CLEMSON
Strom Thurmond Institute

South Carolina Water Resources Center

Pickens County Water Supply Plan

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Prepared for the Pickens County Water Authority

20 February 2012

Acknowledgments

The authors thank the representatives of eleven Pickens County water districts and three Pickens County water wholesalers for their time and information, without which this report would not have been possible.

The authors thank representatives of the Pickens County Water Authority for their comments on earlier drafts, and the Beeson-Rosier Group for providing system capacity information. Representatives from the following organizations also gave insight into and/or provided supporting data, including:

- U.S. Geological Service
- S.C. Department of Health and Environmental Control, Bureau of Water
- S.C. Department of Natural Resources
- The Nature Conservancy
- Pickens County Planning Department and Assessor
- Carnegie Mellon University Green Design Institute

The authors thank the following graduate students in the Clemson University Master of City and Regional Planning program for the work on the baseline portion of this report: Fred Combs, Ben Fields, Samantha Jackson, Mary Kathy Johnson, Alissa Kitzo, Guong Miao, Leah Sirmin, and Tamara Tavaros.

The authors also thank Sandra L. Sanderson for report design, layout, and copyediting.

EXECUTIVE SUMMARY

With growing population in Upstate South Carolina and on the Georgia side of the Savannah River headwaters, as well as increasing drought frequency and reliance on interbasin transfers, the Pickens County Water Authority commissioned the South Carolina Water Resources Center in Clemson University's Strom Thurmond Institute in 2009 to generate a 20 year water supply and demand plan for Pickens County, South Carolina. The project team was tasked to do the following, contingent on data availability and quality:

an assessment of existing supply (including existing resource constraints, historic and current use trends for all sectors, facilities capacity for treatment and storage in the PCWA member agencies' systems (e.g. location and capacity through GIS), supply sources (surface, groundwater or inter-basin transfer), and emergency interconnection sources);

a basic demographic profile for Pickens County, projecting population growth, land use change and economic change in 2010, 2020, and 2030; and

water demand forecasting based on land use change and sectoral projections with two scenarios, accounting for basic conservation measure assumptions.

The existing supply assessment showed that the majority of the water supply for Pickens County comes from surface water, through precipitation that is captured in local reservoirs and lakes. Precipitation levels have been historically decreasing, while temperature is gradually increasing and the drought frequency and duration are increasing. Consequently, water availability will be a growing issue in the area. The primary sources for Pickens County water purveyors include Lakes Keowee and Hartwell, and to a lesser extent, from Saluda and City Lakes, and Twelve Mile Creek.

The county straddles two basins, with water moving across the county from west to east, and a significant volume transferred through an interbasin transfer outside of the county (22.22 million gallons per day (MGD)). Constraints to water movement are physical and legal, as well as financial.

The twelve purveyors in the county sell amongst themselves, with purchases varying by purveyor's service area size and sectoral composition. Purchases ranged from 21,500 GPD to 8,876,000 GPD per purveyor in 2008. There are three purveyors whose service areas extend outside of the county boundaries. They were unable to differentiate the volume of their purchases that were consumed within the Pickens County part of their service area, and the volume consumed in the remainder of their service area.

The total consumption in Pickens County was 17.45 MGD in 2008, although some percentage of that figure is actually consumed outside of the county (Southside, Powdersville, and Highway 88's service areas).

Although most of the purveyors' service areas are metered, they were unable to assign consumption averages to the different water use sectors. This created a problem in the demand forecasting section of the report. Depending on purveyor, there was appreciable system water loss that ranged from three to 37 percent of their total purchases.

The county-level water budget showed a net positive supply (128.2 MGD) that incorporated inputs from precipitation, septic systems, NPDES permits, and imported water, as well as outputs from export, surface and groundwater consumption, evapotranspiration, and natural stream flow. There is a positive supply to meet the existing needs.

To examine the future demand, the project team used a novel approach. Demand is often generated on a per capita basis, but that can severely underestimate needs, particularly in less populated areas. So the team projected the land use and economic growth sectors to determine where and the kinds of demands anticipated for Pickens County. Using a land use change model that relied on population as an input, the team determined where and when (in decadal increments) the undeveloped acreage would become developed.

The growth model was projected from 2000, and the 2010 growth basically matched existing use locations, confirming the model's accuracy in predicting growth further out in time. It is important to note that the model was not determining the kind of land use—merely the change from undeveloped to developed. The projected growth locations were compared with the current system capacity (through water line location and their size), showing that the infrastructure is basically in place to support anticipated future growth. The pixels of land use change were converted to acreage from 2010 through 2030 at the purveyor service area level.

Using the Pickens County Planning Department's projected land use character areas and parcel level actual use from the county assessor's office, the project team created its own use categories with associated densities (i.e. low to medium residential, which ranged from one to five units per acre; high density residential, at 20 units per acre; commercial; industrial; protected; and another category, which included land uses such as permanent right of ways, etc.). These were projected linearly, with several assumptions included in the Appendices.

The predominant developed land use in Pickens County in 2030 is low density residential, with 71,257 acres in 2030. Six Mile and Dacusville Cedar-Rock service areas will receive the most low density residential growth.

In order to quantify demand based on land use, the project team again used a novel approach. Relying on a New Economic Geography model, the Regional Dynamics Economic Model (REDYN) generated value in 2008 dollars of economic output on an annual basis from 2001 through 2030 for commercial and industrial sectors in Pickens County. In 2030, the highest value of output was projected to be from computer and electronics manufacturing, textile mills, machinery manufacturing, and fabricated metal product manufacturing. Combined with another input-output model, the Carnegie Mellon Economic Input-Output Life Cycle Assessment tool, the project team was able to project 2030 industrial and commercial demand, which were 2.30 and 1.64 MGD, respectively.

Residential demand was linearly projected through two forecast scenarios, using a modified demand modeling equation that relies on number of units per sector and class. The two residential densities were based on zoning in Rock Hill, South Carolina, and were one unit per acre for the low to medium density residential and 20 units per acre for the high density residential.

Since the purveyors were unable to determine their daily sectoral or class use, the project team summed the total units by purveyor from the land use change projections, and divided the daily consumption with the unit count. Purveyors with more than 95 percent low density residential in their service area were isolated to garner to low density residential consumption (since it was the majority of the residential land use type). Averaging after dropping an outlier generated 234.1 gallons per day per low density residential unit, and high density residential was determined to be 152.2 gallons per day, based on a ratio from Vickers (2001).

Total 2030 residential demand was projected to be 20.46 MGD across the county. The demand forecasting approach was generated for 2010 so that it could be checked for predictive accuracy, and showed 14.49 MGD total demand for consumption in the county. This is lower than the daily purchase figure of 17.45 MGD, but the total purchases include water used outside of the county in three service areas, and doesn’t account for considerable system leakage. Additionally, there is more variation in the residential densities across the county than one or 20 units, so the demand may be underestimated.

Total demand in Pickens County across all sectors is predicted to be 32.74 MGD. The conservation scenario was admittedly conservative, relying primarily on technology replacement (i.e. toilets), and reduced the total county 2030 demand to 31.21 MGD. It could be bolstered with additional programs.

Overall, the report does not project supply availability because there are climate models currently under development at the University of South Carolina that should inform the local effects of climate change in Upstate South Carolina.

This report shows that there is a current net positive water budget, but that the demand in 2030 is almost double the current purchases in the county (and more than double from the 2010 demand projection), with the primary driver from the residential sector.

Pickens County water management can be improved in the following ways, both at the purveyor and county levels:

- implement increasing block rate structures for demand management and efficiency,
- combine the tiered rate structure with other non-price demand management strategies,
- increase efficiency in water distribution,
- incorporate climate scenarios into future water demand forecasts,
- maintain sectoral and class usage data by month and year, and
- improve overall recordkeeping to establish a baseline for future demand and supply projections.

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INTRODUCTION

Water supply, and its corresponding management, are becoming increasingly important throughout the country, as climate change is projected to alter both the timing and volume of precipitation and snowpack (NRC 2010).Although the Southeastern states have traditionally enjoyed ample water supply, virtually every state has now experienced varying degrees of drought over the past twenty years. And the droughts are likely to become more prolonged and deeper through 2100 for the Southeast and particularly the Southwest (NRC 2010).

While the Southeastern issues are not comparable in scale or longevity to those in the western U.S., there are enduring and increasingly common water management conflicts occurring east of the Mississippi. These generally involve tensions between sectoral users, particularly urban demand and environmental flow protection for endangered species, evidenced by the on-going ACT/ACF conflict between the states of Georgia, Florida, and Alabama (Jordan and Wolf 2006; In re Tri-State Water Rights Litigation 2009).But they are also starting to escalate into tensions within sectors, between urban communities who seek to preserve the option to grow (e.g. the *South Carolina v. North Carolina* parens patriae lawsuit (Dyckman 2011)).This is in part because of a growing Southeastern population, particularly in Georgia, North Carolina, and South Carolina (Stafford 2011). Adaptation, coupled with mitigation strategies, will allow these states to maintain their growth rates while increasing the efficiency of their water use and managing for all water use sectors.

Adaptation and mitigation start with sound water supply and demand planning. Water supply planning has been occurring in many states around the country for decades. South Carolina's neighboring states have been implementing some form of water supply planning throughout the entire state and at the local level for the past eight to thirteen years.

North Carolina adopted legislation in 1989 mandating both state and local level water supply planning (N.C. Gen. Stat. §143-355).In response to the extreme drought starting in 1989 and extending through 2002, the state also instituted 50-year river basin supply planning, using commissions and stakeholder groups. The North Carolina Division of Water Resources started with the Yadkin-Pee Dee and Catawba basins (N.C. Division of Water Resources 2011).

In 2004, the Georgia state legislature adopted the Comprehensive State-wide Water Management Planning Act, which mandated the creation of a state-level water supply plan (O.C.G.A. §12-5-522). In a coordinated effort, the 2008 state-level plan then established 10 regions and mandated regional water supply planning, with support from the Georgia Environmental Protection Division and the Georgia Water Council. The regional plans were developed and submitted in September 2011.

In 2010, South Carolina adopted a regulated riparian system effective in 2011, which institutes a permitting process for withdrawals equivalent to or greater than 3 million gallons per month from all of its surface water sources. This legislation subsumed the previous interbasin transfer statute, grandfathering existing approved transfers under their effective renewal dates. At that time, their renewal review will be conducted according to the criterion for existing surface water withdrawers (S.C. Code Ann. § 49-4-70(C)).While the legislation is a significant shift toward more efficient water management in the state, the state still lacks a statutory mandate for local or regional water supply planning. And yet, this is clearly a need that South Carolina's neighboring states have acknowledged, given the growth in the upper portion of the seminal Savannah River watershed, and the projected climate change impacts.

Even without statutory mandate, the Pickens County Water Authority realized the growing need for regional water supply planning and asked the research team in the Water Resources Center at Clemson University to generate a county-level water supply plan. The team was comprised of a planning professor, the director of the Water Resources Center, a GIS specialist, a researcher in the Water Resources Center, two master's students in city planning and a policy studies Ph.D. student.

SECTION 1: PHYSICAL CHARACTERISTICS

Pickens County is located in the Upstate region of South Carolina, bordered by the Appalachian Mountains to the north, the rolling hills of the Piedmont to the east and south, and lakes Hartwell, Keowee, and Jocassee to the west, which dam the upper part of the interstate Savannah River (Figure 1). Pickens County is considered the Piedmont region of the Southern Blue Ridge Escarpment.

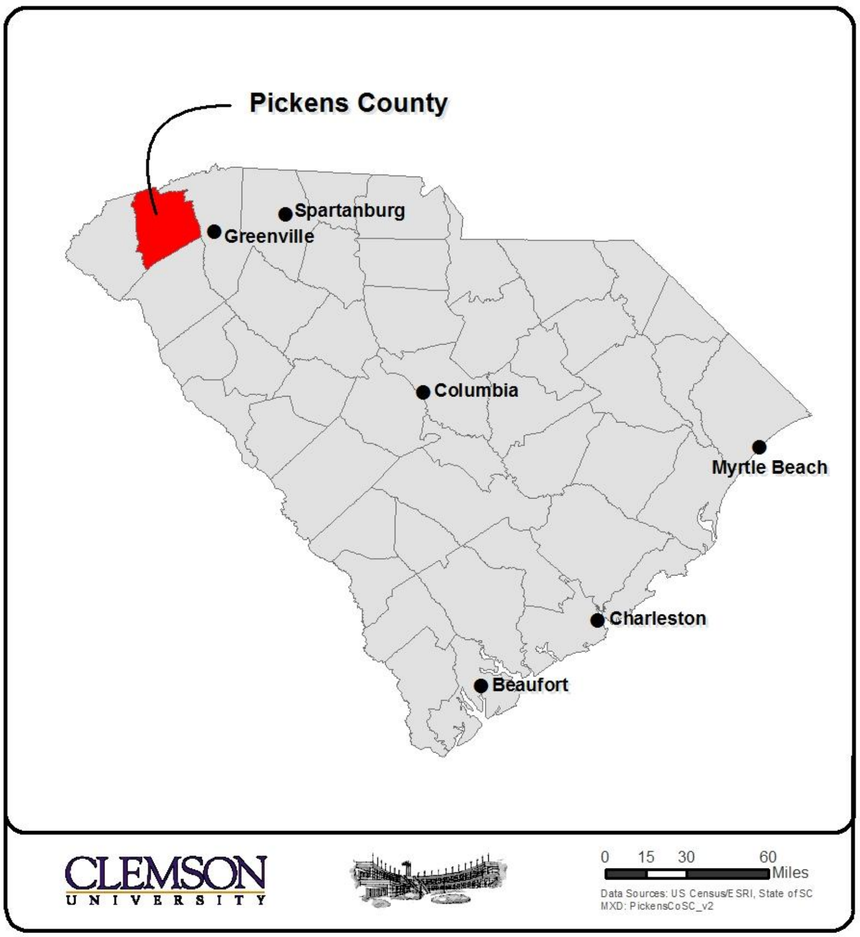


Figure 1: Map of Pickens County Location within South Carolina

Figure 2 shows the location of major roads and urban boundaries within Pickens county. The majority of the urban development follows the highway corridors, particularly US 123 and US 178, which includes the cities/towns of Central, Clemson, Easley, Liberty, Norris, Pickens, and Six Mile. The City of Pickens, the county seat and the northernmost city, is located at the convergence of SC 8 and US 178. One of the state's major public universities, Clemson University, is located within the county, at its southwestern edge.

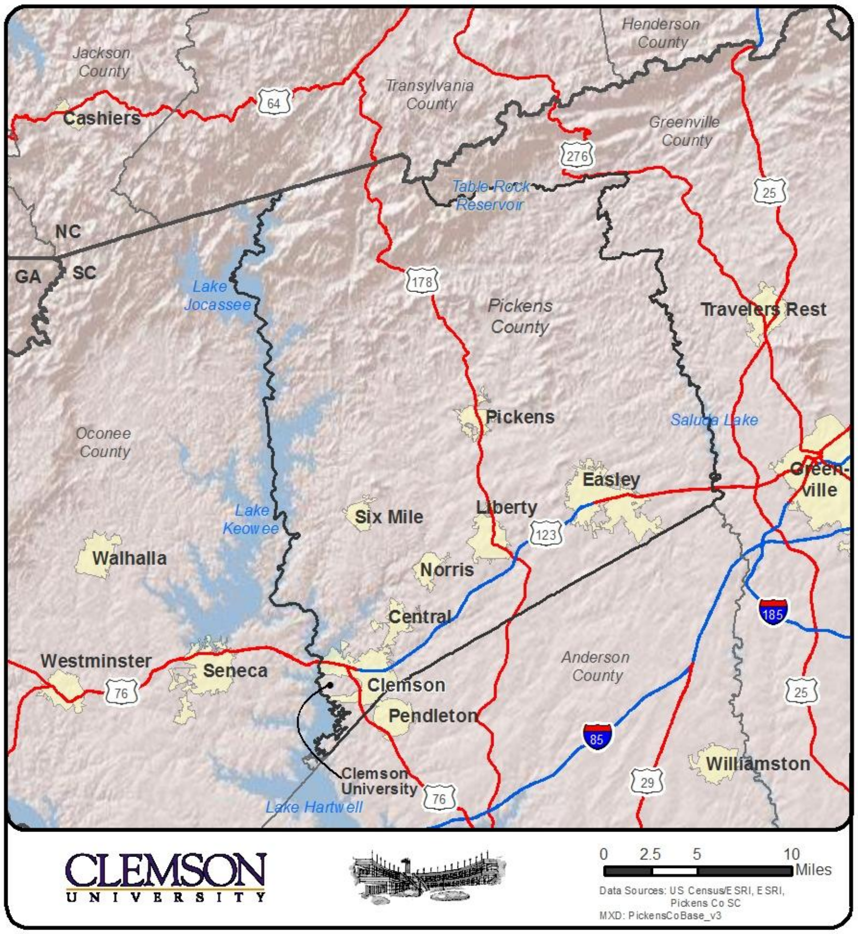


Figure 2: Pickens County Base Map

As Figure 3 illustrates, while the southern part of the county is increasingly urbanized, the northern one-half of the land area remains in protected lands and relatively rural land uses. Adjacent counties and communities with whom Pickens County shares water resources are urbanizing more rapidly, including Greenville County to the east, and Anderson County to the south. Oconee County lies to the west of Pickens County.

Land uses in Pickens County significantly affect both water quality and quantity. Agriculture is one of the largest contributors to non-point source runoff pollution (being exempt from the Federal Clean Water Act); non-point sources such as urban stormwater runoff are others. Land uses also influence water demand, as thermoelectric power generation and agricultural irrigation remain the largest water users nationally; followed by public supply and industrial uses (Barber 2009).Thermoelectric uses are primarily non-consumptive, while the others are consumptive.

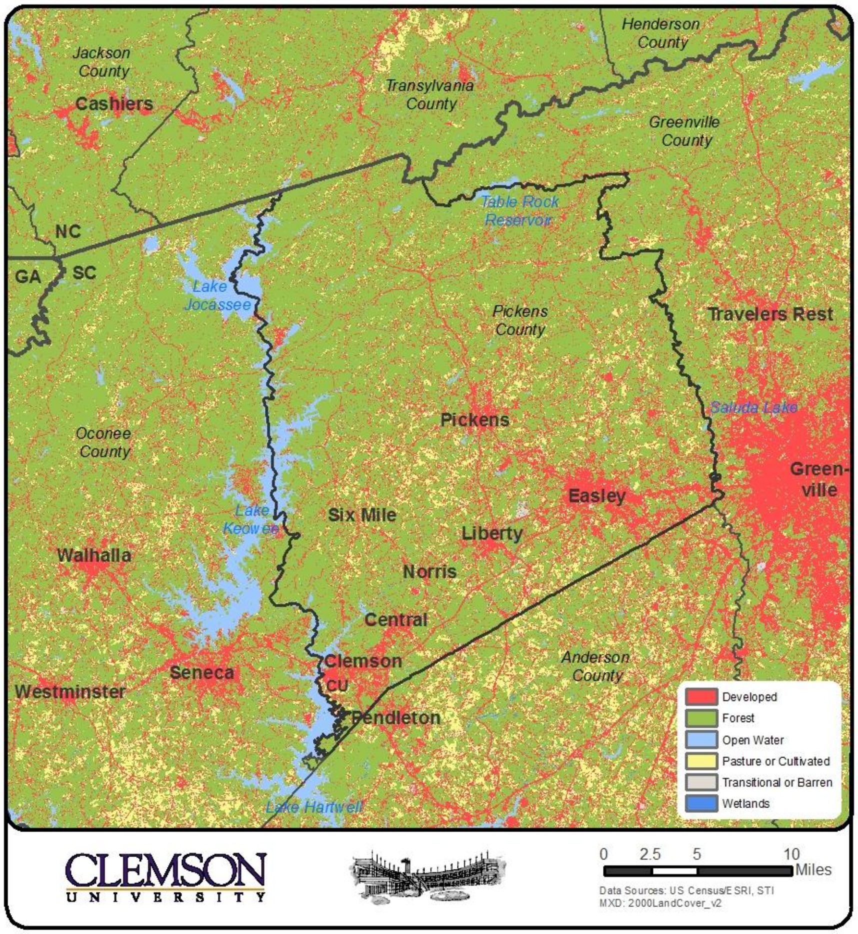


Figure 3: Pickens County Land Cover

Figure 4 shows the 2011 parcel level land use, categorized from the county assessor's office records. There are numerous vacant parcels, which likely fall into agricultural uses, as well as a substantial volume of low-to-medium density residential parcels (which may also contain agricultural uses) throughout the county.

The following physical characteristics are important natural inputs into the water cycle, affecting water supply and demand in Pickens County. They also contribute to the baseline for demand forecasting.

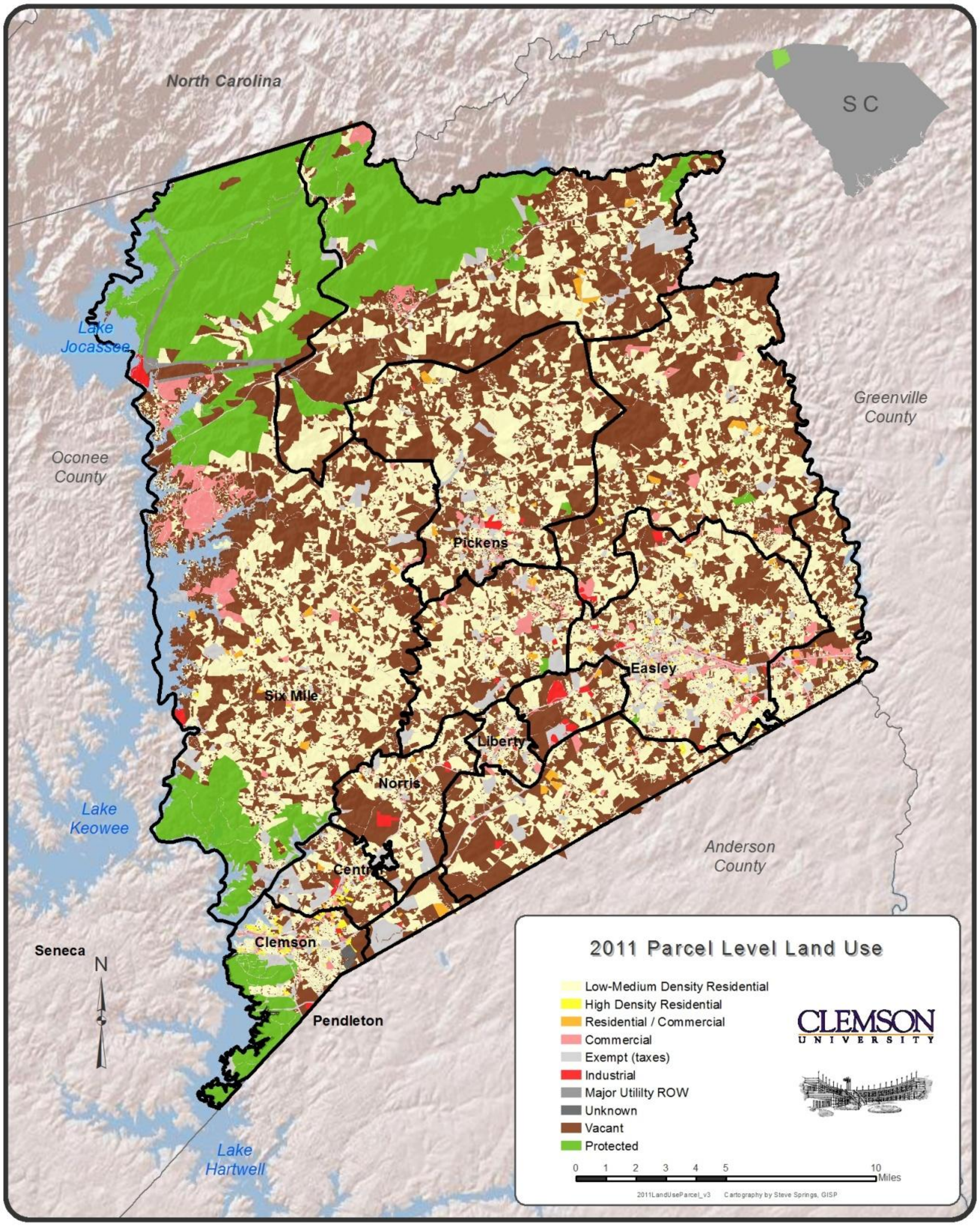


Figure 4: Parcel Level Land Use

WATERSHEDS

Pickens County bridges two of South Carolina's official watersheds. The Saluda watershed is located in the eastern third of the county land area, and the Tugaloo/Seneca River watershed, which is part of the larger Savannah River watershed, comprises the majority of the remainder of the county (Figure 5).

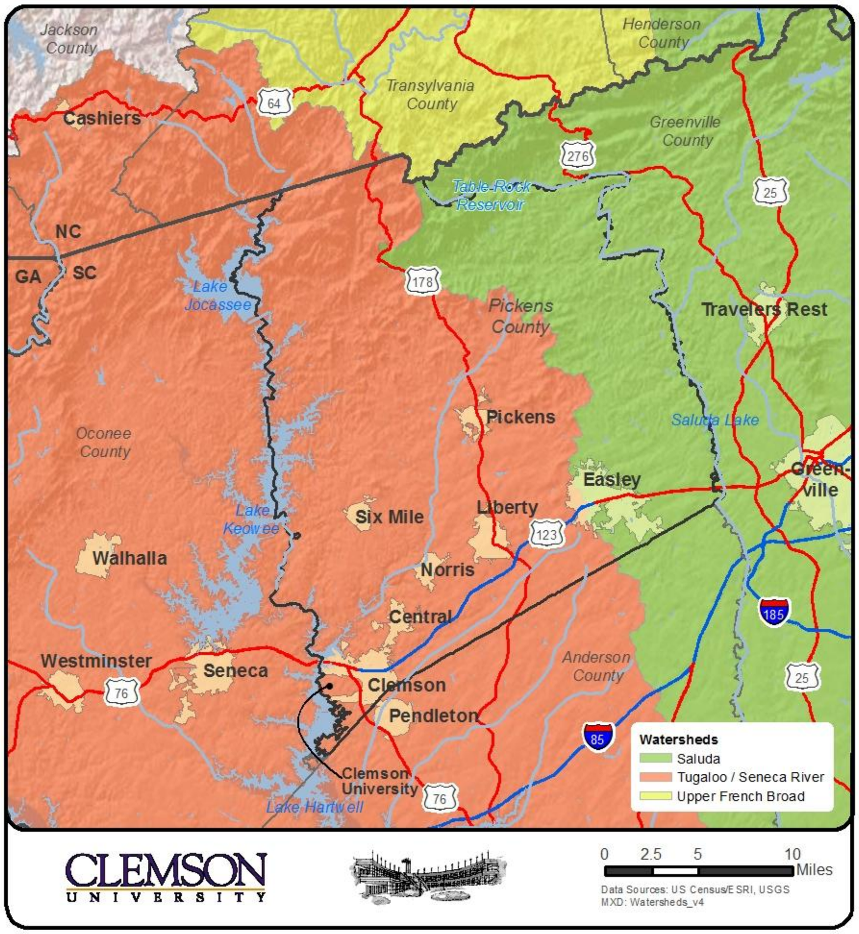


Figure 5: Major Watersheds in Pickens County, SC

PHYSICAL WATER SOURCES

Pickens County has a number of water bodies that feed its two watersheds, including streams, rivers and natural and man-made lakes (Figure 6). In the western area, the county contains important tributaries to the Savannah River, including the Toxaway River, Keowee River, Seneca River, Twelve Mile Creek, and Eighteen Mile Creek, which affect both water quality and quantity in the receiving reservoirs, also known as Lakes Hartwell, Keowee and Jocassee. Bridging two watersheds means that the movement of water across the county involves an interbasin transfer under South Carolina law, which has the potential to affect supply assurance (S.C. Code Ann. § 49-4-70(C)). Any withdrawal equivalent to or exceeding three million gallons per month must be permitted through the new state-level process (S.C. Code Ann. §§ 49-4-20(28) & 49-4-70(A)).

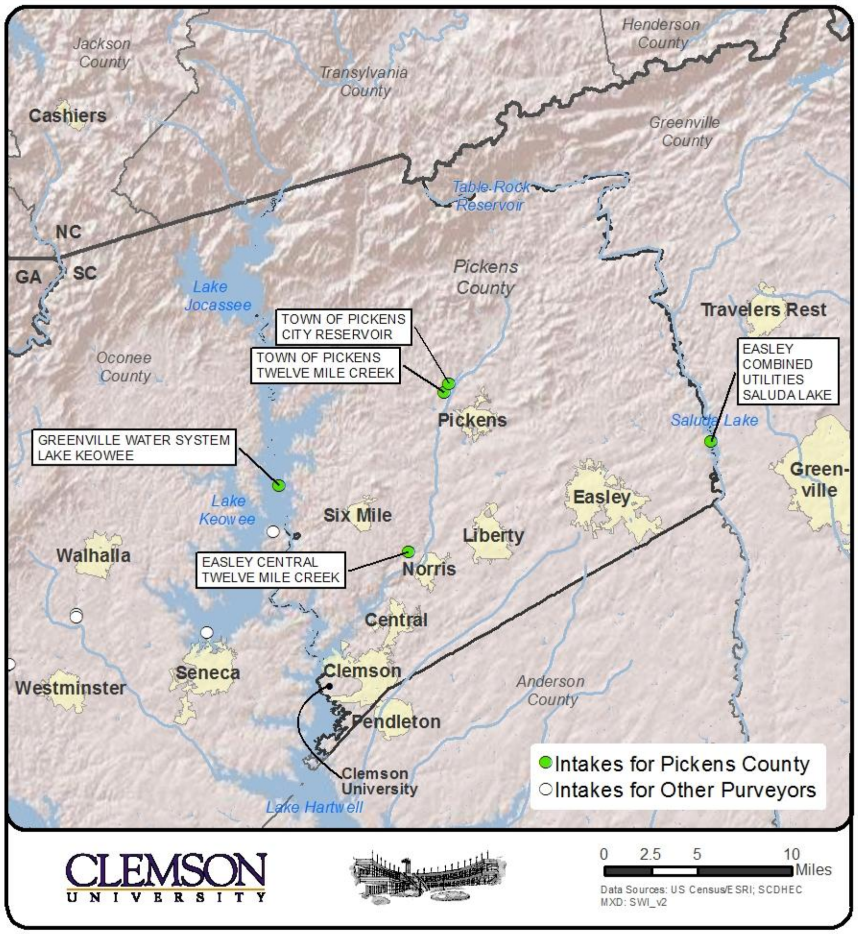


Figure 6: Pickens County Water Sources

Pickens County land uses have more import than they might otherwise, given the number of tributaries within the county that affect the lakes, which provide drinking water for Upstate South Carolina and populations on both sides of the Savannah River. The western portion of the county has access to large amounts of surface water located primarily in Lake Keowee as well as Lake Jocassee and a portion of Lake Hartwell, which are the primary drinking water sources for the Pickens County purveyors. There is also some reliance on Saluda and City Lakes in the middle and eastern parts of the county. There is significant water storage available in Lakes Keowee and Hartwell however, not all of this water is available for consumptive use. The primary source of water is from surface water; there is minimal groundwater supply (Badr et al. 2004).

Temperature directly affects water supply (and associated management) by altering rates of evaporation from plants (aka evapotranspiration), water bodies, and even soils (NRC 2010). It also directly affects water quality, as lower volume levels and increasing ambient temperature raises water temperature, creating thermal pollution that decreases dissolved oxygen and adversely impacts riverine ecosystems. As ambient temperature changes in response to climate change, regional water cycles are projected to be impacted.

Historic records are a starting point to begin to anticipate future temperatures for the county, and as a result, water supply and demand fluctuations. According to the Southeast Regional Climate Center's records for Pickens County, June, July, and August consistently experience the highest average temperatures, while December, January, and February are generally the lowest in average temperatures. The annual average maximum temperature is 71.7°F, and the annual average minimal temperature is 49.2 °F (Table 1). The average total snowfall is only 2.9 inches per year. There is no reliable snowpack, but based on the average annual maximum temperature, the area is not arid.

Table 1: Climate Summary of Pickens County (1951-2010)

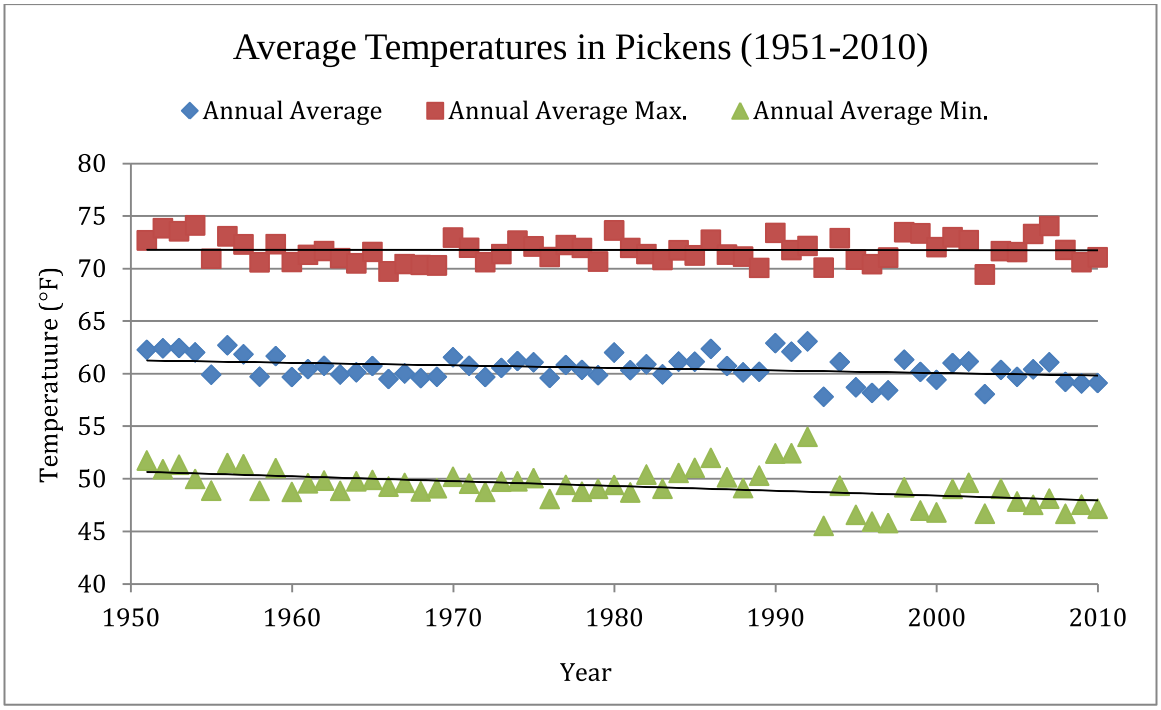
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Avg. Max. Temp. (F)	52.2	56.0	64.2	73.3	79.9	86.2	88.9	88.0	82.2	72.9	63.1	53.8	71.7
Avg. Min. Temp. (F)	31.0	33.3	40.0	48.1	56.2	63.6	67.1	66.7	61.0	50.0	40.4	33.3	49.2
Avg. Total Snow (in.)	1.1	0.8	0.5	0	0	0	0	0	0	0	0.1	0.4	2.9
Avg. Snow Depth (in.)	0	0	0	0	0	0	0	0	0	0	0	0	0

Source: Southeast Regional Climate Center's Period of Record Data Tables, Monthly Tabular Data

Shown by the trend lines in Figure 7, the annual average temperature in Pickens County has decreased slightly in the last 50 years, while the average maximum temperature has remained even and the average minimum temperature has decreased.

Precipitation is the primary input into the water cycle for Pickens County, and for the Southeastern region more generally. Figure 8 shows that precipitation levels in the county for the past 60 years are very gradually declining, with the highest precipitation at 78.46 inches in 1964, and the lowest at 33.4 inches in 1981.

Even if overall precipitation volumes don't change appreciably over decades, their timing and the intensity of storm events will affect all sectoral uses, particularly those that rely on a steady volume for survival. Although it is still difficult to predict regional effects of climate change on precipitation,[1] the following trend is anticipated:



Source: Southeast Regional Climate Center's Period of Record Data Tables, Monthly Tabular Data

Figure 7: Annual Average Temperature in Pickens County (1951-2010)

"A higher fraction of rainfall is expected to fall in the form of heavy precipitation events as temperatures increase, and in many locations such a shift has already been observed (see also CCSP, 2008f; Bates and Kundzewicz, 2008).Higher temperatures are also projected to increase soil and surface water evaporations, producing overall drier conditions even if total precipitation remains constant. Higher temperatures and runoff from intense rainfall can both negatively affect the physical and chemical characteristics of freshwater and thus water quality" (NRC 2010, 258 – 259).

The historical trends reveal that March is the wettest month, followed by January, December and February in average precipitation (Figure 9). The average annual precipitation in Pickens is 59.93 inches.

Temperature affects evaporation rates from water bodies, soil, and plants. Unfortunately, records were not available beyond 1992 from Clemson University on average monthly pan evaporation rates from water sources in Pickens County. But there exists a lengthy record on which to base future patterns (Table 2).

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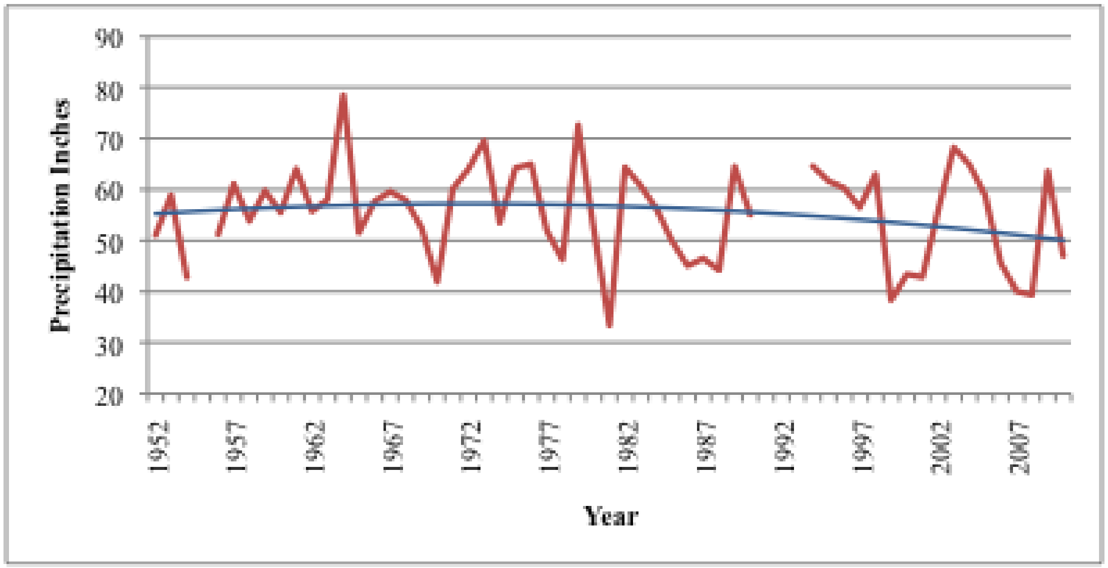
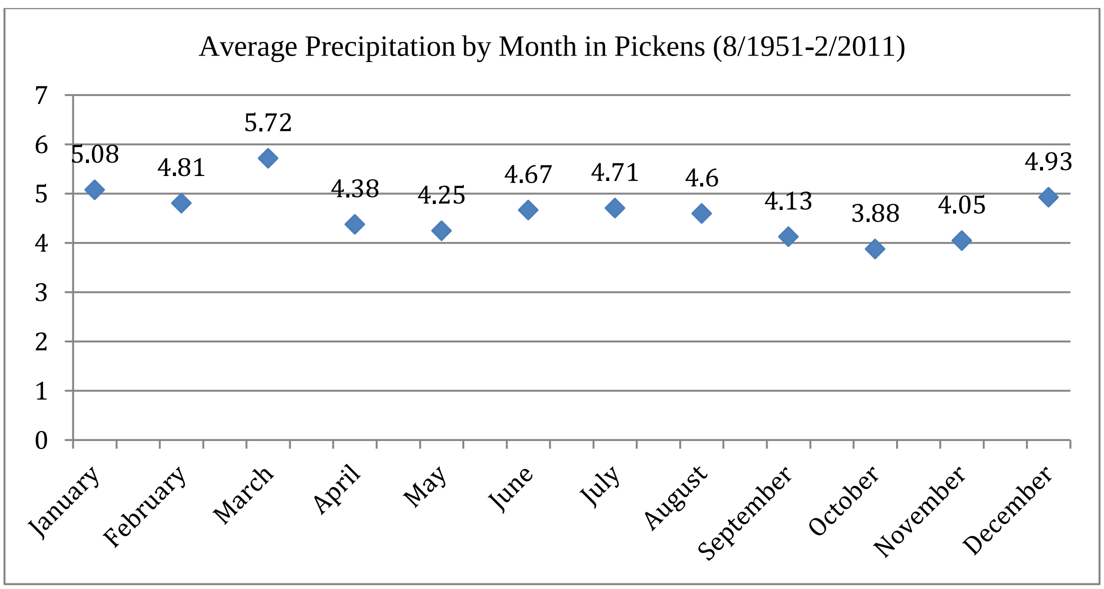
[1]There is on-going work at the University of South Carolina to generate models that predict these regional effects of climate change. However, they have not yet been completed. When they are, this plan should integrate the model for the Upstate to more accurately predict climate effects on precipitation and overall water supply availability.



