Rivanna Water and Sewer Authority Water Demand Analysis

Technical Memorandum 2

Draft Regional Water Demand Forecasts

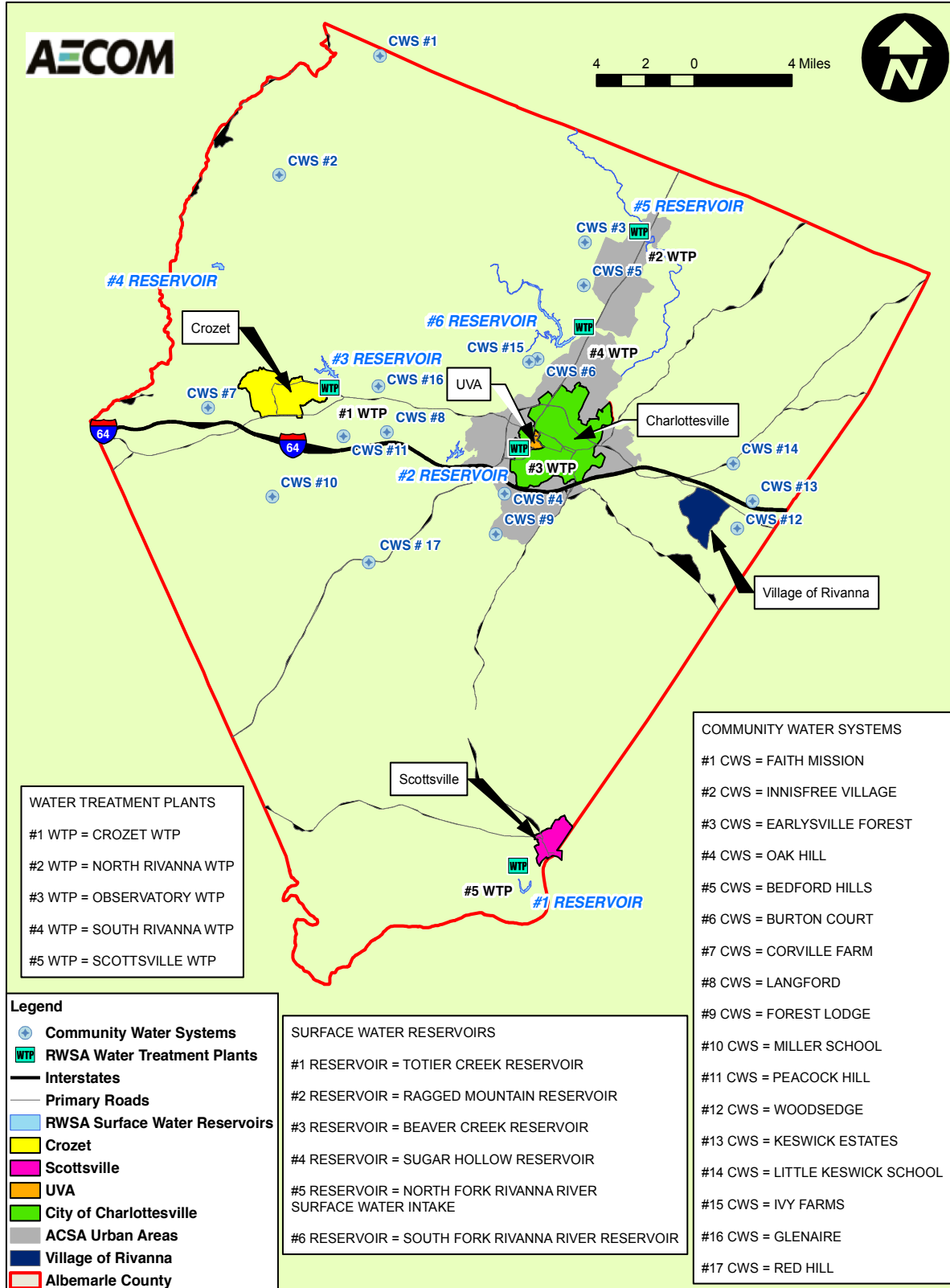|			
TO:	Tamara Ambler, Rivanna Water and Sewer Authority	**PAGES:**	44
SUBJECT:	Draft Regional Water Demand Forecasts Memorandum		
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DATE:	July 5, 2011		

Background

The Rivanna Water & Sewer Authority (RWSA) is a wholesale water provider that produces and distributes potable water to two customers; the City of Charlottesville (Charlottesville Public Utilities Division) and the Albemarle County Service Authority (ACSA). These two customers receive wholesale water then directly retail the water to residential and commercial water customers. The City of Charlottesville provides water service to the City of Charlottesville and the Grounds of the University of Virginia (UVA). The ACSA provides water service to the urban areas in Albemarle County surrounding the City of Charlottesville, as well as Crozet, the Town of Scottsville, and the Village of Rivanna. ACSA also serves a research park and some other off-Grounds facilities owned by UVA or its foundations. Figure 1 shows the location of the service areas within Albemarle County.

In addition to the RWSA, there are a number of smaller Community Water Systems (CWS) in Albemarle County that produce and distribute drinking water. In 2009, there were 17 CWS including; Bedford Hills, Burton Court Apartments, Earlysville Forest, Faith Mission Home, Forest Lodge Water Company, Glenaire Subdivision, Innisfree Village, Ivy Farms Water Company, Keswick Estates, Langford Subdivision, Little Keswick School, Miller School, Oak Hill Trailer Park, Peacock Hill Subdivision, Corville Farm Subdivision, Woods Edge Subdivision, and Red Hill. Also within Albemarle County, there is a segment of the population that is considered "self-supplied" which means they have a private well to supply their individual home.

Figure 1. Location Map of RWSA service area

Figure 1. Location Map of RWSA service area

AECOM

CWS #1

4 2 0 4 Miles

N

CWS #2

#5 RESERVOIR

CWS #3 WTP

#2 WTP

CWS #5

#4 RESERVOIR

#6 RESERVOIR

WTP

Crozet

CWS #15

#4 WTP

#3 RESERVOIR

CWS #16

CWS #6

CWS #7 WTP

UVA

#1 WTP CWS #8

Charlottesville

64

64

CWS #11

CWS #14

CWS #10

#3 WTP

CWS #13

#2 RESERVOIR

CWS #12

CWS #4

CWS #9

Village of Rivanna

CWS # 17

COMMUNITY WATER SYSTEMS

#1 CWS = FAITH MISSION

#2 CWS = INNISFREE VILLAGE

Scottsville

#3 CWS = EARLYSVILLE FOREST

#4 CWS = OAK HILL

#5 CWS = BEDFORD HILLS

#6 CWS = BURTON COURT

WATER TREATMENT PLANTS

#7 CWS = CORVILLE FARM

#1 WTP = CROZET WTP

#8 CWS = LANGFORD

#2 WTP = NORTH RIVANNA WTP

#9 CWS = FOREST LODGE

#3 WTP = OBSERVATORY WTP

#10 CWS = MILLER SCHOOL

#4 WTP = SOUTH RIVANNA WTP

#11 CWS = PEACOCK HILL

#5 WTP = SCOTTSVILLE WTP

#12 CWS = WOODSEDGE

WTP

#13 CWS = KESWICK ESTATES

#5 WTP

#1 RESERVOIR

#14 CWS = LITTLE KESWICK SCHOOL

Legend

#15 CWS = IVY FARMS

Community Water Systems

SURFACE WATER RESERVOIRS

#16 CWS = GLENAIRE

WTP RWSA Water Treatment Plants

#1 RESERVOIR = TOTIER CREEK RESERVOIR

#17 CWS = RED HILL

Interstates

Primary Roads

#2 RESERVOIR = RAGGED MOUNTAIN RESERVOIR

RWSA Surface Water Reservoirs

#3 RESERVOIR = BEAVER CREEK RESERVOIR

Crozet

Scottsville

#4 RESERVOIR = SUGAR HOLLOW RESERVOIR

UVA

#5 RESERVOIR = NORTH FORK RIVANNA RIVER

City of Charlottesville

SURFACE WATER INTAKE

ACSA Urban Areas

#6 RESERVOIR = SOUTH FORK RIVANNA RIVER RESERVOIR

Village of Rivanna

Albemarle County

RWSA is developing a Regional Water Supply Plan in accordance with the Virginia Local and Regional Water Supply Planning Regulations (9 VAC 25-780) for all of the water users both in the RWSA service area and the CWS/self-supplied areas, which is defined as the "planning area" in 9 VAC 25-780. By regulation, the Regional Water Supply Plan shall contain the following elements:

- Description of existing water sources (9 VAC 25-780-70)
- Description of existing water use (9 VAC 25-780-80)
- Description of existing water resource conditions (9 VAC 25-780-90)
- Assessment of projected water demand (9 VAC 25-780-100)
- Description of water management actions (9 VAC 25-780-110 & 120)
- Statement of need (9 VAC 25-780-130)
- Maps identifying important elements (e.g., environmental resources, existing water sources, existing significant water uses, proposed new sources, etc.) of the Water Supply Program
- Copies of local ordinances or amendments that incorporate elements of the Water Supply Program
- Copies of resolutions from the local governments in the planning area approving the Water Supply Plan
- Records of local public hearing

The Regional Water Supply Plan must be submitted by November 2, 2011 for review by the Virginia Department of Environmental Quality and for approval by the Virginia State Water Control Board. The Regional Water Supply Plan must be reviewed every 5 years. If circumstances upon which the Plan was based change, or new information indicates that water demands cannot be met by the alternatives contained in the Regional Water Supply Plan, then the Plan must be updated and re-submitted to the Virginia Department of Environmental Quality for approval. Even if no changes have occurred that would change the conclusions of the Regional Water Supply Plan, it must be updated and submitted to the Virginia Department of Environmental Quality for approval every 10 years.

One of the critical elements in creating the Regional Water Supply Plan is the Water Demand Analysis, which identifies the future demand for drinking water. RWSA retained AECOM to complete the water demand analysis and develop the potable/drinking water forecasts that will be used as the foundation for the Regional Water Supply Plan. These water demands reflect water needs for human consumption. The Regional Water Supply Plan will integrate these human water demands along with the ecological demands (instream flow requirements) as shown in Figure 2.

Figure 2. Total Water Demands Considerations for the Regional Water Supply Plan

The Regional Water Supply Plan will follow an integrated approach that considers minimum instream flow for aquatic habitat, water supply sources, and other considerations as well as the demands for human consumption that are outlined in this Technical Memorandum.

The Local and Regional Water Supply Planning regulation contains specific requirements for the water demand analysis (9 VAC 25-780-100). These requirements, in summary, include:

- Use of appropriate data sources and documented methodology
- Forecast demands for a minimum of 30 years and a maximum of 50 years
- Estimate the water demands for each decade (2010, 2020, 2030, etc.)
- Include projections for community water systems
- Include self-supplied water demands (private non-farm wells)
- Include self-supplied agricultural demand
- Consider the reduction in future water demands associated with water conservation and leak detection programs

The major tasks associated with this project include:

- Forecasting the water demands for a 50-year planning horizon in 10-year increments.
- Soliciting input on water usage from the various stakeholder groups and the general public.
- Communicating the water demand forecast methodology and water demand forecast results to the stakeholder groups and the general public.

Stakeholders, advocacy groups, and citizen involvement will play a major role throughout the planning process with RWSA. Stakeholders include elected officials, planning staff, community water systems in the region, and representatives from the University of Virginia. AECOM will engage these groups and the RWSA at important stages in the forecasting process to allow for relevant and available data to be obtained and considered during the development of the water demand forecasts in the Regional Water Supply Plan. Key milestones of the project are shown in Figure 3.

Figure 3. Key Water Demand Forecast Milestones
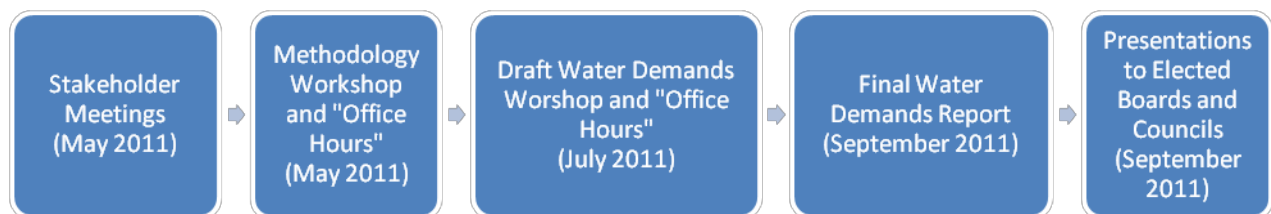
Public interest in water supply planning is high in the City of Charlottesville and Albemarle County planning area. Much public dialogue has focused on the roles played by adverse economic conditions, short-term drought management responses, and long-term water conservation efforts in recent water use figures. This study evaluated these conditions and estimated the potential impacts of existing and future water conservation programs.

