

# HENRICO COUNTY WATER SUPPLY PLAN

A PORTION OF THE  
REGIONAL WATER SUPPLY PLAN  
For Cumberland County, Goochland County,  
Henrico County and Powhatan County



Prepared For:

Henrico County

**August 2011**

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Echo Lake Park	X	X
Glendale / Elkhill School	X	X
Osborne Park		X
Poplar Springs Baptist Church	X	X
Richmond Elks Lodge #45	X	X
St Anthony's Church	X	X
Tuckaway West Child Care Ctr.	X	X

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## EXECUTIVE SUMMARY

The Henrico County Water Supply Plan is a portion of the regional water supply developed in response to the State Water Control Board's Local and Regional Water Supply Planning Regulation 9 VAC 25-780 (the "Regulation"). The participants in the regional plan include Henrico, Goochland, Powhatan and Cumberland Counties. The Regulation requires that certain information be reviewed, evaluated and presented in the Plan. The following describes major sections of the Plan.

### I. Existing Water Supply and Existing Usage of Water

The Plan describes the existing uses of water and provides data or estimates of the amount of water used by the various types of users.

- **Henrico County Water System:** The Plan includes a description of the Henrico County water system and details the withdrawals from the James River, the capacity of the treatment facility and storage tanks, and current disaggregated uses.
- **Golf Courses:** The withdrawals from surface and ground water sources, as reported by the six (6) golf courses are detailed.
- **Purchases from City of Richmond:** The purchase of treated water from the City of Richmond is detailed.
- **Agricultural Uses:** The 2007 Census of Agriculture was used to estimate the demands for livestock and crops.
- **Self-Supplied Homes:** The estimated number of homes that rely on wells is estimated.
- **Non-Community Systems:** The demands of the recreational parks, schools, churches, etc. that are VDH-permitted systems are provided.

The table on the following page summarizes the 2009 water demands in Henrico County.

Name of System	Population Served	Water Usage (MG)	
		MGD	Annual Usage (MG)
Henrico County CWS	273,335	32.80	11,972.00
Wholesale to Goochland and Hanover		1.10	401.50
Non-Community Systems	Not Applicable	0.00	1.94
Self-Supplied Residential	23,080	2.07	758.18
Agricultural – Livestock	Not Applicable	0.01	4.20
Agricultural – Crops	Not Applicable	Not Available	Not Available
Golf Courses	Not Applicable	<u>.23</u>	<u>82.44</u>
<b>Total</b>	<b>296,415</b>	<b>36.21</b>	<b>13,220.26</b>

## II. Projected Water Demands

The Plan includes projected water demands in Henrico County through 2060. The projected demands for Henrico are consistent with the demands presented in the Joint Permit Application for the Cobbs Creek Reservoir project. In the Joint Permit Application, the 2055 Henrico demands were estimated at 110 MGD (with Henrico’s demands at 89.2 MGD and Goochland’s demands at 20.9 MGD. Demands for both counties were based on 2005 data).

The Henrico Water Supply Plan provides a projected demand in 2060 of 93.3 MGD for Henrico’s needs and 10.2 MGD for Goochland’s needs in 2060. The combined 2060 demands are 103.5 MGD as shown below.

	Joint Permit Application (2055 Demands)	Regional Water Supply Plans (2060 Demands)
Goochland	20.9 MGD	10.2 MGD <sup>1</sup>
Henrico	<u>89.2 MGD</u>	<u>93.3 MGD</u>
<b>Total</b>	<b>110.1 MGD</b>	<b>103.5 MGD</b>

<sup>1</sup> Includes Tuckahoe Creek SD, Eastern Goochland Management Area, Manakin Farms and Oilville areas and includes 5.0 MGD for economic development demands. The 2060 demands are reduced from the demands included in the JPA because actual growth from 2005 – 2011 was less than projected and the JPA assumed that buildout would be achieved by 2055. Goochland now assumes that buildout will occur beyond 2060.

**III. Statement of Need and Alternatives for Future Supply**

Henrico County’s current contract with the City of Richmond provides for up to 35 MGD and the County water treatment plant is permitted for 45 MGD. In order to meet the projected 2060 demand of approximately 103.5 MGD, Henrico needs an additional 23.5 MGD of water to meet the needs of citizens and businesses in Henrico and in Goochland.

	<b>Joint Permit Application (2055 Demands)</b>	<b>Regional Water Supply Plans (2060 Demands)</b>
Henrico/Goochland Need	110.1 MGD	103.5 MGD
Current Henrico Supply	<u>80.0 MGD</u>	<u>80.0 MGD</u>
<b>Need</b>	<b>30.1 MGD</b>	<b>23.5 MGD</b>

The Cobbs Creek Reservoir is identified as the key alternative for future water supply for Henrico County as well as for Powhatan and Goochland Counties and is designed to meet the 50-years demands of Henrico, Goochland and Powhatan as well as the future demands of Cumberland County.

**IV. Drought Plan and Ordinance**

The Regulation requires that localities develop a drought plan and ordinance. The existing Henrico County ordinance, approved by the Board of Supervisors in 2007 and revised in October 2010, meets the requirements of the Regulation.

**V. Summary**

It is recommended that the Henrico County Board of Supervisors, pursuant to a public hearing as required by the Regulation, adopt the Water Supply Plan and direct the submittal the plan to the Virginia Department of Environmental on or before November 2, 2011, as required by the Regulation.

## **1.0 INTRODUCTION**

### **1.1 Purpose of the Study**

Henrico County has prepared this Water Supply Plan to evaluate the current and future water supply needs in Henrico County to ensure that the water needs of the County will be met now and in the future.

The water supply planning process is designed to:

- ◆ Ensure that adequate and safe drinking water is available;
- ◆ Encourage, promote and protect all other beneficial uses<sup>2</sup> of water resources;
- ◆ Encourage, promote, and develop incentives for alternative water sources; and
- ◆ Promote conservation.

This Water Supply Plan was developed to comply with the State Water Control Board's Local and Regional Water Supply Planning Regulation (9 VAC 25-780-10 through 9 VAC 25-780-190, hereinafter, the "Regulation") which establishes a comprehensive water supply planning process for the development of local, regional and state water supply plans.

### **1.2 Regional Plan**

The Regulation allows for the submittal of a "regional water plan" developed and submitted by two or more counties. Since Henrico County, Powhatan County, Goochland County and Cumberland County are cooperating in the development of, or are beneficiaries of, the proposed Cobbs Creek Reservoir; these counties are participating in the development and submittal of a regional water supply plan.

This document represents Henrico County's portion of the regional plan and addresses the water sources, water uses, resources, demand management and

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<sup>2</sup> "Beneficial use" means both in-stream and off-stream uses. In-stream beneficial uses include, but are not limited to, the protection of fish and wildlife habitat, maintenance of waste assimilation, recreation, navigation, and cultural and aesthetic values. Off-stream beneficial uses include, but are not limited to, domestic (including public water supply), agricultural, electric power generation, and commercial and industrial uses.

drought responses and projected demands in Henrico County. In addition this document includes an alternatives analysis discussing the projected future needs of Henrico County.

The regional section of the Plan summarizes the sources, uses and projected demands for all counties in the region and discusses the regional alternatives to meet future demands in the region.

### **1.3 General Location and Description**

Henrico County is approximately 244 square miles in area and is located in the central portion of the Commonwealth of Virginia. The County is bordered to the south/southwest by the James River and the City of Richmond, which separates Henrico from Chesterfield County. New Kent and Charles City Counties lie to the east. To the west, Tuckahoe Creek defines Henrico's boundary with Goochland County, and the Chickahominy River to the north forms the boundary with Hanover County.

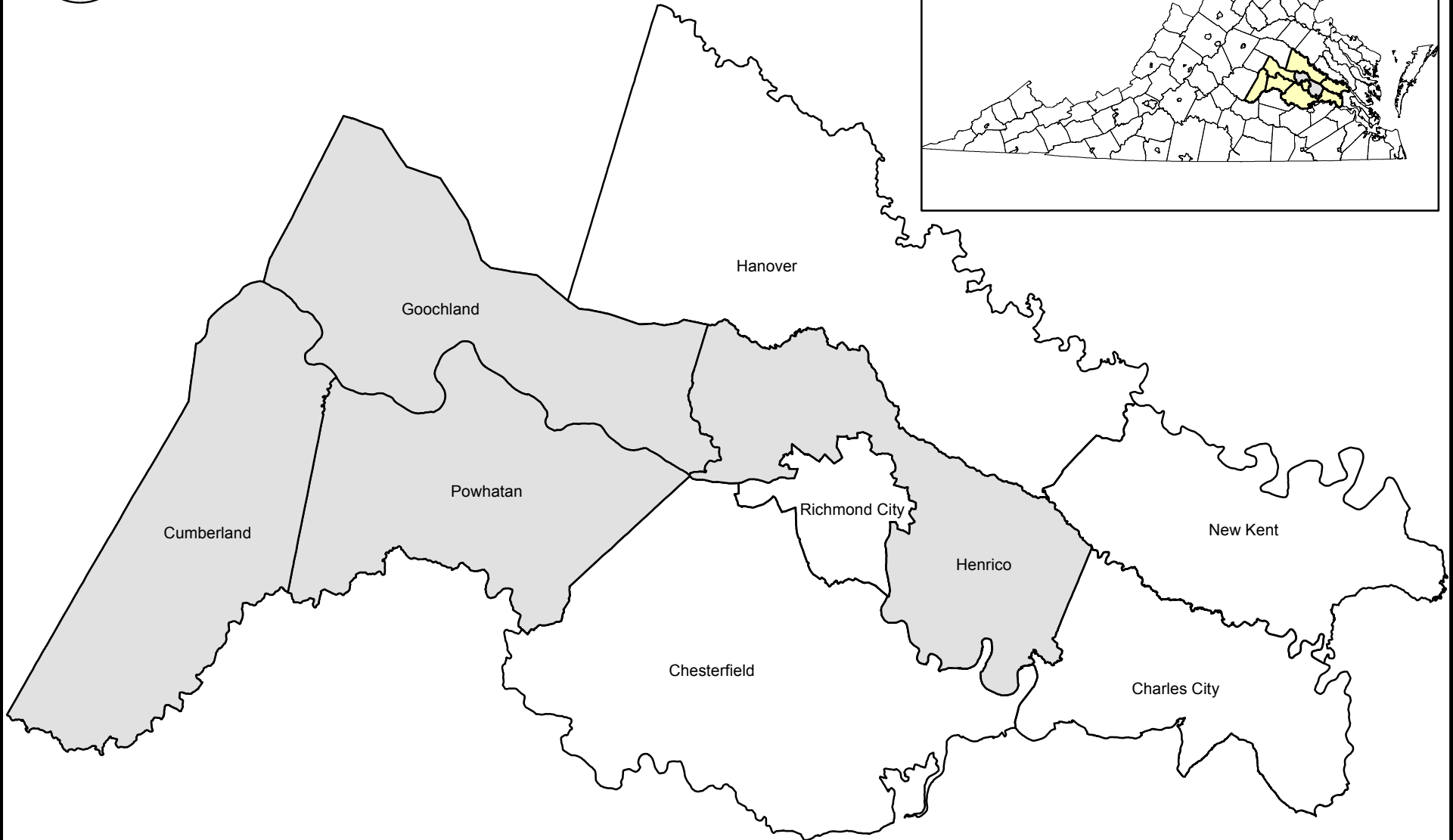
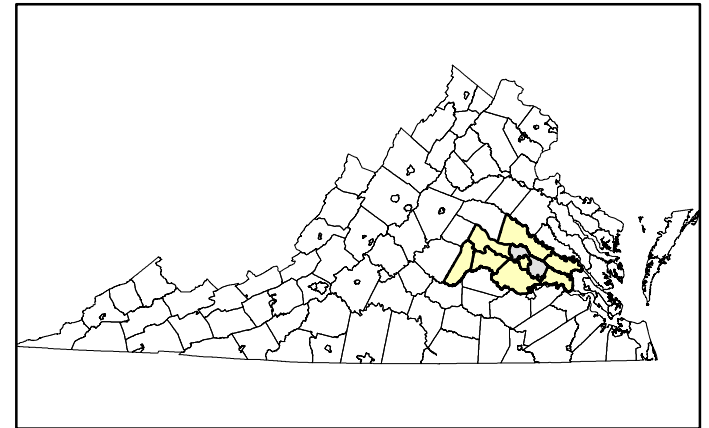
The population in 2000 was 262,300 and increased to 306,935 in 2010. **Figure 1-1** shows Henrico County's location in relation to Goochland County, Powhatan County, Chesterfield County, Hanover County, Charles City County, New Kent County, and the City of Richmond. **Figure 1-2** is a more detailed map of Henrico County and includes surface waters and major transportation corridors.

### **1.4 Abbreviations Used in This Plan**

Throughout this Water Supply Plan, a number of abbreviations are used. The following table provides definitions for each.

**Table 1-1: Abbreviations Used**

<b>Abbreviation</b>	<b>Definition</b>
cfm	Cubic feet per minute
cfs	Cubic feet per second
CWS	Community Water System
GPD or gpd	Gallons per day
GPCPD or gpcpd	Gallons per capita per day
GWMA	Ground Water Management Area
MG or mg	Million gallons
MGD or mgd	Million gallons per day
NTNC	Non-Transient Non-Community
TDH	Total Dynamic Head
TNC	Transient Non-Community
UAW	Unaccounted for Water / Water Loss
VDCR	Virginia Department of Recreation and Conservation
VDEQ	Virginia Department of Environmental Quality
VDGIF	Virginia Department of Game and Inland Fisheries
VDH	Virginia Department of Health
VOF	Virginia Outdoors Foundation



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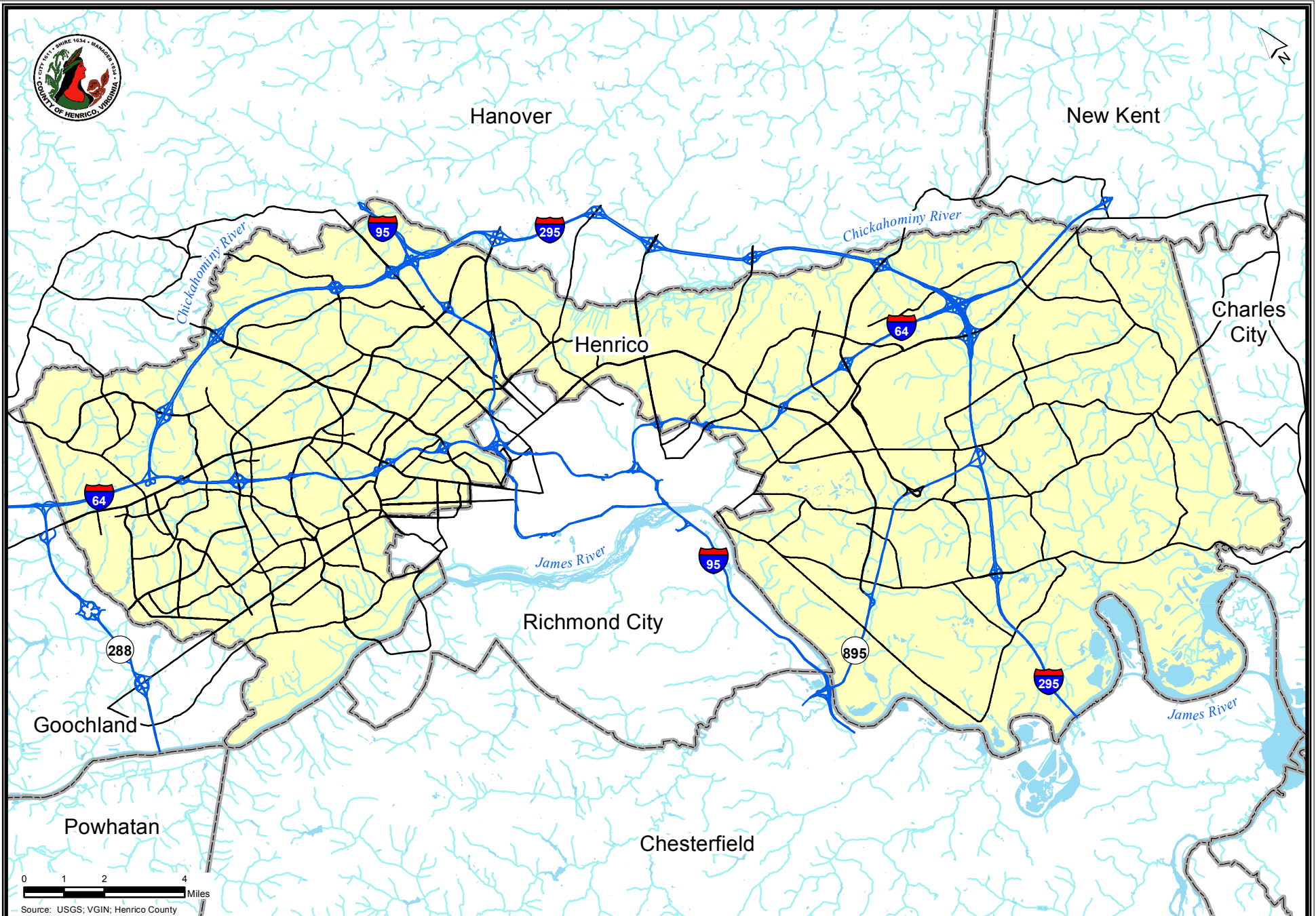
Source: USGS; ESRI; Henrico County

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BLACKSBURG, VA CHARLOTTESVILLE, VA HAMPTON ROADS, VA RICHMOND, VA

## Henrico County and Surrounding Region

Figure  
1-1



Source: USGS; VGIN; Henrico County

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BLACKSBURG, VA CHARLESFORD, VA HAMPDEN ROAD, VA RICHMOND, VA

## Henrico County, Virginia

Figure  
1-2

## 2.0 EXISTING WATER SOURCES

As required by the Regulation<sup>3</sup>, current information on existing water sources is detailed in the following sections.

### 2.1 Existing Water Sources

The residential, commercial, industrial, institutional, and agricultural sectors of Henrico County rely on ground water and surface water sources including the James River. The Henrico County water system withdraws water from the James River and purchases water from the City of Richmond.

### 2.2 Community Systems Using Ground Water<sup>4 5</sup>

Based upon review of records from the Virginia Department of Health (VDH) and the Virginia Department of Environmental Quality (VDEQ), there are no active community ground water systems in Henrico County. However, the five wells listed below are owned by Henrico County and are available for emergency needs but are not routinely used.

The following table lists these inactive wells; the general location of each is shown in **Figure 2-1**.

**Table 2-1: Inactive Henrico County Wells<sup>6</sup>**

Name	Source	Status
Bradley Acres	Well	Emergency
Elko Rd.	Well	Emergency
Old Williamsburg Rd.	Well	Emergency
Sandston Woods	Well	Emergency
White Oak	Well	Emergency

**Appendix C** includes the Engineering Description Sheets for the wells.

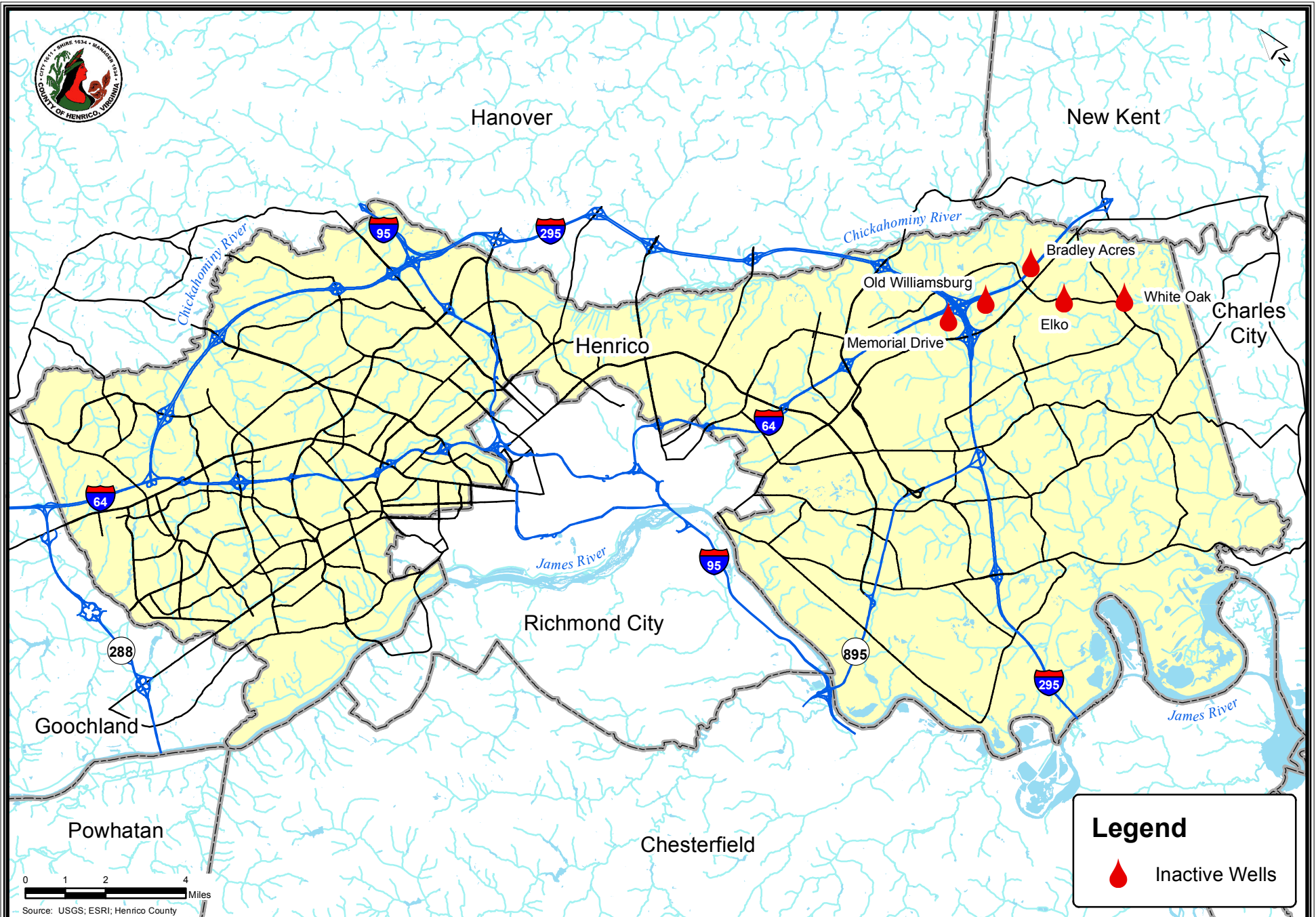
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<sup>3</sup> 9 VAC 25-780-70.

<sup>4</sup> 9 VAC 25-780-70 B.

<sup>5</sup> "Community water system" means a waterworks that serves at least 15 service connections used by year-round residents or regularly serves at least 25 year-round residents, and is regulated by the Virginia Department of Health Waterworks Regulation (12 VAC 5-590).

<sup>6</sup> These wells are all Henrico County wells.



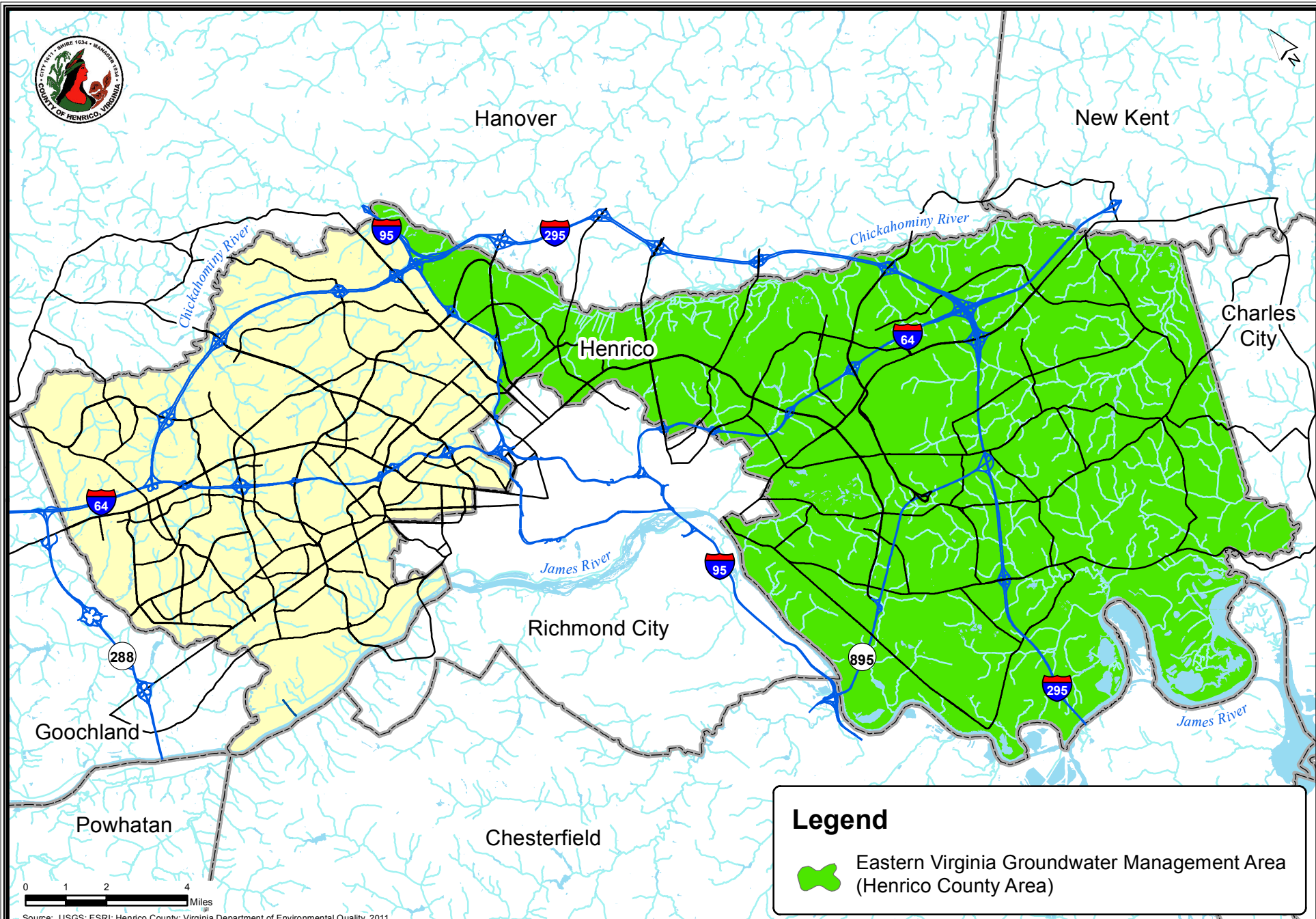
# Inactive Henrico County Wells

Henrico County, Virginia


Figure 2-1

### **2.3 Ground Water Management Area**

VDEQ regulates the withdrawal of groundwater in the Groundwater Management Areas (GWMA) of Virginia. There are two GWMA in the state – the Eastern Virginia Ground Water Management Area and the Eastern Shore Ground Water Management Area. The Eastern Virginia GWMA includes southeastern Virginia below the Mattaponi and York Rivers, and the Eastern Shore GWMA includes Accomack County and Northampton County. A portion of Henrico County is included in the Eastern Virginia GWMA. In compliance with the Ground Water Management Act of 1992, Virginia requires a permit to withdraw 300,000 gallons or more of ground water per month. The portions of Henrico County that are east of I-95 are in the Eastern Virginia Ground Water Management Area. See **Figure 2-2**.



