South Cumberland Water Resources
Regional Planning Pilot
Draft Report
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Water Resources Technical Advisory Committee
Tennessee Department of Environment and Conservation
www.tn.gov/environment/regionalplanning

Chapter 1. Description of the Planning Region

1.1 Overview

The South Cumberland study area includes Grundy County and parts of Franklin, Marion, and Sequatchie counties. Although the area has not experienced much growth or development, forested tracts of land are being converted to residential development. The construction of new homes has not kept pace with the creation of lots, but the potential for population growth is certainly there. Because many of these subdivisions are scattered across the region, their location can make it difficult to provide public services to them, including police and fire protection, as well as water. And though the area has experienced little growth—it has no large industries or commercial centers—meeting its water supply needs remains a challenge, and droughts can drastically affect its limited water supplies.

The University of the South at Sewanee is a unique development on the plateau in a corner of Franklin County just outside of Monteagle. The 13,000-acre domain contains the university campus, a small village, residential areas and thousands of acres of forests.

All of the study area is atop the Cumberland Plateau, a major uplift in the Appalachian chain of mountains. It rises about 1,000 feet above the valleys and level lands on either the west or east sides of the plateau. It is a unique area of tablelands on top and steep walled gulfs that have been cut into the plateau by rivers and streams.

The Cumberland Plateau is the largest remaining forested plateau in the country and is one of the most intact biologically diverse natural landscapes in the eastern United States. It is the home of some of the finest state parks and natural areas in the state. Land acquisition through both public and private is continuing to add to the attractions of the area. Because of the unique environment of the plateau, a large number of rare aquatic and terrestrial species exist in the area. Loss of forestland, climate changes, construction activity, and increased development pressure can affect the plateau environment, its biodiversity and the natural watersheds.

Population growth has not been a major factor in the study area. It is an area of slow to no growth, and while Franklin, Marion, and Sequatchie Counties have had some population growth, most of that is not on the plateau but in the areas in the valleys and flat lands below.

Land development in the study area is concentrated in the small communities with the town of Monteagle having the largest amount of non-residential development. Most of the plateau area is largely undeveloped remaining in forests or agricultural land. However, many of the large forested tracts have recently been sold off and have either been bought for speculative land developments or for smaller tracts of land, which fragments the forest envirnoment. The land developments for second or vacation homes can have a dramatic effect on the demand for water, particularly during the summer months when occupancy can be high and rainfall low.

The economy of the region revolves around jobs in other locations. The only large employer on the plateau in the study area is the University of the South. Most workers who reside in the area work in job centers in Jasper, South Pittsburg, Winchester, and Chattanooga.

In addition to the county governments, all of the municipalities in the area are small. Only two of the municipalities operate water and wastewater systems. There is little structure or history in planning. Most of the municipalities do not have an active planning commission, and this limits their ability to plan for future water supplies, particularly as related to land development.

There are four major water systems in the area that provide water and have developed raw water resources. These are the Big Creek Utility District, Sewanee Utility District, Monteagle Public Works Department, and Tracy City Water Department. There are three other utility districts that purchase water from the larger systems.

1.2 Introduction

Background

The South Cumberland study area has a history of water supply challenges. Situated high on the Cumberland Plateau, where four watersheds meet, the utilities in the area lack access to large rivers, streams, or lakes to meet customers' needs. All of those resources are located in the valleys below. Water supply sources in the study area are mainly small impoundments of small headwater streams with limited capacity. This limited capacity affects the area's potential for growth. Moreover, some areas of the study region are difficult to serve at affordable rates because they are so sparsely populated. Providing water to sparsely populated areas is difficult and expensive, not only because of the initial cost of laying the lines, but also because small, long water lines must be flushed more often to ensure good quality water.

This study and the planning process reflected here are focused on determining the best way to ensure a sufficient water supply for all utilities in the study area. It does not directly address the issue of whether or how to extend service to areas that are presently unserved. It does, however, include the populations of those areas when analyzing demand to ensure sufficient supply for the region as a whole. Determining when and how to extend service to any particular area within the region is beyond the scope of the study at hand and is something that must be done case by case and requires considerably more detailed information about individuals' water usage than could be managed as part of this planning process. This is most appropriately done by the utility that provides the water service.

The South Cumberland study area has long been a popular location for vacation and second homes. Summer temperatures are somewhat cooler than in the valleys, and the area is within a reasonable driving distance of Chattanooga and Nashville. And the area contains some of Tennessee's outstanding natural resources and state parks. It is home to the University of the South, a nationally known liberal arts college owned by the Episcopal Church. It is located in Franklin County just west of Monteagle on the western face of the plateau. While not an incorporated municipality, the 13,000 acre Sewanee Domain, as it is known locally, contains the campus, the village of Sewanee, residential areas, and thousands of acres of forests, lakes and streams. This unusual physical environment provides a unique academic and recreational resource.

Why This Topic Matters

Planning for future water supplies and for the protection of water sources requires an examination of a wide variety of issues. This chapter introduces some of these issues and describes how they may affect the plan and the ability of the area to implement it. It is relevant to explore the study area's geography and ecology and to analyze population growth and economic development. The land development pattern affects the demand for water and the watershed itself. Ideally, governments will integrate water resource and land-use planning and will adopt and enforce regulations to minimize or mitigate those effects changes in land use on the water supply. The utilities—in some cases utility districts and in other cases utility departments of municipalities—of the region provide water to the consumer and must work with other planners to make the best use of the region's water sources as they plan for population growth and development. If the water needs and the growth and development of the areas are related in a planning document, future problems can be identified and corrective measures taken before a crisis develops.

1.3 The Geography of the Region

The Planning Region

Areas in Grundy County

- Altamont
- Beersheba Springs
- Coalmont
- Gruetli-Lager
- Monteagle
- Palmer
- Tracy City

Areas in Franklin County

- Sewanee

Portions of Marion and Sequatchie Counties

The Cumberland Plateau is a major uplift that is a part of the Appalachian chain of mountains extending from North Georgia and Alabama through Tennessee, Kentucky, West Virginia, Pennsylvania, and New York. Specifically, it is a part of the Appalachian Plateau. As a physiographic province, it was formed by the continental convergence (mountain building) in the Unaka Mountains and the valley and ridge province to the east of the plateau over 200 million years ago.[1] Much of the bedrock of this area is flat-lying sandstone, which is very resistant to weathering. As a result, there has been little erosion, and the resulting landscape is a tableland or plateau. It is bounded on all sides by outfacing escarpments. Elevations on the plateau in this area range from 1,200 feet on the side slopes to over 2,000 feet above sea level at the top.[2] The area is also known for the steep walled "gulfs" that have been cut into the plateau by rivers and streams and can be over 1,000 feet below the rim of the plateau.

The geology of the Appalachians dates back more than 480 million years. A look at rocks exposed in today's Appalachian Mountains reveals elongated belts of folded

[1] There are seven physiographic provinces across Tennessee; from east to west, Unaka Mountains, Valley and Ridge, Cumberland Plateau, Eastern Highland Rim, Central Basin, Western Highland Rim, and the Coastal Plain.

[2] Clay Harris, Middle Tennessee State University, *Tennessee Geology Summarized,* in About.Com.Geology, 2009.

and thrust-faulted marine sedimentary rocks, volcanic rocks, and slivers of ancient ocean floor—strong evidence that these rocks were deformed during plate collision. These mountain ranges were once higher than today's Himalayan mountain range, which was also formed by continental collision.[3]

1.4 The Ecology of the Region

The Cumberland Plateau is the largest remaining forested plateau in the United States. It is somewhat remotely located and has historically had a small population. Thus, much of the natural environment remains intact. The plateau is covered in forests, dotted with waterfalls, and spanned by stone arches. It is an area of great natural resources and a refuge for wildlife and much flora including many rare and endangered species.[4]

The South Cumberland Plateau region in Tennessee is one of the most intact and biologically diverse natural landscapes remaining in the eastern United States. Several environmental factors including geology, climate, elevation, and soils play a major role in influencing the diverse plant, animal, and natural community composition present in the South Cumberlands. The topography throughout much of the area is rugged with elevations ranging from 1,000 feet in the coves to nearly 2,400 feet on the top of the Plateau. The high point in the study area is located south of Palmer off state route 108 with an elevation of 2,384 feet.[5] The vast majority of the landscape is forested, and scenic waterfalls, bluffs, and sandstone outcroppings are common.

The strongly dissected plateau surface in the South Cumberland region exposes limestone features along the northwest and southeast facing perimeters of the plateau. The long growing season, high annual rainfall, and the abundance of microhabitats created by exposed limestone provide favorable conditions for a diverse forest community. Depending on slope, aspect, and soil depth, the dominant canopy tree species in cove forests in the South Cumberlands include white oak, northern red oak, white ash, yellow poplar, hickories, black oak, maple, and chestnut oak. Lower slopes and rock outcroppings often contain basswood, American beech, magnolia, walnut, chinquapin oak, and buckeye.[6]

Plateau forest communities comprise a smaller percentage of the land area in the South Cumberlands. Tableland forest types in the South Cumberlands are positioned atop a relatively thin sandstone cap with shallow, infertile soils. They serve as important biological corridors between cove forests and contain several rare plant species and communities, including unique isolated perched wetlands. Dominant over story species include white oak, hickories, chestnut oak, blackjack oak, scarlet oak, and black gum.[7] Most of the forests in the study area, both cove and tableland, have been cleared or high-graded since the 1950s. Even so, total forest cover in the South Cumberlands remains very high.

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[3] *Geology of the Appalachians,* Wikipedia, The Free Encyclopedia, 2009.

[4] Ron Castle, Webmaster, Friends of South Cumberland State Recreation Area, Inc.

[5] Tennessee Landforms, County High Points, viewed at www.cs.utk.edu/~dunigan/cohp/.

[6] G.W. Smalley, Classification and evaluation of forest sites on the Mid-Cumberland Plateau. U.S. Department of Agriculture publication. 1982.

[7] G.W. Smalley, Classification and evaluation of forest sites on the Mid-Cumberland Plateau. U.S. Department of Agriculture publication. 1982.

Tennessee is a state of great biodiversity, with a wider variety of species than nearly any other inland states in the country, and the South Cumberland region is one of the most biodiverse regions in the state.[8] Located in the heart of area is the South Cumberland State Recreation Area, which includes Savage Gulf Natural Area, Fiery Gizzard Natural Area, Foster Falls, and Grundy Lakes. These state recreation lands contain outstanding natural features and contribute to the major recreational opportunities there. The largest and most significant from a natural feature protection position is the Savage Gulf State Natural Area, which contains over 15,000 acres. It contains perhaps the largest virgin mixed mesophitic hardwood forest in the east. The state Division of Forestry also owns Franklin State Forest located in both Franklin and Grundy County, and the Sewanee Domain located in Franklin County contains a large forested and undeveloped area.

During the past decade, private non-governmental organizations have worked with State and Federal government programs to increase the acreage of protected forestlands in the region. The Nature Conservancy purchased 5,200 acres along a portion of the northwestern escarpment, and this area is now managed by the Tennessee Wildlife Resources Agency (TWRA) as a public wildlife management area. Along the Tennessee-Alabama state line, the Conservancy facilitated the purchase of the 21,453 Walls of Jericho site. The Tennessee portion of this area is also now managed for the public by TWRA as the Bear Hollow Mountain Wildlife Management Area. The Land Trust for Tennessee is developing a communication plan describing land acquisition, private timber management, and other conservation opportunities in the region, and it is working with the Conservation Fund and the Friends of the South Cumberland State Recreation Area to preserve an additional 6,200 acres of the Fiery Gizzard trail, cove forests, and view shed.

The high plateau topography of the Southern Cumberlands results in a number of watersheds beginning in the study area and flowing down the escarpment into larger bodies of water. Portions of the Elk River drainage area flow to the west and southwest. The Collins River watershed flows to the northwest, and tributaries of the Sequatchie River to the southeast. Another watershed drains south to the Tennessee River at Guntersville Reservoir, which was constructed by the Tennessee Valley Authority in 1935 for flood control and hydropower production.

Because of the wide range of geology, forests, and stream habitats, a tremendous number of rare aquatic and terrestrial fauna, plants, and cave dependant species are known to exist in the region. These species include rare or endangered mammals, birds, mollusks, reptiles, fish, crustaceans, amphibians, insects, and flowering and non-flowering plants. Seventy-nine of these species are found in Grundy County alone.[9] A few well known examples include the least trillium, Canada lily, white fringeless orchid, Bald Eagle, barking tree frog, and green salamander. In addition, the Southern Cumberlands contain the highest concentration of caves in the world and the largest number of cave invertebrate species in the world. Among the rare cave species found in this area are the Tennessee cave salamander, the southern cavefish, the gray bat, and the Indiana bat. Figures 1, 2, and 3 the most important habitat areas for freshwater, terrestrial, and cave animals within the study area according to the Tennessee Wildlife Action Plan written by TWRA.

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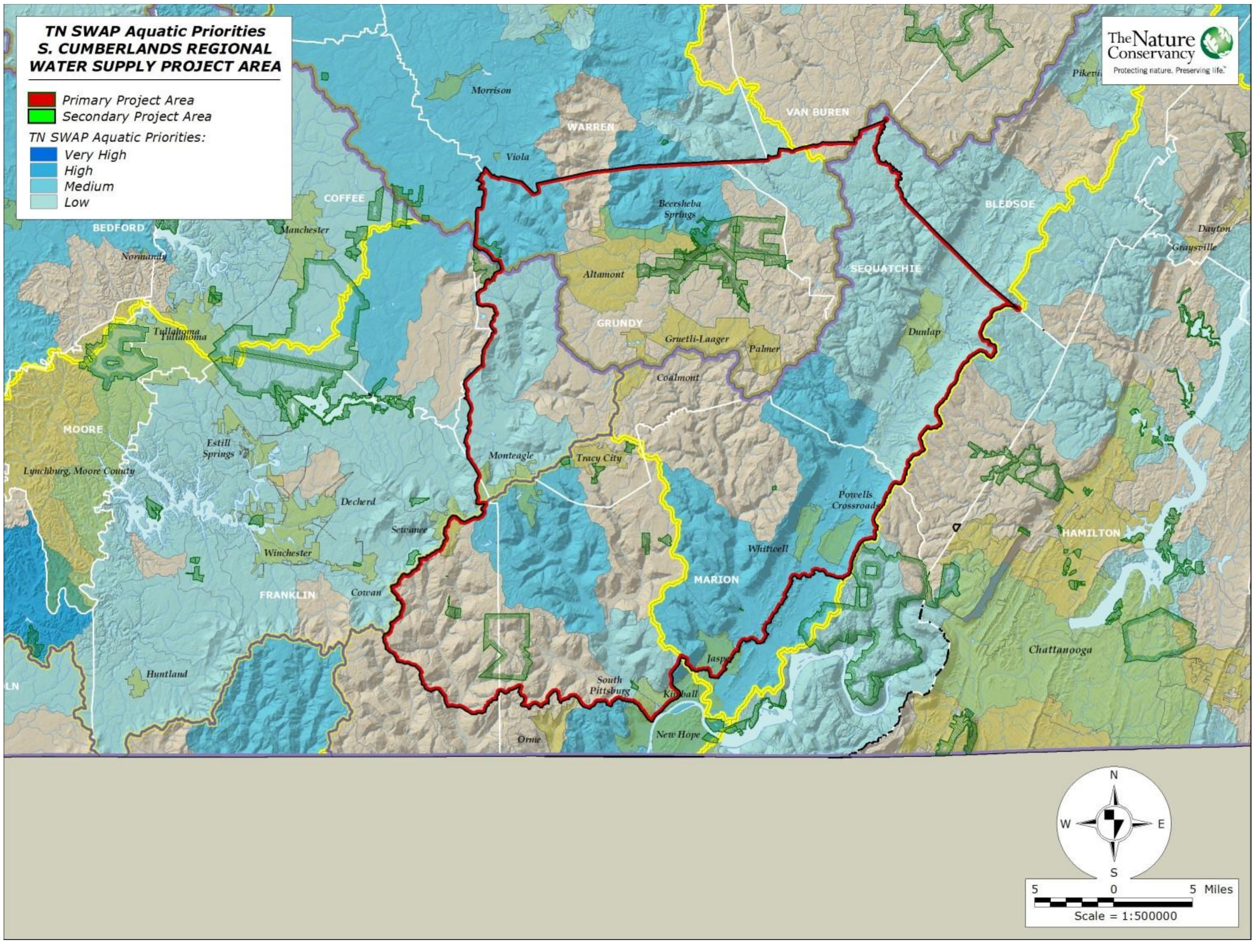
[8] The Tennessee Conservationist, *The Cumberland Plateau's Significance in Today's World*, LynnAnn Welch.

