2012 Rivanna Watershed Snapshot

RIVANNA RIVER BASIN COMMISSION
A Confluence of Interests

Appendices

December, 2014

Front Cover photo credit: David Harp
Chesapeakephotos.com

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Appendix A: GIS Methods and Data

RRBC performed all GIS analysis for the *2012 Rivanna Watershed Snapshot* using ESRI's ArcGIS 10.1 for Desktop.

A-1: Methods and Data Used for Determining Locality Areas

Methods:

To determine square miles of jurisdictions within the Rivanna watershed, the percentage of jurisdictions with the watershed, and the percentage of the watershed within localities, RRBC performed the following steps:

1. Imported source data into ArcGIS using the coordinate system setting NAD_1983 State Plane_ Virginia_South_FIPS_4502_Feet.
2. Calculated the total area of the watershed from the *Rivanna Watershed Boundary* shapefile, using the Calculate Geometry tool in ArcGIS.
3. Used the "Clip" tool to clip all localities with land in the watershed and derive only the parts of these localities that are within the watershed.
4. Computed acres for each clipped locality within the watershed ("Acres of Watershed in Jurisdiction") using the Calculate Geometry tool.
5. Converted acres to square miles by multiplying acre figures by 0.0015625.
6. Divided the area of each clipped locality by the total area of the watershed and then multiplied by 100 to determine "% Watershed in Jurisdiction."
7. Divided the area of individual clipped localities by the total area those individual localities and multiplied by 100 to determine "% Jurisdiction in Watershed."

GIS Data Sources:

1. *County Boundaries*
   File name: dtl_cnty.shp
   Source: ESRI
   http://www.arcgis.com/home/item.html?id=a00d6b6149b34ed3b833e10fb72ef47b
   Accessed: 10/19/12

   The County Boundaries shapefile contains counties of the United States that intersect the Rivanna Watershed. It was created by extracting counties within ESRI's *dtl_cnty* layer that intersect the Rivanna Watershed Boundary layer. The 2010 ESRI *dtl_cnty* layer contains counties in the 50 states, the District of Columbia, and Puerto Rico. Boundaries within it are consistent with tract, block group, and state data sets and are effective at regional and state levels. The largest scale when displaying the data is 1:100,000.

2. *Rivanna Watershed Boundary*
   File name: WBD_HU8_RRB.shp
   Source: National Hydrography Dataset
   http://viewer.nationalmap.gov/viewer/nhd.html?p=nhd
   Accessed: 02/25/12

   The Rivanna Watershed Boundary shapefile is the Rivanna watershed exported from the USGS's National Hydrography Dataset (NHD). This feature and other hydrographic units features within the NHD are derived from the National Watershed Boundary Dataset (NWBD).

   NWBD boundaries are delineated and georeferenced to the USGS 1:24,000 scale topographic base map meeting National Map Accuracy Standards (NMAS). USGS Map Accuracy standards for 1:24,000 scale require 90% of well-defined features to lie within 40 feet of their true geographic position.

A-2: Methods and Data Used for Determining Watershed Elevations

Methods:

To determine the highest and lowest elevations in the Rivanna watershed, RRBC performed the following steps:

1. Imported source data into ArcGIS using the coordinate system setting NAD_1983 State Plane_ Virginia_South_FIPS_4502_Feet.
2. Identified the lowest point in the watershed using the *USGS 30 Meter Digital Elevation Model* (DEM) raster grid and the *Rivanna Watershed Boundary* shapefile to determine the elevation of the raster cell at the watershed's outlet (where the Rivanna River meets the James River).
3. Hid parts of the DEM that exist outside of the *Rivanna Watershed Boundary* shapefile.
4. Identified the highest elevation in the watershed using ArcGIS display settings to highlight only the highest elevations within the DEM.

5. Determined the names of these highpoints within in Watershed using DeLorme's *Virginia Atlas & Gazetteer* (DeLorme, 2003) to determine the names of these highpoints within the watershed.
6. Crosschecked highpoints with Topozone.com, which lists the names and elevations of the highest point in each Virginia county.

GIS Data Sources:

1. *USGS 30 Meter Digital Elevation Model*
   File name: w001001.adf
   Source: USGS / National Elevation Dataset
   http://ned.usgs.gov/
   Accessed: 10/19/12

   This DEM was derived from the National Elevation Dataset (NED), which is the primary elevation data product of the United States Geological Survey (USGS). NED data are in geographic coordinates with units of decimal degrees and are in conformance with the North American Datum of 1983 (NAD 83). All elevation values are in meters and are referenced to the North American Vertical Datum of 1988 (NAVD 88) over the conterminous United States.

2. *Rivanna Watershed Boundary*
   See Appendix A-1 for shapefile details.

A-3: Methods and Data Used for Estimating Stream Miles

Methods:

To estimate perennial and intermittent stream miles in the Rivanna watershed, RRBC performed the following steps:

1. Imported source data into ArcGIS using the coordinate system setting NAD_1983 State Plane_ Virginia_South_FIPS_4502_Feet.
2. Calculated total perennial or permanent river and stream miles in the watershed by selecting water segment features from the National Hydrography Dataset (NHD) Flowlines data with FCode 46006 (all segments) and FCode 55800 (only named segments). Used the "Calculate Geometry" tool to estimate waterway miles.
3. Calculated total intermittent stream miles in the watershed by selecting water segment features from the National Hydrography Dataset (NHD) Flowlines data with FCode 46003. Used the "Calculate Geometry" tool to estimate waterway miles.
4. Clipped perennial and intermittent waterway miles by locality and used the "Calculate Geometry" tool to determine mileages by individual localities.

GIS Data Sources:

1. *National Hydrography Dataset Flowlines*
   File name: NHDFlowline.shp
   Source: National Hydrography Dataset
   http://viewer.nationalmap.gov/viewer/nhd.html?p=nhd
   Accessed: 08/29/12

   The NHD is a combination of USGS hydrologic digital line graph files (DLG) and EPA reach files (version 3.0). The USGS files were used for spatial accuracy, and the EPA files were used for attribute information. The NHD data are stored and made available at 1:24,000-scale resolution.

   Flowlines are the fundamental flow network of an area, consisting predominantly of stream and river lines and artificial paths (e.g., flowlines through a 2-dimensional feature, such as a lake or a double-banked stream). Flowline data model the flow of water and contain spatial geometry and linear referencing measures for locating events on the network.
2. *County Boundaries*
   See Appendix A-1 for shapefile details.
3. *Rivanna Watershed Boundary*
   See Appendix A-1for shapefile details.