**Legend**

-  Eastern Virginia Groundwater Management Area (Henrico County Area)

## 2.4 Community Systems Using Surface Water Reservoirs <sup>7</sup>

According to records provided by the VDH and the VDEQ, there are no community water systems withdrawing from surface water reservoirs in Henrico County. See **Appendix D** and **Appendix E**.

## 2.5 Community Systems Using Stream Intakes <sup>8</sup>

Henrico County historically operated a system of groundwater wells and purchased water on a wholesale basis from the City of Richmond to supply the county water distribution system.

In April 2004, Henrico County began operating its own 55 mgd water treatment plant using the James River as the source of raw water, while continuing to purchase water from the City of Richmond. The current VDEQ Water Protection Permit allows Henrico County to make average daily James River withdrawals of 45 mgd while maximum daily use of 80 mgd is allowed. Under the current agreement with Richmond, Henrico will continue to purchase water from Richmond (up to 35 mgd) through 2040. Under this agreement, the County can currently rely on an average supply of up to 80 mgd (45 mgd withdrawn from the James River and 35 mgd purchased from City of Richmond). The VDH Engineering Description sheet for Henrico describes the Henrico County Water System waterworks as being limited by source capacity to a flow of 80 mgd. <sup>9</sup>

### 2.5.1 *James River Intake and Pump Station*

The Henrico County Water Treatment Facility is the only community water system in Henrico County that withdraws water from a river or stream. See **Figure 2-3**.

The Henrico County Water Treatment Facility is supplied by an intake located in the James River a few miles upstream of Boshers' Dam. The James River has an approximate drainage area of 6,753 square miles above the

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<sup>7</sup> 9 VAC 25-780-70 C.

<sup>8</sup> 9 VAC 25-780-70 D.

<sup>9</sup> Virginia Department of Health, Engineering Description Sheet, January 20, 2005. Appendix A.

intake point.<sup>10</sup> The intake is located within the Middle James River Watershed Sub-Basin. The lowest daily mean flow recorded in the James River by the USGS James River gage at Cartersville<sup>11</sup>, which is located in Goochland County upstream of the existing intake, was 330 cubic feet per second (cfs) on September 14, 1966. Data collection at this site began in October 1898.<sup>12</sup>

Henrico County is wholly dependent on the James River for its water supply, which is provided by the County's own water treatment plant and water purchased from the City of Richmond. The City of Richmond's water treatment plant also withdraws and treats water from the James River from a location downstream of Boshers' Dam. Water purchased from Richmond is supplied to Henrico through 39 master meters.<sup>13</sup>

The raw water intake structure/screens for Henrico's water withdrawal are located in the James River, south of Gaskins Road, approximately 5 miles from the Henrico County Water Treatment Facility. There are two arrays of seven tee screens, each 14x42-inch diameter, and passive wedge-wire screens with 2mm openings. The screens are backwashed with an air burst system which consists of two 44-cfm air compressors and two 400-gallon receiver tanks in the air compressor building at the river. Water then flows by gravity to the wet well in the pump station.

The pump station is located 0.5 miles from the James River intake, on the north side of the river and is shown in **Figure 2-3**. There are five 700-HP, water-lubricated, vertical turbine pumps installed at the pump station. Each of these pumps has a capacity of 10,000 gpm at 200 feet TDH. Three of the pumps are variable speed and two have constant speed drives. Four pumps operating simultaneously are rated at 47 mgd at 220 feet TDH with one transmission main in service. With two transmission mains in service, they

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<sup>10</sup> USGS James River above Richmond gage drainage area data.

<sup>11</sup> USGS Gage number 02035000.

<sup>12</sup> USGS National Water Information Service, Web Interface.

<sup>13</sup> Virginia Department of Health, Engineering Description Sheet, January 20, 2005.

are rated at 72 mgd at 90 feet TDH. There is a hydropneumatic surge arrestor system for each of the two transmission mains.

Two parallel, 54-inch diameter, transmission mains carry raw water from the pump station to the treatment plant. These mains are equipped with air release and blow-off facilities.

### *2.5.2 Henrico Water Treatment Facility*

Henrico's water treatment capacity is currently 55 mgd and is expected to increase to 80 mgd when additional facility modifications are made. As of the summer of 2011, VDH is reviewing the re-rating of the facility and it is expected that VDH will increase the permitted capacity to 80 mgd.

The Henrico Water Treatment Facility treatment is configured into three treatment trains. Each train consists of coagulation, flocculation, sedimentation, and ozonation/deozonation, and filtration. Detailed descriptions of the treatment trains are included in the VDH Engineering Description Sheet for the Henrico system (see **Appendix C**).

### *2.5.3 Storage Capacity*

The system design capacity based on storage for the system is approximately 30.5 million gallons, which is adequate for the system. A description of storage facilities and capacity for each is shown in **Table 2-2** and is further detailed in **Appendix C**.

**Table 2-2: Henrico County Storage Facilities** <sup>14</sup>

<b>Pressure Zone</b>	<b>Facility Name</b>	<b>Capacity (MG)</b>
Greater Eubank	Elko Road Tanks	6.0
	Eubank Tank	1.0
	Robin Avenue Tank	3.0
Laburnum/Azalea	Len Avenue Tanks	2.5
Greater Hermitage	Mountain Road Tank	3.0
	Glen Allen Standpipe	1.1
Three Chopt Central	Cox Road Tank	2.0
	Lawrence Road Tanks	3.4
	Three Chopt Tanks	2.5
	Pouncey Tract Tanks	2.5
Three Chopt Gravity	Ridge Road Tanks	3.5
<b>TOTAL</b>		<b>30.5</b>

#### 2.5.4 *Safe Yield*

Safe yield is defined as “the quantity of water which may be withdrawn from a water source during some critical dry period without totally depleting or exhausting the source.” The Virginia Department of Health (VDH) definition of safe yield for a simple river intake is defined as “the minimum withdrawal rate available during a day and recurring every 30 years, which is equivalent to the 30 year-one day low flow.”<sup>15</sup> The 1Q30 in the James River just above Richmond is larger than Henrico County’s maximum allowable withdrawal under its DEQ VWP permit, which is 80 mgd, as described above.

Low flow events recorded in the James River by the USGS James River at Cartersville gage<sup>16</sup> for the period on record (October 1, 1898 to the present) are presented in **Table 2-3**.

<sup>14</sup> Virginia Department of Health, Engineering Description Sheet, January 20, 2005.

<sup>15</sup> 12 VAC 5-590-830.

<sup>16</sup> USGS gage number 02035000.

**Table 2-3: James River at Cartersville Gage – Low Flow Events** <sup>17</sup>

Date	Lowest Daily Mean Flows	
	cfs <sup>18</sup>	mgd <sup>19</sup>
9-14-1966	330	213
10-5-1930	348	225
9-22-1932	358	231
9-15-2002	447	289
10-15-2007	543	351
8-16-2008	474	306
9-23-2010	668	431

The lowest daily mean flow recorded in the James River by the USGS James River gage at Cartersville<sup>20</sup>, which is located in Goochland County upstream of the existing intake, was 330 cubic feet per second on September 14, 1966. This is equivalent to 213 mgd, which is significantly higher than the maximum allowable withdrawal of 80 mgd.

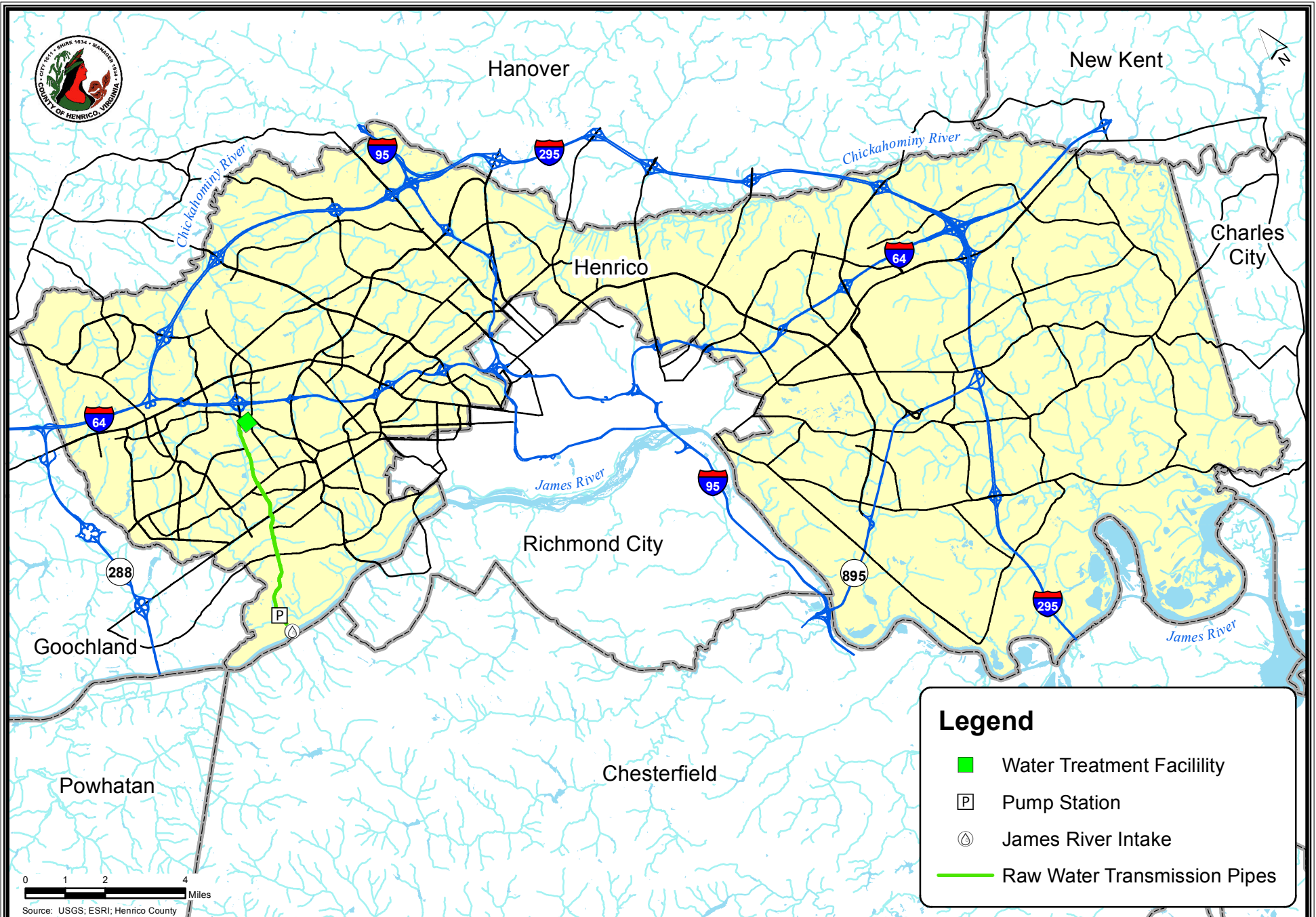
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<sup>17</sup> USGS James River at Cartersville flow data.

<sup>18</sup> Cubic feet per second.

<sup>19</sup> Million gallons per day.

<sup>20</sup> USGS gage number 02035000.



**Legend**

- Water Treatment Facility
- P Pump Station
- ⊙ A James River Intake
- Raw Water Transmission Pipes

## **2.6 Self-Supplied Non-Agricultural Users**

Two freshwater springs, located off of Turner Road in the eastern portion of Henrico County, provide commercial bottled water. The two springs, Camp Holly Spring and Diamond Spring, appear to originate in separate shallow aquifers or distinct regions within a single aquifer. Recharge for the springs is from surface water infiltration or water that travels through the soil from surface water such as ponds, creeks, or precipitation.

According to Camp Holly Springs, Inc., the company does not measure the volume of water used from the springs and does not report usage to VDEQ or any other government agency.

## **2.7 Self-Supplied Non-Agricultural Users of More Than 300,000 Gallons per Month of Surface Water and/or Ground Water<sup>21</sup>**

Water withdrawal records from VDEQ include the golf courses that withdraw more than 300,000 gallons of water per month.<sup>22</sup> Most of the golf courses use a combination of surface and groundwater. Detailed data from VDEQ is included in **Appendix E**.

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<sup>21</sup> 9 VAC 25-780-70 E and F.

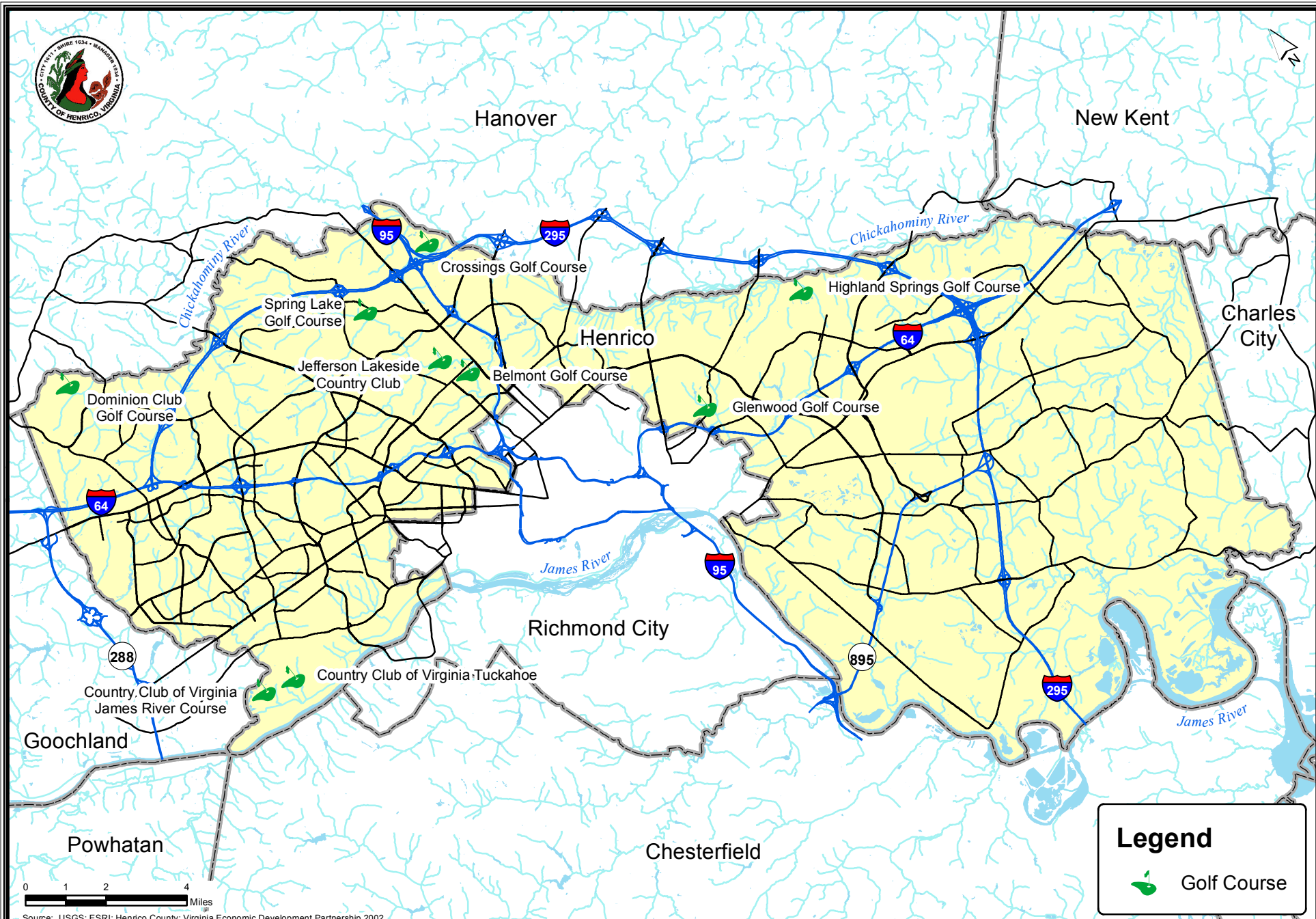
<sup>22</sup> The systems or facilities included here reported withdrawal of 300,000 gallons per month at least once during the timeframe from 2004 – 2009.

**Table 2-4: Self-Supplied Non-Agricultural Users - 2009<sup>23</sup>**

<b>System or Facility</b>	<b>Source</b>	<b>Withdrawal in 2009 (mg)</b>	<b>Average Daily Withdrawal (2009) (mg)</b>	<b>Max Day (2009) (mg)</b>	<b>Max Month</b>
Belmont Golf Course <sup>24</sup>	Ground and Surface Water including one irrigation lake, irrigation wells, North Run and Upham Creek	24.50	.0671	4.49	Not Provided
Country Club of Virginia	Surface Water, Kanawha Canal	8.00	.0219	.123	June
Glenwood Golf Course	Surface Water, Glenwood Pond	15.15	.0415	.230	August
Highland Springs Golf Course	Surface Water, 13 Lakes	No Withdrawal Data for 2008 or 2009			
Jefferson-Lakeside Country Club	Ground and Surface Water, #16 Well and Lakeside Lake	21.13	.0579	.400	September
The Crossings Golf Course	Surface Water, Buck's Pond and Chickahominy River	13.66	.0374	.500	July
<b>Total Annual Withdrawal</b>		<b>82.44</b>			

<sup>23</sup> Source: VDEQ Water Withdrawal Records, see Appendix E.

<sup>24</sup> Data for 2008, no data available for 2009.



Source: USGS; ESRI; Henrico County; Virginia Economic Development Partnership 2002

## 2.8 Amount of Surface Water Purchased from Outside of Henrico County<sup>25</sup>

Under an agreement with the City of Richmond, Henrico County may purchase water from Richmond (up to 35 mgd) through 2040.<sup>26</sup> The contract requires that Henrico purchase 11.8 mgd and as shown below, Henrico has purchased 12 mgd, or more each year from 2006 – 2010. The amount of water purchased from the City of Richmond for the years from 2004 – 2010 is presented in the following table. (The Richmond/Henrico Contract is included in **Appendix I.**)

**Table 2-5: Henrico Water Purchases from City of Richmond – 2004 – 2010<sup>27</sup>**

<b>Date</b>	<b>Average Water Purchases (mgd)</b>
2004	33.8
2005 <sup>28</sup>	31.0
2006	17.1
2007	16.4
2008	15.3
2009	16.0
2010	12.3

## 2.9 Agricultural Users Using More than 300,000 Gallons per Month<sup>29</sup>

Generally, VDEQ records are one of the few sources of information regarding agricultural users of surface and ground water. However, VDEQ’s withdrawal records for Henrico County do not include any data submitted by agricultural users.

## 2.10 Estimate of Total Agricultural Usage by Source and Usage for Irrigation vs. Non-Irrigation<sup>30</sup>

The 2007 Census of Agriculture provides certain information that is often useful in estimating the number of farms that irrigate crops or use water for farm animals.<sup>31</sup> However, the information for Henrico County not detailed enough to estimate usage for irrigation.

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<sup>25</sup> 9 VAC 25-780-70 G.

<sup>26</sup> Richmond-Henrico Water Agreement, September 29, 1994

<sup>27</sup> Source, Henrico County Department of Public Utility records, dated June 29, 2011.

<sup>28</sup> Decrease in 2005 is the result of Henrico starting operation of the Henrico County water treatment facility.

<sup>29</sup> 9 VAC 25-780-70 I.

<sup>30</sup> 9 VAC 25-780-70 I.

<sup>31</sup> Source: Tables 1 and 10. County Summary Highlights, 2007 Census of Agriculture.

The following tables and narrative concerning crops and livestock was made available by the 2007 Census of Agriculture and is the basis for estimating the water usage for livestock. Based on the information available, it is not known if any one user exceeds 300,000 gallons per month. Further, it is not known if the water is from ground water or surface water sources.

### 2.10.1 Crop Irrigation

In 2007, there were 178 farms in Henrico totaling 20,096 acres. The average farm was 113 acres and the median farm was 35 acres. Only 16 farms irrigated cropland; the total acreage irrigated was not disclosed and the types of crops irrigated were not disclosed. Since the Census of Agriculture does not provide information about the types of crops irrigated, or the acreage of the various types, it is not possible to estimate the irrigation usage in Henrico County.

### 2.10.2 Livestock Needs

The 2007 Census of Agriculture provides the following information concerning livestock in Henrico County.

**Table 2-6: Henrico County Livestock Information- 2007<sup>32</sup>**

	<b># Farms</b>	<b># of Animals</b>	<b>Gallons of Water Needed Per Day Per Animal<sup>33</sup></b>	<b>Estimated Annual Usage (Gallons)</b>
Cattle and Calves	65	951	12.00	4,165,380
Poultry – Layers	17	399	0.06	8,738
Hogs and Pigs	3	11	3.50	14,053
Sheep and Lambs	5	138	2.00	<u>100,740</u>
<b>Total</b>				<b>4,288,911</b>
				<b>4.2 MG per year</b>

## 2.11 Estimated Residences that are Self-Supplied <sup>34</sup>

The Regulation requires that the water supply plan include an estimate of the number of residences and businesses that are self-supplied by individual wells.

<sup>32</sup> Source: 2007 Census of Agriculture. Table 1.

<sup>33</sup> Source: Method for Estimating Water Withdrawals for Livestock in the United States, 2005; U.S. Department of Interior, U.S. Geological Survey; page 3; median water-use coefficients are used. Based on the 2007 Census of Agriculture, it is assumed that most cattle are beef cattle, not dairy cattle.

<sup>34</sup> 9 VAC 25-780-70 J.

Neither Henrico County nor the local health department maintains records detailing the number of self-supplied users in the county. The following calculations provide an estimate of 9,657 self-supplied homes. The majority of the businesses in the county are in areas that are served by the public water system.

**Table 2-7: Estimate of Self-Supplied Homes - 2009<sup>35</sup>**

Item	#
County Population – 2009 Estimate	296,415
Persons in Group Quarters	6,811
Single-Family Connections <sup>36</sup>	86,255
Estimated Single-Family Population Served by Henrico County Public Utilities <sup>37</sup>	206,149
Single-Family Consumption <sup>38</sup>	80 gallons per capita per day
Multi-Family Consumption <sup>39</sup>	4.83 mgd
Estimated # MF Population Served <sup>40</sup>	<u>60,375</u>
Estimated Population Served by DPU	273,335
Balance of Population - Self-Served <sup>41</sup>	23,080
# of Self-Served Homes <sup>42</sup>	9,657

## 2.12 Findings from Source Water Assessment Plans (SWAPs) <sup>43</sup>

Source water assessments have been completed for most areas in the Commonwealth. The VDH Source Water Assessment results for wells in Henrico County are shown in **Table 2-8**. Most of the wells in Henrico were assessed in 2002 and most were considered to have a “High Susceptibility” to water quality degradation. As noted in **Table 2-8**, many of the wells have been abandoned since 2002, when this SWAP was completed.

All areas of the Commonwealth are vulnerable to ground water quality degradation. Common land use activities that threaten ground water quality include on-site

<sup>35</sup> Source: 2007 Census of Agriculture. Table 1.

<sup>36</sup> Source: March 2010 DPU Managers Report.

<sup>37</sup> Connections X 2.39 persons per household.

<sup>38</sup> Source: Calculated from Department of Public Utilities fiscal year reports.

<sup>39</sup> Source: Department of Public Utilities fiscal year reports.

<sup>40</sup> Multi-family consumption / 80 gpcpd

<sup>41</sup> 296,415 - 6,811 - 266,524 = 23,080

<sup>42</sup> Self-served population divided by 2.3 persons per household.

<sup>43</sup> 9 VAC 25-780-70 K.

sewage systems, fuel storage systems, pastures, crop and fodder production, roadways, parking lots, gasoline stations and service centers, solid waste collection and transfer sites, wastewater pumping stations and underground storage tanks.

There are no wellhead protection plans or source water protection programs in effect in Henrico County.

**Table 2-8: SWAP Results**

<b>PWSID</b>	<b>Name</b>	<b>Active or Inactive</b>	<b>Source Name</b>	<b>Susceptibility</b>	<b>SWAP Date</b>	<b>Type<sup>44</sup></b>
4087200	Deep Bottom Boat Ramp	Active	Well	High	12/18/2002	NC
4087250	Echo Lake Park	Active	Well	High	12/18/2002	NC
4087300	Fort Harrison National Park	Active	Well	High	2/6/2002	NC
4087360	Glendale / Elkhill School	Active	Well		7/15/2004	NTNC
4087380	Gravel Hill Community Center	Active	Drilled Well #2	High	12/18/2002	NC
4087850	Kingsland Reach Marina	Active	Well	High	12/18/2002	NC
4087720	Osborne Park	Active	Drilled Well #1			NC
4087760	Poplar Springs Baptist Church	Active	Well	Low	12/18/2002	NC
4087770	RF&P Park Phase I	Active	Phase I - Well #1	Moderate	12/18/2002	NC
4087771	RF&P Park Phase II	Active	Phase II - Well #2	Moderate	12/18/2002	NC
4087775	Richmond Elks Lodge #45	Active	Well	High	12/13/2002	NC
4087790	Sailor's Tavern	Active	Bored Well #1			NC
4087815	St Anthony's Church	Active	Drilled Well No. 2	High	3/27/2002	NTNC
4087860	Tuckaway West Child Care Center	Active	Drilled Well	High	2/6/2002	NTNC
4087880	VDOT 895	Active	Drilled Well			NTNC
4087240	Verizon	Active	Drilled Well	Low	3/27/2002	NTNC
4087075	Biltmore	Inactive	Drilled Well	High	2/6/2002	C
4087140	Colonial Court	Inactive	CC #1 Well (EP#3)	Low	3/27/2002	C
4087140	Colonial Court	Inactive	EG #1a Well (EP#2)	High	3/27/2002	C
4087140	Colonial Court	Inactive	EG #2a Well (EP#4)	High	3/27/2002	C
4087140	Colonial Court	Inactive	NH #1 Well (EP#1)	Low	3/27/2002	C
4087160	Courtney Subdivision	Inactive	Well No. 1	High	2/6/2002	C
4087160	Courtney Subdivision	Inactive	Well No. 2	High	2/6/2002	C
4087370	Glenwood Gardens	Inactive	Drilled Well	High	2/6/2002	C
4087500	Kildare	Inactive	Drilled Well	High	2/6/2002	C
4087660	Mechanicsville Gardens	Inactive	Drilled Well	High	2/6/2002	C
4087680	Mimosa Park	Inactive	Drilled Well #1	High	2/6/2002	C
4087680	Mimosa Park	Inactive	Drilled Well #2	High	2/6/2002	C
4087750	Pine Heights	Inactive	Drilled Well	High	2/6/2002	C
4087780	Ridgecrest Subdivision	Inactive	Well No. 3	High	2/6/2002	C
4087900	Wedgewood Farms	Inactive	Well #1A	Low	3/27/2002	C
4087910	West Wistar	Inactive	Drilled Well	High	2/6/2002	C
4087920	Westwood Manor	Inactive	Drilled Well	High	2/6/2002	C
4087960	Woodlawn Farms	Inactive	Well #2 (Ep#2)	High	3/27/2002	C

### **2.13 Self-supplied Businesses using Less than 300,000 Gallons per Month <sup>45</sup>**

The Regulation requires that the water plan include an estimate of the businesses that are self-supplied by individual wells withdrawing less than 300,000 gallons per month.