Early in the water demand forecasting process, RWSA engaged the water users and public providing an opportunity for input and data. The methodology used to calculate these demands was presented during a public meeting on May 26, 2011. Feedback provided during the public meeting and at the subsequent "office hours" (individual meetings with citizens and public interest groups) was considered throughout this analysis. This document and the draft water demand forecasts will be presented at a series of three public meetings on July 11-12, 2011. Feedback provided at these meetings will be considered and the draft forecasts will be revised into a final technical memorandum. The final water demands will be integrated into the larger Regional Water Supply Plan.

The draft water demand forecasts are presented by the four distinct character areas within the regional water supply planning area; Urban, Crozet, Town of Scottsville, and CWS/self-supplied areas. These areas are defined below.

- **Urban** – City of Charlottesville, University of Virginia, urban portions of the ACSA
- **Crozet** – ACSA rural areas, in and around the Crozet area
- **Town of Scottsville** – area served by ACSA within the town limits
- **Community Water Systems (CWS)** – 16 independently-operated water systems, plus Red Hill (operated by ACSA) and the self-supplied population

Introduction

The purpose of this memorandum is to present the draft forecasted water demands for the Regional Water Supply Plan Planning Area. These draft forecasts were calculated following the methodology contained in Technical Memorandum No. 1 – Water Demand Forecast Methodology and as presented to the public on May 26, 2011.

The methodology, shown in Figure 4, is based on the "Disaggregate Water Use Model" outlined in the American Water Works Association (AWWA) M50 Water Resources Planning Manual (AWWA M50 Manual). The Disaggregate Water Use Model considers the different water use patterns for each customer type and applies these water use patterns to the future customers within that specific water use category (e.g., residential). Due to the complexity of each step, shown in Figure 4, and the uncertainty associated with future conditions, the forecasts presented in this technical memorandum include a number of scenarios that could have a potential impact on future water demands. The water demand forecasts, once finalized, will be reviewed every 5 years as required by the Local and Regional Water Supply Planning regulation; therefore the expectation is that the likely demands will be adjusted, over time, based on changed conditions.

Figure 4: Process for Developing Water Demand Forecasts

*Adapted from AWWA M50 Manual
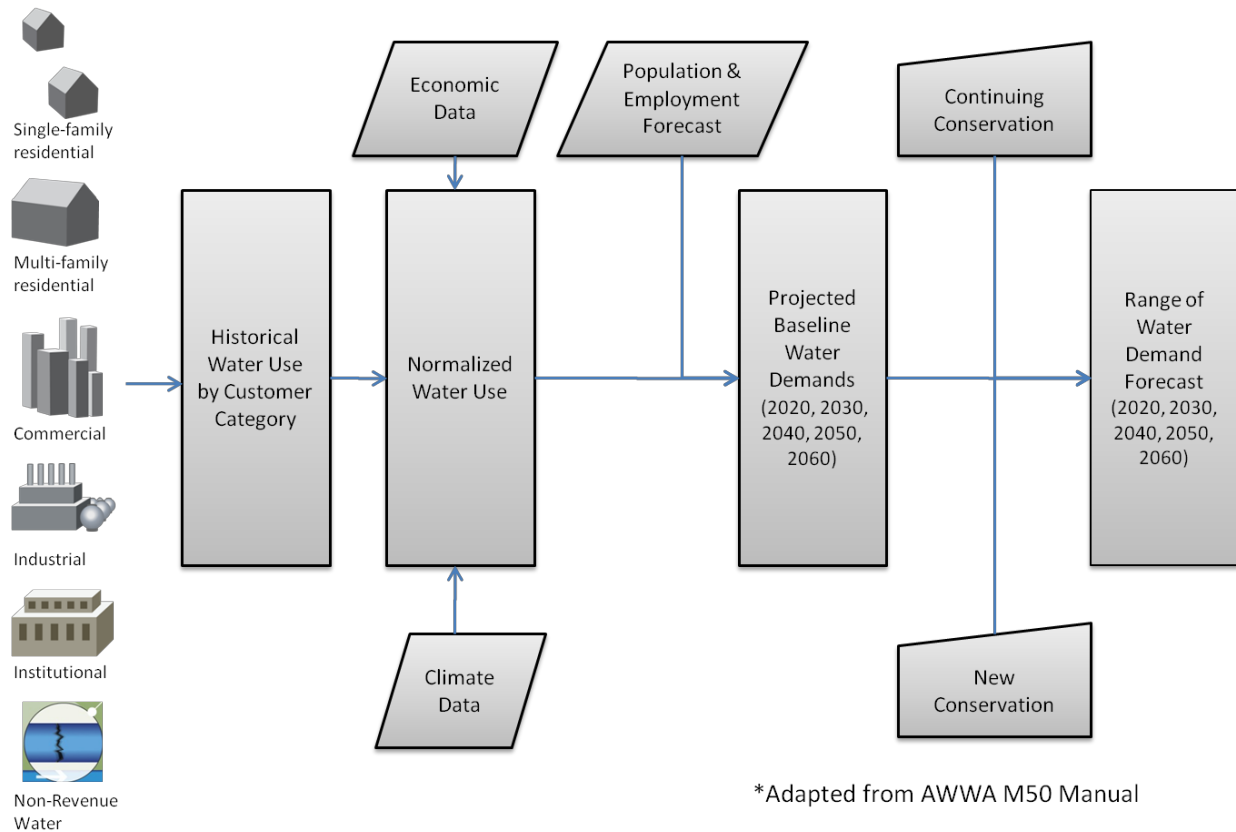
The disaggregate water use model was used for the Urban, Crozet, and Scottsville character areas. Disaggregated data was not available for the CWS areas, therefore the per capita method was used for the CWS areas. The overall per capita will be applied to the future population served by CWS as well as the self-supplied population. The demands calculated for the CWS and self-supplied populations will be summed with the demands for the Urban, Crozet, and Scottsville character areas to determine the regional water demand.

This Technical Memorandum presents the draft water demand forecasts following this methodology. This document is organized in the following sections:

- Historical Water Use Data – presents historical water use and production data and how the water is used; including, use by customer category, per capita/per employee water use, water use by end use, and estimates for non-revenue water.
- Normalized Water Use – presents an evaluation of climate data, economic data, and historical water use to determine whether the 2006 to 2010 disaggregated water use data is likely to be representative of future trends.

- Population and Employment Data – summarizes the future population and employment used for the water demand forecasts.
- Baseline Water Demands – presents the draft baseline future water demands, which reflect current water use trends continuing into the future.
- Water Demand Forecasts – presents the likely future water demands. The draft water demand forecasts are based on baseline scenarios for each of the four character areas that were adjusted to reflect likely circumstances as well as a number of possible circumstances.
- Next Steps – presents a summary of the next steps to completing the future water demand forecasts.

Historical Water Use Data

Historical water use data (i.e., billing and production data) was provided by RWSA for the City of Charlottesville and ACSA service area (ACSA urban, Crozet, and Town of Scottsville). The RWSA historical urban water production record (Charlottesville and ACSA urban) was provided for 1983 to 2010. The historical water use by customer category, needed to use the disaggregate water use method, was provided by both the City of Charlottesville and the ACSA from FY2006 to FY2010[1]. The RWSA also compiled and provided water use data for the CWS providers from 2008 to 2009. The historical water production and total use data is presented in million gallons per day (MGD) in Table 1.

Table 1. Historical Water Production and Use by Character Area for FY2006 – FY2010 (in MGD)

Character Areas	FY2006	FY2007	FY2008	FY2009	FY2010
RWSA Production	11.12	10.93	10.04	9.80	9.85
Urban Water Use	8.87	8.95	8.33	8.47	8.35
Crozet Water Use	0.35	0.37	0.36	0.36	0.37
Town of Scottsville Water Use	0.07	0.08	0.06	0.06	0.05
Community Water Systems Use			1.29	1.18	
Total Consumption	9.29	9.4	10.04	10.07	8.77

Note 1: RWSA production data was provided by RWSA, the water use was provided by the City of Charlottesville and the ACSA, and the Community Water System data was derived from the Virginia Department of Health data sheets.

This water use data was disaggregated to provide a foundation for the draft water demand forecasts and also to provide a better understanding of current water use patterns to guide water conservation analysis presented later in this memorandum. The analysis presented in this section, except where

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[1] FY = fiscal year which is from July through June

noted otherwise, used the historical water use and water production data from FY2006 to FY2010. The larger historical record was used as part of the normalization step, described later in this memorandum.

Water Use by Customer Category

The water use by customer category for the City of Charlottesville and ACSA is presented in Table 2 and Figure 5. For the areas where disaggregated water use data was available, single-family residential water use was highest with multi-family, institutional, and commercial use sharing a very similar percentage of the total water use. Most of the CWS and self-supplied customer water use is considered to be single-family residential as well.

Table 2. Percentage of Total Water User by Customer Type by Service Area

Character Area	Single-Family	Multi-Family	Commercial	Institutional	Industrial	Irrigation[1]
City of Charlottesville (Urban)	30%	19%	18%	32%	1%	0%
ACSA Urban	42%	24%	20%	8%	1%	5%
Crozet	73%	5%	6%	9%	4%	3%
Town of Scottsville	33%	4%	21%	5%	37%	0%
Total[2]	37%	21%	18%	21%	1%	2%

Notes:
1. Irrigation only includes properties with a separate irrigation meter that only tracks water use for irrigation.
2. The total represents an average percentage based on the dividing the sum of water use for each customer category for all four character areas by the sum of the total water use for all four character areas. The total reflects water use for the character areas with disaggregated data.

Figure 5. Percentage of Total Water Use by Customer Type
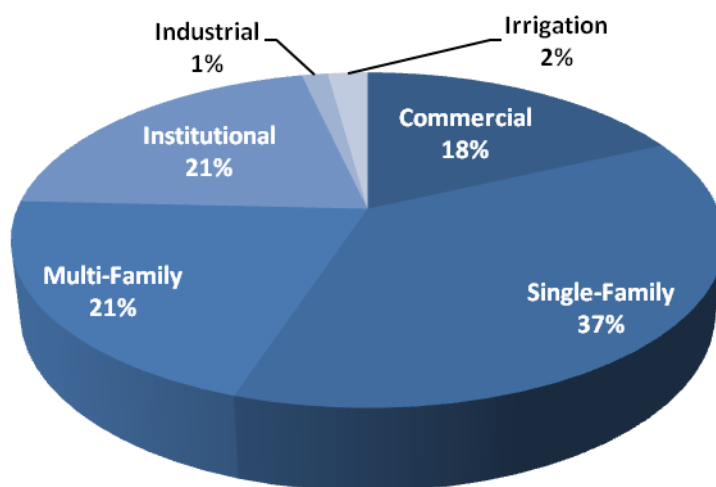
Per Capita and Per Employee Water Use

The per capita and per employee water use was calculated based on the water use data presented in Table 1 and the 2010 population based on the 2010 U.S. Census[2] and the 2010 employment based on the 2010 Quarterly Census on Economics and Wages (QCEW)[3] from the U.S. Department of Labor: Bureau of Labor Statistics. To be consistent with the population and employment data (presented later in this document), the customer categories were grouped into three categories; residential, employment, and irrigation. Irrigation includes only usage associated with separate irrigation meters and does not represent all outdoor water use. Table 3 presents the average gallons per capita per day (gpcd) and gallons per employee per day (gped) water use based on data from FY2006 to FY2010.

Table 3. Average Per Capita and Per Employee Water Demand by Service Area for FY2006 to FY2010

Character Area	Total Overall System[1] (gpcd)	Overall[2] (gpcd)	Residential (gpcd)	Employment (gped)	Irrigation[3] (gpcd)
RWSA	106				
City of Charlottesville (Urban)		107.1	51.7	66.5	0.05
ACSA Urban		82.5	55.2	24.4	3.84
Crozet		68.3	53.2	43.7	1.98
Town of Scottsville		112.4	41.6	204.8	n/a
CWS[4]	81				

Notes:
1. The total overall system per capita use reflects all of the water produced and therefore includes non-revenue water
2. The overall per capita water use reflects the water used divided by the total population and therefore is influenced by the extent and type of employment in the community.
3. Irrigation includes only usage associated with separate irrigation meters and does not represent all outdoor use
4. The CWS population served was based on information from the Virginia Department of Health data sheets.

