	Investigate outfall	Bank erosion, excessive sedimentation
TB-07	OT-7	Investigate outfall	Bank erosion
TB-07	SC-1	N/A	Failing embankment, sediment deposition
TB-08	OT-1	Discharge investigation	Outfall partially submerged, algae in stagnant water
TB-08	OT-2	Investigate outfall	N/A
TB-08	OT-3	Trash removal	Trash & debris
WP-2	TR-1	Trash removal	Trash includes plastic, paper, bottles & cans; swing set

5.2. Unified Subwatershed and Site Reconnaissance

Overview

Center staff and JRA volunteers conducted the Unified Subwatershed and Site Reconnaissance (USSR) field work on April 3 and 4, 2006. The USSR is a field survey to evaluate potential pollution sources and restoration opportunities within urban subwatersheds (Wright *et al.*, 2004). Prior to going in the field, potential residential, pervious area, and hotspot locations for the USSR were identified.

The USSR conducted in Old Town Creek focused on three assessments; the Neighborhood Source Assessment (NSA), Hotspot Site Investigation (HSI), and Pervious Area Assessment (PAA). The USSR field teams evaluated 9 residential neighborhoods, 14 potential hotspots, and 6 pervious areas within the Oldtown Creek subwatershed. The results of the evaluations were used to determine potential retrofit opportunities, improvements in stewardship practices, and focus areas for educational outreach efforts.

Neighborhood Source Assessment

The NSA assesses residential neighborhoods in terms of age, lot size, tree cover, drainage, lawn size, general upkeep, and residential stewardship. Distinct neighborhood units were delineated using GIS data layers and digital orthophotography.

Neighborhoods with similar characteristics and restoration potential were grouped into a single assessment form. Neighborhoods were assigned a pollution severity of "severe," "high," "moderate," or "low," using a set of benchmarks set forth in Wright et al. (2004). Pollution severity is an index of how much non-point source pollution a neighborhood likely generates based on easily observable features (e.g. lawn care practices, rooftop runoff management, and open space management). A restoration potential of "high," "moderate," or "low" was also determined for each neighborhood type. Restoration potential is a measure of how feasible onsite retrofits or behavior changes are based on various factors (e.g. available space, number of opportunities, and presence of a strong homeowners association). The NSA results are shown in **Table 5.5 and Map A-2: Neighborhood Source Assessment.** General neighborhood outreach projects are outlined in **Section 6.**

Table 5.5. Neighborhood Pollution Severity and Restoration Potential for Oldtown Creek Subwatershed

Subwatershed	Site ID	Location	Pollution Severity	Restoration Potential	Recommended Actions
Old Town Creek	NN-8	Brevard	None	Moderate	Rain barrels and Rain Gardens
	NN-7	Colonial Pine	Moderate	Moderate	Investigate Ponds
	NN-1	Compton Street	Moderate	Moderate	Common Space Management
	NN-2	Lundy	Moderate	Moderate	Open Space Retrofit
	NN-10	Cedar Trace	Moderate	Moderate	Plant trees
	NSA-11	Willow Run Town Homes / Maple	Moderate	Low	Reduce sediment/open space retrofit
	NSA-12	Brander's Bridge	Moderate	Low	Open Space Retrofit
	NSA-13	Walnut Court	Moderate	Low	N/A
	NSA-14	Chesterfield Highlands & Others	Moderate	Low	Open Space Retrofit
	NSA-15	Colonial Square Town Homes	None	Low	N/A

Hotspot Site Investigation

The HSI assesses potential hotspots. Hotspots are defined as commercial, industrial, institutional, municipal, or transport-related operations that produce higher levels of stormwater pollutants, and/or present a higher potential risk for spills, leaks or illicit discharges. Individual hotspot locations were assessed for pollution potential based on observed sources of pollution and the potential of the site to generate pollutants that can enter the storm drain network. The hotspot designation criteria was used to determine whether the site is considered a severe, confirmed or potential hotspot based on field crew observations (Wright *et al.*, 2004). The HSI results are shown in **Table 5.6 and Map A-3: Hotspot Site Investigation.** Specific commercial and business outreach ideas are noted in **Section 6.**