A-4: Methods and Data Used for Estimating Wetland Acreage

Methods:

To estimate wetland acreage in the Rivanna watershed, RRBC performed the following steps:

1. Imported source data into ArcGIS using the coordinate system setting NAD_1983 State Plane_ Virginia_South_FIPS_4502_Feet.
2. Clipped the *Wetlands* layer by the *Rivanna Watershed Boundary* shapefile to determine which wetland features in the dataset are within the watershed.
3. Used calculate geometry tool to calculate acreage of different wetland and waterway types.

GIS Data Sources:

1. *Wetlands*
   File name: CONUS_wet_poly.shp
   Source: National Wetlands Inventory
   http://www.fws.gov/wetlands/Data/State-Downloads.htm
   Accessed: 11/12/12

   This data set represents the extent, approximate location, and type of wetlands and deep water habitats in the conterminous United States. These data delineate the areal extent of wetlands and surface waters as defined by Cowardin *et al*. (Cowardin, 1979). Excluded are certain types of "farmed wetlands" that may be defined by the Food Security Act or that do not coincide with the Cowardin *et al.* definition. The data are intended for use in publications at a scale of 1:24,000 or smaller. Due to the scale, the primary intended use is for regional and watershed data display and analysis, rather than specific project data analysis. This dataset was published in October of 2010.
2. *Rivanna Watershed Boundary*
   See Appendix A-1 for shapefile details.

A-5: Methods and Data Used for Estimating Population and Population Density

Methods:

To estimate population density within each subwatershed of the Rivanna watershed, RRBC employed a methodology developed by Rob Kurtz in a study for Advocates for a Sustainable Albemarle Population (Kurtz, 2010). Kurtz derived population density values by distributing each locality's population across buildings and addresses in the locality. Kurtz explains:

> *Building footprint GIS data layers are available from local governments. The layers are created by hand digitization of building outlines visible on aerial photographs. In these data layers, building outlines are represented by shape polygons. Address point data mark the actual positions of physical addresses in a locality … Building footprints were first converted to a point layer by finding the geometric center, or centroid, of each building polygon. Then the building centroid layer and address point layer were merged into a single point layer* (Kurtz, 2010).

The resulting *Buildings/Addresses* point layer from the Kurtz study was used as the basis for using GIS analysis to determine population density for the *Snapshot*. RRBC performed the following steps for this analysis:

1. Imported source data into ArcGIS using the coordinate system setting NAD_1983 State Plane_Virginia_South_FIPS_4502_Feet.
2. Used the 2010 US Census Bureau's "QuickFacts" website to attain the most up-to-date population totals for each jurisdiction represented in the watershed (US Census Bureau, 2010).
3. Assigned each building/address point within a locality an equal portion of that locality's population by dividing the locality's population by the number of points that fall within its boundaries. This results in a specific population quotient for each centroid, shown in *Table 1*.

Table 1: Population Quotients for Locality Centroids

Locality	Population Quotient
Charlottesville	1.572788
Albemarle County	1.176827
Fluvanna County	1.168342
Greene County	0.961490
Orange County	0.900608
Louisa County	0.888558
Nelson County	0.417269

4. Clipped *Buildings/Addresses* layer by the watershed *Subwatersheds Boundaries* layer to show those building/address points that fall within each of the 22 Rivanna HUC-12 subwatersheds.
5. Summed the population quotients associated with each point by subwatershed, resulting in a total population for each subwatershed.
6. Divided each subwatershed population by the subwatershed area to arrive at population density within that subwatershed.

GIS Data Sources:

1. *Buildings/Addresses GIS Layer*
   File name: all_points
   Source: Rob Kurtz
   Accessed: 10/24/12

   The "all_points" shapefile was created by Rob Kurtz of Advocates for a Sustainable Albemarle Population

for the report *Population Density and Forest Cover on Stream Health in the Rivanna River Basin*. This layer contains building footprint GIS data layers from the seven Rivanna watershed local governments that were merged with address point data from the same localities (Kurtz, 2010).

2. *Watershed Subwatersheds Boundaries*
   File name: WBD_HU12_RRB.shp
   Source: National Hydrography Dataset
   http://viewer.nationalmap.gov/viewer/nhd.html?p=nhd
   Accessed: 08/29/12

   This National Hydrography Dataset (NHD) layer represents HUC-12 subwatersheds within the watershed. The features within the layer, and other hydrographic units features of the NHD, are derived from the National Watershed Boundary Dataset (WBD). NWBD boundaries are delineated and geo-referenced to the USGS 1:24,000 scale topographic base map. USGS Map Accuracy standards for 1:24,000 scale require 90% of well-defined features to lie within 40 feet of their true geographic position.

3. *County Boundaries*
   See Appendix A-1 for shapefile details.

A-6: Methods and Data Used for Estimating Trail Miles

Methods:

To estimate the number of miles of trail ("trail miles") within the Rivanna watershed and the number of trail miles within watershed localities, RRBC performed the following steps:

For Determining Mileage within the Entire Watershed

1. Imported source data into ArcGIS using the coordinate system setting NAD_1983 State Plane_Virginia_South_FIPS_4502_Feet.
2. Clipped the *Albemarle Trails* and *Shenandoah National Park Trails* layers by the Rivanna watershed's boundary using the *Rivanna Watershed Boundary* layer.
3. Calculated total trail miles from the clipped shapefiles to determine Albemarle and Shenandoah National Park trail miles in the watershed, using the "Calculate Geometry" tool.
4. Compared the *City of Charlottesville Trails* and *Rivanna Trail Foundation Trails* layers and selected and manually deleted probable overlapping trails from the shapefiles.
5. Calculated total trail miles from the edited *City of Charlottesville Trails* and *Rivanna Trail Foundation Trails* layers using the "Calculate Geometry" tool.
6. Obtained estimates of Rivanna watershed trail miles in the counties of Fluvanna and Greene from the county staff of the respective counties. (The Greene estimate excluded Shenandoah Trail miles included in the *Shenandoah National Park Trails* layer.)
7. Summed all estimates to obtain an estimate of total trail miles in the Rivanna watershed.

For Determining Mileages within Individual Localities

1. Fluvanna: Obtained a mileage estimate for Fluvanna County trails within the watershed from county staff.
2. Greene: Obtained a mileage estimate for Greene County trails within the watershed from county staff; however, this estimate excluded Shenandoah Park trails in Greene County.