Source: Southeast Regional Climate Center, Historical Climate Summaries for South Carolina

Figure 8: Pickens County Precipitation Trend



Source: Southeast Regional Climate Center's Monthly and Seasonal Climate Information.

Figure 9: Average Precipitation by Month in Pickens County

Temperature affects evaporation rates from water bodies, soil, and plants. Unfortunately, records were not available beyond 1992 from Clemson University on average monthly pan evaporation rates from water sources in Pickens County. But there exists a lengthy record on which to base future patterns (Table 2).

Average annual pan evaporation from Pickens County water sources is 51.67 inches over the 43 year record between 1950 and 1992. When analyzed by decade, annual evaporation decreased after 1980. Monthly pan evaporation is highest in June and July and lowest in December and January.

Table 2: Average Monthly Pan Evaporation in Pickens County (1950-1992)

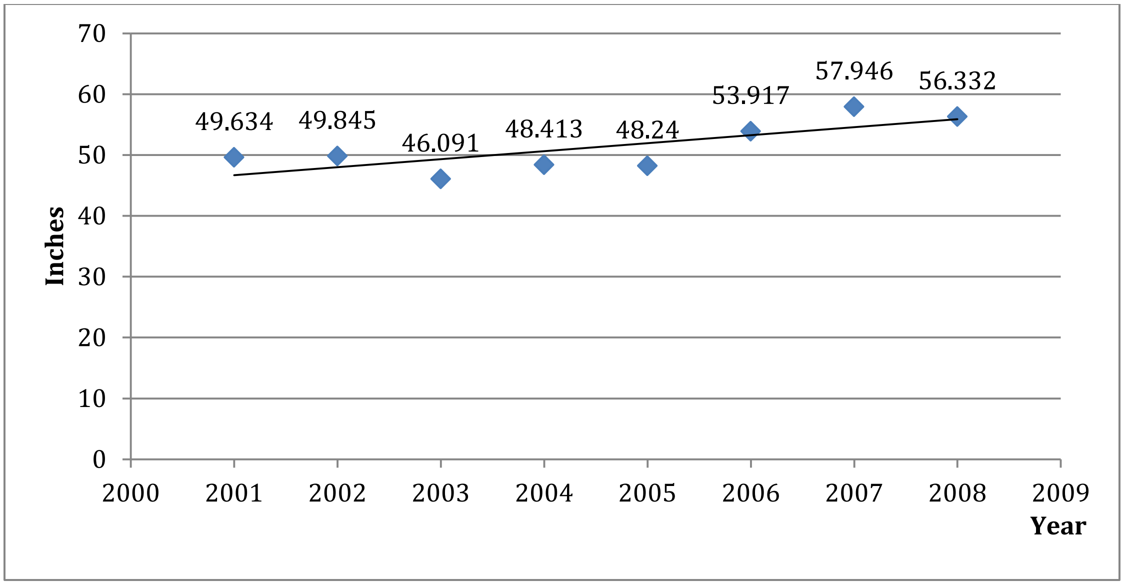
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1950-1992	1.46	2.27	3.96	5.33	6.22	6.68	6.92	6.34	4.96	3.79	2.54	1.47	51.67
1950-1959	1.81	2.58	3.89	5.65	6.42	6.92	6.98	6.63	4.82	3.78	2.45	1.59	53.52
1960-1969	1.59	2.55	4.34	5.58	6.69	6.76	7.01	6.68	4.79	3.85	2.51	1.52	53.88
1970-1979	1.23	2.35	3.57	5.58	6.28	7.10	7.66	6.95	5.1	3.97	2.79	1.40	53.97
1980-1989	1.47	1.89	3.77	5.31	6.37	6.95	7.12	6.34	4.86	3.83	2.33	1.15	51.39
1990-1992	1.33	2.43	3.49	4.69	5.27	5.83	6.71	5.48	4.33	3.26	2.27	1.06	46.15

Source: South Carolina State Climatology Office's Pan Evaporation Records for the South Carolina Area

Figure 10 shows recent evapotranspiration data collected by State Climate Office of North Carolina. The average evapotranspiration from 2001 to 2008 in Pickens County was 51.3 inches. The trend line indicates a gradual increase in evapotranspiration over time, which corresponds to the steady average maximum temperature and the gradually decreasing precipitation.

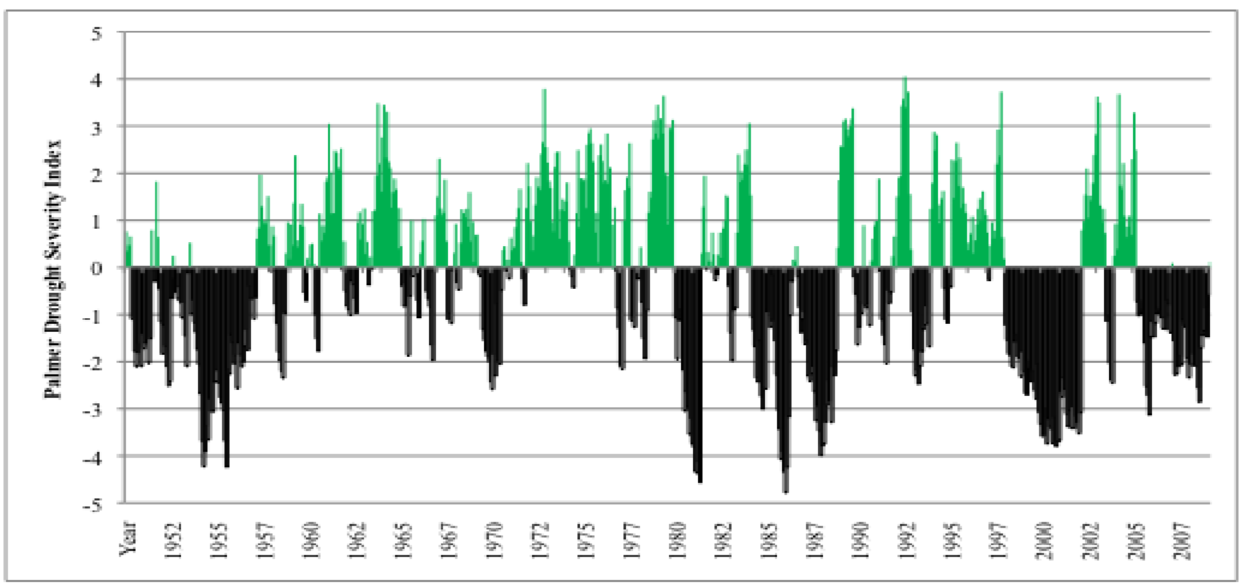
Evapotranspiration data also corresponds to the drought record for Pickens County, confirming the climate change concerns about increasing frequency, endurance, and intensity of drought events.

While there are several measures of drought, the Palmer Drought Severity Index (PDSI) is a generally accepted and empirically defensible scale. Figure 11 shows the PDSI for Pickens County on a monthly basis from 1950 through late 2009. It captures the severe drought in the early 1950s (index of -4), as well as those in the early and mid 1980s (index over -4), and again, the dip back into severe and more prolonged drought from 1998 through the end of 2001 (index between -3 and -4).But after a short respite in 2002, there was a quick dip back into drought in 2003, followed by another and continuing drought from 2005 through 2009 (index of -2 to -3).These data suggest that the duration of droughts are increasing in Pickens County, as well as their frequency, and occasionally, their intensity.



Source: State Climate Office of North Carolina. FAO56 Penman-Monteith Reference Evapotranspiration Estimates. (http://www.nc-climate.ncsu.edu/et)

Figure 10: Annual Evapotranspiration in Pickens County (2001-2008)



Source: South Carolina Department of Natural Resources' Dynamic Drought Index for Basins in North and South Carolina (https://www.dnr.sc.gov/drought/index.php?pid=1)

Figure 11: Palmer Drought Severity Index for Pickens County

Pickens County water purveyors have been involved in drought planning and emergency preparedness for several years. A general plan framework was provided by the South Carolina Department of Natural Resources and the South Carolina Rural Water Association, and purveyors modified it to meet their individual needs. The Pickens County Council has reviewed and approved these emergency drought plans (see further discussion in Section 2).

Together, Pickens County's steady average maximum temperatures, increasing drought frequency, the gradually increasing evapotranspiration and gradually decreasing precipitation trends suggest that water supply and its quality may be adversely affected. However, there is no regional-specific climate change model yet available to confirm this observation. But one is currently in development, and may be able to inform this plan when it is updated. Until then, the demand forecasting section must omit a climate scenario.

SECTION 2: EXISTING WATER SUPPLY & DEMAND

Before projecting demand, it was necessary to determine water sources, infrastructure capacity, and water use by sector in each water purveyors' service area (where possible). There are twelve special purpose or municipal water districts retailing water to customers in Pickens County that are either fully or partially contained within the county. There are also three other water purveyors that wholesale water to the twelve districts, and/or have an interbasin transfer to remove water from one of the county's water sources. Figure 12 shows the twelve water district service areas within the county. Only one portion of the county, in the northernmost section, has no official water district service.

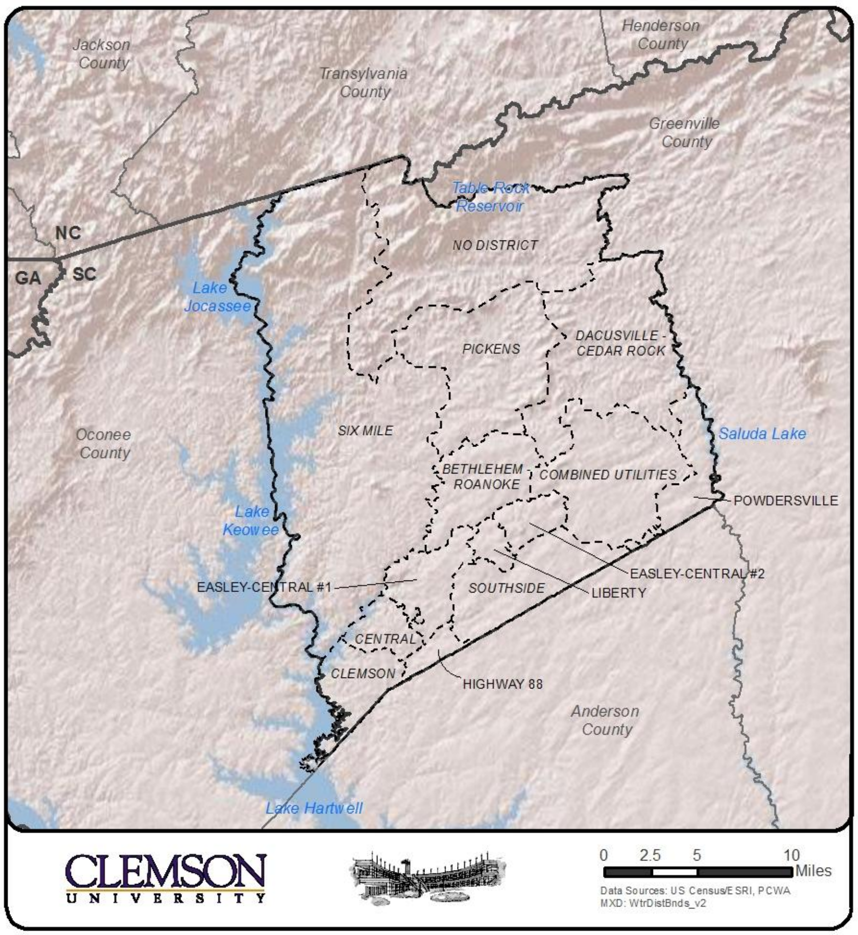


Figure 12: Water District Boundaries

PICKENS COUNTY WATER PURVEYORS AND THEIR SELF-IDENTIFIED DEMAND

Meetings were held with each Pickens County water purveyor at the very beginning of the planning process in fall 2009. The purpose of these discussions was to gather baseline information about each water district and the same questions were asked of each purveyor (see Appendix 2 for the complete data checklist); however the type and level of detail provided varied among purveyors. Where possible, data from other sources was used to resolve inconsistencies and to fill in any missing data. Highway 88 Water Company was the only purveyor that did not meet with the project team.

Similar discussions were held with the water purveyors' wholesalers, which include Pickens County Water Authority (PCWA), Anderson Regional Joint Water System (ARJWS), and Greenville Water System (GWS). The types and quantities of information gathered from county water purveyors and wholesalers varied greatly, due in part to the fact that each water purveyor records and stores data with different levels of comprehensiveness and detail. Most water purveyor data is from 2008. Reported system infrastructure age in years is based on 2009 discussions.

Bethlehem-Roanoke Water District

Bethlehem-Roanoke Water District is located in the south central portion of Pickens County and is operated jointly with Dacusville-Cedar Rock Water District. Its service area is approximately 22.6 square miles.

Water is supplied to Bethlehem-Roanoke from City of Pickens, PCWA, and Easley Combined Utilities (only for emergency use). Physical water sources are City Lake, Twelve Mile Creek, Lake Keowee and Saluda Lake. The district does not presently resell any of its water. Bethlehem-Roanoke Water District consumed 179.8 million gallons (MG) per year in 2008, an average of 492,476 gallons per day (Table 3).

Bethlehem-Roanoke Water District pays wholesale rates for water of $1.35 per 1,000 gallons to City of Pickens, $1.51 per 1,000 gallons to PCWA and $1.71 per 1,000 gallons to Easley Combined Utilities. Bethlehem-Roanoke also pays 25 percent of the $12,000 per month debt service ($3,000) to have access to the tap from PCWA. The district does not have any new water supplies planned at this time.

Bethlehem-Roanoke Water District has its water lines mapped in AutoCAD. The district has two water storage tanks: a 300,000 gallon tank located on Highway 178 near the airport and a 250,000 gallon tank located on Highway 9 near Bethlehem Road. Most of the water lines are around 42 years old and the district replaces lines as needed on an ongoing basis. The capital improvement plan includes a new office building. In addition to hydraulic pumps, Bethlehem-Roanoke uses technology through VISA/MasterCard online billing.

At the end of 2007, Bethlehem-Roanoke had 2,402 taps; 2,372 residential and 30 nonresidential. The total number of taps in the district increased by 371 over the period from 1998 to 2008.

Bethlehem-Roanoke reports 2008 daily water consumption ranged from 486,500 gallons to 643,500 gallons. This range was lower than daily consumption levels in 1998, which were estimated to be between 500,000 gallons and 770,000 gallons a day. There is water loss of 8 to 10 percent within the system, resulting from fire flushing (about 5 percent) or leaks in pipes. Bethlehem-Roanoke meters all of its accounts and reports that all of its households only have one meter.

Table 3: Bethlehem-Roanoke Water District

Number of accounts:	*2,402*
Miles of pipe:	*not provided by district; 75.1 miles calculated*
System water loss:	*8% - 10%*
District storage capacity:	*0.55 MG*
Year of data:	*2007*

Bethlehem-Roanoke Water District		
Sources	**Purchases (MG/Yr)**	**Purchases (Gals/Day)**
City of Pickens	144.2	395,167
PCWA	35.5	97,309
Easley Combined	0	0
Subtotal	179.8	492,476
Sold To	**Sales (MG /Yr)**	**Sales (Gals/Day)**
None	0	0
Consumption in District (Purchases LESS Sales)	**179.8**	**492,476**

Town of Central

The Town of Central is located in the southwestern corner of Pickens County. The municipal utility's service area is 8.8 square miles or 1.7 percent of the total county land area. It serves 3.2 percent of the total county population through 1,915 taps.

In 2008, Central received its water supply from Easley Central and ARJWS through the City of Clemson. Since 2009, the town's water supply has been from ARJWS. The Town of Central consumed 242.6 MG per year in 2008, an average of 664,534 gallons per day. A small portion of this total, about 16.8 MG a year, was sold to Highway 88 Water District (Table 4). The mill in Central used about 12 MG a year.

Central is charged the following rates for its water supply: $1.38 per 1,000 gallons from Easley Central and about $0.90 per 1,000 gallons from ARJWS, depending on the volume purchased. Physical water sources are Lake Hartwell and Twelve Mile Creek. Central does not report any supply reliability problems.

Central has about 51 miles of transmission and distribution lines and one tank that are jointly owned with the City of Clemson. The pipes range in size from less than two inches to ten inches in diameter. From the street to the house, the lines are usually two inches in diameter. All lines are gravity fed. Some pipes are 30 years old and some are brand new. Central has replaced about 20 percent of its original pipes; new pipes are made of PVC.

Central replaces infrastructure by following a priority list of problems. The town will not expand its system unless the municipal limits expand or there is a new development close by. A new tank was recommended by a recent study, however. The town also will not run lines in anticipation of growth. Replacing pipes is a slow process and is done as time and money allow. Central does not report any water quality issues coming from their sources. The utility monitors its water quality once a month as required by DHEC, and sends out samples once a year for a more comprehensive test.

The Town of Central breaks out its water use by district boundaries and sectors. Categories include: 1) account location inside or outside of city limits; and 2) account type (residential or nonresidential, Central or Highway 88 consumer). Central reported about a five percent loss of water in the system. Residential and commercial users are charged the same rate and there is one meter per household.

Table 4: Town of Central

Number of accounts:	*1,915*
Miles of pipe:	*51*
System water loss:	*5%*
District storage capacity:	*0.5 MG*
Year of data:	*2008*

Town of Central		
Sources	**Purchases (MG/Yr)**	**Purchases (Gals/Day)**
Easley Central (thru 2008)	174.9	479,178
City of Clemson	84.5	231,384
Subtotal	259.4	710,562
Sold To	**Sales (MG /Yr)**	**Sales (Gals/Day)**
Highway 88	16.8	46,027
Consumption in District (Purchases LESS Sales)	**242.6**	**664,534**

City of Clemson

The City of Clemson is located in the southernmost part of Pickens County. The city surrounds Clemson University, which has a separate water system. Together, the City of Clemson and Clemson University cover about 16 square miles.

The City of Clemson purchased 722.5 MG from ARJWS in 2009 and consumed 638.1 MG, an average of about 1.75 million gallons a day (MGD). The water comes from Lake Hartwell. ARJWS charges Clemson $1.35 per 1,000 gallons. The city sells to Central. The 2008 amount was 84.5 MG (Table 5).

Residential consumption accounts for about 88 percent of annual water consumption within the district. Commercial consumption is about 10.6 percent of the total and industrial and irrigation consumption combined is less than three percent of the total. As of September 2009 the city had 1,184 irrigation meters. Clemson does not have any planned new water supplies and does not report any supply reliability problems.

The Clemson water utility's facility is located at 300 Cochran Road in Clemson. System distribution lines vary in diameter from 3/4 inch service lines to 16 inches. The system has about 101 miles of line. The topography of the area necessitates the use of pumps in portions of the system. The service lines are copper and the mains are ductile iron. There is some PVC, but not much. The city owns two tanks and is part owner of the tank in Central.

The City of Clemson expands facilities as development dictates, but water lines are replaced and upgraded continuously. The utility has replaced about five to 10 percent of its water lines in the last ten years. The City of Clemson uses a SCADA (supervisory control and data acquisition) system, which has an automated emergency call system. The rate structure has not changed in the past 10 years, but rates have gone up. The city reports water losses of about 18 to 20 percent in the system.

Clemson University

Clemson University supplies water to the university property and a few outlying adjacent areas including the Fants Grove Water System. The main campus of Clemson University supplies water to approximately 22,000 people during the spring and fall semesters. About 6,300 of these people are counted as year-round residents.

All water is purchased from ARJWS. The University pays $1.35 per 1,000 gallons. Clemson University is a member of ARJWS; although as a state institution, it is not a voting member.

In 2008, Clemson University received 374.6 MG per year for the main campus and 9.8 MG for the Fants Grove Water System. Consumption at the university averaged 1 MG a day in 2008 (Table 6). The University has no plans for new water supplies. While the University would like ARJWS to increase the phosphate dosage, it has not had water quality problems.

The University's water system dates back to 1895. Most pipes are six to 12 inches in diameter and are ductile or cast iron. Generally, pipes laid today are ductile iron. There are water towers, two of which are operated and maintained by ARJWS. These tanks hold 1.55 MG all together and were built in the 1950s. The only supply reliability problem occurs if there is an interruption in the ARJWS service line, although this is rare. In such a case, the University is able to run off tank pressure for a period of time.

Table 5: City of Clemson

Number of accounts:	*7,545 + 1,184 irrigation*
Miles of pipe:	*101*
System water loss:	*18% - 20%*
District storage capacity:	*not provided*
Year of data:	*2009*

City of Clemson		
Sources	**Purchases (MG/Yr)**	**Purchases (Gals/Day)**
ARJWS	722.5	1,979,569
Sold To	**Sales (MG /Yr)**	**Sales (Gals/Day)**
Town of Central	84.5	231,384
Consumption in District (Purchases LESS Sales)	**638.1**	**1,748,186**

Table 6: Clemson University

Number of accounts:	*not applicable*
Miles of pipe:	*not provided by district; 55.2 miles calculated*
System water loss:	*not provided*
District storage capacity:	*1.55 MG*
Year of data:	*2008*

Clemson University		
Sources	**Purchases (MG/Yr)**	**Purchases (Gals/Day)**
ARJWS	374.6	1,026,301
Sold To	**Sales (MG /Yr)**	**Sales (Gals/Day)**
Fants Grove	9.8	26,849
Consumption in District (Purchases LESS Sales)	**364.8**	**999,452**

Dacusville-Cedar Rock Water District

Dacusville-Cedar Rock Water District is located in the eastern section of Pickens County that borders Greenville County. It is operated jointly with Bethlehem-Roanoke Water District. The district's service area is 56.9 square miles. Dacusville-Cedar Rock purchases water from GWS and Easley Combined Utilities. Total consumption in 2008 was 286.2 MG or about 784,000 gallons per day (Table 7). Physical water sources are Lake Keowee and Saluda Lake. The district does not currently resell any of its water. Dacusville-Cedar Rock pays wholesale rates of $1.51 per 1,000 gallons to GWS and $1.71 per 1,000 gallons to Easley Combined. The district does not have any new water supplies planned.

Dacusville-Cedar Rock has its water lines mapped in AutoCAD. The district has three storage tanks: a 100,000 gallon elevated tank located on Highway 135 at the Hickory Heights Subdivision, a 500,000 in-ground storage tank located at Boundary Drive, and a new 750,000 gallon elevated storage tank. Most of the district's water lines are approximately 40 years old and are replaced as needed on an ongoing basis. Dacusville-Cedar Rock Water District uses hydraulic pumps. The district's capital improvement plan includes a new office building. No water quality issues are reported.

In 2008, Dacusville-Cedar Rock had a total of 3,270 residential service connections with 11 non-residential taps. The district meters all of its accounts and reports that all of its households have only one meter. There is a loss of 12 to 15 percent within the system resulting from fire flushing (about 5 percent) or from leaks in pipes.

Table 7: Dacusville-Cedar Rock Water District

Number of accounts:	*3,270*
Miles of pipe:	*not provided by district; 164.7 miles calculated*
System water loss:	*12% - 15%*
District storage capacity:	*1.35 MG*
Year of data:	*2008*

Dacusville-Cedar Rock Water District		
Sources	**Purchases (MG/Yr)**	**Purchases (Gals/Day)**
Greenville Water	109.5	300,000
Easley Combined	176.7	484,000
Subtotal	286.2	784,000
Sold To	**Sales (MG /Yr)**	**Sales (Gals/Day)**
None	0	0
Consumption in District (Purchases LESS Sales)	**286.2**	**784,000**

Easley Central Water District

Easley Central Water District has two distinct service areas within Pickens County. Both service areas are located in the southern section of the county and are separated by the Town of Liberty's service area. Easley Central District #1 serves the areas located near the Town of Central and the Town of Norris and is 15.2 square miles in size. It draws water from Twelve Mile Creek. Easley Central District #2 serves an area that is west of the City of Easley and is 7.6 square miles in size. It obtains water from Easley Combined Utilities. Total district service area size is 22.8 square miles.

Easley Central has a 3 MGD water treatment plant located on Twelve Mile Creek and also purchases water from Easley Combined Utilities. In an emergency, the district can also purchase water from the City of Liberty and Southside Rural. Physical water sources are Twelve Mile Creek, Saluda Lake and Lake Keowee. Easley Central Water District does not have any new water supplies planned presently. In 2008, Easley Central's two service areas consumed 174.5 MG, an average of 480,548 gallons per day. The utility sold more than twice as much water as it consumed in 2008 (Table 8).

Easley Central has approximately 2,600 accounts, about 80 percent of which are residential. Easley Central meters all of its accounts and estimates that the vast majority have only one tap, with only about 10 accounts having a second meter for irrigation purposes. System water loss is estimated to be from one to three percent.

Easley Central has 3 MG of storage tank capacity: one 250,000 gallon in-ground tank, two 1 MG in-ground tanks, and three 250,000 gallon elevated tanks. Approximately half of the system's water lines are old and about half are new. Main water lines are 10, 16, and 18 inch pipes and were placed between 1962 and 1989. In 2008, Easley Central updated its water treatment plant and installed SCADA. No other capital improvements were planned. Easley Central Water District does not report any water quality issues at this time and has a source water assessment available.

Easley Central pays 25 percent of the $12,000 a month debt service ($3,000) to have access to the tap from PCWA, even if they take no water. (This tap is off the 72 inch water line owned by GWS coming from Lake Keowee.) Easley Central considers this payment an insurance plan for future water supply needs. In 2009, the City of Clemson and Town of Central started buying from ARJWS when their contracts with Easley Central expired. As a result, Easley Central's water sales have been dramatically reduced.

Easley Central is also affected by pollution remediation efforts on Twelve Mile Creek. Two of the three dams on the creek were removed between 2009 and 2011. The dam removal was a product of a federal settlement over polychlorinated biphenyls (PCBs) from the pollution associated with capacitors manufactured by Sangamo Weston, Inc., the prior owner of the plant on Twelve Mile Creek, which is now owned by the remediator and defendant, Schlumberger Corporation. There was ongoing controversy over the removal of a third dam on Twelve Mile Creek, where Easley Central's 3 MGD water treatment plant is located. But with the environmental debates associated with the removal of the first two dams, it is unlikely that the third dam will be removed. Contaminated sediment in the creek remains an issue although there has been extensive cleanup related to this Superfund site.

Table 8: Easley Central Water District

Number of accounts:	*about 2,600*
Miles of pipe:	*not provided by district; 94.1 miles calculated*
System water loss:	*1% - 3%*
District storage capacity:	*3.0 MG*
Year of data:	*2008*

Easley Central Water District		
Sources	**Purchases (MG/Yr)**	**Purchases (Gals/Day)**
Twelve Mile Creek	466.7	1,278,671
Easley Combined	99.0	271,127
City of Liberty - emergency only		
Southside Rural - emergency only		
Subtotal	565.7	1,549,799
Sold To	**Sales (MG /Yr)**	**Sales (Gals/Day)**
Highway 88	179.8	492,693
Southside Rural	35.5	97,380
Town of Central	174.9	479,178
City of Liberty – emergency only		
Subtotal	390.3	1,069,251
Consumption in District (Purchases LESS Sales)	**175.4**	**480,548**

Easley Combined Utilities

Easley Combined Utilities is a municipal utility created to provide water and sewer to the city of Easley, although it also provides service outside the city limits. The service area for Easley Combined Utilities is located in the southeastern part of Pickens County and is approximately 41 square miles in size.

Easley Combined Utilities owns and operates a water supply plant on Saluda Lake with 18 MGD output capacity. The plant was built in 1967 and was upgraded in 2005 and 2007. Other than an emergency contract with GWS for water from Lake Keowee, Easley Combined relies completely on Saluda Lake for its water supply. GWS charges Easley Combined $3.04 per 1,000 gallons used from the emergency connection. Supplemental water sources have been considered by Easley Combined, and there may be possibilities for a new reservoir at an undisclosed location in the future.

In 2008, the utility withdrew 3,239.7 MG from Saluda Lake, an average of 8,875,918 gallons per day. About 39 percent of this total was sold to four other water systems in the county. Consumption within the Easley Combined service area was 1,972.1 MG in 2008, or an average of 5,402,887 gallons per day (Table 9).

Table 9: Easley Combined Utilities

Number of accounts:	*not provided*
Miles of pipe:	*not provided by district; 163.4 miles calculated*
System water loss:	*10% - 20%*
District storage capacity:	*9.778 MG*
Year of data:	*2008*

Easley Combined Utilities		
Sources	**Purchases (MG/Yr)**	**Purchases (Gals/Day)**
Saluda Lake (own source)	3,239.7	8,875,918
Greenville Water	0	0
Subtotal	3,239.7	8,875,918
Sold To	**Sales (MG /Yr)**	**Sales (Gals/Day)**
Dacusville-Cedar Rock	176.7	484,000
Easley Central	99.0	271,127
Powdersville	528.0	1,446,5750
Southside Rural	319.9	876,420
Subtotal	1,267.7	3,473,031
Consumption in District (Purchases LESS Sales)	**1,972.1**	**5,402,887**

Easley Combined uses the following technology: GIS, a SCADA system, radio-read water meters, and plate settlers at the water plant. The utility upgraded a pumping station in 2002. It is also investigating the possibility of adding 36,000 feet of 36-inch lines connecting the plant to a remote clearwell and high pressure pumping station.

Easley Combined has the capacity to store 9.8 MG in above ground storage tanks. There are four 1 MG gallon tanks, one 5 MG tank, one 500,000 gallon tank, one 200,000 gallon tank, and one 78,000 gallon tank. Water lines in the district are up to 60 years old and are replaced as needed.

No water quality issues have been identified and a source water assessment for Saluda Lake is on file with DHEC. Increasing siltation in the upper arm of Saluda Lake is a major concern for Easley Combined. The Saluda River continually pushes sediment into the reservoir, which becomes trapped behind the dam. While water quality is not seriously affected, the taste, smell, and appearance of the water concern the citizens who consume it. According to the utility, siltation in Saluda Lake must be addressed within the next ten years and may require as much as 300,000 cubic yards of sediment to be removed from the lake. Jurisdiction may become an issue in the future. Saluda Lake is owned by Northbrook Energy Company.

Consumption accounts are classified as residential in the city limits, residential out of city limits, commercial in the city limits, commercial out of city limits, and residential irrigation, and commercial irrigation. There are no meters for fire use.

Highway 88 Water Company

Representatives from Highway 88 Water Company did not meet with the project team. However, water sales to Highway 88 were reported by two other purveyors in Pickens County: the Town of Central and Easley Central Water District (Table 10). No information is available on other sources of water for Highway 88. Only about five percent of Highway 88's service area is located in Pickens County.

City of Liberty

The service area of the City of Liberty's municipal water utility is approximately 4.3 square miles. The utility purchases water from PCWA, which comes from Lake Keowee via the GWS conveyance pipe across the top of the county. Liberty pays 25 percent of the $12,000 per month debt service ($3,000) to have access to the tap from PCWA off of the GWS line. The city also has backup connections with Easley Central, Bethlehem-Roanoke, and Southside Rural that are not currently utilized. The utility does not resell any water.

The City of Liberty purchased 192.0 MG from PCWA in 2008, an average of 526,026 gallons per day (Table 11). The 2008 rate the city was billed by PCWA for water purchased was $1.51 per 1,000 gallons. No water quality issues were reported.

The utility's service area has about 70 miles of pipes ranging from 2 to 24 inches in diameter. Much of the infrastructure was originally laid in 1925. Prior to initiating water acquisition from PCWA in 2004, the City of Liberty operated a water treatment plant on Eighteen Mile Creek. However, wastewater was being discharged upstream and the creek was too low to allow the city to draw enough water for treatment. The city is still paying debt service on this plant. Liberty has 1 MG of above-ground storage and two additional 350,000 gallon above-ground tanks in the water plant storage facility.

Table 10: Highway 88 Water Company

Number of accounts: *not provided*
Miles of pipe: *not provided by district; 3.6 miles calculated*
System water loss: *not provided*
District storage capacity: *not provided*
Year of data: *2008*

Highway 88 Water Company		
Sources	**Purchases (MG/Yr)**	**Purchases (Gals/Day)**
Town of Central	16,800,000	46,027
Easley Central	179,833,000	492,693
Other source(s) not provided	0	0
Subtotal	196,633,000	538,721
Sold To	**Sales (MG /Yr)**	**Sales (Gals/Day)**
Not provided	0	0
Consumption in District (Purchases LESS Sales)	**286.2**	**784,000**
Estimated Consumption in Pickens County (5% of total)	**9.8**	**26,936**

Table 11: City of Liberty

Number of accounts: *about 1,300*
Miles of pipe: *70*
System water loss: *37%*
District storage capacity: *3.7 MG*
Year of data: *2008*

City of Liberty		
Sources	**Purchases (MG/Yr)**	**Purchases (Gals/Day)**
PCWA	192.0	526,027
Easley Central	0	0
Subtotal	192.0	526,027
Sold To	**Sales (MG /Yr)**	**Sales (Gals/Day)**
No data provided	0	0
Consumption in District (Purchases LESS Sales)	**192.0**	**526,027**

In the near future, the City of Liberty would like to begin using 2 MG of in-ground storage available at the old plant. Several miles of original pit cast and galvanized pipes are still in the ground. As replacements are made, the district uses PVC pipes or ductile iron pipes for larger lines. System rehabilitation and upgrades are conducted as money is available. While the utility does not report any supply reliability problems, the utility has a significant amount of system water loss (estimated at 37 percent) due to the age of its infrastructure.

The City of Liberty has approximately 1,300 taps. Only 23 taps are commercial, including a mill. There are also 65 irrigation meters. The mill consumes 21,000 to 22,000 gallons per month. Metering is done with one meter per user.

City of Pickens

The City of Pickens supplies water to an area in the central portion of Pickens County. The municipal utility's service area is 47.8 square miles. The city has three water sources. Primary sources are City Lake (a 100 acre manmade lake owned by the City located off Highway 178) and Twelve Mile Creek (on Red Hill Road, used primarily for high demand times).

In 2008, the utility drew 579.4 MG from City Lake and 7.9 MG from Twelve Mile Creek, together about 1.6 million gallons a day on average (Table 12). The city can also purchase water from GWS, which obtains its water from Lake Keowee, and expressed an interest in obtaining future water from Lake Keowee. The City of Pickens pays GWS a tap fee of $15,000 a quarter ($60,000 a year) for water, regardless of use.

Consumption within the city's service area was 321.6 MG in 2008, or 881,005 gallons per day (Table 12). The utility also sold 265.7 MG of water to Bethlehem-Roanoke and Six Mile Water Districts in 2008.

The City of Pickens served 4,324 accounts in 2008. Of these, four are industrial, two are wholesale (Bethlehem-Roanoke and Six Mile) and the balance are residential or commercial. There are 1,366 taps within the city limits and 2,958 taps outside the city. The utility reports a 6 to 8 percent loss due to leaks in pipes. The city meters all of its accounts and reports that some households have more than one meter.

The City of Pickens does not have its water service area mapped. In the past, the city's water supply has been affected by drought, during which time it imposed mandatory restrictions for three to four months.

The water plant on Twelve Mile Creek has a current capacity of 4 MGD. The city has plans to upgrade this facility soon, but the upgrade will not increase capacity. The pump station at City Lake also will have some minor upgrades made soon. Currently, the utility has six storage tanks that hold over five million gallons combined. Some of the utility's pipes are approximately 53 years old. The city replaces pipes on an ongoing, as needed, basis. Pickens recently purchased a new software package for billing and plans on getting a SCADA system within two years.

Pickens reports that they have had some water quality problems with iron manganese in their supply (increasing in times of heavy rain and runoff). They treat this problem with potassium permanganate. The property surrounding City Lake is privately owned, but Pickens does have some dock restrictions.

Table 12: City of Pickens

Number of accounts:	*4,324*
Miles of pipe:	*not provided by district; 126.4 miles calculated*
System water loss:	*6% - 8%*
District storage capacity:	*over 5.0 MG*
Year of data:	*2008*

City of Pickens		
Sources	**Purchases (MG/Yr)**	**Purchases (Gals/Day)**
City Lake (own source)	579.4	1,587,288
Twelve Mile Creek (own source)	7.9	21,534
Greenville Water	0	0
Subtotal	587.2	1,608,822
Sold To	**Sales (MG /Yr)**	**Sales (Gals/Day)**
Bethlehem-Roanoke	144.2	395,167
Six Mile	121.4	332,650
Subtotal	265.7	727,817
Consumption in District (Purchases LESS Sales)	**321.6**	**881,005**

Powdersville Water District

Powdersville Water District is located in the southeastern corner of Pickens County. This special purpose district has about 20 percent of its customer base in Pickens County and the balance in Anderson County. Data for Powdersville Water District could not be separated by county.

The district's service area is 14.2 square miles in size. Growth has been strong in and around Powdersville since 1980, primarily due to its proximity to Greenville and Interstate 85. The estimated population in the Powdersville Water District's service area in 1980 was 4,570. In 2000, the population was estimated to be 6,359, an increase of 1,789, or 39.2 percent. In the future, population growth in the Powdersville area is expected to continue and reach an estimated population of 9,189 by 2030.

Powdersville Water District receives its water supply from ARJWS, GWS, and Easley Combined Utilities. Physical water sources are Lake Hartwell, Lake Keowee and Saluda Lake. In 2008, Powdersville purchased 1043.4 MG (nearly 2.9 MG a day) from these three suppliers (Table 13).