The overall system per capita water use of 106 is very low. However, it is important to understand that the per capita water use reflects the nature of the community and that use will vary based on employment, climate, geography, water source, cost of water, availability of water, and a host of other factors. For example, the Town of Scottsville has a higher overall per capita water use and the lowest residential per capita use, because of a large manufacturing facility. While it is important to use care when comparing overall per capita water demands, it does provide a method for comparing communities. Figure 6 shows 2009 per capita water use data from 20 other communities across the

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[2] http://quickfacts.census.gov/qfd/states/51/51003.html and http://quickfacts.census.gov/qfd/states/51/51540.html
[3] http://beta.bls.gov/maps/cew/VA?period=2010-Q1&industry=10&pos_color=blue&negcolor=orange &Update=Update& chartData=3&ownerType=0&distribution=Quantiles

United States, including several communities (Cary, NC and Spartanburg, SC) that are similar to Albemarle County and the City of Charlottesville. For the communities listed, the RWSA has the second lowest overall per capita water use, next to the City of Seattle, Washington. The relatively low per capita water use is in part due to the strong water conservation ethic practiced within the Regional Water Supply study area.

Figure 6. Comparison of Per Capita Water Use across the United States
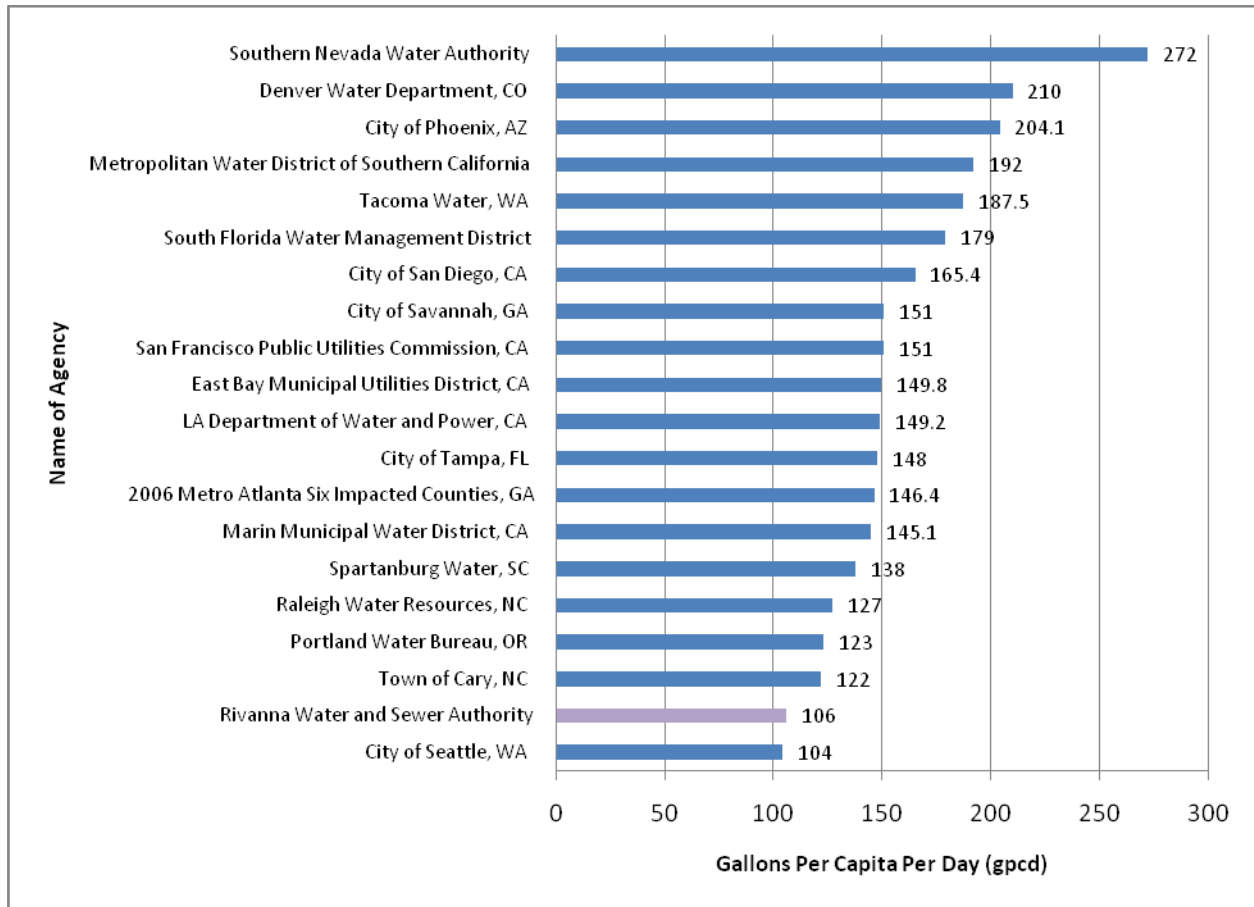
Adapted from: *Catawba-Wateree Water Management Group Benchmarking Survey of Current Successful Water Demand Management Programs.* JJ&G. 2010.

Water Use by End Use

The end uses of water include outdoor water use (i.e., irrigation) as well as indoor water uses (i.e., toilets, showers, sinks, washing machines, etc.). The water use by end use category was estimated to guide the water conservation analysis, presented later in this technical memorandum.

The outdoor water use was estimated by comparing the average water use during winter months to the average annual water use. Typically, there is little or no irrigation during the winter months (November through February) and therefore the winter average is considered to be indoor usage. Therefore, any

water use in excess of the winter average water use is considered to be outdoor water use. Table 4 presents the percent indoor and outdoor water use as well as a demand-weighted average for the Urban, Crozet, and Scottsville character areas.   Outdoor water use typically ranges from 10-percent to 20-percent of total water use in the mid-Atlantic. In arid areas of the United States, such as Nevada and Florida, the outdoor water use can climb to as high as 6o-percent of overall demand. At 12-percent, the Urban, Crozet, and Scottsville character areas are within the typical range. The City of Charlottesville and ACSA have several ongoing education programs to increase awareness and present alternatives for water used for irrigation.

Table 4. Average Indoor versus Outdoor Water Use by Service Area for 2006 to 2010

Character Area	% Indoor Water Use	% Outdoor Water Use
City of Charlottesville (Urban)	90%	10%
ACSA Urban	86%	14%
Crozet	88%	11%
Town of Scottsville	87%	13%
AVERAGE	**88%**	**12%**

Figure 7. Example Determination of Outdoor versus Indoor Water Use (City of Charlottesville)
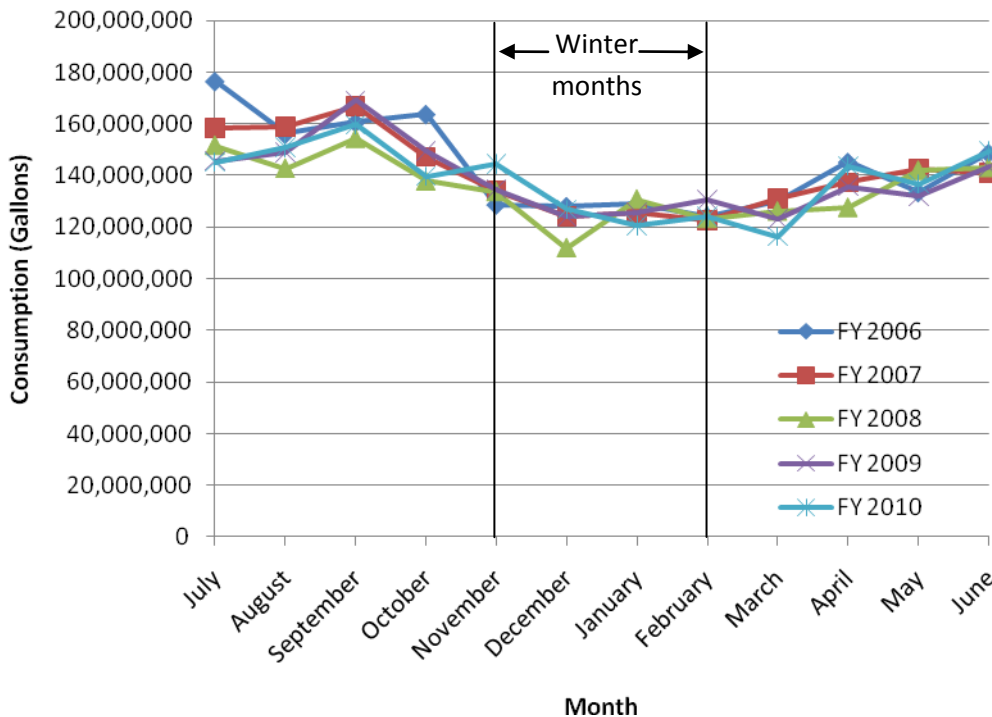
The average flow-weighted residential per capita water use[4] is approximately 53 gpcd and includes indoor and outdoor water use. Based on the average percent of indoor water use of 88-percent, from Table 4, the average indoor per capita water use is approximately 46.6 gpcd[5]. The indoor water use was sub-divided into the various end uses for residential properties based on the AWWA Research Foundation (AWWARF) Residential End Uses Report[6]. This 1999 study identifies the average percentage of water use by end use within the home, shown in Figure 8. The residential per person water use by end use is presented in Table 5 for the Urban, Crozet, and Scottsville character areas was calculated by applying these percentages to the calculated indoor water use of 46.6 gpcd. This information was used for the water conservation analysis performed later in this memorandum, and is important given that residential customers comprise the largest portion of water use.

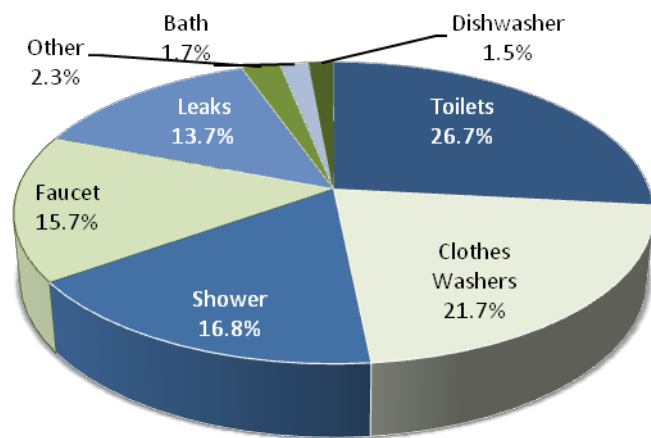**Figure 8. Percent of Residential Water Use by End Use**

Table 5. Estimated Residential Indoor Per Capita Use for Urban, Crozet, and Scottsville Character Areas

End Use	Residential Use by End Use (%)[6]	Calculated Indoor Per Person Water Use (gpcd)
Toilets	26.7%	12.4
Clothes Washers	21.7%	10.1
Shower	16.8%	7.8
Faucet	15.7%	7.3
Leaks	13.7%	6.4
Other	2.3%	1.0
Bath	1.7%	0.8
Dishwasher	1.5%	0.7
Total	**100%**	**46.6**

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[4] Calculated based on the overall residential water use divided by the overall population for Urban, Crozet, and Scottsville.
[5] Calculated by multiplying the residential per capita of 53 gpcd by the 88-percent indoor water use
[6] *Residential End Uses of Water*. AWWA Research Foundation. Peter W. Mayer, William B. DeOreo. 1999.

Non-Revenue Water

Non-revenue water (NRW), as defined by the AWWA, includes unbilled authorized consumption (i.e., fire fighting, line flushing, etc.), apparent losses (i.e., water not billed through clerical error, metering inaccuracies or unauthorized uses), and real losses (i.e., leaks, main breaks) as shown in Figure 9. Since NRW includes unbilled authorized consumption and real losses (AWWA methods confirm that all water systems will have an unavoidable level of leakage), it is rare to see a system with less than 10% NRW. NRW above 20% is typically considered high and programs would be needed to target the highest areas of NRW.