Table 5.6. Hotspot Confirmation Based on USSR for Oldtown Creek Subwatershed			
Hotspot	**Site ID**	**Location**	**Recommendation**
Not a Hotspot	HN4	Little Caesars	Education on downspout disconnection and waste management.
	HN5	Waffle House	Education and follow-up inspection on disposal of grease.
	HN6	Jersey Mikes	Education on dumpster management.
	HN7	Trophy Place, Jersey Mikes, Dairy Queen	Education on downspout disconnection.
	HN8	MeDucks Family Restaurant (Boulevard)	Education on disposal of grease.
	HN9	Tops China	Education on dumpster management
	HSI-11	Colonial Square Auto Care	Education on outdoor storage materials.
	HSI-15	Strip mall across from South Park Mall	Education on downspout disconnection.
Potential	HSI-1	DPU - Colonial Heights (804-520-9393)	Education and follow-up investigation of material storage.
	HN2	Sheetz	Education on stormwater management.
	HN3	Marshalls Shopping Center	Education on downspout disconnection.
	HSI-10	Hardees	Education on downspout disconnection.
	HSI-12	Town Hall Centre	Education on dumpster management.
	HSI-13	Toyota Dealership & Repair Shop	Education on outdoor material storage.
	HSI-14	Battle Park Body Shop	Education on dumpster management.

Pervious Area Assessment

The PAA assesses larger parcels of open land for potential land reclamation, reforestation or revegetation. Preliminary sites were identified in the office using aerial photos, and then visited in the field to confirm their presence. Each site was evaluated based on the quality of the vegetation present and any conditions that prevent the site from being considered a good candidate for restoration efforts. The PAA results are shown in **Table 5.7 and Map A-4: Pervious Area Assessment**.

Table 5.7. Pervious Area Assessment Results for Oldtown Creek Subwatershed				
Site ID	**Type of Project**	**Location**	**Restoration Opportunity Index**	**Feasibility**
PN-1	Open Pervious Area Restoration	Department of Public Works Yard	Poor reforestation or regeneration site.	Possible native grass planting to avoid conflicts with power lines and cell tower.
PN-2	Open Pervious Area Restoration	Marshall's Shopping Center	May be reforested with minimal site preparation.	Located adjacent to existing forest area. Salt storage on the site.
PN-3	Open Pervious Area restoration	At end of Old Town Drive	May be reforested with extensive site preparation.	Located at the end of a residential street. Site constraints include underground utilities and a basketball court.
PN-4	Open Pervious Area restoration	Located in neighborhood NN-1	May be reforested with moderate site preparation.	Good Access. Located adjacent to the stream.
PN-5	Open Pervious Area restoration	Near auto repair shop.	Good candidate for natural regeneration.	Next to auto repair shop, strip area, need to contact adjacent land owner.
PN-7	Open Pervious Area restoration	Located in neighborhood NN-2	May be reforested with moderate site preparation.	Adjacent to overhead utilities, need to enhance the soils.

5.3. Stormwater Retrofit Survey

Stormwater retrofitting is the practice of identifying stormwater treatment opportunities in developed areas where stormwater management is currently absent or poorly provided. Stormwater retrofit practices may include modifying existing stormwater facilities to enhance storage and/or treatment, and/or construction of ponds, wetlands, bioretention, sand filters and infiltration practices. Other smaller scale practices that treat and reduce stormwater runoff include stormwater planters, rain gardens and rain barrels. Retrofitting is best practiced at a subwatershed level, where, on a cumulative basis, meaningful improvements can be made to receiving water bodies. Primary retrofit sites are often located upstream of impacted stream reaches, at failing or inadequate stormwater facilities, on publicly owned land, and at uncontrolled hotspots. In Old Town Creek, retrofitting is focused on demonstration projects, projects to treat stormwater hotspots and projects to reduce stormwater impacts.

CWP staff and JRA volunteers visited retrofit sites in the field in April 2006. Nine stormwater retrofits projects were identified. The locations of the proposed stormwater retrofits are shown in **Table 5.8 and Map A-5: Stormwater Retrofits**. **Table 5.8** provides a summary of each proposed stormwater retrofit site, and selected sites are described in more detail in **Section 6.**

Table 5.8. Stormwater Retrofit Sites for Oldtown Creek Subwatershed			
Site ID	**Proposed Project(s)**	**Business/ Location**	**Observations**
R-1	On-line retrofit, in dry swale	Sheetz Gas Station and Department of Public Works Yard.	• Unmanaged existing development • 1/4 of Sheetz site with storm drainage & DPW yard • Outfall behind Sheetz & next to DPW yard is stained & origin unknown • A lot of trash
R-2	Basically needs maintenance, not much opportunity for other retrofit	Sheetz Gas Station	• Started as sediment basin - clogged and holding water, full of cattails • Probably designed with low-flow orifice, but clogged above orifice.
R-3	On-line retrofit, existing curb cut; redirect runoff from parking lot to grassy area.	Between McDonalds & Golden Corral	• Possible demonstration site. • Site needs maintenance.
R-4	On-line & off-line retrofit possible - rain garden in yard behind school; check dams	Lakeview School	• School site has 2 outfalls that lead to creek; Erosion from school yard under fence; • Areas of bare soil in field behind school
R-5	Off-line retrofit; may be difficult to capture a lot of area; tear up asphalt & restore riparian buffer with future site plan	Storage center off Boulevard (back)	• Site might be redeveloped in the future.
R-6	Remove existing asphalt adjacent to stream bank; Install bioretention cell	Storage center off Boulevard (front)	• Large expanse of asphalt - asphalt to top of stream bank • Existing curb cuts allow runoff to drain directly to stream
R-20	Off-line retrofit; create more meandering flow path so inlet does not go directly to outlet; two bioretention cells	Sam's Club and adjacent gas station	• Huge basin draining Sam's Club & gas station • Flow straight into over flow (15') • Quantity is not issue, looking for quality treatment
R-21	Engineered swale or bioretention cell with curb cuts	Adjacent to Sam's Club parking, Old Country Buffet & Mall	• Swale area with storm drain inlet.
R-22	Dig out & replace grassed area with biofilter soil mix & plants	Adjacent to Hardees and Boulevard	• Dry detention pond for water quality infiltration