Table 13: Powdersville Water District

Number of accounts: *11,491 (approximately 2,388 in Pickens County)*
Miles of pipe: *not provided by district; 70.4 miles calculated*
System water loss: *10% - 12%*
District storage capacity: *3.9 MG*
Year of data: *2008*

Powdersville Water District		
Sources	**Purchases (MG/Yr)**	**Purchases (Gals/Day)**
ARJWS	219.4	601,041
Greenville Water	296.0	810,959
Easley Combined	528.0	1,446,575
Subtotal	1,043.4	2,858,575
Sold To	**Sales (MG /Yr)**	**Sales (Gals/Day)**
None	0	0
Consumption in District (Purchases LESS Sales)	**1,043.4**	**2,858,575**
Estimated Consumption in Pickens County (20% of total)	**208.7**	**571,715**

The district reports some water loss within the system, normally between 10 to 12 percent annually due to system leaks and theft. However, this amount is down from 18 percent a few years ago. The district set a peak demand in August 2008 of 5.38 MG a day. The district does not currently resell water.

Powdersville Water District is charged the following rates for its water supply: $0.90 per 1,000 gallons from ARJWS, $1.12 per 1,000 gallons from GWS and $1.47 per 1,000 gallons from Easley Combined Utilities. The district's rate from ARJWS is based on the district's joint ownership share of that supplier. The district planned to increase its supply of water from ARJWS in 2010. Powdersville reports no supply reliability problems and states that it has redundancy in its system.

Powdersville Water District water lines are mapped in GIS. The district has three elevated towers (300,000 gallons each) with another one MG tower under construction. The district also has two underground storage tanks (one MG each). District water lines are 12, 16 or 18 inches in diameter and none are older than 38 years. There are some iron pipes, but most lines are PVC.

Future plans include upgrading meters, purchasing land for an additional tank site, and replacing various water lines as needed. The district has an aggressive capital improvement plan that extends out to year 2018. The plan is primarily funded by state revolving loans, in-house revenues, grants and commercial loans. Powdersville Water District currently makes use of technology with automatic meter reading, lockbox billing and SCADA system monitoring. The district would like to add GPS, laptops in the field and online bill payment in the future.

Powdersville reports some disinfection by-products in their water supply, which is related to water age within the system. The district has purchased a hydraulic model that determines where the oldest water in the system is located.

Eighty-nine percent (approximately 10,245) of the accounts of Powdersville Water District are residential. The district also serves 1,246 non-residential customers, consisting of about 15 small industries and various commercial accounts. These accounts, however, are located in two counties. Anderson County hosts approximately 80 percent of Powdersville's customers with Pickens County comprising the remaining 20 percent (approximately 2,388 customers). Powdersville Water District meters all of its accounts and indicates that a few households have more than one meter.

Six Mile Rural Water District

Six Mile Rural Water District covers approximately 165 square miles in western Pickens County. The only municipality within the service area is the town of Six Mile. Water is purchased from GWS and from the City of Pickens. The district does not resell any water. Total 2008 consumption in the district was 402.5 MG, an average of 1.1 MGD (Table 14).

In 2008, 70 percent of the district's total water volume came from GWS, from which the district is permitted to draw up to a maximum of 1 million gallons per day (MGD). Average withdrawals from GWS were 770,137 gallons per day in that year. The rate paid to Greenville has a base charge plus a cost per thousand gallons and is based on an assessment of maximum hour/ maximum day.

The remaining 30 percent of water for Six Mile Rural Water District, which averaged 332,650 gallons per day, came from the City of Pickens. The City of Pickens charges a "cost per thousand" rate with no minimum or base charge. Water quality issues are communicated with the suppliers as they arise.

The Six Mile Rural Water District has approximately 400 miles of pipes but does not use pumps to move the water. Infrastructure expansion is dictated by growth and a capital improvement plan. The district reports that an idea for system expansion has been around for a while, but that there are no concrete plans in place. The district has not experienced any supply reliability problems and loses "normal" amounts of water within its system. Some pipes are 40 years old and are gradually being replaced with ductile iron instead of PVC.

The Six Mile Rural Water District serves a primarily residential customer base. The only industry of note in the district is a concrete plant. Metering is done with one meter per household. The district does not wholesale any of its water and does not report significant water loss.

Table 14: Six Mile Rural Water District

Number of accounts:	*not provided*
Miles of pipe:	*400*
System water loss:	*"normal"*
District storage capacity:	*2.0 MG*
Year of data:	*2008*

Six Mile Rural Water District		
Sources	**Purchases (MG/Yr)**	**Purchases (Gals/Day)**
Greenville Water	281.1	770,137
City of Pickens	121.4	332,650
Subtotal	402.5	1,102,787
Sold To	**Sales (MG /Yr)**	**Sales (Gals/Day)**
None	0	0
Consumption in District (Purchases LESS Sales)	**402.5**	**1,102,787**

Southside Rural Water District

The Southside Rural Water District has a service area of approximately 45 square miles, with 26.6 square miles in Pickens County. The district purchases water from two main suppliers: Easley Combined Utilities and Easley Central Water District. The district purchased 355.4 MG from these suppliers in 2008, an average of 973,800 gallons per day. Southside Rural does not resell water (Table 15).

Like the City of Liberty, Southside Rural pays 25 percent of the $12,000 per month debt service ($3,000) to have access to the tap from PCWA off of the GWS line. No 2008 purchases from PCWA were reported. For water it purchases from Easley Combined Utilities, Southside Rural is charged $1.71 per 1,000 gallons up to the contract minimum volume of 9 MG per month. For additional amounts, the district is charged $1.17 per 1,000 gallons. Southside Rural pays $1.39 per 1,000 gallons for water from Easley Central and $1.51 for water from PCWA. Southside Rural reported no plans for new water supplies and no water quality issues.

There are currently 150 miles of pipelines in Southside Rural's system, with most being two to 10 inches in diameter. The system is all gravity-fed and the district hopes to avoid the need for pumps. Currently, most pipes are PVC, including replacements. The system was originally laid in 1967 and 1968, although the bulk of the system has been added since that time.

Southside Rural is in the process of adding five to eight miles of pipes for connections and a new 1 MG tank. This work will provide better service to developing parts of Northern Anderson County and will also provide backup for the western areas of the system in Pickens County.

After completion of this work, a SCADA system will be implemented. Southside does not report any supply reliability problems. Estimated system water loss is around 17 percent.

Southside Rural Water District has approximately 3,600 customers, only 57 of which are nonresidential. There is one meter per household.

Table 15: Southside Rural Water District

Number of accounts:	*about 3,600*
Miles of pipe:	*150*
System water loss:	*17%*
District storage capacity:	*1.0 MG*
Year of data:	*2008*

Southside Rural Water District		
Sources	**Purchases (MG/Yr)**	**Purchases (Gals/Day)**
Easley Combined	319.9	876,420
Easley Central	35.5	97,380
PCWA	0	0
Subtotal	355.4	973,800
Sold To	**Sales (MG /Yr)**	**Sales (Gals/Day)**
None	0	0
Consumption in District (Purchases LESS Sales)	**355.4**	**973,800**
Estimated Consumption in Pickens County (59% of total)	**209.7**	**574,542**

Anderson Regional Joint Water System

ARJWS is an organization with 15 members owning a share of capacity in the system. Members cover the majority of Anderson County and portions of Pickens County. ARJWS owns and operates a water treatment plant on Lake Hartwell with a 48 MGD capacity as well as a transmission system connecting to its members' systems. Nearly 6.7 billion gallons of water was distributed to ARJWS members in 2008. ARJWS has explored the idea of opening a plant at a smaller remote water source to meet peak local demand. ARJWS reported sales to the Town of Central, City of Clemson, Clemson University, and Powdersville were used in this report in place of self-reported district data.

Pickens County Water Authority

PCWA receives water from Lake Keowee through a contract with GWS. PCWA has no actual service area since it is exclusively a water wholesaler. PCWA supplies water to the City of Liberty, Southside Rural, and Bethlehem-Roanoke. PCWA charges a monthly base fee of $12,000 for the tap on GWS's 72-inch line coming off Lake Keowee. Payment for the base charge is split equally between Liberty, Bethlehem-Roanoke, Easley Central, and Southside Rural. PCWA owns a 24-inch line that runs for eight miles from the 72-inch line owned by GWS. Line diameter drops to 16 inches. The City of Liberty is contracted to maintain these lines.

PCWA has no plans to expand or replace any facilities. PCWA has no source water assessment because it has no water sources under its control. Any proposed line extensions within the county that extend beyond water district service area boundaries must be reviewed by PCWA along with any agreements between purveyors and GWS.

All water sold by PCWA to other suppliers is sold at the purchase price paid by PCWA. PCWA was paying GWS $1.51 per 1,000 gallons, but that rate dropped to $1.07 per 1,000 gallons on February 2, 2010. Generally, this rate has increased approximately 3 to 5 percent per year. The average amount of water PCWA receives and sells is between 20 and 22 MG per month; it did not report annual usage by the four districts it serves. On a maximum usage day, PCWA purchases a total of approximately 6 MG from GWS. According to PCWA, there is no water loss in the system and it is monitored closely.

Greenville Water System

GWS is a major wholesale supplier of water for Pickens County. Lake Keowee is the primary water source for GWS. The Adkins plant was constructed by GWS on Lake Keowee in the 1980s and was designed for a maximum capacity of 90 MGD. Currently, the plant can supply 60 MGD, although it pulls 24.1 MGD on average. GWS supplies water to the following Pickens County wholesale customers: Six Mile, City of Pickens, PCWA, Easley Combined, Dacusville-Cedar Rock and Powdersville. GWS did not report annual usage by customer.

CAPACITY (WATER LINES)

Pickens County purveyors each have varying amounts of infrastructure in place to supply their respective service areas. The existing water lines shown in Figure 13 are based on available GIS information and the hard copy maps that the Beeson-Rosier group generated by water purveyor and shared with their permission. Most of the water lines are interconnected, creating redundancy and security during emergencies or shortage, as well as allowing sale between purveyors (since many share sources).The entire system is gravity-fed where possible. Additionally, the line capacity to support urban growth is available through the majority of the county—save for the northern third of the county area (primarily in the "no district" area). As Figure 13 shows, the line locations generally correspond to the projected growth areas from the urban growth model, particularly in the more heavily urbanized areas of the county.

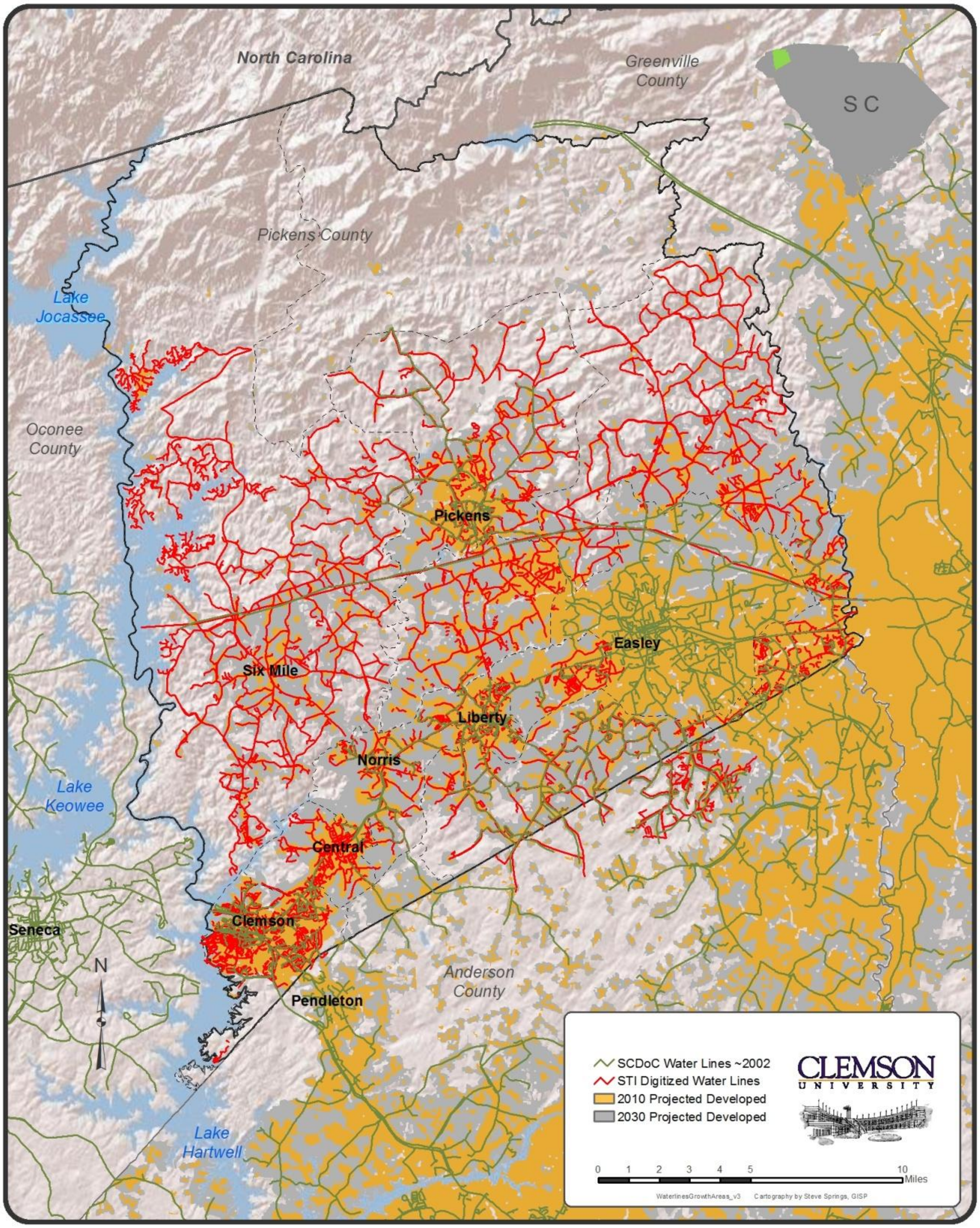


Figure 13: County Water Lines and Growth Areas

SUPPLY CONSTRAINTS

Line capacity and coverage are not the only factors that affect the ability to provide water and have implications for water supply planning. Pickens County water purveyors operate under a myriad of physical, legal, and financial constraints in providing potable water to county consumers. Discussions with each water purveyor uncovered some of the constraints that must be considered to ensure an effective and efficient water system (Table 16).

Table 16: Purveyor Constraints

Purveyor	Self-identified Constraint
Bethlehem-Roanoke	Constraining service area boundaries.
City of Pickens	Age of infrastructure and of water plant; DNR mandates on City Lake water levels.
Easley Combined Utilities	Rise in elevation to the north; legal and political battles; situation in the upper–arm of Saluda Lake.
Dacusville-Cedar Rock	Age of infrastructure; elevation to the north.
Easley-Central	Paying for water they cannot sell; some infrastructure needs to be updated.
Powdersville	Geography; water quality (being treated with disinfectants); age of water mains; need to raise fire flows.
Town of Central	Age of infrastructure.
City of Clemson	There are still some old asbestos lines that are a priority for replacement.
Clemson University	Geographic constraints and university policies.
City of Liberty	Age of infrastructure; geographically bound by other water providers.
Southside Rural	None.
Six Mile	None currently, but envision "money" to be a constraint in future.
PCWA	Currently, rates charged by GWS; in the future, relationship between agencies and FERC re-licensing.

Physical Constraints

Topography

Purveyor concerns about geography are very real, given the nature of the county's topography and because it saddles two watersheds. Elevation in Pickens County ranges from over 3,200 feet in the northern sections of the county to less than 700 feet in the southern sections, as shown in Figure 14.The change in elevation is more drastic in the northernmost area of Pickens County given the presence of the Blue Ridge Mountains, and is less pronounced in the middle and southern portions of the county.

Through proper planning and engineering, topography is more of an asset than a constraint. Gravity is the most cost-efficient way to move water across the county. Considering topography in future water line construction to ensure that water is moving from higher elevations to lower elevations will reduce the number of water pumps needed within the system. Because population growth is predicted in the southern areas of the county, which are the lowest in elevation, future additional lines can capitalize on the gravity feed to reduce the need—and expense—of water pumps.

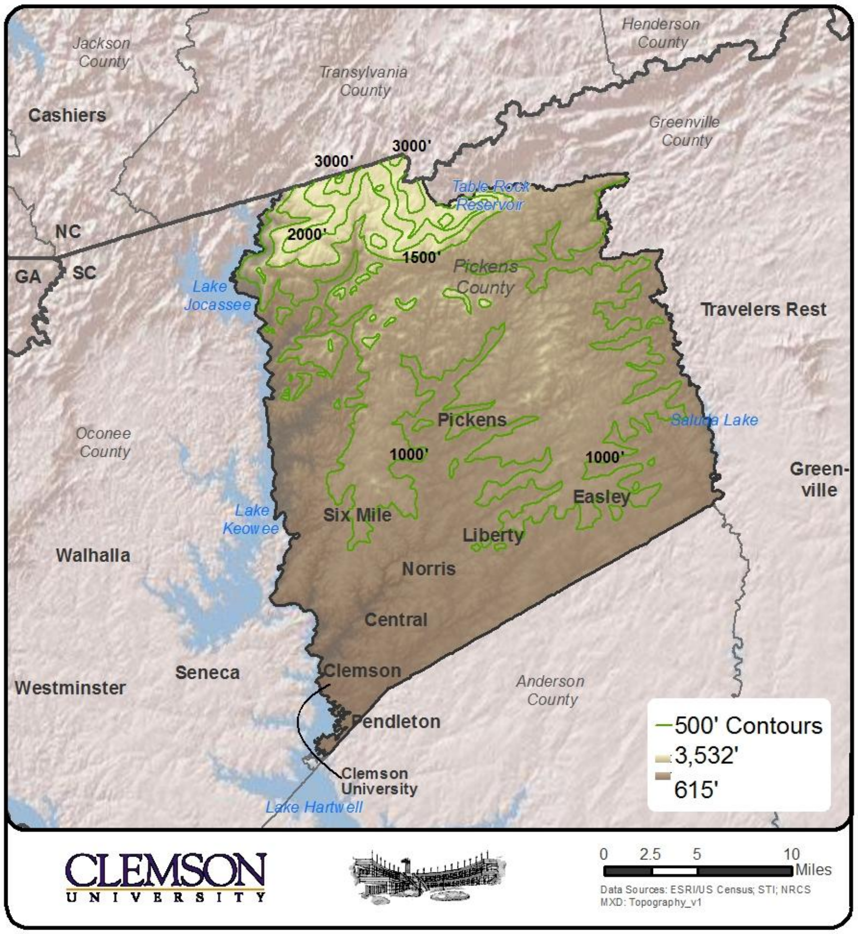


Figure 14: Pickens County Topography

Age of Facilities

Age of existing facilities directly affects a water purveyor's ability to provide water to consumers, given the potential for line rupture as well as the inefficiency caused by system leakage. Continuing maintenance and updating of facilities across the county is costly in both time and money, yet vital to the health of the system. Water purveyors in Pickens County should begin planning for replacement of facilities that are approaching the end of their functional lifespan. Priority should be given to those facilities that are located in areas of expected future growth, especially increased density, which will stress line capacity (Table 17).

Table 17: Age of Purveyors' Facilities in 2008

Purveyor	Age of Facilities
Bethlehem-Roanoke	42 years
City of Pickens	Up to 53 years old
Easley Combined Utilities	Up to 60 years, replaced as needed
Dacusville-Cedar Rock	Over 40 years old
Easley-Central	Plant: 47 years old updated in 1985 and 2008.Main lines: 20 to 47 years old
Powdersville	Up to 38 years
Town of Central	Up to 30 years
City of Clemson	Distribution center is 69 years old; water plant is 40 years old; line have been replaced as needed
Clemson University	Some piping dates back to 1895, but those may not be in use
City of Liberty	Mains were recently upgraded; above water tanks upgraded 2 years ago; plant storage facility upgraded in 1982
Southside Rural	Up to 47 years old
Six Mile	Up to 40 years old
PCWA	Up to 16 years old

The urban growth model in Section 3 of this report identifies areas of county urbanization with corresponding population growth between 2000 and 2030, primarily in the southern areas of Pickens County. Several water purveyors in this area have facilities that are 50 years old or older, including the City of Pickens, Easley Combined Utilities, the City of Clemson, and Clemson University. Water purveyors in areas of significant projected growth that have identified facilities between 40 and 50 years old include Bethlehem-Roanoke, Dacusville-Cedar Rock, Easley Central, and Southside Rural. Some of Powdersville's facilities are up to 38 years old. The Town of Central has facilities up to 30 years old. The Six Mile service area and the northern area of Pickens County served by the Pickens County Water Authority are expected to experience growth according to the urban growth model but not as heavily as other districts. Some of Six Mile's facilities are up to 47 years old, while PCWA's are the youngest, at 16 years old.

Legal Constraints

Endangered Species Act & Species Richness

The Federal Endangered Species Act of 1973 (ESA) bridges the physical and legal constraints because it is legal in nature with an appreciable physical effect. The ESA was designed to protect the ecosystems and habitats on which endangered and threatened species depend. There is equivalent South Carolina legislation that offers additional protections and includes species that are not nationally listed. Figure 15 displays the species richness throughout the county, which is slightly differentiated from endangered species habitat and species diversity.

Species richness is the sheer number of different kinds of species in a given area, while species diversity measures both the kinds and the population numbers of species in a biological community on an index (Randolph 2004). The areas with higher species richness on the map show where the richness and habitat are highest, which means that they have the highest species diversity. The northern area of the county and the eastern shore of Lake Keowee are the areas that contain the highest species richness. Other areas of high species richness are scattered throughout the county.

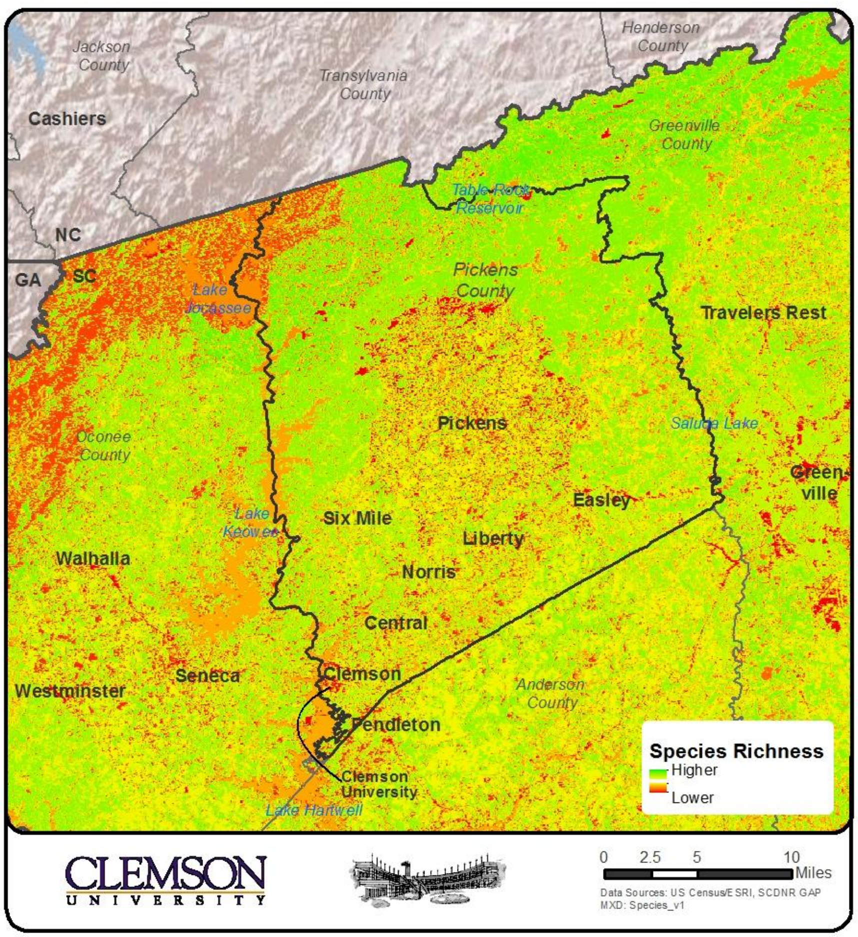


Figure 15: Pickens County Species Richness Map

Combined with the urban growth model, Figure 16 shows where urbanization has conflicted with species richness, particularly in the southern part of Pickens County. The urban growth model incorporates protected areas, so no growth is projected to occur on them—and they may be habitat for some endangered species.

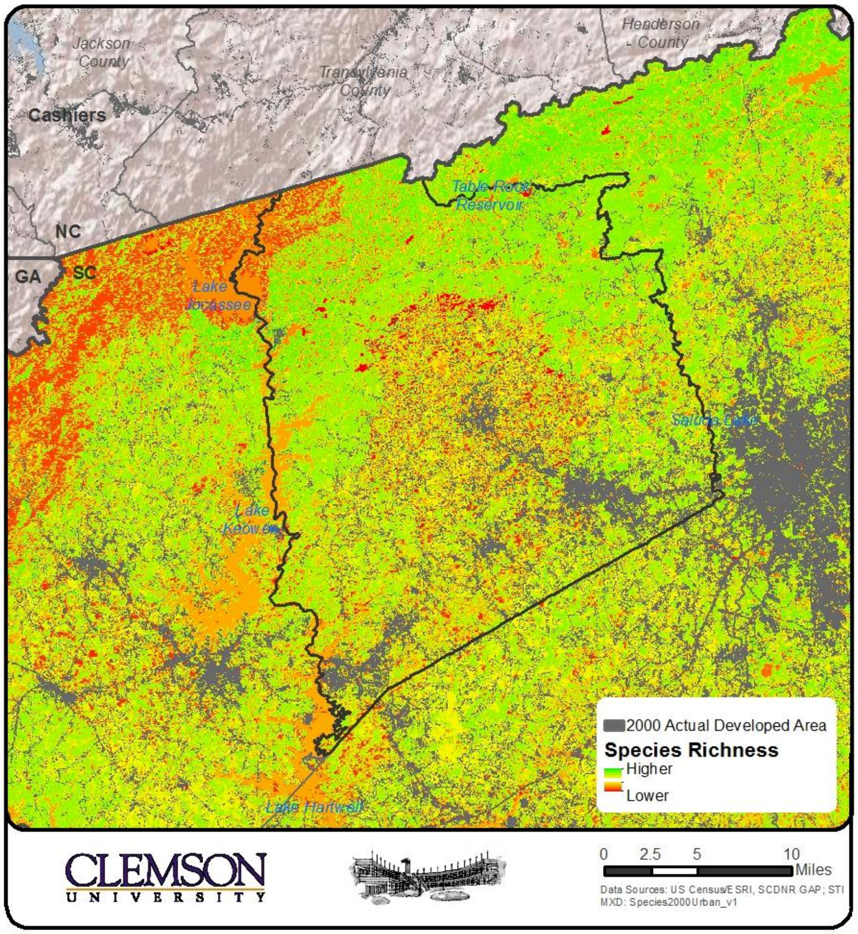


Figure 16: Species Conflict and 2000 Urbanized Areas

The impact of urbanization on species richness in 2000 was relatively minimal in comparison with the species conflict anticipated with projected 2030 urbanization (Figure 17). Particularly, areas within the Easley Combined district are projected to experience high growth while currently containing high species richness. So there may be conflict between the two, particularly if endangered species' habitats are present.

Water Quality

Another constraint involves the water quality in the sources throughout the county. Under the Clean Water Act of 1972 (CWA), the "fishable and swimmable" goal is applied to every surface water body in the country, and to each water body in Pickens County. Consequently, water bodies must meet water quality standards established to achieve the goal, which the Environmental Protection Agency (EPA)—tasked with implementing the CWA—must generate.

Any water body (or stretch of it) that threatens to and/or violates these standards is put on the EPA's 303(d) list as an impaired water body. The associated state(s) and the EPA then set the total maximum daily loads (TMDLs) for the contaminants, which limit the amount of acceptable contaminant over a 24 hour period.

The CWA's National Pollutant Discharge and Elimination System (NPDES) monitors pollutants coming from a discrete conveyance, such as a pipe or sewer system discharge, and has reduced what are known as point source contaminants in many water bodies. However, more diffuse non-point sources such as urban runoff are harder to control.

Agricultural use, a particularly ubiquitous contaminator, is completely exempt from the CWA regulation. So even with the more holistic view of watershed protection and restoration that the CWA has embraced in the last decade, the EPA continues to face challenges in improving the nation's water quality.

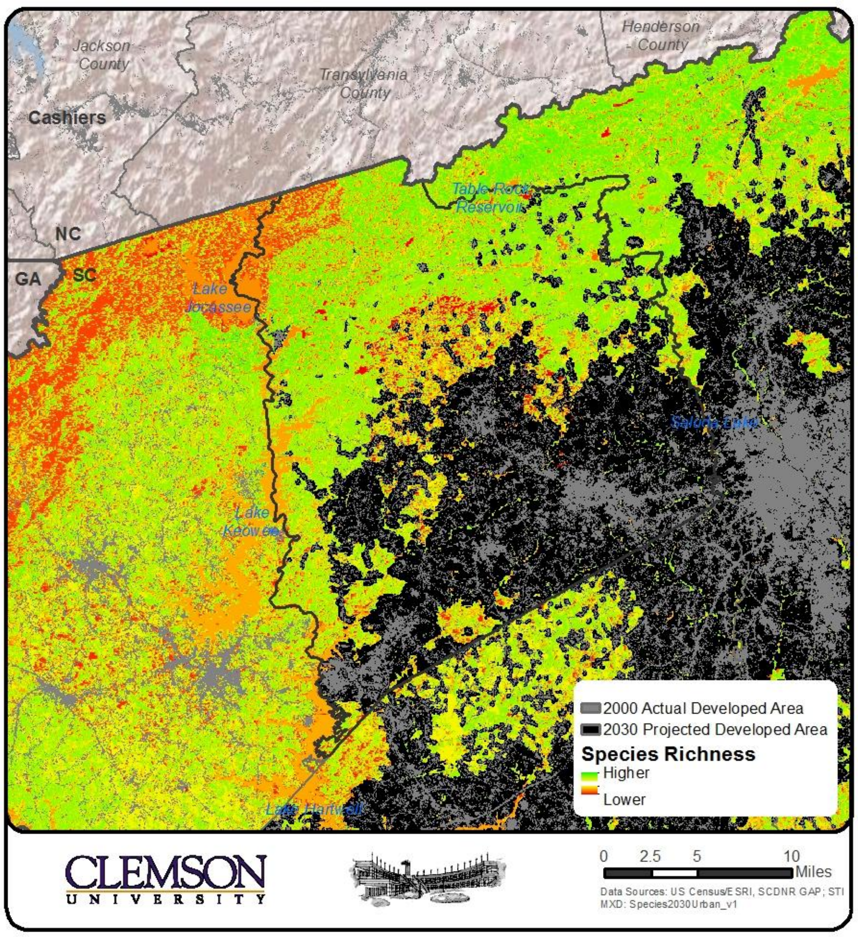


Figure 17: Species Conflict and 2030 Urbanized Areas

In South Carolina, any discharger must secure a NPDES permit from the South Carolina Department of Health and Environmental Control (DHEC). Permits are replete with monitoring and reporting requirements and involve inspections from both the EPA and DHEC. If the discharges exceed the acceptable level in the permits, or if the discharger does not properly report, water quality is potentially compromised. Table 18 shows all unique NPDES permit IDs in Pickens County. The presence of NPDES violators in Pickens County decreases the quality of the water sources upon which purveyors rely, imposing a constraint on future supply.

Table 18: NPDES Permits in Pickens County (2009)

Permit ID	Permit Number*	Owner Name	Latest Permit Update	Receiving Stream	Quarters out of compliance (last 3years)
9747586	SC0000370	Alice Manufacturing Co.	13-OCT-08	Rice CK/12-Mile CK/ LK Hartwell	-
9753271	SC0001171	Alice Manufacturing Co.	13-APR-09	Burdine/Georges/Saluda RVR	-
9742767	SC0000132	Amer. House Spinning Inc.	26-AUG-08	Pike CK to 12-Mile CK	-
9722642	SC0022012	Cateechee WWTF	10-MAR-08	12-Mile CK	-
9743993	SC0023141	Christoff Construction Co.	10-NOV-08	Tributary to LK Hartwell	-
9788728	SC0020010	Clemson City of WWTF	14-APR-09	LK Hartwell @ 12-Mile CK	12
9722600	SC0022004	Clemson University	31-JAN-08		-
9765598	SC0034843	Clemson Univ. WWTF	11-DEC-08		-
9743850	SC0023035	Easley Combined Util.	22-APR-09	Golden CK/12-MI CK/ LK Hartwell	-
9743926	SC0023043	Easley Combined Util.	31-MAR-09	Georges CK	-
9796430	SC0039853	Easley Combined util.	01-APR-09	Middle Branch/ Bushy CK	-
9826738	SC0046396	Easley Site Trust	03-DEC-08	Unnamed tributary to Hamilton CK	-
9795183	SC0029548	Heatherwood SD/Madera Util	02-JUL-03	Tributary to 18-MI CK	-
9747071	SC0000264	Liberty Denim LLC	29-JAN-09	Trib. to Woodside to 18-Mile CK	-
9774787	SC0026492	One World Tech. Inc.	07-FEB-08		-
9917759	SC0047716	Pickens 12 Mile CK & Wolf CK	27-FEB-08	12-Mile CK	3
9777649	SC0042994	Pickens County18 Mile CK	09-OCT-08	18-Mile CK/ LK Hartwell	3
9774269	SC0026191	Pickens County Liberty Roper	10-NOV-08	Golden CK to 12-Mile CK	-
9873069	SC0047856	Pickens Cnty. Mid. Reg WWTP	26-MAR-09	18-Mile CK	9
9759948	SC0024996	Pickens Cnty. PSC/Central-North	03-JUL-08	12-Mile CK	-
9885614	SC0047899	Pickens County Stockade WWTF	07-FEB-08	12-Mile CK	-
9790769	SC0028762	R C Edwards Jr. HS	16-MAR-09	Tributary LK Hartwell	-
9759483	SC0024856	SC Dpt/Table Rock Arated	12-NOV-08	Tributary to Carrick CK	-
9826527	SC0046612	Schlumberger Tech Corp.	27-APR-09	Town CK/ 12-Mile CK/ LK Hartwell	-
9853097	SC0047198	Schlumberger Tech Corp.	28-APR-09	Schlumberger Tech Corp.	-
9747361	SC0000302	Shaw Ind. Group Inc.	14-APR-08	Huggins CK/12-Mile CK/LK Hartwell	3
9747806	SC0000434	Spangers' Grocery	20-MAY-08	Praters CK TO 12-Mile CK	-

*Unique NPDES Permit numbers under "Active/Operating" status in Pickens County, SC

Source: The New York Times citing the Environmental Protection Agency - http://projects.nytimes.com/toxic-waters/polluters/south-carolina; accessed in December, 2009

Impaired Waters

Pickens County has impaired water bodies despite NPDES permits. DHEC maintains monitoring stations throughout the state and determines whether basins should be listed as impaired on a five-year rotating cycle. According to DHEC's manual on 303(d) listings,

Water bodies are listed by point locations; however, the impairment is considered to extend for some distance upstream and/or downstream of the point location listed. The extent of the impairment of the water body is determined during TMDL development and implementation (DHEC 2010, 9).

For the 2002 through 2006 cycle, the county had 13 impaired water bodies (Table 19 and Figure 18).

Table 19: Pickens County Impaired Water Bodies

Basin	Hydrologic Unit Code	Station	Station Location	Use	Cause	TMDL Target Date
Saluda	030501090201	RS-02330	Adams CK @ UNPVD Rd from SC 8 and end of S-39-34	Aquatic Life	Turbidity	2010
Saluda	030501090201	S-103	Oolenoy RVR @ S-39-47	Aquatic Life	BIO	2013
Saluda	030501090302	RS-06151	Burdine CK @ Bdg on S-39-192 3 Mi NE of Easley	Aquatic Life	BIO	2016
Saluda	030501090302	S-300	Georges CK @ S-39-28	Aquatic Life	CU	2019
Saluda	030501090302	S-865	Georges CK @ Rd above SR 36	Aquatic Life	BIO	2019
Savannah	030601010202	SV-806	Little Eastatoe CK@ Moccasin Rd (Across from Broggs ppty)	Recreational (Swimming)	FC	2011
Savannah	030601010402	SV-206	North Fork @ US 178 2.9 Mi N of Pickens	Aquatic Life	BIO	2013
Savannah	030601010405	SV-740	Rices CK. @ SR 158	Aquatic Life	BIO	2014
Savannah	030601010406	SV-738	Golden CK @ Golden CK Rd.	Aquatic Life	BIO	2014
Savannah	030601010408	SV-107	Lk Hartwell @ 12 Mi CK	Fish Consumption	PCB	2017
Savannah	030601010601	SV-241	Woodside BR @ US 123 1.5 Mi E of Liberty	Aquatic Life	PH	2013
Savannah	030601010801	SV-205	6 Mi CK @ S-39-160	Recreational (Swimming)	FC	2016

BIO: Non-support or partial support of micro invertebrate; CU: Copper; FC: Fecal Coliform; PCB: Polychlorinated Biphenyl; PH: Hydrogen Ion Concentration

Source: South Carolina Department of Health and Environmental Control

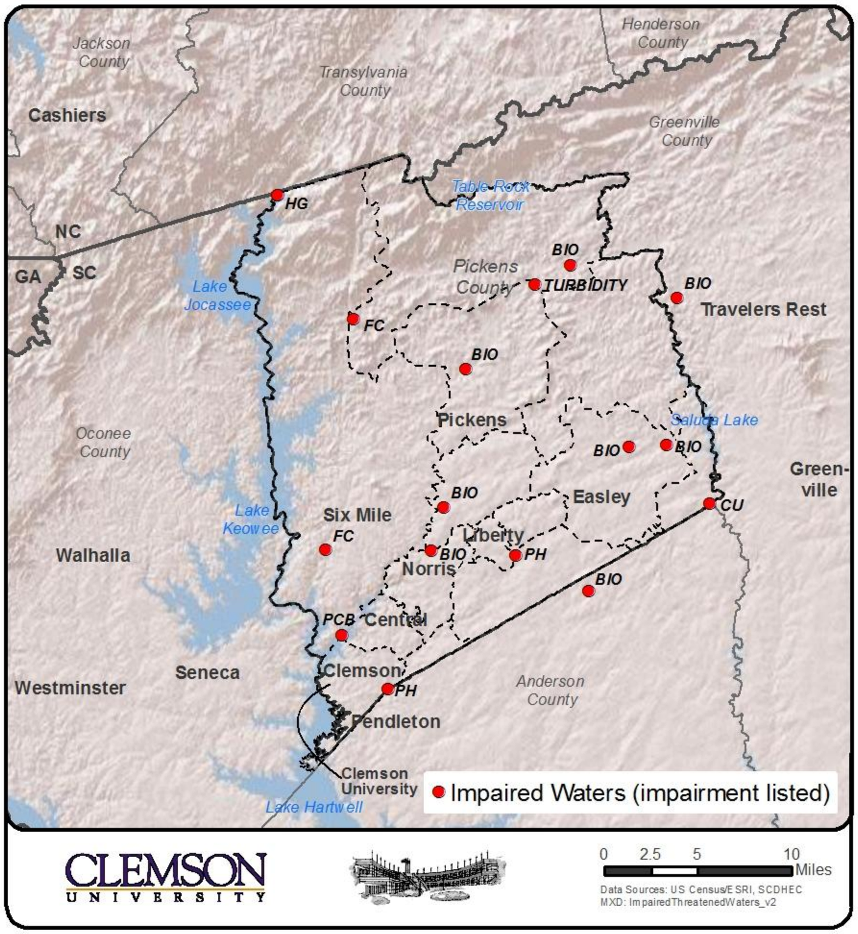


Figure 18: Impaired or Threatened Waters 2008

Source Water Assessment and Protection Programs

Source water protection was mandated for public supply systems in the federal 1996 Safe Drinking Water Act Amendments. The State of South Carolina received approval for their program in 1999 (DHEC 1999).Unlike the CWA, the Safe Drinking Water Act covers both surface and groundwater, providing protection through identification of both point and nonpoint source pollution for public water supply. Each South Carolina public supplier with source water must submit a Source Water Assessment to DHEC, which then submits to the EPA.