   To arrive at an estimate of Greene County trails within the watershed, clipped the *Shenandoah National Park* trails layer by the County's boundary using the *County Boundaries* layer. Estimated mileage using the ArcGIS "Calculate Geometry" tool and added the total to the mileage estimate provided by Greene County.
3. Charlottesville: Clipped the edited *City of Charlottesville Trails* and *Rivanna Trails Foundation* layers[1] by the City of Charlottesville boundary using the *County Boundaries* layer. Estimated trail miles within each layer using the "Calculate Geometry" tool and summed for an estimate of total trail miles within the City.
4. Albemarle: Clipped the already clipped *Shenandoah National Park Trails* layer[2] by the Albemarle County boundary using the *County Boundaries* layer to determine Shenandoah National Park trails within Albemarle County. Calculated trail mileage from this layer and the clipped *Albemarle Trails* layer using the "Calculate Geometry" tool. Summed mileages to arrive at an estimate of total trail miles within Albemarle County.

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1 See step 4 in "For Determining Mileage within the Entire Watershed"
2 See step 2 in "For Determining Mileage within the Entire Watershed"

GIS Data Sources:

1. *Albemarle Trails*
   File name: *Albemarle_Trails_RRB_Only.shp*-
   Source: Albemarle County [Derek Bedarf, GIS Specialist II]
   Accessed: 10/12/12

   This October 2012 layer contains all trails in Albemarle County. It was obtained from the County on October 12, 2012, and includes newly added portions of Old Mills Trail.

2. *City of Charlottesville Trails*
   File name: trail_line_11_24_2012.shp
   Source: City of Charlottesville
   http://www.charlottesville.org/Index.aspx?page=1674
   Accessed: 11/27/12

   This November 2012 layer represents the digital City of Charlottesville Trails layer that is accessible from the City's Mapping and Spatial Data Sources webpage[3]. Charlottesville Parks and Recreation staff continually updates this layer when improvements are made to existing trails or new trails are added to the system. The City reminds GIS users that the information contained in this file is NOT to be construed or used as a "legal description."

3. *Rivanna Trail Foundation Trails*
   File name: RTFTrail.shp
   Source: City of Charlottesville [Chris Gensic, Parks and Trails Planner]
   Accessed: 10/15/12

   This file represents the City of Charlottesville's digital Rivanna Trail Foundation (RTF) trails layer, obtained by the RRBC from the City on October 15, 2012, via email. City Parks and Recreation staff continually updates this layer when changes are made to the Rivanna Trail. The information contained in this file is NOT to be construed or used as a "legal description." The Rivanna Trail Foundation[4] is a private foundation that assists in developing and maintaining trails on city land.

4. *Shenandoah National Park Trails*
   File name: *ShenandoahNP_Trails.shp*
   Source: Thomas Jefferson Planning District Commission
   Accessed: 10/17/12

   This file represents Shenandoah National Park trails and was provided by the Thomas Jefferson Planning District Commission on October 17, 2012. The origin of the file and its last update are unknown.

5. *County Boundaries*
   See Appendix A-1 for shapefile details.

6. *Rivanna Watershed Boundary*
   See Appendix A-1 for shapefile details.

A-7: Methodology for Estimating DEQ Stream Miles

Methods:

To estimate mileage of streams DEQ lists as impaired, meeting standards, and unassessed in the Rivanna watershed and localities within the watershed, RRBC performed the following steps:

1. Imported source data into ArcGIS using the coordinate system setting NAD_1983 State Plane_Virginia_South_FIPS_4502_Feet.
2. Clipped the *DEQ Flowlines* layer by the Rivanna watershed boundary using the *Rivanna Watershed Boundary* shapefile.
3. Calculated total miles considered by DEQ using ArcGIS' "Calculate Geometry" tool on the *DEQ Flowlines* layer.
4. Within the *DEQ Flowlines* attribute table, selected streams considered impaired, meeting standards, and unassessed to determine associated mileages.
5. Within the same attribute table, selected streams impaired for benthic macroinvertebrates, *E. Coli,* DO, pH, and Fecal Coliform to determine associated mileages.
6. Clipped the *DEQ Flowlines* layer by all individual localities' boundaries using the *County Boundaries* shapefile and recalculated mileages for impaired, meeting standards, and unassessed using the "Calculate Geometry" tool.

GIS Data Sources:

1. *DEQ Flowlines*
   File name: va_10ir_aus_riverine
   Source: DEQ Final 2010 305(b)/303(d) Water Quality Assessment Integrated Report
   http://www.deq.virginia.gov/Programs/Water/WaterQualityInformationTMDLs/WaterQualityAssessments/2010305b303dIntegratedReport.aspx
   Accessed: 10/24/12

3 http://www.charlottesville.org/Index.aspx?page=16744
4 http://www.rivannatrails.org/

This dataset was originally developed by the Virginia Department of Environmental Quality (VA DEQ) from various iterations of the United States Geological Survey (USGS) National Hydrography Dataset (NHD) circa 2000. The dataset is maintained and updated by VA DEQ during each biennial assessment cycle from the current NHD product and aerial photography and by freehand where necessary. The riverine data layer within represents data from DEQ's 2010 305(b)/303(d) Water Quality Assessment Integrated Report. The Virginia Department of Environmental Quality (DEQ) released the Final 2010 305(b)/303(d) Water Quality Assessment Integrated Report on February 9, 2011. The 2010 Integrated Report is a summary of the water quality conditions in Virginia from January 1, 2003, through December 31, 2008.

2. *County Boundaries*
   See Appendix A-1 for shapefile details.

3. *Rivanna Watershed Boundary*
   See Appendix A-1 for shapefile details.

A-8: Methodology for Estimating Acreage of Protected Lands

Methods:

To estimate the acreages of protected lands in the Rivanna watershed, RRBC performed the following steps:

1. Imported source data into ArcGIS using the coordinate system setting NAD_1983 State Plane_ Virginia_South_FIPS_4502_Feet.
2. Clipped the Conservation *Lands* and *Easements* shapefiles by the *Rivanna Watershed Boundary* shapefile to ensure that managed lands under consideration were within the watershed.
3. Merged and dissolved the clipped *Conservation Lands* and *Easements* shapefiles into a single feature to determine total acreage of managed land in the watershed. Used the "Calculate Geometry" tool to determine the acreage of this feature, which represents the total acreage managed in the watershed.
4. To determine acreages of easements, and acreages of federal, state, local, and non-profit lands, as a percentage of all managed lands, categories where determined from the merged (but not dissolved) *Conservation Lands* and *Easements* layer's attribute table and assigned a "managed land code" (1-5) within a new field of the same layer's attribute table.
5. Dissolved the merged layer by this "managed land code" and calculated the resulting 5 areas using the "Calculate Geometry" tool. Divided individual category areas by the layer's total area and multiplied by 100 to find percentages for all categories.