[9] Tennessee Department of Environment and Conservation Resource Management Division.

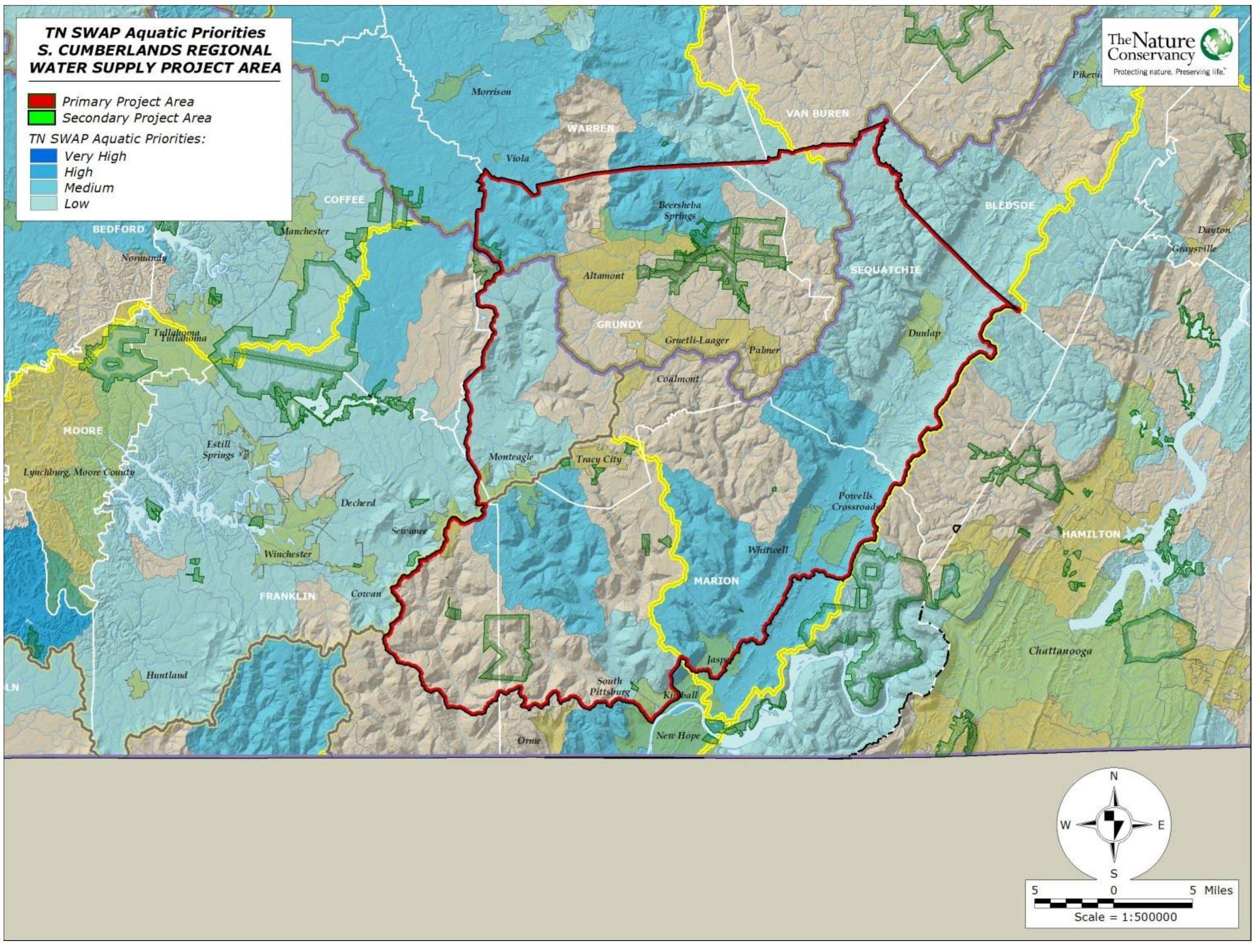
Figure 1. Priority Freshwater Habitats In The Southern Cumberlands Study Region Identified In The Tennessee Wildlife Action Plan.



Hunting and forestry are the principal private land uses at higher elevations in the project area. The production of hardwood timber is still the principal economic focus of forestry operations in the Southern Cumberlands region. Maintenance of native hardwood forests on private timberlands has played a key role thus far in preserving the integrity of the Southern Cumberlands forest. However, prolonged high grading and large-scale clear cutting over the decades have degraded many large forest stands in the area, forcing both private individual and industrial scale landowners to consider selling their landholdings to a higher value land use such as second-home development. Relatively inexpensive land and increasing development interest in the region have serious implications for large-scale forest habitat loss and degradation.

In addition to the loss of forestland, increased development can put pressure on the small headwater streams that emerge from the plateau. Any construction activity, whether for new development or for water supply reservoirs, can affect the plateau environment and the biodiversity there. The region also faces increased environmental uncertainties because of future climate changes. The most recent review of potential climate change effects in Tennessee indicates that Tennessee's forest systems will undergo changes in species composition and dominance, migratory song bird ranges may change, exotic plant infestations will increase, and more extreme drought and flood events are expected.[10] These challenges require a thoughtful approach to land and water management in the Southern Cumberlands region to achieve a balance that conserves resources and improves the reslience of natural systems.

Figure 2. Priority Terrestrial Animal Habitats in the Southern Cumberlands Study Region Identified in the Tennessee Wildlife Action Plan.



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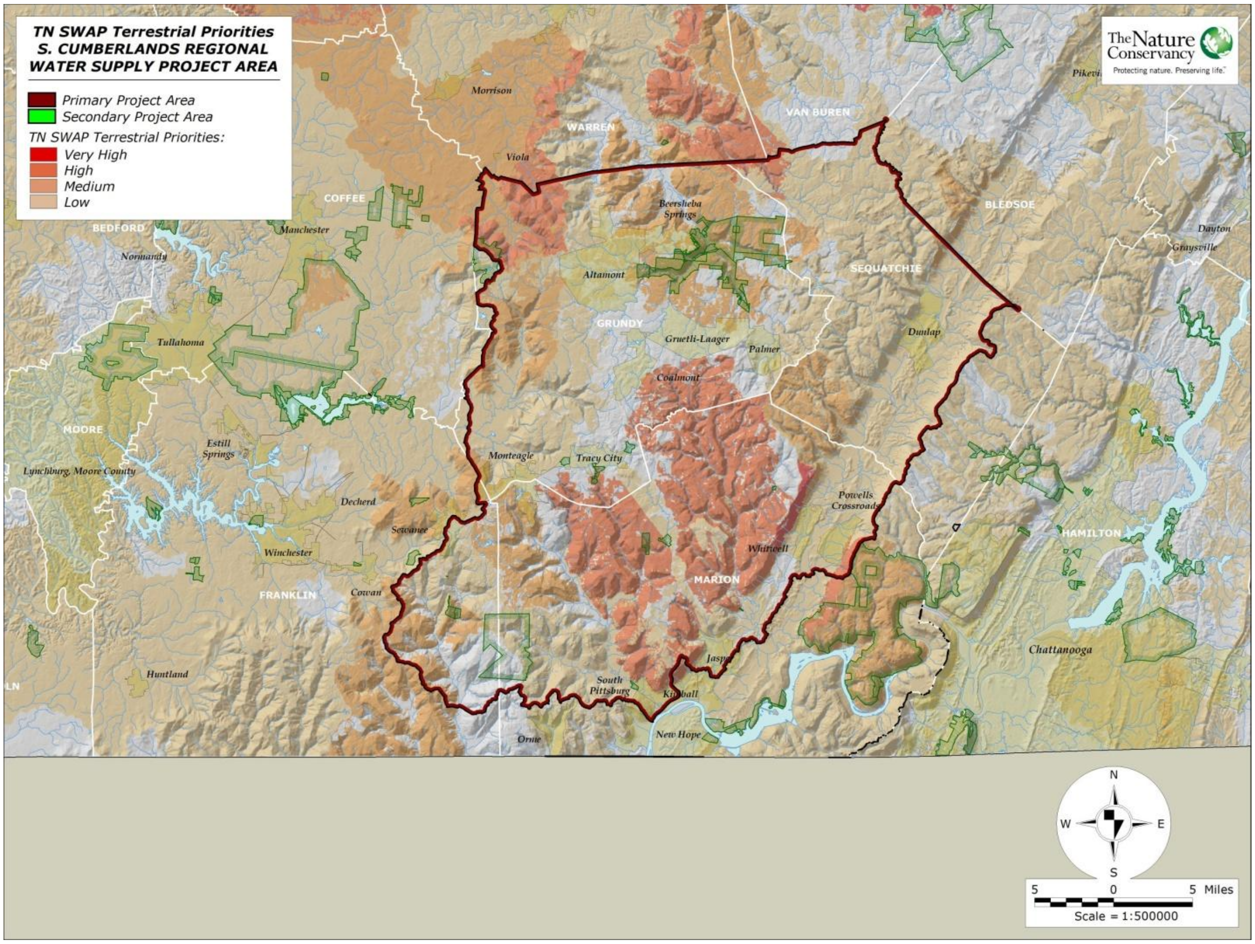
[10] Tennessee Wildlife Resources Agency. Climate Change and Potential Impacts to Wildlife in Tennessee.

Figure 3. Priority terrestrial animal habitats in the Southern Cumberlands Study Region identified in the Tennessee Wildlife Action Plan



1.5 The Population of the Region

The South Cumberland study area has had little to slow growth. Table 1 shows the population growth in the area since 1980. Grundy County, the center of the region, grew by 970 people or 7.3% from 1980 to 2000. However, the 2009 estimate shows a drop of 202. The other three counties show much more growth than does Grundy County. But considering the growth of these counties to see population trends in the study area would present a skewed picture of growth because with the exception of Sewanee most of their population is not on the plateau but in lower elevations below the plateau.

Table 1. Historical Population Growth in the Study Area
Select Years 1980 through 2009*

				Actual Change 1980 to 2000		
	1980	**1990**	**2000**	**Number**	**Growth Rate**	**2009***
Tennessee	**4,591,120**	**4,877,203**	**5,689,276**	1,098,156	23.9%	**6,296,254**
Grundy County	13,787	13,362	14,332	545	4.0%	14,130
Altamont	679	742	1,136	457	67.3%	1,130
Beersheba Springs	643	591	553	-90	-14.0%	541
Coalmont	625	813	948	323	51.7%	941
Gruetli-Laager	**	1,810	1,867	n/a	n/a	1,843
Monteagle	1,126	1,138	1,238	112	9.9%	1,213
Palmer	1,027	769	726	-301	-29.3%	700
Tracy City	1,356	1,556	1,679	323	23.8%	1,613
Unincorporated Grundy County	8,331	5,943	6,185	-2,146	-25.8%	
Franklin County	31,983	34,725	39,270	7,287	22.8%	41,310
Sewanee*****	2,298	2,016	2,361	63	2.7%	
Marion County	24,416	24,860	27,776	3,360	13.8%	28,068
Sequatchie County	8,605	8,863	11,370	2,765	32.1%	13,915

Source: U. S. Bureau of the Census

* Estimated.

** Not incorporated for 1980 Census.

***** Sewanee is not an incorporated municipality; however, the Census shows a population for it as a part of the Census County Division.

Table 2 shows other demographic characteristics of the four counties. It reveals that Grundy County, which is most representative of the plateau area, has the lowest household income, the highest levels of poverty and the lowest levels of educational attainment. All of the counties exceed the state number of population without a high school diploma, and all but Franklin County have less population with a college degree. For median household income, only Grundy County is less that the state median. All of the counties have higher poverty rates that the state as a whole, and the lowest levels of educational attainment.

Table 2. Other Demographic Characteristics

	Grundy	Franklin	Marion	Sequatchie	Tennessee
2000 Median Age	36.6	38.1	38.2	36.7	35.9
2000 Average Household Size	2.5	2.5	2.5	2.5	2.5
2000 Educational Attainment					
Pop without HS Diploma	44.8%	26.2%	35.4%	33.3%	23.1%
Pop with College Degree	7.1%	15.3%	9.5%	10.2%	12.8%
2007 Income & Poverty					
Median Household Income	$26,844	$41,528	$39,059	$38,683	$36,360
Poverty, All Ages	27.0%	11.8%	14.0%	18.8%	10.3%
Child Poverty (0-17)	41.0%	18.3%	21.9%	28.8%	17.6%

Source: Tennessee Advisory Commission on Intergovernmental Relations, *County Profiles,* 2009.

1.6 The Land Use and Development Patterns of the Region

Land development in the plateau area is concentrated in the several small communities. The Town of Monteagle contains the greatest amount of non-residential development. The presence of two interchanges of Interstate 24 (I-24) in the town has spurred the development of commercial service facilities at the interchanges and along U.S. Highway 41, which connects the two interchanges through the town. The town of Gruetli-Laager is the largest municipality in size and in area with a corporate limits extending several miles along the state highway. The development character here is basically residential, but the development is scattered along State Route 108, which extends completely through the town. Tracy City also is largely residential with a small commercial area at the junction of U.S. Highway 41 and State Route 56. A new but small commercial area has developed in the Town of Coalmont at the intersection of state routes 56 and 108. All of the other municipalities have small local commercial facilities that service the immediate needs of the residents. The Town of Altamont is the county seat of Grundy County and contains the county courthouse.

.Some development, predominantly residential but including small industrial land uses, has occurred along State Route 111 in the Sequatchie County part of the study area. Recently, a small industrial area has been developed in the unincorporated Pelham community of Grundy County at the intersection of U.S. Highway 41 and State Route 50 about two miles from an interchange with I-24; however, this area is not on the plateau but down the mountain at a lower elevation.

The Sewanee area is also developed, containing the university, residential areas, and a small commercial village in the Franklin County part of the study area. It is somewhat unusual in the sense that the Sewanee Domain and the University of South are owned by the Dioceses of the Episcopal Church, and the domain community provides most of the "public" services available within the developed area including police and fire protection. At one time water and sewer utilities also were provided by the Domain, but those functions have been absorbed by the formation of the Sewanee Utility District. The undeveloped part of the Domain is also a managed area, and several management plans have been developed over the years since the first one was done in the early 1900s to the most recent plan developed in 2003.[11]

Another type of development has started to occur within the last several years. Large forested tracts of land that were formerly held by the paper and timber industry have been sold off to land developers. A number of these tracts of land have been converted into residential developments that may or may not be of benefit to the area. Because of a lack of planning commissions or regulations governing the development of land, these developments are basically unplanned from the perspective of local government planning. Many are not located on a public water supply system, and the wastewater disposal is generally with septic tanks and field lines. Many soil types on the plateau are not well suited for septic tank disposal systems, and this has resulted in fears about water quality by residents in the valleys below. Little consideration appears to have been given to the need for an adequate water supply or proper wastewater disposal or to the karst subsurface conditions of the plateau. These are problems that the counties will have to address in some way in the future if these developments are successful and sell out.