DHEC has delineated three zones that represent the "relative susceptibility of the intake to potential contamination sources" (DHEC 1999, 12). Zone 1 is immediately adjacent to the water source and covers immediate input/runoff into the water source. Zone 2 is a buffered area around Zone 1 "…established as a zone of concern, based on proximity to the surface water and associated travel time of potential contaminants, but as an area of relatively less concern than the very rapid overland flow and groundwater discharge typical of Zone 1" (DHEC 1999, 13). Zone

3 buffers Zone 2. Zone 3 is the remainder of the land area within the hydrologic unit code (HUC) from USGS.

For the Pickens County Water Supply Plan, Source Water Assessments were requested from all purveyors and received from ARJWS, Easley Combined Utility and Easley Central Water District. Tables 20, 21 and 22 summarize information in these three Source Water Assessments, including potential contaminant sources, eight categories of potential contaminants of interest for susceptibility analysis, and the level of susceptibility of each zone to each category of contaminant. Potential contaminant sources are land uses or site-specific activities that could potentially release contaminants of interest within the source water protection area.

Table 20: ARJWS Contaminants

800 Potential Contaminant Sources on Lake Hartwell
18 impaired waters in this system

Type of Contaminant	Zone 1	Zone 2	Zone 3
Volatile Organic Compounds	HS	HS	MS
Petroleum	HS	MS	LS
Metals	HS	MS	LS
Nitrates	HS	MS	LS
Pesticides/Herbicides	HS	HS	MS
Pathogens	HS	HS	MS
Radionuclides	HS	HS	MS
Unknown	HS	HS	MS

HS= High Susceptibility; MS= Medium Susceptibility; LS= Low Susceptibility

Table 21: Easley Combined Utility Contaminants

153 Potential Contaminant Sources on Saluda Lake
5 impaired waters in this system

Type of Contaminant	Zone 1	Zone 2	Zone 3
Volatile Organic Compounds	HS	HS	MS
Petroleum	HS	MS	LS
Metals	HS	MS	LS
Nitrates	HS	MS	LS
Pesticides/Herbicides	HS	HS	MS
Pathogens	HS	HS	MS
Radionuclides	HS	HS	MS
Unknown	HS	HS	MS

HS= High Susceptibility; MS= Medium Susceptibility; LS= Low Susceptibility

Table 22: Easley Central Water District Contaminants

211 Potential Contaminant Sources on Twelve Mile Creek
3 impaired waters in this system

Type of Contaminant	Zone 1	Zone 2	Zone 3
Volatile Organic Compounds	HS	HS	MS
Petroleum	HS	MS	LS
Metals	HS	MS	LS
Nitrates	HS	MS	LS
Pesticides/Herbicides	HS	HS	MS
Pathogens	HS	HS	MS
Radionuclides	HS	HS	MS
Unknown	HS	HS	MS

HS= High Susceptibility; MS= Medium Susceptibility; LS= Low Susceptibility

All three of Pickens County water sources assessed have a high susceptibility level to all eight categories of contaminants of interest in Zone 1. Protection of Zone 1 from contaminants is critical to the medium- and long-term health of drinking water sources in the area. Source Water Assessments should be the foundation for a local effort to develop better protection strategies for drinking water sources. Water quality information from the remaining purveyors in Pickens County should be sought in order to compile a more complete picture of the health of drinking water sources and to ensure the viability of these sources in the future as demand increases.

Drought Planning and Emergency Preparedness

The South Carolina State Climatology Office (SCSCO) is housed within the South Carolina Department of Natural Resources and has statewide responsibilities for drought management. Its actions are guided by the South Carolina Drought Response Act (S.C. Code Ann. §§ 49-23-10 et seq.), which dictates that all planning and management activities also be coordinated with the South Carolina Water Resources Planning and Coordination Act (S.C. Code Ann. §§ 49-3-10 et seq.).

The SCSCO responds to drought conditions through the actions of the South Carolina Drought Response Committee. The committee consists of members from the Department of Natural Resources, the South Carolina Department of Health and Environmental Control, the South Carolina Department of Agriculture, the South Carolina Emergency Management Division and the South Carolina Forestry Commission. Other invited participants come from various federal agencies, the South Carolina Farm Bureau and the Governor's Office. The Drought Response Committee meets on a regular basis, but more frequently when drought conditions intensify. They act in an advisory capacity to the governor and help guide actions necessary for emergency water management.

The SCSCO also provides assistance to communities and water districts in drought planning, as well as writing specific drought ordinances. Individual water districts work through their respective regional representatives to provide water use information to the SCSCO as well as to request assistance. Pickens County is in the West Drought Management Area, which is primarily comprised of counties within the Savannah River Basin. While the SCSCO can provide generalized drought management recommendations, it is up to individual water purveyors to implement water conservation measures or water restrictions during a drought period.

Emergency preparedness within Pickens County varies among the water purveyors. Bethlehem-Roanoke, the City of Pickens and Easley Combined Utilities rely on GWS as an alternative water source in case of an emergency. Easley Central relies on Easley Combined in case of an emergency, as well as on emergency generators at the plant and pump stations in Liberty and Central. The Town of Central has an agreement with Pickens County in case of an emergency, as well as connections with Clemson.

The City of Clemson has emergency interconnections with Clemson University and the Town of Central. Clemson University has emergency interconnections with the City of Clemson, and the ability to draw water from water tanks. The City of Liberty cited Bethlehem-Roanoke, Southside and Easley Central as alternative water sources. Southside, Powdersville, and PCWA have regular connections with multiple providers that should suffice in case of an emergency. Dacusville-Cedar Rock cited an emergency communication and notification list for use in the event of an emergency. Powdersville also cited their emergency preparedness and vulnerability assessment plans. Six Mile identified no emergency plans or alternative water sources.

Pickens County could benefit from expanding communication and collaboration throughout the county's water purveyors to develop emergency and drought response plans. As the county's population grows and demand for water increases, emphasis should be placed on protecting the quality of life for the community in times of emergency. County-wide redundancy in water infrastructure and emergency interconnections between purveyors should be expanded for use in case of emergency.

WATER BUDGET

The water budget for Pickens County is shown in Table 23. Typically, a water budget takes into account the natural hydrological cycle and is therefore only concerned with precipitation, evapotranspiration, surface runoff and groundwater recharge within a watershed or some other natural system. However, human uses of water need to be taken into consideration when constructing a water budget for water planning purposes. The budget accounts for all of the contributions to the county's water supply and the drainage, to generate a net amount of water available for all sectors (including the environment, whose flows are not calculated).

The inputs for the Pickens County water budget include precipitation, septic tanks, NPDES permits, water transfer, imported and exported water, surface water consumption, groundwater consumption, evapotranspiration, and stream flow. These inputs into the water budget are either positive if water is entering the county or negative if water is leaving the county. The output of the water budget tells whether there is net gain or net loss of water in the system, in this case, Pickens County.

Some water budgets contain more comprehensive categories as well as results of flow modeling analysis, but the Pickens County water budget is based on available data for the categories described with no modeling analysis because of budget and time constraints. The water budget permits a general accounting of availability for future growth so that demand projections can be compared with existing allocations and available supply. Some inputs and outputs cannot be controlled (e.g. precipitation, evapotranspiration, etc.). Others inputs and outputs are affected by social and legal arrangements (e.g. water transfer, NPDES input, water export, etc.).

Table 23: Water Budget for Pickens County

Source	Amount (MGD)
Precipitation	1,323.22
Septic Input	3.38
NPDES Input	3.42
Water Imported	4.09
Water Exported	-22.22
Surface Water Consumption	-17.45
Ground Water Consumption	-0.34
Evapotranspiration	-849.58
Natural Stream Flow	-316.31
Balance	128.21

Precipitation

The average annual precipitation rate in Pickens County, as recorded by South Carolina State Climatology Office, was 55.93 inches from 1951 to 2006, represented by the observation point Pickens 5 SE. This record was converted to feet, multiplied by the total acreage in Pickens County, divided by days in a year and then multiplied by a conversion factor of one acre-feet of water equals 325,851 gallons to find that Pickens County receives about 1,323.22 MGD of precipitation.

Septic Input

In a study conducted by the Saluda-Reedy Watershed Consortium that generated a water budget for the Saluda-Reedy watershed in Pickens and Greenville Counties, it was assumed that 30% of the watershed's population is served by on-site wastewater systems (septic systems). Using this percentage for the current water plan, it is assumed that 35,767 individuals in Pickens County are on septic systems. The water plan assumes 234.1 gal/day/unit in single-family households, based on the current usage by purveyor and assumes 2.48 people per house, based on the 2010 U.S.

Census. These numbers result in a per person usage rate of 94.4 gallons per day. Using an accepted average water per capita daily usage formula (94.4 GPD * 35,767 individuals), it can be assumed that 3.38 MGD of water is returned to the hydrologic system in Pickens County.

NPDES Input

The 2008-2009 Pickens County Budget contained records of the amount of wastewater being discharged from NPDES permit holders. The amount of NPDES discharge entering the county was found to be 0.86 MGD by using the 2007 actual discharge number as an estimate of current discharge for wastewater treatment plants. Data for industrial and commercial NPDES permits was lacking for this study so an estimate from the demand forecast model was used that included 1 MGD for commercial and 1.5 MGD for industrial. The total of these three sectors is 3.42 MGD for NPDES input of water.

Water Transferred

The volume of water transferred across county boundaries by water purveyors was calculated based on purveyor-provided information. Water is moved into, out of, and around the county in significant amounts. Figure 19 illustrates the movement patterns of water between different purveyors.

- Certain assumptions based on available data were made in order to calculate water transfers in Pickens County. These assumptions are:

- Water movement is based upon the amount purchased minus the amount sold. These are total amounts as reported per district realizing that some districts have land area and customers outside of Pickens County.

- All water bodies on the county border are considered in-county (i.e. all water from Lakes Saluda and Keowee is in-county)

- Greenville is using 24.1 MGD of its IBT permit (estimate based on best available data at the time interview data with Greenville Water System was collected)

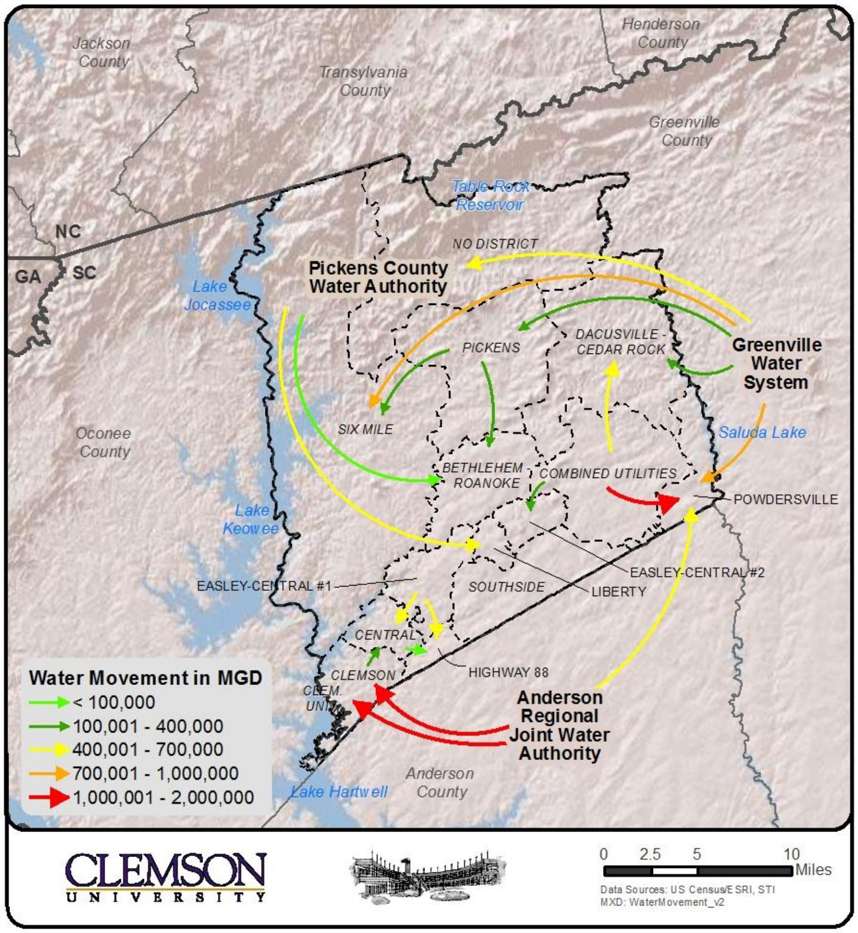


Figure 19: Water Movement in the Pickens County Area

Water Imported

The water utilized by Pickens County purveyors was divided based on whether it came from an in- or out-of-county source. All in-county sources include water being withdrawn from any intake within the jurisdiction of Pickens County. This includes the Greenville Water System intake on Lake Keowee. It does not include the Anderson Regional Joint Water System intake on Lake Hartwell, which is located in Anderson County. Water that was transferred within Pickens County from purveyor to purveyor was eliminated to avoid double counting.

The amount of water imported into Pickens County by ARJWS was 4.09 MGD in 2008. This figure includes the amount of water that the Town of Central purchased from Easley Central in 2008 because Central's contract is now with ARJWS.

Table 24: Purveyor Water Purchases and Consumption in Pickens County, 2008

Water System	Water Source	Volume Purchased or Withdrawn (MGY)	Volume Sold (MGY)	Volume Consumed In District (MGY)	Volume Consumed In District (GPD)
Bethlehem-Roanoke	Pickens PCWA Easley Combined	179.8	0	179.8	492,476
Central	Easley Central City of Clemson	259.4	16.8	242.6	664,534
City of Clemson	ARJWS	722.5	84.4	638.1	1,748,186
Clemson University	ARJWS	374.6	9.8	364.8	999,452
Dacusville-Cedar Rock	GWS Easley Combined	286.2	0	286.2	784,000
Easley Central	Twelve Mile Cr. Easley Combined Liberty Southside	565.7	390.3	175.4	480,548
Easley Combined Utilities	Saluda Lake GWS	3,239.7	1,267.7	1,972.1	5,402,887
Highway 88	Central Easley Central	196.6	Not provided	196.6	538,721
Liberty	PCWA Easley Central	192.0	0	192.0	526,027
City of Pickens	City Lake Twelve Mile Cr. GWS	587.2	265.7	321.6	881,005
Powdersville	ARJWS GWS Easley Combined	1,043.4	0	1,043.4	2,858,575
Six Mile	GWS Pickens	402.5	0	402.5	1,102,787
Southside	Easley Combined Easley Central PCWA	355.4	0	355.4	574,542
TOTAL		8,405.0	2,034.6	6,370.3	17,452,095

Data for Highway 88, Powdersville and Southside Rural includes total consumption within the district, although we realize that these districts have some customers outside of Pickens County. Using estimated water consumption in Pickens County for these districts, total water consumed in 2008 Pickens County may be lower at 14,255,095 GPD. Highway 88 data is incomplete. Detail may not add to totals due to rounding.

Water Exported

It is important within the water budget to know if large amounts of water are being exported from the county. The Greenville Water System draws approximately 24.1 MGD from Lake Keowee, which is considered a Pickens County water source. Some of this water (approximately 1.88 MGD) goes to Pickens County purveyors. However, the majority of the exported water (approximately 22.22 MGD) goes to Greenville County and the Greenville Water System.

Surface Water Consumption

Surface water consumption is the difference between all of the water withdrawn from sources inside of the county and all of the water that is transferred out of the county. The total volume of water from all sources that is used within Pickens County was calculated to be 17.45 MGD in 2008. Water transferred out of the county was already counted as part of the water budget in the export section. Table 24 gives a detailed account of surface water consumption by purveyor. This calculation includes the assumption that 1.88 MGD of the 24.1 MGD that Greenville Water System exports actually stays with purveyors in Pickens County.

Ground Water Consumption

According to numbers received from SCDHEC, 1,445 residential groundwater well permits were issued in Pickens County between 1990 and 2008. If this number is multiplied by the Pickens County average household size of 2.48 people per house, based on the 2010 U.S. Census it can be assumed that 3,584 people use groundwater as their primary water source. These numbers result in a per person usage rate of 94.4 gallons per day. Using an accepted average water per capita daily usage formula (94.4 GPD * 3,584 individuals), it can be assumed that 0.34 MGD of groundwater is consumed from the hydrologic system in Pickens County.

Evapotranspiration

According to data retrieved daily from Clemson-Oconee Airport (KCEU) from 2001to 2008 (3,287 days) by the Southeast Regional Climate Center at the State Climate Office of North Carolina, the average evapotranspiration rate applied to Pickens County is 51.30 inches per year. This record was converted to feet, multiplied by the total acreage in Pickens County, divided by days in a year and then multiplied by a conversion factor of one acre-feet of water equals 325,851 gallons to find that Pickens County loses about 1,213.68 MGD of evapotranspiration. Because these rates are calculated from pan evaporation rates a conversion factor of 0.7 must be applied to factor a slower actual evaporation rate (Purvis, J. http://www.dnr.sc.gov/climate/sco/Publications/pan_evap_records.php). After applying the conversion factor, the final rate of evapotranspiration is 849.58 MGD.

Natural Stream Flow

Reports obtained from USGS water flow gauges record average stream flow from 1943 to 2008 for the Saluda River and from 1955 to 2008 for Twelve Mile Creek. The average flow for Saluda River over this time period was found to be 615.63 ft^3/sec and the average flow for Twelve Mile Creek was found at 180.32 ft^3/second. For calculation purposes only one half of the flow of the Saluda was used for flow calculations because it borders Greenville County.

It is important to note that Pickens County sits high in its watersheds and is very near the Eastern Continental Divide. There is very little stream flow into the county so it is highly dependent on precipitation. The total average stream flow of the two major rivers of 488.13 ft^3/second was converted to gallons per second, gallons per minute, gallons per hour and gallons per day to reach the final value of 316.31 MGD of water leaving the county.

Interbasin Transfer

The legal authority for the interbasin transfer across Pickens County formerly originated in an interbasin transfer statute, which has now been repealed and superseded by the South Carolina Surface Water Withdrawal and Reporting Act of 2010. Effective on Jan. 1, 2011, the new legislation subsumed the existing interbasin transfers into the broader existing surface water withdrawer category, effectively grandfathering them for the term stipulated in the original transfer agreement under the old statute.

Like other prospective surface water withdrawers, "a renewal of an inter basin transfer permit or registration must be made pursuant to the criteria established . . . for existing surface water withdrawers, except that permits or registrations renewed within three years after the effective date of this chapter must be renewed for a quantity at least equal to the permitted quantity in the expired permit" (S.C. Code § 49-4-70 (C) (2011)).

All surface water withdrawers must comply with the enumerated permit application contents, reasonableness of the use, and safe yield for the water body from which the water will be withdrawn (S.C. Code § 49-4-80 (2011)).Additionally, if there is not enough water left in the system, DHEC will convene the existing permit holders to determine if they can decrease their allocation to accommodate the permit applicant's needs.

Presently, water is being transferred between two basins within Pickens County. The county is split between these two water basins: the Upper Savannah River and the Saluda River basins. The Upper Savannah contains the majority of the land in Pickens County, but the eastern portion of the county drains into the Saluda Basin.

For purposes of this report, some assumptions were made in order to simplify the calculations. Specifically, Dacusville-Cedar Rock, Easley Combined Utilities and Powdersville Water were assumed to fall entirely within the Saluda River Basin. All other water providers within the county were assumed to fall entirely within the Upper Savannah River Basin. Additionally, Powdersville is estimated to have 20% of its water supplied to accounts in Pickens County (Table 25).

Table 25: Interbasin Transfers

Transfer From	Transfer To	Amount (GPD)
From Savannah Basin	*To Saluda Basin*	
Lake Keowee	GWS	21,286,632
Lake Keowee	Dacusville-Cedar Rock	242,000
Lake Keowee	Powdersville	810,958
ARJWS	Powdersville (only 20% going to Pickens Co.)	122,570
Total transferred from Savannah Basin to Saluda Basin		***22,462,160***
From Saluda Basin	*To Savannah Basin*	
Easley Combined	Southside	16,048
Easley Combined	Easley Central	335,253
Total transferred from Saluda Basin to Savannah Basin		**351,661**
Net Interbasin Transfer from Savannah Basin to Saluda Basin		***22,110,499***

Note: Dacusville-Cedar Rock, Easley Combined Utilities, and Powdersville fall entirely within the Saluda River Basin. All other Pickens County water purveyors fall entirely within the Savannah River Basin. GWS withdraws 24,100,000 GPD from Lake Keowee at the Adkins Plant.

SECTION 3: WATER DEMAND FORECASTS

METHODOLOGY

There are a myriad of accepted ways to generate water demand forecasts (Baumann et al. 1998). This plan uses a simple linear projection methodology in ten-year intervals from 2010 through 2030. This approach was selected to accommodate data limitations encountered throughout the data gathering process, including lack of district-specific accounting for water use by sector and class.

This model of water demand also relies on a combination of land use and economic forecasting to generate water demand scenarios instead of being based on population by sector. The model projects demand based on fiscal output and units associated with land use change. Population projections are used to verify the demand forecasts because they can drive residential and commercial water demand.

Thermoelectric generation and irrigation are the highest water consuming sectors nationally (although the former is generally non-consumptive, while the latter is consumptive). These are followed by public supply —including commercial and most residential— and industrial sectors, respectively (Barber 2009). In Pickens County, there are no thermoelectric generation or mining sectors. The county's primary water use sectors are residential, commercial, industrial, irrigation and livestock.

GROWTH PROJECTIONS

Population Trends

In 2010, the population in Pickens County was 119,224 (U.S. Census 2010). Since the 1960s, the population in Pickens County has steadily grown, which reflects the growth trend of South Carolina as a whole. Population in Pickens County increased by 159% in the last 50 years, compared with 94.1% in South Carolina and 72.2% in the United States (Table 26). While there was over a 20,000- person increase between 1970 and 1980, the county population is generally increasing by a range of 8,000 to 17,000 each decade. According to the United States Census, the population of Pickens County had its slowest growth in the last 50 years (over 8,000 people) during the 2000 – 2010 decade. Continued growth despite the economic downturn from 2007 – 2009 suggests that Pickens County's population will grow at a substantial pace for a mostly rural South Carolina county.

Table 26: Historical Population Numbers in Pickens Co., South Carolina and the U.S.

	1960	1970	1980	1990	2000	2010	% Change 1960-2010
US	179.3M	203.2M	226.5M	248.7M	281.4M	308.7M	72.2%
SC	2,382,594	2,590,516	3,121,820	3,486,703	4,012,012	4,625,364	94.1%
Pickens	46,030	58,956	79,292	93,894	110,757	119,224	159.0%

Sources: 1. US Census Bureau, 2000 and 2010 US Census. 2. South Carolina Budget and Control Board

From 2010 to 2020, the county is projected to add almost 17,500 additional people, and over an additional 14,000 in the following decade (Table 27). Pickens County is estimated to reach a population that exceeds 150,000 people by 2030, an increase of about 32,000 people from 2010. And more people, whether from natural increase or a greater net immigration rate, as well as the associated industries and land uses generate varying but increasing levels of water demand.

Table 27: Population Change

	2000 [1]	2010 [1]	2020 [2]	2030 [2]	Difference 2010-2030	% Change 2010-2030
SC Total	4,012,012	4,625,364	4,949,090	5,407,890	782,526	16.92%
Pickens	110,757	119,224	136,700	151,280	32,056	26.89%

Sources: 1. US Census Bureau, 2000 and 2010 US Census. 2. South Carolina Budget and Control Board

Population Distribution and Change

Population density shows population concentration in different parts of the county, which directly corresponds to the water supply needs for each purveyor's service area. Pickens County covers 497 square miles of land area and in 2010 had a population of 119,224 people, an average density of 233 persons per square mile. In Figure 20, the population density for every census group shows the 2010 population distribution in Pickens County. Population density is highest in the Easley Combined Utilities and City of Clemson service areas.

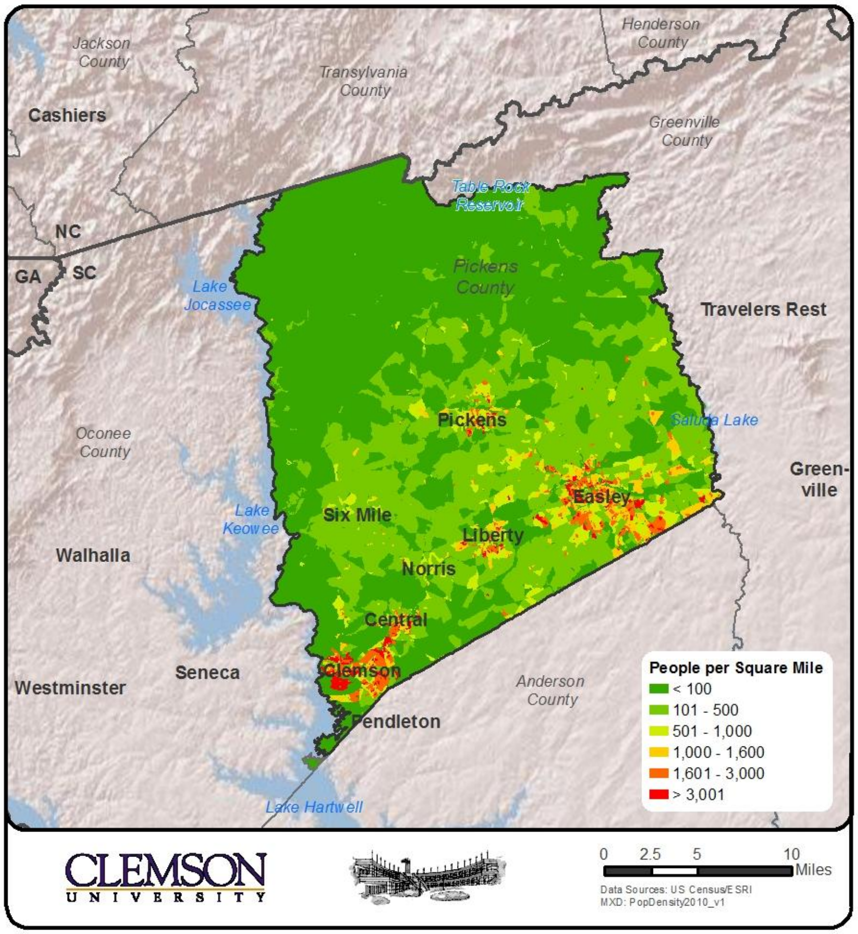


Figure 20: 2010 Population Density

Figure 21 shows recent estimated county population growth by block group from 2000 through 2007. Year 2010 is not used because that census changed block group location. Although the total county-level population increased, the map shows that density did not increase uniformly throughout the county. Instead, block groups lost population in the Cities of Clemson and Pickens and in Southside Rural's service area. Some of the Six Mile service area added anywhere from 201 – 1,000 people per square mile, as did Easley Central #2, Easley Combined Utilities, Dacusville-Cedar Rock, and Powdersville.

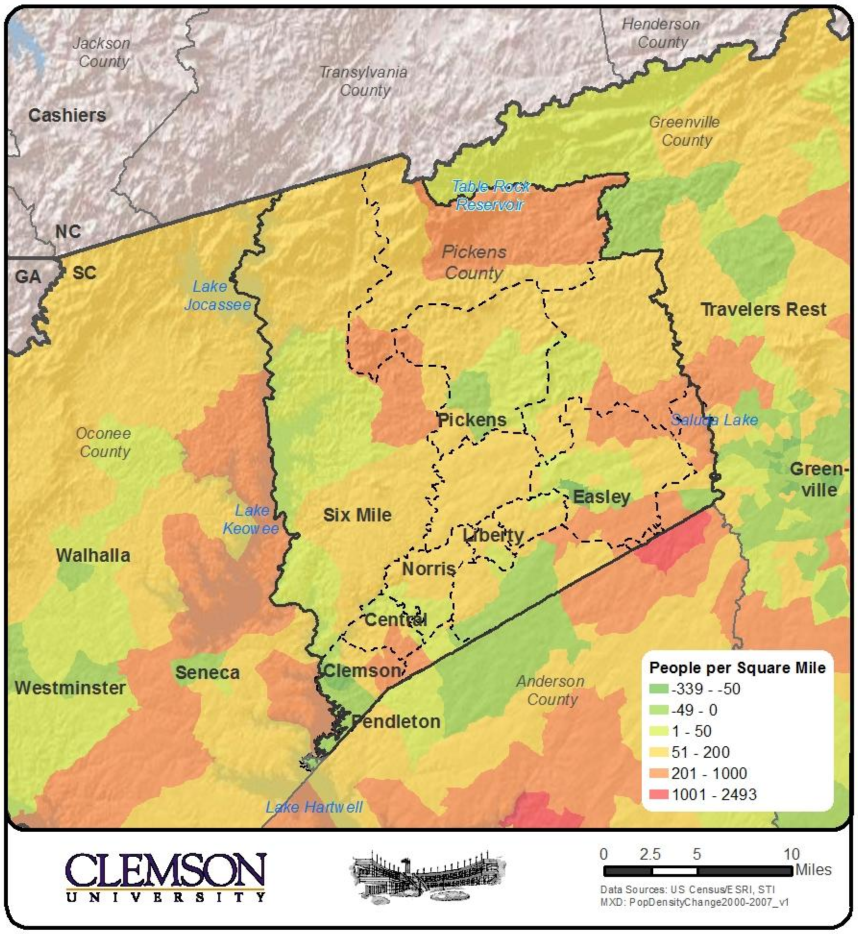


Figure 21: 2000 – 2007 Population Density Change

Land Use Change

Population growth drives urbanization, affecting where and how land uses will change. Land uses also drive water demand. The future growth pattern of developed land was modeled for Pickens County using a GIS-based logistic regression model developed by STI. Results from this model were used as input into the water supply plan to help understand where and when growth is likely to occur, and subsequently, where and when water demand is likely to increase.

The GIS growth model operates in the following manner: paired GIS data sets depicting developed land for Pickens County at two points in time show the change over that period. The developed land data sets are raster images that have been extracted from land cover data, which is derived from remotely-sensed imagery. The model also uses geographic features that appear to have influenced growth during the two points in time and which are likely to influence future growth; e.g. the presence of interstate highways, infrastructure service (water and sewer lines), etc. The model maps the distance to these features and uses them as input variables.

Using the two historic developed land data sets and the input variables, a binary logistic regression establishes the correlation between each variable and the observed change in developed land. The regression results generate a future probability grid to indicate the relative likelihood that each cell develops. If a cell is already developed at the time of the regression, it is given a probability of 1.0. Protected and/or undevelopable areas (water bodies, wetlands, protected lands, etc.) are assigned a future development probability value of 0.0. Between 0 and 1, cells with higher probability values are more likely to develop than those with lower probability values. Once complete, the future probability grid, existing developed land, future population forecast, and ratio of developed land growth to population growth are combined to calculate the desired developed land area at future dates. The GIS growth model then uses the probability grid to select cells, starting with the highest probabilities and working down, until the total area is equal to the desired future area.

For this water supply plan, the growth model was projected from 2000 to 2010 and from 2000 to 2030. The year 2010 projections were compared with actual land use in Pickens County, and the result basically matches existing use locations, confirming the model's accuracy in predicting growth further into the future.

It is important to note that the land use change indicated in Figure 22 does not indicate the kind of land use; merely that the land is changing from undeveloped to an unspecified developed use (with different intensities and water demand). Appendix 4 includes a more detailed example of the anticipated growth within each water district, with maps of both the 2010 and 2030 growth, as well as the water lines. A comparison of the water lines with the future growth will aid a discussion of future infrastructure capacity.

To obtain a projection of future water demand based on land use type and associate density, pixels of developed land in 2010 and 2030 generated by the GIS growth model were converted to actual acreage. Table 28 shows the projected change in developed acreage by water purveyor service area from 2010 to 2030. The yellow cells in Table 28 indicate nearing build out (over 80% developed), and the red cells indicate close to build out (over 90% developed). Again, it is important to note that "developed" means any urbanized use of any density.

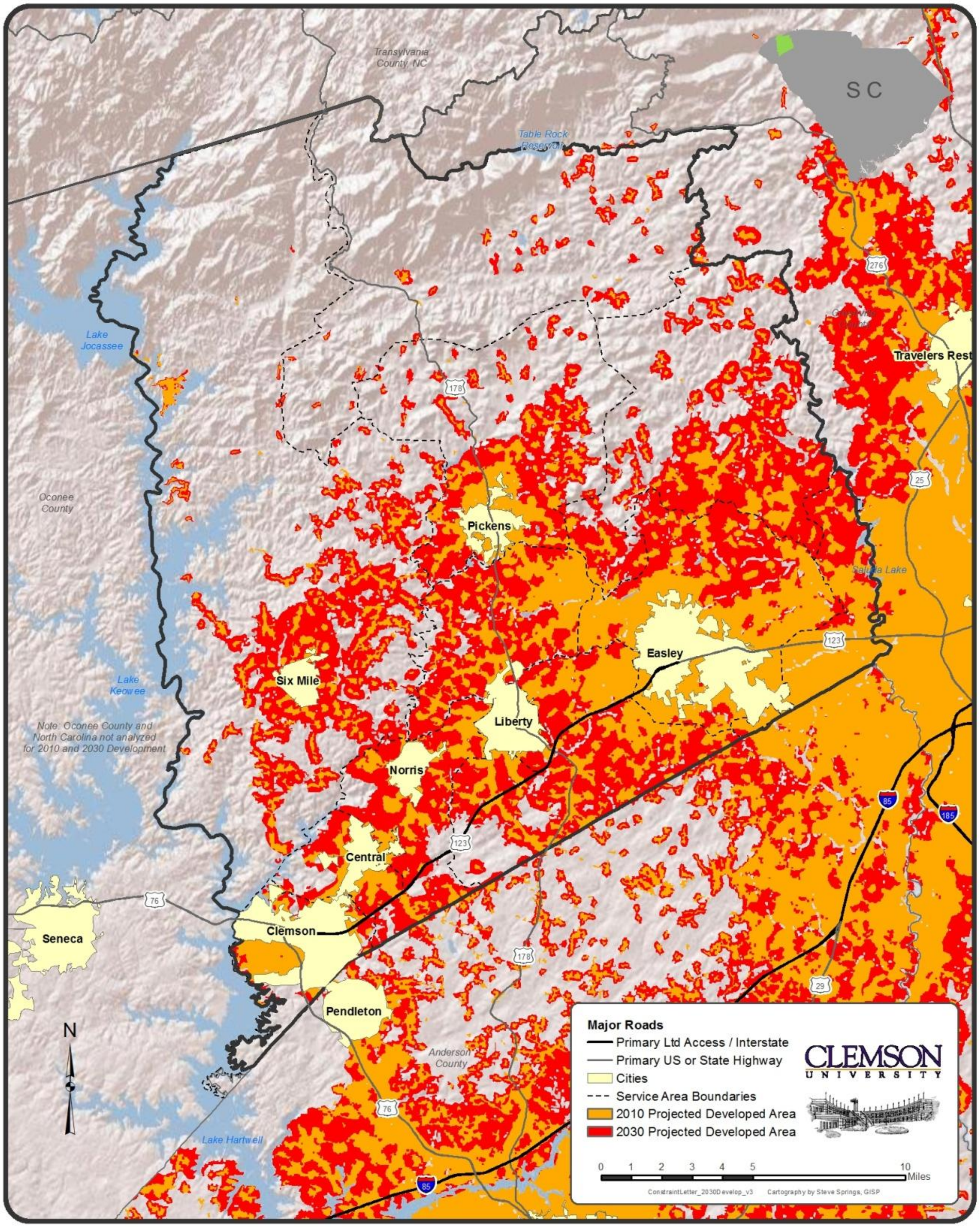


Figure 22: Growth Areas

Table 28: Land Use Change in Developed Acreage by Service Area

Water District	Total Area Acres	Parcel Land Use Acres	2010 Developed Pixels	2010 Developed Acres	2010 Developed %	2020 Developed Pixels	2020 Developed Acres	2020 Developed %	% Growth 2010 - 2020	2030 Developed Pixels	2030 Developed Acres	2030 Developed %	% Growth 2020 - 2030
Bethlehem-Roanoke	14,448	9,265	27,248	6,060	42%	40,858	9,087	63%	50%	54,195	12,053	83%	33%
Central	5,664	3,733	11,964	2,661	47%	16,315	3,628	64%	36%	19,109	4,250	75%	17%
Clemson	10,254	6,858	27,045	6,015	59%	29,637	6,591	64%	10%	30,195	6,715	65%	2%
Combined Utilities	26,234	15,798	81,362	18,094	69%	101,407	22,552	86%	25%	107,802	23,975	91%	6%
Dacusville-Cedar Rock	36,388	24,565	28,089	6,247	17%	48,471	10,780	30%	73%	80,321	17,863	49%	66%
Easley-Central #1	9,729	6,651	16,686	3,711	38%	28,599	6,360	65%	71%	37,316	8,299	85%	30%
Easley-Central #2	4,885	3,508	12,654	2,814	58%	18,587	4,134	85%	47%	20,829	4,632	95%	12%
Highway 88	2,732	2,144	2,412	536	20%	4,361	970	36%	81%	8,430	1,875	69%	93%
Liberty	2,755	1,688	10,517	2,339	85%	11,928	2,653	96%	13%	12,057	2,681	97%	1%
Pickens	30,618	20,718	32,448	7,216	24%	47,083	10,471	34%	45%	60,083	13,362	44%	28%
Powdersville	9,091	5,535	26,203	5,827	64%	34,701	7,717	85%	32%	36,658	8,153	90%	6%
Six Mile	105,617	75,870	39,841	8,860	8%	62,390	13,875	13%	57%	99,754	22,185	21%	60%
Southside	17,044	11,418	25,585	5,690	33%	42,589	9,472	56%	66%	59,466	13,225	78%	40%
No District	52,688	42,877	9,530	2,119	4%	12,476	2,775	5%	31%	16,532	3,677	7%	33%
TOTAL	**328,147**	**230,627**	351,584	78,190		499,402	111,064			642,747	142,944		

Because land use type corresponds to sectoral water demand, categories of land uses were assigned to projected county developed land acreage by district. The Pickens County Planning Department projected land use character areas to guide future use location in the developable areas (Figure 23). Land use character areas are not actual zoning or a guarantee of a particular development type. But when they were compared to actual parcel level land use, which was done through assessor's office records for the county, the land classes were quite similar. This finding lends validity to the predictive capacity of these character areas, suggesting that they present a realistic scenario of future development patterns.