<sup>44</sup> C = Community System, NC = Non-Community System, and NTNC = Non-Transient Non-Community System.

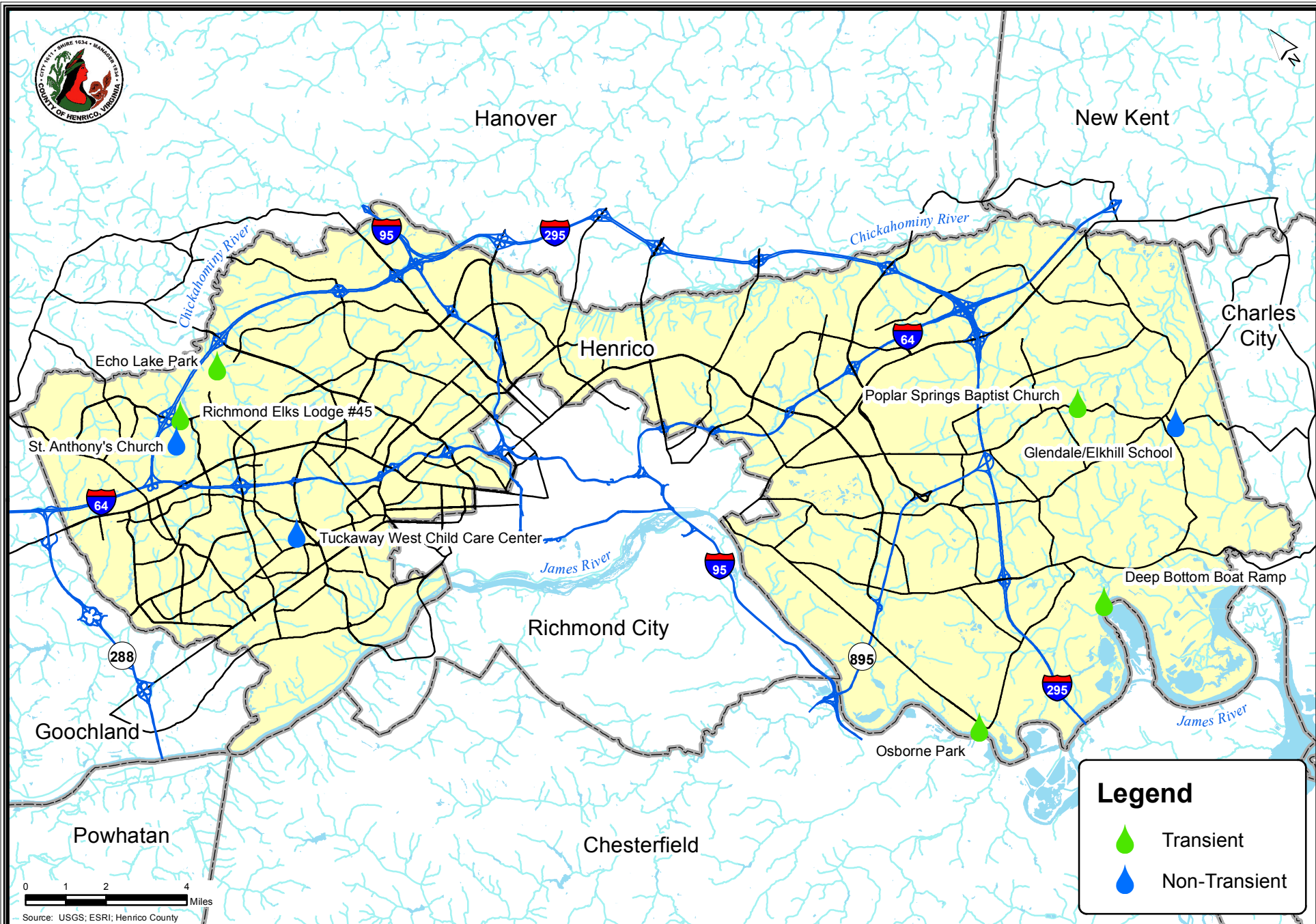
<sup>45</sup> 9 VAC 25-780-70 J.

Review of Henrico County GIS data indicates that there are 344 commercial parcels with wells. It is not possible to determine which of these parcels are in active commercial use and which are withdrawing groundwater, or how much groundwater is withdrawn.



**Table 2-9** lists the non-community water systems in Henrico County. All withdraw less than 300,000 gallons per month.

**Table 2-9: Non-Community Systems**

<b>PWSID</b>	<b>System Name</b>	<b>Type</b>	<b>Service Connections</b>	<b>Population Served</b>	<b>Owner</b>
4087200	Deep Bottom Boat Ramp	NC	2	50	Henrico County Recreation And Parks
4087250	Echo Lake Park	NC	1	50	Henrico County Recreation And Parks
4087360	Glendale / Elkhill School	NTNC	2	60	Glendale Community Bible Church
4087720	Osborne Park	NC	2	50	Henrico County Recreation And Parks
4087760	Poplar Springs Baptist Church	NC	1	250	Poplar Springs Baptist Church
4087775	Richmond Elks Lodge #45	NC	1	50	Richmond Elks Lodge #45
4087815	St Anthony's Church	NTNC	6	60	St Anthony's Church
4087860	Tuckaway West Child Care Ctr.	NTNC	2	50	Tuckaway, Inc.



**Legend**

-  Transient
-  Non-Transient

### 3.0 EXISTING WATER USE

The water use information required by 9 VAC 25-78-80 is summarized in the following text and tables.

#### 3.1 Community Water Systems

The Henrico County Water Treatment Facility is the only community water system in Henrico County and the public system is supplied wholly by the James River. The estimated population served by the Henrico County water system was approximately 273,335 in 2009. Henrico County provides water service to approximately 95,800<sup>46</sup> residential, commercial and industrial retail customer accounts.<sup>47</sup> In addition, Henrico County has wholesale water service agreements to supply water to the adjoining counties of Goochland and Hanover.

Henrico County operates 26 water pumping stations and water storage facilities, maintains 1,400 miles of water mains and has 10,400 fire hydrants in service.

The amount of water used in the planning area comes from two sources: the Henrico County Water Treatment Facility, and purchases from the City of Richmond. Monthly water production for the Henrico Water Treatment Facility and water purchases from the City of Richmond for the years 2005 through 2007 are presented in **Table 3-1**.

Under an agreement with the City of Richmond, Henrico County may purchase water from Richmond (up to 35 mgd) through 2040.<sup>48</sup> The contract requires that Henrico purchase 11.8 mgd and as shown below, Henrico has purchased 12 mgd, or more each year from 2006 – 2010. The amount of water purchased from the City of Richmond for the years from 2008 – 2010 is presented in the following table. (The Richmond/Henrico Contract is included in **Appendix I**.)

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<sup>46</sup> Source: Water Utility – Sales and Revenue, 5-Year Summary, Fiscal Year Ending June 30, 2009; prepared by Henrico Co. DPU.

<sup>47</sup> Data provided by Henrico County Public Utilities, Monthly Manager Reports.

<sup>48</sup> Richmond-Henrico Water Agreement, September 29, 1994

**Table 3-1: Henrico Water Purchases from City of Richmond – 2008 – 2010<sup>49</sup>**

<b>Date</b>	<b>Average Water Purchases (mgd)</b>
2008	15.3
2009	16.0
2010	12.3

**Table 3-2** details the monthly production at the Henrico water treatment facility and the purchases from the City of Richmond for 2005 – 2007. The decrease in amount purchased from 2005 to 2006 is a result of starting operation of Henrico County’s own water treatment facility.

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<sup>49</sup> Source: Henrico County Department of Public Utility records, dated 6/29/2011.

**Table 3-2: Henrico County – Monthly Water Production and Water Purchase - 2005 - 2007<sup>50</sup>**

Month	Water Production / Monthly (MG)								
	2005			2006			2007		
	WTP	City	Total	WTP	City	Total	WTP	City	Total
Jan	417.9			494.2	518.4	1,012.6	561.1	465.0	1,026.1
Feb	390.4			498.8	395.6	894.4	538.9	410.1	949.0
Mar	420.4	Monthly data for water purchases from City of Richmond is not available for 2005.		587.0	450.6	1,037.6	608.6	474.6	1,083.2
Apr	445.5			696.0	478.8	1,174.8	714.3	440.2	1,154.5
May	618.2			822.0	532.0	1,354.0	936.6	478.0	1,414.6
Jun	817.5			936.9	512.5	1,449.4	1,035.0	504.5	1,539.5
Jul	934.2			1,053.2	509.5	1,562.7	1,146.1	499.6	1,645.7
Aug	905.2			1,166.4	487.1	1,653.5	1,075.5	539.0	1,614.5
Sep	1,081.2			825.8	448.2	1,274.0	1,128.8	449.8	1,578.6
Oct	776.8			767.5	468.5	1,236.0	1,052.8	461.3	1,514.1
Nov	593.0			600.8	450.3	1,051.1	624.8	439.9	1,064.7
Dec	<u>461.3</u>			<u>559.8</u>	<u>462.7</u>	<u>1,022.5</u>	<u>560.0</u>	<u>508.7</u>	<u>1,068.7</u>
Annual Total	<b>7,861.6</b>	<b>8,265.0</b>	<b>16,126.6</b>	<b>9,008.4</b>	<b>5,714.2</b>	<b>14,722.6</b>	<b>9,982.5</b>	<b>5,670.7</b>	<b>15,653.2</b>
Daily Average (MGD)	<b>21.5</b>	<b>22.6</b>	<b>44.2</b>	<b>24.7</b>	<b>15.7</b>	<b>40.3</b>	<b>27.3</b>	<b>15.5</b>	<b>42.9</b>
Monthly Average. (MG)	<b>655.1</b>	<b>688.8</b>	<b>1,343.9</b>	<b>750.7</b>	<b>476.2</b>	<b>1,226.9</b>	<b>831.9</b>	<b>472.6</b>	<b>1,304.4</b>

<sup>50</sup> Based on VDEQ Water Usage Reports for Henrico County. No monthly data available for purchases from City of Richmond in 2005.

Disaggregated water usage for Henrico County is presented in the following table.

**Table 3-3: Henrico County 2009 Disaggregated Use** <sup>51</sup>

Disaggregated Category	No. of Connections	Water Use (mgd)	Percentage of Total Usage (%)
Residential – Single-Family	85,505	16.09	47.5%
Residential – Multi-Family	1,923	4.83	14.3%
Commercial	5115	9.42	27.8%
Industrial	619	2.43	7.2%
Wholesale (to Goochland and Hanover)	-	1.10	3.2%
<b>Total</b>	<b>93,162</b>	<b>33.86</b>	<b>100.0 %</b>

Henrico County’s peak day water use by month for the period 2005 through 2007 is shown in **Table 3-4**.

**Table 3-4: Henrico County Peak Day Water Use by Month (2005-2007)**

Month	Peak Day Flow (mgd)		
	2005	2006	2007
January	34.14	35.71	31.04
February	33.79	36.08	35.99
March	32.58	39.78	39.88
April	38.74	45.40	49.35
May	43.71	59.28	54.62
June	57.53	56.89	59.59
July	57.88	58.18	60.43
August	57.24	60.82	62.61
September	59.52	47.51	60.09
October	54.78	46.58	59.64
November	43.65	39.07	41.65
December	38.10	32.40	38.02

As shown above, the highest peak day use occurs during the summer months. In 2007, the highest peak day use occurred in August and was 62.61 MGD.

<sup>51</sup> Source: Henrico County DPU Records.

### 3.2 Self-Supplied Non-agricultural Users of More than 300,000 Gallons per Month of Surface and Ground Water within the Service Area of a Community Water System<sup>52</sup>

Water withdrawal records from VDEQ include a number of golf courses that withdraw more than 300,000 gallons of water per month.<sup>53</sup> All of these golf courses are within the service area of Henrico County’s public water system. Detailed data from VDEQ is included in **Appendix E**.

**Table 3-5: Self-Supplied Non-Agricultural Users - 2009<sup>54</sup>**

System or Facility	Source	Withdrawal in 2009 (mg)	Average Daily Withdrawal (2009) (mg)	Max Day (2009) (mg)	Max Month
Belmont Golf Course <sup>55</sup>	Ground and Surface Water including one irrigation lake, irrigation wells, North Run and Upham Creek	24.50	.0671	4.49	Not Provided
Country Club of Virginia	Surface Water, Kanawha Canal	8.00	.0219	.123	June
Glenwood Golf Course	Surface Water, Glenwood Pond	15.15	.0415	.230	August
Highland Springs Golf Course <sup>56</sup>	Surface Water, 13 Lakes	No Withdrawal Data for 2008 or 2009			
Jefferson-Lakeside Country Club	Ground and Surface Water, #16 Well and Lakeside Lake	21.13	.0579	.400	September
The Crossings Golf Course	Surface Water, Buck’s Pond and Chickahominy River	13.66	.0374	.500	July
<b>Total</b>		<b>82.44</b>			

<sup>52</sup> 9 VAC 25-780-80 C.

<sup>53</sup> The systems or facilities included here reported withdrawal of 300,000 gallons per month at least once during the timeframe from 2004 – 2009.

<sup>54</sup> Source: VDEQ Water Withdrawal Records, see Appendix B.

<sup>55</sup> Data for 2008, no data available for 2009.

<sup>56</sup> Highland Springs Golf Course is adjacent to a neighborhood that is served by the community water system.

### 3.3 Self-Supplied Agricultural Users of More than 300,000 Gallons per Month of Surface and Ground Water within the Service Area of the Community System

Based on review of water withdrawal records from VDEQ, there are no known self-supplied agricultural users of more than 300,000 gallons per month from a surface or ground water source in Henrico County. Therefore, it is assumed that there are no self-supplied agricultural users of more than 300,000 gallons per month within the service area of the Henrico County community water system.

### 3.4 Self-Supplied Users of Less than 300,000 Gallons per Month of Ground Water within the Service Area of the Community System<sup>57</sup>

There is no available data that provides the number of self-supplied users (residential and non-residential) users within the service area of the community water system. However, the following non-community systems are located within the service area of the Henrico County water system. The following table summarizes water use data for these systems. All rely on ground water.

**Table 3-6: Water Usage Data - Non-Community Systems<sup>58</sup>**

Name of System	Type <sup>59</sup>	Number of Connections	Population Served	GPD
Deep Bottom Boat Ramp	NC	2	50	No Information Available
Echo Lake Park	NC	1	50	47
Glendale Elkhill Schools	NTNC	2	30 <sup>60</sup>	627
Osborne Park	NC	2	50	241
Poplar Springs Baptist Church	NC	2	250	At least 647
Richmond Elks Lodge #45	NC	1	15 - 50	1,078
St. Anthony's Church	NTNC	6	60	2,249
Tuckaway West Child Care Center	NTNC	2	50	343
<b>Total</b>				<b>Approximately 5,323 GPD</b>

### 3.5 In-Stream Beneficial Uses

The Henrico County community water system relies on the James River. The in-stream beneficial uses of the James River are as follows:

- ◆ Fish and wildlife habitat;

<sup>57</sup> 9 VAC 25-780-80 B, 8.

<sup>58</sup> Source: VDH Groundwater System Sanitary Survey Reports, various dates, see **Appendix F**.

<sup>59</sup> NTNC – Non-Transient Non-Community; NC – Non-Community.

<sup>60</sup> School is licensed by Social Services for 65 students and staff. As of 2007, there were 21 students and 9 staff.

- ◆ There are numerous point source discharges in the James Basin; the river is important of the assimilation of waste from point source discharges;
- ◆ The James River is also important for the assimilation of non-point sources of pollution;
- ◆ The James River, from Winginia to Maidens, has been evaluated by the Virginia Department of Conservation and Recreation (VDCR) and has been found to have components that may qualify it for designation as a scenic river.
- ◆ Recreational uses of the James River include fishing, boating and swimming;
- ◆ Farmers use the James River for irrigation; and
- ◆ The James River has scenic, geologic, hydrologic, historic and botanic values.

### **3.6 Estimate of Water Used by Self-Supplied Non-Agricultural Users of more than 300,000 Gallons per Month and Outside of the Service Areas of the Community Water System**

VDEQ and VDH records do not indicate the presence of any non-agricultural users outside of the community water system service area that report usage of more than 300,000 gallons per month. As noted in Section 2 of this report, two springs in the eastern portion of Henrico are used for bottled water. The bottling company, Camp Holly Springs, Inc., does not meter the flow and does not report to VDEQ.

### **3.7 Estimate of Water Used by Self-Supplied Agricultural Users of more than 300,000 Gallons per Month and Outside of the Service Areas of the Community Water System**

VDEQ records do not include any water withdrawal reports for agricultural users. The following table provides an estimate of the amount of water used on an annual basis by agricultural users. However, it is not known if any one user withdraws more than 300,000 gallons in any given month.

The following tables and narrative concerning crops and livestock was made available by the 2007 Census of Agriculture and is the basis for estimating the water usage for agriculture.

### 3.7.1 Usage for Irrigation

In 2007, there were 178 farms in Henrico totaling 20,096 acres. The average farm was 113 acres and the median farm was 35 acres. Only 16 farms irrigated cropland; the total acreage irrigated was not disclosed and the types of crops irrigated were not disclosed. Since the Census of Agriculture does not provide information about the types of crops irrigated, or the acreage of the various types, it is not possible to estimate the irrigation usage in Henrico County.<sup>61</sup>

### 3.7.2 Estimated Usage for Livestock

The 2007 Census of Agriculture provides the following information concerning livestock in Henrico County.

**Table 3-7: Henrico County Livestock Information- 2007<sup>62</sup>**

	# Farms	# of Animals	Gallons of Water Needed Per Day Per Animal <sup>63</sup>	Estimated Annual Usage (Gallons)
Cattle and Calves	65	951	12.00	4,165,380
Poultry – Layers	17	399	0.06	8,738
Hogs and Pigs	3	11	3.50	14,053
Sheep and Lambs	5	138	2.00	100,740
<b>Total</b>				<b>4,288,911</b>
				<b>4.2 MG per year</b>

## 3.8 Estimate of Water Used by Self-Supplied Users of Less than 300,000 gallons per Month

As shown in **Table 2-7**, it is estimated that approximately 9,657 households, serving 23,080 persons are self-supplied.

<sup>61</sup> Source: Tables 1 and 10. County Summary Highlights, 2007 Census of Agriculture.

<sup>62</sup> Source: 2007 Census of Agriculture. Table 1.

<sup>63</sup> Source: Method for Estimating Water Withdrawals for Livestock in the United States, 2005; U.S. Department of Interior, U.S. Geological Survey; page 3; median water-use coefficients are used. Based on the 2007 Census of Agriculture, it is assumed that most cattle are beef cattle, not dairy cattle.

Assuming that the average usage per capita is 80 – 100 gallons per capita per day, the estimated daily usage is 1.8 million – 2.3 million gallons per day and the annual usage is 673.9 million – 842.4 million.

Review of Henrico County GIS data indicates that there are 344 commercial parcels with wells. It is not possible to determine which of these parcels are in active commercial use, which are withdrawing groundwater, or how much groundwater is withdrawn.

### 3.9 Summary of All Uses

The following table summarizes the water usage in Henrico County and is based on 2009 data.

**Table 3-8: Summary of All Withdrawals<sup>64</sup>**

Name of System	Population Served	Water Usage (MG)	
		MGD	Annual Usage (MG)
Henrico County CWS	273,335	32.8	11,972.00
Wholesale to Goochland and Hanover		1.10	401.50
Non-Community Systems	Not Applicable	0.00	1.94
Self-Supplied Residential <sup>65</sup>	23,080	2.07	758.18
Self-Supplied Non-Residential	Not Applicable	Not Available	Not Available
Agricultural – Livestock	Not Applicable	0.01	4.20
Agricultural – Crops	Not Applicable	Not Available	Not Available
Golf Courses	Not Applicable	.23	82.44
<b>Total</b>	<b>296,415</b>	<b>36.21</b>	<b>13,220.26</b>

<sup>64</sup> Based on 2009 population and water usage.

<sup>65</sup> Estimated usage based on 90 gpcpd.

## **4.0 EXISTING RESOURCE INFORMATION** <sup>66</sup>

This section includes information on the existing geologic, hydrologic, and meteorological conditions within Henrico County, Virginia. Also included are descriptions of the existing environmental conditions pertaining to in-stream flow, in-stream uses, and sources that provide the current supply. The description of conditions includes the following items:

- ◆ state or federal listed threatened or endangered species or habitats of concern,
- ◆ significant fisheries,
- ◆ river segments with recreational significance,
- ◆ sites of historical or archaeological significance,
- ◆ unusual geologic formations or special soil types,
- ◆ wetlands,
- ◆ riparian buffers and conservation easements,
- ◆ land use and land coverage,
- ◆ impaired streams,
- ◆ point source discharges, and
- ◆ any other potential threats to existing water quantity and quality.

### **4.1 Geologic, Hydrologic, and Meteorological Conditions**<sup>67</sup>

#### *4.1.1 Geologic Conditions*<sup>68</sup>

Henrico County is divided by the Virginia Fall Line, where the Piedmont of the Appalachians descends steeply and meets the coastal plain. The western half of the County is located within the Piedmont province and the eastern half is located within the Coastal Plain province. The fall line between the two physiographic provinces generally follows the CSX Transportation System

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<sup>66</sup> 9 VAC 25-780-90.

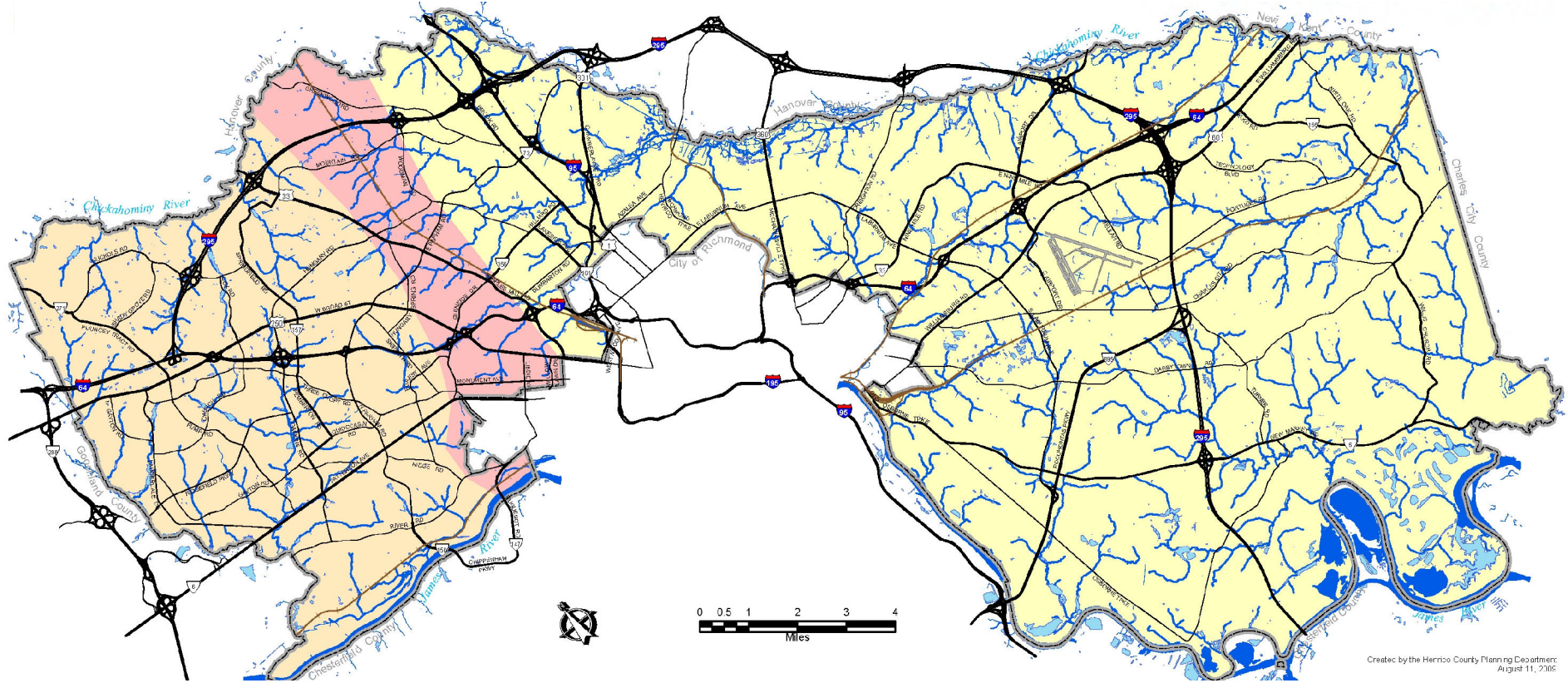
<sup>67</sup> 9 VAC 25-780-90 A.

<sup>68</sup> Soil Survey of Henrico County, Virginia. United States Department of Agriculture – Soil Conservation Services in cooperation with Virginia Agricultural Experiment Station, 1975.

right-of-way, formerly the RF&P Railroad, located approximately two miles west of U.S Route 1. Near Hungry Road, the CSX Transportation System turns easterly and the fall line continues in a southern direction across the County<sup>69</sup>. The following figure depicts the physiographic provinces and the Virginia Fall Line in Henrico County.

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<sup>69</sup> Henrico County 2026 Comprehensive Plan.



Created by the Henrico County Planning Department  
August 11, 2005



- Coastal Plain Province
- Fall Zone
- Piedmont Province
- Rivers and Streams
- Ponds, Lakes, Reservoirs

Source: Henrico County 2026 Vision Comprehensive Plan

The Piedmont Physiographic Province is a rolling to hilly area that extends from the Fall Line on the east to the foot of the Blue Ridge Mountains on the west. The Fall Line is a low-profile, east-facing scarp that separates crystalline rocks of the Piedmont Province (west) from Cretaceous-age (>65 million years) to Quarternary-age (current), less-resistant, marine and terrigenous sediments of the Coastal Plain Province (east). The Coastal Plain is composed of unconsolidated sediments of Cretaceous to recent age overlying a bedrock basement.