Figure 9. International Water Standard Water Balance (adapted from AWWA M50)

Authorized Consumption	Billed Authorized Consumption	Billed Metered Consumption	Revenue Water
		Billed Unmetered Consumption	
	Unbilled Authorized Consumption	Unbilled Metered Consumption	Non-Revenue Water (NRW)
		Unbilled Unmetered Consumption	
Water Losses	Apparent Losses	Unauthorized Consumption	
		Customer Metering Inaccuracies	
		Systematic Data Handling Errors	
	Real Losses	Leakage on Transmission and Distribution Mains	
		Leakage on Overflows at Storage Tanks	
		Leakage on Service Connections up to Customer Meters	

The NRW, shown in Table 6, was calculated for each character area by subtracting the water billed to customers from the water produced by RWSA. The NRW for the urban area cannot be divided between the ACSA service area and the City of Charlottesville service area because the water plants send flows into both systems. The NRW for the Urban area and Crozet are very low. The NRW for the Town of Scottsville is higher than the normal range and should be investigated to determine that all accounts are being properly metered and billed and that there aren't any unresolved water leaks.

Table 6. Average Non-Revenue Water by Character Area for FY2006 to FY2010

Character Area	NRW (%)
Urban	13
Crozet	13[7]
Town of Scottsville	31
CWS	NA

Normalized Water Use

Weather and economic conditions can have a dramatic effect on water use patterns; therefore, it is important to analyze the data trends for anomalies. The normalization process considered any unusual circumstances that may have impacted "normal" water use during the time period evaluated. Normalization is an important step in the analysis, as using a lower than normal baseline water use could result in insufficient water to meet the regional water supply planning area needs. One of the goals of the Regional Water Supply Plan is to "ensure that adequate and safe drinking water is available to all citizens of the Commonwealth" (9VAC 25-750-20). Similarly, forecasting future water demands based on higher than normal conditions could result in building additional water supply capacity ahead of demands. For this Regional Water Demand Analysis, potential irregularities in climate, economic conditions, and historical water use were considered.

Climate Data

Historical rainfall patterns were reviewed to identify years with irregular weather patterns. Typically, during "wet" years, outdoor watering levels decline as ample rainfall decreases outdoor water needs and during "dry" years there are often watering restrictions that can reduce typical consumption levels. Historical rainfall data from the National Weather Service rain gage located on the UVA campus near the McCormick Observatory were used to determine the average rainfall was 46.9-inches during the period of record from 1893 to the present, shown in Figure 10[8].

Years with rainfall below the average are considered to be "dry" years and above this level are "wet" years. For the 2006 to 2010 time frame, Table 7 shows that on average rainfall was about 6.7% below average and the rainfall in 2007 was over 25% below normal. Water use restrictions were in place in 2007, which is the year with the lowest rainfall total since 1977.

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[7] The actual average NRW for FY2006 to FY2010 was 9%, however in FY2006 the NRW was 14% and FY2010 the NRW was 13%. The intermediate years had overly low NRW and that data was not considered in the average due to irregularities in the data that appear to have been addressed.

[8] For several years within the record, including from 1893 to 1922, only partial rainfall data was available (i.e., only 11 months of data). However, a complete record of rainfall data was needed to determine if the weather patterns from 2006 to 2010 are "normal"[8]. When there was one month of missing rainfall data, that month was replaced with data from the Free Union rain gage for 1955 to 2010 and from the rain gage near the Observatory WTP for 1931 to 1954.

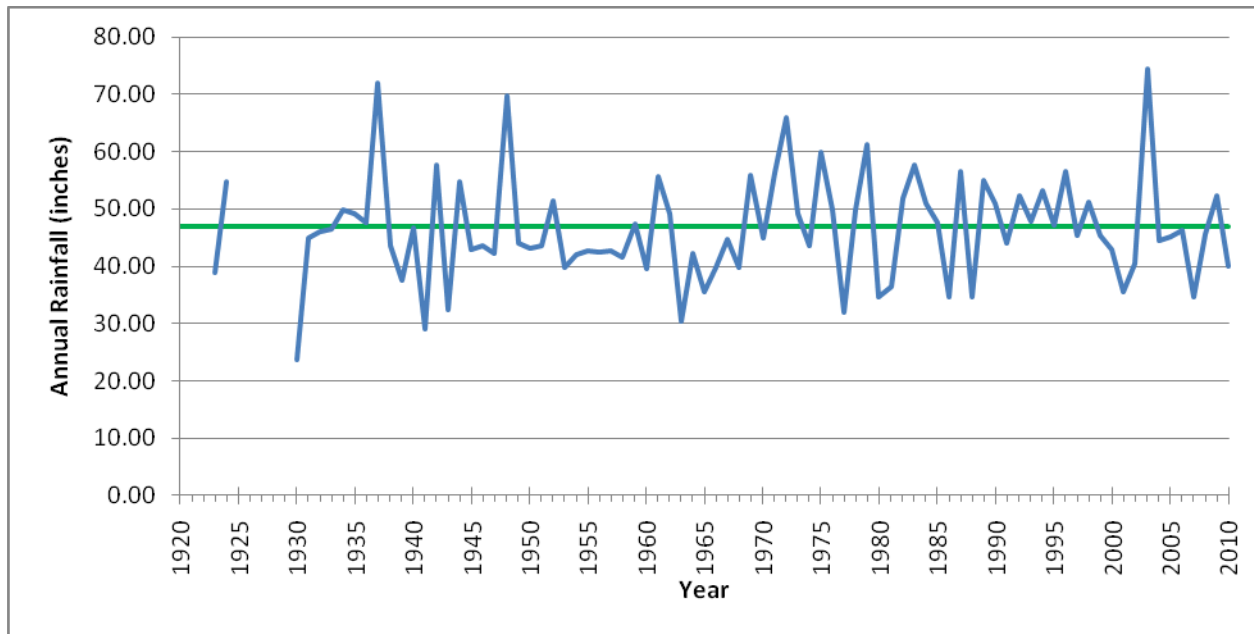**Figure 10. Historical Rainfall Data for the City of Charlottesville**

Table 7. Percent Variation in Annual Rainfall Compared to Average for FY2006 to FY2010

Fiscal Year	Rainfall (inches)	% of Normal	Average Consumption Per Capita
2006	46.26	-3%	94.4
2007	34.61	-27%	96.9
2008	45.57	-4%	88.5
2009	52.27	+10%	90.4
2010	40.03	-16%	87.6
5-year Average	43.75	-8%	91.6

One important reason for weather normalization is to determine the impacts, if any, of emergency drought water use restrictions on normal water use. Emergency drought restrictions are a very important tool for addressing water shortages during periods of low water use. The worst drought of record is likely to be exceeded in the future and it is prudent to plan based on "normal" use to ensure sufficient supplies to meet demands during a worse drought. Therefore, using artificially depressed water demands as a basis for future planning is inappropriate. Water conservation programs should

account for the long-term changes in water use that may result from a drought response whereas the expectation is that outdoor watering will resume when the drought ends.

Table 7 shows that the per capita water use was almost 6% higher in 2007 than the average for FY2006 to FY2010, despite the mandatory watering restrictions. The overall range of per capita water use from FY2006 to FY2010 was considered reflective of current water use and therefore no normalization for weather conditions was recommended.

Concerns were raised during the May 27, 2011 "Office Hours" meetings with interested citizens and groups following the methodology meeting on May 26, 2011, regarding global climate change and the increasing changes in normal weather patterns. The following reports regarding global climate change and the impacts on water supply and availability in the region were reviewed, including:

- *Climate Change and the Chesapeake Bay: State-of-the-Science Review and Recommendations*. Chesapeake Bay Program Science and Technical Advisory Committee (STAC). September 2008. This source states that "Climate models have, in general, been unable to simulate this long-term change in precipitation in the northeast United States.[9]"
- *Governor's Commission on Climate Change Final Report: A Climate Change Action Plan*. Governor's Commission on Climate Change. December 2008. This source states that "more research to determine the specific effects [of climate change] is needed. The lack of specific information on the impacts hinders Virginia's ability to adapt and prepare for these changes."
- *Are Climate Variations Reducing the Reliability of Our Water Supplies*. Robert R. Osborne, Pamela Kenel, and Hope Walker. Proceedings of the 2009 Georgia Water Resources Conference.   April 2009.

While these reports all indicate there are uncertainties and that future rainfall patterns will become increasingly irregular, there is not a precise impact that has been identified to account for the future variations. As the Regional Water Supply Plan will be reviewed and updated (as needed) every 5 years, the recommendation at this time is to continue to watch the trends and revise the water demands as needed.

Economic Trends

The number of unemployed persons from 2001 to 2010 for the Charlottesville Metropolitan Statistical Area (MSA), presented in Figure 11, shows a steady rise in unemployment from 2007 to 2010. The highest period of unemployment was January 2010 and the lowest period was January 2001. While the Charlottesville MSA unemployment remains much lower than the national average, the change is noteworthy.

The unemployment for the period of 2006 to 2010 was compared to per capita water use to see if there was a noticeable decline in water use. While there is a small (2%) decrease in per capita water use between 2009 and 2010, the difference is not definitively tied to economics. This water demand forecast covers a 50-year planning horizon. Undoubtedly, during the 50-years there will be several

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[9] Hayhoe et al., 2007; Najjar et al., 2008.

periods of slower economic growth and periods of higher economic growth. Maintaining employment forecasts with steady growth allows the region to plan for future water needs without requiring adjustments to current employment use as part of the normalization process. Instead of adjusting the per capita water use to respond to a decline in employment, the forecasts are based on steady and continued employment.

Figure 11. Historical Unemployment Data for the Charlottesville MSA[10]
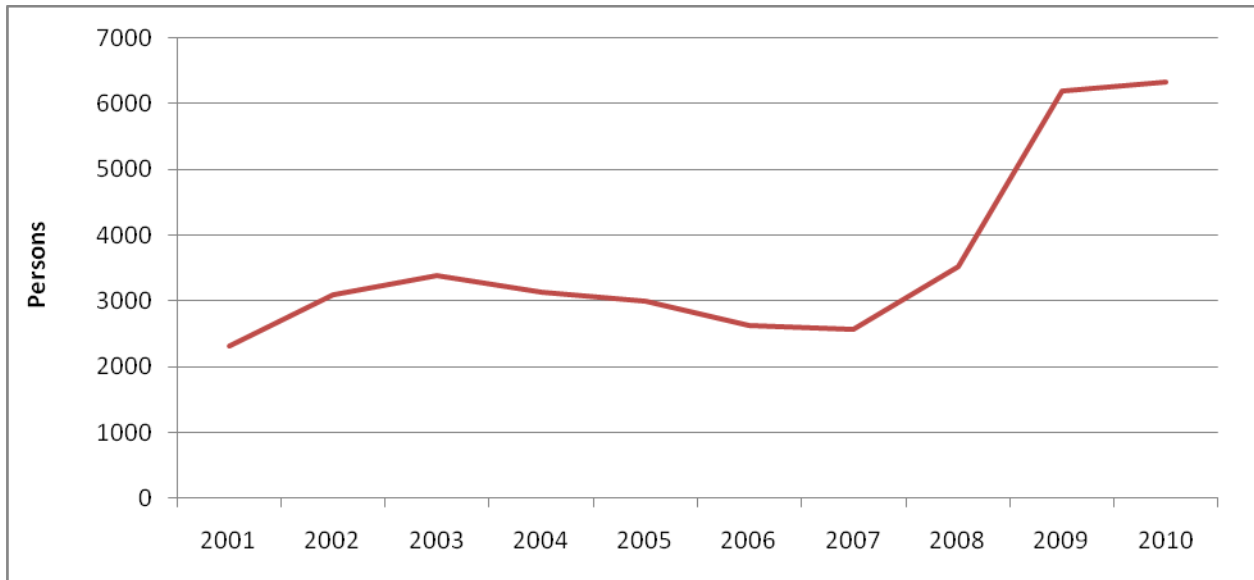
Table 8. Unemployment Data and Per Capita Water Use for FY2006 - FY2010

Fiscal Year	Unemployment (Persons)	Average Consumption Per Capita
2006	2,619	94.4
2007	2,563	96.9
2008	3,532	88.5
2009	6,193	90.4
2010	6,333	87.6

Based on the review of weather and economic conditions compared to the per capita water use, normalization of the actual data is not considered necessary at this time.

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[10] U.S. Bureau of Labor Statistics trends for the Metropolitan Statistical Area from http://www.bls.gov/ro3/charlottesville.pdf

Historical Water Use Patterns

Disaggregated water use data was only available from FY2006 to FY2010. Water production and total water use data for the urban area was available from FY1983 to FY2010. The analysis looked at the data prior to FY2006 to confirm that it was appropriate to use the smaller data set. The historical water use and production data is shown in Table 9 along with the calculated average for both the historical record as well as for the FY2006 to FY2010 period.