GIS Data Sources:

1. *Conservation Lands*
   File name: conslands.shp
   Source: DCR [David Boyd, Conservation Lands GIS Planner]
   Accessed: 12/13/12

   This dataset is up to date through December 2012 and comes from the Virginia DCR's Conservation Lands Database, which contains the boundaries for lands of conservation and recreational interest in Virginia. Most federal, state, regional and interstate lands are included. Existing GIS boundaries were collected from the landowner or managing agency and integrated into the database. DCR's Natural Heritage Program staff digitized new boundaries using best available sources. DCR re-projected shapefiles to decimal degrees NAD83 and standardized attributes for consistency. DCR continually seeks GIS data from conservation partners to update and improve this database.

2. *Easements*
   File name: easements.shp
   Source: DCR [David Boyd, Conservation Lands GIS Planner]
   Accessed: 12/13/12

   This dataset also comes from the Virginia DCR's Conservation Lands Database. It is current through December 2012 and contains the boundaries for easements in the Commonwealth of Virginia. This data must be requested directly via email: mailto:david.boyd@dcr.virginia.gov

3. *Rivanna Watershed Boundary*
   See Appendix A-1 for shapefile details.

A-9: Methodology for Estimating Acreage of Forested Land 100 Feet from Waterways

Methods:

To estimate the acreage of forested land 100 feet from waterways in the Rivanna watershed and subwatersheds, RRBC performed the following steps:

1. *For Determining Acreages within the Entire Watershed*
2. Imported source data into ArcGIS using the coordinate system setting NAD_1983 State Plane_ Virginia_South_FIPS_4502_Feet.
3. Clipped the *VBMP Hydrolines Dataset* by the boundary of the watershed using the *Rivanna Watershed Boundary* shapefile and the "Clip" tool.
4. Buffered the clipped *VBMP Hydrolines Dataset* by 100 feet to create a "100 foot buffer" shapefile using the "Buffer" tool. Calculated the area of this new buffer shapefile using the "Calculate Geometry" tool.
5. Converted the *Rivanna Watershed and Vicinity Land Use/Land Cover Dataset (2009)* to vector using the "Raster to Polygon" tool and the "Unsimplified Polygons" option.
6. Exported forest and water data from the newly vectorized land use/land cover layer using the "Export Data" tool, after selecting "Deciduous Tree Cover," "Evergreen Tree Cover," "Water," and "Pine Plantation" features to create a new shapefile with only these features.
7. Clipped this new land use/land cover shapefile by the boundary of the watershed using the *Rivanna Watershed Boundary* shapefile and the "Clip" tool.
8. Clipped the land use/land cover shapefile again by the "100 foot buffer" shapefile created in Step 3 to create a "forest and water in the 100 foot buffer" shapefile.
9. Calculated the area of both forested land and water in the "forest and water in the 100 foot buffer" shapefile using the "Calculate Geometry" tool.
10. Subtracted water area from the total area of the "100 foot buffer" shapefile (found in Step 3) to determine the area of all land in the "100 foot buffer".
11. Divided forested land in the buffer area by total land in the buffer area and multiplied by 100 to derive "Forest within 100 foot Buffer (%)" metric.

For Determining Acreages within Subwatersheds

1. Determined acreages in subwatersheds by clipping the "forest and water in the 100 foot buffer" shapefile (created in Step 7 above) by selected subwatersheds within the watershed *Subwatersheds Boundaries* layer.
2. Calculated areas of water, total land, and forest to determine acreages and percentages by subwatershed.

GIS Data Sources:

1. *VBMP Hydrolines Dataset*
   File name: vbmp_hydro_lines.shp
   Source: VBMP / TNC
   Accessed: 10/19/2012

   This dataset was created as a higher resolution and more spatially accurate representation of streams in the Rivanna watershed than what it available through other sources such as NHD. Note, however, that it does not include some intermittent streams that are captured in the NHD. For part of the 2002 Virginia Base Mapping Program, hydrography was captured from high resolution aerial imagery (2 ft. or less pixel size). For wider waterways and ponds the dataset captures the shoreline as opposed to a centerline. The Nature Conservancy extracted and merged a Rivanna focused version of the data and made the layer available to the RRBC.

   Note: In 2013, The Nature Conservancy and RRBC agreed that it would be helpful to work off the same datasets, and further agreed that the above data layer would be the best choice for most analyses.
2. *Watershed Subwatersheds Boundaries*
   See Appendix A-6 for shapefile details.
3. *Rivanna Watershed and Vicinity Land Use/Land Cover Dataset (2009)*
4. *Rivanna Watershed Boundary*
   See Appendix A-1 for shapefile details.

A-10: Methodology for Estimating Acres Treated by Urban Stormwater BMPs

Methods:

To estimate the acreage of land treated by urban stormwater best management practices (BMPs) in the Rivanna watershed, RRBC performed the following steps:

1. Imported source data into ArcGIS using the coordinate system setting NAD_1983 State Plane_ Virginia_South_FIPS_4502_Feet.
2. Clipped *Albemarle BMP Locations*, *Fluvanna BMP Locations*, and *Green BMP Locations* point data by the *Rivanna Watershed Boundary* shapefile to ensure that the county stormwater BMPs fell within the watershed.
3. Clipped *Albemarle Treated Watershed Area (Private)* and *Albemarle Treated Watershed Area (Regional)* polygon data by the *Rivanna Watershed Boundary* shapefile to ensure that these treated areas fell within the watershed.
4. Calculated acreage treated in Charlottesville by dissolving the *Charlottesville Treated Watershed Area* polygon data using the "Dissolve" tool in such a way that the layer consisted of only one feature. [This was done to eliminate overlapping polygons of acreage treated by different BMP locations in Charlottesville, and also to prevent any treated acreage in the City from being double counted.] Used the "Calculate Geometry" tool to obtain the acreage of the dissolved layer, which represents the total acreage of land treated by urban stormwater BMPs in the City.
5. Calculated the acreage for UVA in the same way that the acreage of Charlottesville was calculated, but using the *UVA Treated Watershed Area* data.