Separate land use categories with their associated densities were generated by the models, building upon the Pickens County Planning Department's projections and the parcel-level use data from the Pickens County Assessor's office. Densities from Rock Hill, South Carolina, which is similar to Pickens County in spatial layout and land use types, were also used. These categories include: low to medium residential (1 to 5 units per acre), high density residential (20 units per acre), commercial, industrial, protected, and other (permanent right of ways, etc). Densities were then projected linearly across each category by water district for years 2020 and 2030, with several assumptions that are enumerated in Appendix 1. Tables 29 and 30 show the acreage by water district in each land use category.

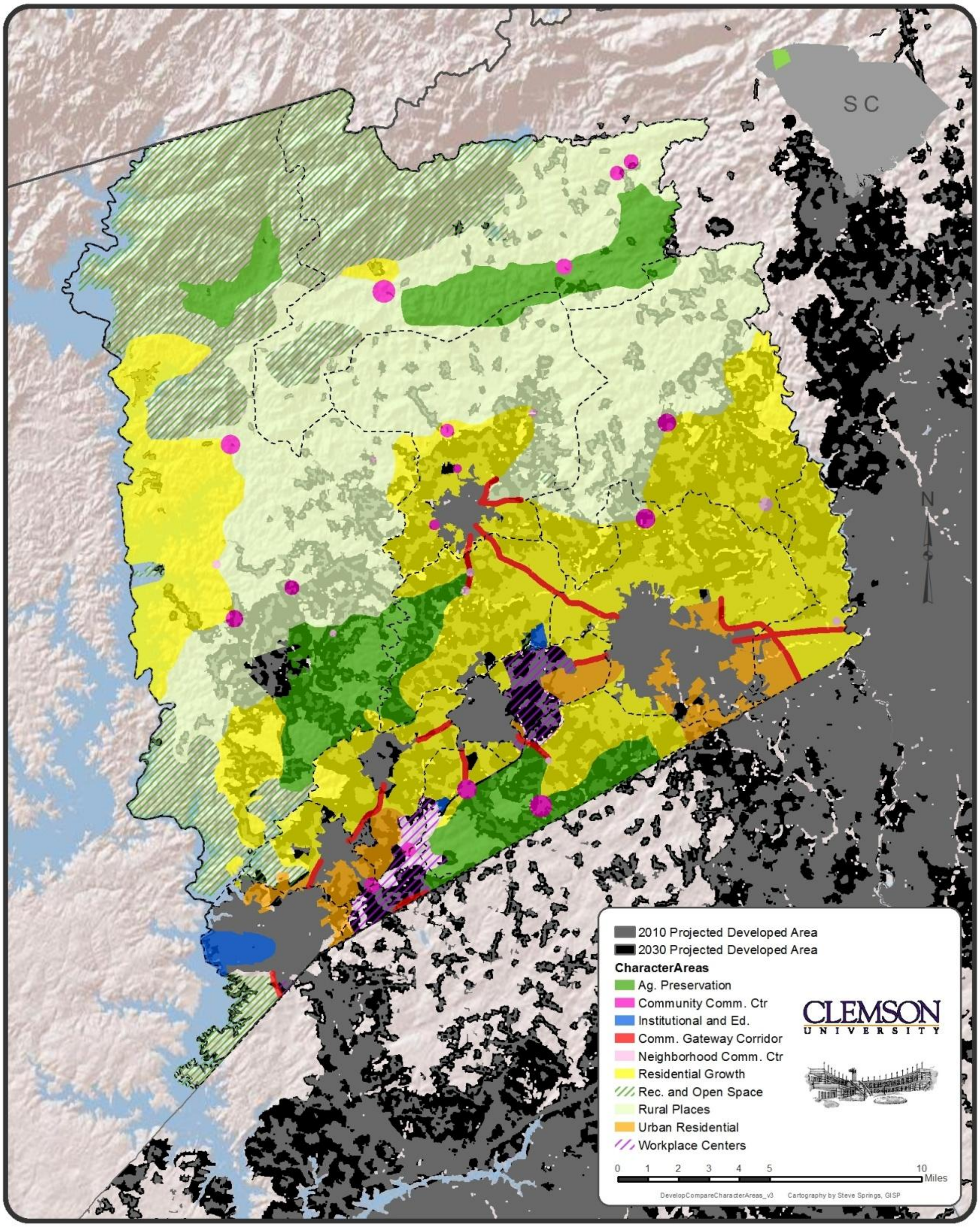


Figure 23: Character Areas + Projected Growth Areas

Table 29: Estimated Pickens County Land Use by District for 2020

Water District	Low to Med. Density Residential	High Density Residential	Resid./ Comm.	Commercial	Industrial	Protected	Other
	acres	acres	acres	acres	acres	acres	acres
Bethlehem-Roanoke	3,179	5	18	74	84	91	5,428
Central	760	167	53	191	100	-	3,202
Clemson (City & CU)	718	402	20	348	55	3,117	3,838
Dacusville-Cedar Rock	8,502	27	42	106	169	123	12,292
Easley Central #1	1,962	5	73	109	315	-	4,422
Easley Central #2	673	2	69	124	563	8	2,133
Easley Combined	4,785	218	160	1,411	317	44	8,744
Highway 88	377	5	240	8	20	-	2,033
Liberty	395	21	20	172	15	-	1,104
Pickens	5,769	51	199	428	265	94	10,884
Powdersville	1,616	56	175	681	26	-	3,178
Six Mile	13,132	68	256	271	570	32,315	38,644
Southside	3,622	57	328	415	87	1	6,447
No District	5,040	-	34	88	-	16,964	14,773
TOTAL	50,530	1,084	1,687	4,426	2,586	52,758	117,122

Table 30: Estimated Pickens County Land Use by District for 2030

Water District	Low to Med. Density Residential	High Density Residential	Resid./ Comm.	Commercial	Industrial	Protected	Other
	acres	acres	acres	acres	acres	acres	acres
Bethlehem-Roanoke	4,217	6	24	98	111	96	4,053
Central	890	196	62	224	117	-	2,899
Clemson (City & CU)	732	410	20	355	56	3,117	3,349
Dacusville-Cedar Rock	14,089	45	70	176	280	129	7,180
Easley Central #1	2,560	7	95	142	411	-	3,377
Easley Central #2	754	2	77	139	631	8	1,435
Easley Combined	5,086	231	170	1,500	337	46	5,692
Highway 88	728	10	464	16	38	-	3,005
Liberty	400	21	20	174	15	-	794
Pickens	7,361	65	254	546	338	99	6,263
Powdersville	1,707	60	185	719	27	-	1,995
Six Mile	20,997	109	410	433	911	33,931	38,896
Southside	5,057	80	457	579	122	1	4,314
No District	6,678	-	46	117	-	17,813	8,357
TOTAL	71,257	1,241	2,354	5,218	3,396	55,240	91,607

Economic Growth

Even after characterizing future developed acreage in Pickens County by land use category, the volume of growth in larger water-consuming sectors had to be determined in order to quantify demand. To do so, estimates of the value of economic output (goods and services produced) was generated on an annual basis from 2001 through 2030 for commercial and industrial sectors in Pickens County by the Regional Dynamics (REDYN) Economic Model.

REDYN is currently the largest computer model of the United States economy ever built, with data for every county in the nation (over 3,100 regions). The REDYN model contains a baseline estimate of economic and fiscal activity in each region, which is based on historical and projected estimates of "status quo" economic activity. User inputs are processed by the model to estimate the changes relative to the baseline that these inputs would have on the economy within the selected region(s) and in state and local governments' fiscal position.

REDYN is a true New Economic Geography model. It does not estimate economic impacts for a region in a vacuum; rather, every model takes into account the impacts to the remainder of the nation and all surrounding counties (including those the user has not selected to be available for output). This allows the model to incorporate the effect of land and transportation costs on the allocation of labor and capital and product flows. Transportation is modeled using data from the Oak Ridge National Laboratory's transportation study. The REDYN model is also dynamic, modeling impacts over multiple years, beginning in 2001 and projecting forward as far as 2055.

To examine how the economic character of Pickens County would change from 2010 to 2020 and from 2020 to 2030; the plan used the Input-Output (I/O) function of the REDYN model. I/O models are the industry standard and the linear assumptions associated with I/O models are scalable and additive. Yearly economic output from 2001 through 2030 was generated and normalized to thousands of 2008 dollars by 3-digit NAICS codes (an industry classification structure). Although the model generated estimates at the 4 and 5-digit NAICS code level as well, the 3-digit codes were used because they correspond to the USGS water use numbers. REDYN output is too large to show within the report, so please see Appendix 6.

In 2030, the highest value of output in the industrial water use sectors was projected to be from computer and electronics manufacturing, textile mills, machinery manufacturing, and fabricated metal product manufacturing. Industrial water use sectors were also evaluated on their projected growth from 2010 to 2020 and from 2020 to 2030. Table 31 shows the thirteen industrial sectors that the REDYN model projected would have the highest dollar value of outputs in Pickens County. The sectors were consolidated to allow for better management of the larger industrial category.

Clearly industry is going to be an important economic driver—and big water consumer—in Pickens County's future. The plan does not assign future locations for types of industry, however. Instead, Figure 24 shows possible industrial expansion area locations derived from a combination of existing and projected sites from the Appalachian Council of Governments (ACOG), the South Carolina Department of Commerce, Alliance Pickens, and the University of South Carolina's GIS lab. These sites have the potential for synergy with existing uses, transit access and other infrastructure, all of which could make them attractive for future industrial location. However, these are only possible industrial expansion areas, which could have implications for the water districts in which they are located.

Table 31: 13 Key Industry Sectors from Projected REDYN Growth 2010 – 2030

Assigned Category	NAICS	R2010	R2020	R2030
Apparel	315	$ 65.81	$62.00	$77.41
Chemicals	325	43,889.15	50,813.68	63,827.35
Computer and Electronics Product Manufacturing	334	348,698.00	512,430.86	636,649.32
Electrical Machinery	333	205,797.62	276,208.03	345,491.49
Fabricated Metal Products	332	165,456.51	212,031.03	264,368.87
Food-Food Manufacturing	311	11,111.84	13,968.27	17,323.20
Petroleum and Coal Products	324	6,657.27	8,304.85	10,368.55
Plastics and Rubber Products Manufacturing	326	40,978.02	53,763.02	66,862.94
Primary Metals	331	21,830.69	29,022.59	36,519.22
Textiles- Textile Mills	313	282,211.42	337,135.38	425,616.14
Textiles-Textile Product Mills	314	103,740.27	129,725.75	162,266.07
Transportation Equipment Manufacturing	336	132,502.61	168,429.66	211,326.40
Other Industrial	233, 234, 235, 316, 321, 323, 327, 335, 337, 339, 511	224,102.19	282,688.39	349,259.47
Grand Total		**$1,587,041.40**	**$2,074,583.50**	**$2,589,956.42**

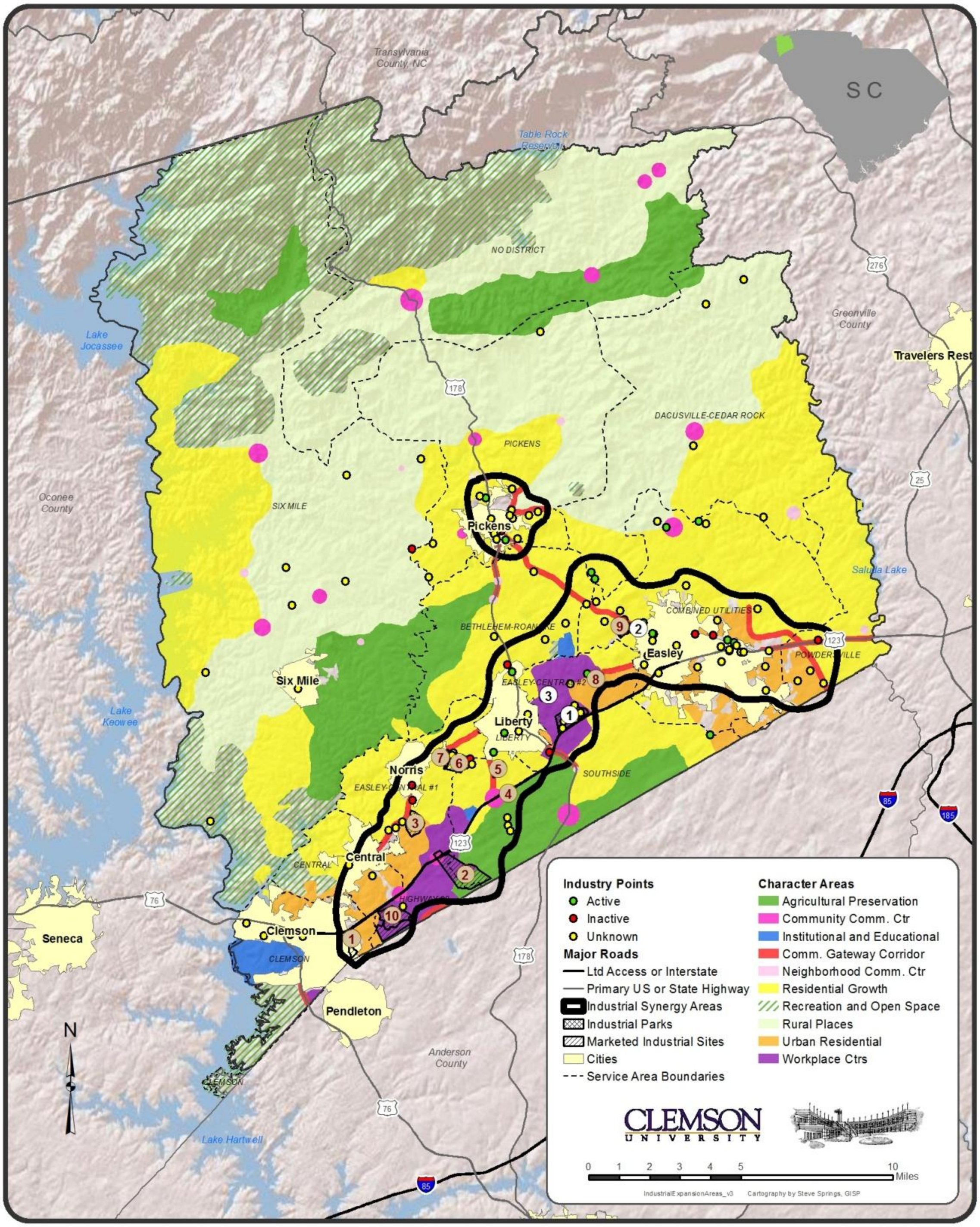


Figure 24: Industrial Expansion Areas

Sectoral Demand Forecasts

Once land use change projected by water district was established, it was possible to project water demand by water use sector. To do so requires baseline water consumption by sector. Given the regional nature of water use, it was initially expected that discussions with Pickens County water purveyors would generate that baseline consumption. The purveyors were each asked about their delivery volume and/or consumption by sector, the number of accounts for each sector, and the consumption data associated with each sector (Section Two and Appendix 2). However, despite metering, purveyor self-reporting revealed that most of the water districts were unable to identify the amount of water being consumed by classes within sectors (i.e. single-family versus multi-family residential). And in some cases, purveyors could not identify water consumption by sector (i.e. residential versus commercial).

Consequently, the plan has had to rely on an amalgam of water use sources for different sectors. To determine low density residential, the project team averaged total water consumption for the Pickens purveyors with more than 95% residential in their land use, and used a ratio of that average for higher density residential (see description below). For the industrial and commercial sectors, the project team used volumes from a life cycle assessment (again, see description below). For the other water use sectors (e.g. irrigation, livestock, etc.), the plan relied on USGS county-level water consumption data, which is reported to DHEC and conveyed to USGS every five years (Appendix 4). However, the project team found that the USGS record of water use for the past twenty years included flawed reporting acknowledged by DHEC and USGS. So records from 2000 were dropped from the series of data from 1985 to 2005. In addition, the USGS condenses residential and commercial into a "public supply" category, which prevents differentiation of commercial and residential demand by density. Given the inaccuracy of the USGS numbers and the lack of data from the purveyors, the project team generated estimates of water demand by type of land use and acreage conversion and compared them with the USGS extrapolations to improve the accuracy of demand projections.

By Purveyor: Residential and Commercial Demand

The industrial sector in Pickens County is projected to increase in size, value of output and water demand through 2030. But projected population growth over the same period suggests that residential uses also will be the most significant water-consuming sector. Residential water demands include both indoor and outdoor uses.

To forecast residential water consumption in Pickens County, two residential scenarios were considered, using mostly low to medium density figures. The model used the following formula, based on the California Bay Delta water demand modeling process but modified to fit demand by number of units per sector and class (Davis 2003):

Water use = (acres of land use) * (density per acre) * (daily water use per unit)

The two densities for low to medium density residential, which were based on zoning in Rock Hill, South Carolina, were 1 unit per acre and 5 units per acre. But the scenario using a countywide residential density of 5 units per acre yielded a county population that exceeded official 2030 population projections by nearly an order of magnitude, so this scenario was deemed unlikely and is not included in the plan. High density residential was defined as 20 units per acre in Pickens County, also based on Rock Hill, South Carolina residential densities.

Daily water use values for residential property in Pickens County were based on the following approach, because the USGS does not differentiate public supply, and the purveyors were unable to give average or annual water use by class.

1. The project team summed the total units by purveyor (including low density residential, high density residential, residential/commercial, commercial and industrial) for 2011 from the land use change projections.

2. Total average daily consumption by purveyor was divided by total units to obtain the average gallons per day consumed per unit (Table 32).

3. Five purveyors have more than 95% low density residential in their service area. Of these, the most accurate calculations for consumption per unit are for Bethlehem Roanoke, Dacusville-Cedar Rock, Easley Central and Six Mile. (Southside is an outlier because it bridges two counties, so the units reflect the total within the county but an undisclosed portion of Southside's water is used in the service area outside of the county. Therefore Southside's per unit daily consumption average is overestimated.)

4. Average daily water use of 253.2 gallons per day per unit was calculated for Bethlehem Roanoke, Dacusville-Cedar Rock, Easley Central and Six Mile. But Dacusville Cedar Rock's average consumption is also an outlier and was dropped from the purveyor average.

5. Low density residential water consumption was estimated at 234.1 gallons per unit per day for Pickens County.

This figure is higher than the American Water Works Association Research Foundation's 171.8 average gallons per day per single family residential unit (Mayer et al. 1999). But it is fairly comparable to regional single family demand, which has been around 240 gallons per single family unit per day (Bereskin 2012).

High density residential daily water demand is lower per unit because it involves more minimal outdoor water use than its low density residential development counterpart with landscaping coverage (Vickers 2001). Consequently, the project team decided to use the ratio from Vickers (2001) of 65% of the standard single family water consumption for higher density residential. This generates an estimate of 152.2 gallons per day per high density residential unit.

Table 32: Per Unit Water Use by Purveyor

Purveyor	Avg Gal/Day per unit	Total Unit Count	Low Density Residential Unit Count	Low Density Residential (% of Total Unit Count)
Bethlehem-Roanoke	248.2	1,984	1,954	98.5
Central	490.7	1,354	1,028	75.9
Clemson (City & CU)	449.6	3,888	2,886	74.2
Dacusville-Cedar Rock	310.5	2,525	2,461	97.5
Easley Central	218.9	2,195	2,096	95.5
Easley Combined	483.4	11,178	10,219	91.4
Highway 88*	8,689	62	52	83.9
Liberty	397.3	1,324	1,190	89.9
Pickens	235.8	3,737	3,439	92
Powdersville*	1276.1	2,240	2,071	92.5
Six Mile	235.2	4,688	4,533	96.7
Southside*	516.1	1,887	1,835	97.2

* Highway 88, Powdersville and Southside all have significant service area outside of Pickens County, so the average gallons per day per unit figures are skewed on the high side. Water consumption within districts includes the entire district service area, but unit counts are only for the portion of service areas within Pickens County.

As Tables 33 and 34 illustrate, the majority of the Pickens County residential demand in 2030 can be attributed to low to medium density structures, which is 16.68 MGD. In contrast, high density residential consumes only 3.78 MGD. City of Central, City of Clemson, and Easley Combined Utilities have the most acreage in high density residential use, largely because of the student populations associated with Clemson University (Table 34). The county is anticipated to continue to have a relatively low volume of high density residential through 2030. Total residential water demand in 2030 is projected to require 20.46 MGD, which is almost a doubling of the 2010 demand at the county level (Table 35).

Table 33: Low to Medium Density Residential Water Demand Forecast (1 unit per acre)

Water District	2010 acres	2010WD (MGD)	2020 acres	2020WD (MGD)	2030 acres	2030WD (MGD)
Bethlehem-Roanoke	2,120	0.50	3,179	0.74	4,217	0.99
Central	557	0.13	760	0.18	890	0.21
Clemson (City & CU)	655	0.15	718	0.17	732	0.17
Dacusville-Cedar Rock	4,927	1.15	8,502	1.99	14,089	3.30
Easley Central #1	1,145	0.27	1,962	0.46	2,560	0.60
Easley Central #2	458	0.11	673	0.16	754	0.18
Easley Combined	3,839	0.90	4,785	1.12	5,086	1.19
Highway 88	208	0.05	377	0.09	728	0.17
Liberty	349	0.08	395	0.09	400	0.09
Pickens	3,976	0.93	5,769	1.35	7,361	1.72
Powdersville	1,220	0.29	1,616	0.38	1,707	0.40
Six Mile	8,386	1.96	13,132	3.07	20,997	4.92
Southside	2,176	0.51	3,622	0.85	5,057	1.18
No District	3,850	0.90	5,040	1.18	6,678	1.56
TOTAL	33,866	7.93	50,530	11.83	71,256	16.68

None of the Pickens County water service areas are projected to lose low to medium density residential acreage over the next 20 years, but acreage and water demand in some water service areas is expected to grow at a much faster rate than in others. Low to medium density residential is projected to increase significantly in the Dacusville-Cedar Rock and Six Mile service areas, more than doubling current acreage by 2030. High density water demand is also expected to increase by almost seventy percent in 2030, primarily in the City of Clemson, Easley Combined, Town of Central and Six Mile service areas.

Total residential water demand in Bethlehem-Roanoke, Dacusville-Cedar Rock, Easley Central #1, Highway 88, Six Mile, and Southside Rural is expected to double by 2030. Demand in other service areas, including City of Clemson, City of Liberty, and Powdersville, is expected to remain relatively constant and/or experience only a slight increase. These areas already have a substantial amount of development in their service areas. The largest future consumers in low density residential demand by sheer volume (in descending order) will be Six Mile, Dacusville-Cedar Rock, City of Pickens, and Easley Combined, each with over 1.7 MGD in 2030. These water districts are expected to consume more than half (12.50 MGD) of the county's total 20.46 MGD total residential sector demand in 2030.

Table 34: High Density Residential Demand Forecast (20 units per acre)

Water District	2010 acres	2010WD (MGD)	2020 acres	2020WD (MGD)	2030 acres	2030WD (MGD)
Bethlehem-Roanoke	3	0.01	5	0.02	6	0.02
Central	122	0.37	167	0.51	196	0.60
Clemson (City & CU)	367	1.12	402	1.22	410	1.25
Dacusville-Cedar Rock	16	0.05	27	0.08	45	0.14
Easley Central #1	3	0.01	5	0.02	7	0.02
Easley Central #2	1	0.00	2	0.01	2	0.01
Easley Combined	175	0.53	218	0.66	231	0.70
Highway 88	3	0.01	5	0.02	10	0.03
Liberty	18	0.05	21	0.06	21	0.06
Pickens	35	0.11	51	0.16	65	0.20
Powdersville	43	0.13	56	0.17	60	0.18
Six Mile	43	0.13	68	0.21	109	0.33
Southside	34	0.10	57	0.17	80	0.24
No District	-	-	-	-	-	-
TOTAL	863	2.63	1,084	3.30	1,242	3.78

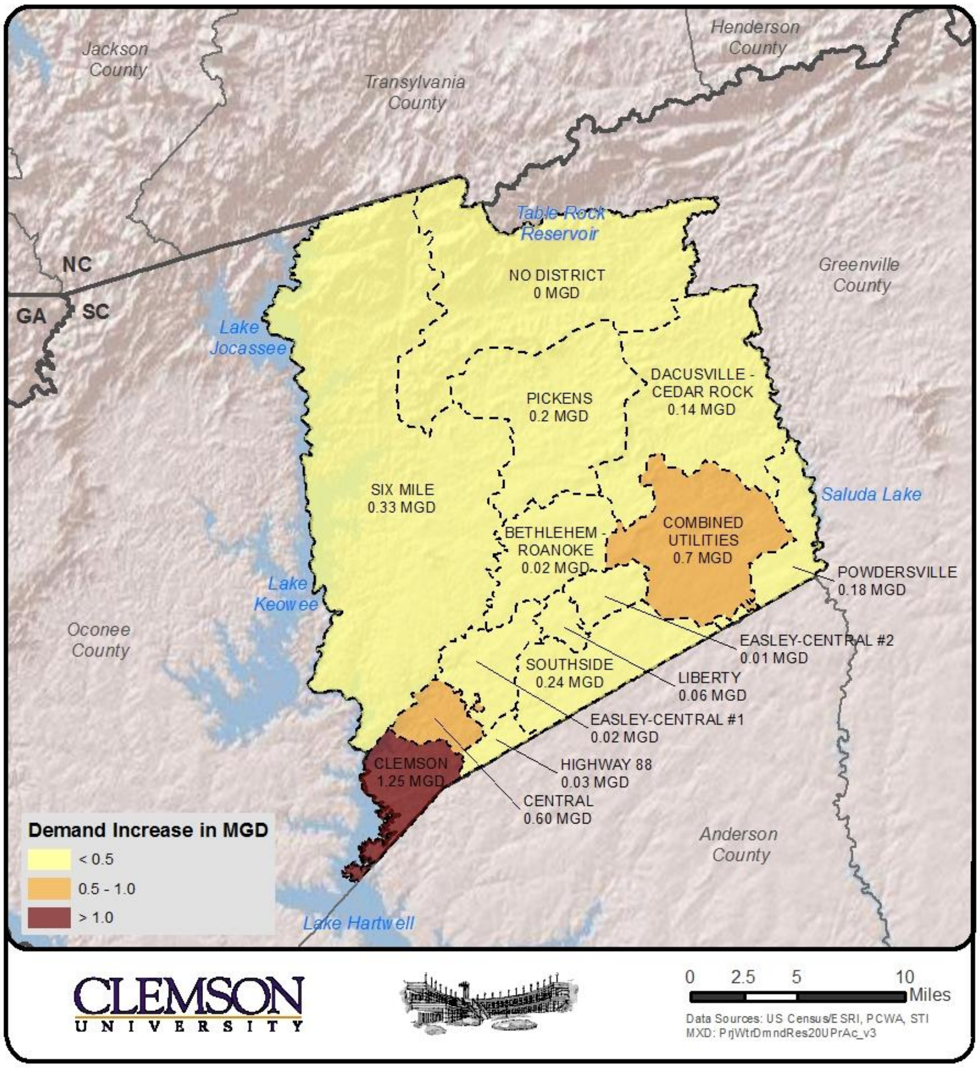


Figure 25: Projected Residential Water Demand (1 unit/acre)

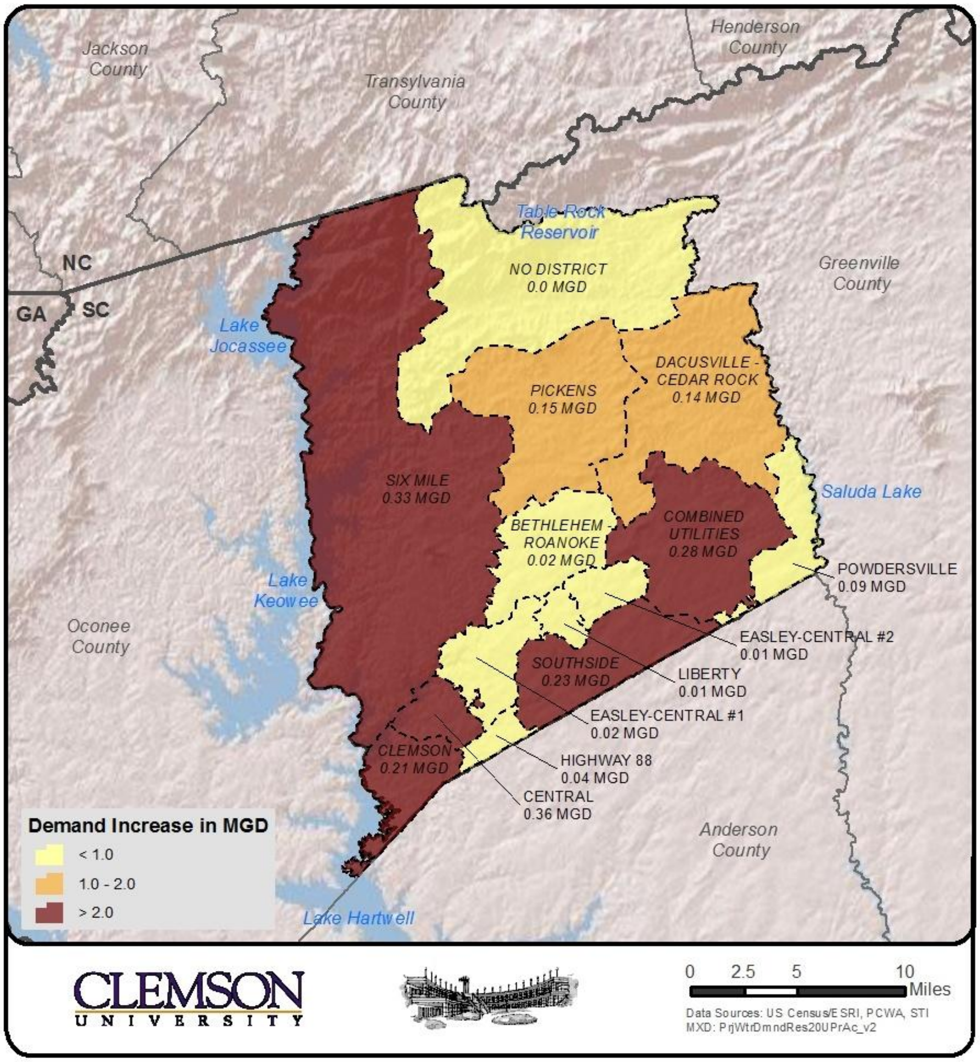


Figure 26: Projected Residential Water Demand (20 units/acre)

Table 35: Total Residential Demand Forecast (MGD)

Water District	2010	2020	2030
Bethlehem-Roanoke	0.51	0.76	1.01
Central	0.50	0.69	0.81
Clemson (City & CU)	1.27	1.39	1.42
Dacusville-Cedar Rock	1.20	2.07	3.44
Easley-Central #1	0.28	0.48	0.62
Easley-Central #2	0.11	0.17	0.19
Easley Combined	1.43	1.78	1.89
Highway 88	0.06	0.11	0.20
Liberty	0.13	0.15	0.15
Pickens	1.04	1.51	1.92
Powdersville	0.42	0.55	0.58
Six Mile	2.09	3.28	5.25
Southside	0.61	1.02	1.42
No District	0.90	1.18	1.56
TOTAL	10.56	15.13	20.46

Commercial water use includes retail, restaurants, hotels, offices, schools, small industries, and other users that are not direct matches for other water use sectors. This category covers a broad range of activities and can be difficult to estimate because of the range of water uses. For example, a laundromat does not use the same volume of water as a dry cleaner, or a restaurant, and yet they're grouped into the same sector.

The REDYN model developed projected economic output from 427 clear commercial sectors (under the NAICS codes). These users were then assigned a daily average water consumption volume ascertained from Vickers' (2001) survey of industrial, commercial and institutional water customers in the Greater Vancouver (B.C.) Regional District. The Greater Vancouver table provided average daily demand in gallons per connection for 37 customer descriptions. This total was then projected for 2020 and 2030 using the percent increases (in monetary output) from the REDYN model. Unlike the other sectors and because of the missing baseline water consumption data from the water purveyors, the study team had to rely on the percentage increase in economic output without the Economic Input-Output Life Cycle Assessment (EIO-LCA) tool used for the industrial output (see below), which may or may not reflect actual physical expansion. So these figures could be overestimated or underestimated. Table 36 shows the projected commercial water demand for both mixed use and commercial, and commercial uses by district service area.

Table 36: Commercial Water Demand Forecast by District (MGD)

Water District	2010		2020		2030	
	Mixed + Commercial	Commercial ONLY	Mixed + Commercial	Commercial ONLY	Mixed + Commercial	Commercial ONLY
Bethlehem-Roanoke	0.0141	0.0153	0.0199	0.0199	0.0264	0.0308
Central	0.0415	0.0435	0.0528	0.0528	0.0620	0.0703
Clemson (City & CU)	0.0779	0.0986	0.0797	0.0797	0.0812	0.1115
Dacusville-Cedar Rock	0.0200	0.0191	0.0320	0.0320	0.0533	0.0553
Easley-Central #1	0.0246	0.0198	0.0394	0.0394	0.0513	0.0448
Easley-Central #2	0.0303	0.0262	0.0418	0.0418	0.0467	0.0438
Easley Combined	0.2924	0.3513	0.3402	0.3402	0.3616	0.4715
Highway 88	0.0318	0.0014	0.0539	0.0539	0.1040	0.0051
Liberty	0.0392	0.0472	0.0416	0.0416	0.0420	0.0548
Pickens	0.1002	0.0914	0.1355	0.1355	0.1730	0.1715
Powdersville	0.1498	0.1595	0.1853	0.1853	0.1958	0.2260
Six Mile	0.0781	0.0537	0.1141	0.1141	0.1825	0.1361
Southside	0.1034	0.0773	0.1607	0.1607	0.2243	0.1819
No District	0.0218	0.0209	0.0266	0.0266	0.0351	0.0367
TOTAL	1.0252	1.0253	1.3235	1.3235	1.6392	1.6400

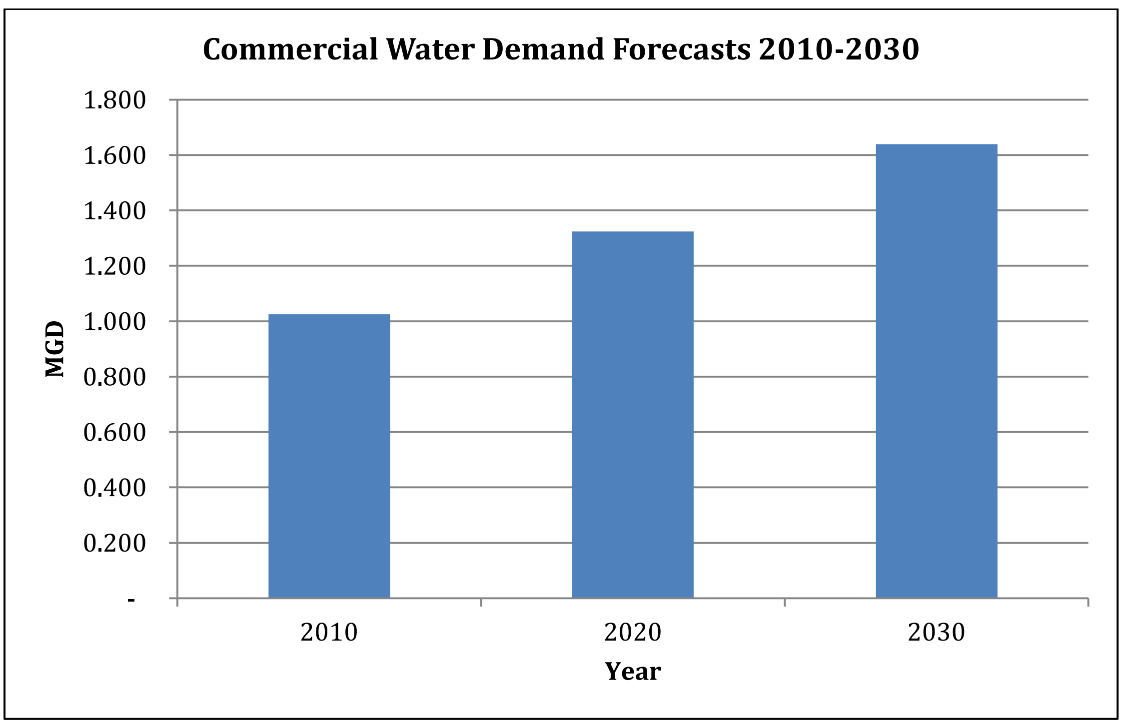


Figure 27: Commercial Water Demand Forecasts 2010-2030

County-Level: Industrial, Irrigation, Livestock and Total Demand

Industrial Demand. Unlike the commercial and residential sectors, although total acreage in industrial use is projected by purveyor service area, the plan does not project the actual industrial demand by district. This is because it is difficult to assign exact locations for industrial use, since it will locate where most convenient and/or it receives the greatest incentives. So this demand is projected purely at the county level. Also, it can be difficult to accurately estimate water demand without regional consumption levels, especially given the variation in water demand by industrial class (e.g. electrical versus chemical manufacturing).

The REDYN output for industrial uses identified through 3-digit NAICS codes were consolidated into 13 industrial sectors. The consolidation was based on highest dollar outputs for the classes of industrial users. Carnegie Mellon University's Green Design Institute developed the Economic Input-Output Life Cycle Assessment (EIO-LCA) tool that is publically available at http://www.eiolca.net. This tool uses the 5-digit NAICS codes as an input into the US 2002 Benchmark model (a producer price model with "cradle to gate" boundaries) to generate water consumption associated with dollar output.

To do so for the 13 industrial sectors from the REDYN model, the associated 5-digit NAICS codes and descriptions were put into the EIO-LCA model. Where exact matches to descriptions or codes could not be found, similar industrial water uses were employed. This generated water consumption amounts per dollar value of REDYN output for 2010, which could then be associated with the 2020 and 2030 economic output as well.

Table 37 shows Pickens County demand for water by category for the county. In 2030 total industrial demand is projected to be 2.3 MGD. This is just over a 50 percent increase in demand from 2010 through 2030. While it is nowhere near the consumption volume of the residential sector, total industrial demand is higher than the projected commercial demand for the county in 2030.

Table 37: Industrial Water Demand Forecast (MGD)

Industrial Category	3 Digit NAICS	2010	2020	2030
Food-Food Manufacturing	311	0.005553	0.006973	0.008622
Textiles- Textile Mills	313	0.318093	0.376775	0.476417
Textiles-Textile Product Mills	314	0.010833	0.013556	0.016938
Apparel	315	0.000016	0.000015	0.000018
Petroleum and Coal Products	324	0.000521	0.000649	0.000811
Chemicals	325	0.844986	0.978082	1.228219
Plastics and Rubber Products Mfg.	326	0.017562	0.023041	0.028767
Primary Metals	331	0.044192	0.057863	0.073068
Fabricated Metal Products	332	0.073280	0.094987	0.118430
Electrical Machinery	333	0.041927	0.056172	0.070330
Computer & Electronics Product Mfg.	334	0.031644	0.044219	0.054849
Transportation Equipment Mfg.	336	0.043020	0.055461	0.069799
Other	233, 234, 235, 321, 323, 327, 335, 337, 339, 511	0.100482	0.126327	0.156154
Total		1.532109	1.834120	2.302424

As Figure 28 indicates, of the thirteen categories, Chemicals and Textile Mills are consistently the highest water consumers.