Table 9. Historical Urban Water Production and Water Use Data for FY1983 to FY2010

Year	Total Urban Water Produced (MGD)	Total Urban Water Consumed (MGD)	Urban Area Consumption Per Capita (gpcd)
FY 1983	8.56	7.50	115.3
FY 1984	9.01	7.92	120.8
FY 1985	8.82	8.07	120.8
FY 1986	9.82	8.18	122.8
FY 1987	9.91	8.41	124.0
FY 1988	10.27	8.78	126.9
FY 1989	10.41	8.89	126.3
FY 1990	10.16	9.04	126.7
FY 1991	10.28	9.18	126.4
FY 1992	9.55	8.89	121.3
FY 1993	10.22	8.80	117.1
FY 1994	11.32	9.42	123.7
FY 1995	10.91	9.37	121.3
FY 1996	11.27	9.72	124.6
FY 1997	10.79	9.31	118.3
FY 1998	11.32	9.88	124.2
FY 1999	11.92	10.33	128.3
FY 2000	11.21	9.89	120.9
FY 2001	11.17	9.55	114.9
FY 2002	10.75	9.88	117.7
FY 2003	9.19	8.20	96.4
FY 2004	9.64	8.24	95.2
FY 2005	9.93	8.29	95.0
FY 2006	10.60	8.77	96.0
FY 2007	10.43	8.81	97.8
FY 2008	9.57	8.14	89.6
FY 2009	9.34	8.45	91.6
FY 2010	9.35	8.22	88.8
Average	10.20	8.86	114.0
Average FY06-FY10	9.86	8.48	92.8

Note: Historical urban area water production data was provided by RWSA and urban consumption data provided by the City of Charlottesville and ACSA.

Table 9 shows that there is approximately a 20% decline in per capita water use from FY2002 to FY2003. Based on our analysis of total water sales, the decline does not appear associated with weather patterns, economic conditions, drought restrictions, water conservation, rate adjustments, outdoor water use, or non-revenue water. These per capita rates are the lowest seen in the last 37 years; however, the per capita water use has remained low for a period of 8 years. Based on the recent records, this analysis assumes that the per capita water use will remain at the reduced rate. The circumstances that caused this change are unknown based on data provided, and therefore we cannot assess the likelihood that these conditions may be reversed in the future. This uncertainty highlights the importance of the review required by the state every 5 years.

Population and Employment Data

The current and future forecasts for population and employment play an integral role in this water demand analysis. As the population and employment decisions are established by the City and County through the comprehensive land use planning process, these forecasts are based on the currently adopted land use plans. Population forecasts were available through 2060 and employment forecasts were generated based on existing ratios of population to employment as described below and displayed in Figure 13.

Population

Current population data was available for the City of Charlottesville and Albemarle County from the 2010 U.S. Census. Future population projections were compiled based on data primarily provided by each jurisdiction as outlined by character area below.

- **Urban area**: The City of Charlottesville population projections were developed based on information provided by the City's Neighborhood Development Services department. The population projections for the urbanized area of Albemarle County were obtained from the Albemarle County Planning Division. The Albemarle County Planning Division recently performed in-depth analysis of the future population growth through 2060 in support of the 2008 Rivanna Water & Sewer Authority's Comprehensive Sanitary Sewer Interceptor Study. The Albemarle County Planning Division recommended using these population forecasts, which were developed based on zoning classifications for each parcel, for this water demand analysis. There are several water-only parcels in and around the urban area that were not included in the 2008 sewer study, as shown in Figure 12. The population associated with buildout for these parcels was calculated based on zoning information provided by the Albemarle County Planning Division. As timing for buildout of these parcels is not known, it was assumed that 80-percent of the buildout would occur by 2060, consistent with guidance from County staff regarding the Crozet Master Plan (outlined below).
- **Crozet**: Crozet's population information was obtained from the Crozet Master Plan which was developed by the Albemarle County Planning Division and adopted on October 13, 2010. This document projected the population through buildout based on the zoning outlined in the Master Plan. The County staff estimated that 80-percent of this buildout development would
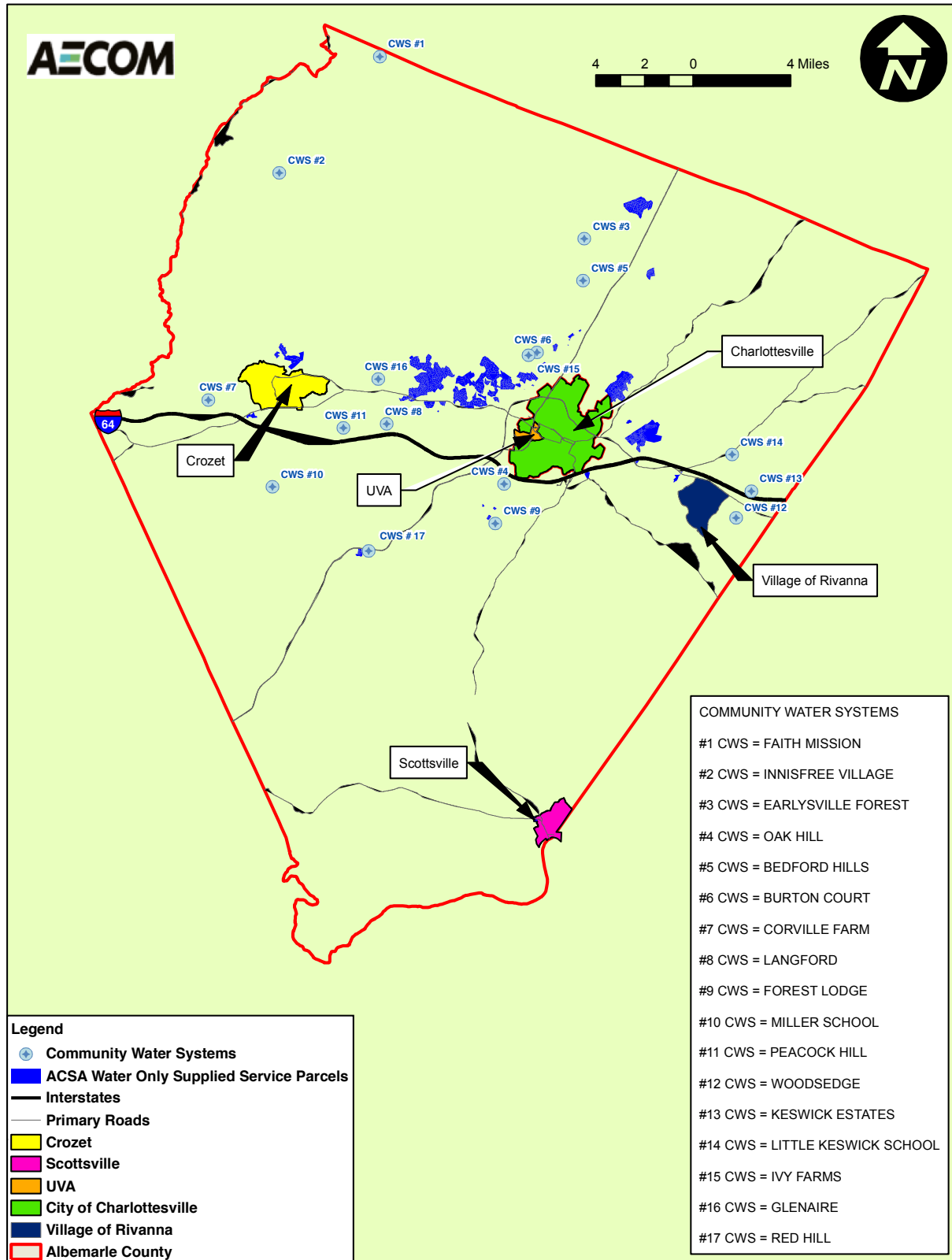
occur by 2060. There are a small number of undeveloped water-only parcels located just outside of the Crozet area that would be served by the same source of water. Of these undeveloped parcels, 80% were assumed to be developed by 2060 to remain consistent with the Master Plan. The water-only population (approximately 60 people) was added to the Master Plan population to determine the total Crozet water-service population.

- **Town of Scottsville**: The Town of Scottsville population forecasts were based on the 2010 Master Plan and information provided by the Town's Planning Commission.
- **CWS and self-supplied**: The population served by a CWS was based on the Virginia Department of Health (VDH) and Virginia Department of Environmental Quality (DEQ) records. As self-supplied water systems are designed based on a specific demand, the population served by the existing CWS systems is not expected to increase in the future. The current self-supplied population was calculated as the difference between the existing population in Albemarle County according to the 2010 US Census and the population that is served in one of the other character areas (Urban, Crozet, Scottsville, or CWS). The Albemarle County Board of Supervisors has set a future goal that 80-percent of the population resides within the urban growth areas (i.e., areas with water service). Currently, approximately 39-percent of the population in Albemarle County is self-supplied. This percentage was considered to decline to 30-percent of the population in Albemarle County by 2060, moving towards the 20-percent goal. To reach the 20-percent goal by 2060 would require either a decline in population in un-served areas, changes in the urban growth boundary, or changes in density in the urban growth boundary. These actions are outside of the scope of this study and therefore the percentage of 30-percent was used.
- **University of Virginia:** Population projections for UVA are included in the City of Charlottesville & ACSA Urban projections. The current and future population estimates for UVA were provided by the University of Virginia Academic Facilities Planning Department. UVA students live both on grounds and off grounds (both in the City of Charlottesville and in the ACSA Urban area). The current percentage of students living in the City of Charlottesville versus in the ACSA Urban area was provided by the University of Virginia Parking and Transportation Department and was expected to continue through 2060.

The population forecasts for the water demand study area are presented in Table 10 by character areas; urban, Crozet, Scottsville, and CWS. These population projections were compared to the projections developed by the Virginia Employment Commission through 2030. The forecasts used for this analysis are still within the reliable range as defined by the VEC[11].

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[11] VEC forecasts have not been updated to reflect the 2010 US Census results, per discussions with VEC staff.

Figure 12. Water-Only Service Parcels

COMMUNITY WATER SYSTEMS

#1 CWS = FAITH MISSION

#2 CWS = INNISFREE VILLAGE

#3 CWS = EARLYSVILLE FOREST

#4 CWS = OAK HILL

#5 CWS = BEDFORD HILLS

#6 CWS = BURTON COURT

#7 CWS = CORVILLE FARM

#8 CWS = LANGFORD

#9 CWS = FOREST LODGE

#10 CWS = MILLER SCHOOL

#11 CWS = PEACOCK HILL

#12 CWS = WOODSEDGE

#13 CWS = KESWICK ESTATES

#14 CWS = LITTLE KESWICK SCHOOL

#15 CWS = IVY FARMS

#16 CWS = GLENAIRE

#17 CWS = RED HILL

Legend
- Community Water Systems
- ACSA Water Only Supplied Service Parcels
- Interstates
- Primary Roads
- Crozet
- Scottsville
- UVA
- City of Charlottesville
- Village of Rivanna
- Albemarle County

Employment

Current employment data was based on the 2010 U.S. Department of Labor Quarterly Census of Employment and Wages (QCEW). Employment forecasts were not available through 2060. Most of the employment forecasts completed by the Virginia Employment Commission (VEC) and Weldon Cooper were for the near-term future (2018) and included a wider geographic extent than the Regional Water Supply Plan. The comprehensive land use plans, however, included a ratio of jobs per household and/or jobs per capita. Therefore, this ratio was used to project the future employment based on the future population forecasts.

- **Urban area**: The City of Charlottesville comprehensive land use plan did not include a ratio of employment per household or employment per capita, so one was developed. As the unemployment rate in 2010 is high at 7.7%, the ratio was based on an average of the employment per household for 2005 and the employment per household in 2010. The employment for 2005 and 2010 was based on the QCEW data and the 2005 and 2010 population was from the U.S. Census data. The resulting ratio was 1.95 jobs per household for the City. The 2010 Crozet Master Plan included the population per household ratios for both the Crozet area and for Albemarle County. The Albemarle County ratio of 1.22 jobs per household was used for the ACSA urban area.
- **Crozet**: The 2010 Crozet Master Plan ratio of 0.74 jobs per household was used.
- **Town of Scottsville**: An average historical employment rate of 175 employees was used for this analysis based on discussion with staff. This assumes that the tire manufacturing facility will be re-purposed at the average historical employment levels.
- **CWS and self-supplied**: The water demands for the population served by these systems were calculated using the per capita method and therefore future employment was not needed for this analysis.
- **University of Virginia:** Employment projections for UVA were included in the City of Charlottesville & ACSA Urban projections. Faculty and staff employment was provided for 2010 by the University of Virginia Academic Facilities Planning Department and future UVA employment was calculated based on the current faculty/staff to student ratio. UVA Health Systems Facility Planning provided hospital employment data for 2010. The hospital is planning on adding 150 beds by 2030 and the current staff to bed ratio was assumed to remain constant.