   Note: The counties of Greene and Fluvanna had no treated area polygon features associated with their point BMP location data.
6. To estimate treated area for Fluvanna County, obtained an estimate of total acreage treated from the County.
7. In Greene County, the estimated total acreage treated by BMPs is likely higher than the true acreage treated. This is due to the fact that while there are acreages associated with BMP locations in Greene, a number of the BMPs are likely treating overlapping sections of land. We believe that this is so because the polygon layers for Albemarle Charlottesville, and UVA BMPs visibly overlapped, and we assumed that the same was true for Greene. However, unlike in Albemarle, Charlottesville, and UVA, we had no spatial information to enable us to quantify the overlapping sections, thus almost certainly inflating the total acreages treated by BMPs.
8. To calculate acreage treated in Albemarle, dissolved the two clipped treated area polygon feature data sets from Albemarle County (the clipped *Albemarle Treated Watershed Area (Private)* and the clipped *Albemarle Treated Watershed Area (Regional)*) so that each would consist of only one feature (one feature for *private* and one feature for *regional*). We did this to eliminate overlapping polygons of acreage treated by different BMP locations, and to prevent any treated acreage in Albemarle from being double counted.

   (a) Clipped the dissolved layers by each other to discover overlap between the two, and used the "Calculate Geometry" tool to obtain the acreage of overlap.

   (b) Used the "Calculate Geometry" tool to obtain the acreage of the clipped/dissolved *Albemarle Treated Watershed Area (Private)* layer, as well as the acreage of the clipped/dissolved *Albemarle Treated Watershed Area (Regional)* layer. Added the two acreages together and then subtracted the overlap acreage to obtain total acreage of treated land in the County.
9. To obtain total acreage treated in the watershed,

   (a) Merged the dissolved Albemarle, Charlottesville, and UVA acreage treated polygon layers.

   (b) Dissolved the merged layer into one feature and then calculated the acreage using the "Calculate Geometry" tool.

   (c) Added the merged acreage to the estimated acreage treated for Greene and Fluvanna to obtain an estimated total acreage treated for the entire watershed.

GIS Data Sources:

1. *Albemarle BMP Locations*
   File name: SMFs_050212.shp
   Source: Albemarle County
   Accessed: 09/25/12
   Urban stormwater BMP location point feature data for Albemarle County, current as of May 2012.
2. *Albemarle Treated Watershed Area (Private*File name: private_SMF_watersheds.sh
   Source: Albemarle Count
   Accessed: 09/25/12

   Private urban stormwater BMP treated area polygon feature data for Albemarle County, current as of December 2011.

3. *Albemarle Treated Watershed Area (Regional)*
   File name: regional_SMF_watersheds.shp
   Source: Albemarle County
   Accessed: 09/25/12

   Albemarle County's regional urban stormwater BMP treated area polygon feature data for Albemarle County, current as of December 2011.

4. *Charlottesville BMP Locations*
   File name: char_bmp_urs.shp
   Source: City of Charlottesville
   Accessed: 09/25/12

   Charlottesville urban stormwater BMP location point feature data for City of Charlottesville, current as of December 2011.

5. *Charlottesville Treated Watershed Area*
   File name: char_bmp_area_polygon.shp
   Source: City of Charlottesville
   Accessed: 09/25/12

   Urban stormwater BMP treated area polygon feature data for the City of Charlottesville, current as of December 2011.

6. *Fluvanna BMP Locations*
   File name: Rivanna BMPs 2012.shp
   Source: Fluvanna County
   Accessed: 10/12/12

   Urban stormwater BMP location point feature data for Fluvanna County, current as of October 2012.

7. *Greene BMP Locations*
   File name: Greene BMP Inventory.xls created by Greene County E/S staff (D. Ratzlaff) and provided to RRBC on 10/31/11
   Source: Greene County
   Accessed: 09/25/12

   Urban stormwater BMP location point feature data imported in ArcGIS from a Greene County spreadsheet. Before importing this data, coordinates for point features were located using information in the spreadsheet and Google Maps. Data is current as of November 2011.

8. *UVA BMP Locations*
   File name: SWMF_Points.shp
   Source: UVa
   Accessed: 10/18/12

   Urban stormwater BMP location point feature data for the University of Virginia, current as of 2011.

9. *UVA Treated Watershed Area*
   File name: UVA_Storm_BMP_Drainage.shp
   Source: UVa
   Accessed: 10/17/12

   Urban stormwater BMP treated area polygon feature data for the University of Virginia, current as of 2011.

10. *Rivanna Watershed Boundary*
    See Appendix A-1 for shapefile details.

Appendix B: Significant Plant and Animal Species

This list was provided by the Virginia Department of Conservation and Recreation's (DCR) Natural Heritage Program.

Scientific Name	Common Name	Global Rank	State Rank	Federal Status	State Status
BIRDS					
Haliaeetus leucocephalus	Bald Eagle	Secure	Imperiled/(No definition for S3)		Listed Threatened
Troglodytes troglodytes	Winter Wren	Secure	Imperiled/(No definition for S4)		
BIVALVIA (MUSSELS)					
Pleurobema collina	James Spinymussel	Critically imperiled	Critically imperiled	Listed Endangered	Listed Endangered
Lexingtonia subplana	Virginia Pigtoe	Critically imperiled	Critically imperiled	Species of Concern	
Fusconaia masoni	Atlantic Pigtoe	Imperiled	Imperiled	Species of Concern	
Elliptio lanceolata	Yellow Lance	Imperiled/Vulnerable	Imperiled/(No definition for S3)		

Table Continued...