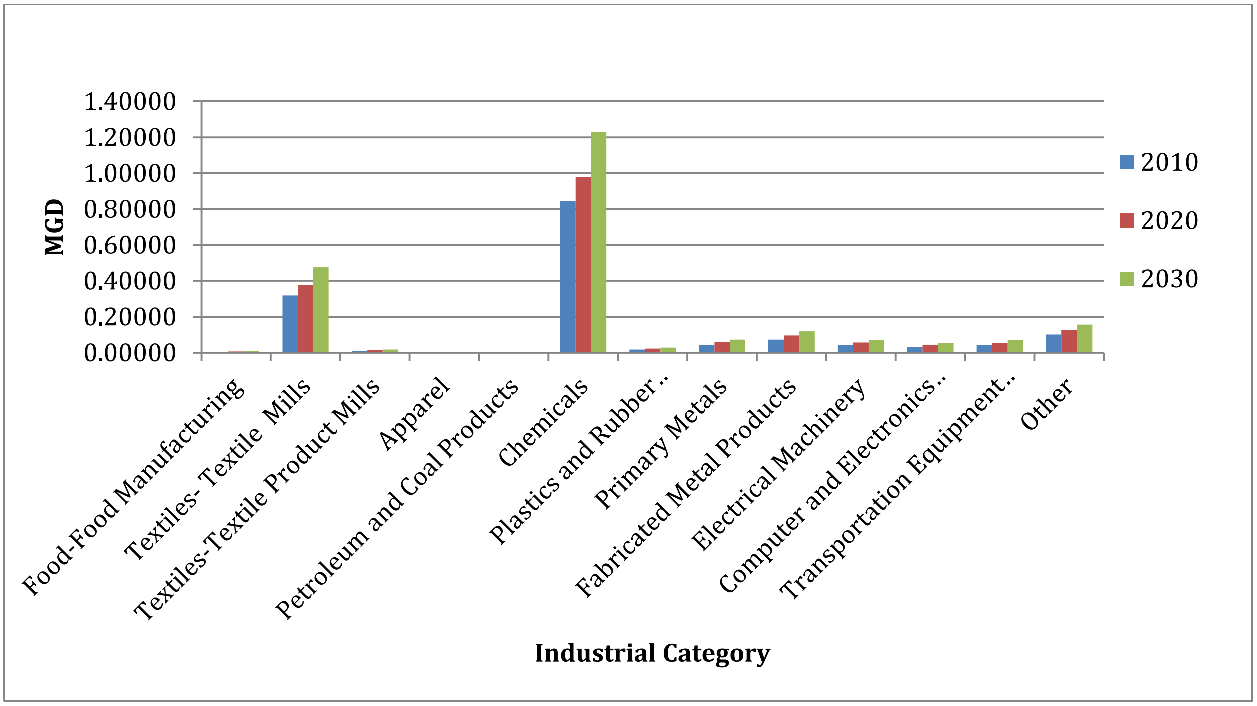


Figure 28: Industrial Water Demand Forecast 2010-2030

Irrigation Demand - Crops. Also projected at the county level, irrigation water use includes both crops and golf. Forecasts were developed slightly differently, but both originate from a base of the 2005 USGS water use.

In the original REDYN model output, the crops and livestock were combined in an agriculture category. To separate these classes within the irrigation sector, a percentage split was used from the United States Agricultural Census. After doing so, the percentage increases in REDYN for 2020 and 2030 were applied to the 2005 USGS water use number for crops to develop water demand forecasts. As Table 38 shows, crop irrigation is projected to increase to 0.152 MGD in year 2030, or a 48 percent increase from 2010.

Table 38: Irrigation Water Demand Forecasts 2010-2030, MGD

Sector	2010	2020	2030
Irrigation-Crops	0.102	0.127	0.152
Irrigation-Golf Courses	1.127	3.4818	7.963
Total	1.229	3.6088	8.115

Irrigation Demand – Golf Courses. In contrast, golf course irrigation forecasts were calculated using the historical USGS water use estimates from 1985-2005. A trend line was fitted to these water use estimates and projected forward to 2030 (Figure 29).

Water use for golf course irrigation is substantially higher than that of crop irrigation. Unlike crop irrigation, golf irrigation is projected to increase by over 600 percent by 2030. It is projected that golf course irrigation will consume more than the commercial, industrial, livestock and crop irrigation combined in MGD.

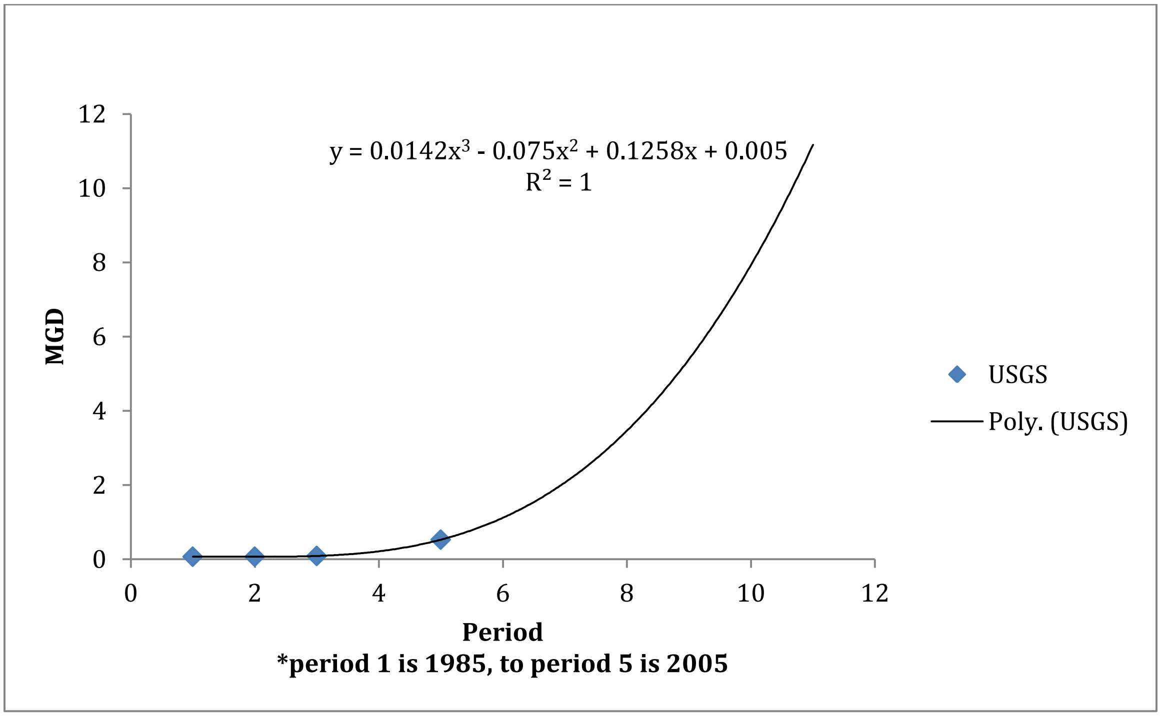


Figure 29: Golf Course Irrigation Demand Forecast

Livestock Demand. The last sector in Pickens County water use is also the second smallest. Livestock water demand forecasting is based on the 2005 USGS livestock water use estimate and projected to 2030, using the percentage change from the REDYN model. As mentioned above, livestock and crops were combined in the REDYN model and had to be split using U.S. Agricultural Census percentages. Thus, the livestock and crop irrigation forecasts increase at the same rate for this study. Livestock water demands are estimated at 0.148 MGD for 2010 increasing over 48 percent to 0.219 MGD in 2030.

Every water use sector in Pickens County is projected to increase its demand from 2010 through 2030, in part because every land use type is projected to increase, although at varying rates across different service areas. For the county as a whole, water demand will increase from approximately 15 MGD in 2010 to 33 MGD in 2030 (Figure 30 and Table 39).

While the total projected demand in 2010 is lower than the self-reported purchases from the purveyors themselves (with a total of approximately 17.5 MGD), their total purchases don't account for system leakage, which is as high as 37% in at least one service area. Additionally, the residential land use density has more variation than 1 and 20 units per acre, so with demand based on average unit count in the residential category, there may be over or underestimation depending on the character of the purveyor's service area. So the total projected demands are likely underestimated for actual demand from 2010 through 2030, given system leakage and density variation across the county.

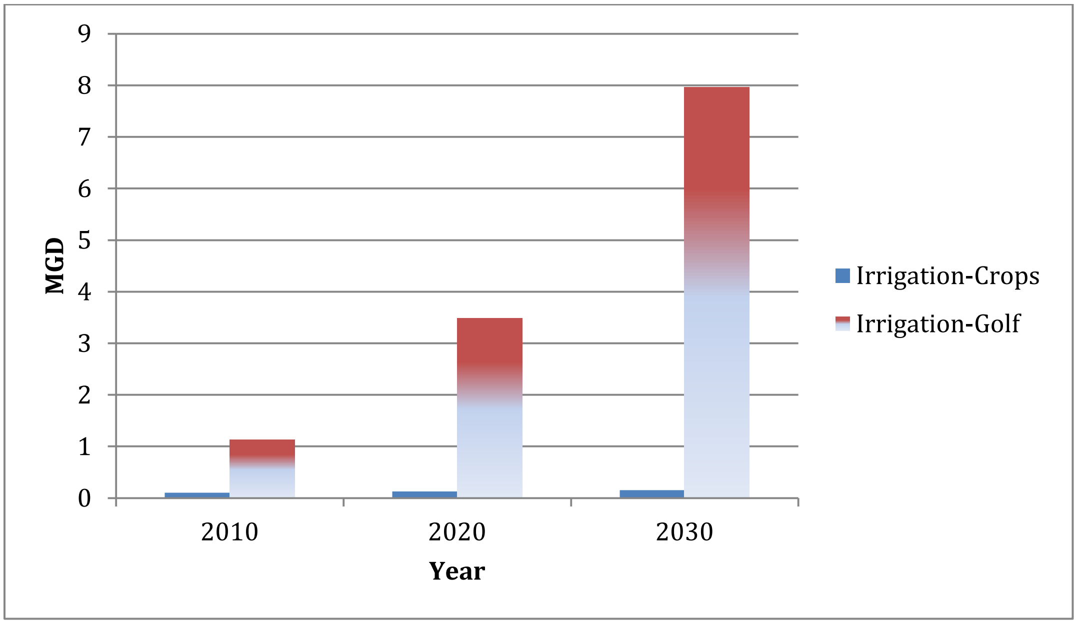


Figure 30: Irrigation Water Demand Forecasts, 2010-2010

Table 39: Total County Water Demand Forecasts 2010-2030, MGD

Sector	2010	2020	2030
Commercial	1.025	1.324	1.640
Industrial	1.532	1.834	2.302
Irrigation-Crops	0.102	0.127	0.152
Irrigation-Golf	1.127	3.482	7.963
Livestock	0.148	0.183	0.219
Mining	0	0	0
Residential*	10.555	15.129	20.462
Thermoelectric	0	0	0
TOTAL	14.489	22.079	32.738

*Includes Low to Medium Density Scenario with 1 unit per acre

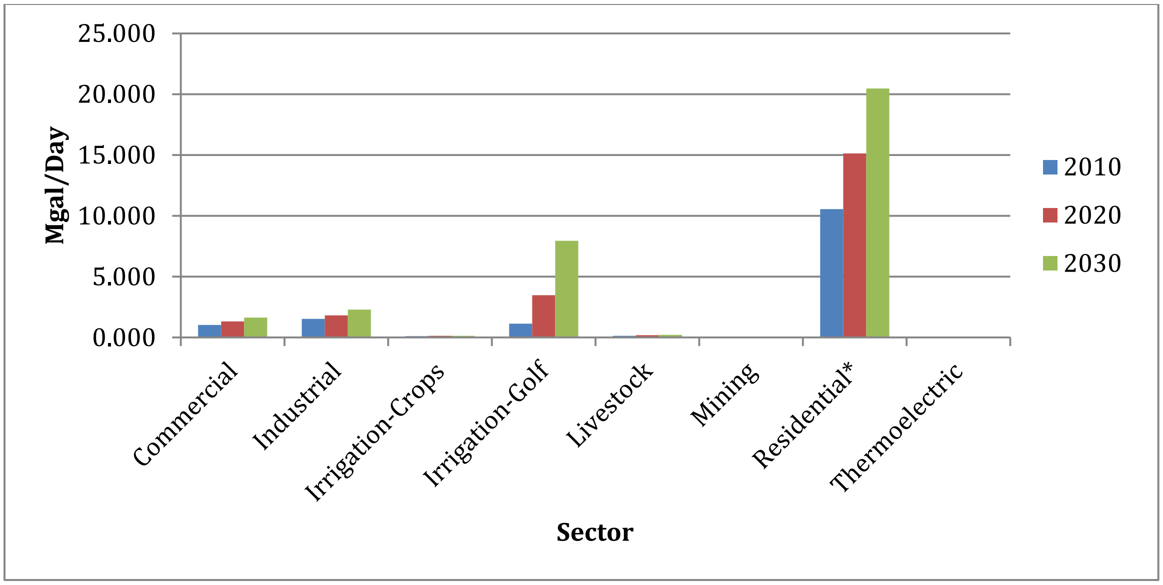


Figure 31: Total County Water Demand Forecast 2010-2030

Clearly, the residential sector is the greatest water consumer in Pickens County, and will continue to dominate the demand, followed distantly by golf irrigation and industrial demand in year 2030. Figures 32 and 33 show that the proportional percentage of demand attributed to residential use actually decreases (from 73 to 63 percent), but the total county water demand slightly more than doubles from 2010 through 2030. Over the same period, industrial decreases by three percent, while commercial decreases by two percent, with the greatest demand growth percentage occurring in the golf class of the irrigation sector.

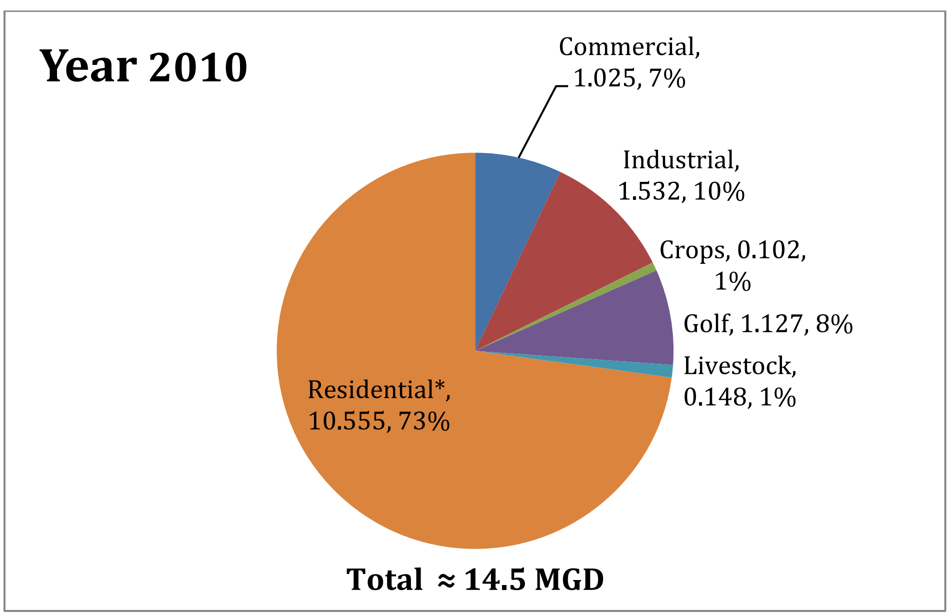


Figure 32: Total Water Demand by Percent in 2010

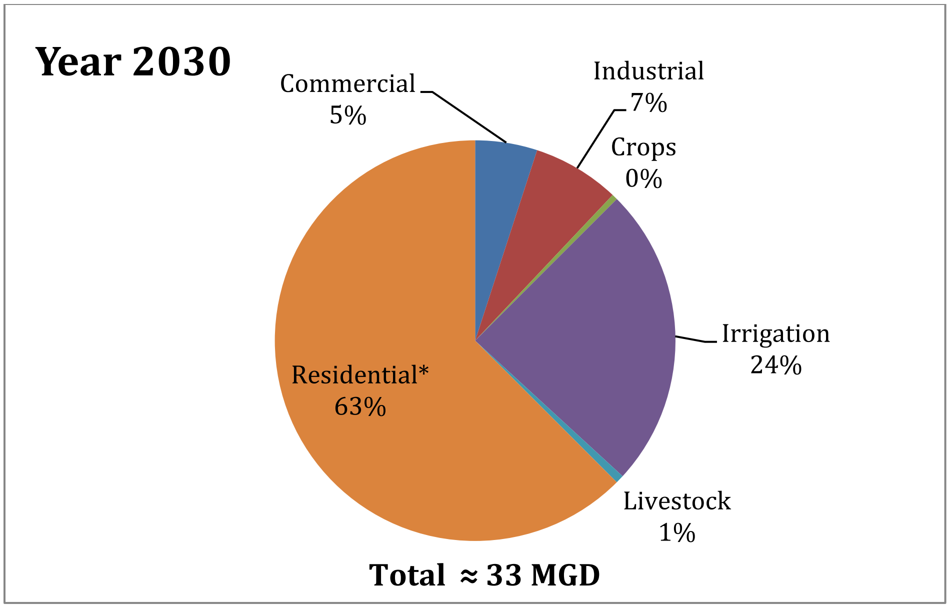


Figure 33: Total Water Demand by Percent in 2030

Conservation Scenario

The status-quo demand forecasts suggest that water demand management in Pickens County should focus on residential and irrigation sectors (particularly golf). The most effective conservation management approach for residential demand is shown to be a combination of regulatory, educational, and conservation pricing structures. California water districts using different combinations of policies and tiered rate structures showed overall decreases in residential water consumption compared to other districts not using such strategies (Renwick and Green 1999).

The plan adopted a conservative water conservation scenario involving toilet replacement with low-flow options at a coverage rate of 65 percent of users in the commercial, industrial, and residential sectors.

The conservation model in the commercial sector demand forecasting applied a coverage rate of 65 percent single-toilet replacement, saving 37 gallons per day per toilet replaced. For the industrial sector, the model again applied the 65 percent coverage rate and estimated a 5-toilet replacement rate at a savings of 23 gallons per day per replaced toilet (Vickers 2001).

For calculations involving the residential sector, water savings per household were taken from a survey study completed by Vickers (2001). For low to medium density residential users, the conservation model applied 65 percent coverage replacing one toilet, saving an estimated net of 21.6 gallons per day. High density residential users were assigned a savings of 30.95 gallons a day, which was the average of single family and multifamily estimated net savings per toilet replaced (Tables 40 and 41). As expected, conservation savings were highest in the service areas with the greatest projected residential increase, and lower density residential had more savings than higher density residential.

Table 40: Low to Medium Density Residential Conservation Savings (MGD: 1 unit per acre)

Water District	2010 WD	2010 Cons	2010 CSvgs	2020 WD	2020 Cons	2020 CSvgs	2030 WD	2030 Cons	2030 CSvgs
Bethlehem-Roanoke	0.50	0.47	0.03	0.74	0.70	0.04	0.99	0.93	0.06
Central	0.13	0.12	0.01	0.18	0.17	0.01	0.21	0.20	0.01
Clemson (City & CU)	0.15	0.14	0.01	0.17	0.16	0.01	0.17	0.16	0.01
Dacusville-Cedar Rock	1.15	1.08	0.07	1.99	1.87	0.12	3.30	3.10	0.20
Easley-Central #1	0.27	0.25	0.02	0.46	0.43	0.03	0.60	0.56	0.04
Easley-Central #2	0.11	0.10	0.01	0.16	0.15	0.01	0.18	0.17	0.01
Easley Combined	0.90	0.84	0.05	1.12	1.05	0.07	1.19	1.12	0.07
Highway 88	0.05	0.05	0.00	0.09	0.08	0.01	0.17	0.16	0.01
Liberty	0.08	0.08	0.00	0.09	0.09	0.01	0.09	0.09	0.01
Pickens	0.93	0.87	0.06	1.35	1.27	0.08	1.72	1.62	0.10
Powdersville	0.29	0.27	0.02	0.38	0.36	0.02	0.40	0.38	0.02
Six Mile	1.96	1.85	0.12	3.07	2.89	0.18	4.92	4.62	0.29
Southside	0.51	0.48	0.03	0.85	0.80	0.05	1.18	1.11	0.07
No District	0.90	0.85	0.05	1.18	1.11	0.07	1.56	1.47	0.09
TOTAL	7.93	7.45	0.48	11.83	11.12	0.71	16.68	15.68	1.00

The total result of this minimal conservation scenario was a water savings ranging from 0.839 MGD to 1.525 MGD depending on the year. This is a 4.66 to 5.79 percent total reduction in Pickens County water demand (Tables 42 and 43).

Ideally, this conservation scenario would be strengthened with other non-price approaches such as lawn replacement programs, rebates for water saving technology and appliances (whether from the purveyors or the state), public education on water use efficiency and native landscaping, water reclamation for the industrial and residential sectors, etc. (Gleick et al. 2003; Renwick and Green 1999; Vickers 2001). Additionally, it could be augmented with increasing block rate structures, which have been effective in managing demand but which none of the purveyors are currently employing (Hanemann 1997; Gleick et al. 2003).

Table 41: High Density Residential Conservation Savings (MGD: 20 units per acre)

Water District	2010 WD	2010 Cons	2010 CSvgs	2020 WD	2020 Cons	2020 CSvgs	2030 WD	2030 Cons	2030 CSvgs
Bethlehem-Roanoke	0.01	0.01	0.00	0.02	0.01	0.00	0.02	0.02	0.00
Central	0.37	0.32	0.05	0.51	0.44	0.07	0.60	0.52	0.08
Clemson (City & CU)	1.12	0.97	0.15	1.22	1.06	0.16	1.25	1.08	0.16
Dacusville-Cedar Rock	0.05	0.04	0.01	0.08	0.07	0.01	0.14	0.12	0.02
Easley-Central #1	0.01	0.01	0.00	0.02	0.01	0.00	0.02	0.02	0.00
Easley-Central #2	0.00	0.00	0.00	0.01	0.01	0.00	0.01	0.01	0.00
Easley Combined	0.53	0.46	0.07	0.66	0.58	0.09	0.70	0.61	0.09
Highway 88	0.01	0.01	0.00	0.02	0.01	0.00	0.03	0.03	0.00
Liberty	0.05	0.05	0.01	0.06	0.06	0.01	0.06	0.06	0.01
Pickens	0.11	0.09	0.01	0.16	0.13	0.02	0.20	0.17	0.03
Powdersville	0.13	0.11	0.02	0.17	0.15	0.02	0.18	0.16	0.02
Six Mile	0.13	0.11	0.02	0.21	0.18	0.03	0.33	0.29	0.04
Southside	0.10	0.09	0.01	0.17	0.15	0.02	0.24	0.21	0.03
No District	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL	2.63	2.28	0.35	3.30	2.86	0.44	3.78	3.28	0.50

Table 42: Total Water Demand Forecast with Conservation Scenario Applied (MGD)

Sector	2010	2020	2030
Commercial	1.01	1.31	1.62
Industrial	1.53	1.83	2.30
Irrigation-Crops	0.10	0.13	0.15
Irrigation-Golf	1.13	3.48	7.96
Livestock	0.15	0.18	0.22
Mining	-	-	-
Residential	9.73	13.98	18.96
Thermoelectric	-	-	-
Total	13.65	20.91	31.21

Conservation scenario applied to Commercial, Industrial, and Residential sectors.

Table 43: Actual Water Savings by Sector from Conservation Scenario (MGD)

Sector	2010	2020	2030
Commercial	0.010	0.013	0.016
Industrial	0.004	0.005	0.007
Irrigation-Crops	-	-	-
Irrigation-Golf	-	-	-
Livestock	-	-	-
Mining	-	-	-
Residential	0.825	1.149	1.502
Thermoelectric	-	-	-
Total Savings	0.839	1.168	1.525
% Saved	5.79%	5.29%	4.66%

Conservation scenario applied to Commercial, Industrial, and Residential sectors.

SECTION 4: SYSTEM CAPACITY

Water demand will more than double in Pickens County by year 2030, based on the model's status quo demand forecasts. This will be an increase in daily demand from the current level of 14.489 MGD to 32.738 MGD.

The locations of existing water lines generally correspond to the anticipated growth in the county based on the growth model projections. However, this does not hold for all areas. Without a complete engineering assessment of system water line location, capacity and condition, the project team was unable to determine conclusively whether Pickens County's water system contains sufficient infrastructure capacity to sustain the anticipated level of increase in demand for water over the next 20 years.

The project team recommends that PCWA and all other Pickens County water purveyors:

- Conduct a full engineering assessment of water line and other infrastructure location, capacity, and condition in water district service areas;
- Compare water district infrastructure data with this areas of anticipated growth in developed land in Pickens County described in this report; and
- Compare water district infrastructure data with projected land uses described in this report.

This full, countywide system assessment will determine the areas within the system that are most likely to require upgrading and installation of new capacity. This assessment will augment this water supply plan by giving PCWA and the water purveyors a complete picture of future water management needs.

SECTION 5: RECOMMENDATIONS, IMPLEMENTATION AND WATER RESOURCES ISSUES

A need for better and more efficient water management at the water purveyor level was one of the most glaring issues that emerged during the planning process. In addition to the system engineering assessment recommendation above, district water management in Pickens County can be improved in the following ways.

Implement and maintain more consistent and more accurate water demand accounting for each purveyor's service area. This should include maintaining a daily or monthly consumption record by account for each sector and class. Such accounting is possible because most of the purveyors have entirely metered service areas. A comprehensive, detailed timeline of consumption data will allow each water district to make more accurate projections of future water demand by sector and class. It will also promote more efficient water use when consumers are made aware of their consumption level, and particularly changes in consumption over time.

Implement an increasing-block rate structure for demand management and efficiency in each water district. This water supply plan projects large increases in water demand in all sectors in Pickens County through 2030, and particularly from golf irrigation and residential uses. Drought trends also are anticipated to continue and intensify, which could require some purveyors to restrict supply in the short term. A tiered rate structure is one of the most efficient ways to quickly change water consumption behavior, especially in the residential sector (Renwick and Green 1999).A tiered rate structure also effectively funds future infrastructure investment (e.g. for recycled water) and water conservation and associated rebate programs.

Combine a tiered rate structure with other non-price demand management strategies in each water district. Combining a tiered rate structure with other approaches to demand management can further improve efficiency. This plan's water conservation scenario included only one rebate program for low-flow toilet replacement, which was introduced across most sectors. But other demand management strategies should be considered, including rebate programs for water-saving appliances (i.e. dishwashers, washing machines, showerheads, etc.), free water audits from purveyors, education (i.e. water fairs, public school campaigns, native plants in local nurseries, etc.), outdoor water restrictions during drought, and requirements for dual plumbing in new houses and water-conserving fixtures and landscaping in new construction.

Increase efficiency in water distribution. Several purveyors mentioned rates of water loss in their systems, with one as high as 37 percent loss and the rest averaging between 5 and 8 percent loss. With the likelihood of continued droughts, county water purveyors should also investigate how and when to invest in infrastructure for recycled water for all sectors.

Incorporate climate scenarios into water demand forecasts. The water budget accounts solely for the availability of current supply. In Pickens County, it shows a water surplus, while demand is projected to more than double over the next 20 years. Precipitation is the largest input into the county water budget, which makes the county heavily reliant on climate and associated climate scenarios. While legal and social arrangements, such as the water export from the county, can be altered to meet projected need, it is not possible to change natural precipitation or evapotranspiration rates.

The Pickens County Water Supply Plan clearly shows that the projected demand for water in Pickens County is expected to more than double over the next 20 years. The importance of water use efficiency in Pickens County is reinforced when these findings are combined with water districts' incomplete information about consumption by sector, and system inefficiencies due to leakage and infrastructure condition. The more efficient the water use in Pickens County, the more favorably the legal system will receive future water allocation disputes over shared water bodies, should they occur.

Pickens County Water Supply Plan recommendations for the next three years should be implemented as follows in Table 44. Monitoring at the purveyor and county level should follow the introduced programs, so that evaluation can occur.

Table 44: Implementation Schedule

Year	Actions by Individual Purveyors	Actions by PCWA	Actions by the State/DHEC/DNR
One	• Implement the recording system for sectoral and class usage • Institute metering if none is present in the service area • Introduce an increasing block rate structure across sectors and classes	• Convene the purveyors and establish a uniform recording system • Generate funding for a rebate program • Possibly renegotiate the water transfer out of Pickens County	• Introduce legislation for mandatory water supply planning at the purveyor or county level • Secure funding for rebate programs
Two	• Hire a dedicated water conservation specialist in each service area • Start planning for recycled water infrastructure	• Organize a public education campaign on water conservation	• Improve rules and regulations for water recycling, making it easier for purveyors to use it
Three	• Invest in separate meters for outdoor irrigation at the residential level	• Coordinate with local nurseries to start carrying native plants (and featuring them) • Start engaging in studies (seeking grants, etc.) for new water saving technology (e.g. ET controllers)	• Introduce legislation that mandates dual piping in appropriate sectors (e.g. residential)

SECTION 6: FUTURE PLAN EVALUATION

The plan should be revisited every five years and updated every 10 years to determine whether water demand projections correspond to the actual water use and to evaluate the impact of conservation efforts implemented during that period. A ten year review will also allow the county to maintain consistency with the South Carolina Comprehensive Planning process.

In discussions with the Pickens County Water Authority, it was noted that they have the following complimentaryLong Range Goals:

- Assist in the development of a methodology to insure that each withdrawal from Lake Keowee be reviewed by the Pickens County Water Authority before final approval;

- Establish a time frame and the maximum gallons/day to be withdrawn by each water district and IBT in Pickens County;

- Develop reserve allocations for privately contracted water quantities to assure fair and equitable future county reserve allocations; and

- Review goals/results every five years and establish new maximums based upon past actual.

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APPENDICES

APPENDIX 1: DATA SOURCES AND MODELING ASSUMPTIONS

Data Sources:

1. GIS Maps—*varies by map so some of these are grouped*
    - Base Data including roads, county lines, city points, city polygons, etc = ESRI / US Census
    - Hillshade with major hydrography = ESRI
    - 2000 Land Cover = STI
    - Watersheds = USGS
    - 2010 Population Density = US Census
    - 2000-2007 Population Density Change = US Census, ESRI, STI analysis
    - Water Source Points = SCDHEC
    - Water District Boundaries = PCWA
    - Pickens Co Water Lines = STI digitized from water district files (some digital and some hardcopy)
    - Topography = NRCS
    - Species Richness = SCDNR
    - 2000, 2010, 2030 Projected Developed Areas = STI
    - 2008 Impaired Waters = SCDHEC
    - Water Movement arrows = STI from PCWA and district data
    - 2011 Parcel Level Land Use = Pickens Co Assessor and GIS via GIS
    - Character Areas = Pickens Co Planning via GIS : **NOTE: THIS LAYER IS NON-REGULATORY; IT IMPOSES NO STANDARDS OR RESTRICTIONS ON PROPERTY USE**
    - Industry Points = combination of Infomentum via ACOG, University of South Carolina GIS, Alliance Pickens pulled from their website, & SC Dept of Commerce,
    - Industrial Parks = Infomentum via ACOG
    - Marketed Industrial Sites = Infomentum via ACOG
    - Protected Lands = The Nature Conservancy, then generalized to approximate property boundaries
    - Industrial Synergy Areas = STI from other industrial data
2. REDYN Model
    - Base data = U.S. Bureau of Economic Analysis, National Income and Product Accounts (NIPA), Bureau of Labor Statistics Input-Output Tables, U.S. Census of Governments
3. Residential Demand Forecasting
    - Population data = American Factfinder (U.S. Census)
    - Low to medium density residential demand = Actual county consumption
    - High density residential demand = Vickers (2001)
4. Commercial Demand Forecasting
    - Commercial class demand = Greater Vancouver (B.C.) Regional District survey results in Vickers (2001)
5. Industrial Demand Forecasting
    - Water and monetary output = EIO-LCA model (see U.S. 2002 Benchmark producer price model from www.eiolca.net)
6. Irrigation Demand Forecasting
    - Water use for crops = 2005 USGS water use

- Water use for golf irrigation = historic USGS water use (1985 – 2005, dropping year 2000 because of officially acknowledged faults)

7. Livestock Water Demand Forecasting
    - Water use for livestock = 2005 USGS water use

Modeling Assumptions:

1. Growth Model
    - Uses Landsat Thematic Mapper imagery over a ten-year period to determine historic changes in land cover.
    - Uses the land cover classification process based on the Multi-Resolution Land Characteristics (MRLC) consortium classification scheme.
    - Uses the Anderson land use/land cover classification scheme to determine "developed area."
    - Growth ratio of population change to land development change of the measured ten-year historic period will continue through the future growth period.
    - Predictor variables are comprehensive and represent all possible predictor variables (including physical characteristics, accessability, market factors, policy factors and growth constraints).
    - Major changes in future economic conditions and ordinances/laws/policies are not considered in future land development
2. Land Use Change by District
    - 2011 parcel level land use from Pickens County is equivalent to 2010 STI projected developed/land use.
    - "Unknown" category maintained at 2011 levels as unknown parcels should not increase, and should not exist.
    - "Major Utility ROW" maintained at 2011 levels, with the assumption that these areas (primarily in Jocassee Gorges) will not significantly increase.
    - "Protected Lands" was increased 5% per year across all district service areas.
    - "Vacant" reduced evenly across all Service Districts for 2020 by 50% to balance land use acreage.
    - "Vacant" reduced evenly across all Service Districts for 2030 by 74% to balance land use acreage.
    - "Protected Land" for City of Clemson was maintained at 2011 levels for 2020 and 2030, since most of that land is Clemson University property and is not expected to significantly increase with conservation easements and similar acquisitions.
    - Existing parcel level land use will continue and not change use (continuing current development trends).
    - For parcel land use categories that over represented land use area - used the following district service area cuts for 2011 and continued in 2020 & 2030:
        - No District - cut "Commercial" and "Residential/Commercial" by 90%.
        - Dacusville-Cedar Rock - cut "Commercial" and "Residential/Commercial" by 90%.
        - Bethlehem-Roanoke - cut "Commercial" and "Residential/Commercial" by 90%.
        - Six Mile - cut "Commercial" by 95% and "Residential/Commercial" by 50%.
        - All of the above cuts in acreage were added to "Vacant" category.
    - Low/Medium Density Residential was decreased 68.3% across the board to balance 2011 parcel level land use with 2010 STI developed area.
3. Population by District

- GIS data of blocks with incorporated population counts from USC for 2000 are accurate
- Population densities across blocks are consistent - used a population density x square miles to calculate population of blocks once merged with water purveyors

4. REDYN Model
    - This is a nationwide database being taken to the county level, meaning that it is difficult to precisely penetrate the county change.
    - Input-Output (I/O) models assume fixed input prices and constant returns to scale.
    - Historical data was available through 2007, with following years projected upon the historical data, so existing trends will continue.
5. Industrial Site Location
    - Industry will locate near existing infrastructure (roads, railroads, water supply, etc.).
    - Industry will locate where they are given the best fiscal incentives.
6. Residential Water Demand Forecasting
    - 1 unit per acre (on average) for low to medium density residential, 20 units per acre (on average) for high density residential.
    - Average daily water demand for low density residential is determined by districts with more than 95 percent low density residential land use.
    - Vickers (2001) national ratio of high to low density residential water use is accurate in Upstate South Carolina.
7. Commercial Water Demand Forecasting
    - Average daily water demand for commercial classes in Pickens County, SC will be equivalent to the average daily water demand for commercial classes in Greater Vancouver (B.C.) Regional District.
8. Industrial Water Demand Forecasting
    - EIO-LCA model (from http://www.eiolca.net/Method/assumptions-and-uncertainty.html)
        - Linear model, with "a $1,000 change in demand or level of economic activity will be 10 times the results of a $100 change in demand."
        - "The results represent impacts through the production of output by the sector with increased demand. For the most part then, the use phase and end-of-life phases are not directly included in the results."
        - "Many assumptions go into creating the impact vectors (the values for the environmental effects and materials consumption). We allocate values using weighted averages, or information from data sources or other publications."
        - The data from 2002 is used in the U.S. 2002 Benchmark model, "including the economic input-output matrix and the associated environmental data."
        - The original data may be incomplete, involve uncertainty, and is aggregated in some sectors.
9. Irrigation Water Demand Forecasting
    - Assume that the original data from the USGS is accurate.
    - Assume that the percentage split based on the United State Agricultural Census for the REDYN output (which combines livestock and crops in output) is representative.
    - Assume that percentage increase in REDYN output is representative of higher demand for water (for crops).
10. Livestock Water Demand Forecasting
    - Assume that the original data from the USGS is accurate.
    - Assume that the percentage split based on the United State Agricultural Census for the REDYN output (which combines livestock and crops in output) is representative.
11. Conservation Scenarios
    - Assume that regulatory conservation measures will not be used in Pickens County.

- Application across commercial, industrial and residential sectors.
- Vickers (2001) survey is correct in assigning a higher water savings volume for the high density residential (30.95 gal/day) than that in low density residential (21.6 gal/day) with replacement of one toilet per unit.
- Assume a 5-toilet replacement volume in the industrial sector.
- Assume a 65% toilet replacement rate across chosen sectors.

APPENDIX 2: DATA CHECKLIST FOR THE PURVEYORS

Data Checklist for Purveyors

Data Gatherers:

Date:

Contact info: name, mailing address, physical address, phone number(s), fax #, email(s)

Sources

What are your physical water sources?

If you are purchasing from a wholesaler, from whom do you purchase?

What rates are you charged for the water you receive? How have they changed over the past 10 years? Can we receive a copy of those rates?

How much do you receive annually?

What is their primary water source?

Do you re-sell the water you purchase to another water provider? If so, to whom?

Do you have any planned new water supplies? If so, from where?

Is any of your water transferred through inter-basin transfer, and if so, how much and from which basin(s)?Do you have any anticipated future transfer opportunities?

What is your service area?

Do you have it mapped?

Do you have any supply reliability problems, and if so, what is causing them and how are they affecting your normal water levels?

Is there any water loss in your system, and if so, by how much?

What are your current constraints? (E.g. geographic, supply availability, water quality, infrastructure system capacity)

What do you envision as future constraints?

Customer base

What is your delivery volume and/or consumption by sector? To how many accounts in each sector?

Can we have the consumption data for these sectors (as disaggregated as possible, e.g. to the household level for the residential sector and by plant for the industrial sector)? For past 10 years or further back if available.

In what form is the data available?

Do you meter any of your sectors?

If so, for which?

If for residential, is there more than one meter per household (e.g. irrigation versus household)?

Rates

What rate structures do you use for each sector?

How has the structure itself changed in the past 10 years?

What were your previous rates (and structures) over at least the past 10 years? Are they available electronically or in hard copy, and May we have them?

Infrastructure

Where are your facilities located? What are the sizes of your pipes, and where are your plants located? What are their capacities?

Do you have maps of your water provision infrastructure, and can you share them with us?

Do you have plans to expand or replace your facilities? If so, where and when? How many plants? What is the anticipated pipeline mileage? What is the anticipated capacity of the new or expanded facilities? What source will supply the new capacity?

How old are your current facilities?

What technologies are you currently using and with what technologies do you anticipate replacing them?

Are you currently using any recycled water? If so, how and where?