The results are presented in Table 11 and were submitted to and reviewed for accuracy by the stakeholders.

Table 10. Population Forecasts by Area (2010 – 2060)

Character Area [1,2]	2010	2015	2020	2025	2030	2035	2040	2045	2050	2055	2060
TOTAL	142,445	153,308	163,832	174,035	183,935	193,545	202,882	211,960	220,793	229,394	237,775
City of Charlottesville (Urban)	43,475	45,693	48,023	50,473	53,048	55,754	58,598	61,587	64,728	68,030	71,500
Albemarle County	98,970	107,615	115,809	123,562	130,887	137,791	144,284	150,373	156,065	161,364	166,275
ACSA Urban	53,492	58,914	64,223	69,412	74,477	79,411	84,206	88,857	93,355	97,692	101,862
Crozet	5,562	6,366	7,170	7,973	8,777	9,581	10,385	11,189	11,992	12,796	13,600
Town of Scottsville	618	649	680	712	743	774	806	837	868	900	931
CWS	2,611	2,611	2,611	2,611	2,611	2,611	2,611	2,611	2,611	2,611	2,611
Self Supplied	36,687	39,075	41,125	42,854	44,278	45,414	46,277	46,880	47,238	47,364	47,272
University of Virginia[3]											
UVA Students – Total	21,000	22,000	23,000	24,000	25,000	26,000	27,000	28,000	29,000	30,000	31,000
UVA Students – On Grounds	6,600	6,820	7,130	7,440	7,750	8,060	8,370	8,680	8,990	9,300	9,610
UVA Students – Charlottesville	9,300	9,680	10,120	10,560	11,000	11,440	11,880	12,320	12,760	13,200	13,640
UVA Students - County	5,100	5,500	5,750	6,000	6,250	6,500	6,750	7,000	7,250	7,500	7,750

Note:
1. 2010 population is based on the U.S. Census data.
2. Population forecasts are based on data provided by RWSA and the stakeholders during meetings held in Spring 2011.
3. The population for the University of Virginia is included in the City of Charlottesville and ACSA Urban area, as detailed here.

Table 11. Employment Forecasts by Area (2010 – 2060)

Character Area [1,2]	E:P Ratio[3]	2010	2015	2020	2025	2030	2035	2040	2045	2050	2055	2060
TOTAL		81,997	95,270	101,534	107,671	113,694	119,612	125,435	131,174	136,837	142,436	147,978
City of Charlottesville (Urban)	1.95	34,644	39,402	41,412	43,524	45,744	48,078	50,530	53,108	55,817	58,664	61,656
Albemarle County		47,353	55,868	60,122	64,147	67,950	71,534	74,905	78,066	81,021	83,772	86,321
ACSA Urban	1.22	45,540	53,689	57,689	61,461	65,011	68,342	71,460	74,368	77,069	79,567	81,864
Crozet	0.74	1,638	2,005	2,258	2,511	2,764	3,017	3,270	3,523	3,776	4,029	4,283
Town of Scottsville	NA	175	175	175	175	175	175	175	175	175	175	175
University of Virginia[4]												
UVA– Total		13,000	13,741	14,482	15,223	15,963	16,297	16,630	16,963	17,297	17,630	17,963
UVA Faculty/Staff		7,000	7,333	7,667	8,000	8,333	8,667	9,000	9,333	9,667	10,000	10,333
UVA Hospital		6,000	6,408	6,815	7,223	7,630	7,630	7,630	7,630	7,630	7,630	7,630

Note:
1. 2010 employment is based on the U.S. Department of Labor Quarterly Census of Employment and Wages data.
2. Employment forecasts are based on data provided by RWSA and the stakeholders during meetings held in Spring 2011.
3. E:P Ratio is the employment: population ratio used.
4. The population for the University of Virginia is included in the City of Charlottesville and ACSA Urban area, as detailed here.

Figure 13. Population and Employment Forecasts (2010 – 2060)
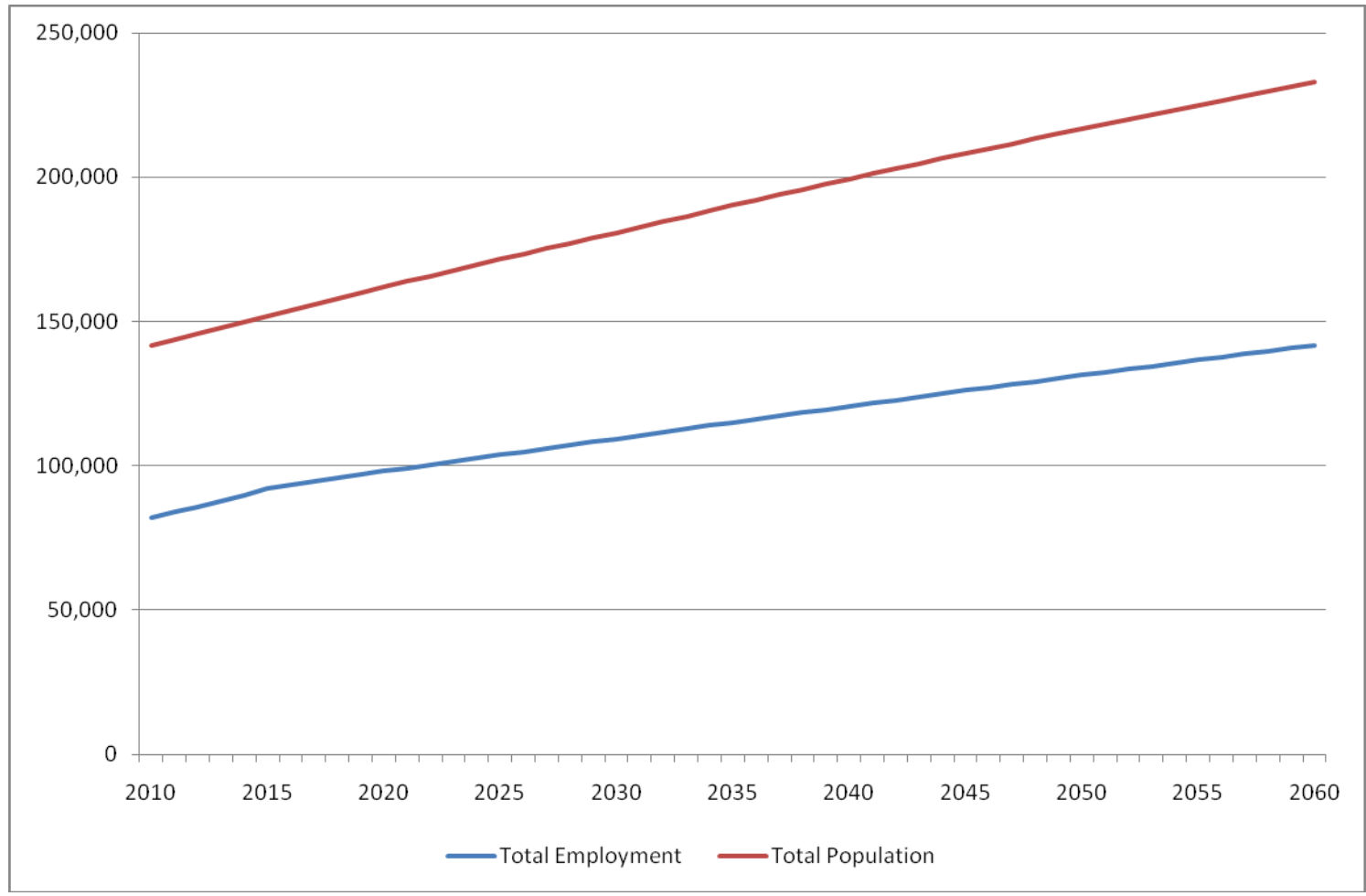
Baseline Water Demands

The draft baseline water demands represent the future water need if the existing trends remain constant into the future. The projected baseline demands were calculated by multiplying the population and employment from Table 3 by the residential per capita water use and per employee water use in Table 4, respectively, as shown in Figure 14. This number was multiplied by a percent non-revenue factor to yield the total baseline water demand. The water demands were developed for each of the four character areas; Urban, Crozet, Scottsville, and CWS. The Urban baseline water demand was further disaggregated into the City of Charlottesville, ACSA urban, and UVA areas.[12] The draft baseline water demands are shown in Table 12.

Figure 14. Baseline Water Demand Forecast Calculation

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[12] The number of persons served by the ACSA was calculated by multiplying the total number of residential accounts by 2.35, the average number of people per household for the City of Charlottesville based on the U.S. Census American Community Survey as a five-year average from 2006 to 2009.The number of persons served by the City of Charlottesville is assumed to be the total population in the City.

Table 12. Baseline Water Demands by Character Area for 2010 through 2060 (in MGD)

Character Area	2010	2015	2020	2025	2030	2035	2040	2045	2050	2055	2060
City of Charlottesville	5.14	5.62	5.91	6.21	6.53	6.86	7.21	7.58	7.96	8.37	8.80
ACSA Urban	4.81	5.40	5.86	6.31	6.75	7.17	7.57	7.96	8.34	8.69	9.03
Urban Total	9.95	11.02	11.77	12.52	13.27	14.03	14.78	15.54	16.30	17.06	17.83
Crozet	0.43	0.50	0.56	0.62	0.68	0.75	0.81	0.87	0.93	1.00	1.06
Town of Scottsville	0.08	0.08	0.08	0.09	0.09	0.09	0.09	0.09	0.09	0.10	0.10
Urban + Crozet + Scottsville Total	10.46	11.60	12.41	13.23	14.05	14.86	15.68	16.50	17.33	18.16	18.99
CWS	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22
Self Supplied	3.07	3.27	3.44	3.58	3.70	3.80	3.87	3.92	3.95	3.96	3.95
Regional Water Supply Plan Total	13.74	15.08	16.07	17.03	17.96	18.88	19.77	20.64	21.49	22.33	23.16
UVA[1]	2.24	2.35	2.46	2.58	2.69	2.78	2.87	2.96	3.05	3.14	3.23

Notes:
1. The UVA water demands are included in the City of Charlottesville and ACSA Urban water demands.

Water Demand Forecasts

The draft baseline water demands represent an extension of current trends and are a starting point for other considerations. Starting from the draft baseline water demand forecasts, several different scenarios were evaluated to determine the most representative draft future water demands. The scenarios evaluated in this section include:

- Water Conservation – Continue Implementation of Existing Programs – reflects continued demand reductions associated with the existing water conservation program as well as the demand reductions associated with the Energy Policy Act of 1992.
- Additional Water Conservation Initiatives - New Mandatory Programs – reflects additional water conservation programs to reflect a best-in-class conservation program.
- Increase in Population/ Employment – recognizes a potential increase in forecasted population and employment. Based on local trends, an increase of 5% in 2060 was used.
- Decrease in Population/ Employment - recognizes a potential decrease in forecasted population and employment. Based on local trends, a decrease of 5% in 2060 was used.
- Other Changes in Water Use Patterns – includes a discussion of changes that were considered but not calculated as part of the draft forecasts.

These scenarios are described in greater detail below followed by the resulting forecasted water demands.

Water Conservation – Continue Implementation of Existing Programs

This scenario includes continued demand reductions associated with the existing water conservation program as well as demand reductions associated with "passive" conservation through implementation of the National Energy Policy Act of 1992. This scenario also addresses future improvements in water efficiency associated with future mandates of more efficient fixtures.

The National Energy Policy Act of 1992 mandated that all new toilets installed after 1994 meet a minimum efficiency standard of 1.6 gallon per flush or more efficient. This scenario assumes that toilets installed prior to 1994 are replaced at a rate of 2-percent per year through "passive" conservation, as part of compliance with the National Energy Policy Act.

Information on the age of housing structures and estimates of the number of toilet fixtures per house were provided by both the City of Charlottesville and Albemarle County. Table 13 shows the number of toilets associated with pre-1994 homes.

Table 13. Estimated Number of Toilets in Homes Constructed prior to1994

Housing Stock Age	City of Charlottesville	Albemarle County
Pre-1994 (to be Replaced)	20,207	61,658
Post-1994 (Efficient)	3,369	30,992

Water efficient technologies are continuing to improve and currently, there are many communities (California and Atlanta, GA) which require 1.25 gallon per flush toilets by law, exceeding the current National Energy Policy Act. This analysis assumed that there will be a change in the National Energy Policy Act that will require 1.25 gallon per flush toilets at sometime during the 50-year planning horizon. For this analysis, toilets that are replaced after 2018 were assumed to be replaced with a 1.25 gallon per flush fixture.