Scientific Name	Common Name	Global Rank	State Rank	Federal Status	State Status
Lasmigona subviridis	Green Floater	Vulnerable	Imperiled		Listed Threatened
HETEROPTERA (TRUE BUGS)					
Sigara depressa	Virginia Piedmont Water Boatman	Critically Imperiled/ Imperiled	Critically Imperiled/ Imperiled	Species of Concern	
LEPIDOPTERA (BUTTERFLIES & MOTHS)					
Speyeria idalia	Regal Fritillary	Vulnerable	Critically imperiled		
ODONATA (DRAGONFLIES & DAMSELFLIES)					
Gomphus quadricolor	Rapids Clubtail	Vulnerable/ Apparently Secure	Imperiled/(No definition for S3)		
REPTILES					
Pituophis melanoleucus	Pine Snake	Apparently secure	Critically imperiled		
TERRESTRIAL NATURAL COMMUNITY					
Aronia melanocarpa - Gaylussacia baccata / Carex	High-Elevation Outcrop Barren (Black Chokeberry Igneous / Metamorphic Type)	Critically imperiled			
Acer rubrum - Nyssa sylvatica / Ilex verticillata - Vaccinium fuscatum / Osmunda cinnamomea	Central Appalachian Low-Elevation Acidic Seepage Swamp	Imperiled	Imperiled		
Fraxinus americana - Carya glabra / Muhlenbergia sobolifera - Helianthus divaricatus - Solidago ulmifolia (	Central Appalachian Basic Ash - Hickory Woodland	Imperiled	Imperiled		
Fraxinus americana / Physocarpus opulifolius / Carex pensylvanica - Allium cernuum - (Phacelia dubia)	Central Appalachian Mafic / Calcareous Barren (Mid-Elevation Type)	Vulnerable	Imperiled		
Tsuga canadensis - Fagus grandifolia - Quercus (montana, alba)	Piedmont / Coastal Plain Hemlock - Hardwood Forest	Imperiled/Vulnerable	Critically Imperiled/ Imperiled		
Tilia americana - Fraxinus americana / Acer pensylvanicum - Ostrya virginiana / Parthenocissus quinquefolia - Impatiens pallida	Central Appalachian Montane Rich Boulderfield Forest	Vulnerable	No definition		
Quercus rubra - Carya (ovalis, ovata) - Fraxinus americana / Cimicifuga racemosa - Hydrophyllum virginianum	Central Appalachian Montane Oak - Hickory Forest (Rich Type)	Vulnerable/ Apparently Secure	No definition		

Table Continued...

Scientific Name	Common Name	Global Rank	State Rank	Federal Status	State Status
Quercus rubra - Quercus montana - Carya ovalis / (Cercis canadensis) / Solidago (caesia, curtisii)	Inner Piedmont / Lower Blue Ridge Basic Oak - Hickory Forest	Vulnerable/ Apparently Secure	No definition		
Betula lenta - Quercus montana / Parthenocissus quinquefolia	Central Appalachian Acidic Boulderfield Woodland	Apparently secure	No definition		
Tsuga canadensis - Betula alleghaniensis / Maianthemum canadense	Appalachian Hemlock - Northern Hardwood Forest	Apparently secure	Imperiled		
Lasallia (papulosa, pensylvanica) - Dimelaena oreina - (Melanelia culbersonii)	Central Appalachian Low-Elevation Acidic Lichen / Bryophyte Boulderfield	Secure	No definition		
VASCULAR PLANTS					
Phlox buckleyi	Sword-leaved Phlox	Apparently secure	Imperiled		
Carex roanensis	Roan Mountain Sedge	Imperiled/Vulnerable	Imperiled	Species of Concern	
Thalictrum macrostylum	Piedmont Meadow-rue	Vulnerable/ Apparently Secure	Critically imperiled		
Asplenium bradleyi	Bradley's Spleenwort	Apparently secure	Imperiled		
Prunus nigra	Canada Plum	Apparently secure/ Secure	Critically imperiled		
Botrychium simplex	Least Grape-fern	Secure	Critically imperiled		
Cornus canadensis	Bunchberry	Secure	Critically imperiled		
Platanthera peramoena	Purple Fringeless Orchid	Secure	Imperiled		
Populus tremuloides	Quaking Aspen	Secure	Imperiled		
Verbena scabra	Sandpaper Vervain	Secure	Imperiled		
Cuscuta coryli	Hazel Dodder	Secure	Imperiled		
Corallorhiza maculata var. occidentalis	Western Spotted Coralroot	Secure	Critically imperiled		
Solidago randii	Rand's Goldenrod	Secure	Imperiled/(No definition for S3)		
Cerastium arvense ssp. velutinum	A Field Chickweed	Secure	Imperiled		
Alnus incana ssp. rugosa	Speckled Alder	Secure	Imperiled		
Betula cordifolia	Mountain Paper Birch	Secure	Imperiled		
Rubus idaeus ssp. strigosus	Red Raspberry	Secure	Imperiled		

Appendix C: VA Pollutant Discharge Elimination System Permit Holders

The institutions in the table below hold Virginia Pollutant Discharge Elimination System Permits (VPDES) in the Rivanna Watershed (DEQ, 2012b). Design flow represents millions of gallons per day and is the flow expected to be received in the design year divided by 365 days.

Facility Name	Location City	Major/Minor	Municipal/Industrial	Design Flow
Avionics Specialties, Inc.	Charlottesville	Minor	Municipal	0.005
Blue Ridge School STP	St George	Minor	Municipal	0.035
Camelot WWTP	Charlottesville	Minor	Municipal	0.365
Carysbrook Holdings LLC	Fork Union	Minor	Municipal	0.010
Comfort Inn Monticello STP	Charlottesville	Minor	Municipal	0.040
Cooper Industries	Earlysville	Minor	Industrial	0.040
Crossroads Village Center STP	North Garden	Minor	Industrial	0.020
Crozet WTP	Crozet	Minor	Industrial	0.186
Deer Park STP	Zion Crossroads	Minor	Municipal	0.090
DOC - Fluvanna Correctional Center for Women	Troy	Minor	Municipal	0.300
Dominion - Bremo Power Station	Bremo Bluff	Major	Industrial	4.590
Envoy at the Village	Fork Union	Minor	Municipal	0.020
Fluvanna County High School STP	Palmyra	Minor	Municipal	0.050
Fluvanna Middle School	Palmyra	Minor	Municipal	0.012
Fork Union Military Academy	Fork Union	Minor	Municipal	0.099
Glenmore STP	Charlottesville	Minor	Municial	0.381
Greene County WTP	Ruckersville	Minor	Industrial	0.026
Keswick STP	Keswick	Minor	Municipal	0.060
Lake Monticello STP	Palmyra	Minor	Municipal	0.775
Lake Monticello STP	Palmyra	Minor	Municipal	0.775
Lake Monticello WTP	Palmyra	Minor	Industrial	0.065
Moores Creek Regional STP	Charlottesville	Major	Municipal	15.000
Morris Well WTP	Fork Union	Minor	Industrial	0.035
North Rivanna WTP	Charlottesville	Minor	Industrial	0.065
Omohundro Well WTP	Palmyra	Minor	Industrial	0.005
Palmyra Area WWTP	Palmyra	Minor	Municipal	0.150
Rapidan WWTP	Ruckersville	Minor	Municipal	0.600
Scottsville WTP	Scottsville	Minor	Industrial	0.116
Scottsville WWTP	Scottsville	Minor	Municipal	0.200
Tenaska Virginia Generating Station	Scottsville	Major	Industrial	1.250

Appendix D: Land Use and Land Cover

Categories, descriptions and statistics according to the 2009 Rivanna Watershed and Vicinity Land Use/Land Cover Dataset.