Emergency Events

In the event of a discrete emergency event (e.g. earthquake, tornado, bioterrorism, sudden infrastructure failure), what are your contingency or backup plans?

Any emergency interconnection with other systems? If so, where? Is this mapped and can we locate those maps?

What are your supply contingency plans in the event of a more gradual problem e.g. drought?

Source Protection and Water Quality

Do you have any water quality issues (coming from the source,) and if so, what/where are they and how are they being remediated (if at all)?

Do you have a source water assessment plan and if so, can we have a copy?

Have you implemented any source water assessment recommendations and/or protection measures?

General

May we have your GIS layers/ data?

Person responsible for getting us the GIS data:

Received the GIS data: Yes, No, By Whom, Date Received

APPENDIX 3: PURVEYORS' RATE STRUCTURE COMPARISON

	Metering			Monthly rate				Billing	Latest rate	Cost of
Purveyor	**Res.**	**Ind.**	**Agr.**	**Res.**	**Ind.**	**Agr.**	**Surcharge**	**period**	**increases**	**new tap**
Bethlehem-Roanoke	Yes	Yes	Yes	$17.5 (0-3k gal.)	same	same	$4.50 per 1k gal.	Bimonthly	2008, 1999	$1500 for a ¾" meter
City of Pickens	Yes	Yes	Yes	$15.50 (0-3k gal. inside city); $24.00 (0-3k gal. outside city)	same	same	$3.50 (per 1k gal. inside city); $4.00 (per 1k gal. outside city)		2009, 2008	
Easley Combined	Yes	Yes	Yes	$1.83 (per 100 cf)	same	same	-		2007	
Dacusville Cedar-Rock	Yes	Yes	Yes	$17.50 (0-3k gal.)	same	same	$4.50 per 1,000 gal	Bimonthly	2008, 1999	$1500 for a ¾" meter
Easley Central	Yes	Yes	Yes	$11.00 (0-3k gal.)	same	same	$3.00 per 1 k gal. (2k to 25k gal.); $2.80 per 1k gal. (>25k gal.)	Monthly	2007, 2005	
Powdersville	Yes	Yes	Yes	$13.22 (minimum); $4.80 per 1,000 gal.	same	same	-	Monthly	Annually since 2005	
Town of Central	Yes	Yes	Yes	$4.70 base + $3.86 per 1k gal (inside town) $7.05 base + $5.59 per 1k gal (outside town)	$10.04 min (0-2k gal) $2.73 per 1k gal.	$6.70 base + $3.86 above min	differs by sector			Entire structure changed 3 years ago
City of Clemson	Yes	Yes	Yes	$8.80	same	same	$2.54 (per 1k inside city) $3.43 (per 1k outside city)	Monthly	$690 for a 3/4" meter $200 for a 3/4" irrigation meter all larger meters carry higher fees	2009
Clemson University				$1.86 (per 1k gal.)	same	same	-			Annually
City of Liberty	Yes	Yes	No	depends on the size of the meter. Min is 5/8 meter. $10.75 (0-2k gal. inside city); $16.50 (0-2k gal. outside city); Max size is 6 meters. $793 (300,000 gal. min inside city); $1586 (300,000 gal. min outside city)			$3.41 (per 1 k gal. over min inside city) $4.73 (per 1 k gal. over min outside city)	Monthly	$700 for a 3/4" meter (inside city) $1200 for a 3/4" meter (outside city) $500 for irrigation tap (inside city) $700 for irrigation tap (outside city) commercial tap fees are determined on a "per case" basis	2009
Southside Rural	Yes	Yes		depends on the size of the meter. Min is 3/4" $35.00 (0-6k gal.) max is 4" $280.00 (0-48k gal.)	same			Bimonthly	$950 for 3/4" tap $1450 for 1" meter cost + 10% for 2" meter	2007 (last known)
Six-Mile	Yes		No	$27.00 (0-4k gal.)	same	same	$3.45 per 1k gal. (4k-24k gal.); $3.75 per 1k gal. (>24k gal.)	Bimonthly		Has gone up in past 2 years
PCWA	Yes	Yes	Yes	$1.51 (per 1k gal.)	same	same				Annually

APPENDIX 4: USGS WATER USE ESTIMATES

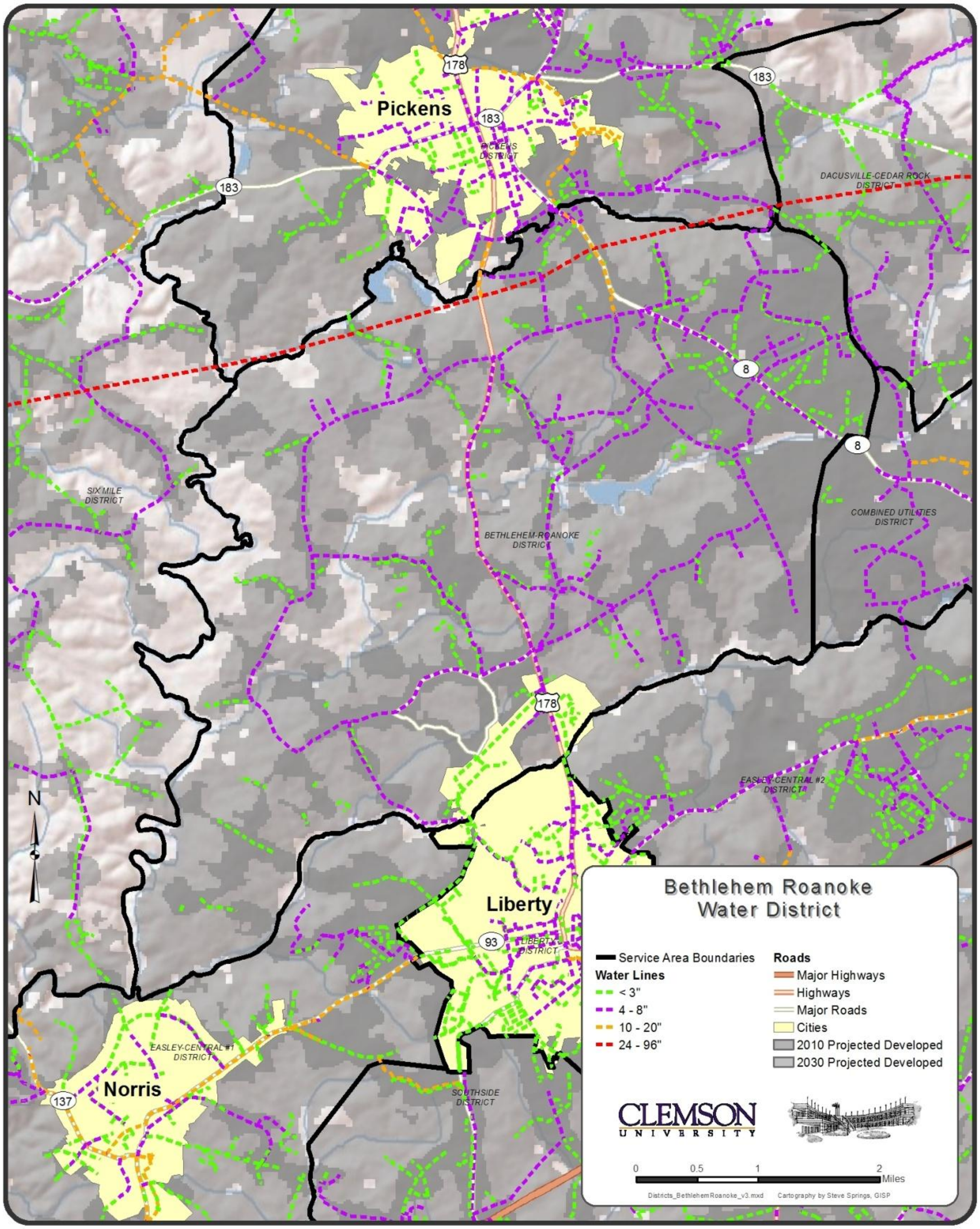
Year	2005	2000	1995	1990	1985
Total population of county	113575	110760	102410	93890	8550
Public Supply population served by GW	482	n/a	70	0	0
Public Supply population served by SW	42840	n/a	69850	54110	78880
Public Supply, total population served	43322	85900	69920	54110	78880
Public Supply, GW withdrawals	0.15	0.03	0.01	0	0
Public supply, SW withdrawals	9.46	28.62	10.49	11.42	8.91
Public Supply Total Withdrawals	9.61	28.65	10.5	11.42	8.91
*Public Supply, Per capita withdrawal, in gallons per day	n/a	n/a	150.17	211.05	112.96
*Public Supply, loss	n/a	n/a	n/a	1.72	1.28
*Public Supply, deliveries	n/a	n/a	n/a	9.7	8.91
*Commercial, self-supplied GW	n/a	n/a	n/a	0	0
*Commercial, self-supplied SW	n/a	n/a	n/a	0	1.52
*Commercial, deliveries from PS	n/a	n/a	0.25	4.47	0.28
*Commercial, total	n/a	n/a	n/a	4.47	1.52
*Commercial, consumptive use	n/a	n/a	0.04	0.67	0.36
Domestic, self-supplied population	70253	24860	32490	39780	66200
Domestic, total ss withdrawals	7.03	1.86	2.44	2.98	0.49
*Domestic, per capita use, self-supplied in gallons per day	n/a	n/a	75.1	74.91	74.02
*Domestic, public supplied population	n/a	n/a	69920	54110	78880
Domestic, deliveries from public supply	4.33	n/a	7.52	4.06	5.92
Domestic, total use	11.36	1.86		7.04	6.41
*Domestic, per capita use, public supplied, in gallons per day	n/a	n/a	107.55	75.03	75.05
*Domestic, consumptive use	n/a	n/a	1.99	1.41	1.28
Industrial, self-supplied total withdrawals	8.98	1.58	1.22	2.17	2.02
Industrial, deliveries from PS	n/a	n/a	1.16	1.17	1.43
*Industrial, consumptive use	n/a	n/a	0.36	0.5	0.54
Irrigation, acres irrigated total	750	780	220		420

USGS Water Use Estimates, table continued

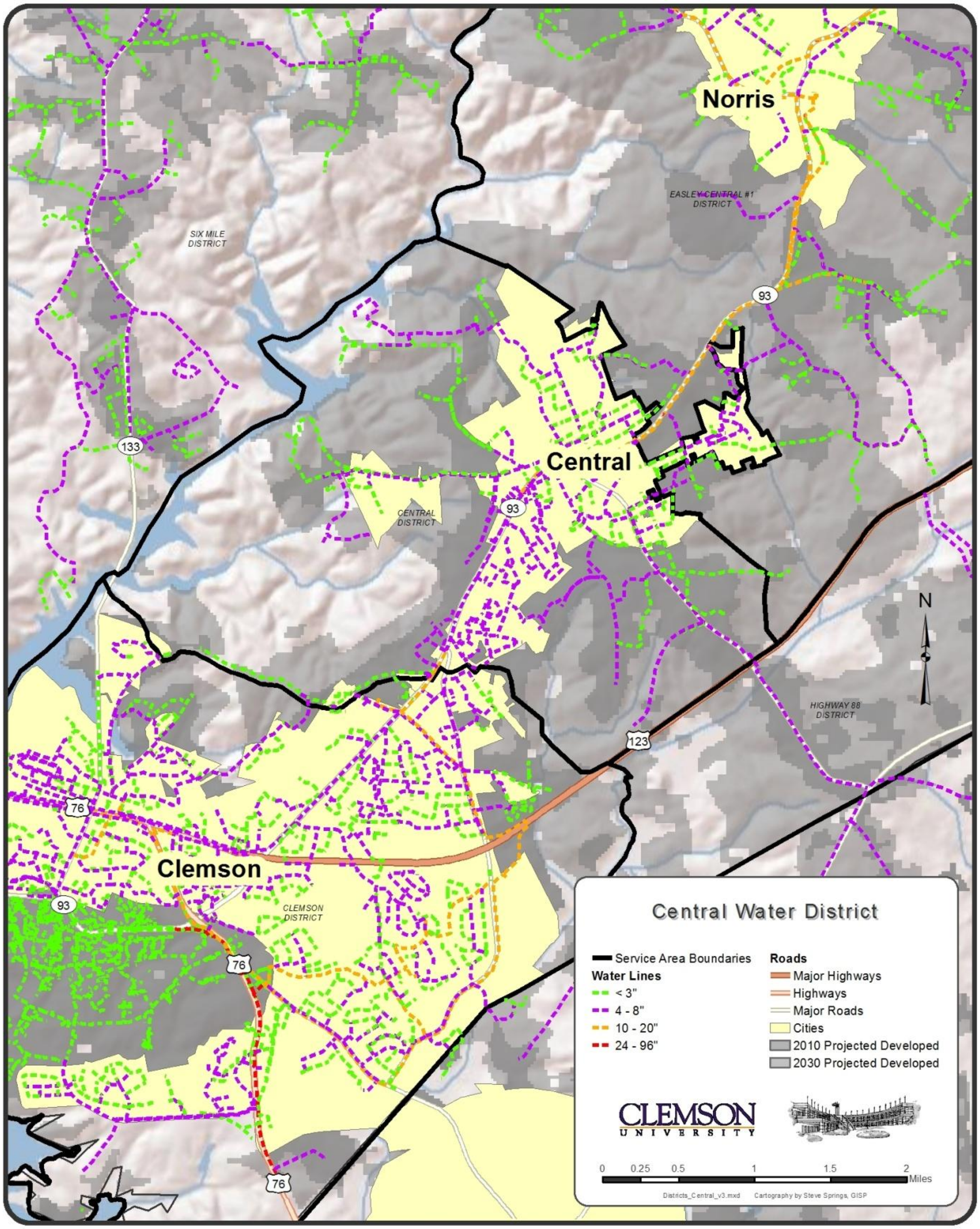
Year	2005	2000	1995	1990	1985
Irrigation, total withdrawals	0.53	1.43	0.09	0.07	0.07
Irrigation-Crop	0	n/a	n/a	n/a	n/a
Irrigation-Golf	0.53	n/a	n/a	n/a	n/a
Livestock, stock total withdrawals	n/a	n/a	0.09	0.09	0.19
Animal Specialties	n/a	n/a	3.52	3.52	0
Livestock, total withdrawals	0.13	n/a	3.61	3.61	0.19
Aquaculture, total withdrawals	0	n/a	n/a	n/a	n/a
Mining, total withdrawals	0	n/a	0	0	0
Thermoelectric, total withdrawals	0	0		0	0
Thermoelectric once-through, total withdrawals	0	0		0	0
Thermoelectric recirculation, total withdrawals	0	0		0	0
Total GW withdrawals	7.18	1.89	2.45	2.98	0.61
Total SW withdrawals	19.1	31.63	15.41	17.27	12.59
Total withdrawals	26.28	33.52	17.86	20.25	13.2

APPENDIX 5: WATER DISTRICT MAPS

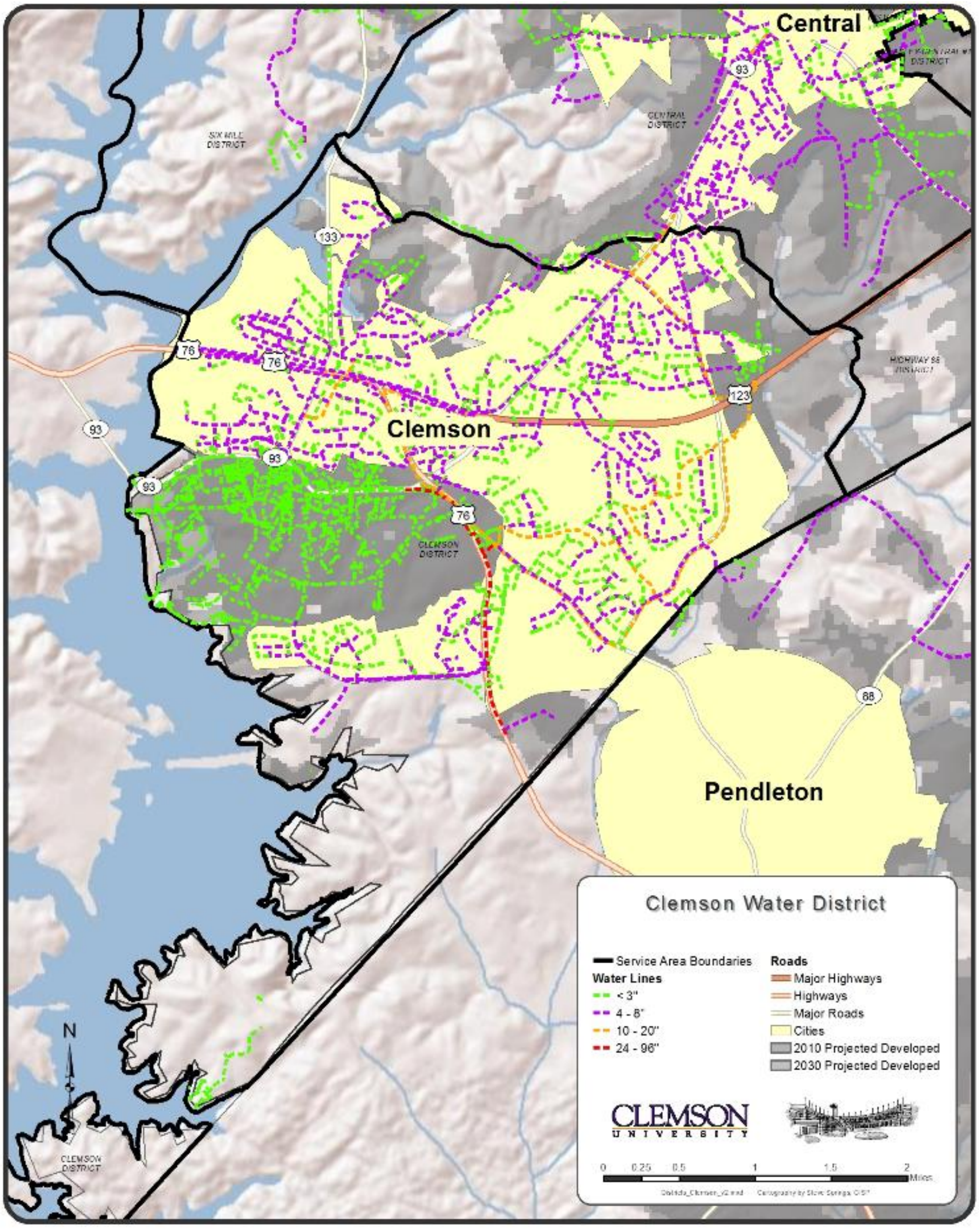
1. Bethlehem-Roanoke
2. Central, Town of
3. Clemson, City & University
4. Dacusville-Cedar Rock
5. Easley Central #1
6. Easley Central #2
7. Easley Combined Utilities
8. Highway 88
9. Liberty
10. Pickens, City of
11. Powdersville
12. Six Mile
13. Southside Rural
14. No District

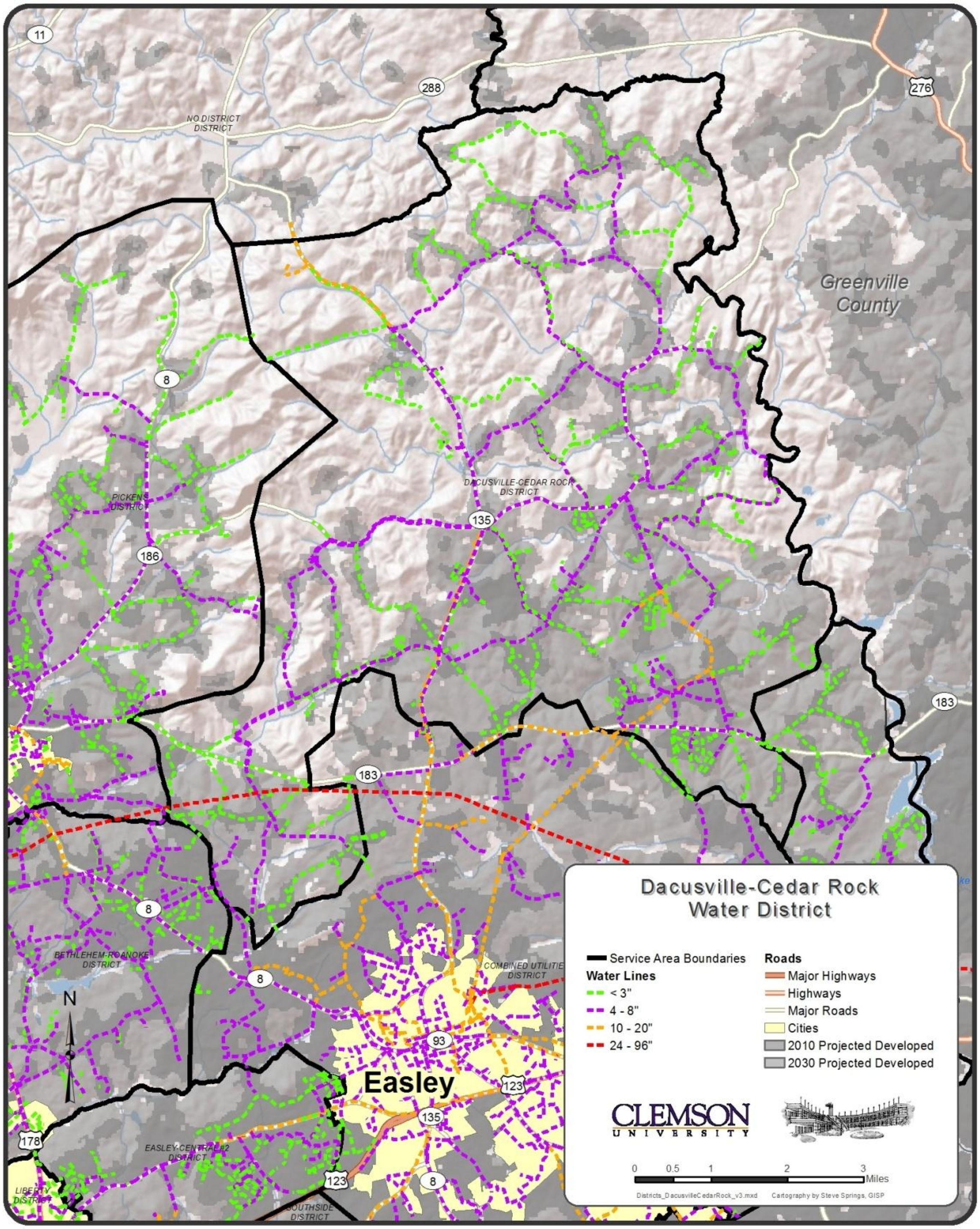


Pickens
PICKENS DISTRICT
DACUSVILLE-CEDAR ROCK DISTRICT
SIX MILE DISTRICT
BETHLEHEM-ROANOKE DISTRICT
COMBINED UTILITIES DISTRICT
EASLEY-CENTRAL #2 DISTRICT
Liberty
LIBERTY DISTRICT
EASLEY-CENTRAL #1 DISTRICT
Norris
SOUTHSIDE DISTRICT
178
183
8
93
137
N
Bethlehem Roanoke
Water District
Service Area Boundaries
Water Lines
< 3"
4 - 8"
10 - 20"
24 - 96"
Roads
Major Highways
Highways
Major Roads
Cities
2010 Projected Developed
2030 Projected Developed
CLEMSON UNIVERSITY
0
0.5
1
2
Miles
Districts_BethlehemRoanoke_v3.mxd
Cartography by Steve Springs, GISP

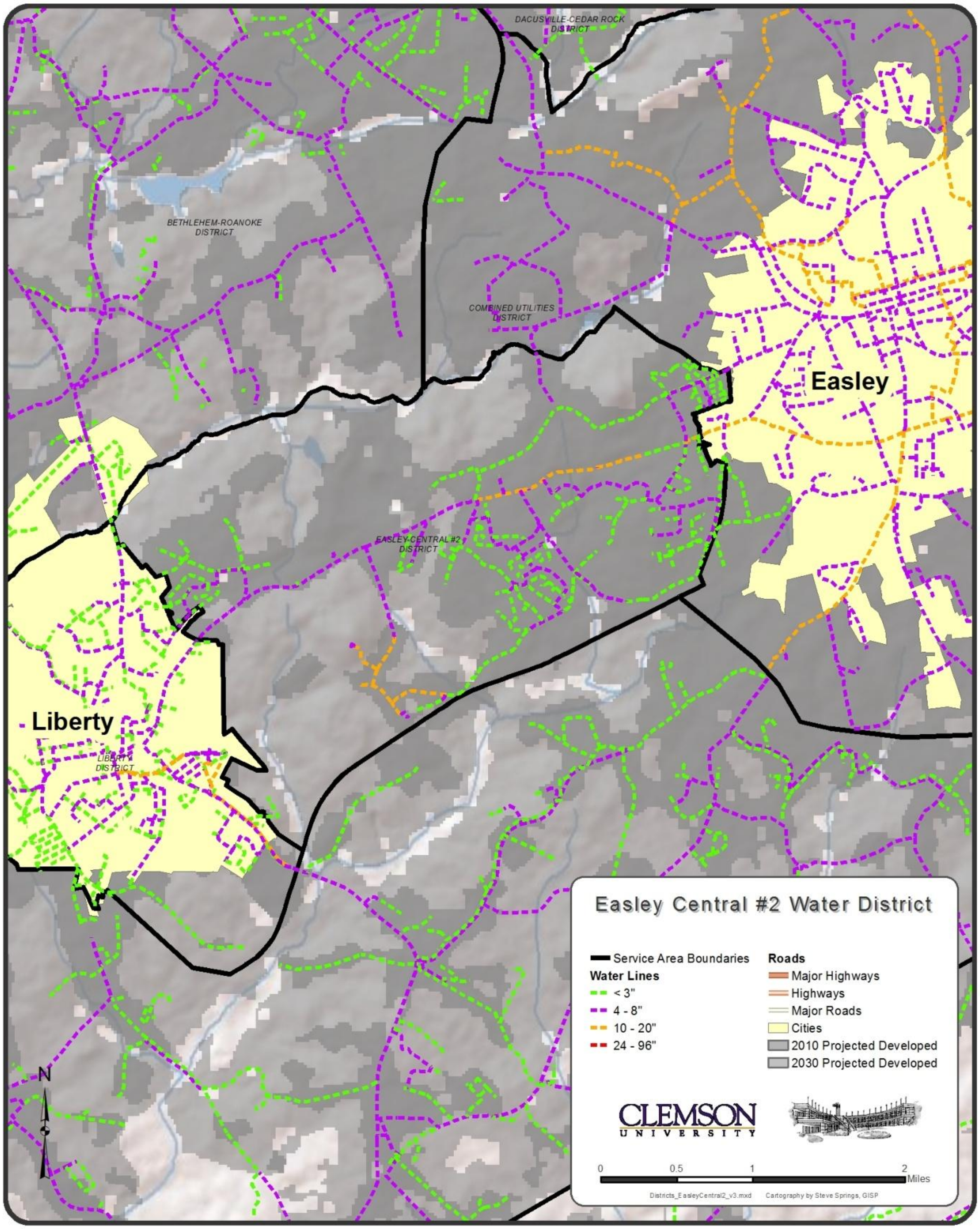


Norris
EASLEY CENTRAL #1
DISTRICT
SIX MILE
DISTRICT
93
133
Central
CENTRAL
DISTRICT
93
N
HIGHWAY 88
DISTRICT
123
76
Clemson
93
CLEMSON
DISTRICT
76
76
Central Water District
Service Area Boundaries
Water Lines
< 3"
4 - 8"
10 - 20"
24 - 96"
Roads
Major Highways
Highways
Major Roads
Cities
2010 Projected Developed
2030 Projected Developed
CLEMSON
UNIVERSITY
0 0.25 0.5 1 1.5 2
Miles
Districts_Central_v3.mxd
Cartography by Steve Springs, GISP

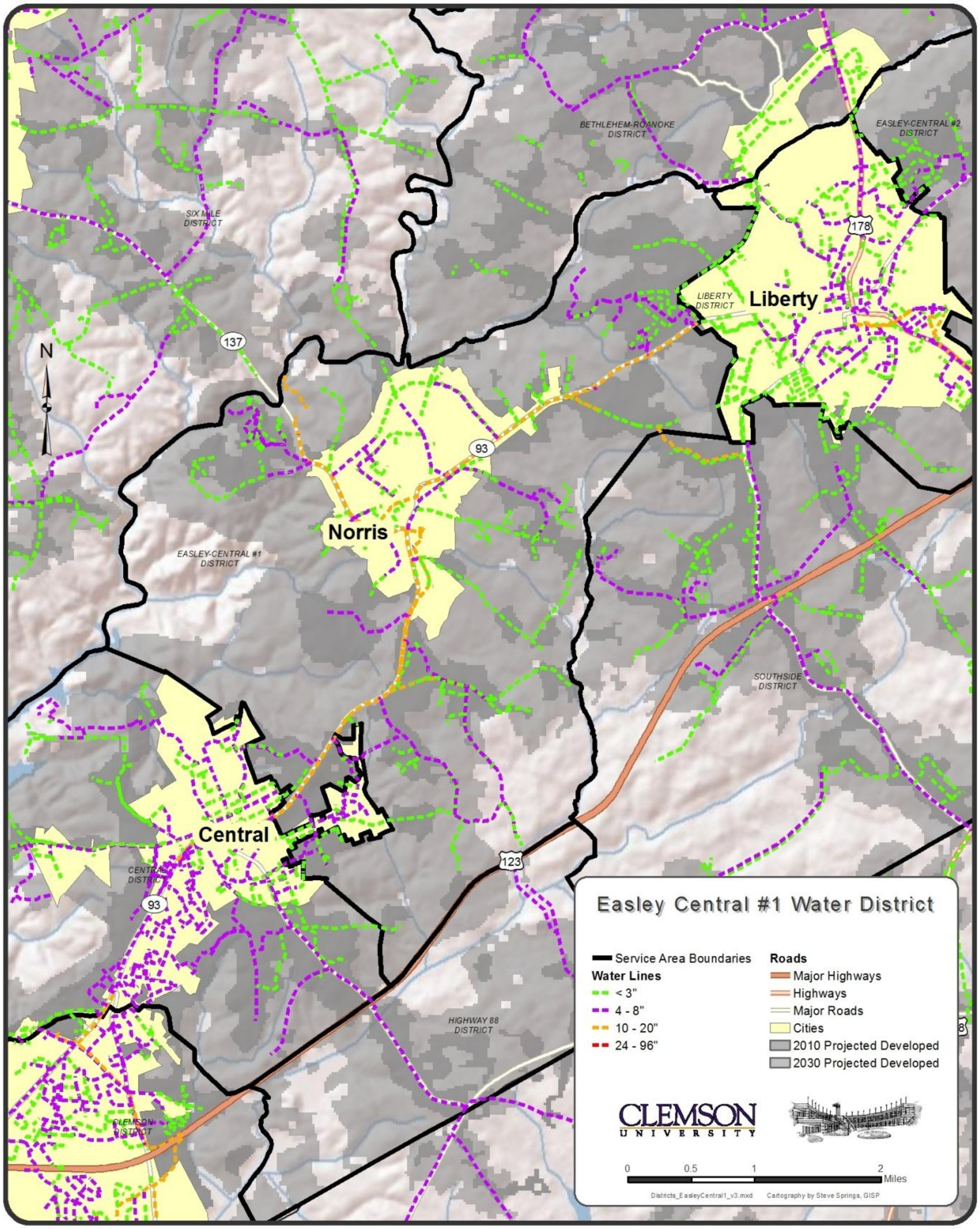

Central
Clemson
Pendleton
SIX MILE DISTRICT
CENTRAL DISTRICT
CLEMSON DISTRICT
HIGHWAY 88 DISTRICT
Clemson Water District
Service Area Boundaries
Water Lines
< 3"
4 - 8"
10 - 20"
24 - 96"
Roads
Major Highways
Highways
Major Roads
Cities
2010 Projected Developed
2030 Projected Developed
CLEMSON
UNIVERSITY
0 0.25 0.5 1 1.5 2 Miles
N

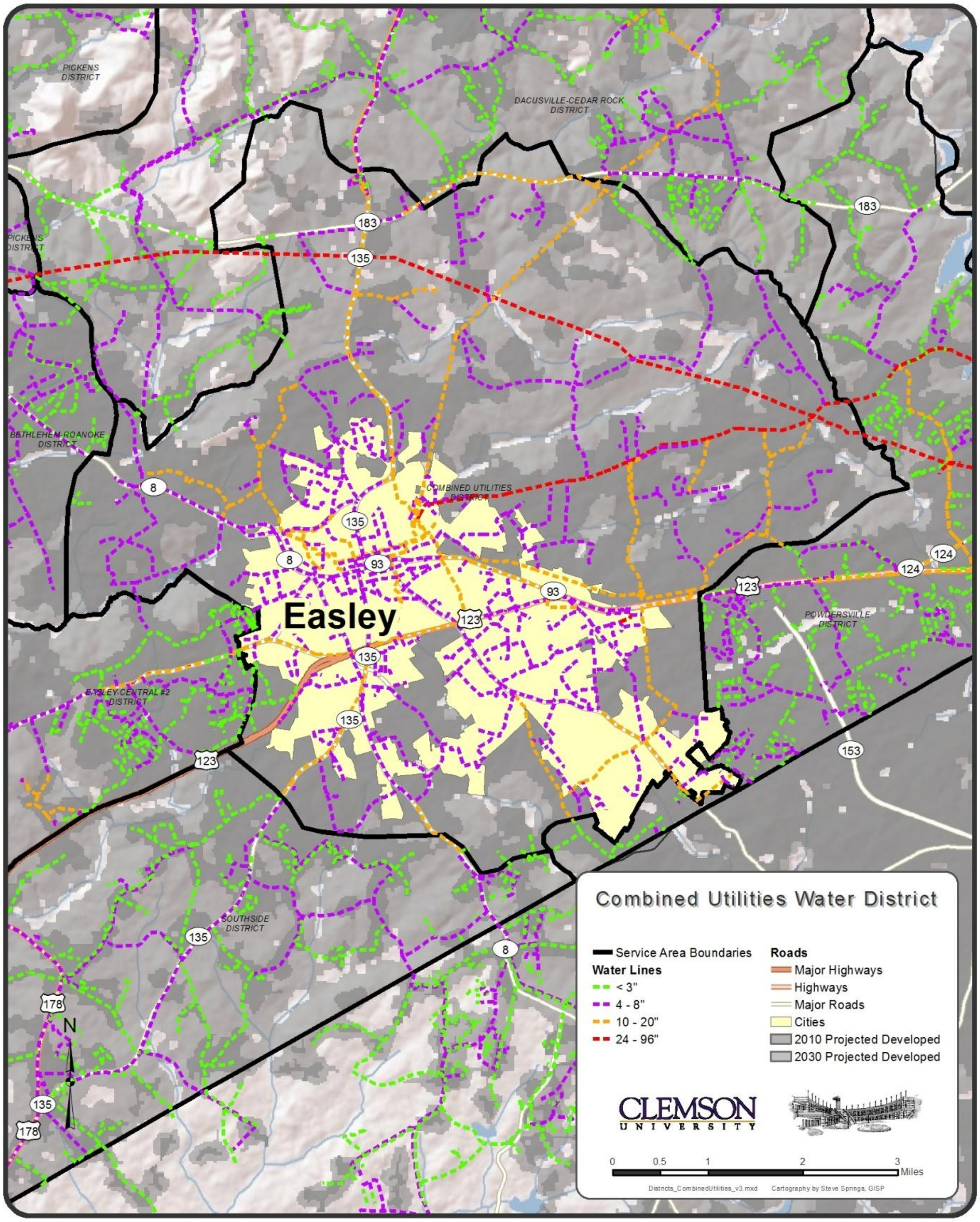


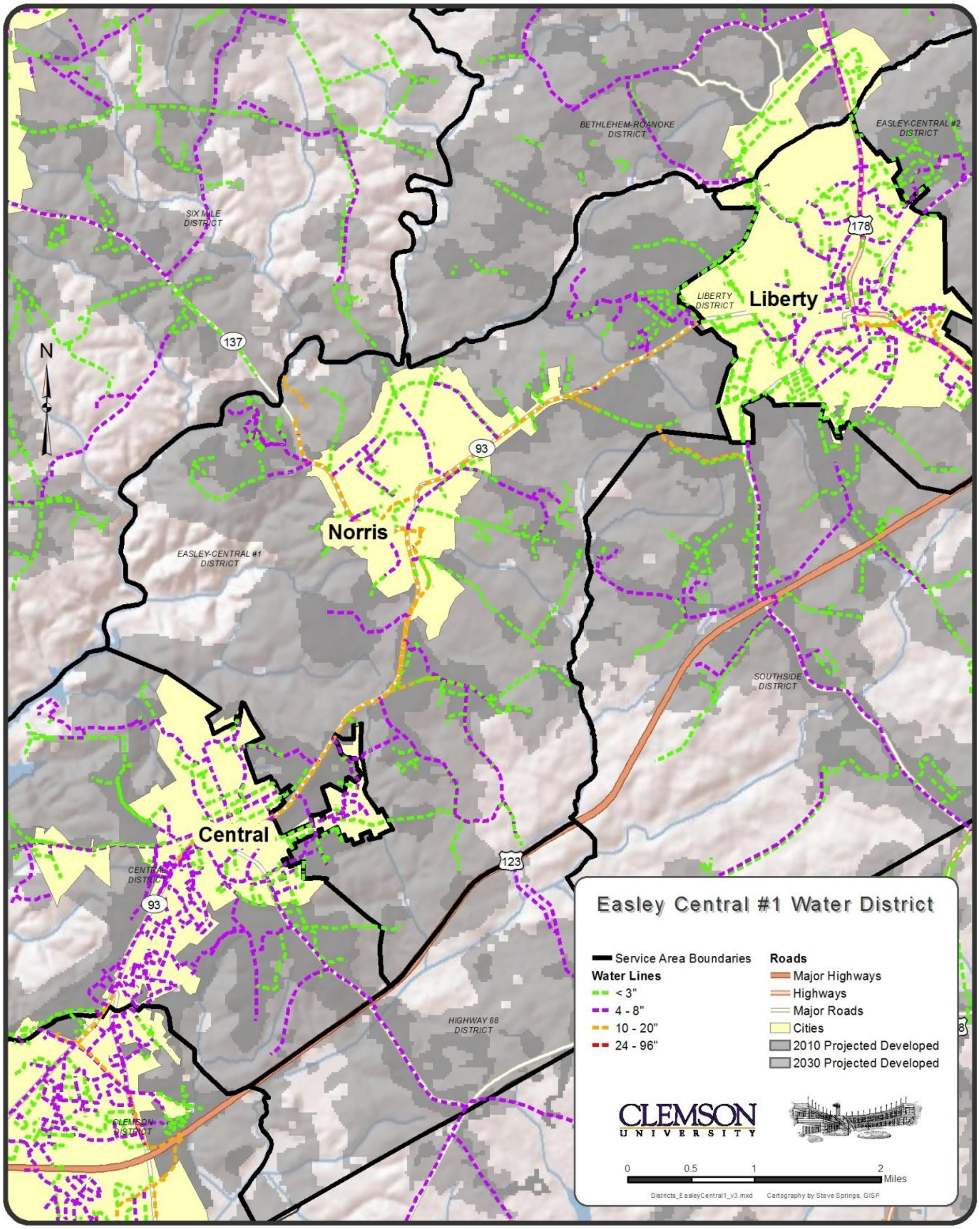
Dacusville-Cedar Rock
Water District
Service Area Boundaries
Water Lines
< 3"
4 - 8"
10 - 20"
24 - 96"
Roads
Major Highways
Highways
Major Roads
Cities
2010 Projected Developed
2030 Projected Developed
Greenville County
NO DISTRICT DISTRICT
DACUSVILLE-CEDAR ROCK DISTRICT
PICKENS DISTRICT
BETHLEHEM-ROANOKE DISTRICT
COMBINED UTILITIES DISTRICT
EASLEY-CENTRAL #2 DISTRICT
SOUTHSIDE DISTRICT
LIBERTY DISTRICT
Easley
0 0.5 1 2 3 Miles
Districts_DacusvilleCedarRock_v3.mxd
Cartography by Steve Springs, GISP