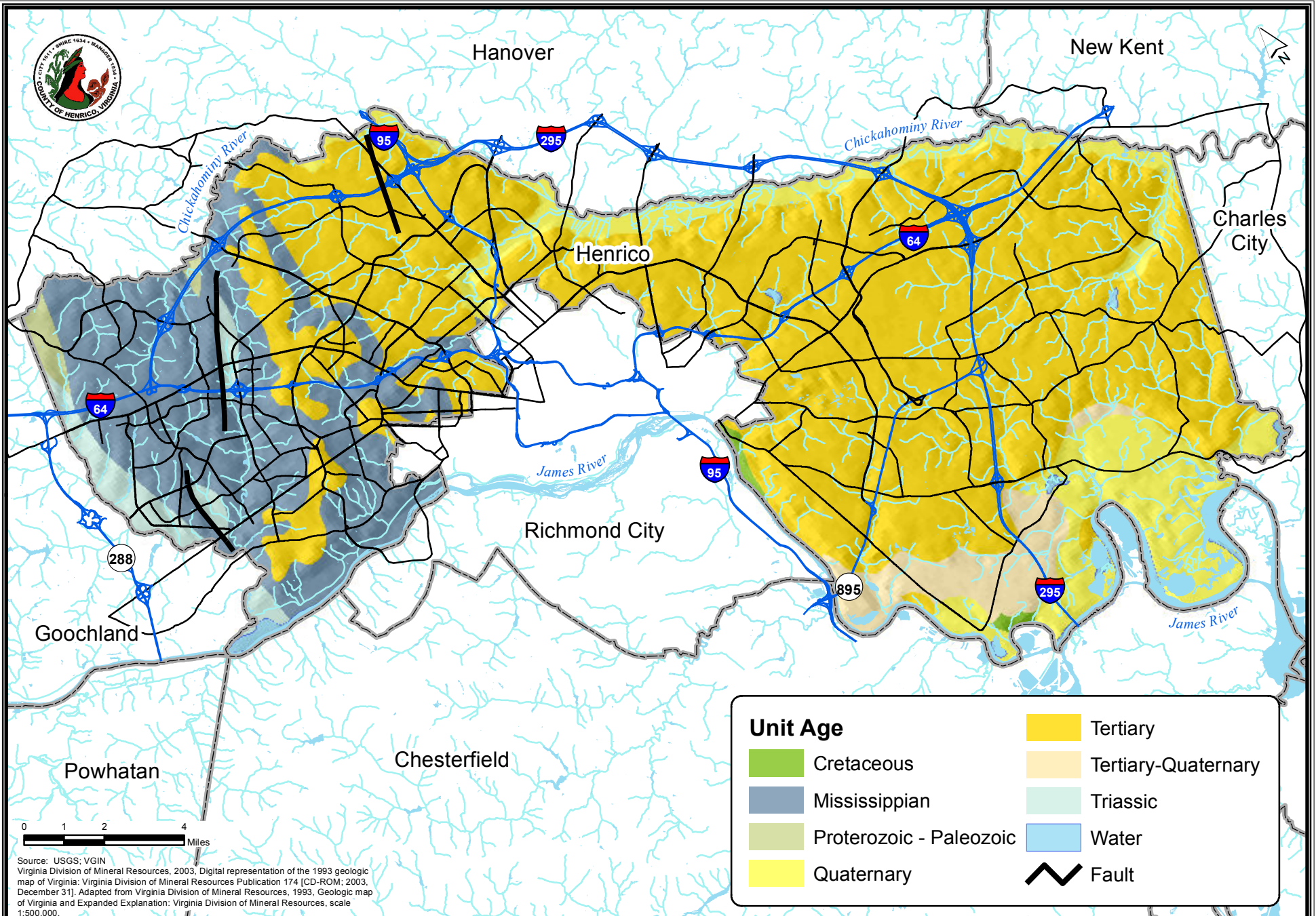
The crystalline rocks of the Piedmont Province are Precambrian-age (>570 million years) and Cambrian-age (570-225 million years) metamorphic and igneous rocks, and within the Piedmont Province are several Triassic-age basins that contain sedimentary rocks.

The Piedmont Province is characterized by deeply weathered bedrock and a relative paucity of solid rock outcrop. The Coastal Plain is generally characterized by broad, nearly level and gently sloping ridges of sands and clays overlying granite. The following table depicts the geologic regions in Henrico County from west to east and their general underlying rock types.

**Table 4-1: Henrico County Geologic Regions and Rock Types**

<b>Geologic Region</b>	<b>Geologic Age</b>	<b>Rock Types</b>
Carolina Slate Belt	Cambrian	Metamorphic Rocks: Island-arc-related Metavolcanic and Metasedimentary Mica Schist, Metabasalt, Phyllite, Slate, Quartzite, Schist, and Gneiss
Blue Ridge and Piedmont	Late Proterozoic to Mississippian	Intrusive Igneous Rocks: Granite, Quartz Monzonite, and Granodiorite
Blue Ridge and Piedmont	Tertiary	Sedimentary Rocks: Unconsolidated Sand, Clay, Glauconitic Sand, Gravel, and Shell Beds
Blue Ridge and Piedmont	Quarternary-Tertiary	Sedimentary Rocks: Unconsolidated Sand, Gravel, Clay

Overall regional fracture orientations would be northeast-southwest, with some localized variation possible. In-situ weathering of these rocks would produce clays and silts. According to the USDA, the soils of Henrico County are predominantly of a silty texture. The following figure details the geologic conditions in Henrico County.



Source: USGS; VGIN  
Virginia Division of Mineral Resources, 2003. Digital representation of the 1993 geologic map of Virginia: Virginia Division of Mineral Resources Publication 174 [CD-ROM; 2003, December 31]. Adapted from Virginia Division of Mineral Resources, 1993, Geologic map of Virginia and Expanded Explanation: Virginia Division of Mineral Resources, scale 1:500,000.

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## Geologic Conditions Henrico County, Virginia

Figure  
4-2

Ridges near the western boundary of the County are the highest, with an elevation of about 340 feet above sea level. The lowest elevation in the County is at sea level along the lower James River. Topography along the western borders of Henrico County consist of gently sloping to sloping ridges while the eastern border consists of broad, nearly level to gently sloping ridges. Slopes can be moderate along drainage ways and steep between the uplands and the terraces and flood plains of the James River. The bottom lands along streams have level to nearly level surfaces. The following table categorizes the topography across the County.

**Table 4-2: Topography and Steep Slopes**

<b>Category</b>	<b>Percentage of County</b>	<b>Description</b>
Very Steep	Greater Than 25%	If disturbed by construction or forest removal, widespread failure of the slope is highly probable. These slopes may be better used as natural areas, trails, and observation points. Land in this category is the least suitable for development.
Steep	16-25%	If plant cover is removed, these slopes are highly susceptible to erosion and gully formation. Special design consideration is required for buildings on slopes greater than 15 percent. Development on these areas is suitable with restrictions to manage erosion.
Moderate	5-10%	These slopes will support residential and agricultural land uses; if misused, they are susceptible to serious erosion. These areas are moderately suitable for development.
Gentle	Less Than 5%	These slopes will sustain the most intensive use with the least erosion management needed. These areas are generally the most suitable for development; however, it is common in the flat areas of the County to encounter drainage problems where standing water can collect.

## **4.2 Hydrologic Conditions**

### *4.2.1 Ground Water Hydrology*

The hydrologic setting is a function of the underlying geologic features. Generally, ground water flow is a function of fracture density, which is generally a function of geologic structure.

Henrico County is underlain by metamorphosed pre-Cambrian rocks of sedimentary and igneous origin, Lower Cambrian quartzites, and Triassic sediments. In general, Henrico County is characterized as having two distinct

geologic units; the Piedmont Crystalline Bedrock System and the Coastal Plain.

The Piedmont system is dependent on fractures for ground water production, yield and recharge. The Piedmont, generally to the west of I-95, is an area of crystalline bedrock containing numerous fracture zones from ancient faulting. Ground water in the Piedmont area tends to be plentiful where wells intersect the fracture zones. However, wells that are developed outside of the fracture zones are likely to experience low yields, especially during dry and excessively dry periods. The depth of wells is a less important determinant of well yield and stability than proximity to a fracture zone. Bored wells in the soil horizons are impractical and vulnerable to deep well pumping in this region.

The Coastal Plain, generally to the east of I-95, is an area of unconsolidated sediments overlying a bedrock basement. In the coastal plain, aquifers are typically composed of one to several layers of eastward thickening, permeable sands or limestone split by discontinuous, clay-rich materials. Confining units, consisting of clay-rich sediments, exist above and below these aquifers. The aquifers are thinner and closer to the land surface so large withdrawals from this multi-layer aquifer system can cause regional declines in water levels and alterations in ground water flow.

#### 4.2.2 *Surface Hydrology*

The major surface water features are the James River on southern boundary and the Chickahominy River on the northern boundary of the County. In total, approximately 4,200 acres of the County are covered by water.

The dendritic system of rivers and small tributary streams affords good drainage in nearly all parts of the County. The only places inadequately

drained are bottoms along streams, sleepy places near the bases of slopes, and nearly level places on interstream divides.<sup>70</sup>

There are two USGS stream gaging stations located on the James River in Henrico County. The following table depicts the location and general statistics for each gage.

**Table 4-3: USGS Stream Gages in Henrico County<sup>71</sup>**

Agency	Site Number	Location	Period of Record	Minimum Flow on Record	Peak Stream Flow on Record	Mean Annual Discharge
				(cfs)	(cfs)	(cfs)
USGS	2037000	James River at Kanawha Canal	October 1936 – 2011 <sup>72</sup>	97 <sup>73</sup>	3,220 <sup>74</sup>	545
USGS	2037500	James River near Richmond <sup>75</sup>	October 1934 – 2011 <sup>76</sup>	10 <sup>77</sup>	296,000 <sup>78</sup>	6,937

#### 4.2.3 Watersheds

The majority of Henrico lies in the James River Basin with that river forming the County’s southern boundary. The western half of Henrico County is part of the Middle James - Willis watershed, while the eastern half is in the Lower James watershed. The James River watershed eventually drains into the Chesapeake Bay. There are several sub-watersheds in the Henrico County.

**Table 4-4** depicts these sub-hydrologic watersheds along with their area percentage of the County.

<sup>70</sup> Soil Survey of Henrico County, Virginia. United States Department of Agriculture – Soil Conservation Services in cooperation with Virginia Agricultural Experiment Station, 1975.

<sup>71</sup> United States Geological Survey Stream Gage Records.

<sup>72</sup> Includes Provisional Data.

<sup>73</sup> October 1, 2006.

<sup>74</sup> October 17, 1942.

<sup>75</sup> Data does not include flow diverted by City of Richmond and flow in Kanawha Canal.

<sup>76</sup> Includes Provisional Data.

<sup>77</sup> Various dates in 1966.

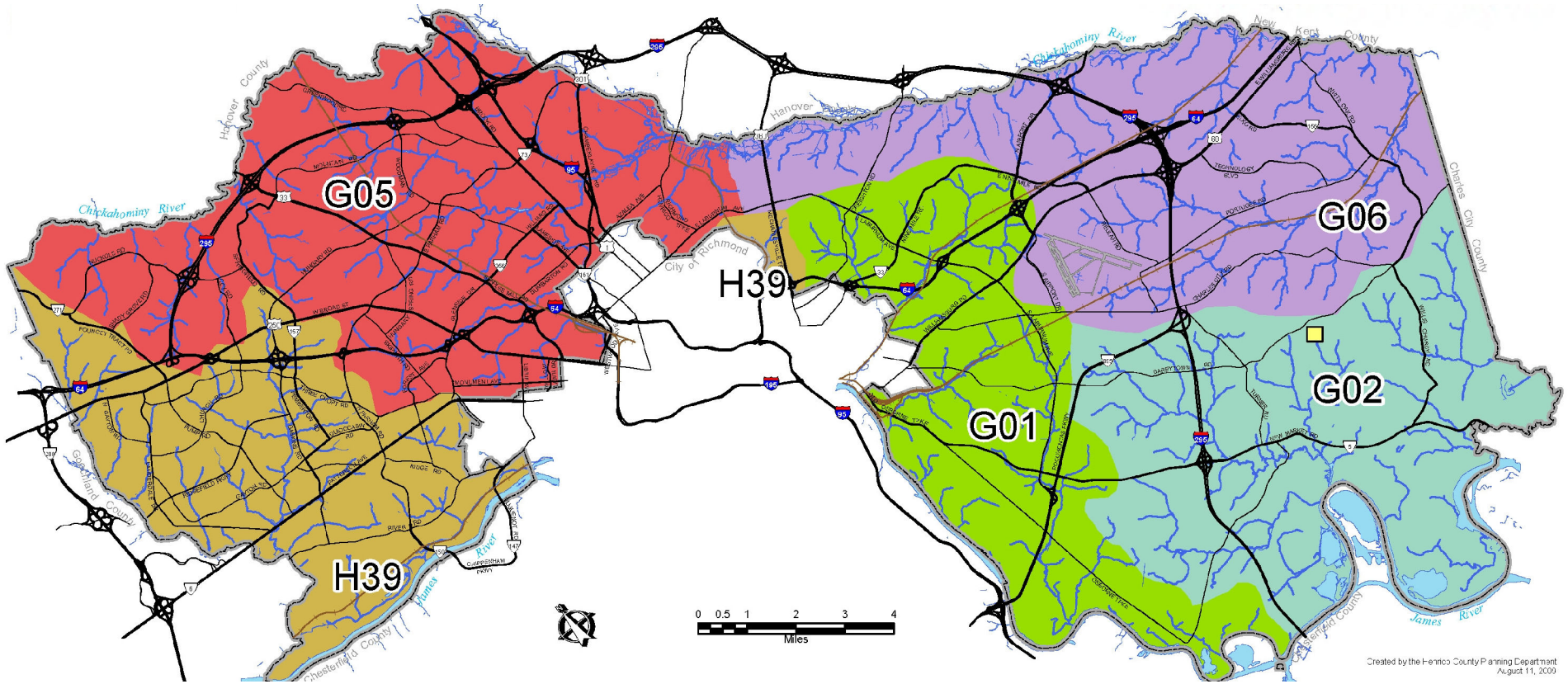
<sup>78</sup> June 23, 1972.

**Table 4-4: Hydrological Watersheds in Henrico County<sup>79</sup>**

<b>Watershed ID</b>	<b>Percentage of County</b>
Upper Chickahominy River/Upham Brook/Lickinghole Creek	26.02
Chickahominy River/White Oak Swamp/Beaverdam Creek	22.16
James River/Turkey Island Creek/Fourmile Creek	20.43
James River/Tuckahoe Creek/Norwood Creek	15.93
James River/Falling Creek/Proctors Creek	15.46

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<sup>79</sup> Virginia Hydrologic Unit Atlas. Department of Conservation and Recreation – Division of Soil & Water Conservation. Information Support System Laboratory – Department of Agricultural Engineering, Virginia Tech, 1991.



Created by the Henrico County Planning Department  
August 11, 2009

- G01-James River/Falling Creek/Proctors Creek
- G02-James River/Turkey Island Creek/Fourmile Creek
- G05-Upper Chickahominy River/Upham Brook/Lickinghole Creek
- G06-Chickahominy River/White Oak Swamp/Beaverdam Creek
- H39-James River/Tuckahoe Creek/Norwood Creek
- Diamond Springs/Camp Holly Springs

Source: Henrico County 2026 Vision Comprehensive Plan

#### 4.2.4 Ground Water Recharge Potential

The recharge potential, also known as the available groundwater supply, can be estimated based on several known variables. These variables include total surface area, average rainfall, and percentage of undeveloped area. The equation for recharge potential does not take into account the geology or hydrogeologic characteristics of the area. This is a theoretical method of calculating the amount that is available for extraction.

The equation and parameters are shown in the following table. Assuming that 25% of the total recharge potential can be extracted through wells, approximately 8.9 mgd of groundwater is potentially available for use. However, the cost and feasibility of withdrawing this water will require further study if it is to be used as a significant source to meet future demands in concentrated areas.

**Table 4-5: Henrico County Ground Water Recharge Potential**

Recharge Potential = Total Surface Area X 43,560 ft <sup>2</sup> per acre X Estimated Recharge X Estimated Percentage of Undeveloped Area X 7.48 gallons per cubic foot
<b>Known Variables:</b>
Total County Surface Area = 244 square miles
Total County Surface Area = 156,160 acres
Estimated Recharge = 44.2 inches <sup>80</sup>
<b>Estimated Variables:</b>
0.5 feet = Estimated Recharge from Annual Precipitation
51% = Estimated Percentage of Undeveloped Area (Agriculture, Wooded)
Recharge Potential = 156,160 X 43,560 X 0.5 X .51 X 7.48 = 12,974,763,479 gallons per year
Assume 25% can be developed through the use of wells, then:
Recharge Potential = 3,243,690,869 gallons per year, or,
Recharge Potential = 8,886,1824 gallons per day

#### 4.2.5 Water Supply

Henrico County contains numerous freshwater streams and groundwater is generally good in quality. There are a total of fourteen state-licensed dams in Henrico County. Of the fourteen dams, only Boshier Dam is categorized as a water supply dam. The other dams are classified recreational for the most part, excluding Miles Dam, which is used for irrigation. Dams are regulated in

<sup>80</sup> Average Annual Rainfall, Soil Survey of Henrico County.

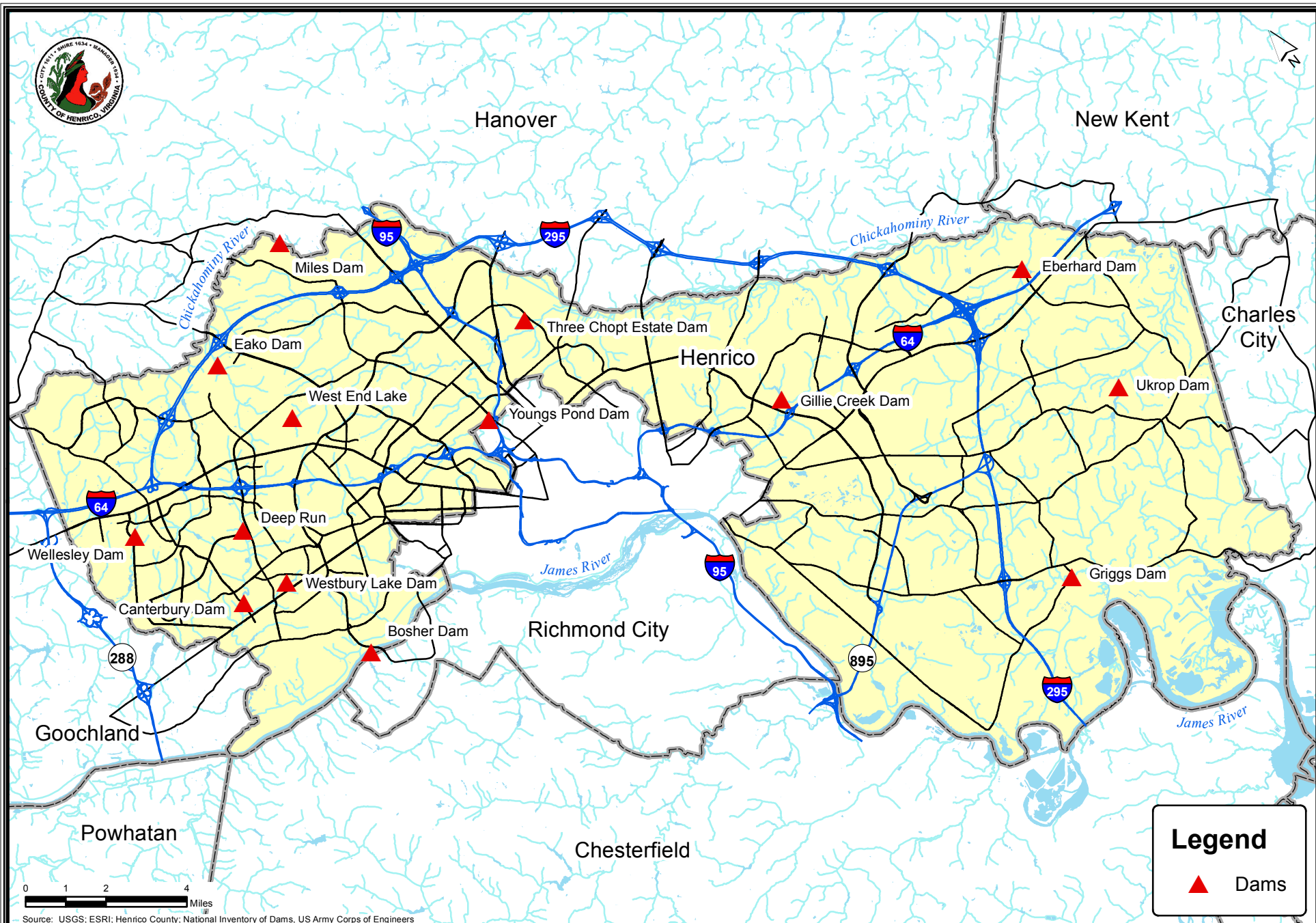
Virginia if they are either 25 feet or greater in height and impound 15 acre-foot or greater, or are 6 feet or greater in height but impound 50 acre-feet or more, unless exempted by statute. The table below provides information for all of the state-licensed dams in Henrico County.

**Table 4-6: State Licensed Dams in Henrico County<sup>81</sup>**

<b>Dam Name</b>	<b>Stream or River</b>	<b>Approximate Contained Water (acre feet)</b>	<b>Classification</b>
Bosher Dam	James River	2,100	Water Supply
Canterbury Dam	Deep Run	Not Available	Recreational
Deep Run Dam	Deep Run	Not Available	Recreational
Eako Dam	Meredith Branch	29	Recreational
Eberhard Dam	Boar Swamp	43	Recreational
Gillies Creek Dam	Stony Run	171	Recreational
Griggs Dam	Fourmile Creek	36	Recreational
Miles Dam	Chickahominy River	18	Irrigation
Three Chopt Estate Dam	Upham Brook	Not Available	Recreational
Ukrop Dam	Hass Creek	160	Recreational
Wellesley Dam	Hardings Branch	67	Recreational
West End Lake Dam	Hungary Creek	26	Recreational
Westbury Lake Dam	Cabin Branch	34	Recreational
Young's Pond Dam	Upham Brook	18	Recreational

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<sup>81</sup> Source: Virginia Department of Game and Inland Fisheries. Fish and Wildlife Information Services: fish impediments database.



Source: USGS; ESRI; Henrico County; National Inventory of Dams, US Army Corps of Engineers

The James River supplies much of the water to urban areas of Henrico County. Additional water is purchased from the City of Richmond. Henrico County, in agreement with the City of Richmond, will continue to purchase treated water from the City of Richmond through July 1, 2040. Henrico County also has agreements to provide treated water to both Goochland County and Hanover County.

#### 4.2.6 *Meteorological Conditions*

According to the USDA Soil Conservation Service, Henrico County has warm summers, relatively mild winters, and normally adequate rainfall. Monthly average precipitation amounts vary greatly from year to year for any given month. Henrico County is well inland from the Atlantic Ocean, which only has a small moderating effect on the climate. The Appalachian Mountains to the west lessen the intensity of many winter storms.<sup>82</sup>

The County is often in the path of warm, moist air currents moving from the south or southwest and in the path of cold, dry air currents moving southward and eastward. Prolonged periods of very cold or very warm weather are unusual. Precipitation is quite variable throughout the year, with the greatest amount of rainfall occurring in July and August. The average annual relative humidity is about 71 percent. The following table provides meteorological statistics for Henrico County.

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<sup>82</sup> Soil Survey of Henrico County, Virginia. United States Department of Agriculture – Soil Conservation Services in cooperation with Virginia Agricultural Experiment Station, 1975.

**Table 4-7: Meteorological Statistics<sup>83</sup>**

<b>Criteria</b>	<b>Data</b>
Average Annual Rainfall	44.2 inches
Average Annual Snowfall	4 inches
Average Annual Temperature	57.5° F
January Average Temperature	38.5° F
Avg. # Days Min. Temp. Lower Than 32° F	90
July Average Temperature	78° F
Avg. # Days Max. Temp Higher Than 90° F	48
Prevailing Winds	Southwest
USDA Cold Hardiness Zone*	7A
Average Annual Minimum Temperature	0°-10° F

#### **4.3 Existing Environmental Conditions that Pertain to or May Affect In-Stream Flow, In-Stream Uses, and Sources that Provide the Current Supply<sup>84</sup>**

##### *4.3.1 State or Federal Listed Threatened or Endangered Species or Habitats of Concern<sup>85</sup>*

The Virginia Department of Game and Inland Fisheries and the Department of Conservation and Recreation list five threatened or endangered species as “known or likely to occur” within Henrico County:

- ◆ State threatened Bald Eagle (*Haliaeetus leucocephalus*);
- ◆ State threatened Migrant Loggerhead Shrike (*Lanius ludovicianus migrans*);
- ◆ State threatened Loggerhead Shrike (*Lanius ludovicianus*);
- ◆ State threatened Atlantic Pigtoe (*Fusconaia masoni*); and
- ◆ State threatened Upland Sandpiper (*Bartramia longicauda*).

In addition, a search of the Department of Conservation and Recreation’s National Heritage Resources database, revealed the Swamp-pink (*Helonias bullata*) as a listed federal threatened and state endangered species for Henrico County. The Sensitive Joint-vetch (*Aeschynomene virginica*) is listed as a federal and state threatened species for Henrico County, while the New Jersey Rush (*Juncus caesariensis*) is listed as a state threatened species.

The Swamp-pink, Sensitive Joint-vetch, and the New Jersey Rush are all vascular plants that prefer wetland and stream bank habitats. Water supply

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<sup>83</sup> Virginia National Weather Service. U.S. Department of Commerce.

<sup>84</sup> 9 VAC 25-780-90 B.

<sup>85</sup> 9 VAC 25-780-90 B.1.

strains and drawdown of the James River and its tributaries could adversely impact the aquatic ecosystem for these species.

Bald Eagles and other avian species generally nest along rivers. The Shrike Loggerhead and Upland Sandpiper are part of the Virginia Wildlife Action Plan, listed as needing “critical conservation”. The Bald Eagle and Atlantic Pigtoe are listed in the Virginia Wildlife Action Plan as needing “very high conservation”.

The Department of Conservation and Recreation recommends coordination with the Virginia Department of Game and Inland Fisheries to ensure compliance with protected species legislation. To minimize adverse impacts to the aquatic ecosystem as a result of any proposed activities, the Department of Conservation and Recreation also recommends the implementation of and strict adherence to erosion and sediment control measures during all land disturbing activities.

#### 4.3.2 *Anadromous, Trout, and other Significant Fisheries*<sup>86</sup>

The Virginia Fish and Wildlife Information Service database maintained by VDGIF indicates three streams with anadromous fish in Henrico County. These streams include: Fourmile Creek, Turkey Island Creek, and three sections of the James River. One of the three areas along the James River consists of a section beginning at Maidens and ending past Tuckahoe Island, on the west side of Henrico County. A second section begins near Mooreland Farms, in Henrico County, and ends around Williams Island in Richmond. The third section begins at Mayo’s Island in Richmond, and continues past Oakland into Henrico County. No other significant fisheries were listed within Henrico County.

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<sup>86</sup> 9 VAC 25-780-90 B.2.