Section 6. Subwatershed Action Plan for Oldtown Creek

Once restoration and protection projects were identified along the stream corridor (see **Section 5**), all relevant project data was entered into a spreadsheet and maps were produced showing project locations. This is the first step in developing a subwatershed action plan.

An important subsequent step in this planning process was to evaluate the projects based on a variety of factors (feasibility, probably cost, community interest, land ownership, and influence on water quality improvement) and develop important implementation information. Implementation factors include: a list of priority projects, potential implementation partners, and estimated costs.

For the Oldtown Creek subwatershed action plan, project prioritization took place at two levels. First, the most beneficial and feasible projects were identified immediately after the field assessments were complete (while the sites were fresh in the minds of project team members). These 29 "first tier" priority projects are described in **Sections 6.1 through 6.4 and shown in Map A-6: Priority Projects.** The first two priority projects address community education and outreach and are not shown on the map. The first tier projects were grouped into the following categories:

- Community Education & Outreach – Projects that target homeowners, business owners, or other audiences with a specific message. These projects can be collaborative efforts between the respective local government and conservation groups, such as JRA. They can also serve to fulfill certain permit obligations for localities that are implementing NPDES Phase II stormwater programs.
- Retrofits, Restoration, and Protection – Projects that pursue some type of on-the-ground improvement, such as a stormwater retrofit (as described in **Section 5.3**) or restoration of an inadequate stream buffer or eroding outfall or stream bank. Once again, these projects are excellent candidates for collaboration between local governments, conservation groups, and other stakeholders (e.g., schools, private facilities).
- Trash Clean-Up – Projects usually led by conservation groups utilizing volunteers that clean-up identified trash sites within the stream corridor. Local governments can provide important logistical and sometimes financial support.
- Investigation & Enforcement -- Efforts needed to investigate the release of pollutants (such as a leaking sewer line) and/or possible violations of local, state, or federal laws and regulations. These efforts should be carried out by the appropriate government agency or utility, and can often be coordinated with illicit discharge programs implemented by NPDES Phase II communities.

After the project data was entered in spreadsheets, mapped, and analyzed, a second tier of prioritization took place to identify the top projects to pursue for near-term implementation. Ten projects were identified as the highest priority. These projects are listed in **Section 6.5** and expected implementation strategies are noted in **Section 6.6.**

6.1. First-Tier Priorities: Community Education & Outreach

1. Commercial Education & Outreach, Especially Along Route 1: Many of the businesses exhibited stormwater drainage problems as well as management activities that pose a potential threat to water quality. Targeted education and outreach to the business could include the following components:
    a. Impervious/Downspout Disconnection: Connection of rooftop drainage to impervious surfaces was a common theme in the areas assessed. One site had several pipes extending the stormwater from the building downspouts to the back parking lot. The garages in the back parking lot had sand bags piled next to the garage to block the stormwater from entering the building. In general, impervious disconnection could include rain barrels, rain gardens, and cisterns, and could be either an outreach and/or cost-share campaign.

Project 1a. Downspouts from businesses on Route 1.

    b. Oil & Grease Management & Disposal: There are several restaurants along the Route 1 corridor that need to improve their oil and grease management. These businesses have oil and grease dumpsters that need to be maintained more frequently. The businesses should be educated on proper disposal of oil and grease and its importance.

Project 1b. Oil and grease dumpster located behind a business.

c. Waste Management: A number of businesses in the watershed (especially along the Route 1 corridor) need to improve their outdoor storage practices for materials. These businesses have overflowing dumpsters or materials stored outside without proper containment. The idea would be a mailout or site visit to educate business owners on the proper techniques to reduce contact between runoff and any materials or garbage located outside.

Project 1c. Overflowing dumpster located behind a business.