In addition to this "natural conservation" or natural replacement, this scenario includes conservation savings associated with the voluntary toilet rebate program. The current replacement rate of 6-percent per year for the City of Charlottesville and 1.5-percent per year for ACSA were forecasted to continue.

Additional reductions associated with the continued implementation of the voluntary water conservation measures, water conservation education program, and outdoor watering schedules were not explicitly calculated. The savings associated with these programs are already factored into the per capita water use calculated based on the 2006 to 2010 water use.

The continuation of existing water conservation programs could result in a 3.9-percent reduction in total demand for the year 2060 compared to the baseline demand. This scenario assumes that toilets have previously been replaced at a nominal rate of 2-percent per year in addition to the rebated fixtures. The reduction in demand will be decreased if more toilets have historically been replaced.

Additional Water Conservation Initiatives – New Mandatory Programs

This scenario is intended to represent a "best-in-class" water conservation program, with new measures to be adopted, enforced and embraced that build on the existing water conservation measures. The new measures outlined in this section will require the support of the elected officials and the public as they include new mandatory water conservation programs as well as some new incentives that would require budget support. The cost of implementing these water conservation measures has been estimated based on available data. The new measures included in this example "best-in-class" water conservation program are outlined in Table 14. These savings will not be realized without adoption of enforceable policies. The Virginia Department of Environmental Quality would likely require copies of adopted ordinances or policies before relying on the decrease in demands reflected in this scenario.

The new water conservation program measures shown in Table 13 were selected based on reviewing commonly implemented water conservation programs successful in other communities and based on

the water use profile outlined in Tables 2, 4, and 5. There are a number of water conservation programs that could be implemented, but these new water conservation programs were considered to be representative of possible water conservation measures and were picked based on the water use by customer type and water use by end use analysis. A more comprehensive water conservation analysis could compare the individual cost and benefit of a wider range of water conservation measures, if there is strong support for additional measures.

Table 14. New Water Conservation Program Assumptions

Measure	Description	Area	Anticipated 2060 Savings	Anticipated Cost through 2060
Adopt Aggressive Conservation Rate Structure [1]	Currently ACSA has strong tiered rate structures that encourage water conservation. Adopting similar rates in the City of Charlottesville could encourage additional water conservation and may achieve up to a 5-percent water savings in 2060[13]. These tiered structures are typical for residential properties but occasionally apply to all customers.	Urban	0.18 MGD	$75,000
		Crozet	N/A	N/A
		Scottsville	N/A	N/A
New Multi-Family Sub-Metering Requirements [2]	Adopt new ordinances or policies that require new multi-family (MF) properties to sub-meter each unit. The *National Multiple Family Submetering and Allocation Billing Program Study* showed that sub-metering could reduce new multi-family water consumption by up to 15-percent[14].	Urban	0.13 MGD	$1,800,000
		Crozet	0.009 MGD	$140,000
		Scottsville	0.0003 MGD	$5,500
New Residential Water Efficiency Requirements [3]	Adopt new ordinances or policies that require that all new residential properties meet "best in class" water efficiency requirements. This requirement is modeled after the new EPA WaterSense New Homes program that projects a savings of up to 20-percent for new single-family residential properties[15].	Urban	0.66 MGD	$78,000,000
		Crozet	0.067 MGD	$8,000,000
		Scottsville	0.0022 MGD	$350,000

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[13] http://www.allianceforwaterefficiency.org/uploadedFiles/Resource_Center/Library/rates/White-Paper-Rate-Structures-and-Conservation-March-13-2009.pdf

[14] *National Multiple Family Submetering and Allocation Billing Program Study.* Aquacraft for East Bay Municipal Utility District, CA. 2004.

[15] U.S. EPA. WaterSense New Home Program. http://www.epa.gov/WaterSense/spaces/new_homes.html

Measure	Description	Area	Anticipated 2060 Savings	Anticipated Cost through 2060
New Residential Rebates for High Efficiency Clothes Washers [4]	Adopt a new rebate program ($100) to encourage purchase of higher water efficiency washers. The savings assume that 1-percent of owner-occupied households with washing machines will participate each year in the voluntary rebate program. The high efficiency washing machines are up to 45-percent more efficient[16].	Urban	0.14 MGD	$6,000,000
		Crozet	0.012 MGD	$500,000
		Scottsville	0.0009 MGD	$35,000
New Commercial Rebate for Cooling System Improvements [5]	Adopt a new rebate or tax incentive program ($600) to encourage improvements. On average, cooling tower retrofits may reduce the water needs by up to 20-percent for the inefficient systems that participate.	Urban	0.05 MGD	$10,000,000 - $40,000,000
		Crozet	0.002 MGD	$500,000 - $2,000,000
		Scottsville	0.0004 MGD	$150,000 - $600,000

Notes:
1. Costs for conservation rates include the estimated cost for a rate study for the City of Charlottesville.
2. Costs for the Multi-Family Sub-metering program reflect include cost to the local government (approximately 10%) and cost to the builder (approximately 90%) based on national averages. Assumes an additional cost to the government of $25/household for program administration and inspections and $250/household for the installation of a meter.
3. Costs for new residential water efficiency requirements reflect include cost to the local government (approximately 1%) and cost to the builder (approximately 99%) based on national averages. Assumes an additional cost to the government of $25/household for program administration and inspections and $3,000/household for the difference in development costs based on national estimates.
4. Costs for clothes washer rebates reflect include cost to the local government for the rebates (approximately 20%) and cost to the builder and/or homeowner (approximately 80%) based on national averages. Includes the cost to the local government of the $100 rebate and the additional cost of $350 paid by the homeowner for the new washing machine (assume a water efficient machine costs $600 and a non-efficient machine costs $200).
5. Costs for cooling tower rebates reflect the cost to the local government for the rebates (approximately 5-10%) and cost to the owner (approximately 90-95%) based on national averages. Includes the cost to the local government of $600 per rebate and the cost to the industry of $5,000 to $20,000.

The adoption of additional water conservation programs in addition to the continuation of existing water conservation programs could result in a 9-percent reduction in total demand for the year 2060 compared to the baseline demand. This scenario assumes that enforceable programs and policies have

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[16] http://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=CW

been adopted by the City Council and Albemarle County Service Authority Board of Directors and appropriate funding sources secured for implementation.

Population/Employment Increase

Albemarle County and the City of Charlottesville have recently begun a comprehensive land use planning process that will look more closely at future population and employment forecasts. This process, however, is expected to take multiple years and therefore the results will not be available until after the November 2011 Regional Water Supply Planning deadline. Given the potential for changes in the population and employment, this analysis considered both a potential increase and decrease in population and employment. If the results of the population and employment forecasts associated with the comprehensive land use planning process vary significantly from these estimates, the Regional Water Supply Plan should be reviewed and updated.

There are several potential sources for an increase in the 2060 population and employment forecasts such as the National Ground Intelligence Center, increased enrollment at UVA, increases in density, or increases in the urban growth boundary. Population and employment may also rise in the future as population and employment migrate inward from the coast. Studies indicate that the sea level is rising and the City of Charlottesville and Albemarle County could be a destination for inward migration[17].

This scenario considered a 0.1% per year increase in the forecasted population, or 5% by 2060. These population increases also translate into increases in employment. The population and employment increases in the year 2060 are shown in Table 15, along with some of the actions that could result in these increases. These actions primarily involve future increases to the urban growth boundary.

Table 15. Potential Increases to 2060 Population and Employment

Character Area	Population	Employment	Potential Sources
Charlottesville	+3,575	+3,083	Increased UVA enrollment Increases in density
Albemarle County[1]	+8,314	+4,316	National Ground Intelligence Center Changes in the Urban Growth Boundary
Urban - ACSA	+5,093	+4,102	Changes in the Urban Growth Boundary
Crozet	+680	+214	Increases in density
Scottsville	+47	0	Increases in density

Notes:
1. The Albemarle County population increase includes the increases listed for the ACSA Urban area, Crozet, and Scottsville.

The increase in population and employment scenario could result in a 4.1-percent increase in water demand for the year 2060 compared to the baseline demand. This scenario assumes that the adopted zoning and land use plans are consistent with the additional increase in population.

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[17] http://papers.risingsea.net/federal_reports/shore-protection-retreat-sea-level-rise-Virginia.pdf#page=52

Population/Employment Decrease

Similar to the increase in population and employment, it is possible that the population and employment forecasts have overstated future growth. The lower population and employment could be associated with changes to the urban growth areas or slower growth than forecasted. Some residents have urged the City of Charlottesville and Albemarle County to adopt policies to reduce the anticipated future population and employment, and feel that the growth forecast should be made on that basis. This scenario considered the corresponding decrease in population and employment of 0.1-percent per year, or 5% by 2060. Table 16 shows the potential decrease in 2060 population and employment and changes that could result in lower future water demand forecasts.

Table 16. Potential Decrease to 2060 Population and Employment

Character Area	Population	Employment	Potential Sources
Charlottesville	-3,575	-3,083	Density allowances not achieved UVA enrollment follows a true distance learning model Martha Jefferson hospital not fully utilized
Albemarle County[1]	-8,314	-4,316	Biscuit Run density is not "re-allocated" Slower than anticipated population growth
Urban - ACSA	-5,093	-4,102	Slower than anticipated population growth
Rural (Crozet)	-680	-214	Slower than anticipated population growth
Scottsville	-47	0	Slower than anticipated population growth

Notes:

1. The Albemarle County population increase includes the increases listed for the ACSA Urban area, Crozet, and Scottsville.

The decrease in population and employment scenario could result in a 4.1-percent decrease in water demand for the year 2060 compared to the baseline demand. This scenario assumes that growth is slower than previously anticipated and therefore the forecasted demands will occur beyond the 2060 planning horizon.

Other Changes in Water Use Patterns

There are other changes that were considered but not evaluated as there was little or no change anticipated. These potential factors should be periodically reviewed and re-evaluated as conditions in the regional water supply planning area change to the extent that future water demands are impacted.

- **Non-Revenue Water** – Currently, most of the RWSA service area has a very low percentage of NRW at 13-percent. This very low level of NRW will likely increase in the next 2 years associated with an increase in the preventative water line flushing program. RWSA will be changing operations to use chloramines for disinfection instead of free chlorine to comply with national safety standards. This change will require a more routine line flushing program to meet drinking

water quality standards. While increases are anticipated, the hope is that the ongoing leak detection and line replacement programs will maintain the current level of NRW into the future.

- **Per Capita Water Use** – The overall current per capita water use of 106 gpcd is very low compared to the national survey shown in Figure 6. Additional reductions in the per capita water use were considered, however the existing and future water conservation efforts effectively reduced the per capita water use and therefore additional manual reductions were not considered appropriate.

- **Per Employee Water Use** – The per employee water use could change substantially depending on the type of new industries or businesses in Albemarle County and the City of Charlottesville. If new employment is more water intensive, such as manufacturing or some research operations, the overall water needs will increase. As future employment information was not available in the level of detail needed, no adjustments were made to the per employee water use.

- **Outdoor Water Use** – Currently, the average outdoor water use is approximately 12% of total use. As discussed in the weather normalization section, the weather patterns are expected to continue to grow more dramatic with higher rainfall intensities and greater spacing between rainfall. The outdoor water use may increase as a result of these changes in weather patterns. As discussed previously, insufficient information is available to forecast the expected weather changes.

Water Demand Forecasts

The Virginia Local and Regional Water Supply Planning Regulation states that the regional water supply plan shall be designed to (i) ensure that adequate and safe drinking water is available" and to "(iv) promote conservation." With these goals in mind, the water demands associated with continuing implementation of the existing water conservation program are the minimum recommended for use in the Regional Water Supply Plan. These forecasts are based on the current zoning and land use plans and on currently adopted and enforceable water conservation measures. Continuing implementation of the existing water conservation program would likely yield the following human water demands by service area in 2060:

- Urban Service Area should plan for 17.01 MGD
- Crozet Service Area should plan for 0.98 MGD
- Scottsville Service Area should plan for 0.09 MGD
- The Community Water Systems should plan for 0.22 MGD
- The self-supplied area should plan for 3.95 MGD

As stated in AWWA M50, "all forecasts are inherently flawed." To this end, monitoring the demands over a period of many years and making adjustments as the trends in a community change is recommended. The Virginia Local and Regional Water Supply Planning Regulation requires that the demands be reviewed every 5 years and revised as necessary. If zoning changes are implemented and/or the more aggressive water conservation programs are implemented and shown to be successful,

then the water demands can be adjusted in future updates to the Regional Water Supply Plan. Similarly, if the higher per capita rates seen prior to 2003 return, the demands should be adjusted in future updates to the Regional Water Supply to reflect that change in conditions.