Category	Description	%	Acres
Deciduous Forest	Includes not only deciduous "forest" but also many suburban areas with deciduous tree cover. An aggregation level of 175 pixels (or 175 sq. meters) was used in the feature extraction software so there may be small pockets of other land cover types within this class that are not captured, primarily open land and evergreen trees. In addition, there may be areas of old field or scrub, where the canopy cover is lower and/or more sparse that are included in the forest classes. No specific threshold for percent tree cover was used; results are mostly based on the automated feature extraction process with occasional judgment calls by a technician during manual clean up.	57.8	284,083
Evergreen Forest	Includes not only evergreen "forest" but also many suburban areas with evergreen tree cover. An aggregation level of 175 pixels (or 175 sq. meters) was used in the feature extraction software so there may be small pockets of other land cover types within this class that are not captured, primarily open land and deciduous forest. In addition, there may be areas of old field or scrub, where the canopy cover is lower and/or more sparse that are included in the forest classes. No specific threshold for percent tree cover was used; results are mostly based on the automated feature extraction process with occasional judgment calls by a technician during manual clean up. It should also be noted that there may be some narrow strips of shadow in open fields, etc. that are called evergreen forest. Significant effort was made to clean up these areas through a manual process but it's likely that not everything was captured.	9.5	46,721
Open Land	This is, in effect, a catch-all for any area that does not fall into one of the other land cover types. It includes areas of grass, hayfield, agriculture, pasture or scrub. In some cases fields with sparse tree cover are called open land. Again, no specific threshold for percent tree cover was used; results are mostly based on the automated feature extraction process with occasional judgment calls by a technician during manual clean up.	22.3	109,858
Water	Any area of perennial open water, including lakes, ponds and streams. These areas were mostly captured by the various municipalities through digitizing high-resolution aerial imagery.	1.1	5,339
Impervious	All impervious features greater than 300 square feet are theoretically captured in this class, including roads, buildings, parking lots, driveways and railroad tracks. Many, though not all sidewalks and paved trails are also captured. Athletic facilities like basketball courts, tennis courts, tracks, etc. are generally not captured (and would be called open land) but this represents only a tiny fraction of the impervious surfaces in the project area. It should also be noted that outside of Albemarle County and Charlottesville, roads are from buffered centerlines but effort was made to vary the buffers based on road class so the actual road width was adequately captured.	3.2	15,868
Pine Plantation	This represents areas that are actively managed for pine and are regularly harvested and re-planted. Generally, any homogenous areas of evergreen tree cover, especially those that are clearly planted in rows, are included in this class. A review was done on other imagery from 1994, 2002 and 2007 and any areas that showed no significant human activity since 1994 were left as evergreen forest and were not called pine plantation. In addition, areas that were less than 4 acres in size and not within 200 feet of a larger pine plantation were left as evergreen forest.	4.3	21,280
Forest Harvest	This represents areas that were recently forest (and likely pine plantation) and have recently been harvested (within the last 5 years or so). Areas planted with young pine trees were generally called pine plantation, though no specific threshold was used in this case. Some effort was made to review previous years' imagery to accurately capture this class.	0.6	3,049
Orchard/ Vineyard	This was mostly captured manually and represents areas that appear in the imagery to contain grape vines or fruit trees planted in rows.	0.4	1,975
Bare Earth	This represents areas of bare ground, often where new development was occurring at the date of the imagery, but it also includes areas that are devoid of vegetation for other reasons.	0.5	2,242
Golf Course	This is mostly the open areas of golf courses (and at least one driving range). Where there are ponds or patches of forest on a golf course these areas are classified as water or forest.	0.2	1,200
TOTAL			**491,615**

Appendix E: Comparison of Indicators

	RRBC Indicator	RRBC Metric	RRBC Source	JRA Indicator/Source	TJPDC Indicator/Source
Watershed Health	Presence of Macro Invertebrate Species	VSCI score	StreamWatch assessments		
	Presence of fish species that indicate a healthy river system	# of species present indicative of healthy streams/river	TNC Conservation Area Plan update; RRBC VCU Healthy Waters Study	Wildlife Habitat: Striped Bass Spawning Stock, Source: Virginia Institute of Marine Science Oyster Abundance, Source: Virginia Marine Resources Commission Smallmouth Bass Abundance, Source: Virginia Department of Game and Inland Fisheries American Shad Abundance, Source: Virginia Institute of Marine Science Brook Trout Population, Source: Eastern Brook Trout Joint Venture	
	Presence of bird species that indicate a healthy riparian habitat	# of species present indicative of healthy riparian habitat	1998 State of the Basin	Wildlife Habitat: Bald Eagle Breeding Pairs, Source: William & Mary Center for Conservation Biology	
	Impaired streams as per Virginia Department of Environmental Quality water quality standards	% of total stream miles impaired	DEQ	Wildlife Habitat: James River Watershed Stream Condition Index (% streams in excellent/ good/poor condition), VDEQ	Natural Resources: Impaired rivers in Charlottesville & Alb. Co., VDEQ, 2010
	Impaired streams as per Virginia Department of Environmental Quality water quality standards	% of total stream miles sampled that are impaired	DEQ		
	Impaired streams as per Virginia Department of Environmental Quality water quality standards	% of stream miles sampled that are impaired from high levels of bacteria	DEQ		
	Impaired streams as per Virginia Department of Environmental Quality water quality standards	% of stream miles sampled that are impaired for aquatic life	DEQ		
	Impervious land cover within the watershed	% Impervious Land Cover	Rivanna & Vicinity Land Use Map	Restoration & Protection Actions: Low Impact Development Policies	Natural Resources: Land Covered by Impervious Surfaces, Rivanna & Vicinity Land Use Map
	Breakdown of land use / land cover within the watershed to track land use / land cover over time	Breakdown of Land Use / Land Cover by Categories to track land cover over time	Rivanna & Vicinity Land Use Map		Natural Resources: Land Cover by type, Rivanna & Vicinity Land Use Map