2. Neighborhood Education & Outreach: The majority of residential homes in the neighborhoods in Old Town Creek direct their downspouts to pervious areas. However, a small percentage could benefit from directing roof runoff to a rain barrel or rain garden. This program would be most beneficial as an educational tool to help residents understand their connection to Oldtown Creek. Some discussion has taken place between a DCR representative and the James Riverkeeper about the feasibility and possible sources for rainbarrels. This type of program could be tied in with other education and outreach efforts for the neighborhoods.

Project 2. Neighborhood Education & Outreach

6.2. First-Tier Priorities: Retrofits, Restoration & Protection

3. Stormwater Retrofit at Storage Center – Large Impervious Parking Lot on Route 1 (R5 & R6): The existing site is a private storage center located off of Route 1. Old Town Creek wraps around three sides of the building and parking lot. There is a loading dock and travel way behind the building. The banks of the creek are currently armored with riprap and have new concrete flumes to the creek. There is erosion along the banks. There are two proposed retrofits (one in front and one behind the building) to create bioretention areas to treat the substantial amount of runoff from this site. The timing of these retrofits may have to be synchronized with any redevelopment plans for the property. A site redesign may provide additional opportunities, such as restoring some riparian buffer area behind the building (where the existing travelway and dumpster pad are located). However, existing regulations may not be enough to ensure these retrofits take place with a redevelopment plan. Some diligence (and maybe cost-sharing through grant opportunities) will be required to make sure the retrofits happen with redevelopment.

Project 3a. Storage Center, back (R5)

Project 3b. Storage Center, front (R6)

4. Install Low-Flow Channel in Modified Channel (Reach TB-06; CM-01): Several years ago, a trapezoidal channel was constructed to alleviate flooding problems along the tributary stream just upstream from Branders Bridge Road. However, the constructed channel does not have a low flow channel, and this affects the depth of flow, water temperature, bed conditions, and, ultimately, biological conditions in the stream (which may be heavily impacted anyway by urbanization). A meandering low-flow channel could be constructed in the bottom of the existing trapezoidal channel.

Project 4. Candidate for low-flow channel (TB06)

5. Outfall Retrofits Along Tributary (Reach TB06-OT01; Reach TB07-OT03 and OT04): A couple of outfalls to the tributary are good candidates for either online or off-line retrofits. Off-line retrofits would use curb cuts to divert the first-flush to a small biofilter (reach TB06-OT01), with overflow/by-pass going to the existing inlet. The online option would construct a small bioswale right at the existing outfall channel (reach TB07-OT04).

Project 5: One of three possible outfall retrofits along tributary (TB07-OT04)

6. Protect High Quality Buffer and Wetlands from Branders Bridge Road to Woodpecker Road (Reach BB04- MI-1): In Chesterfield County between Brander's Bridge Road and Woodpecker Road, there is a nice forested buffer along Old Town Creek. There is also a beaver pond and associated wetlands. This area should be protected from development. Some existing protection may be provided through County flood plain and RPA regulations. However, this should be confirmed and other permanent protection measures (e.g., easements) explored.

Project 6. Wetland area in Old Town Creek (BB04)

7. Further investigate potential reforestation projects (PAA) at Marshall's shopping center (PN-2): There are existing turf areas located next to extensive forest at the Marshalls shopping center. The soils are compacted and probably do not have a good layer of organic matter. Extensive site preparation is needed to reforest the site.

Project 7. Pervious area near Marshalls Shopping Center (PN2).

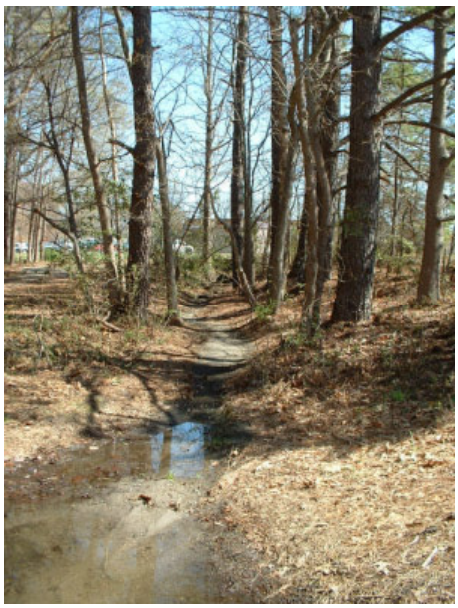
8. Home Depot Slope Stabilization: This project was not picked up by a formal USSR inventory, but is worthy of noting because of the restoration potential. The slope adjacent to Home Depot's entrance road is severely eroding, with many areas of rill and gully erosion. The site is highly visible, and does not seem to be impacted by stormwater. The slope could be regraded and seeded. An erosion control matting would probably help with stabilization. Home Depot may be a willing partner because it would be relatively easy to accomplish and would create a good public relations opportunity.