The Town of Monteagle has had residential developments for permanent residents as well as summer homes for a number of years, and they are located within the corporate limits. The new developments are outside of Monteagle, scattered across the area and along the escarpment of the plateau in Marion and Sequatchie Counties within the transition zone from the top of the plateau to the valley below. Additionally, there are some developments in Grundy County that have been in existence for a number of years that have roads and lots but no houses.

These type developments can have a dramatic impact on the region. The number of lots, if built out, would drastically increase the population and the demand for services, including police and fire protection, street maintenance, health services, water supply, and others. For example, one development that has been proposed in and adjacent to Monteagle would contain 915 houses, although no subdivision plat has been filed. Given the average household size for the county of 2.5 persons per household (see Table 6), the population of just this development is 2,288 people. Another development of 70 houses is proposed in the Monteagle planning region. Other similar developments are advertised in Grundy County, one totalling 347 acres, but information about them is sketchy.[12]

The proliferation of second homes and vacation homes can also have a dramatic influence on demand for water. Since these homes tend to be occupied mainly in late spring, summer and

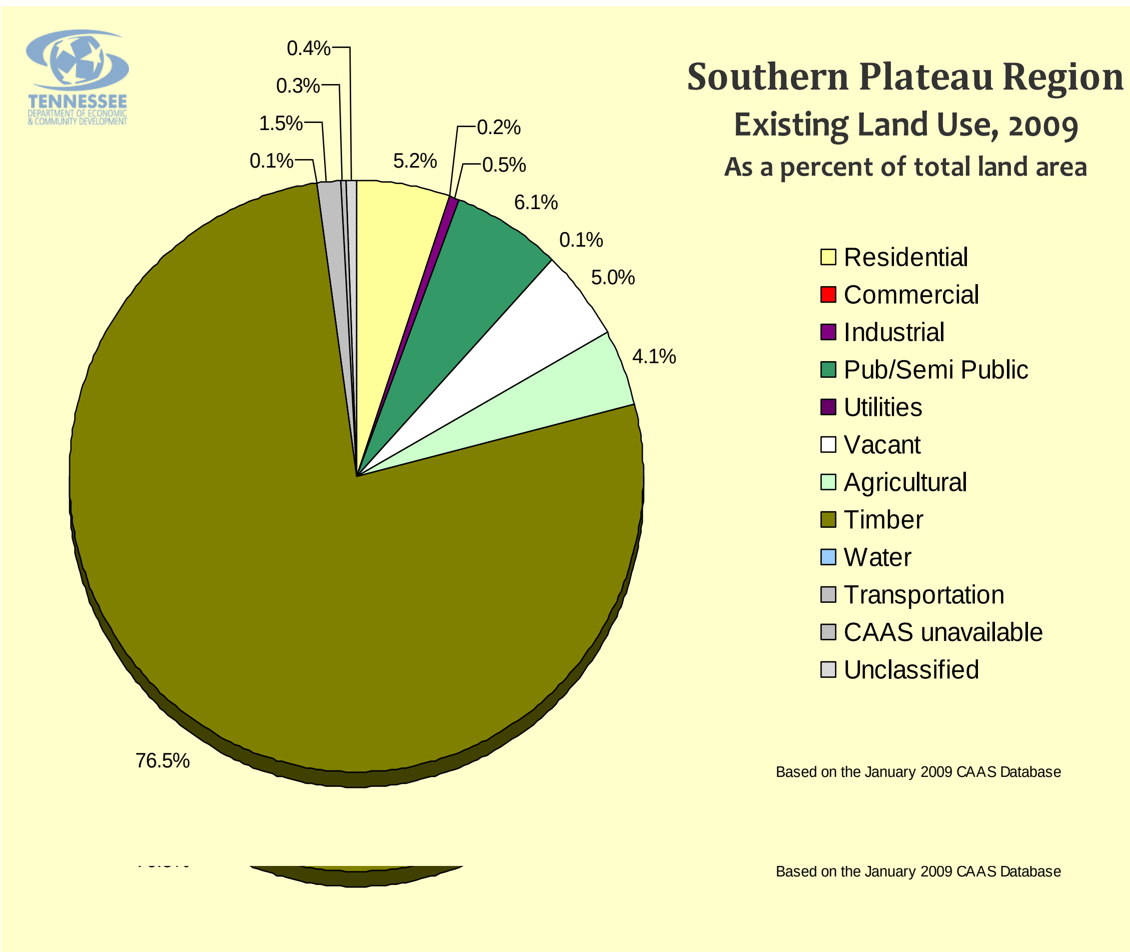
[11] The University of the South, Office of Domain Management, *2003 Management Plan, Beyond Sewanee's Central Campus: A Ten-Year Strategic Plan for the Domain,* Sewanee Web Site.

[12] Survey, Tennessee Department of Economic & Community Development, Office of Local Planning, 2009.

early fall, water demand is greatest when rainfall is least plentiful. This stresses the water suppliers.

The land use chart below in Figure 4 shows the dominant rural character of the plateau region. The largest land use category is timber or forested land, which comprises over 76% of the total area. When coupled with the agricultural and vacant categories, these undeveloped areas make up more than 85% of the study area. Additionally, the public/semi-public land use category, which makes up 6.1% of the area, comprises mainly state park land holdings, and they, too, are of course undeveloped. Consequently, only a little over 8% of the total area is classified as developed, and the largest developed use is residential at 5.2%.

Figure 4.



Source: Tennessee Department of Economic and Community Development, Office of Local Planning Assistance, 2009.

Table 3 shows recent trends in farmland use in the four-county area. Grundy County may be more typical of the study area since farmland in the other counties is more likely to be at the lower elevations where the land is reasonably level and soils are much better for agriculture. The table shows that Grundy County had a slight increase in the number of acres of farmland, while the number of farms dropped by over 20%. Related to that statistic is the increase in the average size of farms by over 26%. The biggest change in farmland came in Franklin County with a 5.7% reduction in the number of acres of land devoted to farming.

Table 3. Trends in Farmland South Cumberland Plateau Study Area 2002 to 2007

	Franklin	**Percent Change**	**Grundy**	**Percent Change**	**Marion**	**Percent change**	**Sequatchie**	**Percent Change**
Land in Farms (in acres)								
2007	144,252	-5.7%	42,668	1.3%	50,593	-0.7%	28,675	1.0%
2002	152,900		42,130		50,932		28,390	
Number of Farms								
2007	1,104	-2.7%	328	-20.8%	392	31.5%	232	11.5%
2002	1,135		409		298		208	
Average Size of Farm(in acres)								
2007	131	-2.0%	130	26.2%	129	-24.6%	124	-8.8%
2002	135		103		171		136	

Source: U. S. Department of Agriculture, *2007 Census of Agriculture-County Data.*

1.7 The Economy of the Region

The economic history of Grundy County revolves around coal mining and coke production, and many place names are tied to that history, including Tracy City, named for the president of the old Sewanee Mining Company; Fiery Gizzard, from the once famous Fiery Gizzard Coke Iron Furnace at Tracy City; Coalmont, where the Sewanee Coal, Coke and Land Company began mining in 1903; and Palmer, where the Tennessee Consolidated Coal Company opened up new coalmines in 1918.

The only large employer in the study area today is the University of the South. Table 4 lists the largest employers for 2006 in the four counties that are part of the study area. Only two of these industries are located on the plateau. Basham Industries is located in Coalmont, and Tullahoma Industries is located in Gruetli-Lager. Toyo Seat USA is located down off the plateau in the unincorporated Grundy County community of Pelham.

Table 4. Largest Private Employers in the South Cumberland Study Area, 2009

Company	City	Employees
Franklin County		
University of the South*		515
Tepro Inc.		507
Shaw Industries		193
Cst Industries		120
Grundy County		
Toyo Seat USA		168
Basham Industries		100
Tullahoma Industries		90
Marion County		
Rock-Tenn Co.		226
Variform Inc.		192
Aladdin Inc.		180
Sequatchie County		
Tecumseh		600
C & D Technologies		175

Source: Tennessee Department of Economic and Community Development, Community Data Sheets, 2009.

* Information on the University of the South was taken from the current web site.

The University of the South employs 380 full-time staff and 135 full-time faculty. Otherwise, most jobs are manufacturing, service, or sales. Mining is a distant 6^{th} with fewer than 70 employees. Table 5 is a snapshot of employment from 2006 in Grundy County. (Only Grundy County is included here because it contains most of the study area and is typical of all of it.) The three largest categories of employment are manufacturing, education and health services, and retail trade. The categories with the highest annual average wages are transportation or warehousing and manufacturing, in that order.

Table 5. Industry Profile of Grundy County, 2006

	Average Number of Firms	Annual Average Employees	Annual Average Wages
All Firms	180	2,047	$22,637
Manufacturing	15	281	$31,572
Education & Health Services	12	266	$23,728
Retail Trade	6	259	$16,543
Leisure & Hospitality	13	134	$8,606
Construction	16	79	$26,361
Financial Activities	15	70	$23,374
Natural Resources & Mining	12	67	$19,239
Professional & Business Services	11	54	$24,702
Information	5	32	$24,468
Transportation & Warehousing	41	31	$32,479
Wholesale Trade	7	16	$29,369

Source: Tennessee Department of Economic and Community Development, *County Data Sheet, 2008.*

Table 6 shows labor force estimates for the months of December 2008 and July 2009 and demonstrates the effect of the national economic recession on the study area.

Table 6. Labor Force Estimates and Unemployment December 2008 and July 2009

					Unemployment			
	Labor Force		**Employment**		**Number**		**Rate**	
County	**12-08**	**7-09**	**12-08**	**7-09**	**12-08**	**7-09**	**12-08**	**7-09**
Franklin	20,120	20,190	18,590	17,970	1,530	2,220	7.6%	11.0%
Grundy	5,970	6,000	5,370	5,100	600	890	10.0%	14.9%
Marion	13,110	13,280	11,950	11,660	1,170	1,620	8.9%	12.2%
Sequatchie	6,130	6,290	5,680	5,550	450	750	7.3%	11.9%

Source: Tennessee Department of Labor and Workforce Development, 2009.

Most workers commute to the nearby job centers of Jasper, South Pittsburg, Winchester/Decherd, and Chattanooga. Of the four counties in the study area, only Franklin provides work for as many of its residents as in Tennessee as a whole. About half of all working residents of the other three counties work at jobs in other counties jobs, and commuting elsewhere for work is increasing in all but Sequatchie County, both in numbers and in percentages. Across the state, around three quarters of workers found work in the county where they lived in 1970. More than 70% still do. (See Table 7.)

Table 7. Commuting by Residents of Study Area Counties, 1970 and 2000

	Residents working . . .				
	in Home County		***Elsewhere***		
		Percent of Total		**Percent of Total**	**Total**
Grundy County					
1970	1,788	53.5%	1,555	46.5%	3,343
2000	2,619	49.7%	2,650	50.3%	5,269
Growth	46.5%		70.4%		57.6%
Franklin County					
1970	6,520	67.4%	3,154	32.6%	9,674
2000	10,335	60.7%	6,694	39.3%	17,029
Growth	58.5%		112.2%		76.0%
Marion County					
1970	3,194	49.6%	3,247	50.4%	6,441
2000	5,600	48.3%	5,992	51.7%	11,592
Growth	75.3%		84.5%		80.0%
Sequatchie County					
1970	1,028	50.6%	1,004	49.4%	2,032
2000	2,385	51.3%	2,260	48.7%	4,645
Growth	132.0%		125.1%		128.6%
Tennessee					
1970	1,121,921	77.8%	319,449	22.2%	1,441,370
2000	1,922,252	74.2%	669,372	25.8%	2,591,624
Growth	71.3%		109.5%		79.8%

Source: U.S. Census Bureau.

When industrial and commercial growth does not keep pace with residential growth—particularly when many working residents are already employed outside the county and not nearly as many commute into the county for work—local governments may have difficulty funding the services their residents desire. One of the reasons so many workers who live in these counties work in other counties is that the number of working residents in these counties outnumbers the number of jobs there based on data from the 2000 federal census:

- Grundy County: 5,269 workers (see Table 7) versus only 3,060 jobs (see Table 8) or 1.7 working residents per job in the county.
- Franklin County: 17,029 workers (see Table 7) versus 12,412 jobs (see Table 8) or 1.5 working residents per job.
- Marion County: 11,592 workers (see Table 7) versus only 7,696 jobs (see Table 8) or 1.7 working residents per job in the county.
- Sequatchie County: 4,645 workers (see Table 7) versus 3,384 jobs (see Table 8) or 1.5 working residents per job.

While a number of workers commute into particularly Franklin and Marion counties from elsewhere, far more people leave both counties than come into them for work each day. And both groups—those commuting in and those commuting out—have grown as faster or faster in both counties than jobs there have grown. (See Table 8.)

Table 8. Commuting Into and Out of Counties in the Study Area 1970 and 2000

	Workers Commuting Out	Workers Commuting In	Number of Jobs in County
Grundy			
1970	1,555	229	2,017
2000	2,650	441	3,060
Growth	70.4%	92.6%	51.7%
Franklin			
1970	3,154	638	7,158
2000	6,694	2,077	12,412
Growth	112.2%	225.5%	73.4%
Marion County			
1970	3,247	840	4,034
2000	5,992	2,096	7,696
Growth	84.5%	149.5%	90.8%
Sequatchie County			
1970	1,004	219	1,247
2000	2,260	999	3,384
Growth	125.1%	356.2%	171.4%

* Based on number of workers reported in the Census.

Source: U.S. Census Bureau.

Table 9 shows the mean travel time for workers in the area to get to work, and it indicates that workers have some long commute distances. A community's location within Grundy County also affects travel times, for example, Monteagle, located on I-24, has the lowest mean travel time.

Table 9. Mean Travel Time to Work (in minutes (In Minutes) 2000

Locality	Mean Travel Time
Tennessee	
Grundy County	32.2
Altamont	30.3
Beersheba Springs	41.7
Coalmont	42.0
Gruetli-Laager	39.3
Monteagle	22.5
Palmer	39.4
Tracy City	25.6
Franklin County	24.1
Marion County	29.2
Sequatchie County	27.7

Source: U. S. Bureau of the Census, *Census of Population and Housing,* 2000.

1.8 The Governments of the Region

There are seven municipalities in addition to the four county governments in the South Cumberland study area, all in Grundy County: Monteagle, Tracy City, Coalmont, Gruetli-Lager, Palmer, Altamont (the county seat), and Beersheba Springs. There is very little structure for municipal and county planning in the study area. Within Grundy County, the only active planning commission is in the Town of Monteagle although a renewed planning commission for Grundy County has been discussed. The town enforces subdivision and zoning regulations. The Monteagle Planning Commission is also designated as municipal-regional and has a planning region outside the town limits wherein subdivision regulations are applied. None of the other local governmental units within the county have a planning program or land development regulations.

The importance of planning for future water supplies cannot be overstated. Traditionally, local planning has been focused on land use and regulating new development. While long-range plans in some cases do examine the ability of a water treatment plant to meet future demands, the issue of the adequacy of the supply source has rarely been a part of a plan. Even as land use planning has begun looking into "smart growth" techniques, water quality and water supply has received very little attention. Despite a lack of comprehensive attention to water supply in planning and smart growth literature, the interrelationship of water resources and land use is one of the hottest topics in land use today.[13]

[13] Environmental Law Institute, Washington, D.C., *Wet Growth: Should Water Law Control Land Use?*, p. 7 & 8, Edited by Craig Anthony Arnold, Chapmen University School of Law, 2oo5,

Land development affects the quality of water supply sources by increasing paved, impervious surfaces, including roadways, parking lots, and sidewalks that are often covered with pollutants. When water and snow runs off these surfaces, it picks up the pollutants and carries them into the water system.[14] Moreover, increased amounts of impervious surfaces can contribute to groundwater shortages, including wells and springs used for drinking water, because paved surfaces do not allow rainwater to seep into the ground to replenish aquifers. The rainwater runs off paved surfaces faster and with more volume than natural surfaces. A joint report by three non-government groups—American Rivers, the Natural Resources Defense Council and Smart Growth American—argues that reduced water absorption has contributed to increased drought across the country.[15]

A planning commission can mitigate these problems by regulating development. The impact of development on the water resources of an area can be reduced through low-impact development. A great deal of literature has been published recently describing low-impact development and how it can promote the natural movement of water in a watershed and restore water supplies.[16] All of the governments and their planning programs should explore how they can use these techniques for development to protect their water supplies.