#### 4.3.3 *River Segments that have Recreational Significance including Scenic River Status*<sup>87</sup>

The Virginia Scenic Rivers program began in 1970 with passage by the General Assembly of the Virginia State Scenic River Act.<sup>88</sup> Since then, 22 river segments totaling approximately 505.85 miles have been designated state scenic rivers (as of July 2007). The intent of the Virginia Scenic Rivers program is to identify, designate and help protect rivers and streams that possess outstanding scenic, recreational, historic, and natural characteristics of statewide significance for future generations.

According to the Virginia Department of Conservation and Recreation, the Chickahominy River along the northeastern border of Henrico County, has been categorized as a Virginia Scenic River. In addition, the Chickahominy River from the New Kent, Henrico, Charles City County line to the Route 618 Bridge has been “evaluated and found worthy of designation.” In addition, the segment of the James River from the western limits of Richmond to Orleans Street has been categorized as a Virginia Scenic River and the James from Orleans Street to Surrey County has been “evaluated and found worthy of designation.”<sup>89</sup> See **Figure 4-5**.

According to the *2007 Virginia Outdoors Plan (VOP)*, set forth by the Virginia Department of Conservation and Recreation, several natural areas in Virginia have been recommended for outdoor recreation and land conservation. The VOP indicates the presence of two river segments of recreational significance within Henrico County. One of these river segments, the proposed James River Heritage Trail, borders the south of Henrico County. The other river segment, the existing Captain John Smith Chesapeake National Historic Trail, follows the James River along the southeastern border of Henrico County. A

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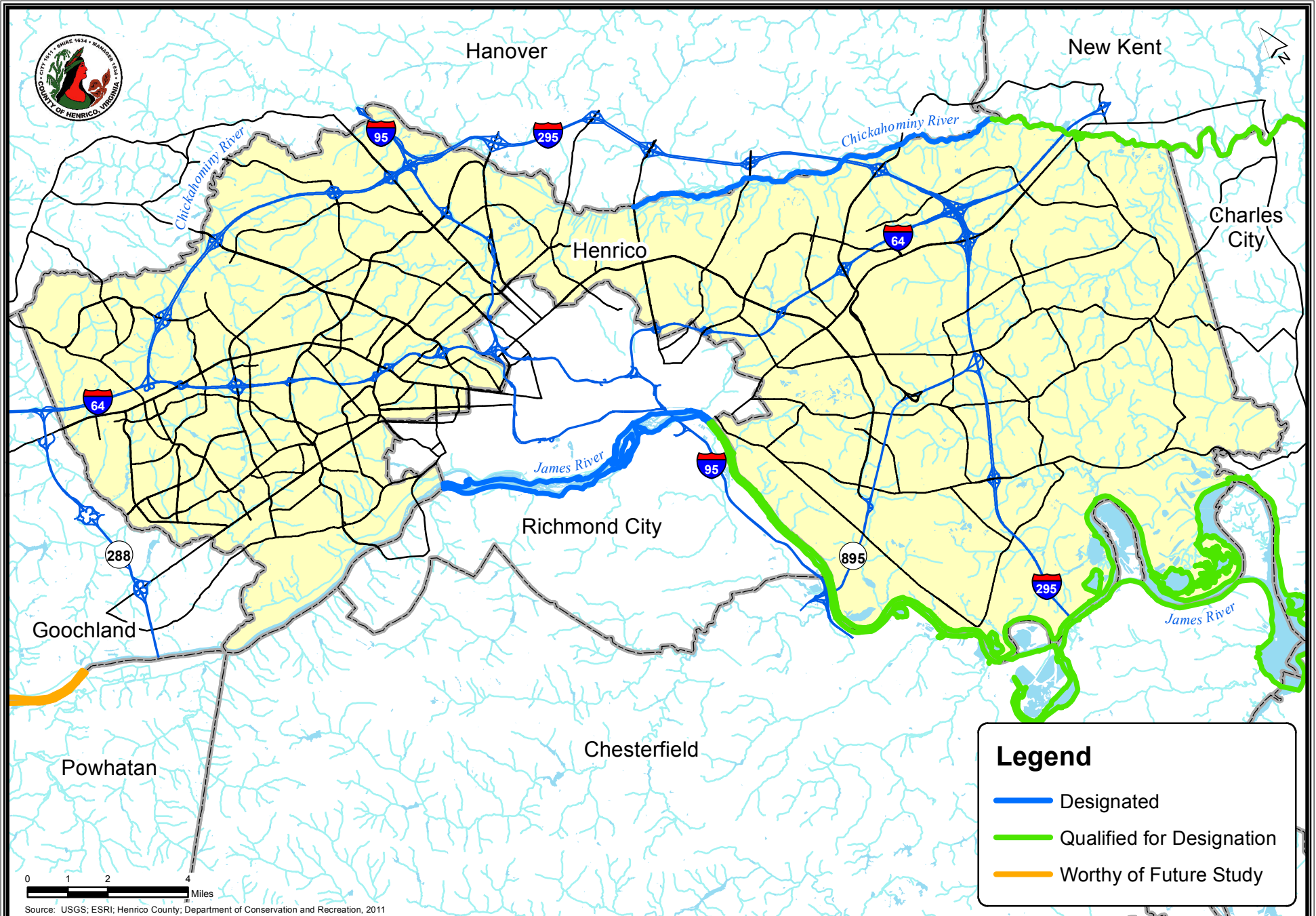
<sup>87</sup> 9 VAC 25-780-90 B.3.

<sup>88</sup> Code of Virginia: Title 10.1, Chapter 4 Sections 10.1-400 through 10.1-418.

<sup>89</sup> Virginia Scenic Rivers Information, Prepared by the Virginia Department of Conservation and Recreation.

proposed section of this trail is to be located along the northeastern border of Henrico County.

The VOP also indicates the presence of other trails and greenways of recreational significance within Henrico County. The existing Virginia Capital Trail passes through the western half of Henrico County before entering Richmond City. The proposed East Coast Greenway, which aims to connect towns and cities of the East Coast with a continuous, traffic free path, will travel through the center of the County from north to south.



**Legend**

- Designated
- Qualified for Designation
- Worthy of Future Study

#### 4.3.4 Sites of Historic Significance

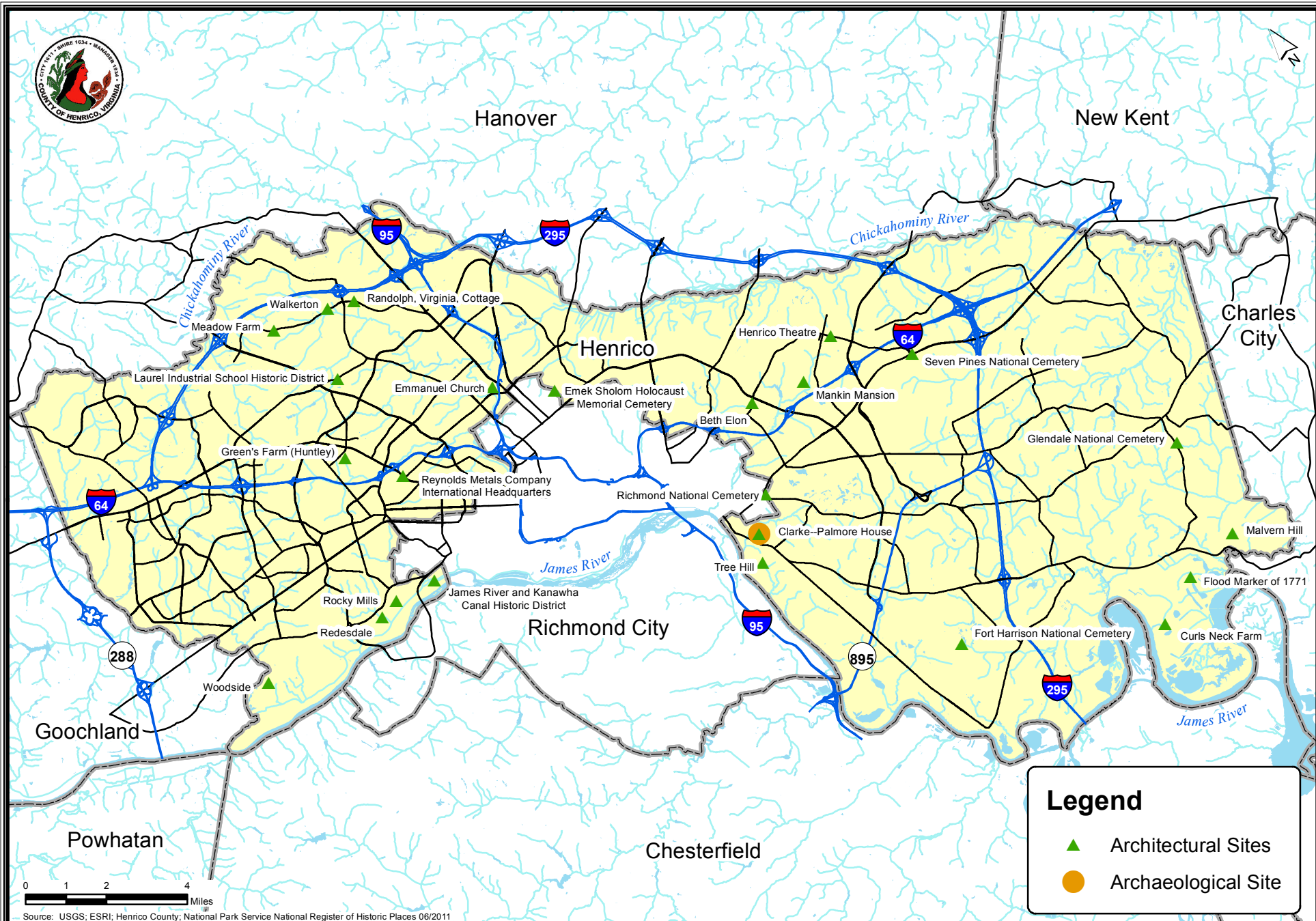
The Virginia Department of Historic Resources lists approximately 787 historic architectural sites in Henrico County. Of these, the following are on the National Register of Historic Places. See **Figure 4-6**.

**Table 4-8: Historic Sites**

VDHR ID 043-0005	Rocky Mills, Bon Air quadrangle
VDHR ID 043-0008	Malvern Hill, Roxbury quadrangle
VDHR ID 043-0012	Woodside, Bon Air quadrangle
VDHR ID 043-0019	Walkerton, Yellow Tavern quadrangle
VDHR ID 043-0020	Varina Farm/Plantation, Dutch Gap quadrangle
VDHR ID 043-0023	Flood Marker of 1771, Dutch Gap quadrangle
VDHR ID 043-0031	Meadow Farm, Glen Allen quadrangle
VDHR ID 043-0032	Tree Hill, Richmond quadrangle
VDHR ID 043-0035	Curles Neck Farm
VDHR ID 043-0043	Virginia Randolph Cottage, Yellow Tavern quadrangle
VDHR ID 043-0068	Mankin Mansion, Richmond quadrangle
VDHR ID 043-0085	Clarke-Palmore House, Richmond quadrangle
VDHR ID 043-0101	Edge Hill, Richmond quadrangle
VDHR ID 043-0103	Emmanuel Church, Richmond quadrangle
VDHR ID 043-0126	Richmond National Cemetery, Richmond quadrangle
VDHR ID 043-0134	Fort Harrison National Cemetery, Dutch Gap quadrangle
VDHR ID 043-0242	Reynolds Metal Co. International Headquarters, Bon Air quadrangle
VDHR ID 043-0287	Henrico Theatre, Seven Pines quadrangle
VDHR ID 043-0292	Laurel Industrial School Historic District, Glen Allen quadrangle
VDHR ID 043-0302	Druin Horner House, Bon Air quadrangle
VDHR ID 043-0753	Glendale National Cemetery, Roxbury quadrangle
VDHR ID 043-0755	Seven Pines National Cemetery, Seven Pines quadrangle
VDHR ID 043-5006	Emek Sholom Holocaust Memorial Cemetery, Richmond quadrangle
VDHR ID 043-5117	Beth Elon, Seven Pines quadrangle
VDHR ID 043-0719	Redesdale, Bon Air quadrangle
VDHR ID 127-6150-0008	Brook Road Marker, Richmond quadrangle
VDHR ID 127-127-0171	James River and Kanawha Canal, Bon Air quadrangle

#### 4.3.5 Sites of Archaeological Significance

The Virginia Department of Historic Resources lists approximately 975 archaeological sites in Henrico County. Of these, only one (VDHR ID 44HE-0281 – Clark Palmore House, Richmond quadrangle) is listed on the National Register of Historic Places. See **Figure 4-6**.



**Legend**

- ▲ Architectural Sites
- Archaeological Site

#### 4.3.7 *Unusual Geologic Formations or Special Soil Types*

According to the USDA<sup>90</sup>, organic-matter content in soils in Henrico County is generally low. Bottom-land soils contain a little more organic matter than upland soils. Most of the soils are acid with reactions in the subsoil being very strongly acid to neutral. Natural fertility ranges from high to very low. See **Figure 4-7**.

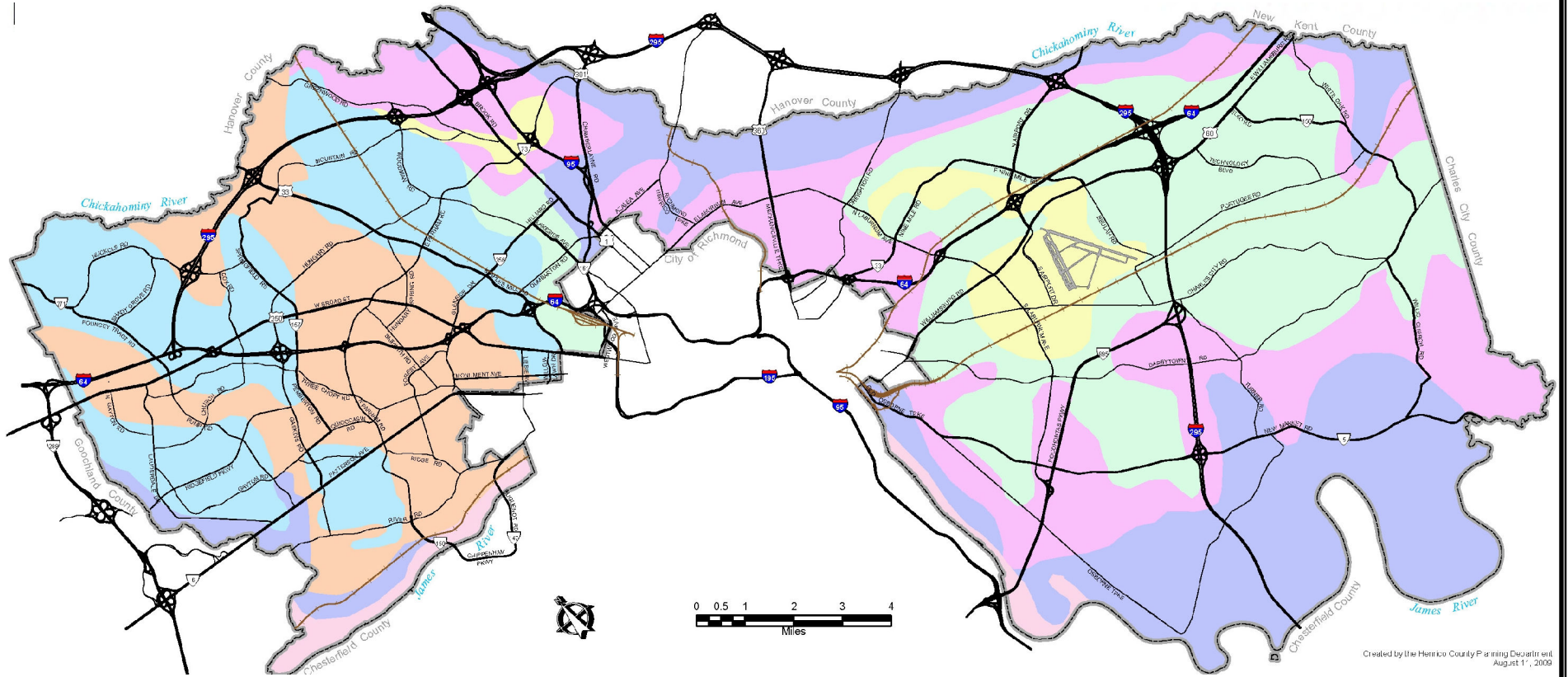
The Department of Mines, Minerals, and Energy<sup>91</sup> lists “Edison Ridge”, a ridge south of Public Fork in the Clover, Virginia quadrangle, as containing mineralized quartz with occurrences of gold and silver deposits. There are also coal beds in the Triassic basin along Tuckahoe Creek and Deep Run Creek.

The Virginia Department of Conservation and Recreation Natural Heritage database maintained by the VDCR does not indicate the presence of any significant geologic formations identified by the *2007 Virginia Outdoors Plan*.

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<sup>90</sup> USDA. 1975. *Soil Survey of Henrico County, Virginia*. United States Department of Agriculture – Soil Conservation Services in cooperation with Virginia Agricultural Experiment Station.

<sup>91</sup> DMME. 1991. *Virginia Minerals*. Virginia Division of Mineral Resources – Department of Mines, Minerals, and Energy.



Created by the Henrico County Planning Department  
August 1<sup>st</sup>, 2009

- Angie-Pamunkey-Lenoir
- Kempsville-Atlee-Duplin
- Appling-Wedowee-State
- Lynchburg-Rains-Coxville
- Chewacla-Riverview-Toccoa
- Ochrepts & Udults-Norfolk-Caroline
- Colfax-Helen-Borne

Source: Henrico County 2026 Vision Comprehensive Plan



BLACKSBURG, VA CHARLESTONVILLE, VA HAMPTON ROADS, VA RICHMOND, VA

## General Soils Henrico County, Virginia

Figure  
4-7

#### 4.3.8 *Wetlands*

According to a GIS database search, there are approximately 12,089 acres of non-tidal wetlands in Henrico County.<sup>92</sup> These areas are highly protected from disturbance as Section 404 of the Clean Water Act empowers the U.S. Environmental Protection Agency to regulate the placement of fill or dredged material into the waters of the United States, including wetlands. The existing wetlands in Henrico County are presented in **Figure 4-8**.

#### 4.3.9 *Riparian Buffers*<sup>93</sup>

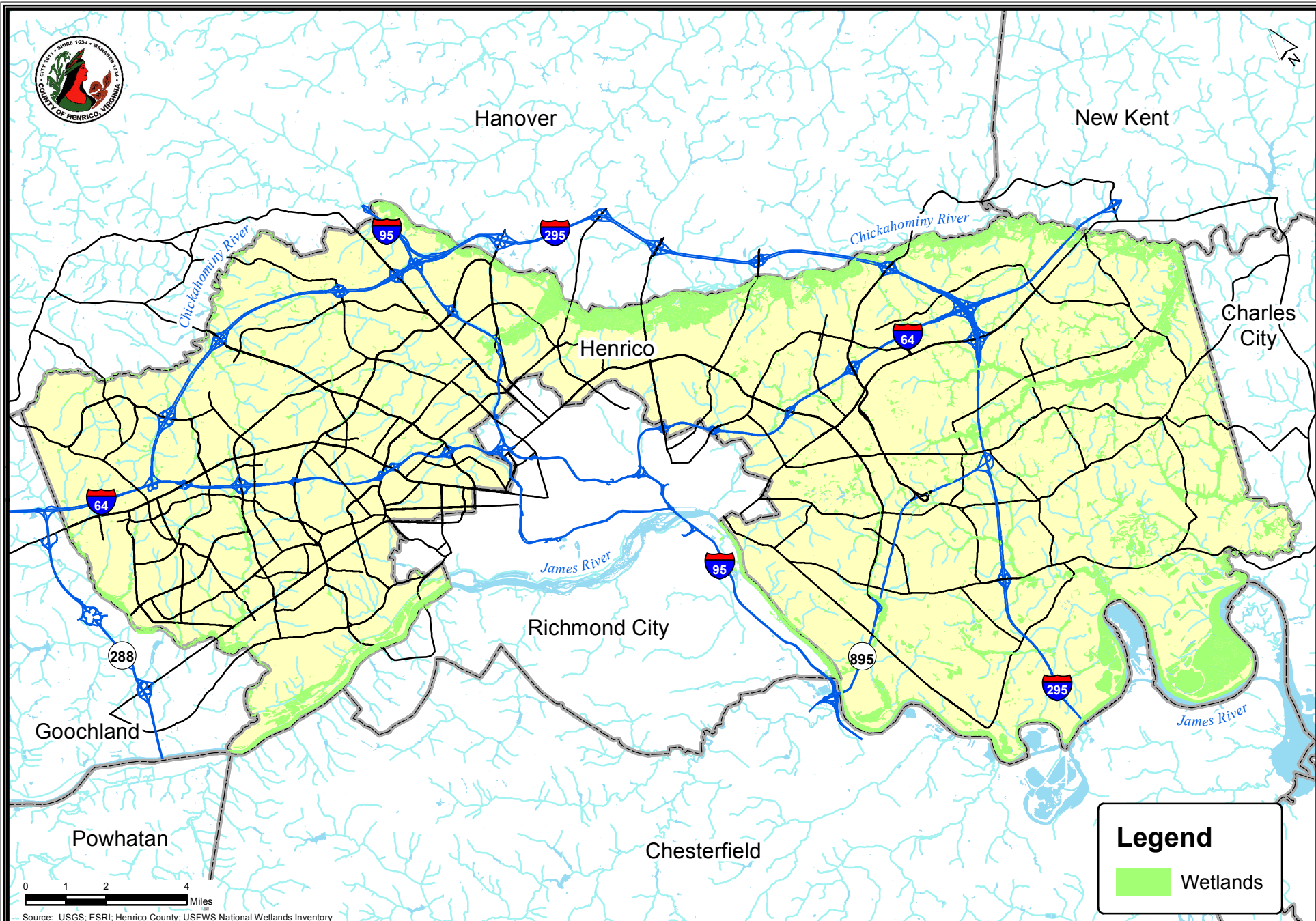
A riparian forest buffer encompasses the area from the streambank in the floodplain to, and including, an area of trees, shrubs, and herbaceous vegetation located upslope from the body of water. Buffers are established and managed to reduce the impact of adjacent land use. The buffers serve several important functions: they preserve the stream's natural characteristics, protect water quality, and improve habitat for plants and animals on land and in the water.

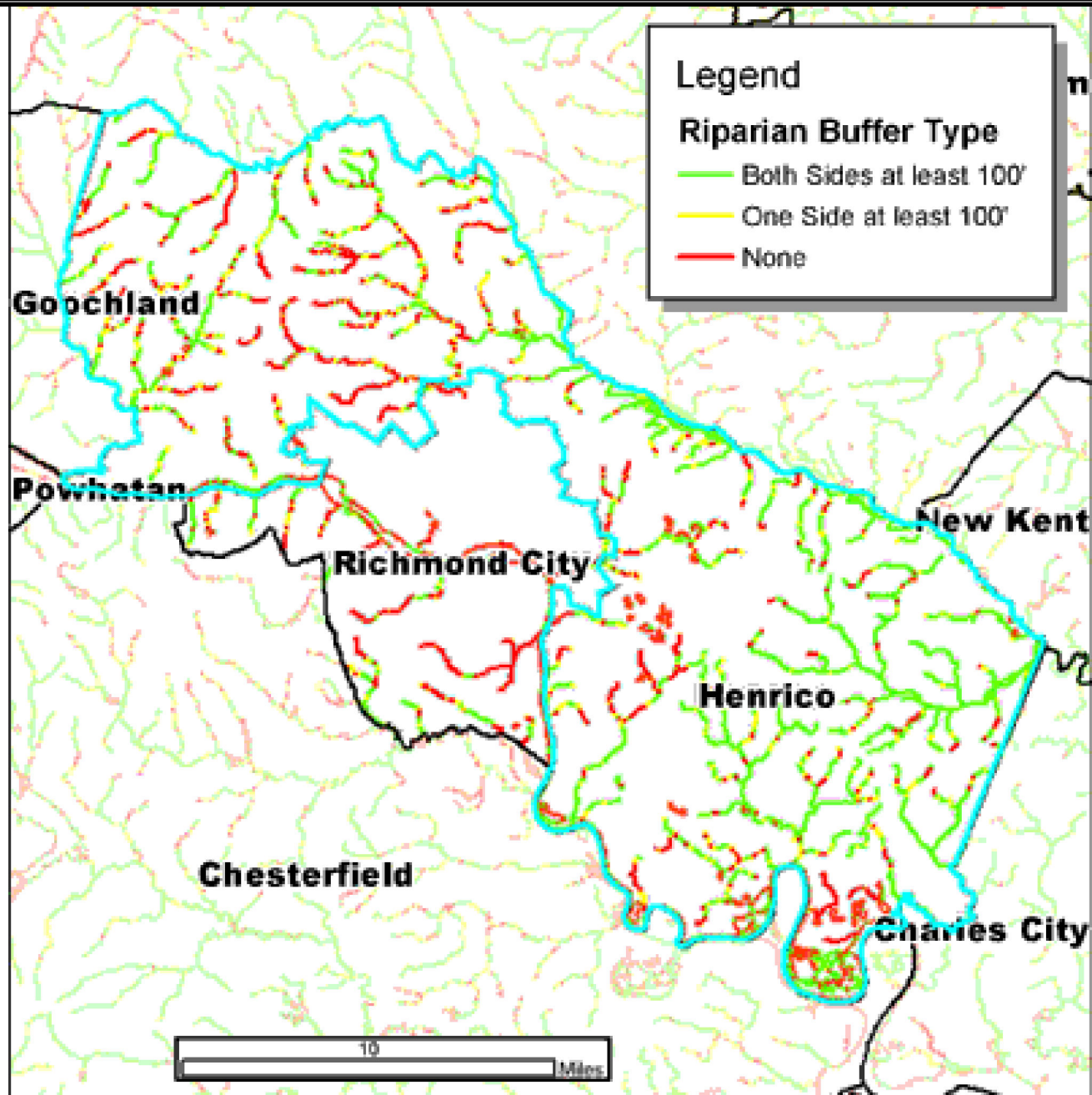
Continued development and clearing of land along streams and other waterways increases the potential for nutrient and sediment runoff. Retention of a vegetated buffer along streams can act as a natural filter to control runoff. A map depicting riparian buffers located in Henrico County is presented in **Figure 4-9**.

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<sup>92</sup> Henrico County. *2026 Comprehensive Plan of Henrico County*. Prepared by the Henrico County Planning Department.

<sup>93</sup> U.S. Dept. of Agriculture, Forest Service. 1966. *Riparian Forest Buffers*.