9. Stormwater Retrofit behind Sheetz & DPW Yard (R-1): There is an existing outfall behind the Sheetz on Conduit Road. The outfall drains approximately 1/3 of the Sheetz site, and also a major section of the public works storage yard behind the pump station (conveyed via a stormwater ditch). There is a lot of trash, debris, and sediment below the outfall. The outfall flows to a natural, vegetated swale. A small water quality basin could be constructed here, possibly with two forebays for the Sheetz and public works yard drainages. A low berm with a passive outlet structure (weir) is recommended, as well as a planting plan for the basin floor (See **Project 21** for photo).

10. Stormwater Retrofit at Sam's Club (R-20): This basin is a "blank slate" or sorts, because it is a large area currently covered in turf. The main inlet from a vast parking lot flows almost directly to the outlet structure, meaning that much of the basin floor area may not be utilized for any water quality purpose. The retrofit can include splitting the flow from the inlet to "biofilter pockets" within the basin floor. Basin landscaping can also enhance the water quality function and aesthetics of the basin.

Project 10: Basin at Sam's Club (R-20)

11. Lakeview School Projects (R-4): This is a cooperative project that JRA is working on. There are several retrofit opportunities at the school. The first is to construct rain garden(s) to capture roof runoff, either at the downspouts themselves or in the field just uphill from the chain link fence. The latter location would have the added benefit of capturing runoff from the turf area, which currently has several bare and eroding spots. The second option is at the existing stormwater outfall adjacent to the school. Several checkdams and a berm could be constructed to reduce erosive flows along the downstream channels. The third option is a riparian buffer planting along Oldtown Creek along the sewer line corridor (provided that the City's utility department concurs with the placement of vegetation in relation to the sewer line).



Project 11: Outfall at Lakeview School – one of several retrofit candidates (R-4)

12. Remove Fish Barriers at Reach OTC-1 and Reach OTC-2; Potential fish barriers are located in Reach OTC-1 at rock dam near Conduit Road (CM-1), and Reach OTC-2 at Interstate 95 (OTC-2, SC-1). At site OTC-1, CM-1 there is large

diameter rip rap in the channel and on the bank which forms small rock dam fish barrier just downstream of Conduit Road. At OTC-2, SC-1, there is a 1-2 ft drop from a span for Interstate 95, which has very shallow flow (also a barrier to upstream fish passage). Addressing barriers in Old Town Creek may be useful due to seemingly good quality water upstream of Colonial Heights.

Project 12A: Rip rap creating a fish barrier (OTC-1, CM-1)

Project 12B: Drop and shallow flow creating a fish barrier (OTC-2, SC-1)

13. Interstate.95 Swale (OTC-2, ER-1): This drainage swale runs adjacent to the north bound lane of Interstate.95 on the northeast side of Old Town Creek. The swale is headcutting and eroding due to uncontrolled highway runoff that is discharged to it from concrete chutes and storm drain outfalls. The recommendation is to look for infiltration opportunities in the highway median and potentially look to stabilize the swale although access is difficult due to steep side slopes from the highway and adjacent Home Depot.

Project 13: Headcut channel from Rt. 95 runoff (OTC-2, ER-1)

14. Hardees Basin Stormwater Retrofit/Plantings as Demonstration Project (R-22): This retrofit is a small stormwater basin located at the Hardees restaurant on Boulevard. Drainage to the site is mostly from the parking lot, with a small amount of road runoff. We could not identify an outlet for the basin, and can only assume it functions like an infiltration basin with no underdrain. The retrofit concept is to possibly create bioretention areas with native low-growing plants as an educational tool and for aesthetic beauty. It is likely that the soil would need to be replaced and/or amended, at least in spots where the planting would take place. The site is ideal for a demonstration project due to its high visibility, although the developed area treated would be small.

Project 14: Hardees basin retrofit (R-22)

15. Trash removal and stream buffer plantings at NSA-12 – Branders Bridge Apartments: These apartments are located adjacent along Old Town Creek in an area identified during the USA field work as needing restoration. There appears to be adequate space for additional planting to enhance the stream buffer, along with signage.

16. Post Office Demonstration Rain Garden: The local post office has some space available for another demonstration project. A small bioretention area (rain garden) can be located on the side of the post office. The benefit is the high

visibility of this project during the day as people use the post office. This would treat only the roof area.

17. Slope stabilization behind Best Buy: The slope behind the Best Buy is denuded of grass and appears to be contributing sediment to the lake. A boom has been placed, but the area could use some stabilization and grass or shrub planting to prevent further runoff.