RRBC Indicator		RRBC Metric	RRBC Source	JRA Indicator/Source	TJPDC Indicator/Source
	Minimum In-stream Flows	Cumulative # of days minimum in-stream flows achieved per year	RWSA and others		
	Threatened & Endangered Species	Presence of endangered or threatened species per year	DCR Natural Heritage & TNC		Natural Resources: Threatened & Endangered Species Sightings
	Invasive Species	Presence of terrestrial invasive species	DCR Natural Heritage & TNC		
	Invasive Species	% area of watershed impacted by terrestrial invasive species	DCR Natural Heritage & TNC		
	Invasive Species	# of aquatic invasive species present			
	Invasive Species	% area of aquatic area impacted by aquatic invasive species			
Habitat Protection & Restoration	Conservation Easements	Acres in conservation easements	DCR database	Public land ownership or conservation easements. % land conservation goal set for Virginia and the Chesapeake Bay watershed in the Chesapeake Bay 2000 agreement.	Natural Resources: Acres of Land in Protected Areas & Acres of Land in Agricultural Use
	Conservation Easements	Acres of "high integrity" resources areas in conservation easements	DCR database		
	Conservation Easements	Acres in conservation easements with water quality protection components	Using Virginia Conservation Lands Needs Assessment ecological integrity model		
	Riparian Buffers	# of urban stream miles with riparian buffers	StreamWatch report Urban = highly disturbed; residential and/or commercial development dominant	% of the 93,000 acres of riparian buffers needed to meet the James River's pollution limits	
	Riparian Buffers	# of non-urban stream miles with riparian buffers	StreamWatch report Non-Urban = light disturbance; sparse population; light cattle farming; occasional orchards and vineyards		
	River Designations	# of miles with special designations (e.g. Scenic River)	DCR or Bay Model 2009 baseline		
	Agriculture BMPs	Linear feet of fencing to exclude cattle from creeks	DCR or Bay Model 2009 baseline	Agriculture • Conservation Tillage	

RRBC Indicator		RRBC Metric	RRBC Source	JRA Indicator/Source	TJPDC Indicator/Source
		and streams		• Winter Cover Crops • Farm Nutrient Management • Stream Protection	
	Agriculture BMPs	Total acres or linear feet of riparian buffers	DCR or Bay Model 2009 baseline		
	Stream Restoration	Total linear feet of stream restoration projects	DCR or Bay Model 2009 baseline		
	Reforestation	Total acres of tree planting projects	Localities	Habitat: % of stream banks in the James River basin to be forested	
	Reforestation	Total acres of tree planting projects in riparian zones	Localities		
	Reforestation	% of total tree planting projects located in riparian zones	Localities		
Stormwater Management	BMPs	# of stormwater management BMP retrofit projects on public property (Project statistics: acres, SF, gallons)	Localities		Number of On-Site Stormwater Treatment Facilities
	Codes / Ordinances	Are there ordinance provisions, or other adopted document, that provides incentives or requires LID techniques during the plan review process or mandated when technically feasible?	Aggregate of locally provided info	Development • Low Impact Development Policies • Stormwater Management Practices • Urban Nutrient Management	
	Codes / Ordinances	Adoption of water protection ordinances that protect steep slopes, intermittent streams, others	Conversations with localities; RCS and JRA reviews		
	E&S Inspection & Tracking of Stormwater BMPs on Private Property	E&S Inspection & Tracking of Stormwater BMPs on Private Property	Conversations with localities; RCS and JRA reviews		

RRBC Indicator		RRBC Metric	RRBC Source	JRA Indicator/Source	TJPDC Indicator/Source
Water Resources Management	Water Conservation	Are there ordinance provisions, or other adopted document, that promote the use of water conservation (e.g. native landscaping)			Infrastructure: Average Cost for Household Water Use
	Water Supply	Are there ordinance provisions, or other adopted document, that promotes water reuse (e.g. rain harvesting, grey water systems)			Infrastructure: Safe Yield of Water System
	Water Supply	% of watershed surveyed for groundwater resources			
Monitoring & Research	Monitoring Sites	# of monitoring sites	StreamWatch & DEQ		
	Data Collection	Frequency of data collection at monitoring sites	StreamWatch & DEQ		
	Pollutants	***# of pollutants monitored***	***StreamWatch & DEQ***	***Restoration & Protection Actions:*** ***Wastewater Pollution*** ***Wastewater treatment from sewage plants and industrial facilities met the goals for reductions for both nitrogen and phosphorus for the first time.*** ***Pollution*** • ***Sediment Pollution, Source: USGS and EPA Chesapeake Bay Program*** • ***Phosphorus Pollution, Source: USGS and US EPA Chesapeake Bay Program*** • ***Nitrogen Load Pollution, Source: USGS and US EPA Chesapeake Bay Program***	***Infrastructure: Wastewater Treatment Capacity (mgd)***
	Research	Frequency of watershed assessments	StreamWatch and others		

RRBC Indicator		RRBC Metric	RRBC Source	JRA Indicator/Source	TJPDC Indicator/Source
Watershed Planning	Watershed planning by locality or basin	# of policies which acknowledge a regional approach to watershed planning	Locality planning documents		
	River Corridor Planning	Comprehensive river corridor plan adopted by localities along the Rivanna River	Locality planning documents		
	Regional Land Use Coordination such as the 1-Community project	Regional Land Use Coordination such as the 1-Community project	Locality land use maps		
	Green Infrastructure Planning Principles Incorporated into comp plans	Green Infrastructure Planning Principles Incorporated into comp plans	Locality planning documents		
	Healthy Watershed Planning Principles Incorporated in comp plans	Healthy watershed planning principles as outlined by EPA's healthy waters initiative incorporated into comprehensive plans	Locality planning documents		
	Cultural & historic preservation coordinated with watershed protection (stream miles or acres)	Cultural & historic preservation coordinated with watershed protection (stream miles or acres)	Locality planning documents		
Public Engagement	Watershed / River Awareness	Watershed curriculum in local schools			
	Watershed / River Awareness	Special "river-centric" events			
	Watershed / River Awareness	# of groups supporting watershed engagement	RCS and others		
	Stream / River Access	***# of miles of public trails with access to streams / rivers***	***Localities***		***Natural Resources: Percent of Population Near a Trail Percent of Population Near a Scenic River***
	Stream / River Access	***# of public boat launches along the Rivanna River***	***Localities***		
	Stream / River Access	***Acres of public space adjacent to streams / river***	***Localities***		***Community: Percent of Population Near a Park***