Source: Virginia Department of Forestry, 06/2011

#### 4.3.10 Conservation Easements<sup>94</sup>

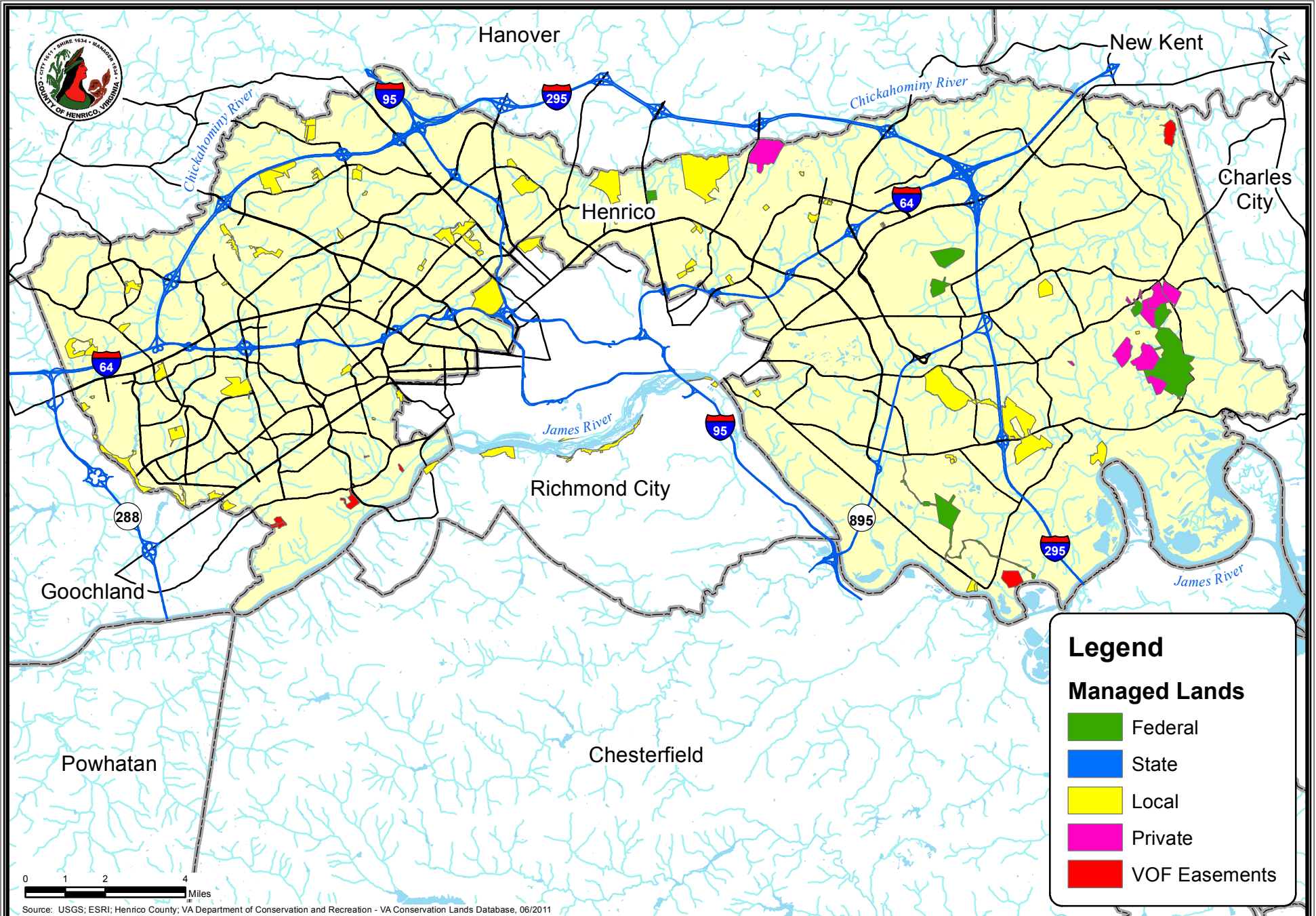
A conservation easement (or conservation restriction) is a legal agreement between a landowner and a land trust or government agency that permanently limits uses of the land in order to protect its conservation value. In Virginia, most conservation easements are held by the Virginia Outdoors Foundation, a state agency founded in 1966. In Henrico County, over 6,300 acres of conservation easements exist. These conservation easements are tabulated below.

**Table 4-9: Land Conservation Easements in Henrico County**

<b>Easement Name</b>	<b>Designation</b>	<b>Managing Agency</b>	<b>Acreege</b>
James River Park	Local Park	City of Richmond	228.47
Pine Camp Park and Arts Center	Local Park	City of Richmond	92.37
Richmond National Battlefield Park	National Park	National Park Service	816.45
Bryan Park	Local Park	City of Richmond	284.40
Bandy Field	Local Park	City of Richmond	18.37
Lewis Ginter Botanical Gardens	Local Park	City of Richmond	75.93
TNC Conservation Easement	Conservation Easement	The Nature Conservancy	50.35
TNC Conservation Easement	Conservation Easement	The Nature Conservancy	740.38
Antioch School Community Center	Local Park	Henrico County	1.97
Belmont Golf Course	Local Park	Henrico County	119.54
Bethlehem Park	Local Park	Henrico County	1.02
Central Gardens Recreation Area	Local Park	Henrico County	16.49
Cheswick Park	Local Park	Henrico County	24.16
Clarke-Palmore House	Local Park	Henrico County	11.54
Confederate Hills Recreation Center	Local Park	Henrico County	5.55
Courtney Road Service Station	Local Park	Henrico County	0.29
Crump Park/Meadow Farm Museum	Local Park	Henrico County	149.30
Cultural Arts Center at Glen Allen	Local Park	Henrico County	6.32
Deep Bottom Park	Local Park	Henrico County	89.14
Deep Run Park	Local Park	Henrico County	157.90
Dorey Park	Local Park	Henrico County	404.36
Dunncroft/Castle Point Park	Local Park	Henrico County	56.14
Echo Lake Park	Local Park	Henrico County	53.49
Elko Community Center	Local Park	Henrico County	4.33
Forest Lodge	Local Park	Henrico County	1.00
Four Mile Creek Park	Local Park	Henrico County	329.85
Gill Dale Park	Local Park	Henrico County	75.34
Glen Allen Softball Complex	Local Park	Henrico County	33.76

<sup>94</sup> Department of Conservation and Recreation. *Land Conservation Data Explorer*.

<b>Easement Name</b>	<b>Designation</b>	<b>Managing Agency</b>	<b>Acreage</b>
Glen Echo Recreation Area	Local Park	Henrico County	15.02
Gravel Hill Community Center	Local Park	Henrico County	3.92
Greenwood Park	Local Park	Henrico County	31.00
Henrico Theatre	Local Park	Henrico County	1.90
Hidden Creek Park	Local Park	Henrico County	32.20
Highland Springs Community Center	Local Park	Henrico County	0.72
Highland Springs Park	Local Park	Henrico County	26.14
Highlands Spring Recreation Area	Local Park	Henrico County	11.90
Holladay Park	Local Park	Henrico County	15.26
Hunton Civic Association	Local Park	Henrico County	4.92
Klehr Field	Local Park	Henrico County	19.06
Lakeside Club Road	Local Park	Henrico County	10.35
Laurel Recreation Area	Local Park	Henrico County	9.62
Meadowview Park	Local Park	Henrico County	593.75
New Market Park	Local Park	Henrico County	218.10
Osborne Park	Local Park	Henrico County	26.60
Osborne Turnpike Boat Landing	Local Park	Henrico County	7.80
Pouncey Tract Park	Local Park	Henrico County	22.85
RF&P Park	Local Park	Henrico County	53.64
Robinson Park	Local Park	Henrico County	8.91
Roslyn Hills Park	Local Park	Henrico County	2.25
Sandston Recreation Area	Local Park	Henrico County	5.10
Short Pump Park	Local Park	Henrico County	50.23
Spring Park Historic Site	Local Park	Henrico County	2.77
Springfield Park	Local Park	Henrico County	5.46
Three Lakes Park	Local Park	Henrico County	118.77
Tuckahoe Creek Park	Local Park	Henrico County	234.19
Twin Hickory Park	Local Park	Henrico County	48.66
Twin Hickory Recreation Center	Local Park	Henrico County	3.23
Varina Recreation Area	Local Park	Henrico County	20.65
Vawter Street Park	Local Park	Henrico County	258.90
Virginia Randolph Recreation Area	Local Park	Henrico County	10.87
Walkerton	Local Park	Henrico County	25.74
Westham Park	Local Park	Henrico County	2.19
Woodman Park	Local Park	Henrico County	4.91
Glendale Battlefield	Non-Profit Fee Simple Holding	Civil War Preservation Trust	318.80
HRO-VOF-1116	VOF Easement	Virginia Outdoors Foundation	245.29
<b>Total</b>			<b>6319.88</b>



Source: USGS; ESRI; Henrico County; VA Department of Conservation and Recreation - VA Conservation Lands Database, 06/2011

#### 4.3.11 *Land Use and Land Coverage* <sup>95</sup>

According to the U.S. Census Bureau, Henrico County has a total area of 245 square miles (or 634 km<sup>2</sup>), of which, 238 square miles (617 km<sup>2</sup>) is land and 7 square miles (17 km<sup>2</sup> and 2.67%) is water. There are no incorporated towns in Henrico County. The two major land uses in Henrico County are residential and commercial/industrial.

A considerable portion of land in Henrico County is classified as “vacant”. According to the 2026 Comprehensive Plan of Henrico County, “It should be noted that not all of this “vacant” land can be considered “developable” since it includes areas in floodplains, wetlands and other lands which are otherwise restricted in terms of development.” Further, much of the land classified as “vacant” is in active agricultural use.

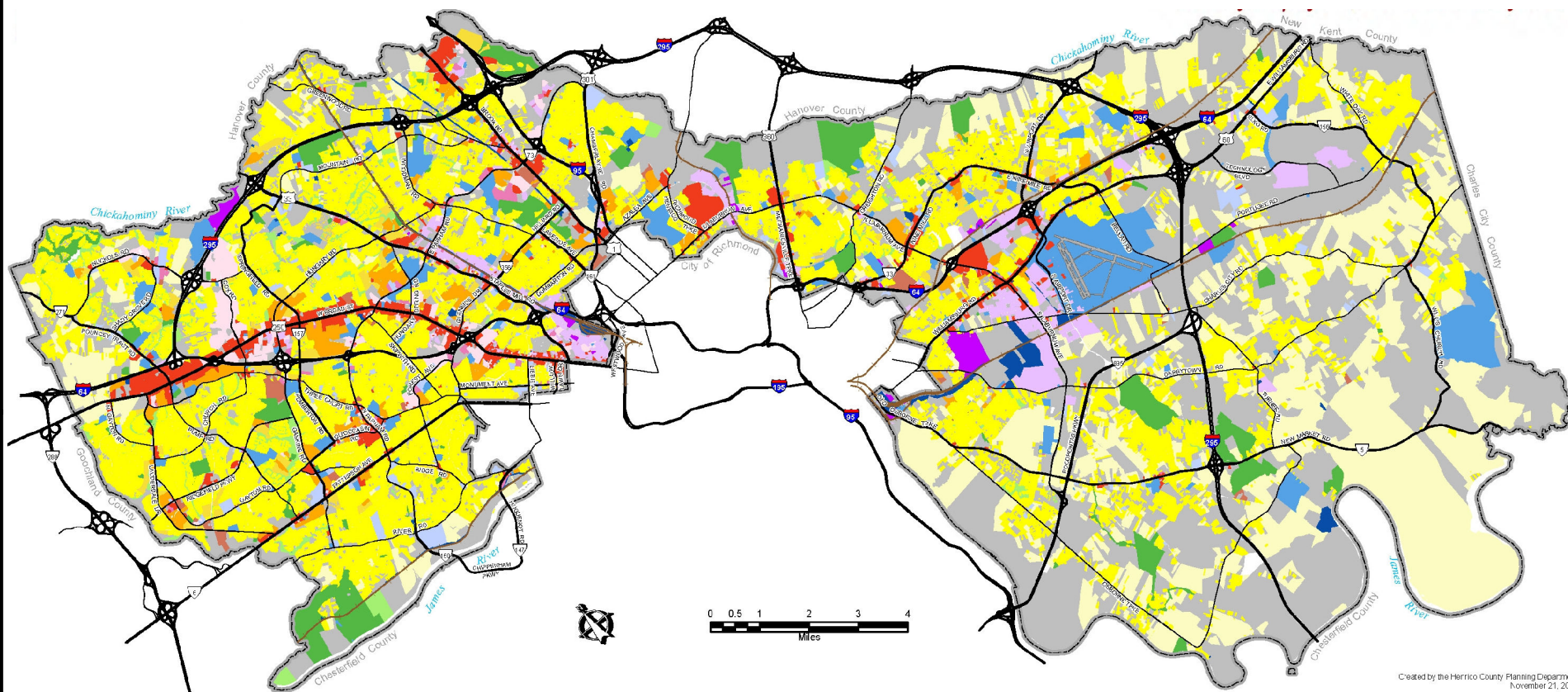
Residential use is the most dominant land use in the County; it currently comprises about twenty-seven percent (27%) of the total land area, more than any other single land use.

Commercial and industrial land use currently compromise close to seven percent (7%) of the total land area in Henrico County. According to the 2026 Comprehensive Plan of Henrico County, “both commercial, (which includes retail and office uses), and industrial land uses increased by over fifty percent (50%) and were among the highest growth rates of all categories. The increases in these two categories show the health of the non-residential sector of Henrico County’s economy.”

The following figure depicts the existing land use in Henrico County.

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<sup>95</sup> Henrico County. *2026 Comprehensive Plan of Henrico County*. Prepared by the Henrico County Planning Department



Created by the Henrico County Planning Department  
November 21, 2009

- |   |   |  |
|---|---|--|
| <span style="display: inline-block; width: 15px; height: 15px; background-color: #ffffcc; border: 1px solid black;"></span> Residential - Single Family - Acreage | <span style="display: inline-block; width: 15px; height: 15px; background-color: #fce4ec; border: 1px solid black;"></span> Commercial - Office         | <span style="display: inline-block; width: 15px; height: 15px; background-color: #add8e6; border: 1px solid black;"></span> Public                     |
| <span style="display: inline-block; width: 15px; height: 15px; background-color: #ffff00; border: 1px solid black;"></span> Residential - Single Family           | <span style="display: inline-block; width: 15px; height: 15px; background-color: #f8bbd0; border: 1px solid black;"></span> Commercial - Office/Service | <span style="display: inline-block; width: 15px; height: 15px; background-color: #add8e6; border: 1px solid black;"></span> Semi-Public                |
| <span style="display: inline-block; width: 15px; height: 15px; background-color: #c8e6c9; border: 1px solid black;"></span> Residential - Single Family - OS      | <span style="display: inline-block; width: 15px; height: 15px; background-color: #ffcdd2; border: 1px solid black;"></span> Commercial - Retail         | <span style="display: inline-block; width: 15px; height: 15px; background-color: #00008b; border: 1px solid black;"></span> Public Service Corporation |
| <span style="display: inline-block; width: 15px; height: 15px; background-color: #ffeb3b; border: 1px solid black;"></span> Residential - Medium Density          | <span style="display: inline-block; width: 15px; height: 15px; background-color: #e1bee7; border: 1px solid black;"></span> Light Industry              | <span style="display: inline-block; width: 15px; height: 15px; background-color: #ffffff; border: 1px solid black;"></span> Public Right-of-Way        |
| <span style="display: inline-block; width: 15px; height: 15px; background-color: #ffb74d; border: 1px solid black;"></span> Residential - Multi-Family            | <span style="display: inline-block; width: 15px; height: 15px; background-color: #e91e63; border: 1px solid black;"></span> Heavy Industry              | <span style="display: inline-block; width: 15px; height: 15px; background-color: #cccccc; border: 1px solid black;"></span> Vacant                     |
| <span style="display: inline-block; width: 15px; height: 15px; background-color: #d97025; border: 1px solid black;"></span> Residential - Assisted Living         | <span style="display: inline-block; width: 15px; height: 15px; background-color: #4caf50; border: 1px solid black;"></span> Open Space - Recreation     |  |

Source: Henrico County 2026 Vision Comprehensive Plan

#### 4.3.12 Presence of Impaired Streams and Type of Impairment <sup>96</sup>

The Virginia Fish and Wildlife Information Service database maintained by VDGIF indicates no “federally” threatened and endangered waters located within Henrico County.

The Virginia Department of Game and Inland Fisheries database listed several “impediments” located within the County, mostly relating to dams within tributaries to the James River, which would impede the migration of aquatic species upstream from this river. These impediments are tabulated below:

**Table 4-10: Stream Impediments in Henrico County <sup>97</sup>**

<b>Impediment Name</b>	<b>ID - County</b>	<b>Stream</b>
Bosher Dam	379 - Henrico	James River
Canterbury Dam	380 - Henrico	Deep Run
Deep Run Dam	390 - Henrico	Deep Run
Eako Dam	383 - Henrico	Meredith Branch
Eberhard Dam	385 - Henrico	Boar Swamp
Gillie Creek Dam	381 - Henrico	Stony Run
Griggs Dam	387 - Henrico	Fourmile Creek
Miles Dam	384 - Henrico	Chickahominy River
Three Chopt Estate Dam	389 - Henrico	Upham Brook
Ukrop Dam	386 - Henrico	Hass Creek
Wellesley Dam	391 - Henrico	Hardings Branch
West End Lake	388 - Henrico	Hungary Creek
Westbury Lake Dam	776 - Henrico	Cabin Branch
Youngs Pond Dam	774 - Henrico	Upham Brook

The Virginia Department of Environmental Quality has compiled a list of streams in Henrico County that are impaired for failure to meet water quality standards for designated water uses. There are six designated uses for surface waters; aquatic life, fish consumption, shellfish consumption,

<sup>96</sup> VDEQ. 2006. *Final 2006 305(b)/303(d) Water Quality Assessment Integrated Report*. Prepared by the Virginia Department of Environmental Quality.

<sup>97</sup> Source: Virginia Department of Game and Inland Fisheries. Fish and Wildlife Information Services: fish impediments database.

swimming, public water supplies, and wildlife. The 2006 Water Quality Assessment Integrated Report is a summary of the water quality conditions in Virginia from January 1, 2000, to December 31, 2004. The Virginia Department of Environmental Quality lists the following Henrico County bodies of water as “impaired”.

**Table 4-11: Impaired Waters of Henrico County <sup>98</sup>**

<b>Waterbody Name</b>	<b>Size</b>	<b>County</b>	<b>Impairment</b>
Almond Creek	2.26 miles	Henrico	pH, Fecal Coliform, Escherichia coli
Chickahominy River	23.21 miles 14.98 miles	Henrico, Hanover Henrico, Hanover	Dissolved Oxygen, Fecal Coliform
Unnamed tributary to Coles Run	1.14 miles	Henrico	Dissolved Oxygen, pH
Crewes Channel	3.31 miles	Henrico	pH
Deep Run	2.33 miles	Henrico	Dissolved Oxygen
Upper Fourmile Creek	5.79 miles	Henrico	Escherichia coli, Dissolved Oxygen
Gillies Creek	5.79 miles	Henrico	pH, Fecal Coliform
James River	0.02 miles	Henrico, Richmond City	Escherichia coli, Aquatic Plants, PCB in fish tissue
James River/Turkey Island Creek/Fourmile Creek	1.50 miles	Henrico, Chesterfield	Fecal Coliform, Aquatic Plants, PCB in fish tissue
James River/Turkey Island Creek/Fourmile Creek	4.81 miles	Henrico, Charles City	Escherichia coli, Aquatic Plants, PCB in fish tissue
James River near Proctors Creek	1.43 miles	Henrico, Chesterfield	PCB in fish tissue
North Run to Hungary Creek	3.65 miles	Henrico	Escherichia coli, pH
North Run from Hungary Creek to Upham Brook	3.94 miles	Henrico	Escherichia coli
Roundabout Creek	2.14 miles	Henrico	Dissolved Oxygen, pH
Upham Brook above Shaaf Pond	0.72 miles	Henrico	Dissolved Oxygen, Escherichia coli
Upham Brook below Shaaf Pond	10.41 miles	Henrico, Richmond City	Escherichia coli
Upham Brook Tributaries	29.32 miles	Henrico, Richmond City	Escherichia coli
Western Run	3.03 miles	Henrico	Fecal Coliform, pH, Escherichia coli
White Oak Swamp	3.47 miles	Henrico	Dissolved Oxygen
White Oak Swamp Creek	3.90 miles	Henrico	Dissolved Oxygen

<sup>98</sup> Virginia Department of Environmental Quality. *Final 2006 305(b)/303(d) Water Quality Assessment Integrated Report*.

The Virginia Department of Environmental Quality has a separate designation for waters of concern where indicators show an apparent decline in water quality. These waters are *not* impaired and are included only for informational purposes. The VDEQ lists the James River, Falling Creek Reservoir, and major Tuckahoe Creek tributaries as “waters of concern” in Henrico County. The VDEQ lists the Falling Creek Reservoir as a “water of concern” for dissolved oxygen and nutrient enrichment issues, while major Tuckahoe Creek tributaries are listed for dissolved oxygen and fecal coliform problems. According to the VDEQ, the James River is under a health advisory for kepone, lead, benthics, and nutrient enrichment from non-point sources.<sup>22</sup>

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<sup>22</sup> Virginia Department of Environmental Quality. *Waters of Concern*. Compiled from the 2002 Total Maximum Daily Load (TMDL) Priority List.



Hanover

New Kent

Charles City

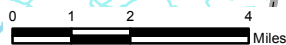
Henrico

Richmond City

Chesterfield

Goochland

Powhatan



Source: USGS; ESRI; Henrico County; US Environmental Protection Agency, 06/2011

**Draper Aden Associates**  
Engineering • Surveying • Environmental Services

BLACKSBURG, VA CHARLETTESVILLE, VA HAMPDEN ROADS, VA RICHMOND, VA

# Impaired Waters Henrico County, Virginia

## Legend

- Water Monitoring Stations
- Impaired Stream

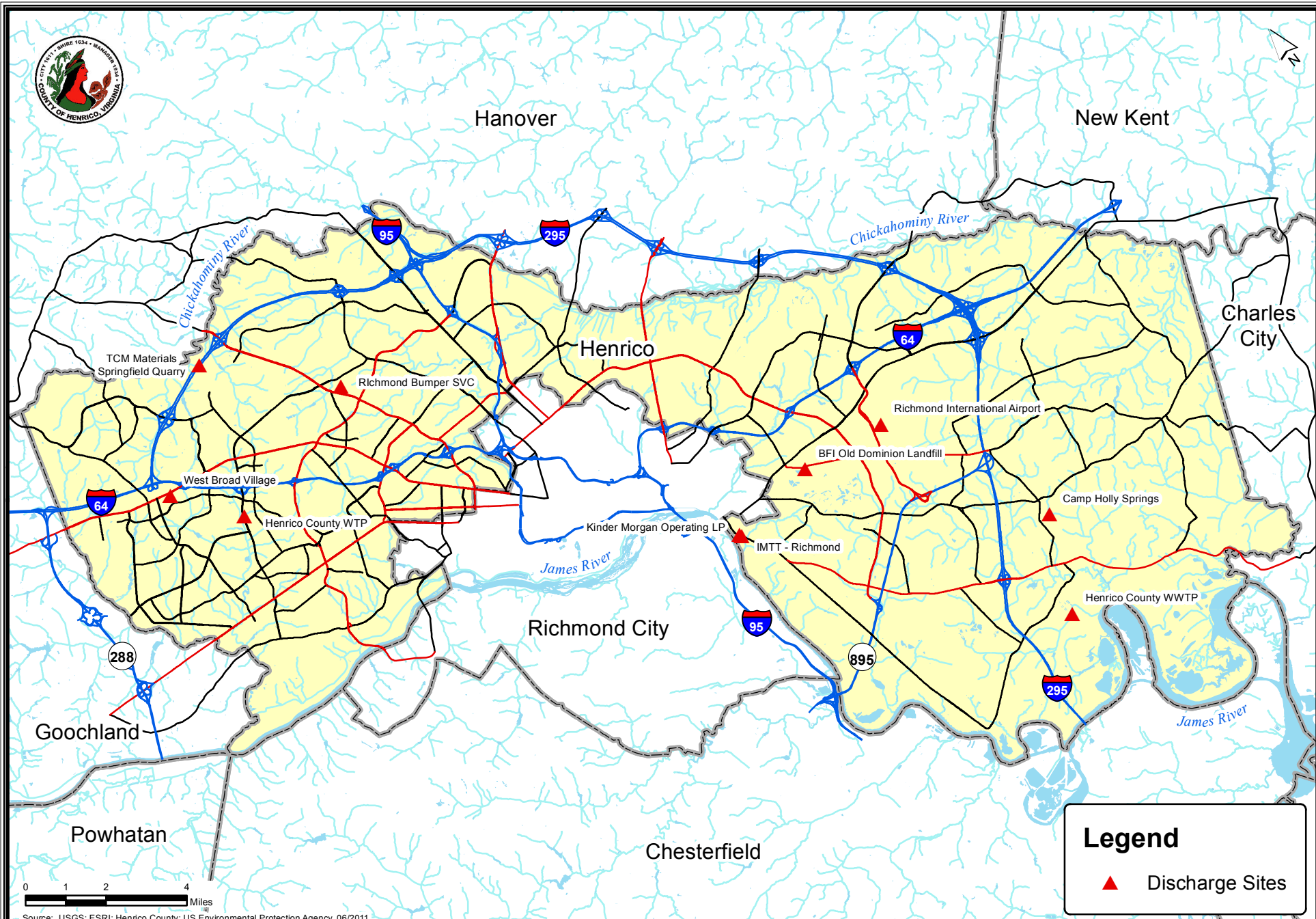
Figure  
4-12

#### 4.3.13 *Location of Point Source Discharges*

Point source discharges are fixed locations from which pollutants are discharged into a water source. A point source can be any single source of pollution, such as a pipe from a sewage treatment plant or a ditch. The Envirofacts database, maintained by the United States Environmental Protection Agency (EPA), lists the following facilities in Henrico County as having a water discharge permit.