Project 17: Slope stabilization behind Best Buy

6.3. First-Tier Priorities: Trash Clean-Up

18. Clean up trash at reach BL-07, TR-01: There is a trash pile located behind a residential house in the floodplain of Oldtown Creek. Trash includes construction materials, and other debris. There is a large amount of trash in a small area with relatively easy access. Trash could be removed by volunteers filling 2 or 3 dumpsters. Landowner education is needed to prevent further trash dumping near the stream.

Project 18. Trash in residential back yard (BL-07, TR-01)

19. Tributary Trash Clean-Up: The tributary stream (TR) has three trash areas with relatively easy access and good clean-up potential: (1) junk, appliances, and household items in the tributary just downstream from Branders Bridge Road (reach TB04-TR02), (2) a small tire dump in the floodplain near Branders Bridge Road (reach TB04-TR01), and (3) bottles, cans, and other debris just upstream from the utility crossing near the confluence with Oldtown Creek (reach TB02-TR01).

Project 19a: Trash in tributary downstream from Branders Bridge Rd (TB-04, TR-02)

Project 19b. Small tire dump downstream from Branders Bridge Rd. (TB-04, TR-01)

20. Reach WP-2 Tributary Trash Cleanup (WP-2, TR-1): This site is located above the pond on reach WP-2 to the upstream road crossing. The majority of trash is residential and includes an old swing set as well as many bottles and plastic in the stream. It appears that this site could be cleaned up by half a dozen volunteers in several hours with perhaps two pickup loads of trash.

Project 20: Residential trash along reach WP-2, TR-1

21. Reach OTC-1 (OT-1) Tributary Trash Cleanup: The majority of trash is located near the OT-1 outfall but there is additional trash and debris that could be cleaned up at this site and upstream to Conduit Rd. It appears that this site could be cleaned up by half a dozen volunteers in several hours with perhaps two pickup loads of trash. Additional cleanup of the public works yard could be performed by Colonial Heights. A retrofit project was also recommended for this site (see project #9).

Projects 9 & 21: Trash at outfall near Sheetz (OTC-1, OT-1 & R1)

6.4. First-Tier Priorities: Investigations & Enforcement

22. Colonial Heights Pump Station & Storage Yard: Evidence of past sewage overflows or spills were observed in the field in the vicinity of the pump station on Conduit Road. The frequency of sewage overflows and the steps which have been taken to address them should be investigated, and existing overflow areas cleaned up. This appears to be a serious water quality issue that should be addressed.

Project 22A: Sewage residue near Colonial Heights pump station

Project 22B: Sewage residue on fence near pump station

23. Reach OTC-4 Sanitary Concerns and Erosion (OTC-4, MI-1): This reach has serious issues including a highly incised channel with many sanitary sewer crossings including one where past failures were obvious and future sewer line breaks imminent. The sewer pipe is plastic and right at stormflow elevation with potential strainers (logs) upstream that can easily break the pipe. A lot of algae was noticed in the channel which may be evidence of past pipe failures. There is the potential for other sanitary leaks in this reach though access was difficult without waders. The sanitary line may need to be reconstructed in this area to protect the pipe from bankfull and flood flows. Upstream opportunities for retrofits may also be evaluated to reduce flows in this channel.

Project 23: Vulnerable sewer line (OTC-4, MI-1)

24. Illicit Discharge Investigations: Investigate potential illicit discharges at outfalls listed below.

Project 24A: Reach OTC-1, OT-2: Outfall with suspicious pool quality

Project 24B: Reach OTC-3, OT-1: Outfall with strong odor and pool quality issues

Project 24C: Reach TB-07, OT-1: Concrete outfall that is chipped and cracked.

Project 24D: Reach BL-03, OT-2: Metal pipe located behind the Lakeview Elementary School.

Project 24E: Reach BL-06, OT-1: Concrete pipe.

Figure 24F: Reach BB-03, OT-1: Concrete pipe that drains a residential neighborhood.

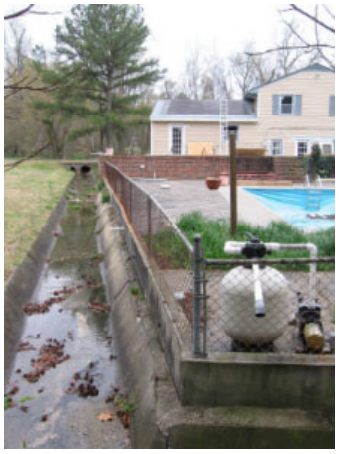


Figure 24G: There is a potential Illicit discharge of residential swimming pool discharge connected to storm drain system located at the end of Old Town Drive.

25. Construction in RPA: Investigate reach OTC-2, MI-1 construction in the RPA zone plus wetland impacts on the far side of the road embankment

Project 25A: Potential RPA encroachment (OTC-2, MI-1)

Project 25B: Wetland encroachment (OTC-2, MI-1)

26. Possible Leaking Oil: Remove Scooter (moped) in the water at reach OTC-2 (MI-2), it seems that it may be slowly leaking oil.