Both Franklin and Marion counties have active planning commissions and enforce subdivision regulations. Only Franklin County has adopted county zoning, which would apply in the Sewanee area of the plateau. This area is governed by three zoning classifications: a mixed-use zone, a residential zone and an agricultural zone, which applies to most of the domain.

A very important element in planning for new developments and in ensuring that water supply and other utilities are available is a requirement that letters of availability be obtained from the appropriate utility prior to approval of new developments. However, without a mechanism for enforcement and a planning structure in place, it is not possible to assure the public that adequate utilities will be available when a lot is purchased for building purposes. It is typical for cities and counties to require a letter of availability prior to the approval of a subdivision plat, a requirement that is implemented through adoption of subdivision regulations by the local planning commission. Those cities and counties that enforce a zoning ordinance may also require a letter of availability as a part of a request for a rezoning amendment. Table 12 illustrates the status of planning in the South Cumberland region.

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[14] Journal of Environmental Engineering, *Investigation of Boundary Shear Stress and Pollution Detachment From Impervious Surface During Simulated Urban Storm Runoff*, C. P. Richardson and G. A. Trapp, Issue 132, pg. 85-92, 2006.

[15] American Rivers, the Natural Resources Defense Council and Smart Growth America, *Paving our Way to Water Shortages: How Sprawl Aggravates the Effects of Drought*, Betsy Otto, Katherince Ransel, Jason Todd, Deron Lovaas, Hannah Statzman, and John Bailey, 2002.

[16] See http://www.epa.gov/owow/NPS/lid.

Table 12. Status of Planning in the South Cumberland Region, 2009

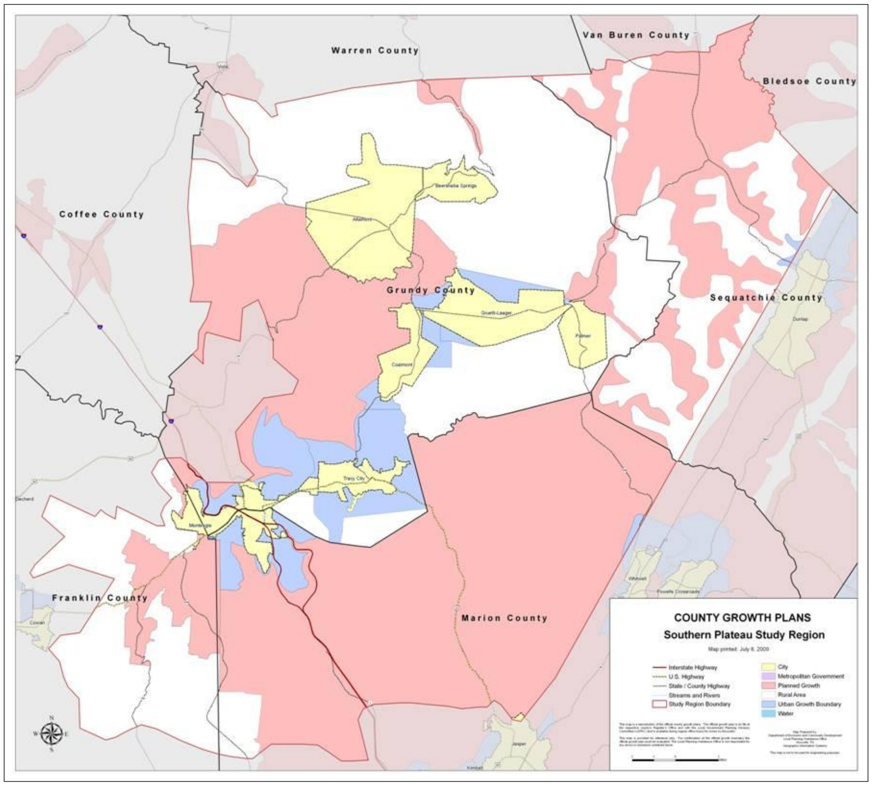
County/City	Planning Commission	Long-Range Plan	Subdivision Regulations	Zoning
Grundy County	No	No	No	No
Altamont	No	No	No	No
Beersheba Springs	No	No	No	No
Coalmont	No	No	No	No
Gruetli-Laager	No	No	No	No
Monteagle	Yes	No	Yes	Yes
Palmer	No	No	No	No
Tracy City	No	No	No	No
Franklin County	Yes	No	Yes	Yes
Sewanee*		Yes		
Marion County	Yes	No	Yes	No
Sequatchie County	No	No	No	No

Source: Tennessee Department Economic and Community Development, Office of Local Planning Assistance, 2009.

* Sewanee is not an incorporated municipality but has prepared a strategic plan for the Sewanee Domain.

As required by state law, each county in the South Cumberland Region has an approved growth plan. The map below shows the growth plans adapted to the regional boundary and reveals that a great deal of the area is mapped as urban growth boundaries (UGBs) and planned growth areas (PGAs). According to the law, known as Public Chapter 1101, these areas are to be established to accommodate future growth based on growth projections, land use needs and which entity can best provide municipal services. It appears that over one-half of the South Cumberland Region is devoted to UGBs and PGAs and thus, an area of this size could absorb an enormous amount of growth. However, the growth plans consist of only a map and contain no planning foundations or data upon which a projection of demand for water can be based. It is obvious from past trends and future projections that these established UGBs and PGAs will likely never be fully developed.

Figure 5.



Tennessee law (Public Chapter 1101, Acts of 1998) also requires each county to have a Joint Economic and Community Development Board (JECDB) with representatives from all governmental entities within the county. In the absence of formal planning, the JECDB can coordinate land use and water supply planning. Indeed, the law establishes the purpose of the board "foster[ing] communication relative to economic and community development between and among government entities, industry and private citizens."[17]

1.9 The Utilities of the Region

There are four major water systems in the study area. Some of these systems serve as both suppliers and distributors, while others purchase and distribute finished water. All four of the major water systems have developed their own raw water sources and have the capacity to to meet drinking water quality standards. Over time and through experience managing through periods of drought, the four water systems have developed significant interconnections to share water resources.[18]

- Big Creek Utility District of Grundy County was incorporated under Tennessee law in 1959. The water supply service area of this district lies in Grundy County north of Tracy City. In addition to supplying water to unincorporated areas of Grundy County, the

[17] Tennessee Code Annotated, § 6-58-114(b).

[18] US Army Corps of Engineers Phase 1 Report, in Appendix B of this report

district supplies Altamont, Beersheba Springs, Coalmont, Gruetli-Laager, and Palmer. The northern portions of the service area lie within the Cumberland River drainage basin while the southern service area is in the Tennessee River Basin. As of February 28, 2010, the district has approximately 3,075 metered water customers.[19]

- Monteagle Public Works Department operates both a water supply system and a sewer system. In 2009, the waterworks had 1,209 customers and the sewer system had 273 customers.[20] The service area for the Monteagle waterworks extends beyond the town limits into Marion County and lies entirely within the Tennessee River drainage basin.

- The Sewanee water utility is as a two-county district incorporated under Tennessee law as the Sewanee Utility District of Franklin and Marion Counties. It operates a water system with 1,329 customer billings and a sewer system with 678 customer billings. Approximately one third of the district's water and sewer revenue is received from one customer, The University of the South.[21] The district lies entirely within the Tennessee River drainage basin.

- The Town of Tracy City operates a water supply system with 1,472 customers and a sewer system with 52 customers.[22] The water supply service area of Tracy City extends beyond the town limits into both Marion and Grundy Counties. The town's water supply service area is bounded on the west by Monteagle's service area and on the north by Big Creek Utility District. Tracy City's service area lies entirely within the Tennessee River drainage basin.

In addition to the four larger water supply systems, there are three utility districts that purchase water from one of the four larger water systems and distribute it to their customers. Foster Falls Utility District purchases water from Tracy City, and Cagle-Fredonia Utility District and Griffith Creek Utility District purchase water from Big Creek Utility District.[23]

Big Creek has the lowest regional retail water prices for water quantities ranging from 5,000 gallons per month (GPM) up to 25,000 GPM. For the 5,000-gallon quantity the Big Creek price is $30.13 as compared to the $43.60 which is paid by Monteagle water customers inside the city limits. For 25,000 GPM the Big Creek UD price is $136.15 as compared to the $223.60 paid by Monteagle water customers inside the city limits. Sewanee UD and Tracy City (inside city limits) prices range between Big Creek UD's lower prices and Monteagle's higher prices, for all water quantities between 5,000 and 25,000 GPM.[24] The water price comparisons above and below include the water rate increases which were placed into effect by Monteagle in September, 2009.

[19] Big Creek Utility District 2010 AUDITED FINANCIAL STATEMENTS AND OTHER FINANCIAL INFORMATIONAudited Financial Statements And Other Financial Information.

[20] 2009 Town of Monteagle Annual Financial Report.

[21] 2008 Sewanee Utility District Financial Statement.

[22]2009 Town of Tracy City Annual Financial Report.

[23] US Army Corps of Engineers Phase 1 Report in Appendix B of this report.

[24] See Appendix A, Table 5 and related text.

According to a recent survey of water prices in Tennessee,[25] Monteagle's September 2009 price for 5,000 GPM inside town limits is greater than prices charged by 92% of the 252 water systems participating in the statewide survey. The Tracy City price for 5,000 GPM inside Town limits is greater than 84% of the 252 water systems in the survey. Sewanee UD's price for 5,000 GPM is greater than 86% of the 252 systems in the survey. Big Creek UD's price for 5,000 GPM is greater than 68% of the 252 systems in the survey. It should be noted that this statewide survey of water prices did not include the "outside rate" portions of city and town water service areas.

The highest regional water prices are found in the "outside" portions of the service areas of Tracy City and Monteagle, which lie outside of the town limits of these two municipalities, and; in the service areas of the three smaller utility districts which have no raw water sources of their own. In the "outside" portion of Monteagle customers pay $65.40 for 5,394 GPM as compared to $32.00 for the same quantity of water in the Big Creek UD service area. Tracy City "outside" customers pay $44.25 for 5,394 GPM as compared to $42.25 for the same quantity of water in the Sewanee UD service area.[26] The highest price in the region, $68.55, for 5,394 GPM can be found in the Griffith Creek UD which buys finished water from Big Creek UD at wholesale prices.

A comparison of water prices to income indicates that water in the region is already expensive based on a standard used by North Carolina for grant assistance to low-income residents. The threshold for that program is monthly water bills exceeding 0.75% of median household monthly income. Because of the relatively low 2008 household incomes in the counties of the South Cumberland study area, all of the water service areas of the region have water prices above that threshold. In most cases the South Cumberland region's "affordability percentages" are double or nearly triple the standard of 0.75% of median household income. Families residing in Grundy County with household incomes below the county median and subject to the "outside" water rates of Monteagle face very serious issues of water affordability. Even the lower inside rates of Monteagle are nearly triple the 0.75% affordability threshold. There are similar water affordability issues for low-income Grundy County residents subject to the outside rates of Tracy City.[27]

[25] Tennessee Water and Sewer Rate Survey, Allen & Hoshall, June,2009.

[26] See Appendix A, Table 5 and related text.

[27] See Appendix A, Table 6 and related text.

Chapter 2. Assessment of Current Sources and Capacity

2.1 Overview

The South Cumberland water supply study area includes four major water suppliers that rely on local surface water sources. Among the supply sources are seven reservoirs, five of which are regularly used for water supply. Because of the study area's location on the top of a plateau, the reservoirs are generally small, have small drainage areas, and are very dependent on rainfall for filling. As a result, drought is one of the biggest risks to the region's water supplies.

The demands on the South Cumberland study area's water come primarily from small business and residential users with a few concentrated developments such as the University of the South.

All of the public water systems in the study area purchase water or obtain it from reservoirs. When these lakes reach low levels, there are no permanent backup sources available. During droughts, the utilities in this area try to assist each other based on who has a greater supply of water at that given time. During the 2007 drought, some of the South Cumberland water systems suffered severe shortages, highlighting the need to look comprehensively at the area's current water sources, its capacity, and demand. Current water sources are barely adequate to support demand. Future growth will almost certainly necessitate developing new sources, as well as improving the efficiency and conservation of existing sources.

Water Quality. In addition to susceptibility to drought, the South Cumberland study area's reliance on surface water makes it more vulnerable to water quality problems than areas that rely primarily on groundwater. Overall, though, water quality in the study area is very good, with no contaminants above legal limits. Most of the utilities did have some disinfection by-products, such as bromodichloromethane and haloacetic acids (HAA5), as well as some metals that occur naturally, such as manganese.

Much of the South Cumberland study area is forested with some low-density residential development. An interstate highway and a truck plaza pose some pollution risk. In addition, the University of the South and Grundy County High School are institutional users.

Firm Yield. For the purposes of this analysis, the firm yield for each lake was estimated independently. In theory, the sum of the firm yields of the individual sources is a lower limit on the firm yield of a properly operated system, but these firm yield estimates do not consider the flexibility available to water managers in the region. Water distribution system improvements and conservation or demand-management programs may slow growth in gross water use or even reduce it. The emergency sources evaluated have been little used in the past, but could add considerable flexibility in the future. Using these emergency sources in proper combination with existing sources might allow a greater overall yield than the sum of the individual source yields.

The most conservative estimates of the total water supply yield for the utility districts are

- Big Creek Utility District: 1.093 million gallons per day
- Town of Monteagle: 468 thousand gallons per day
- Sewanee Utility District: 791 thousand gallons per day
- Tracy City: 347 thousand gallons per day

The combination of the source would yield a total of approximately 2.7 million gallons per day for the study area if all contracts and drawdown limits were respected. If all of Lake Jackson (Sewanee's secondary source) were used, drawdown limits were relaxed for Lake Louisa (one of Monteagle's sources), and release rules Big Fiery Gizzard (Tracy City's sole water source) were suspended, a total of roughly 3.5 MGD may be available in the study area. On the other hand, if neither Lake Louisa nor Lake Dimmick (Sewanee's emergency source) were utilized in any capacity, Lake Jackson was held to its preferential drawdown, and Big Fiery Gizzard respected its release rules, just 2.3 million gallons per day would be available.

Water Conservation Programs. Some water systems in the South Cumberland study area have undertaken water conservation programs, and many utility managers expressed interest in reducing leaks. Utility staff closely monitor water usage at the meters, tank levels, and pumping to detect anomalies that could indicate leaks. Several utility districts in the region use increasing block rates to discourage usage over certain thresholds. Some have implemented or plan to implement drought surcharges on water use. Some have irrigation metering. None, however, indicated that educating consumers about water conservation was a programmatic goal. Education efforts were implemented primarily during the recent drought, but have not been continued. The utilities suggest that at least some of their users are quite aware of the importance of and methods for conserving water at their homes and businesses, but as the memory of the 2007-2008 drought begins to recede, education programs may help remind users of the importance of conservation.

Within the study area, no utilities have programs to actively reduce consumer demand. The utilities do not manage any retrofit, rebate, or fixture replacement programs, and were generally unfamiliar with the concept. Many of the utility districts have large water users. Although they have not performed any water audits, most managers suggested that they would be receptive to better demand management methods for large users. Some large users, such as the University of the South in Sewanee, have voluntarily started managing water use.