**Table 4-12: Facilities with NPDES Permits**

<b>NPDES ID</b>	<b>Facility Name</b>	<b>Address</b>	<b>Permit Issued Date</b>	<b>Permit Expired Date</b>	<b>SIC Code</b>	<b>SIC Description</b>	<b>USGS HUC</b>
VA0091499	BFI Old Dominion Landfill	2001 Charles City Rd Richmond, VA 23231	May-03-2006	May-02-2011	4953	Refuse Systems	02080206
VA0091154	Camp Holly Springs	4100 Diamond Springs Drive Richmond, VA 23231	Sep-18-2007	Dec-19-2012	5149	Groceries And Related Products, Not Elsewhere Classified	02080206
VA0063690	Henrico County Water Reclamation Facility	9101 WRVA Road Richmond, VA 23231	Dec-02-2005	Dec-01-2010	4952	Sewerage Systems	02080206
VA0091197	Henrico County Water Treatment	10111 Three Chopt Rd Richmond, VA 23233	Jun-08-2009	Jun-07-2014	4941	Water Supply	02080205
VA0054291	IMTT - Richmond	5500 Old Osborne Turnpike Richmond, VA 23231	Aug-19-2009	Aug-18-2014	5171	Petroleum Bulk Stations And Terminals	02080206
VA0029165	Kinder Morgan Operating LP - Bickerstaff Road	413 Bickerstaff Road Richmond, VA 232310000	Apr-28-2006	May-01-2011	5171	Petroleum Bulk Stations And Terminals	02080206
VAU000023	Richmond Bumper SVC Inc.	6716 Janway Road Richmond, VA 232282810			5015	Motor Vehicle Parts, Used	
VA0063649	Richmond Country Club WWTP	12950 Patterson Ave Richmond, VA 23233	Jun-09-2009	Jun-22-2014	7997	Membership Sports And Recreation Clubs	02080205
VA0090301	Richmond International Airport	1 Richard E Byrd Terminal Dr. Richmond, VA 23250	Mar-20-2006	Mar-19-2011	4581	Airports, Flying Fields, And Airport Terminal Services	02080206
VA0058041	TCS Materials - Springfield Quarry	11460 Staples Mill Rd Glen Allen, VA 23060	May-11-2009	May-10-2014	1429	Crushed And Broken Stone, Not Elsewhere Classified	02080206
VAU001795	West Broad Village	Off West Broad St, Southwest of Richmond, VA 23233			1542	General Contractors-Nonresidential Buildings, Other Than Industrial Buildings And Warehouses	



**Legend**

▲ Discharge Sites

#### 4.3.14 *Other Potential Threats to the Existing Water Quantity and Quality*

According to the 2026 Comprehensive Plan of Henrico County, Virginia, “from 1990 to 2000, the County grew by approximately twenty percent (20%) from a population of 217,900 to 263,400”. The fact that Henrico County has maintained such a steady percentage of growth over such an extended period of time is a good indication the population will continue to grow at a similar rate in the future.”

Henrico County is rich in natural, cultural, and historic resources. There is a vast array of conditions and features that contribute to the natural, cultural and historic context of the County. Among these are the County’s unique geology, which includes wetlands, varied topography, the Chickahominy and James Rivers, and areas included in Chesapeake Bay Preservation Areas. The County’s geographic location and proximity to Richmond have resulted in a rich resource of cultural and historic landmarks throughout the County. To ensure sustainability, these resources must be balanced with economic development in the County.”

Water supply, sewer service, and good transportation are all necessary for job creation. Water supply will be key to all segments of Henrico County – residential, business and industry. Eventually, ground water sources will be inadequate to meet demand, so utilization of surface water will become even more important. The James River and other water sources must be protected to ensure adequate useable water supply for the future.

#### 4.3.15 *Source Water Assessment Program (SWAP)*

Future residential and commercial development in Henrico may occur in areas where development could impact the quality of ground water sources. The VDH Source Water Assessment Program (SWAP) ranked nearly all ground water sources in Henrico County as high risk or “high susceptibility” to water quality degradation. See **Table 2-8**.

## 5.0 PROJECTED WATER DEMAND

The VDEQ Regulation requires that water supply plans provide estimated water demands within the planning area for a minimum of 30 to a maximum of 50 years into the future. Future water demands were developed for Henrico, Goochland, Powhatan and Cumberland Counties for the Joint Permit Application submitted by Cumberland County for the Cobbs Creek Reservoir project. The Joint Permit Application was prepared in 2005.

The population projections and future water demands detailed below rely, in part, on the projections included in the Cobbs Creek Joint Permit Application. In cases where more current data is included, the data is footnoted or the source is cited.

### 5.1 Historic and Projected Population

Past population trends provide a starting point when estimating future growth and water demands for a jurisdiction. There has been rapid growth in population in Henrico County as evidenced in the U.S. Census data. Henrico County's population grew by 44,419 between the 1990 and 2000 Censuses, which represented a 20.4 percent increase. The population grew at an average annual rate of about 1.8 percent between 1970 and 2000 and, by 2007, had reached an estimated level of 302,518. The 2010 Census reports a population of 306,935. See **Table 5-1**.

**Table 5-1: Historical Henrico County Population<sup>99</sup>**

<b>Year</b>	<b>Population</b>
1970	154,364
1980	180,735
1990	217,881
2000	262,300
2007	302,518
2010 Census	306,935

### 5.2 McBride Dale Clarion Projections – 2026 Comprehensive Plan

Demographic forecasts and development capacity analyses have been prepared for Henrico County by McBride Dale Clarion (MDC) to support the County's

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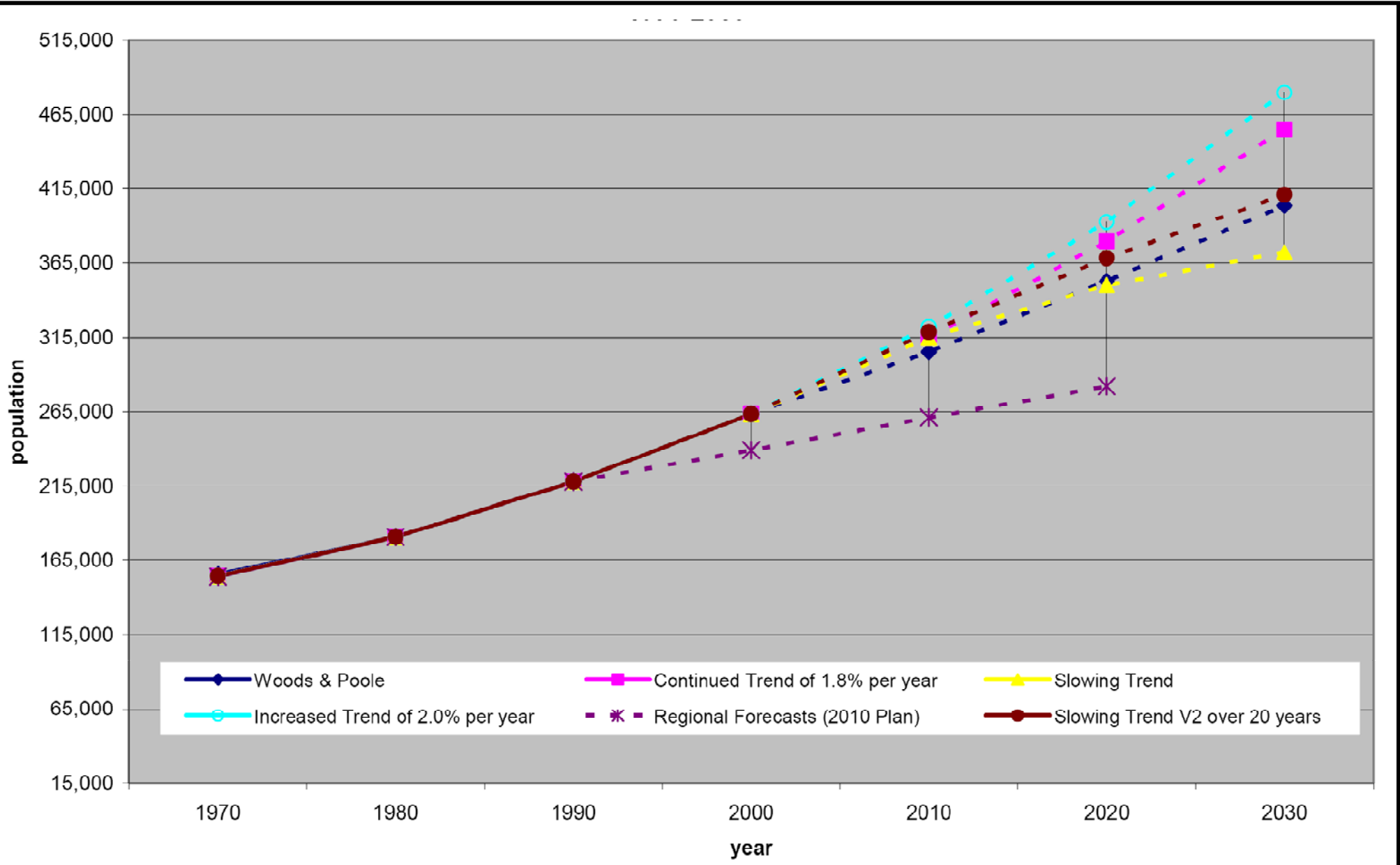
<sup>99</sup> U.S. Census Bureau for years 1970-2000; 2007 estimate from Henrico County 2007 3-C Report (June 2008); 2010; Census Bureau.

comprehensive planning efforts in development of the 2026 Comprehensive Plan. Historic and projected population growth is shown in **Figure 5-1** as published by MDC in January 2005.

Out of the six growth scenarios presented in the figure, MDC has used the “Slowing Trend Version 2” as the population projection for all analyses for the County’s 2026 Comprehensive Plan. This scenario was selected, in part, because of the potential that as the western portions of the County continue to grow, growth will continue into adjoining counties, thereby absorbing a percentage of the regional growth and reducing the rate at which Henrico’s population will grow. Even with the selection of this slowing trend (version 2) growth scenario, the projected 2030 Henrico population is 410,812. Assuming that population growth continues at the same growth rate as predicted in the MDC report, population projections through the year 2060 are presented in **Table 5-2**.

As shown in **Table 5-2**; the 2010 Census reported a county population that is 11,750 less than was projected in by MDC during the development of the County Comprehensive Plan.

Even though the economic downturn impacted growth and development in Henrico County in the years leading up to the 2010 Census, it is projected that the population growth in Henrico will, over the 50-year planning period, conform to the population projections shown in **Table 5-2**.



Source: Henrico County Vision 2026, Demand Analysis, revised February 2005



Henrico County Water Supply Plan

Henrico County: Historic and Forecasted Population Growth (1970-2030)

Figure 5-1

**Table 5-2: Henrico County Population Projections** <sup>100</sup>

<b>Year</b>	<b>Population</b>
2007	302,518
2010	318,685 (MDC)
	306,935 (Census)
2015	344,126
2020	368,316
2025	390,719
2030	410,812
2035	436,282
2040	463,332
2045	492,058
2050	522,566
2055	554,965
2060	589,373

In conjunction with the development of the Cobbs Creek Permit application, Malcolm Pirnie developed water demand projections for Henrico County. Malcolm Pirnie's analysis is detailed below.

The Henrico Planning Department's *2007 3-C Report* (June 2008) was used to verify future population projections. According to the *2007 3-C Report*, Henrico's estimated household size was 2.39 people per household and the estimated 2007 population was 302,518. The overall residential development density was 3.00 units/acre compared to a 2.72 units/acre average for development approved between 2002 and 2005 as documented in a December 1, 2005 Henrico Planning Department memo. In 2007, of Henrico County's total land area of 156,238 acres, 47% was developed (74,145 acres) and 27% was residential (i.e. approximately 58% of developed lands).<sup>101</sup>

Using Henrico's 2000 household size of 2.39, the population density in non-vacant portions of Henrico County is 7.2 persons/acre (compared to 6.5 persons/acre in approved development for 2002-2005). If the vacant land (51% of total land area of 79,681 acres) was ultimately developed under a similar pattern as has occurred in developed portions of the Henrico, about

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<sup>100</sup> McBride Dale Clarion, January 2005, projected to Year 2060 assuming growth rate of 6.2 %.

<sup>101</sup> From 2007 3-C Report.

28 percent more of the land area (43,824 acres) would become residential lands. This appears plausible based on Henrico's most recent existing land use and zoning maps. Under the above assumptions, new residential development would result in an increase of between 285,000 and 316,000 (based on a population density of 6.5 to 7.2 persons/acre). Adding this potential population increase to the 2007 base population (302,518) results in a long-term County development population range of 588,000 to 619,000. This population range brackets the projected 2060 population of 589,373 shown in **Table 5-2**.

### **5.3 Demand Projections Based on Population**

Malcolm Pirnie also developed a disaggregated water demand projection for Henrico County. See **Table 5-3**. The projections were disaggregated from total projected demands estimated by the Henrico County Department of Public Utilities in August 2005. The methodology used to arrive at these water demand projections is discussed on the page following **Table 5-3**.

**Table 5-3: Henrico County Projected Average Water Demand<sup>102</sup>**

<b>Year</b>	<b>Connected Population</b>	<b>Henrico Population<sup>103</sup></b>	<b>% Growth</b>	<b>Total Demand (MGD)<sup>104</sup></b>	<b>Residential Demand (GPCPD)</b>	<b>Residential Demand (MGD)</b>	<b>Commercial Demand (MGD)</b>	<b>Industrial Demand (MGD)</b>	<b>UAW Demand (MGD)</b>	<b>Wholesale Demands – Hanover (MGD)<sup>105</sup> <sup>106</sup></b>
2005	282,285	292,523		38.7	75	21.20	9.80	3.2	5.0	1.8
2010	309,124	318,685 <sup>107</sup>	7.33%	48.1	75	23.20	11.70	5.2	6.2	1.8
2015	335,523	344,126	8.54%	55.7	75	25.20	14.70	6.9	7.1	1.8
2020	360,950	368,316	7.58%	59.9	75	27.10	15.60	7.7	7.7	1.8
2025	386,812	390,719	7.17%	64.1	75	29.00	16.50	8.5	8.2	1.8
2030	410,812	410,812	6.20%	68.2	75	30.80	17.40	9.4	8.7	1.8
2035	436,282	436,282	6.20%	72.4	75	32.70	18.30	10.3	9.3	1.8
2040	463,332	463,332	6.20%	76.6	75	34.70	19.00	11.2	9.8	1.8
2045	492,058	492,058	6.20%	80.8	75	36.90	19.70	12.1	10.3	1.8
2050	522,566	522,566	6.20%	85.0	75	39.20	20.20	12.9	10.9	1.8
2055	554,965	554,965	6.20%	89.2	75	41.60	20.60	13.7	11.4	1.8
2060 <sup>108</sup>	589,373	589,373	6.20%	93.3	75	44.20	20.90	14.5	11.9	1.8

<sup>102</sup> Goochland demands are NOT included in this table. 2011 Goochland demands that are met by Henrico are approximately .70 MGD. Future Eastern Goochland demands are detailed in Table 77 of the Goochland WSP and are .71 MGD in 2010, .95 MGD in 2020; 1.4 MGD in 2030; 2.0 MGD in 2040; 2.95 MGD in 2050 and 4.26 MGD in 2060; based on “mid-range” projections. Oilville projections total .86 MGD in 2060. In addition, the Goochland demands include an additional 5 MGD for non-residential demands that are anticipated in Goochland during the planning period. Total 2060 demands in Goochland in 2060 = 10.2 MGD.

<sup>103</sup> Population demands through 2030 are from McBride Dale Clarion Report, January 2005. Projections after 2030 are based on 6.2% growth rate.

<sup>104</sup> Source of Total Demands: Henrico County Department of Public Utilities, August 2005, includes supply to Hanover County.

<sup>105</sup> Hanover contract allows for .775 MGD; average day demand is currently approximately 550,000.

<sup>106</sup> Based on 1.65 MGD, plus 10% UAW.

<sup>107</sup> 2010 Census = 306,935.

<sup>108</sup> 2060 Projections use the same methodology as in **Environmental Assessment, Cobbs Creek Reservoir Project, Cumberland, VA April 2006.**

Population growth through 2030 was consistent with the McBride Dale Clarion (MDC) January 2005 Demand Analysis study. Beyond 2030, population was extended at the same 6.2 percent growth rate per 5-year period that was included in the last 5-year period of the MDC projections. As there was no strong basis for increasing or decreasing the growth rate, the rate was not altered.

Connected population percentages (the portion of the County's total population that receives water service from the County System) and per capita residential use values used to calculate residential demand were consistent with those used by the Richmond Regional Planning District Commission (RRPDC) in its December 1992 Regional Water Resources Plan for Planning District 15. The per capita residential use value shown in **Table 5-3** was estimated based on Henrico water sales data (1991 - 2007) and the annual population was estimated for the same period using data from Henrico County C-3 reports for each year. Assuming a 95 percent connected population (RRPDC used 95 percent for 1990 and 96 percent for 2000), an average of 73.0 gallons per capita per day (gpcpd) water use rate was estimated over 17 years (1991 - 2007) with a higher demand (79 - 80 gpcpd) during some dry years. However, 75 gpcpd was selected for planning purposes in light of observed Henrico water use trends, growing affluence in the County, and national statistics on residential water use.

The total demand in Henrico was disaggregated into residential demand, unaccounted-for water demand, wholesale water demands, commercial demand, and industrial demand. Henrico water sales data (1991 - 2007) were used to calculate ratios between residential, commercial, and industrial demand. The ratio of the sum of commercial and industrial demand to the residential demand averaged around 50 percent with a high of 59 percent while the ratio of the commercial demand to the residential demand averaged 30 percent, and ranged between 36 percent and 46 percent over the last 5 years. Also, in the last 5 years, the ratio of the commercial demand to the sum of commercial and industrial demand averaged 59 percent, and ranged between 71 percent and 79 percent within the last 5 years. The

commercial and industrial demand splits were selected to be consistent with the ratio of the commercial demand to the sum of commercial and industrial demand.

Unaccounted-for water (UAW) demand was assumed to be 12.8 percent of the total demand. A survey of U.S water utilities sponsored by AWWA was completed in January 2001 and the results presented in Impact of the National Plumbing Standards on Water Infrastructure Investments<sup>109</sup>. As part of this survey, UAW percentages were compiled for utilities nationwide as well as within USEPA's Region 3 (including Virginia). The survey results show that average UAW is 17.5 percent for large utilities in Region 3 serving populations of more than 100,000, while the nationwide average for large utilities was 12.8 percent. The Year 2005 UAW percentage for Henrico County is estimated at approximately 5.5 MGD, as shown in **Table 5.3**.

The Water Loss Management Committee of AWWA has removed non-revenue water goal "percentages" from its most recently updated Manual of Practice. It was determined that establishing 10 percent as a standard goal was unrealistic for many communities. It was recognized that while water utilities around the country have their own financial motivation to manage water loss to its lowest possible level, meeting extremely low percentages will become more difficult as buried infrastructure continues to age.

A discussion of Henrico's programs to reduce UAW is included in **Section 6**.

Ten percent UAW is added on top of the 1.65 mgd value for Hanover County demand supplied by Henrico County DPU, resulting in estimated supply to Hanover of 1.8 mgd throughout the planning period. It may be possible in the future, to increase the Hanover demand over time with the expectation that Hanover will continue to grow and may eventually seek to expand water purchases from Henrico, despite its current dependency on water from the City of Richmond.

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<sup>109</sup> AWWA, 2001.

The total water demand projection was thus based on the disaggregated residential demand, commercial demand, industrial demand, unaccounted-for-water (UAW) demand, and water sales to Hanover County. **Table 5-3** presents Henrico County's total projected future average water demands, which increase from a 2007 demand of 42.9 mgd to a 2060 water demand of 93.3 mgd.

## **6.0 DEMAND MANAGEMENT**

Water demand management is the conscious effort by a utility, business or individual to save water. Every gallon of water not used is one less to be stored, purified, and distributed. It also may represent one less gallon of water that must pass through some form of wastewater treatment before it is returned to the environment.

Water demand management practices are followed at all times, regardless of the state of the County's water supply system. These long-term water conservation programs permanently reduce overall demand at all times, while drought contingency plans are implemented in the short-term in direct response to a water supply emergency. Drought response and contingency planning are discussed in Section 7.0.

### **6.1 Practices for More Efficient Use of Water<sup>110</sup>**

The Virginia Uniform Statewide Building Code (USBC) is a state regulation promulgated by the Virginia Board of Housing and Community Development. The purpose of the regulation is to establish minimum standards to govern the construction and maintenance of buildings and structures.

Henrico County has adopted the Virginia Uniform Statewide Building Code (USBC), as provided in Chapter 6, title 36 (§ 36-97 et seq.) of the Code of Virginia. The adopted building code requires that all new construction within the County utilize water efficient plumbing fixtures, including toilets, kitchens and lavatory faucets, showerheads, and urinals. The County has the authority to enforce these restrictions through its Building Inspections department. Documentation of the adoption of the USBC by Henrico County can be found in Section 6 of the Code of the County of Henrico, Virginia.

As structures that were built prior to the implementation of the Code are remodeled, less efficient plumbing fixtures will be replaced with lower flow fixtures, as those are the only available fixtures on the market.

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<sup>110</sup> 9 VAC 25-780-110A(1)

## 6.2 Water Conservation Measures Used in the Planning Area<sup>111</sup>

### 6.2.1 *Technical Programs*

Henrico Public Utilities has several technical programs in place to conserve water.

The Henrico County Water Reclamation Facility (which currently processes an average of 42 mgd of wastewater) uses approximately 1.58 mgd of effluent water at the facility for wash down, foam and scum suppression/control, and chemical make-up and delivery.<sup>112</sup> The use of effluent for these purposes avoids the use of 1.58 mgd of potable water. At the Water Treatment Facility, there are two filter operations: the backwash cycle and the filter-to-waste cycle (also called the rewash cycle).

Approximately 2/3 of the water used in the backwash cycle is recycled for use again, while all of the water in the rewash cycle is recycled. In 2007, on average, the Henrico Water Treatment Facility recycled 0.44 mgd in its processes.

### 6.2.2 *Educational Programs*

The County's website includes information that is useful to water users including links to other websites that provide drought and conservation information. The Henricopolis Soil and Water Conservation District provides informational and educational programs for children and adults.

Henrico County Public Utilities has a designated Community Liaison that acts as the coordinator for dissemination of conservation information. Quarterly newsletters called "The Water Source" are sent out in water bills. These newsletters provide general information regarding Henrico County's water source, and identify specific water conservation measures that can be implemented.

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<sup>111</sup> 9 VAC 25-780-110 A (2)

<sup>112</sup> Information provided by James Grandstaff, Division Director, Henrico County DPU, Water Reclamation Facility (WRF). August 2008.

The Public Utilities Department provides outreach to schools and distributes “Use Water Wisely” kits to schools. These kits include pamphlets and gifts with the “Use Water Wisely” catch-phrase on them. These are also distributed at the Department of Public Utilities and at public functions in which Public Utilities is involved.

*6.2.3 Financial Programs*

The County’s current water rate structure is different for each user category. For residential users, it is an inclining block rate structure. This means that the amount paid per unit of consumption increases when larger amounts of water are consumed. This structure provides an incentive for customers to conserve. Residential rates are defined in **Table 6-1**.

**Table 6-1: Henrico County Bi-Monthly Single-Family Residential Water and Sewer Rates<sup>113</sup>**

<b>Charges</b>	<b>Water</b>	<b>Sewer</b>
Service Charge	\$10.80	\$21.75
Charge per CCF (if < 6 CCF <sup>114</sup> )	\$1.54	\$1.61
Charge per CCF (if > 6 CCF)	\$2.48	\$2.63

With respect to commercial and industrial customers, the water rate structure is a declining block rate; the amount paid per unit of consumption decreases when larger amounts of water are consumed. This is not structured to encourage conservation to the same extent that a flat or inclining block rate structure would be expected to accomplish.

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<sup>113</sup> Henrico Public Utilities Website, rates effective July 1, 2011.

<sup>114</sup> CCF = 100 cubic feet.

Commercial and industrial rates are as shown below.

**Table 6-2: Henrico County Commercial and Industrial Water and Sewer Rates<sup>115</sup>**

<b>Charges</b>	<b>Water</b>	<b>Sewer</b>
Charge per CCF (First 10,000 CCF)	\$2.48	\$2.63
Charge per CCF (Next 70,000 CCF)	\$1.69	\$1.88
Charge per CCF (Next 80,000 CCF)	\$1.22	\$1.69

### **6.3 Practices to Reduce Water Loss<sup>116</sup>**

In 2004, Henrico Public Utilities initiated consulting services to evaluate and make recommendations regarding the water meter program at the County. The draft final report was issued in May 2005 and included many recommendations. As a result of the study, the County has implemented or is in the process of implementing several of the recommendations.

One of those programs is the implementation of an Automated Meter Reading (ARM) system throughout the County. As part of this program, all meters in all usage categories, will be replaced over a six-year timeframe.

The Water Main Rehabilitation Program implemented by the County currently has a budget of \$2 million dollars per year to rehabilitate or replace older mains that are more susceptible to having leakage issues. This is in addition to money expended each year for emergency repairs. Funding is projected to increase to \$4 M per year beginning in the year 2015.

Further, the Department investigates and looks for leaks whenever they have reason to believe they may exist and leaks are repaired as the Department becomes aware of them.

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<sup>115</sup> Henrico Public Utilities Website, rates effective July 1, 2011.

<sup>116</sup> 9 VAC 25-780-110 A (3).

#### 6.4 Water Reuse as a Demand Management Practice <sup>117</sup>

The reuse of treated wastewater effluent from the Henrico County Water Reclamation Facility is a potential new demand management practice for consideration in Henrico County.

There are two different types of wastewater reuse: direct and indirect. Indirect reuse occurs when treated wastewater effluent, which by definition is non-potable, is discharged to receiving waters and then later withdrawn from those receiving waters for use downstream. Direct water reuse occurs when treated wastewater effluent is piped directly to be used for another non-potable purpose.

In Virginia, treated wastewater effluent may be reused for irrigation, landscape impoundments, construction (i.e. dust control, soil compaction, washing aggregate or making concrete), or industrial uses such as cooling water, commercial laundries, street washing, etc. Minimum standard requirements for the reuse of reclaimed water must be met, as defined in 9VAC25-740, Water Reclamation and Reuse Regulation (effective October 1, 2008).<sup>118</sup> According to the regulation, reclaimed water must be treated to the Level 1 standard in order to be used in any application with the potential for direct public exposure, which includes golf course or residential irrigation. Wastewater effluent that is treated to the less stringent Level 2 standards may be used for certain industrial and irrigation application with restricted access to the public.

The Henrico County Water Reclamation Facility (WRF) is located in the southeast portion of the County, generally away from urban development. See **Figure 6-1**. The WRF has a capacity to treat 75 mgd and has recently averaged treatment of approximately 42 mgd. The WRF was recently upgraded and includes secondary filtration via anthracite filter beds and disinfection treatment of the effluent.

A summary of the Level 1 treatment standards and the status of the existing WRF with regards to satisfying these requirements is presented in **Table 6-3**.

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<sup>117</sup> 9 VAC 25-780-110 B

<sup>118</sup> Source, Virginia Department of Health website.

**Table 6-3: Level 1 Reuse Treatment Standards and Status of Henrico WRF in Meeting Standards**

<b>Parameter</b>	<b>Minimum Treatment Requirement<sup>119</sup></b>	<b>Status for Current WRF<sup>120</sup></b>
Bacterial Standards: 1. Fecal Coliform  2. E. Coli  3. Enterococci	1. Monthly geometric mean less than or equal to 14 colonies/100 ml (corrective action at > 49 colonies/100 ml); or 2. Monthly geometric mean less than or equal to 11 colonies/100 ml (corrective action at > 35 colonies/100 ml); or 3. Monthly geometric mean less than or equal to 11 colonies/100 ml (corrective action at > 24 colonies/100 ml)	Currently, the Henrico WRF averages Fecal Coliform levels (after disinfection) of less than or equal to 1.0 colony/100 ml; which would meet the bacterial standard for Level 1 reuse.
Total Residual Chlorine (TRC)	Corrective action threshold at less than 1 mg/l after a minimum contact time of 30 minutes at average flow or 20 minutes at peak flow.	This parameter is easy to adjust; therefore, no major treatment changes would be required to meet this criterion.
pH	6.0 – 9.0 standard units	This is already a requirement of the discharge permit.
Five-Day BOD or CBOD	Five-Day BOD monthly average less than 10 mg/l OR CBOD monthly average less than or equal to 8 mg/l.	Current discharge permit requires that the Five-Day BOD is less than or equal to 0.6 mg/l; therefore this criterion is also satisfied by the existing treatment train
Turbidity	Daily average (over 24-hour period) less than or equal to 2 NTU	Turbidity is not currently measured, so upgrades may be required based on the turbidity of the existing effluent.