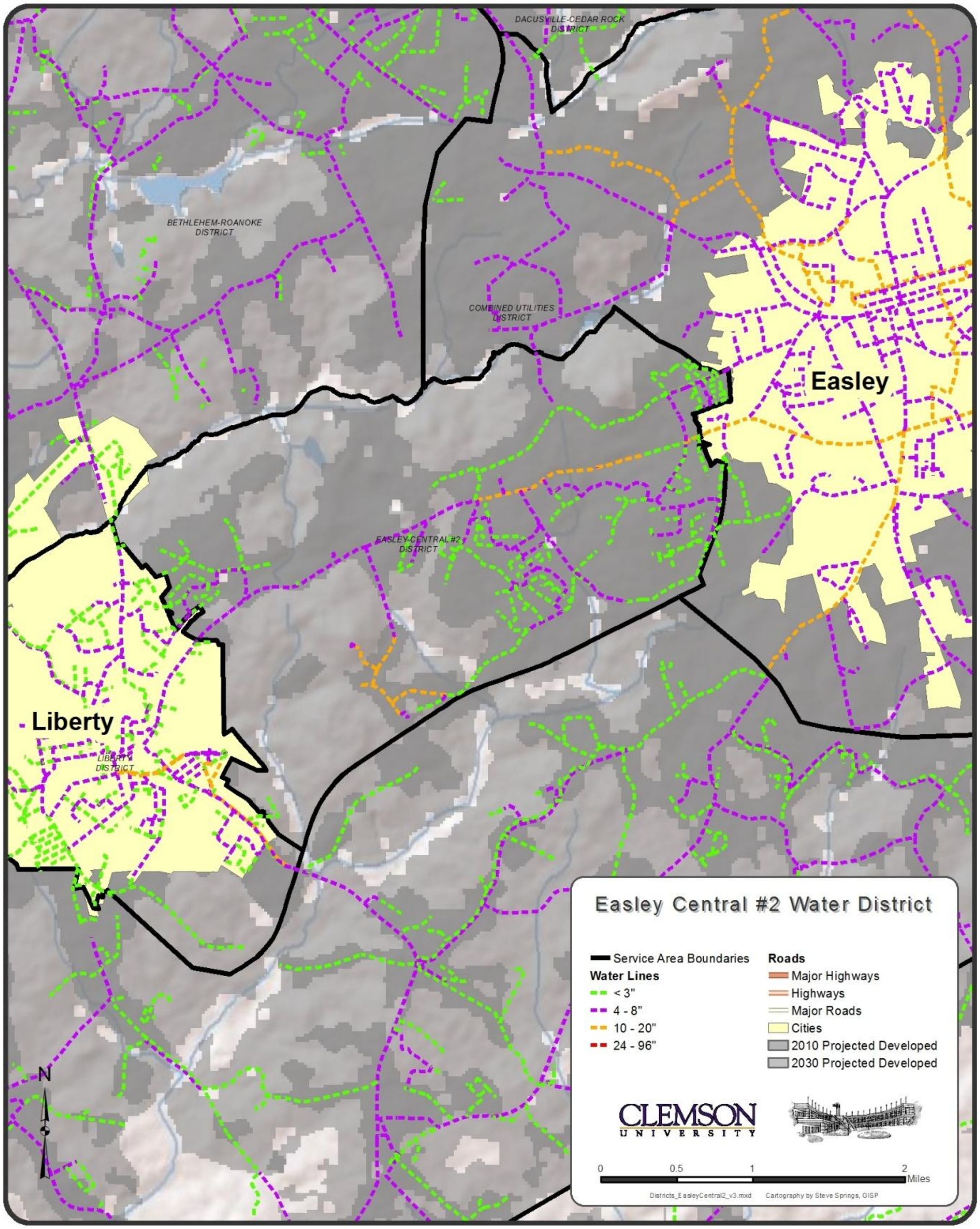


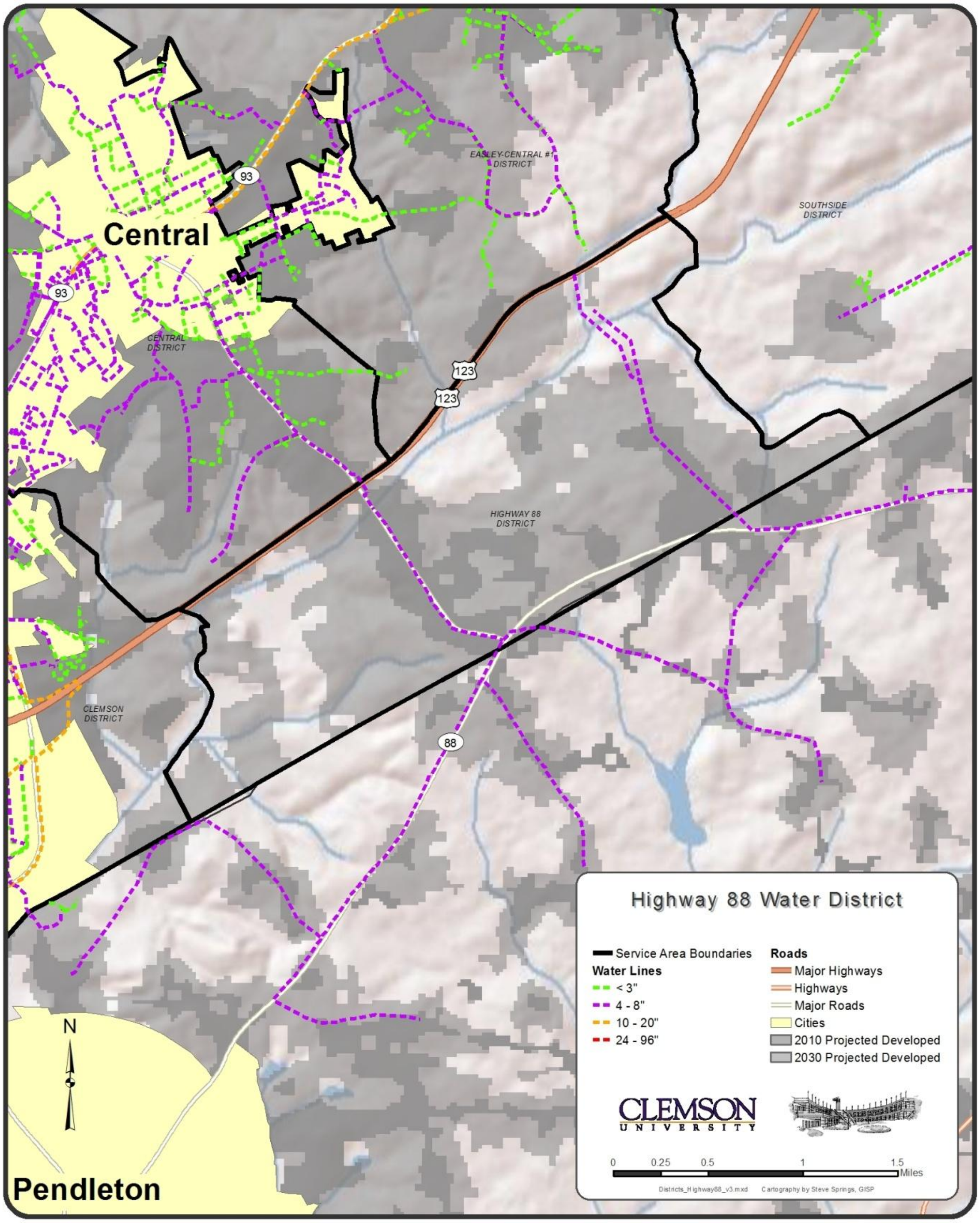
DACUSVILLE-CEDAR ROCK DISTRICT
BETHLEHEM-ROANOKE DISTRICT
COMBINED UTILITIES DISTRICT
Easley
EASLEY-CENTRAL #2 DISTRICT
Liberty
LIBERTY DISTRICT
Easley Central #2 Water District
Service Area Boundaries
Water Lines
< 3"
4 - 8"
10 - 20"
24 - 96"
Roads
Major Highways
Highways
Major Roads
Cities
2010 Projected Developed
2030 Projected Developed
CLEMSON UNIVERSITY
0
0.5
1
2
Miles
Districts_EasleyCentral2_v3.mxd
Cartography by Steve Springs, GISP
N

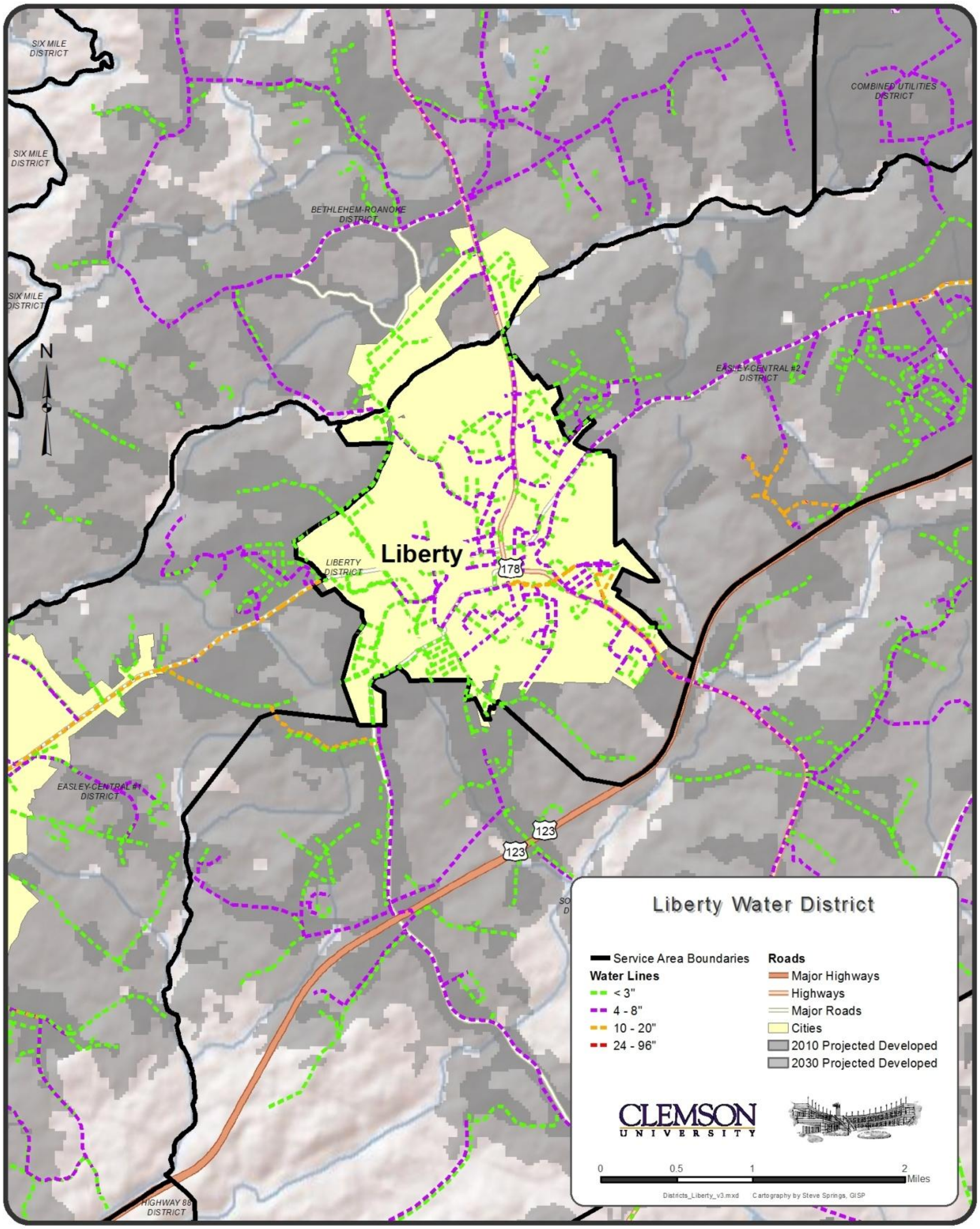

Easley Central #1 Water District
Service Area Boundaries
Water Lines
< 3"
4 - 8"
10 - 20"
24 - 96"
Roads
Major Highways
Highways
Major Roads
Cities
2010 Projected Developed
2030 Projected Developed
CLEMSON UNIVERSITY
Miles
Districts_EasleyCentral1_v3.mxd
Cartography by Steve Springs, GISP
Liberty
Norris
Central
SIX MILE DISTRICT
BETHLEHEM-ROANOKE DISTRICT
EASLEY-CENTRAL #2 DISTRICT
LIBERTY DISTRICT
EASLEY-CENTRAL #1 DISTRICT
SOUTHSIDE DISTRICT
HIGHWAY 88 DISTRICT
CLEMSON DISTRICT
N


Combined Utilities Water District
PICKENS DISTRICT
DACUSVILLE-CEDAR ROCK DISTRICT
BETHLEHEM-ROANOKE DISTRICT
COMBINED UTILITIES DISTRICT
Easley
POWDERSVILLE DISTRICT
EASLEY CENTRAL #2 DISTRICT
SOUTHSIDE DISTRICT
183
135
8
93
123
124
153
178
N
Service Area Boundaries
Water Lines
< 3"
4 - 8"
10 - 20"
24 - 96"
Roads
Major Highways
Highways
Major Roads
Cities
2010 Projected Developed
2030 Projected Developed
CLEMSON UNIVERSITY
0 0.5 1 2 3 Miles
Districts_CombinedUtilities_v3.mxd
Cartography by Steve Springs, GISP

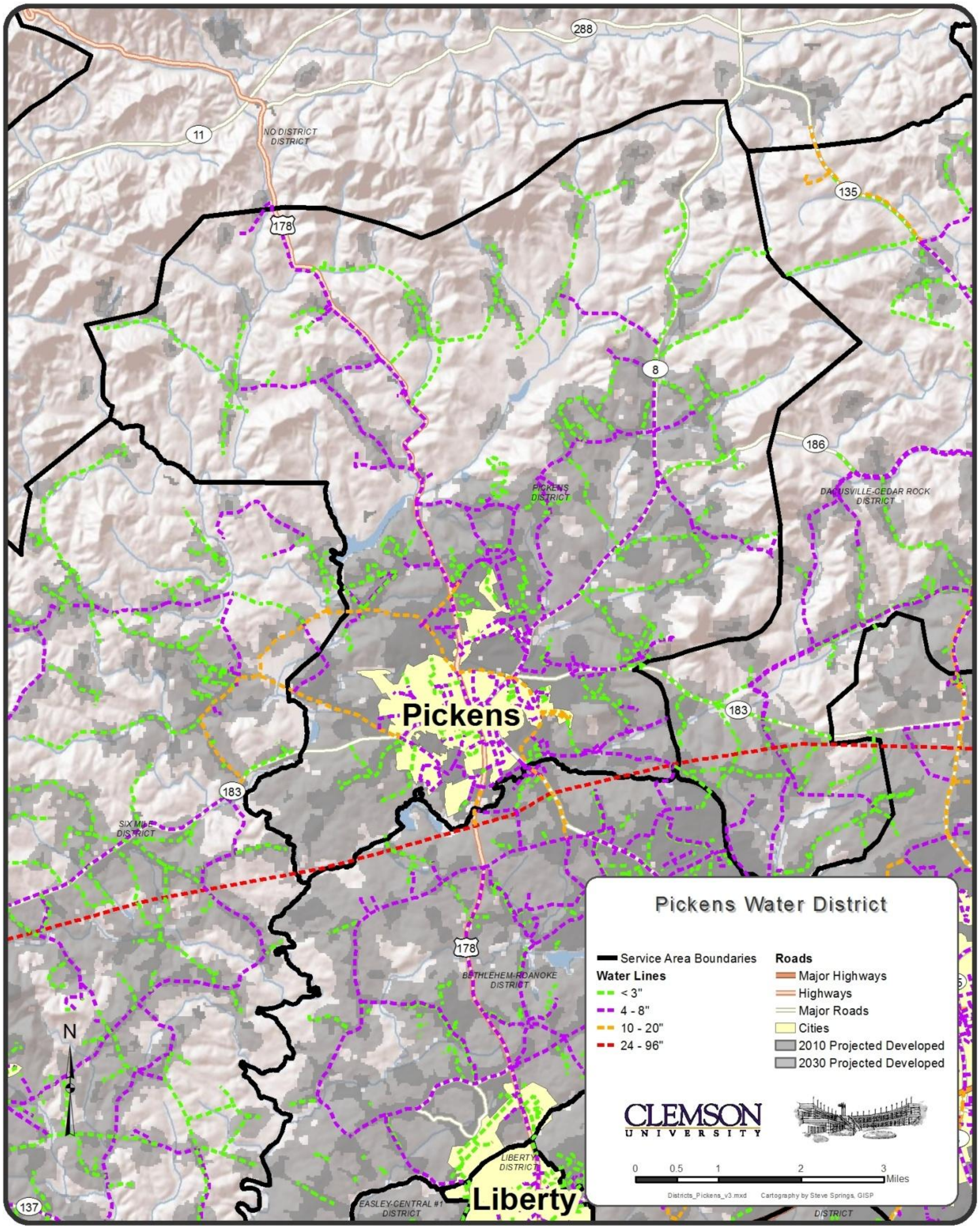

Easley Central #1 Water District
Service Area Boundaries
Water Lines
< 3"
4 - 8"
10 - 20"
24 - 96"
Roads
Major Highways
Highways
Major Roads
Cities
2010 Projected Developed
2030 Projected Developed
CLEMSON UNIVERSITY
0
0.5
1
2
Miles
Districts_EasleyCentral1_v3.mxd
Cartography by Steve Springs, GISP
Liberty
Norris
Central
BETHLEHEM-ROANOKE DISTRICT
EASLEY-CENTRAL #2 DISTRICT
SIX MILE DISTRICT
LIBERTY DISTRICT
EASLEY-CENTRAL #1 DISTRICT
SOUTHSIDE DISTRICT
HIGHWAY 88 DISTRICT
CLEMSON DISTRICT
N
137
93
178
123

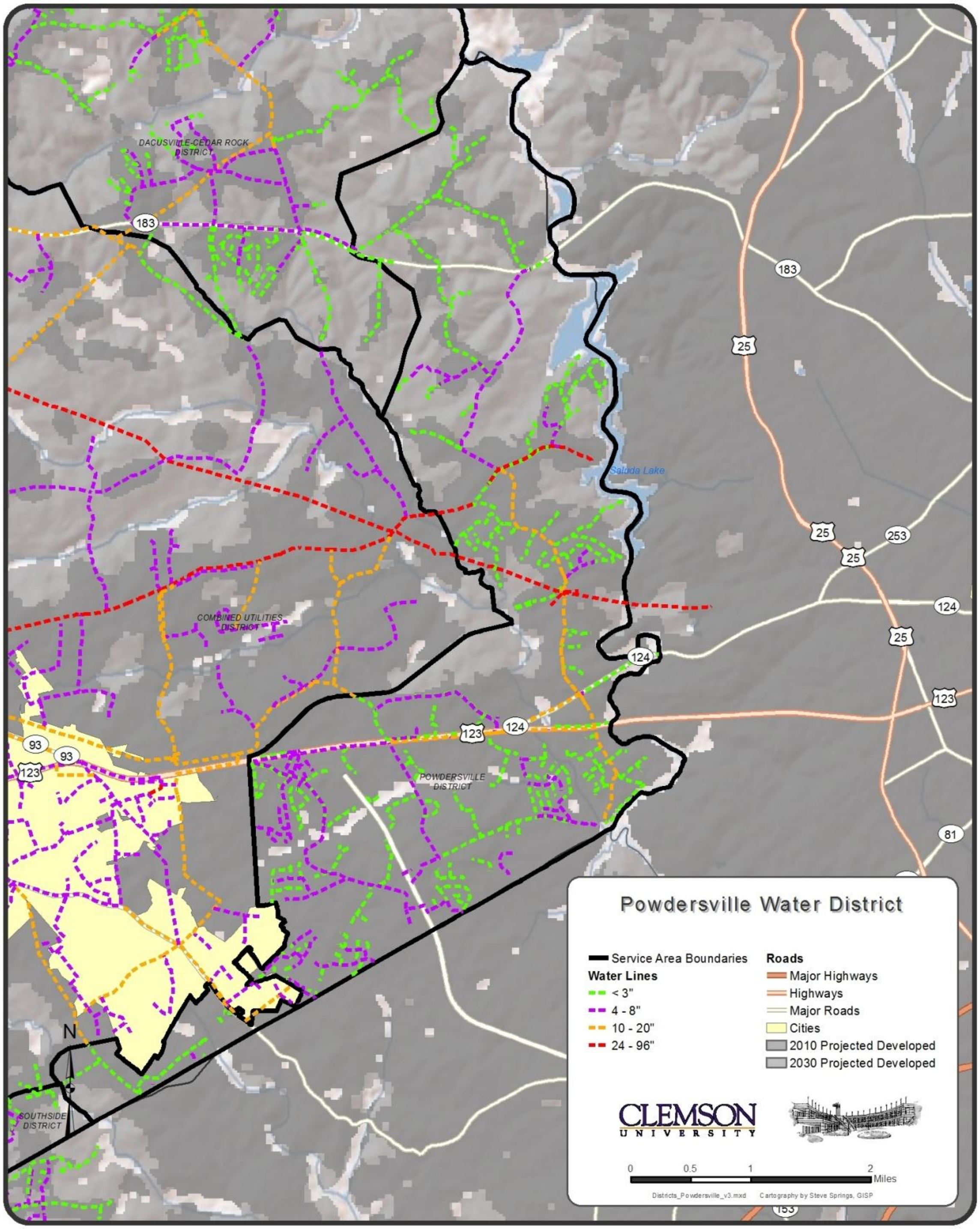

DACUSVILLE-CEDAR ROCK DISTRICT
BETHLEHEM-ROANOKE DISTRICT
COMBINED UTILITIES DISTRICT
Easley
EASLEY-CENTRAL #2 DISTRICT
Liberty
LIBERTY DISTRICT
Easley Central #2 Water District
Service Area Boundaries
Water Lines
< 3"
4 - 8"
10 - 20"
24 - 96"
Roads
Major Highways
Highways
Major Roads
Cities
2010 Projected Developed
2030 Projected Developed
CLEMSON UNIVERSITY
0
0.5
1
2
Miles
N

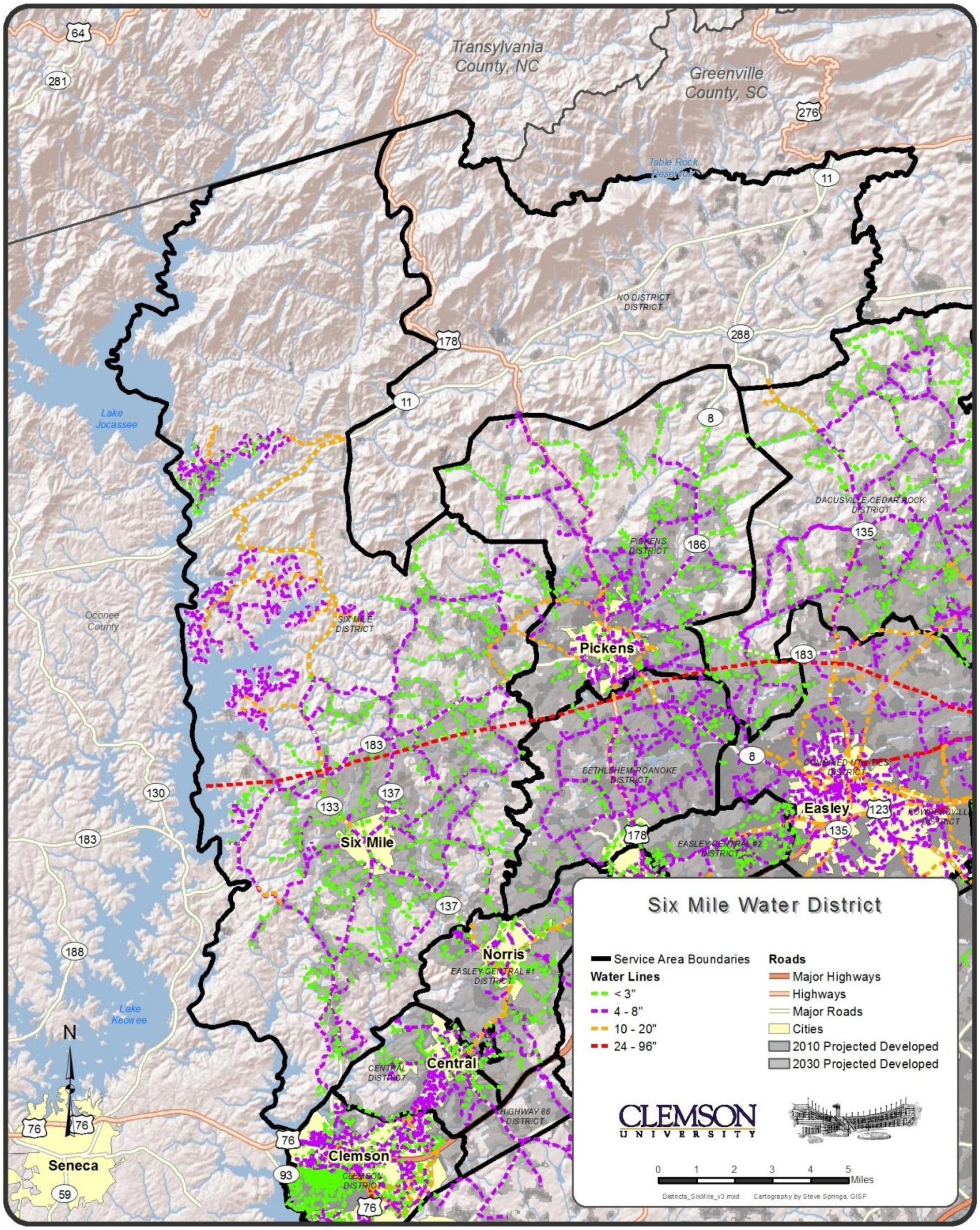

Central
Pendleton
EASLEY-CENTRAL #1 DISTRICT
SOUTHSIDE DISTRICT
CENTRAL DISTRICT
HIGHWAY 88 DISTRICT
CLEMSON DISTRICT
93
123
88
N
Highway 88 Water District
Service Area Boundaries
Water Lines
< 3"
4 - 8"
10 - 20"
24 - 96"
Roads
Major Highways
Highways
Major Roads
Cities
2010 Projected Developed
2030 Projected Developed
CLEMSON UNIVERSITY
0 0.25 0.5 1 1.5 Miles
Districts_Highway88_v3.mxd
Cartography by Steve Springs, GISP

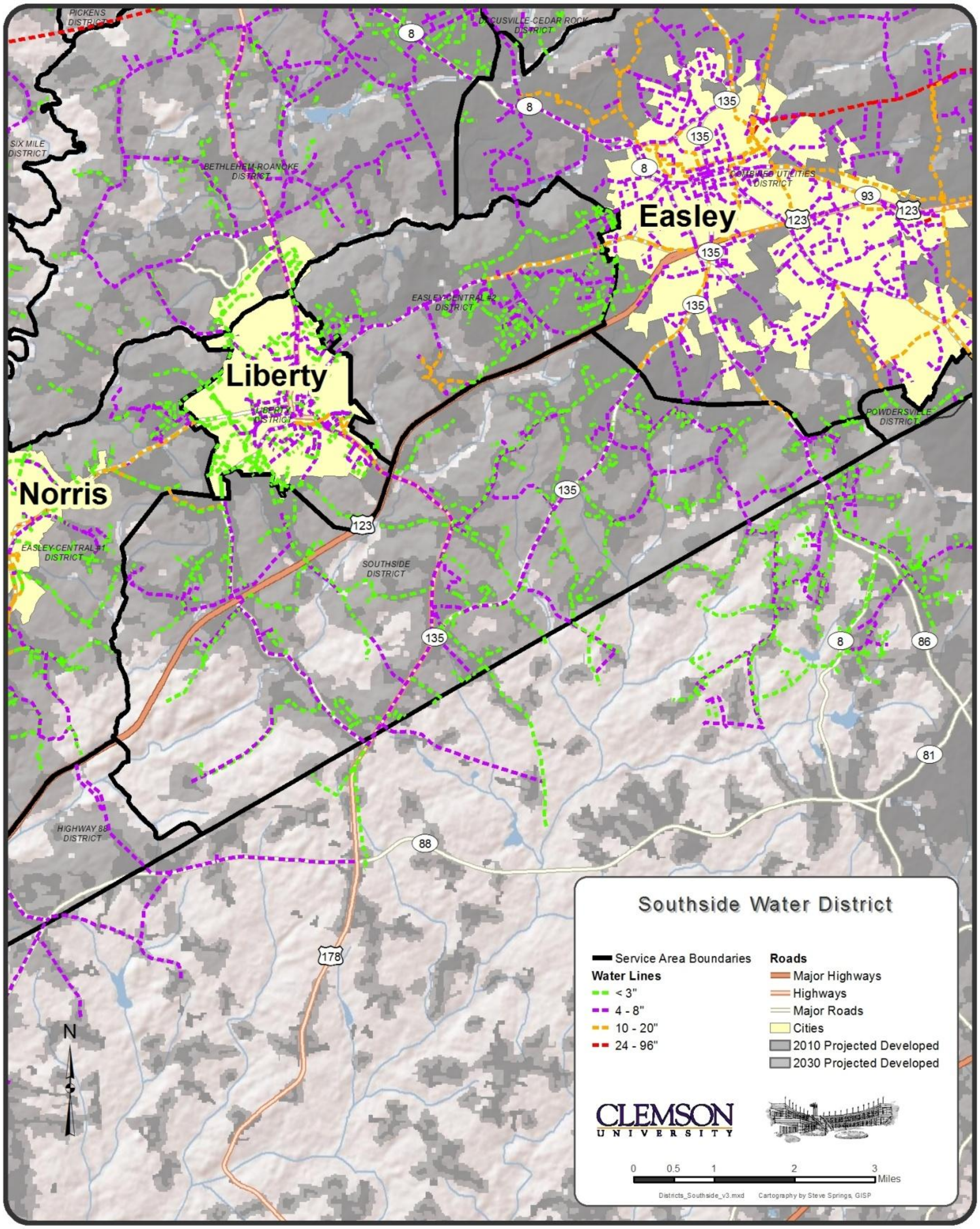


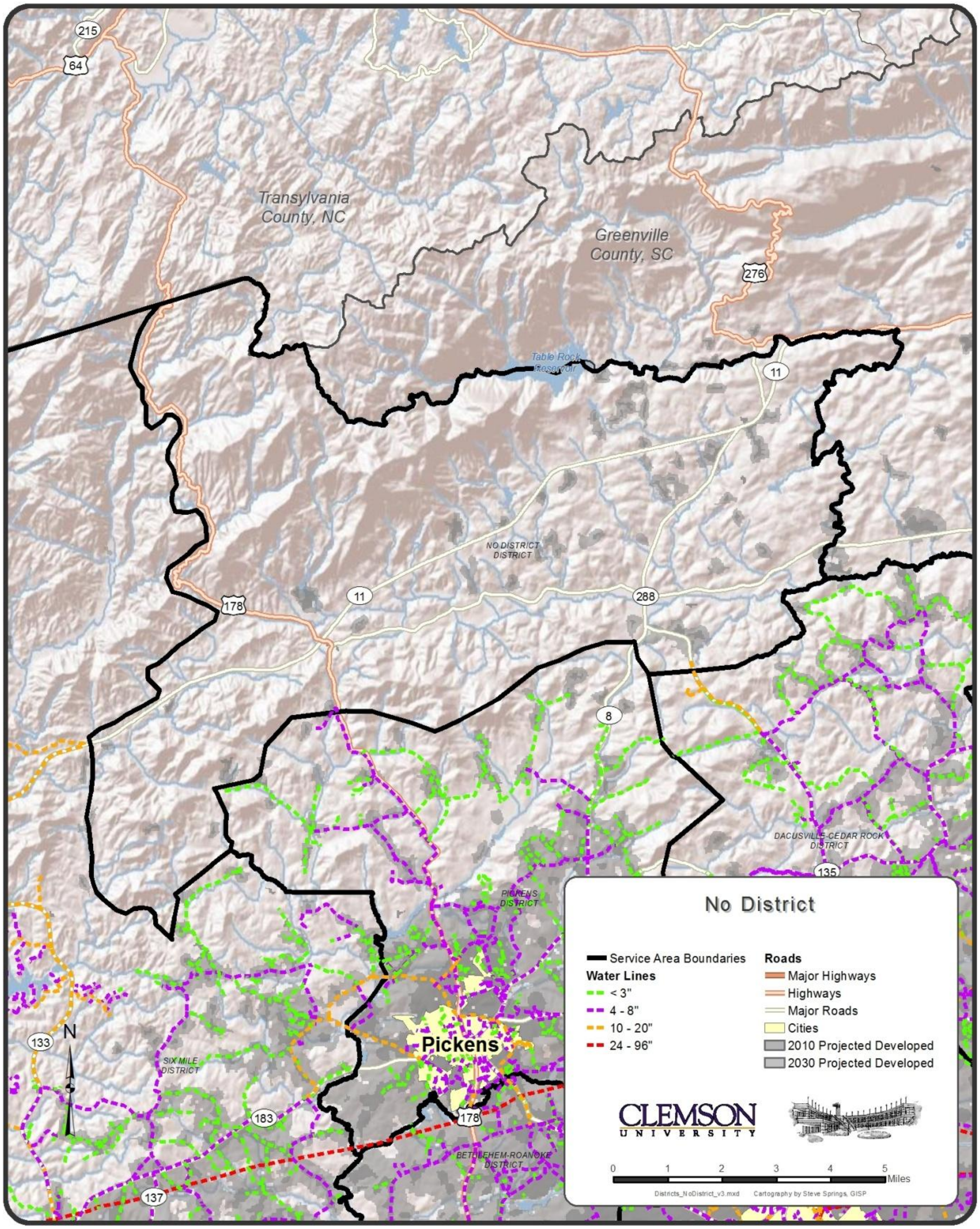
SIX MILE DISTRICT
SIX MILE DISTRICT
SIX MILE DISTRICT
BETHLEHEM-ROANOKE DISTRICT
COMBINED UTILITIES DISTRICT
EASLEY CENTRAL #2 DISTRICT
N
Liberty
LIBERTY DISTRICT
178
EASLEY CENTRAL #1 DISTRICT
123
123
HIGHWAY 88 DISTRICT
Liberty Water District
Service Area Boundaries
Water Lines
< 3"
4 - 8"
10 - 20"
24 - 96"
Roads
Major Highways
Highways
Major Roads
Cities
2010 Projected Developed
2030 Projected Developed
CLEMSON UNIVERSITY
0
0.5
1
2
Miles
Districts_Liberty_v3.mxd
Cartography by Steve Springs, GISP


Pickens Water District
Service Area Boundaries
Water Lines
< 3"
4 - 8"
10 - 20"
24 - 96"
Roads
Major Highways
Highways
Major Roads
Cities
2010 Projected Developed
2030 Projected Developed
CLEMSON UNIVERSITY
0 0.5 1 2 3 Miles
Districts_Pickens_v3.mxd Cartography by Steve Springs, GISP
Pickens
Liberty
PICKENS DISTRICT
NO DISTRICT DISTRICT
DACUSVILLE-CEDAR ROCK DISTRICT
SIX MILE DISTRICT
BETHLEHEM-ROANOKE DISTRICT
LIBERTY DISTRICT
EASLEY-CENTRAL #1 DISTRICT
N
288
11
178
135
8
186
183
137


Powdersville Water District
Service Area Boundaries
Water Lines
< 3"
4 - 8"
10 - 20"
24 - 96"
Roads
Major Highways
Highways
Major Roads
Cities
2010 Projected Developed
2030 Projected Developed
CLEMSON UNIVERSITY
0 0.5 1 2 Miles
Districts_Powdersville_v3.mxd Cartography by Steve Springs, GISP
DACUSVILLE-CEDAR ROCK DISTRICT
COMBINED UTILITIES DISTRICT
POWDERSVILLE DISTRICT
SOUTHSIDE DISTRICT
Saluda Lake
N


Six Mile Water District
Transylvania County, NC
Greenville County, SC
Table Rock Reservoir
Lake Jocassee
Oconee County
Lake Keowee
NO DISTRICT DISTRICT
DACUSVILLE-CEDAR ROCK DISTRICT
PICKENS DISTRICT
SIX MILE DISTRICT
BETHLEHEM-ROANOKE DISTRICT
EASLEY CENTRAL #2 DISTRICT
EASLEY CENTRAL #1 DISTRICT
CENTRAL DISTRICT
HIGHWAY 88 DISTRICT
CLEMSON DISTRICT
Pickens
Six Mile
Norris
Central
Clemson
Seneca
Easley
Service Area Boundaries
Water Lines
< 3"
4 - 8"
10 - 20"
24 - 96"
Roads
Major Highways
Highways
Major Roads
Cities
2010 Projected Developed
2030 Projected Developed
CLEMSON UNIVERSITY
0 1 2 3 4 5 Miles
Districts_SixMile_v3.mxd
Cartography by Steve Springs, GISP


Southside Water District
Service Area Boundaries
Water Lines
< 3"
4 - 8"
10 - 20"
24 - 96"
Roads
Major Highways
Highways
Major Roads
Cities
2010 Projected Developed
2030 Projected Developed
CLEMSON UNIVERSITY
Miles
Districts_Southside_v3.mxd
Cartography by Steve Springs, GISP
Easley
Liberty
Norris
SOUTHSIDE DISTRICT
EASLEY-CENTRAL #2 DISTRICT
EASLEY-CENTRAL #1 DISTRICT
BETHLEHEM-ROANOKE DISTRICT
SIX MILE DISTRICT
LIBERTY DISTRICT
POWDERSVILLE DISTRICT
HIGHWAY 88 DISTRICT
PICKENS DISTRICT


Transylvania
County, NC
Greenville
County, SC
Table Rock
Reservoir
NO DISTRICT
DISTRICT
DACUSVILLE-CEDAR ROCK
DISTRICT
PICKENS
DISTRICT
SIX MILE
DISTRICT
BETHLEHEM-ROANOKE
DISTRICT
Pickens
215
64
276
11
178
288
8
135
133
183
137
No District
Service Area Boundaries
Water Lines
< 3"
4 - 8"
10 - 20"
24 - 96"
Roads
Major Highways
Highways
Major Roads
Cities
2010 Projected Developed
2030 Projected Developed
CLEMSON
UNIVERSITY
0
1
2
3
4
5
Miles
Districts_NoDistrict_v3.mxd
Cartography by Steve Springs, GISP

APPENDIX 6: REDYN OUTPUT FOR PICKENS COUNTY