In the entire study area, the only codes and ordinances related to water conservation are drought emergency plans. Many of the unincorporated areas have no building or plumbing codes at all. The cities and towns have codes, but their objective is safety (e.g. backflow prevention) not conservation. New water conservation codes or ordinances for new construction could help reduce growth in water use even as population increases. Additionally, greater water efficiency may also help alleviate the demand for sewage treatment capacity, which appears to be limiting growth in some parts of the study area. Overall, the utility managers were pessimistic about the prospect of plumbing codes and water conservation ordinances being enacted in areas that do not currently have them.

Grundy County currently does not have any building or plumbing codes, and no specific water conservation ordinances. Prospects for implementation of codes in the near future appear slim.

2.2 Introduction

Background

The South Cumberland water supply study area includes four major water suppliers that rely on local surface water sources. Among the supply sources are seven reservoirs, five of which are regularly used for water supply. Because of the study area's location on the top of a plateau, the reservoirs are generally small, have small drainage areas, and are very dependent on rainfall for filling. As a result, drought is one of the biggest risks to the region's water supplies. For some of the water supply systems, and some of the individual sources, the heavy reliance on surface water can also lead to water quality concerns.

During the 2007 drought, some of the South Cumberland water systems suffered severe shortages, highlighting the need to look comprehensively at the area's current water sources, its capacity, and demand. The U.S. Army Corps of Engineers, Nashville District, (the Corps) and the Tennessee Department of Environment and Conservation (TDEC) collected information on the quality and capacity of existing water supply sources.

Residents of the South Cumberland study area rely both on groundwater and surface water. Self-supplied users—those who are not served by a public water utility—rely mainly on groundwater. All of the public water systems in the study area purchase water or obtain it from reservoirs. When these lakes reach low levels, there are no permanent backup sources available. During droughts, the utilities in this area try to assist each other based on who has a greater supply of water at that given time.

Table 2-1 lists the primary water supply sources and storage capacities for the four major utilities in the South Cumberland study area. The Griffith Creek, Foster Falls, and Cagle-Fredonia utility districts all purchase their water from these providers.

TABLE 2-1. South Cumberland Plateau Public Water Supply Sources

Utility	Source	Storage Capacity (million gallons)
Big Creek Utility District	Ranger Creek Reservoir	254
Town of Monteagle	Lake Laurel—Primary	213
	Lake Louisa—Emergency	94
Sewanee Utility District	Lake O'Donnell—Primary	62
	Lake Jackson—Secondary	112
	Lake Dimmick (Day Lake)—Emergency	218
Tracy City Public Utilities	Big Fiery Gizzard Reservoir	200

Some of the utility systems in the study area experience shortages during periods of peak demand or are expected to experience shortages in the future. Shortages may occur because of inadequate treatment, transmission, or distribution capacity. These systems must supplement their water supplies either through further source development, purchases from other systems, or conservation and demand management.

This chapter assesses three aspects of the utilities' current water supply sources: water quality, "firm yield," and current conservation and demand-management efforts.

Water Quality. In addition to susceptibility to drought, the South Cumberland study area's reliance on surface water makes it more vulnerable to water quality problems than areas that rely primarily on groundwater. For each water supply system, the Environmental Protection Agency's (EPA) Safe Drinking Water Information System and the Environmental Working Group's National Tap Water Quality Database was analyzed to determine the quality of water treated by the utilities in the region. In addition, the EPA's Envirofacts mapping program was used to investigate sites in each watershed with the potential to degrade source water quality.

Firm Yield. The firm yield of a reservoir is typically defined as the maximum amount of water that could have been delivered without complete depletion of the reservoir during the worst drought in recorded history, or the "historical drought of record." In the future, reservoirs will experience droughts that are either more or less severe than the historical drought of record. The firm yield estimates presented here for each reservoir used by the utilities in the South Cumberland study areas are based on the Hydrologic Modeling System developed by the U.S. Army Corps of Engineers Hydrologic Engineering Center.

For the purposes of this analysis, the firm yield for each lake was estimated independently. In theory, the sum of the firm yields of the individual sources is a lower limit on the firm yield of a properly operated system. These firm yield estimates do not consider the flexibility available to water managers in the region. Water-distribution-system improvements and conservation or demand-management programs may slow growth in gross water use or even reduce it. The emergency sources evaluated are resources that have been little used in the past, but could add considerable flexibility in the future. Using these emergency sources in proper combination with existing sources, or operating existing sources with a systems approach might allow a greater overall yield than the sum of the individual source yields. This is explored further in

Chapter 5, Section 5.3, where the reliability of the existing sources operated as a system is evaluated.

Water Conservation Programs. Utility district managers in the region were asked to provide information about their current programs, planned programs, and attitudes about the feasibility of certain conservation measures. This chapter outlines their responses and describes current conservation programs. In the Southern Cumberland Plateau region, most utilities have programs to reduce water loss, but could benefit from conservation practices and programs. Conservation and demand-management strategies that might be used to forestall the need to expand water supply sources are discussed in Chapter 4. Chapter 5 discusses likely future water conservation efforts.

Why this topic matters

In order to anticipate the needs of the future, it's vital to first assess the present. Water availability affects and is affected by natural characteristics, patterns of development, and individual choices. Some areas are sparsely populated while others have experienced heavy growth and development. Local governments have to be able to provide clean water in times of plenty as well as times of drought. The same waters are used for navigation, recreation, consumption, sanitation and in support of natural resources. In addressing issues of quantity, water quality must also be maintained.

Water is essential for so many purposes—agriculture, industry, residential, recreation. When water is in short supply, the demands for these competing purposes can lead to conflict and shortages. The demands on the South Cumberland study area's water come primarily from small business and residential users with a few concentrated developments such as the University of the South.

2.3 Big Creek Utility District—Ranger Creek Reservoir

The Big Creek Utility District's water supply source is Ranger Creek Reservoir. The reservoir's storage capacity is 751.9 acre-feet (254 million gallons).

System Water Quality. The National Tap Water Quality Database reports detection of 12 contaminants in water provided by the Big Creek utility, but there were no contaminants with concentrations above legal limits. The contaminants of greatest concern are all disinfection by-products. Notably, concentrations of bromodichloromethane and total haloacetic acids (HAA5) exceeded the maximum contaminant level goal.

Source Water Quality. Ranger Creek Reservoir is located just north of Coalmont and about five miles south of Altamont. The reservoir's watershed has an area of 1,471 acres. The dominant land uses in the watershed are forest, low density residential, and institutional (Grundy County High School). There are no major EPA regulated sites operating in the watershed and no major concerns about source water quality. If land use within the watershed remains constant, the same level of water quality should be maintained.

The primary source-water contaminant of concern is manganese. Manganese is a naturally occurring metal and is included in the EPA's National Secondary Drinking Water Regulations. Manganese concentrations are generally higher when reservoir levels are low. According to the National Tap Water Quality database, Big Creek Utility District's highest recorded manganese test concentration of 36 parts per billion (ppb) approached but did not exceed the health-based national regulation limit of 50 ppb.

Big Creek Utility District does not have any sewer customers or a wastewater treatment plant.

Firm Yield. Ranger Creek Reservoir has an average inflow of approximately 3.28 million gallons per day (MGD). According to TDEC's Safe Dams Program's records, the reservoir has 832 acre-feet (271.11 million gallons) of water at the normal pool elevation of 1,825.5 feet. No additional credible information pertaining to the available storage or water withdrawal intake elevations was available, so the Safe Dams normal pool estimate was selected as the most conservative storage estimate.

Using the sequent peak algorithm for the simulation period of 1927 to 2010, the calculated firm yield was 1.093 MGD. The critical drought sequence began in May of 1930 and reached the peak in December of 1931, for a length of approximately 18 months. No other drought created a deficit of more than 230 million gallons, except the recent 2007-2008 drought..

Current Water Conservation Programs. In general, Big Creek Utility District has just a few established conservation policies, though the managers are receptive to considering others. The utility has automated all of its meters, and all accounts are metered. Water used to fight fires and flush lines is usually estimated. Its distribution system is highly looped, so less flushing is required than in more branched systems.

There are no active leak detection programs and no system-wide leak surveys have been conducted in recent memory. In general, leaks are detected is through close monitoring of water treatment plant production, water tank levels, and water meters. The utility has one zone meter that could be used to narrow a search for a leak. Big Creek does not have any dedicated conservation education programs, nor does it have a website, or any programs to educate water users through classroom activities, pamphlets, billing inserts, or media outlets.

The utility's increasing block rate structure is designed to discourage wasteful use of water by residential consumers. Use above certain thresholds is more expensive than usage under those thresholds. Their limits are fairly generous, however, and very few users likely use enough water to pay the marginally higher rates. The utility plans to implement drought surcharges in future rate structures.

Big Creek has no active demand management or demand reduction programs. There are no fixture retrofit or rebate programs to replace outdated water using fixtures and appliances. There are no alternative programs such as rain capture or water reuse, but certain residents may practice these techniques independently. Big Creek does not currently audit its large water users or encourage them to conserve, but is considering that possibility. Notably, the high school uses a large amount of water to irrigate its fields, and there is potential to manage that usage more carefully.

In the future, Big Creek is likely to investigate techniques to reduce leakage (including by replacing cast iron pipe) and manage usage by its largest users, and it is willing to consider other conservation programs and policies. The utility district believes that water saving codes and ordinances are unlikely to be implemented, and that it has little influence over their enactment.

An energy audit was performed for Big Creek Utility District as part of this study and is included as Appendix X.

2.4 Town of Monteagle Public Utilities Board

Lake Laurel is Monteagle's primary water supply source. This lake has a surface area of 40 acres at normal pool elevation of 1,820 feet and contains approximately 653.7 acre-ft (213 million gallons) of storage. Monteagle connected to Lake Louisa after the drought of 2007 as an emergency water supply source. Lake Louisa has a storage capacity of 288 acre-feet.

System Water Quality. According to the National Tap Water Quality Database, nine contaminants were detected in a majority of samples between 1998 and 2002. None of the average contaminant concentration exceeded legal limits, and only bromodichloromethane exceeds its maximum contaminant level goal of zero. Four of the contaminants detected were individual or composite measures of disinfection byproducts.

Monteagle has two discharge plants. The first, located on the west side of U.S. Highway 41 toward Pelham, discharges into Juanita Creek. The other plant, also located off Highway 41 but toward Sewanee, discharges into an unnamed tributary of Trussell Creek.

Current Water Conservation Programs. Monteagle's Utility Manager indicates that few conservation measures are in place, but management is considering reducing non-revenue water and encouraging small to moderate reductions in per-capita usage. The water accounts in Monteagle are monitored by manual-read meters. All accounts are metered, and certain accounts with multiple individual units also have master meters. There is no zone metering. Fire fighting and line flushing are not metered.

No specific programs are directed at reducing leaks in the distribution system, nor has the district conducted active leak detection surveys. Leak detection surveys will likely be considered in the future. Additionally, the town has not adopted capital improvement projects to replace older, outdated pipes and pipes made of materials likely to break.

In the absence of drought, Monteagle has no dedicated, water-conservation-education programs, nor any rebate, retrofit, or replacement programs. During droughts, media messages and billing inserts encourage conservation while outlining the limitations on usage and associated penalties.

Monteagle's billing structure is not designed to promote conservation, but does have a block rate structure. A more conservation oriented block rate structure may be implemented in the future. Irrigation accounts can be metered separately.

Monteagle's service area includes municipalities that have plumbing codes and others that do not. The City of Monteagle has plumbing codes for new construction, but there are unincorporated sections of Monteagle's service area in Franklin County and Grundy County that do not have building codes. Even in the city limits of Monteagle, the plumbing codes are not targeted specifically at water conservation.

2.4.1 Laurel Lake

Source Water Quality. The general land use in Monteagle presents some minor water quality concerns. A major interstate highway, Interstate 24 (I-24), passes directly through Monteagle and brings considerable truck traffic. Monteagle's truck plaza and associated travel and vehicle repair facilities increase the risk of accidental contaminant releases. Monteagle's land use is characterized primarily by low-to-medium-density residential and commercial development. Some of the development is concentrated within the watersheds of Monteagle's water sources. Laurel Lake's watershed covers 1,117 acres, and is roughly rectangular with the lake emptying to the South. The southern half of the watershed is generally forested. Near the northern end of the lake, development changes to low density residential (and a cemetery). The northwestern and northern portions of the watershed generally follow the path of Main Street (US 41) through Monteagle. The northern portion of the watershed along this road and along I-24 at the eastern portion includes higher density commercial development. Aside from parking lots and roads, tire service centers, car repair shops, and a gas station may provide the greatest risks to water supply. There are no EPA regulated sites directly within the watershed, but EPA's Resource Conservation and Recovery Act Information System does show an Exxon Mobil corporation site at the far eastern edge of the watershed that could be partially within the watershed boundary.

Firm Yield. Laurel Lake is Monteagle's primary water source. According to Tennessee Safe Dams, Laurel Lake holds 91.24 million gallons at normal pool. Based on the elevation of the lowest intake used for water supply, Laurel Lake has a storage volume of 30.13 million gallons that is unavailable for water supply. This lowest intake is 20 feet below the current normal pool. The Town of Monteagle's Master Drought Management Plan's critical drought response measures are triggered when Laurel Lake drops five feet below normal pool.

At the calculated available storage volume of 61.11 million gallons, Laurel Lake has a firm yield of 0.363 MGD. The average inflow is 2.5 MGD, and the critical drought sequence lasted from May to December of 1944. If the entire storage volume in the lake were available for water supply, a yield of 0.493 MGD might be achievable.

During the 2007-2008 drought, Monteagle connected to Lake Louisa as an emergency water supply source. Lake Louisa has not been thoroughly studied as a water supply source, but has sufficient storage to provide water during drought emergencies.

2.4.2 Lake Louisa

Source Water Quality. The Lake Louisa watershed is 705 acres, and is largely forested with some low density residential development. The watershed is roughly triangular in shape and mostly located within Franklin County, but the watershed outlet and dam is located just across the southwestern border of Grundy County. The watershed has potential to change significantly with development. The most recent development plans for the Cooley's Rift community include forest replaced with low and medium density residential development within the watershed. Additionally, an 18-hole golf course is planned in proximity to the Lake. The additional development would increase the imperviousness of the watershed slightly, and increase the loadings of certain contaminants associated with residential development (nitrates, phosphorus, TSS, and total coliforms). The continuing land use changes will certainly affect water quality, and monitoring may be needed to determine the potential impact on treatment costs. No acute risks to water quality are currently apparent under publicly available development plans, but development plans should be monitored. There are no major EPA regulated sites currently operating in the watershed, and no major concerns for source water quality other than development.

Firm Yield. The average inflow for Lake Louisa is 1.58 MGD. Lake Louisa's total storage at normal pool is 212.78 million gallons according to Safe Dams records. By contract, Monteagle can use only the top two feet of the lake (as measured from the normal pool elevation) for water supply in emergencies. Using stage-storage information made available by Tennessee Safe Dams, the storage in these two feet of the lake is 14.18 million gallons. If operating under the conditions of the contract, the yield would be 0.105 MGD, and the critical drought sequence stretches from April 1931 to November 1931.

If the entire 212.78 MG volume of the lake were made available for water supply, it could support a yield of 0.653 MGD.

2.5 Sewanee Utility District

Sewanee has three surface water sources: Lake O'Donnell, Lake Jackson, and Lake Dimmick. Sewanee's reservoirs are operated as a system with Lake O'Donnell as the primary source, Lake Jackson as a secondary source that pumps to Lake O'Donnell when necessary, and Lake Dimmick as an emergency source.

- Lake O'Donnell has a maximum pool elevation of 1910 feet and can hold 190.71 acre-feet (62 million gallons) of water. Lake O'Donnell has a drainage area of 196.4 acres and a surface area of 18.75 acres. The maximum desirable drawdown is 18 feet and the lake is 28 feet deep. TDEC's Safe Dams staff classify Lake O'Donnell as high hazard because of potential downstream impacts if the dam were to fail. The classification does not reflect in any way the current condition of the dam..