Based on a very preliminary evaluation of the existing treatment at the Henrico WRF, it appears that minimal plant upgrades would be required for the plant effluent to meet Level 1 or Level 2 treatment standards for reuse.

In addition, additional monitoring would likely be needed to satisfy the reuse permit requirements, and additional infrastructure, including extensive “purple pipe” water reclamation piping would be required to connect the reclaimed water to any potential user.

Potential users would have to be identified and the financial feasibility of developing a reuse project would need to be analyzed.

<sup>119</sup> 9VAC25-740-0.A.1 – Level 1 standards for reclaimed water.

<sup>120</sup> Based on telephone conversation with Carol Eisenhower, Asst. Division Director, Henrico Water Reclamation Facility on September 26, 2008.

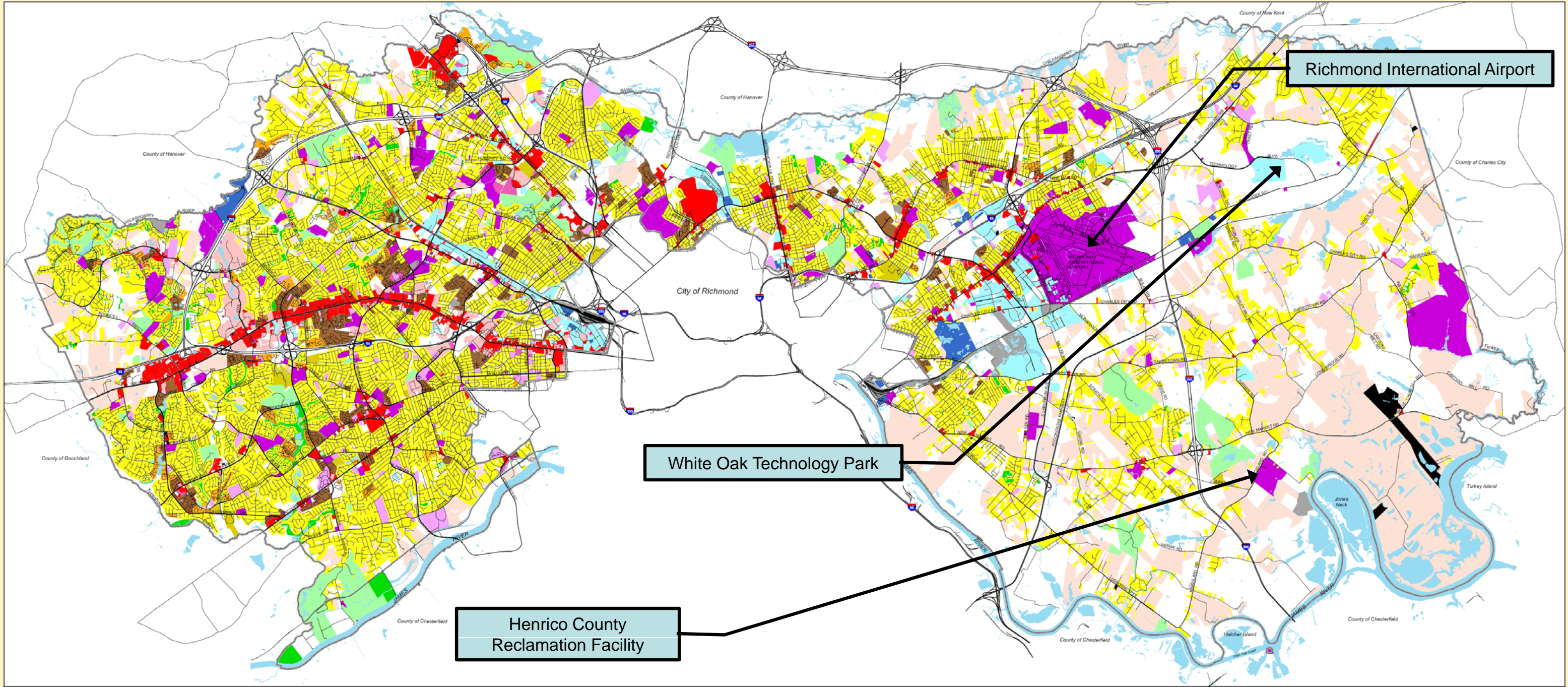

Based on review of existing County land use maps (**Figure 6-1**) and conversations with County Planning staff, the land surrounding the existing WRF is primarily zoned for agriculture. There are existing agricultural fields in that area. None of these is currently using treated effluent for irrigation. In addition, no industries or other entities have approached the County regarding use of plant effluent.

As shown in **Figure 6-1**, the nearest industrial park to the WRF is the White Oak Industrial Park, which is located approximately 6 miles to the northwest of the facility. In order for an industry at White Oak to use effluent for any purpose, they would incur expenditures associated with piping the effluent to the facility in addition to any treatment plant upgrades. It most likely would not be cost efficient to pipe effluent 6 miles to the White Oak Industrial Park, when public water service is available; however, no specific feasibility study has been performed for such as option.


County planning staff has suggested that the potential exists there could possibly be golf courses associated with future development of parcels near the WRF, but no plans are underway. Additional residential development may also occur along the new golf courses, which would create new potential end users for reclaimed water for irrigation of both golf course greens and residential lawns. Should a golf course be planned, the County could encourage the installation of a reclaimed water system as a means of irrigation through an incentive program to developers.<sup>121</sup>

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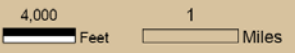
<sup>121</sup> Interview with Seth Humphreys, Henrico County Planner IV, July 2008.

County of Henrico Virginia



Prepared by The Henrico County Planning Department  
5/2/07



**Existing Land Use Classifications**

NO DATA	RESIDENTIAL-SINGLE FAMILY-OS	RESIDENTIAL-ASSISTED LIVING	COMMERCIAL-RETAIL	OPEN SPACE-RECREATION	PUBLIC SERVICE CORPORATION
RESIDENTIAL-SINGLE FAMILY-ACREAGE	RESIDENTIAL-MEDIUM DENSITY	COMMERCIAL-OFFICE	INDUSTRIAL-LIGHT	PUBLIC	PUBLIC RIGHT-OF-WAY
RESIDENTIAL-SINGLE FAMILY	RESIDENTIAL-MULTI-FAMILY	COMMERCIAL-OFFICE/SERVICE	INDUSTRIAL-HEAVY	SEMI-PUBLIC	VACANT

**EXISTING LAND USE**  
May 2, 2007



**Henrico County Water Supply Plan  
Henrico County Land Use Map**

Figure 6-1

## **7.0 DROUGHT RESPONSE AND CONTINGENCY PLAN**

A Drought Response and Contingency Plan is required to set use restrictions on both the water system users and the operation of the water supply source in the event of a drought or other water shortage. Water use restrictions are considered a form of conservation because they result in reduced demands. However, they differ from water demand management measures, such as those described in Section 6, in that they are reserved as contingency measures to be implemented when water supply diminished and generally result in short-term reductions in demands.

Henrico County utilizes an ordinance which outlines specific water supply conditions during which use restrictions are implemented. The County's withdrawal permit for the intake on the James River (VWP Permit No. 88-0898) contains restrictions on withdrawals during drought periods and defines the James River flow triggers that correspond to the voluntary and mandatory conservation stages. These two components of the County's Drought Response and Contingency Plan are discussed below.

### **7.1 Existing Use Restrictions**

A Water Restriction Ordinance was approved by the Board of Supervisors of Henrico County on January 8, 2008 to establish restrictions on the use of water from the County's Public Water System and penalties for violations of the restrictions (ordinance included as **Appendix G**). The water contract between Henrico and the City of Richmond requires that Henrico County participate in water conservation measures to facilitate the region's ability to meet its needs during emergencies such as drought situations.

#### *7.1.1 Drought Stages*

The County's VWP permit for withdrawal from the James River defines when voluntary and mandatory conservation must be implemented, based on the 14-day rolling average of natural streamflow in the James River. These drought stages include: Alert Stage, Voluntary Stage, and Mandatory Stage.

**Table 7-1** depicts the three different drought stages and their governing 14-day rolling average for different times of the year.<sup>122</sup>

**Table 7-1: Henrico County Drought Stages**

Drought Stage	James River Flow Triggers (cfs)	
	November 1 - June 30	July 1 - October 31
Alert	1,800	1,300
Voluntary	1,700	1,200
Mandatory	1,250	700

### 7.1.2 *Alert Stage*

Henrico County implements the Alert Stage in order to provide advance notice of a possible drought. During this stage, the County can begin to prepare for an upcoming drought.

### 7.1.3 *Voluntary Stage*

Henrico County shall take steps to call for voluntary conservation whenever the 14-day rolling average of natural streamflow in the James River falls below 1,700 cfs from November 1<sup>st</sup> through June 30<sup>th</sup> or below 1,200 cfs from July 1<sup>st</sup> through October 31<sup>st</sup>.<sup>123</sup> During this drought stage, all actions to conserve water are voluntary and no legal action can be taken against individuals who do not conserve water. **Table 7-2**, details the voluntary water conservation measures.

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<sup>122</sup> Henrico Withdrawal Permit. Permit No. 88-0898. Section D.

<sup>123</sup> cfs =Cubic Feet per Second.

**Table 7-2: Henrico County Voluntary Conservation Measures**

<b>Category</b>	<b>Voluntary Conservation Measure</b>
Established Lawns, Landscape & Gardens	Monday: No Watering  Odd property addresses: Water on Tuesday, Thursday and Saturday  Even property addresses: Water on Wednesday, Friday and Sunday  (Odd/Even designation is determined by last digit of address number)  Watering is permitted for one day before and 30 days after refurbishment of established lawns by means of motorized core aeration and seeding, motorized thatching and seeding, or motorized light tilling and seeding, provided such refurbishment takes place between September 1 and October 31.
Bucket watering (five gallon max. permitted anytime)	
New Lawns & Landscape	Unrestricted for first 10 days after planting, then limited to the "Established Lawns, Landscape & Gardens" measures
Vegetable Gardens	Limited to any two days per week and between 8 p.m. and 10 a.m. on any day. Bucket watering is unrestricted
Paved Areas/Washing (Streets, Drives, Patios, Walks, etc.)	Limited to two days per week. Unrestricted for immediate health and safety concerns
Vehicle Washing (Commercial Businesses Exempt)	Limited to two days per week using a hand-held hose with an automatic shut-off nozzle
Golf Courses (Greens Exempt)	Limited to 8 p.m. through 10 a.m. on any day
Swimming Pools	Limited to filling to maintain health and safety
Fountains	Limited to two days per week, between 8 p.m. and 10 a.m. on any day
Businesses	Limited to essential uses
Restaurants	No restrictions
All Other Consumption Uses	Encourage conservation by any means

*7.1.4 Mandatory Stage*

Henrico County shall take steps to call for mandatory conservation whenever the 14-day rolling average of natural streamflow in the James River falls below 1,250 cfs from November 1<sup>st</sup> through June 30<sup>th</sup> or below 700 cfs from July 1<sup>st</sup> through October 31<sup>st</sup>. During this drought stage, water use restrictions are enforceable by law. **Table 7-3** details these mandatory water use restrictions that apply to users of the county water system.

**Table 7-3: Henrico County Mandatory Water Restrictions<sup>124</sup>**

<b>Category</b>	<b>Mandatory Conservation Measures</b>
Fountains	Water use is prohibited.
Paved Areas	Washing is prohibited except for health and safety requirements.
Swimming Pools	Filling and replenishing to maintain health and safety is permitted. New or repaired pools may be filled as needed to maintain their structural integrity. All other uses are prohibited.
Vehicle Washing	Non-commercial washing of cars is prohibited, except that construction, emergency or public transportation vehicles, may be washed as needed to preserve their proper functioning and safe operation. Commercial vehicle washing businesses are permitted to operate under normal conditions.
Established Landscaping	Watering is limited to three days per week by address. Addresses ending with an odd number may water only on Tuesday, Thursday, and Saturday. Addresses ending with an even number, or with no number, may water only on Wednesday, Friday, and Sunday. No watering is allowed on Mondays. Bucket watering is permitted any time.
Established Lawns	Watering is prohibited. Bucket watering (five gallon maximum size) is permitted any time.
New Landscaping	Watering is permitted for the first 30 days after planting. Thereafter, the restriction for established landscaping shall apply.
New Lawns	Watering is permitted for the first 30 days after sodding or seeding. Thereafter, the restriction for established lawns shall apply. New lawns do not include refurbishment of established lawns by means of aeration and seeding, dethatching and seeding, or power overseeding.
Restaurants	Water shall be served to customers only upon request.
Golf Courses	Watering is prohibited from 10:00 a.m. to 8:00 p.m., except for the watering of greens or watering by hand held hoses that are one inch or smaller in diameter.
All Other Businesses	Water use is limited to uses essential for business use and human hygiene.
Athletic Fields	Athletic fields may be watered only between 8:00 p.m. and 10:00 a.m. and only at a rate not exceeding a total of one inch during any ten-day period.

**7.1.5 Enforcement<sup>125</sup>**

According to the County’s Water Restriction Ordinance, any person who violates or fails to comply with the mandatory conservation restrictions after a public notice has been issued shall be subject to the following penalties:

<sup>124</sup> Henrico Withdrawal Permit. Permit No. 88-0898.

<sup>125</sup> Emergency Ordinance, Section 4

- ◆ For the first offense, violators shall receive a written warning delivered in person or posted by a representative of the Henrico County Department of Public Utilities;
- ◆ For the second offense, violators shall be fined \$50.00, which will be imposed on the violator's next water bill;
- ◆ For the third and each subsequent offense, violators shall be fined \$100.00 for each offense, which will be imposed on the violator's next water bill; and
- ◆ Each violation by a person shall be counted as a separate violation by that person, irrespective of the location at which the violation occurs.

Persons who have been assessed a penalty shall have the right to challenge the assessment by providing a written notice to the Director of Public Utilities within 10 days of the assessment date. The Director shall determine whether the penalty was properly assessed and notify the complaining individual in writing of his determination. Should the Director determine that the penalty was properly assessed, the person may appeal that determination by providing written notice to the County Manager within 10 days of receiving the notice of determination. The County Manager or his designee shall determine whether the penalty was properly assessed and notify the complaining person in writing of his determination.

The Director of Public Utilities also has the right to waive the penalty if he determines that the violation occurred due to no fault of the person.

## **7.2 Other Water Users**

### *7.2.1 Drought Plan – Self-Supplied*

Portions of Henrico County rely on community and privately owned well systems for water. It is recommended that the County develop a Drought Plan for the many residents who rely on wells.

During periods of drought, ground water sources do not see the effects of a drought as quickly as surface water sources. Water shortages in ground water could potentially be several months delayed from a surface water

drought event. Therefore, Henrico County's municipal water system, which relies on the James River, would experience the effects of drought conditions significantly before ground water users. However, this natural lag time in when ground water users and surface water users experience the effects of a drought should not influence when conservation efforts should take place.

The County will advise ground water users of drought conditions at any time the users of the county system are notified of voluntary or mandatory water use restrictions. The declaration of a drought stage would not only apply to the water use of municipal water users, but it would also recommend voluntary water conservation to all well users in the County.

### **7.3 Goochland County and Hanover County**

Because Henrico County provides water to the Eastern Goochland water system and the Hanover water system, whenever Henrico goes into a drought stage, Goochland and Hanover are required to implement the same drought stage and restrictions on use.

## **8.0 STATEMENT OF NEED**

The Water Supply Planning Regulation (9 VAC 25-780-130) states that “A water plan shall determine the adequacy of existing water sources to meet current and projected demand by preparing a clear statement of need .... And a determination of whether the existing sources are adequate to meet current and projected demands.”

### **8.1 Henrico County Water System**

Water supply needs in Henrico County have been evaluated and Henrico’s projected demands exceed the current permitted supply (45 mgd average daily withdrawal for Henrico’s water treatment plant plus up to 35 mgd from Richmond). Average day demand supplied by Henrico in 2060 is expected to be at or upwards of 103.5 mgd.<sup>126</sup> To meet the future needs of Henrico County (including the demands of Goochland that are met by Henrico); the Cobbs Creek Reservoir project has been selected as the preferred alternative. The Cobbs Creek Reservoir project is discussed in greater detail in the “Alternatives” section of this report.

The Plan includes projected water demands in Henrico County through 2060. The projected demands for Henrico are consistent with the demands presented in the Joint Permit Application for the Cobbs Creek Reservoir project. In the Joint Permit Application, the 2055 Henrico demands were estimated at 110 MGD (with Henrico’s demands at 89.2 MGD and Goochland’s demands at 20.9 MGD. Demands for both counties were based on 2005 data).

The Henrico Water Supply Plan provides a projected demand in 2060 of 93.3 MGD for Henrico’s needs and 10.2 MGD for Goochland’s needs in 2060. The combined 2060 demands are 103.5 MGD as shown below.

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<sup>126</sup> Henrico demands of 93.3 MGD and Goochland demands of 10.2 MGD.

**Table 8-1: Henrico County and Goochland County Demands - 2060**

	<b>Joint Permit Application (2055 Demands)</b>	<b>Regional Water Supply Plans (2060 Demands)</b>
Goochland	20.9 MGD	10.2 MGD <sup>127</sup>
Henrico	<u>89.2 MGD</u>	<u>93.3 MGD</u>
<b>Total</b>	<b>110.1 MGD</b>	<b>103.5 MGD</b>

## 8.2 Statement of Need and Alternatives for Future Supply

Henrico County’s current contract with the City of Richmond provides for up to 35 MGD and the County water treatment plant is permitted for 45 MGD. In order to meet the projected 2060 demand of approximately 103.5 MGD, Henrico needs an additional 23.5 MGD of water to meet the needs of citizens and businesses in Henrico and in Goochland.

**Table 8-2: Calculation of Need – Henrico and Goochland Counties**

	<b>Regional Water Supply Plans (2060 Demands)</b>
Henrico/Goochland Need	103.5 MGD
Current Henrico Supply	<u>80.0 MGD</u>
<b>Need</b>	<b>23.5 MGD</b>

The Cobbs Creek Reservoir is identified as the key alternative for future water supply for Henrico County as well as for Powhatan and Goochland Counties and is designed to meet the 50-years demands of Henrico, Goochland and Powhatan as well as the future demands of Cumberland County.

## 8.3 Self-Supplied Users

Currently there are a number of basins identified in the Comprehensive Plan (Chapter 11) that are “partially served” or “not served” by the Henrico County water system. It is anticipated that, over time, as additional development occurs, the municipal system will provide service to a larger area and to both newly developed and currently developed sites.

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<sup>127</sup> Includes Tuckahoe Creek SD, Eastern Goochland Management Area, Manakin Farms and Oilville areas and includes 5.0 MGD for economic development demands. The 2060 demands are reduced from the demands included in the JPA because actual growth from 2005 – 2011 was less than projected and the JPA assumed that buildout would be achieved by 2055. Goochland now assumes that buildout will occur beyond 2060.

The County's Comprehensive Plan (Chapter 11) includes the following recommendations:

In addition to full system improvement recommendations for sewer and water services in the *Public Utilities Plan*, the following recommendations should be used to guide water and sewer improvements:

1. Support improvements recommended in the *Public Utilities Plan*.
2. Continue the construction of water and sewer lines to serve growing areas of the county.
3. Developers should be responsible for funding the expansion of sewer and water lines to serve new development.
4. In instances where the *Public Utilities Plan* indicates a necessary capacity greater than that which is needed to serve new development, the facility should be built to handle the capacity stated in the plan. The developer should receive credits for the additional capacity, which can be used for future developments or transferred to another developer.
5. Redevelopment and infill projects are desirable when consistent with Chapter 5: Land Use and Chapter 7: Planning & Economic Focus Areas, and are to be approached with caution from the provision of utilities. The county and developers should recognize there may be limitations to the capacity of existing sewer and water facilities in these areas.
6. Encourage new development adjacent to existing lines to tie into the sewer and water systems in the most efficient way possible. It may be necessary to loop water lines to provide redundancy within the system

In 2009, the number of homes that rely on groundwater for drinking water needs is estimated to be 9,657. Many of these homes are east of I-95. While groundwater tends to be plentiful, it is important that the groundwater be protected from harmful impacts and that ground water users be mindful of conserving water, not only during periods of drought, but at all times.

Appendix J. includes a database of well information.

## **9.0 ALTERNATIVES FOR FUTURE SUPPLY**

### **9.1 Regional Partnership – Cobbs Creek**

The key alternative for future water supply for Henrico County is the Cobbs Creek Reservoir which is a regional project designed to meet the future water needs of Henrico, Cumberland and Powhatan counties as well as a portion of Goochland County.

The reservoir will be built, owned and operated by Henrico County. The 1,107 acre reservoir will be located in northwest Cumberland County and will withdraw water from the James River during period of high flows and will release water to the James River during periods of low flow.

The raw water storage capacity is 14.8 billion gallons of water and the safe yield is estimated to be 47 million gallons per day which is projected to provide water to meet the regional needs through most, if not all, of the 50-year planning horizon.

Key project components include:

- ◆ James River withdrawal facilities
- ◆ A dam and reservoir
- ◆ Reservoir withdrawal facilities
- ◆ A transfer pipe between the river and the reservoir.

The focus of the regional water supply planning effort in planning and permitting the Cobbs Creek Regional Reservoir Project has been to meet the needs of the region - i.e., Henrico, Cumberland, Powhatan, and Goochland counties. The growing needs of other nearby communities north of the James River such as New Kent, Hanover and Louisa counties are outside the scope of the region's current water supply planning effort; however, it should be recognized that these communities may ultimately need to access James River water to meet part of their needs. In fact, Hanover County already does so indirectly through purchases made from Richmond and Henrico. Until very recently, Louisa County was partnered with Fluvanna County to develop a joint water supply project based on James River withdrawals

near Bremono Bluff, just upstream from the Cobbs Creek Reservoir site. As the region continues to grow, it seems inevitable that additional communities will need to find ways to access the region's largest and most reliable water supply - the James River. Augmentation of James River flows during drought conditions will be provided through Cobbs Creek Reservoir releases and will help make this source a more sustainable long-term supply for communities relying on its flow.

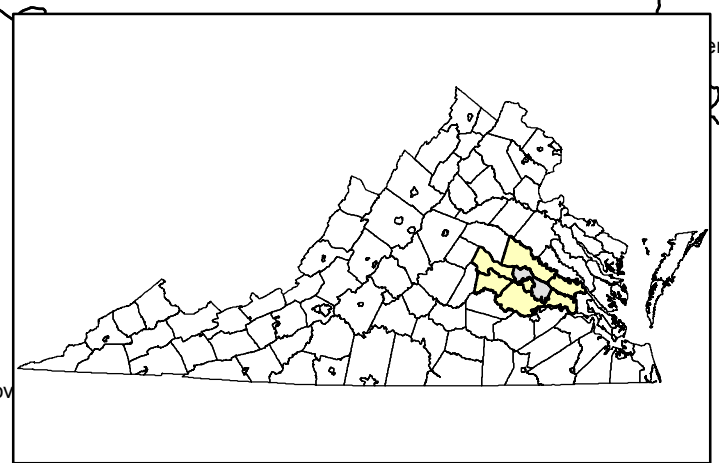


Fluvanna

Louisa

Goochland

Hanov



Cumberland

Powhatan

Richmond City

New Kent

Henrico


Chesterfield

Amelia



Source: USGS; ESRI; Henrico County

### Legend

 Proposed Cobbs Creek Reservoir

## **9.2 Self-Supplied Ground Water Users**

Today, there are approximately 9,657 self-supplied ground water users in Henrico. While it is likely that much of the future growth in the eastern area of Henrico will occur in areas that are or will be served by the county water system, there is also undeveloped land that will likely develop for residential use with large lots and these homes will rely on individual wells. Further, some currently developed areas that are not served by the municipal water system may be served in the future, as growth occurs and as the municipal water services are extended.

While the eastern area of the county may not be suitable for large industrial users that rely on groundwater, the quantity and quality of groundwater is likely to meet the needs of existing residential development as well as future homes on large lots.

## **9.3 Potential Water Savings from Demand Management Actions**

Based on trends seen in many utilities in Virginia and across the United States, it is likely that per capita water consumption will decrease in Henrico County. Utilities across Virginia are reporting a noticeable decline in usage as newer appliances and fixtures that require less water are installed in both new and older homes and businesses. In addition, data from other utilities suggests that as the charges imposed for water service increase, households and businesses increasingly attempt to conserve water in order to decrease utility charges.

Even though the savings as a result of these changes is not quantifiable, it is important to recognize that many people are voluntarily reducing daily water use.

## 10.0 SUMMARY

The purpose of the water supply planning process is to accomplish the following:

- ◆ Ensure that adequate and safe drinking water is available to citizens in Henrico County;
- ◆ Encourage, promote and protect the beneficial uses of the water resources;
- ◆ Encourage and promote water conservation; and
- ◆ Enable the County to analyze the impact of proposed development on the water resources.
- ◆ Further, the Water Supply Plan enables the County to consider the projected future water needs of the County in order to plan to meet those needs.

Henrico County has identified and quantified a need for additional water to meet not only the future needs in Henrico, but also in Goochland, Cumberland and Powhatan Counties. And, Henrico County and its partners have taken proactive steps to identify a source of water, prepare a joint permit application and has been granted approval from VDEQ to withdraw water from the James River. The development of the Cobbs Creek reservoir, as outlined in Section 9, is envisioned to meet the regional water supply needs for the next 50 years.

Some households, businesses, farms and golf courses will continue to rely on other surface water sources and groundwater, it is anticipated that the existing water supply is adequate to continue to meet the demands of the self-supplied users.

# APPENDIX

Appendix A. VDEQ Data Sheets

Appendix B. Database of Inactive Wells in Henrico County

Appendix C. Henrico County Community Water System – Engineering Description Sheet

Appendix D. VDH Listing of Waterworks

Appendix E. VDEQ Withdrawal Records, 1999 - 2009

Appendix F. Non-Community Systems Using Groundwater

<b>Non-Community Water System</b>	<b>Engineering Description Sheet</b>	<b>Sanitary Survey Report</b>
Deep Bottom Boat Ramp	X	X
Echo Lake Park	X	X
Glendale / Elkhill School	X	X
Osborne Park		X
Poplar Springs Baptist Church	X	X
Richmond Elks Lodge #45	X	X
St Anthony's Church	X	X
Tuckaway West Child Care Ctr.	X	X

Appendix G. Drought Ordinance

Appendix H. Contracts with City of Richmond, Hanover County and Goochland County

Appendix I. Henrico County Zoning Map

Appendix J. Well Database