If the region would like to reduce these planned water demands, then ACSA and the City of Charlottesville would need to promptly adopt the ordinances and budgets needed to support the enhanced water conservation measures outlined in this report. The ACSA and City of Charlottesville would need to establish programs to monitor the water savings over a 10 year period to develop a basis for future forecasting efforts.

The basis and calculations for the water demand forecasts for each of the character areas are presented in individual profiles in Appendix A.

Table 17. Minimum Recommended Water Supply Planning Forecasts by Supply Area for 2010 through 2060 (in MGD)

Scenario	2010	2015	2020	2025	2030	2035	2040	2045	2050	2055	2060
Urban	9.95	10.80	11.41	12.05	12.71	13.39	14.09	14.80	15.53	16.26	17.01
Crozet	0.43	0.48	0.53	0.59	0.64	0.69	0.75	0.81	0.86	0.92	0.98
Town of Scottsville	0.08	0.08	0.08	0.08	0.08	0.09	0.09	0.09	0.09	0.09	0.09
CWS and self-supplied	3.28	3.48	3.65	3.80	3.92	4.01	4.09	4.14	4.17	4.18	4.17
TOTAL	13.75	14.86	15.69	16.53	17.37	18.20	19.03	19.85	20.66	21.47	22.25

Note: These forecasts reflect the Continued Implementation of Existing Water Conservation Program Scenario

Next Steps

The draft water demand forecasts will be revised based on the input provided at the Draft Forecast Workshop as well as additional data provided during office hours. The final water demand forecasts will be used in the Regional Water Supply Plan.

APPENDIX A: CHARACTER AREA PROFILES

City of Charlottesville (Urban)[18]

Description	2010	2015	2020	2025	2030	2035	2040	2045	2050	2055	2060
# of People	43,475	45,693	48,023	50,473	53,048	55,754	58,598	61,587	64,728	68,030	71,500
# Employees	34,644	39,402	41,412	43,524	45,744	48,078	50,530	53,108	55,817	58,664	61,656
Residential Per Capita	51.7	51.7	51.7	51.7	51.7	51.7	51.7	51.7	51.7	51.7	51.7
Employee Per Capita	66.5	66.5	66.5	66.5	66.5	66.5	66.5	66.5	66.5	66.5	66.5
Irrigation Per Capita	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Residential Demand (MGD)	2.25	2.36	2.49	2.61	2.75	2.89	3.03	3.19	3.35	3.52	3.70
Employment Demand (MGD)	2.30	2.62	2.75	2.89	3.04	3.20	3.36	3.53	3.71	3.90	4.10
Irrigation Demand (MGD)	0.002	0.002	0.002	0.002	0.003	0.003	0.003	0.003	0.003	0.003	0.003
Total Baseline Demand (MGD)	4.56	4.99	5.24	5.51	5.79	6.08	6.39	6.72	7.06	7.42	7.80
Total Baseline Demand + NRW (MGD)	5.14	5.62	5.91	6.21	6.53	6.86	7.21	7.58	7.96	8.37	8.80
Recommended Water Demand Forecasts[1]	5.14	5.54	5.78	6.04	6.34	6.66	7.00	7.36	7.74	8.15	8.57

Notes:
1. This scenario reflects the Continued Implementation of Water Conservation Program scenario.

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[18] The City of Charlottesville water demands include the University of Virginia water demands and these should not be summed.

University of Virginia (Urban)[19]

Description	2010	2015	2020	2025	2030	2035	2040	2045	2050	2055	2060
On Grounds Demand											
# of Students On Grounds	6,600	6,820	7,130	7,440	7,750	8,060	8,370	8,680	8,990	9,300	9,610
# of Faculty/Staff	7,000	7,333	7,667	8,000	8,333	8,667	9,000	9,333	9,667	10,000	10,333
# of Hospital Staff	6,000	6,408	6,815	7,223	7,630	7,630	7,630	7,630	7,630	7,630	7,630
Students On Grounds Per Capita	65.25	65.25	65.25	65.25	65.25	65.25	65.25	65.25	65.25	65.25	65.25
Faculty/Staff Per Capita	69.63	69.63	69.63	69.63	69.63	69.63	69.63	69.63	69.63	69.63	69.63
Hospital Per Capita	50.77	50.77	50.77	50.77	50.77	50.77	50.77	50.77	50.77	50.77	50.77
Student On Grounds Demand (MGD)	0.43	0.44	0.47	0.49	0.51	0.53	0.55	0.57	0.59	0.61	0.63
Faculty/Staff Demand (MGD)	0.49	0.51	0.53	0.56	0.58	0.60	0.63	0.65	0.67	0.70	0.72
Hospital Demand (MGD)	0.30	0.33	0.35	0.37	0.39	0.39	0.39	0.39	0.39	0.39	0.39
Total On Grounds Baseline Demand (MGD)	1.22	1.28	1.35	1.41	1.47	1.52	1.56	1.60	1.65	1.69	1.73
Total On Grounds Baseline Demand+ NRW (MGD)	1.38	1.44	1.52	1.59	1.66	1.71	1.76	1.81	1.86	1.91	1.95
Off Grounds Demand											
# of Students Charlottesville	9,300	9,680	10,120	10,560	11,000	11,440	11,880	12,320	12,760	13,200	13,640
# of Students ACSA	5,100	5,500	5,750	6,000	6,250	6,500	6,750	7,000	7,250	7,500	7,750
Students Charlottesville Per Capita	51.75	51.75	51.75	51.75	51.75	51.75	51.75	51.75	51.75	51.75	51.75
Students ACSA Per Capita	55.16	55.16	55.16	55.16	55.16	55.16	55.16	55.16	55.16	55.16	55.16
Student Charlottesville Demand (MGD)	0.48	0.50	0.52	0.55	0.57	0.59	0.61	0.64	0.66	0.68	0.71
Student ACSA Demand (MGD)	0.28	0.30	0.32	0.33	0.34	0.36	0.37	0.39	0.40	0.41	0.43
Total Off Grounds Demand (MGD)	0.76	0.80	0.84	0.88	0.91	0.95	0.99	1.02	1.06	1.10	1.13
Baseline											
Total UVA Demand (MGD)	1.99	2.09	2.19	2.29	2.39	2.47	2.55	2.63	2.71	2.79	2.87
Total Demand + NRW (MGD)	2.24	2.35	2.46	2.58	2.69	2.78	2.87	2.96	3.05	3.14	3.23

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[19] The UVA demands are included in the City of Charlottesville and ACSA Urban demand calculations and should not be added.

ACSA (Urban)[20]

Description	2010	2015	2020	2025	2030	2035	2040	2045	2050	2055	2060
# of People	53,492	58,914	64,223	69,412	74,477	79,411	84,206	88,857	93,355	97,692	101,862
# Employees	45,540	53,689	57,689	61,461	65,011	68,342	71,460	74,368	77,069	79,567	81,864
Residential Per Capita	55.16	55.2	55.2	55.2	55.2	55.2	55.2	55.2	55.2	55.2	55.2
Employee Per Capita	24.45	24.4	24.4	24.4	24.4	24.4	24.4	24.4	24.4	24.4	24.4
Irrigation Per Capita	3.84	3.84	3.84	3.84	3.84	3.84	3.84	3.84	3.84	3.84	3.84
Residential Demand (MGD)	2.95	3.25	3.54	3.83	4.11	4.38	4.65	4.90	5.15	5.39	5.62
Employment Demand (MGD)	1.11	1.31	1.41	1.50	1.59	1.67	1.75	1.82	1.88	1.95	2.00
Irrigation Demand (MGD)	0.21	0.23	0.25	0.27	0.29	0.30	0.32	0.34	0.36	0.38	0.39
Total Baseline Demand (MGD)	4.27	4.79	5.20	5.60	5.98	6.36	6.72	7.06	7.39	7.71	8.01
Total Baseline Demand + NRW (MGD)	4.81	5.40	5.86	6.31	6.75	7.17	7.57	7.96	8.34	8.69	9.03
Recommended Water Demand Forecasts[1]	4.81	5.27	5.64	6.00	6.37	6.74	7.09	7.44	7.79	8.12	8.43

Notes:
This scenario reflects the Continued Implementation of Water Conservation Program scenario.

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[20] The ACSA Urban water demands include a small portion of the University of Virginia water demands and these should not be summed.

Crozet (ACSA)

Description	2010	2015	2020	2025	2030	2035	2040	2045	2050	2055	2060
# of People	5,562	6,366	7,170	7,973	8,777	9,581	10,385	11,189	11,992	12,796	13,600
# Employees	1,638	2,005	2,258	2,511	2,764	3,017	3,270	3,523	3,776	4,029	4,283
Residential Per Capita	53.2	53.2	53.2	53.2	53.2	53.2	53.2	53.2	53.2	53.2	53.2
Employee Per Capita	43.7	43.7	43.7	43.7	43.7	43.7	43.7	43.7	43.7	43.7	43.7
Irrigation Per Capita	1.98	1.98	1.98	1.98	1.98	1.98	1.98	1.98	1.98	1.98	1.98
Residential Demand (MGD)	0.30	0.34	0.38	0.42	0.47	0.51	0.55	0.60	0.64	0.68	0.72
Employment Demand (MGD)	0.07	0.09	0.10	0.11	0.12	0.13	0.14	0.15	0.16	0.18	0.19
Irrigation Demand (MGD)	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.03
Total Baseline Demand (MGD)	0.38	0.44	0.49	0.55	0.60	0.66	0.72	0.77	0.83	0.88	0.94
Total Baseline Demand + NRW (MGD)	0.43	0.50	0.56	0.62	0.68	0.75	0.81	0.87	0.93	1.00	1.06
Recommended Water Demand Forecasts[1]	0.43	0.48	0.53	0.59	0.64	0.69	0.75	0.81	0.86	0.92	0.98

Notes:
This scenario reflects the Continued Implementation of Water Conservation Program scenario.

Scottsville (ACSA)

Description	2010	2015	2020	2025	2030	2035	2040	2045	2050	2055	2060
# of People	618	649	680	712	743	774	806	837	868	900	931
# Employees	175	175	175	175	175	175	175	175	175	175	175
Residential Per Capita	41.6	41.6	41.6	41.6	41.6	41.6	41.6	41.6	41.6	41.6	41.6
Employee Per Capita	204.8	204.8	204.8	204.8	204.8	204.8	204.8	204.8	204.8	204.8	204.8
Residential Demand (MGD)	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.04	0.04	0.04
Employment Demand (MGD)	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
Total Baseline Demand (MGD)	0.06	0.06	0.06	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
Total Baseline Demand + NRW (MGD)	0.081	0.083	0.084	0.086	0.088	0.090	0.091	0.093	0.095	0.096	0.098
Recommended Water Demand Forecasts[1]	0.08	0.08	0.08	0.08	0.08	0.09	0.09	0.09	0.09	0.09	0.09

Notes:

This scenario reflects the Continued Implementation of Water Conservation Program scenario.

Community Water Systems and Self-Supplied

Description	2010	2015	2020	2025	2030	2035	2040	2045	2050	2055	2060
Community Water Systems											
# of People	2,611	2,611	2,611	2,611	2,611	2,611	2,611	2,611	2,611	2,611	2,611
Residential Per Capita	83.57	83.57	83.57	83.57	83.57	83.57	83.57	83.57	83.57	83.57	83.57
Residential Demand (MGD)	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22
Total Baseline Demand (MGD	**0.22**	**0.22**	**0.22**	**0.22**	**0.22**	**0.22**	**0.22**	**0.22**	**0.22**	**0.22**	**0.22**
Self-Supplied (Private Wells)											
# of People	36,687	39,075	41,125	42,854	44,278	45,414	46,277	46,880	47,238	47,364	47,272
Residential Per Capita	83.57	83.57	83.57	83.57	83.57	83.57	83.57	83.57	83.57	83.57	83.57
Residential Demand (MGD)	3.07	3.27	3.44	3.58	3.70	3.80	3.87	3.92	3.95	3.96	3.95
Total Baseline Demand (MGD)	3.07	3.27	3.44	3.58	3.70	3.80	3.87	3.92	3.95	3.96	3.95
Baseline											
Total Baseline CWS & Self-Supplied (MGD)	3.28	3.48	3.65	3.80	3.92	4.01	4.09	4.14	4.17	4.18	4.17