- Lake Jackson is a 23.73 acre lake with a maximum pool elevation of 1,850 feet and can hold 343.49 acre-feet (112 million gallons) of water. Lake Jackson has a drainage area of 470.15 acres and is 60 feet deep. Water is drawn off near the bottom of the lake and is pumped into Lake O'Donnell. The maximum desirable drawdown is 14 feet. At that level, 110.5 acre-ft (36 million gallons) of storage remains, but the lake can be drawn down completely.

- Lake Dimmick (Day Lake) is owned and controlled by The University of the South. The lake is fed by tributaries from an 803-acre watershed. The maximum pool elevation is 1,810 feet and it has 669.09 acre-feet (218 million gallons) of storage, with a surface area of 85.52 acres. The maximum depth of Lake Dimmick is 28 feet. The maximum allowable drawdown is two feet.

System Water Quality. Sewanee's water quality is generally very good. According to EPA's Safe Drinking Water Information System, Sewanee Utility District has had one health-based violation and three minor reporting violations, but none since 2005. Other than coliform bacteria, Sewanee has had no legal violations for any chemical contamination. According the National Tap Water Quality Database, nine contaminants were detected in a majority of samples taken. Four of the contaminants include individual or composite measures of disinfection by-products. Only one, bromodichloromethane, exceeded the maximum contaminant level goal. The majority of the rest of the contaminants were at extremely low levels. These contaminants include Barium, sulfates, and alpha particle activity.

Concentrations of two metals, manganese and aluminum, were high enough to approach the limits of the National Secondary Drinking Water Rules. Land use in Sewanee currently appears to be conducive to high source-water quality for Sewanee's reservoirs.

Sewanee Utility District does not have a permit to discharge treated wastewater into a river or stream, but is permitted to apply it over land.

Current Water Conservation Programs. The Sewanee Utility District has taken some steps to improve efficiency and to encourage customer conservation. The district has managed to keep its total unaccounted for water down to roughly 14%. About 25% of UAW not attributable to leaks is due to fighting fire, flushing lines, and major line breaks. The distribution system is generally constructed of PVC pipes less than 30 years in age, and the utility currently plans to continue its normal pipe replacement schedule. In 2009, SUD found its residential meters to be 95% accurate and their larger meters only 75% accurate. This prompted a replacement program. It will also install several zone meters in the coming year.

Sewanee U.D. encourages consumers to conserve. Its website includes its shortages and emergency policy. Conservation materials from the American Water Works Association (AWWA) and Tennessee Association of Utility Districts (TAUD) are available at the SUD office, and age appropriate conservation materials are distributed to elementary schools. Staff encourage conservation when meeting with community organizations. During the 2007 drought, SUD promoted voluntary conservation measures, but saw only moderate success with a reduction in demand of less than 10%.

SUD has not implemented demand reduction measures such as voluntary water audits, supplying retrofit kits, or providing rebates for the installation of higher efficiency fixtures and appliances. The utility is studying the potential for direct or indirect reuse in the operations of its wastewater treatment plant. One of the district's largest water users, the University of the South, has independently taken steps to increase its efficiency by installing water conserving fixtures, and managing its water use more effectively. Sewanee officials believe that the most effective conservation measure is to promote conservation through a well-designed billing structure because customers respond to economic incentives to conserve. Sewanee proposes to charge nearly one dollar more for irrigation water than water for normal use. Residential accounts have an increasing block rate schedule.

Conservation pricing used in drought emergencies takes the form of a drought surcharge. At Stage 1, there is a surcharge only on irrigation accounts. At Stages 2 and 3, the irrigation surcharge increases, and other accounts face both a water and sewer surcharge. This provides an added incentive to conserve. In a Stage 4 drought, irrigation penalties can be applied along with significant surcharges for water and sewer usage.

2.5.1 Lake O'Donnell

Source Water Quality. Lake O'Donnell has a relatively small drainage area of just 157 acres. The watershed is predominantly forested, and the only developed land within the watershed is the Franklin County Airport. Typical water quality concerns at airports include jet fuel discharges, glycol and urea, that are used for airplane de-icing, and ammonia that is created when urea breaks down (EPA, 2009). Only the far eastern portion of the Franklin County Airport runway is within the Lake O'Donnell watershed, however, and the major aircraft parking, fueling, and hangar operations appeared to be outside of the watershed. No EPA regulated facilities were found within the watershed.

Firm Yield. Lake O'Donnell is the primary water supply source, but it is also the smallest reservoir in Sewanee's system and the entire study area. A yield study by CTI Engineers calculated the total storage in Lake O'Donnell as 62.14 million gallons with 4.14 million gallons not available for water supply for a total of 58 million gallons. The Tennessee Safe Dams estimate of total storage at normal pool elevation is 59.96 million gallons, but was considered outdated having been developed in 1992, so the newer CTI estimate was used.

The modeling of Lake O'Donnell resulted in an average inflow of 0.367 MGD. The sequent peak algorithm was used to calculate a firm yield of 0.172 MGD. At this yield, the critical drought sequences lasted from late May 1930 to early December 1931.

2.5.2 Lake Jackson

Source Water Quality. Lake Jackson's 471-acre drainage area is primarily forested, but has some low density development in the northern portion of the watershed. No EPA regulated facilities were found within watershed.

Firm Yield. Lake Jackson is typically used as a source of water to pump to Lake O'Donnell. CTI Engineers performed a detailed survey of the lake's stage-storage relationship and computed the lake's total storage to be 107.34 million gallons at a normal pool elevation of 1,852 feet. According to CTI, Lake Jackson can be drawn down completely, but it has a preferential drawdown of 14 feet. CTI computed the available storage volume above this level to be 70.76 million gallons. Yields were calculated at both of the CTI storage estimates, and either could be considered the firm yield depending on the operating rules in place for the lake.

The overall firm yield for 107 million gallons of storage was estimated at 0.391 MGD. Taking into account the reduced storage at the preferred drawdown level, the yield was 0.326 MGD. In both cases, the critical drought sequences were identical and lasted from late May 1930 to December 1931.

2.5.3 Lake Dimmick

The third water source used by Sewanee Utility District is Lake Dimmick, which is owned by the University of the South. Lake Dimmick is a large lake used primarily for recreation. It has the largest surface area of the lakes in the study area. By contract, SUD is allowed to use only the top two feet of Lake Dimmick as an emergency water supply.

Source Water Quality. Much of Lake Dimmick's 1277-acre watershed is currently undeveloped and is part of the University of the South's Domain. There are unconfirmed reports of illegal activities that may damage water quality including trash dumping, off-road vehicle operation, and to a lesser extent, hunting. A bigger threat to Dimmick's water quality may come from potential residential and commercial development of the watershed being considered by the University of the South. No EPA regulated facilities were found within watershed.

Firm Yield. CTI and Safe Dams estimates differ significantly in terms of elevations and storage values. The Safe Dams estimate was the more credible of the two when compared with the hydraulic characteristics (i.e. surface area, storage, hydraulic height) of other lakes in the study area. The difference between the two estimates is not of great importance, as only the top two feet of Lake Dimmick, which contain 53.85 million gallons of storage, can be used for water supply. The firm yield calculated at the contractual limit is 0.293 MGD. The critical drought was April 1931 through late November 1931.

2.6 Tracy City Public Utilities—Big Fiery Gizzard Reservoir

Tracy City's water supply source is the Big Fiery Gizzard Lake. The normal pool elevation is 1,829.7 feet, and it has 612.2 acre-feet (200 million gallons) of storage. There are three inlets on the reservoir with the first at 9.7 feet, the second at 19.7 feet, and the third at 25.7 feet (all below normal pool elevation). Big Fiery Gizzard Reservoir has a minimum release requirement of 450 gallons per minute to Big Fiery Gizzard Branch.

System Water Quality. Tracy City generally provides very high quality water. Water quality issues appear more related to treatment and distribution than to source quality. The National Tap Water Quality Database lists nine contaminants detected in a majority of samples taken. Three of the contaminants are individual or composite measures of disinfection by-products. The concentration of bromodichloromethane exceeds the maximum contaminant level goal of zero. Some tests of total trihalomethanes approached the maximum contaminant level goal. Aside from disinfection by-products, the most common contaminants include metals, nitrates, and sulfates. Nitrate and sulfate concentrations remain quite low. Like many of the reservoirs, Tracy City has detected alpha particle activity and barium at low levels.

Tracy City Utility District has only a wastewater collection system and pumps its sewage to the Town of Monteagle.

Current Water Conservation Programs. Tracy City Public Utilities has upgraded some infrastructure and has its unaccounted for water under control (roughly 15%), but has no specific conservation policies or actions in place. The utility closely monitors its automated (remotely readable) meters as a form of passive leak detection. Tracy City is attempting to invest more in pipe replacement to reduce potential for future leaks.

One challenge that Tracy City faces is that it has to release a significant amount of water to flush the mains to comply with drinking water regulations on total trihalomethanes (THMs) and haloacetic acids (HAA5). Changes in the treatment process may be considered to reduce the necessity for flushing. The utility's distribution system is already considerably looped, so there is limited potential to reduce flushing needs by further looping of lines.

Tracy City has an education and outreach program through which provides water-conservation wheels for customers who come into the office. It has no other education programs and no retrofit or rebate programs. Its rate structure is a flat rate after an initial charge for the first 1,500 gallons. It does not have programs to manage water use by its largest users. There are no plumbing codes in Grundy County or Tracy City. The city remains open to all suggestions for water conservation measures.

Source Water Quality. Tracy City Public Utilities' primary water supply is Big Fiery Gizzard Reservoir. In general, Tracy City has few source-water-quality issues based on land use and presence of EPA regulated sites. The reservoir's watershed is approximately 1,511 acres and generally rectangular in shape. The reservoir empties to the south. Big Fiery Gizzard Reservoir's watershed's land cover is a mix of undeveloped forest, open land and meadow, small agricultural parcels, and low-density residential development. The watershed also has several small lakes on the upstream tributaries of Big Fiery Gizzard Reservoir. These lakes may improve water quality by capturing some of the contaminants in runoff, especially sediment. There are no EPA regulated sites in the watershed.

Firm Yield. Several sources, including Tennessee Safe Dams and Tracy City, estimate total storage as approximately 200 million gallons. According to stage-storage data for Big Fiery Gizzard Reservoir provided by Tracy City, there is 1.9 million gallons of storage remaining below the lowest inlet. Therefore, the storage volume used to calculate firm yield was approximately 198 million gallons. The average inflow from the watershed to Big Fiery Gizzard reservoir is 3.57 MGD (5.52 cubic feet per second or cfs). The median flow, however, is 0.67 MGD (1.03 cfs). There is also a minimum release requirement of 1 cfs (0.646 MGD) for in-stream flow preservation. This flow is equivalent to 0.42 cfs per square mile. Using the sequent peak algorithm, the firm yield of the source is 0.993 MGD. Of that total, 0.646 MGD goes to meeting the in-stream flow requirement, so the firm yield for water supply is 0.347 MGD. The critical drought lasted from April 1931 to December 1931.

Chapter 3. Projection and Assessment of Potential Future Water Uses/Demands

3.1. Overview

Future water demand was estimated for the Southern Cumberland Pilot area in Tennessee through 2030. The water demand models were developed using two primary data sets: population and water use. The water demand projections were assembled from published population projections for counties in Tennessee for the years 2010, 2020, and 2030 (The University of Tennessee Center for Business and Economic Research). For the purposes of this study the population served by each public water supply system was projected as a fixed portion of the population of the county in which the water supply system is located. Two sources of water use data from 2005, the monthly operator reports and water system surveys, were compiled for the analysis of water demand projections in the South Cumberland plateau area (Tennessee Department of Environment and Conservation). Water use was projected for residential, commercial and industry, and treatment and non-revenue water using projected population served.

Water sold to commercial and industrial customers was combined for the purposes of demand projections. The combined commercial and industrial projection was as a system-specific proportion to growth in both population served and county population density. In 2005, statewide, the ratio of commercial to residential water use generally increases as county population density increases up to a ratio of 1:1 at an urban density of about 1,000 persons per square mile. Computations of commercial to residential use ratios as a function of density were detailed and were labeled as commercial rate adjustments.

From 2010 to 2030, raw water withdrawals for 4 of the 7 systems located in the South Cumberland Pilot area are projected to increase from 2.1 to 2.2 million gallons per day (MGD), or about 5.1 percent (table 7). The projected increases in raw water withdrawals, totaling 0.106 MGD in the South Cumberland Pilot area, by category, are: finished water sold to residential customers 58 percent (0.061 MGD); finished water sold to commercial and industrial customers 24 percent (0.025 MGD); and treatment and non-revenue water 18 percent (0.020 MGD). The projected increase of raw water withdrawals in the South Cumberland Pilot area includes increases in total finished water sold to 3 systems in the South Cumberland Pilot area and total 0.254 MGD in 2010, 0.289 MGD in 2020, and 0.313 MGD in 2030. Lake O'Donnell, Laurel Lake Creek, Big Fiery Gizzard, and Ranger Creek are the primary source of water for public water supply systems in the study area.

3.2. Introduction

Water-use data and population projections were used to develop water-use demand and to project the water demand from 2010 to 2030. Seven public water supply systems are included in the analysis for water demand projections in the South Cumberland Pilot area and are located in five counties in southeastern Tennessee; Sewanee Utility District, located in Franklin County; Big Creek Utility District, Monteagle Public Utility Board, and Tracy City Water System, located in Grundy County; Foster Falls Utility District, Griffith Creek Utility District, located in Marion County; and Cagle-Fredonia located in Sequatchie County.

Background

Population and water use data were used to estimate water demand for the study are to 2030 at 10-year intervals. Water use was projected for residential, commercial and industry, and treatment and non-revenue water using projected population served (based on county-level projections).

The South Cumberland Pilot area is a combination of sections of four counties (Franklin, Grundy, Marion, and Sequatchie) located in southeastern Tennessee. Grundy and Marion Counties have experienced little to no growth over the past decade. Similar, low growth trends in population are projected during 2010 to 2030 in these two counties (see appendix). From 2000 to 2009 Franklin County's percent change in population was 5.2 percent. Percent changes in population projections from 2010 to 2030 for Franklin County are expected to be 15 percent. From 2000 to 2009 Sequatchie County's percent change in population was 22.3 percent. Percent changes in population projections from 2010 to 2030 for Sequatchie County are expected to be about 40 percent (see appendix).

Grundy and Marion counties in the Southern Cumberland pilot area are experiencing little to no growth, although substantial growth is occurring along transportation corridors within the South Cumberland Pilot area.

Why This Topic Matters

Understanding and anticipating current and future demands for water are essential to effective water supply planning. In economic terms, public demand for water can be thought of as the amount of water used in public supply at a given cost to obtain it. Failure to plan adequately for water supply systems can increase the cost of water and limit economic activity. Water systems that are too small, for example, will result in relative water scarcity increasing cost and diminishing economic opportunity. Water systems that are too large may result in idle infrastructure adding unnecessary debt burden and reducing economic efficiency.

Systems at either extreme may be constrained in their ability to provide for either environmental maintenance or long-term institutional stability. The sizing of water systems and investments in infrastructure to achieve the best possible social and environmental outcomes relies on reasonably precise and accurate knowledge of likely demand for water in the future. Because water demand patterns change with cost they can be difficult to describe and predict directly. Current demands (existing water-use rates) can be projected into the future based on proportional changes in economic productivity or population. If relative costs remain largely the same in the future, these water use projections serve to approximate water demand and when balanced against acceptable risk can provide a suitable basis for effective public policy and decision-making.