Project 26: Scooter in Stream (OTC-2, MI-2)

27. Utility Impacts: Investigate utility impacts listed below.

Project 27A: Reach TB-06, UT-01: Possible leaking sewer line near trapezoidal section of tributary.

Project 27B: Reach TB-06, UT-02: The pipe has joint failure, cracks and a milky gray color and staining.

Figure 27C: Reach OTC-2, UT-1: The exposed utility pipe crosses the stream and is cracked.

Figure 27D: Reach TB-01, UT-01: The pipe is corroding and cracking. There is orange iron bacteria associated with the pipe. The pipe appears to be out of service and could be removed.

28. Stormwater Maintenance at CVS Swale: There appears to be a designed swale in the grassy area in front of the CVS on Boulevard. Sediment blocks at least two of the curb cuts to this swale, and cleanout of the curbcuts together with a swale redesign to reduce channel formation may be in order. It is also possible that a bioretention swale could be located in this space to provide more stormwater treatment.

Project 28: Stormwater maintenance at CVS Swale

29. Broken Pipe behind Lakeview Elementary School (BL-03, OT-1): A section of storm drain pipe in the stream corridor behind Lakeview Elementary has broken off. The pipe should be investigated and repaired or removed.

Project 29: Reach BL-03, OT-1 metal pipe that has section broken off.

6.5. Top Project Priorities for Implementation

The desired outcome of all of the field assessments was to produce a prioritized list of projects for near-term implementation. The "first-tier" projects listed in **Sections 6.1 through 6.4** were further evaluated and ranked based on feasibility, probable cost, community interest, and ability to improve water quality. The top project list is contained in **Table 6.1.** Projects numbers in bold can be funded with sources that are already secured. Other projects will require additional funding.

Table 6.1. Top Projects for Oldtown Creek Subwatershed

Project #	Project Code	Recommendation	Potential Partners	Estimated Cost
11	R-4	Lakeview School projects: rain gardens, outfall retrofit, riparian plantings	• JRA • Lakeview School • City of Colonial Heights • Contractor	15 K
8	N/A	Slope stabilization at entrance road	• JRA • Home Depot • City of Colonial Heights	10 K
18 - 21	BL-07, TR-01 TB-04, TR-01 TB-04, TR-02 TB-02, TR-01	Clean up various trash sites in stream corridor	• JRA • City of Colonial Heights • Chesterfield County • Community groups & volunteers	2 K
3	R5 & R6	Stormwater retrofits at storage center; timing may be coordinated with redevelopment of property	• JRA • City of Colonial Heights • Property Owner • Community groups & volunteers • Contractor	35 K

Table 6.1. Top Projects for Oldtown Creek Subwatershed				
Project #	**Project Code**	**Recommendation**	**Potential Partners**	**Estimated Cost**
5	TB-06, OT-01 TB-07, OT-03 TB-07, OT-04	Stormwater retrofits at existing outfalls along tributary stream	• JRA • City of Colonial Heights • Neighborhood representatives • Community groups & volunteers	15 K
9	R1	Retrofit small basin at outfall behind Sheetz & Public Works Yard	• JRA • City of Colonial Heights • Sheetz	15 K
10	R20	Basin retrofit at Sam's Club parking lot	• JRA • City of Colonial Heights • Sam's Club • Community groups & volunteers • Contractor	15 K
14	R22	Basin retrofit at Hardees on Boulevard	• JRA • City of Colonial Heights • Hardees • Community groups & volunteers	10 K
12B	OTC-2, SC-1	Eliminate fish barrier at I-95 stream crossing	• JRA • VDOT • State/Fed game & fisheries agencies	15 K
22 - 29	Various (see project descriptions)	Investigations, corrections & possible enforcement actions; these will be turned over to the appropriate local agency.	• JRA • City of Colonial Heights • Chesterfield County	various

6.6. Next Steps for Subwatershed Action Plan

The next step is to implement specific priority projects identified in the Subwatershed Action plan (see Table 6.1, pages 58 and 59). JRA will launch the restoration efforts of Oldtown Creek with the *Extreme Stream Makeover* initiative. Over the course of this project, JRA will establish a high-profile urban restoration process for the Oldtown Creek watershed, one that can easily be replicated in other subwatersheds, via the following activities:

- Discuss results of Subwatershed Action Plan and selected retrofits with the City of Colonial Heights and Chesterfield County staff; encourage localities to continue to restore and retrofit projects identified in the Plan beyond the *Extreme Stream Makeover* project
- Build community support for the Oldtown Creek watershed through volunteer and workshop opportunities
- Implement selected projects (Table 6.2)
- Educate students, teachers and administrators about the watershed and how restoration projects on school property can improve water quality