Tracking and projecting water demand are important for water supply planning and indentifying potential stressors on the environment including surface water and groundwater resources. Although increases in projected water demand may be small, stressors on limited resources may have a great impact on water resource needs in certain areas of Tennessee. Examples of this dilemma occurred in a portion of the South Cumberland Pilot area as a result of the drought in 2007.

3.3. Population growth and projections

The water demand projections are a function of published population projections for counties in Tennessee for the years 2010, 2020, and 2030 (CBER reference). For the purposes of this study the population served by each public water supply system was projected as a fixed portion of the population of the county in which the water supply system is located. This assumed that customers moving into or out of each county were moving to served and un-served areas in proportions consistent with previous development patterns and that distribution systems were not expanding to add customers beyond adjacent development.

The approach used by CBER to generate the population projections is the cohort component method. This method relies exclusively on population measures--an initial population from the 2000 Census, historic fertility, mortality, and migration rates (Middleton and Murray, 2009). The cohort component method integrates migration rates based upon county data within Tennessee from 1990 through 2005.

It is a given that population forecasts contain considerable uncertainty when viewed over long periods into the future, especially for small geographic areas near regions of rapidly changing population, industrialization (or deindustrialization), and natural hazards. An example of unforeseen changes in migration patterns might be drawn from the New Orleans region where the city's population decreased more than 60 percent in less than a year following Hurricane Katrina and population in the state of Louisiana declined by 0.5 percent from 2000 to 2009 (U.S. Census Bureau, 2010). The socioeconomic effects of recent flooding in parts of east and middle Tennessee (early May 2010), though significantly less severe than those of Katrina, were not entirely dissimilar and may have an impact on local population growth and migration rates that is unforeseen in the current population projection for the region. In addition, recent deterioration of economic conditions across the U.S. (from late 2007) may have changed economic opportunity, employment, and patterns of population movement in both rural and urban areas of Tennessee. These effects can be quite large as in the population of Detroit, Michigan which has decreased by more than 50 percent (about 900,000 people) over the last 60 years (U.S. Census Bureau, 2010).

Although uncertainties in population estimates might be inferred from measures of past performance (i.e. comparing old projections to current reality) these types of analyses were not readily available and were outside the scope of this study to complete. Other empirical trend forecast methods such as Box-Cox, linear, and log-linear extrapolations (Hutson and Schwarz, 1996) were tested and forecasts generally agreed with CBER estimates within reasonable bounds of uncertainty given unknowns in measurement error and assumptions about socioeconomic conditions in the future. These projections, however, were based on the same 5-year-old history of population growth and may be insensitive to recent changes in economic conditions in the region.

Overall, any reasonable projection of population can provide good basis for planning so long as (1) those projections are reviewed and adjusted to reflect reality as new information becomes available and (2) the risk of being wrong is weighed against confidence (certainty) in being right. In this light, CBER population projections represent the best and most precise analysis of population trends available at the present time and therefore provide the best single basis for planning. However, plans based on these projections should also recognize that actual populations (and demands based on those populations) might routinely be expected to be 15-20 percent larger or smaller than those predicted twenty years into the future. This would represent an average annual uncertainty in rates of 0.5 percent or more per year.

Each decade, Tennessee has experienced positive population growth and most recently, Tennessee's population increased 10.7 percent from 2000 to 2009. In the United States, the increase in population from 2000 to 2009 is 9.1 percent. (See Appendix X for supporting tables.) Although Tennessee's population growth has increased positively over time, and is slightly higher than the increase in population in the United States over the past 9 years, fluxes in population in Tennessee counties have been negative in 20 counties and positive in 75 counties.

3.4. Water Use and Demand Projections

3.4.1. Water Use

Two sources of water use data from 2005, the TDEC monthly operator reports (MORs) and water system surveys on water use data (WSSs), were compiled for the analysis of water demand projections in the South Cumberland Pilot area. The 2005 MORs provided raw water withdrawals by principle suppliers, finished water purchased from other systems, finished water sold to other systems, and water source (i.e. groundwater or surface water). The MORs were used to tabulate the gross, raw water withdrawals by each water system, the amount of water sold or purchased, and the net amount of water used internally by the water systems.

The WSSs provided information on the amount of total finished water distributed, including water sold to other water-supply systems during the water use reporting period. In addition, the WSSs included number of accounts and billed water for residential, commercial, and industrial customers. Finally, the total amount of water used for purposes such as firefighting, line flushing, maintenance, and other public uses or losses are provided in the WSSs (tables 5 and 6). Quality assurance and quality control reviews were conducted to evaluate consistency and accuracy of the two water use data sets. The monthly data was inspected for missing months, very large variability in withdrawals, and for consistency with previous years. The system surveys were inspected for consistency of units and balance of overall water use. System operators were contacted as needed and data were corrected based on information provided in interviews.

Billed residential water use was based upon water system surveys and includes water sold to individual households and apartment complexes. Billed commercial and industrial water use was based on WSSs and includes water sold to businesses for commercial use (restaurants, offices, etc.) and limited industrial use. Industrial and commercial water use classes were combined for the purposes of water demand projections. Non-revenue water was determined from the results of the water system surveys and mathematical differences between total water minus residential, commercial, and industrial water use. In the past, the non-revenue water has been given a different definition and was often poorly defined. As used here, non-revenue water includes water used during plant operation and maintenance (such as back washing), flushing of water lines, fire hydrant testing, firefighting, leaks in the plant or water lines, under registration of meters, and other public losses. For the purposes of this report non-revenue water was calculated and is the difference between withdrawals and water sold to other systems and residential, commercial, and industrial customers.

Water sold to commercial and industrial customers was combined for the purposes of demand projections. There is very little industrial use in the pilot area. In 2005, statewide, the ratio of commercial to residential water use generally increases as county population density increases up to a ratio of 1:1 at an urban density of about 1,000 persons per square mile (figure 1). Computations of commercial to residential use ratios as a function of density are detailed and are labeled as commercial rate adjustments. These adjustments are used to derive overall commercial and industrial use based on estimates of residential use (a function of simple population growth). Public water supply system population served estimates were extrapolated based on direct proportionality to TACIR/CBER growth estimates for the counties in which these systems reside. (See Appendix X for supporting tables.)

3.4.2. Water Demand Projections

Seven public water supply systems are included in the analysis for water demand projections in the Southern Cumberland Pilot area and are located in five counties in southeastern Tennessee; Sewanee Utility District, located in Franklin County; Big Creek Utility District, Monteagle Public Utility Board, and Tracy City Water System, located in Grundy County; Foster Falls Utility District, Griffith Creek Utility District, located in Marion County; and Cagle-Fredonia located in Sequatchie County.

From 2010 to 2030, raw water withdrawals for 4 of the 7 systems located in the Southern Cumberland Pilot area are projected to increase from 2.1 to 2.2 MGD, or about 5.1 percent (table 7). The projected increases in raw water withdrawals, totaling 0.106 MGD in the Southern Cumberland Pilot area, by category, are: finished water sold to residential customers 58 percent (0.061 MGD); finished water sold to commercial and industrial customers 24 percent (0.025 MGD); and treatment and non-revenue water 18 percent (0.020 MGD). The projected increase of raw water withdrawals in the Southern Cumberland Pilot area includes increases in total finished water sold to 3 systems in the Southern Cumberland Pilot area and total 0.254 MGD in 2010, 0.289 MGD in 2020, and 0.313 MGD in 2030. Lake O'Donnell, Laurel Lake Creek, Big Fiery Gizzard, and Ranger Creek are the primary source of water for public water supply systems in the study area.

Table 7. Water demand projections for public water supply systems in the Southern Cumberland Pilot area, 2010, 2020, and 2030.
[All values in million gallons per day except where indicated]

		Projections for 2010						Projections for 2020						Projections for 2030					
County, public water system ID, and system	Source of supply (seller, buyer)	System population served (persons)	Finished water sold to residential customers	Finished water sold to commercial and industrial customers	Treatment and non-revenue water	Supply of raw and/or finished water needed to meet internal demand	Raw water withdrawals by principal suppliers	System population served (persons)	Finished water sold to residential customers	Finished water sold to commercial and industrial customers	Treatment and non-revenue water	Supply of raw and/or finished water needed to meet internal demand	Raw water withdrawals by principal suppliers	System population served (persons)	Finished water sold to residential customers	Finished water sold to commercial and industrial customers	Treatment and non-revenue water	Supply of raw and/or finished water needed to meet internal demand	Raw water withdrawals by principal suppliers
Southern Cumberland Pilot Area																			
Franklin, 623 Sewanee Utility District	Lake O-Donnell	4,849	0.126	0.096	0.080	0.303	0.303	5,286	0.137	0.105	0.088	0.330	0.330	5,576	0.145	0.111	0.092	0.349	0.349
Grundy,470 Monteagle Public Utility Board	Laurel Creek Lake	3,163	0.193	0.091	0.150	0.434	0.434	3,138	0.191	0.090	0.149	0.431	0.431	3,166	0.193	0.091	0.150	0.434	0.434
Grundy, 706 Tracy City Water System	Big Fiery Gizzard	3,624	0.269	0.014	0.154	0.437	0.471	3,595	0.267	0.014	0.153	0.433	0.467	3,628	0.269	0.014	0.154	0.437	0.471
	Foster Falls UD * (buyer)	--	--	--		--		--	--	--		--		--	--	--		--	
Grundy, 122 Big Creek Utility	Ranger Creek Impoundment	7,814	0.376	0.090	0.195	0.661	0.881	7,751	0.373	0.089	0.194	0.655	0.910	7,821	0.376	0.090	0.196	0.661	0.940
	Griffith Creek UD (buyer)	--	--	--		--		--	--	--		--		--	--	--		--	
	Cagle-Fredonia (buyer)	--	--	--		--		--	--	--		--		--	--	--		--	
Marion, 278 Griffith Creek	Big Creek UD* (seller)	1,179	0.072	0	0.007	0.079		1,164	0.071	0	0.007	0.078		1,166	0.071	0	0.007	0.078	
Marion, 8049 Foster Falls Utility	Tracy City WS (seller)	607	0.031	0	0.003	0.034		600	0.031	0	0.003	0.034		600	0.031	0	0.003	0.034	
Sequatchie, 927 Cagle-Fredonia Utility District	Big Creek UD* (seller)	1,950	0.105	0.019	0.017	0.141		2,428	0.131	0.025	0.021	0.177		2,739	0.148	0.029	0.024	0.201	

Chapter 4. Identification of Potential Sources and Means of Meeting Projected Need

4.1 Overview

The list of potential water supply source alternatives for the Southern Cumberland Plateau planning region was developed in conjunction with stakeholders through a series of meetings with local government officials, utility managers, and the public. The alternatives selected for additional study were in the broad categories of conservation and demand management, regionalization or water sharing among utilities, existing source improvement, and new source development.

Many of the utilities in the region have already implemented management practices to avoid significant water losses, but they have not taken the next step to implement conservation practices and programs. Practices that are widely applicable and provide a broad range of options include

- reductions in leakage and unaccounted-for-water;
- water pricing for conservation;
- conservation education;
- retrofit, replacement, and rebate programs; and
- water efficiency codes and ordinances.

In addition, an energy audit of the Big Creek Utility District was done and is attached as Appendix???

Preliminary engineering and design activities were completed to define the scope of four regional structural alternatives for water supply. These alternatives are

- modification of the existing Big Fiery Gizzard Reservoir,
- construction of a new dam and reservoir on Big Creek,
- purchase and conversion of Ramsey Lake from recreation to water supply, and

- construction of a treated water pipeline from the Tennessee River at South Pittsburg to the Plateau.

4.2 Introduction

Background

The current raw water supply in the South Cumberland region was perceived as barely sufficient during the recent drought (2007). The hardest hit utility, Monteagle, managed the drought by purchasing finished water through connections to Sewanee and Tracy City and by establishing several emergency raw water sources. Overall raw-water demand in the region is expected to grow only slightly through 2030, from approximately 2.1 million gallons per day (MGD) to 2.2 million gallons per day (MGD). Demand projections for the Big Creek and Sewanee utility districts are well below the firm yields of their existing raw water sources. Existing and projected raw water demands for Monteagle and Tracy City, however, are currently greater than the firm yield of their primary sources. The composite firm yield of the region's existing raw water sources is barely sufficient to meet the projected demand, indicating a need for additional source development. Interconnections between the utilities are well established, with existing formal contracts between Tracy City and Big Creek, as well as Tracy City and Monteagle. Because the small drainage areas of the South Cumberland Plateau's water sources leaves them particularly vulnerable, maintaining and improving the ability to share sources among utilities is paramount to each utility's ability to meet demand during droughts.

The list of potential alternatives to meet the needs of the region was developed in conjunction with stakeholders through a series of meetings with local government officials, utility managers, and the public. The alternatives fell into four categories and included conservation and demand management, regionalization or water sharing among utilities, improving existing sources, and developing new sources. In addition, the Sewanee Utility District is investigating re-use of wastewater for landscape irrigation and groundwater/watershed recharge as an alternate means of wastewater disposal.

Why This Topic Matters

Considering a wide range of potential alternatives ensures that less obvious measures are not overlooked and that the best plans are developed. There are a finite number of basic alternatives available to meet the projected water supply need in a planning region. These alternatives fall into the following general categories: conservation and demand management, regionalization or source sharing, existing source improvement, new source development (surface water or groundwater) and direct wastewater re-use. A comprehensive list of alternatives, developed with stakeholder collaboration and input, is crucial to ensure options are not overlooked and to foster stakeholder ownership in the process.

4.3 Conservation and Demand Management

During the drought of 2007-2008, many of the utilities on the Southern Cumberland Plateau promoted water conservation and, in some cases, enacted mandatory drought usage restrictions. These measures helped reduce the effects of the drought, but they were temporary. This section describes conservation measures that can reduce pressure on water sources year round, year in and year out, throughout the region. They are drawn from a number of sources, including the U.S. Environmental Protection Agency's *Water Conservation Plan Guidelines* first issued in 1998. While the list below is not exhaustive, the conservation measures presented are widely applicable and provide a broad range of options.

4.3.1 Reducing Water Loss

Utilities and their customers can no longer afford inefficiencies in water distribution systems even where or when water is plentiful. Increases in pumping, treatment, and other operational costs make the loss of revenue from unbilled water a significant financial burden. Unbilled water generally takes two forms: water that is lost through leaks in the distribution system and water that is used in non-revenue-producing ways such as fighting fires and flushing lines to ensure good water quality. Reducing leaks is the most obvious way to save both money and water. The financial savings stems not only from reduced operational costs, but also from avoiding or postponing capital investment in new water supply sources, which can have additional, cost-free environmental benefits.

Water lost through leaks generally cannot be directly accounted for, but will be evident when the volume of water treated or purchased is compared with water use that is metered or can be accurately estimated. And for individual leaks, the amount lost can be multiplied by its retail value to produce a dollar amount that can be compared with the cost to detect and repair it.

Losses through leaks may occur anywhere in the system, and a variety of strategies are necessary to a comprehensive water loss prevention program. The biggest challenge is finding leaks. Larger leaks (e.g., a water main break or major breach in a pipe) may be evident from surface signs, changes in water pressure, or unexplained increases in water produced but not consumed, and so are usually found and repaired quickly. Smaller leaks, however, may lead to larger losses because they are not so obvious, yet they are easier to find with listening devices because they are noisier than large leaks. Listening devices are a good investment when used as part of a regular leak detection program. Most water utilities find it economical to survey the entire distribution system every one to three years.

Similarly, a regular valve-exercise program can reduce losses through leaks by ensuring that valves operate effectively so that the part of the distribution system where the leak is located can be isolated and repaired. And automated meters can aid in leak reduction by detecting unexplained decreases in water pressure or increases in water flow, including water flowing constantly through customer meters. Finding and fixing leaks on either side of customer meters is a conservation measure that benefits the system as a whole.