Table 6.2. Retrofits & Restoration for Extreme Stream Makeover

Project #	Project Code	Project Location	Activity	Estimated Cost
11	R-4	Lakeview Elementary School	Rain gardens, rain barrels, outfall retrofit, riparian plantings	$15 - $20,000
8	N/A	Home Depot (Conduit Road)	Slope stabilization	$10,000
10	R-20	Sam's Club parking lot	Basin retrofit	$15 - $20,000
14	R-22	Hardees on Boulevard	Bioretention retrofit	$10,000
18 – 21	BL-07, TR-01, TB-04, TR-02, TB-02	Branders Bridge Apartments, etc.	Trash cleanup in stream corridor	$2,000

Funding for the *Extreme Stream Makeover* has been made available through the Virginia Department of Conservation and Recreation's Water Quality Improvement Fund, Home Depot and Philip Morris.

Project Timeframe

The project will begin with classroom instruction led by JRA staff at Lakeview Elementary School in late fall of 2006. The design and planning phase for retrofits will occur in fall 2006 through winter 2007. The Extreme Stream Makeover event will take place in Colonial Heights over a 6-day period in April 2007 where hundreds of volunteers will contribute their time and energy to the improvement of Oldtown Creek watershed.

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APPENDIX A

ACRONYMS

CC = County Classification metric for comparative subwatershed analysis (Section 4)

CM = Channel Modification inventory for Unified Stream Assessment (Table 5.1)

CSA = Comparative Subwatershed Analysis (Section 4)

CWP = Center for Watershed Protection

DPW = Department of Public Works (City of Colonial Heights)

ER = Severe Erosion inventory for Unified Stream Assessment (Table 5.1)

FC = Forest Cover metric for comparative subwatershed analysis (Section 4)

GIS = geographic information system

HSI = Hotspot Investigation component of Unified Subwatershed and Site Reconnaissance (Section 5)

HUC-11 = 11-digit hydrologic unit code

IB = Impacted Buffer inventory for Unified Stream Assessment (Table 5.1)

IC = Impervious Cover metric for comparative subwatershed analysis (Section 4)

IH = Impacted High category for Impervious Cover metric (Section 4)

IL = Impacted Low category for Impervious Cover metric (Section 4)

IS = Impaired Streams metric for comparative subwatershed analysis (Section 4)

JRA = James River Association

MI = Miscellaneous inventory for Unified Stream Assessment (Table 5.1)

MS = Monitoring Station metric for comparative subwatershed analysis (Section 4)

NPDES Phase II = National Pollutant Discharge Elimination System stormwater permit for small MS4s (municipal separate storm sewer systems)

NS = Non-Supporting category for Impervious Cover metric (Section 4)

NSA = Neighborhood Source Assessment component of Unified Subwatershed and Site Reconnaissance (Section 5)

OT = Outfall inventory for Unified Stream Assessment (Table 5.1)

PAA = Pervious Area Assessment component of Unified Subwatershed and Site Reconnaissance (Section 5)

PL = Protected Lands metric for comparative subwatershed analysis (Section 4)

RCH = Reach segment for Unified Stream Assessment (Section 5)

RPA = Resource Protection Area designated in local ordinance for Chesapeake Bay Preservation Act

RTE = rare, threatened, and endangered species

SC = Stream Crossing inventory for Unified Stream Assessment (Table 5.1)

SP = Sensitive Protected category for jurisdiction classifications (Section 3)

ST = Sensitive category for Impervious Cover metric (Section 4)

STATSGO = State Soil Geographic Database produced by the Natural Resources Conservation Service (NRCS)

SU = Sensitive Unprotected category for jurisdiction classifications (Section 3)

TR = Trash & Debris in Stream Corridor inventory for Unified Stream Assessment (Table 5.1)

UD = Urban Drainage category for Impervious Cover metric (Section 4)

USA = Unified Stream Assessment (Section 5)

USFW = U.S. Fish & Wildlife Service

USSR = Unified Subwatershed and Site Reconnaissance

UT = Utilities in Stream Corridor inventory for Unified Stream Assessment (Table 5.1)

VA DCR = Virginia Department of Conservation & Recreation

VA DEQ = Virginia Department of Environmental Quality

VD = Vulnerable Developing category for jurisdiction classifications (Section 3)

VDR = Vulnerable Developing Rapidly category for jurisdiction classifications (Section 3)

VI = Vulnerable Impacted category for jurisdiction classifications (Section 3)

VP = VPDES (Virginia Pollutant Discharge Elimination System) Discharger metric for comparative subwatershed analysis (Section 4)

APPENDIX B