> Of the many options available for conserving w a t e r, leak detection is a logical first step. If a utility does what it can to conserve water, customers will tend to be more cooperative in other water conservation programs, many of which hinge on individual efforts.
>
> *Leak Detection and Water Loss Control*
> National Drinking Water Clearinghouse

4.3.2 Reducing Line Flushing

Line flushing is another common form of non-revenue water. It may or may not be accounted for, depending on whether the amount flushed is measured in some reliable way such as by metering it. Flushing smaller pipes near the ends of distribution lines removes mineral deposits and ‘old’ water containing concentrations of disinfection by-products and metals that exceed healthy drinking water limits. Lines need to be flushed more often when customers are spread out and distribution lines are branched rather than looped so that water sits unused in the lines long enough to deteriorate in quality. Water flushed from lines is rarely captured so that it can be retreated. This one of the greatest impediments to serving customers in sparsely populated areas. Looping systems can reduce the need to flush lines in these areas, and automatic line flushing systems can reduce the amount of water used in flushing where looped lines are not feasible.

4.3.3 Metering All Water Use

Metering is a fundamental tool of water system management and conservation. Both the supplier and the customer benefit from metering. As noted in the EPA’s *Water Conservation Plan Guidelines*,

- source metering is essential for water accounting purposes,
- service-connection metering is needed to track usage and bill properly, and
- metering water provided free of charge is necessary to determine water loss and to cost and price water accurately; this includes water used for fighting fires and flushing lines.

Meters should be read at fixed intervals to support accurate comparisons and analysis so that the amount of non-revenue-producing water can be determined. This is a major strategy for reducing unaccounted for water, which is important to identifying controllable losses.

Meters must be accurate and so should be tested, calibrated, repaired, and replaced at regular intervals to ensure accurate water accounting and billing. And meters should be properly sized. Meters that are too large for a customer’s usage tend to under-register use, which leads to under-billing.

4.3.4 Pricing Water for Conservation

Water for drinking is literally priceless. We cannot survive without it. Because some minimum amount of water is required for necessities, conservation pricing strategies designed to discourage waste and leakage

Apparent and Real Losses

Apparent losses are the non-physical losses that occur in utility operations due to customer meter inaccuracies, systematic data handling errors in customer billing systems and unauthorized consumption. In other words, this is water that is consumed but is not properly measured, accounted or paid for. These losses cost utilities revenue and distort data on customer consumption patterns.

Real losses are the physical losses of water from the distribution system, including leakage and storage overflows. These losses inflate the water utility's production costs and stress water resources since they represent water that is extracted and treated, yet never reaches beneficial use.

http://www.awwa.org/Resources/WaterLossControl.cfm?ItemNumber=48026 must take affordability into consideration. Typical conservation pricing strategies include

- eliminating volume discounts that act as disincentives to conservation,
- charging a higher price as consumption rises (e.g., increasing block rates), and
- varying seasonal rates so that prices rise and fall as water supplies increase and decrease with weather conditions.

The most common of these is adoption of price schedules with increasing block rates; the least common is seasonal rates. All three strategies encourage customers to conserve. Water utilities may also provide separate meters for discretionary uses such as irrigation and charge higher prices for water billed through those meters. To ensure that water bills remain affordable, utilities may offer

- lifeline rates based on minimum required usage that may be free or reduced in price (usage above that level may be priced at either the standard rate or some discounted rate),
- credits and discounts for qualified customers whose bills may be reduced by a specified dollar amount or by a percentage of the total bill or some portion of it (discounts may vary by household size),
- exemption from paying the fixed cost portion of bill (fixed costs may be reduced or eliminated so that qualified customers pay only for actual water use, either at full cost or at a discount),

This is a sample of conservation and affordability strategies. Others may be found in the American Water Works Association's 1998 report titled *Water Affordability Programs*, the U.S. Environmental Protection Agency's 2002 report titled *Rate Options to Address Affordability Concerns for Consideration by District of Columbia Water and Sewer Authority* and its 2003 report titled *Water and Wastewater Pricing*.

4.3.5 Encouraging Landscape Efficiency

Utilities can promote water conserving principles in the planning, development, and management of new landscape projects such as public parks, building grounds, and golf courses. Low-water-use landscaping can be important conservation strategies for both residential and nonresidential customers with large properties. Xeriscaping^{tm} is an efficiency-oriented approach to landscaping popularized in arid climates, but adaptable anywhere. Its seven essential principles encompass

- planning and design,
- limited turf areas,
- efficient irrigation,
- soil improvement,
- mulching,

- use of lower water-demand plants, and
- appropriate maintenance.

Existing landscapes can be renovated to incorporate these principles. Utilities can work with commercial and industrial customers to plan or renovate landscaping and with nurseries to ensure the availability of appropriate plants. For large-volume customers, irrigation management systems that use meters, timers, and water- and moisture-sensing devices can be cost-effective, especially when irrigation systems are separately metered and billed at higher rates than domestic use.

4.3.6 Informing and Educating the Public.

Educating water consumers about their water use and water conservation not only can lead to moderate savings but also can increase the effectiveness of other conservation measures. Education programs generally have a fairly low cost, and an extensive literature search indicates that a comprehensive program can reduce usage by 3% to 7%. At the most basic level, utilities should strive to make customers' bills easy to read and understand by identifying the volume of water used, rates and charges applied, and other relevant information. They should also include comparisons to previous bills and may include comparison to typical bills for similar customers. Other measures suggested by the USEPA include

- information pamphlets explaining the costs involved in supplying drinking water and how conserving water will produce long-term savings for all water users;
- water bill inserts that provide information about water use and costs along with tips on conserving water in the home;
- school programs that help young people understand the value of water and conservation techniques;
- outreach programs such as speaker's bureaus, booths at public events, printed and video materials, and coordination with civic organizations;
- workshops for plumbers, plumbing fixture suppliers, builders, and landscape and irrigation system providers; and
- water conservation committees to involve the public in conservation, provide feedback to utilities about their plans, and develop ideas and materials to inform the public and build community support for conservation.

4.3.7 Retrofitting and Replacing Old Fixtures and Appliances.

A step up from information and education programs, and a bit more expensive, are retrofitting programs that improve existing plumbing fixtures and appliances. Retrofit kits may include low-flow faucet aerators, low-flow shower heads, leak detection tablets, and replacement flapper valves. The may be provided free of charge or for a small cost directly or through community organizations, and they may be offered to certain customer classes (e.g., residential users, low-income households, etc.). Retrofit programs should conform to local plumbing codes and ordinances.

Another step up are rebates and incentives to accelerate replacement of older fixtures. Coupled with high-efficiency standards, programs to accelerate replacements can yield substantial water savings. Utilities can provide fixtures at no cost, offer rebates to customers who purchase them, or help suppliers provide them at a reduced price. Rebate and incentive programs can be targeted at both the residential and nonresidential sectors and to both indoor and outdoor uses.

Short of these more costly programs, utilities can promote new technologies through demonstrations and pilot programs or through contests that showcase new products such as high-efficiency washing machines.

4.3.8 Regulating Water Use.

Regulations to manage water use during drought or other water-supply emergencies should already be in water utilities drought management plans, but utilities may also extend similar measures to promote conservation more generally. Among the examples listed in the USEPA's *Water Conservation Plan Guidelines* are

- restricting nonessential uses, such as watering lawns, washing cars and sidewalks, filling swimming pools, and irrigating golf courses;
- adopting standards for water-using fixtures and appliances;
- banning or restricting once-through cooling; and
- banning non-recirculating car washes, laundries, and decorative fountains.

The Guidelines also suggest adopting standards for landscaping, drainage, and irrigation of new developments through codes, ordinances, regulation, planning guidance, or incentive programs to curb future demand, but note that utilities may lack authority to impose such restrictions themselves and that they should be justified by local conditions and not unduly compromise customers' rights or quality of service.

4.3.9 Reusing and Recycling Water

Water reuse and recycling reduces production demands on water systems. Utilities should work with their nonresidential customers to identify ways to reuse water. One alternative is using "gray water" (treated wastewater) for non-potable purposes such as irrigation and groundwater recharge. Properly treated water already supplies direct reuse in some parts of the country. It has long been regularly returned to streams where it becomes part of the source for others, and it has more recently, here in Tennessee and elsewhere, been returned upstream of the treating utility to replenish its own source of supply, especially in times of drought. Treated wastewater is often of higher quality than the original water supply, especially with the newer membrane treatment systems that remove even some unregulated contaminants.

4.4 Regionalization

During the recent drought, the hardest hit utility, Monteagle, mitigated impacts in part by purchasing finished water through connections to Sewanee and Tracy City. The small drainage areas of the Southern Cumberland Plateau's water sources leave them particularly vulnerable to drought. Fortunately, interconnections between utilities in the region are well established, with existing formal contracts between Tracy City and Big Creek, as well as between Tracy City and

Monteagle. Some of the connections provide water on a permanent basis and some only on a temporary basis. Both types of connections are needed to ensure a system is resilient not only to drought, but also to other potential disasters such as flooding, tornados or hazardous spills. Treatment plants can be taken completely out of production for weeks or months. Having agreements in place and improving a utility's ability to share water before it is needed helps to ensure water will be available during emergencies.

Regionalization as an alternative involves increased water sharing between utilities using existing or improved connections. Optimizing the way in which utilities in the region share individual water resources can extend limited supplies. Regionalization is often the most publicly acceptable and least environmentally damaging means of providing additional water to a utility.

As discussed in Chapter 3, considering only the firm yield of the existing water sources on Southern Cumberland Plateau indicates that the region as a whole could supply its needs through 2030 through better regionalization. Big Creek and Sewanee had more supply than they needed and Tracy City and Monteagle did not have enough. However, a further examination of the reliable capacities of the existing sources (See Chapter 5) revealed that if Big Creek and Sewanee did try to supply Monteagle and Tracy City, their systems would be severely stressed. In other words, Big Creek and Sewanee could not reliably supply Monteagle and Tracy City's needs. While this alternative was modeled and is discussed in Chapter 5, a specific design and cost was not done because it cannot meet the existing and future demand of the region.

4.5 Existing Source Improvement—Modification of Big Fiery Gizzard Dam and Reservoir

Big Fiery Gizzard Reservoir (BFGR), impounded by the Tracy City Dam, is currently the sole water source for Tracy City Public Utilities. TCPU can sell significant quantities of water from the reservoir to Monteagle and potentially to Big Creek Utility District. Because the reservoir's yield may not be sufficient in dry years to meet Tracy City's demand and also satisfy the demands of other utilities in the area, TCPU has proposed raising the dam to increase the reservoir's storage capacity.

Nolen Engineering Group, LLC prepared a document titled *Strategic Plan 2007-2027,* (NEG, 2007) in April 2007 for the Tracy City Municipal Waterworks to evaluate the existing water supply system and identify future water supply issues. Nolen recommended expanding the reservoir by raising the dam seven feet. An Aquatic Resource Alteration Permit (ARAP) to raise the dam was approved by TDEC with an effective date of June 3, 2009, and an expiration date of June 2, 2014.

***Description of the Alternative*.** The Tracy City Dam was constructed in 1996 on Big Fiery Gizzard Creek, downstream of its confluence with Meeks Branch and west of Tracy City. The top of the dam is 1,470 feet long and 20 feet wide. It has a structural height of 44.7 feet and holds 34.7 feet of water at normal pool. The proposed modification involves raising the dam and normal reservoir pool seven feet. Crushed rock fill, excavated from near the existing emergency spillway, would be placed on the downstream face of the dam to raise it. The storage capacity of the expanded reservoir would increase by approximately 168 million gallons, its surface area would increase by approximately 37 acres, and its shoreline would increase about 4,000 feet.

Design of the Alternative. The conceptual plan and cross sections are shown in Exhibit C.2, in Appendix C. Figure XX shows the existing reservoir, dam, and intake riser structure extending from the center of the dam into the normal pool. The proposed dam alteration should not change the existing size or hazard classifications.

Figure X. Aerial photo of Big Fiery Gizzard Reservoir

The existing outlet structure includes uncontrolled low flow orifices to regulate flow to Big Fiery Gizzard Creek. At the current normal pool elevation of 1829.7, the uncontrolled orifices discharge roughly 1 cfs, which is the permitted release requirement. Without modifying the low flow orifices, the raised water surface will result in higher flows since the rate of flow for uncontrolled orifices depends directly on the hydraulic head. NEG has proposed modifying the outlet structure to keep the same 1 cfs flow rate at the new normal pool elevation of 1836.7. A metal duct with slots at various elevations would be installed inside the outlet structure to control (i.e. reduce) the discharge through the low flow pipes and still satisfy in-stream flow requirements. Raw water would continue to be pumped from the reservoir to the existing, onsite treatment plant. The reservoir would continue as the principal water source for TCPU.

Potential Costs. Operations, maintenance, repair, replacement, and rehabilitation (OMRR&R) costs for the Big Fiery Gizzard Reservoir include annual inspection, incidental repair, and the assumption that major replacement of the recirculation pumps and low flow outlet modification weir would occur at 10- and 20-year intervals, respectively. A breakdown of the quantities for the individual line items may be found in Appendix D. The following table contains a summary of the major cost items for the raising of Big Fiery Gizzard Reservoir. As shown, the total present value cost for the reservoir is about $3.5 million including the OMRR&R cost.

The cost estimates are conceptual and do not include the additional detailed studies associated with all alternatives. Nor do they include all necessary upgrades to distribution systems or treatment plants. These needs are discussed where known. The costs represent the sum of the first cost (initial capital construction cost) and the present value of the operation and maintenance costs associated over an assumed 50-year project life using an interest rate of 4.375%. Costs included a 25% contingency, 10% for engineering and design, 10% for engineering during construction and 10% for supervision and administration during construction. Standard construction methods were assumed to be used for each alternative.

Table X. Cost Summary Big Fiery Gizzard Reservoir Modification

Item		Cost
Mob/Demob		$ 142,545
Site Preparation		$ 491,308
Rock Excavation and Placement		$ 1,051,440
Outlet Structure Raise		$ 35,029
Spillway Weir		$ 40,992
Low Flow Outlet Modification		$ 4,070
Water Recirculation Equipment		$ 122,115
Real Estate		$ 222,000
Construction Subtotal		**$ 2,109,498**
Contingency	25%	$ 527,375
Supervision and Administration	10%	$ 210,950
Planning Engineering and Design	10%	$ 210,950
Total First Cost		**$ 3,058,772**
Present Value OMRR&R Costs		$ 436,159
Total Present Value		**$ 3,494,932**

4.6 New Source Development

Three alternatives were considered for new source development. These alternatives are presented in detail in the following sections.

4.6.1 Big Creek Reservoir

A location east of Altamont, along Big Creek, was identified by BCUD and James C. Hailey & Company (JCH) as suitable for a reservoir of considerable size. Though this alternative has been described in several reports, no preliminary design exists for the reservoir. Existing data was leveraged to develop preliminary design details. BCUD and JCH provided documents showing a proposed location of the new dam, and the existing Tracy City ARAP for modification of Big Fiery Gizzard Reservoir outlined general reservoir/watershed characteristics if an impounding structure were constructed at this location. The Tracy City ARAP reports that a new Big Creek Reservoir with a normal pool elevation of 1800 feet would have a contributing watershed larger than 12,000 acres, a surface area greater than 200 acres, and a yield of about 5 million gallons per day (MGD).

Description of the Alternative. The Big Creek Reservoir alternative involves constructing an earthen embankment dam roughly 1100 feet upstream of the Route 56 Bridge over Big Creek.

It would impound approximately 1575 million gallons (MG) at a normal pool elevation and inundate a surface area of roughly 306 acres. Figure X shows the drainage area (green line), normal pool, and nearby water treatment plant which would serve the proposed alternative. There are about 13,000 acres (i.e. over 20 square miles) draining to the proposed Big Creek Reservoir Dam. The majority of the watershed is rural, and predominantly forested.

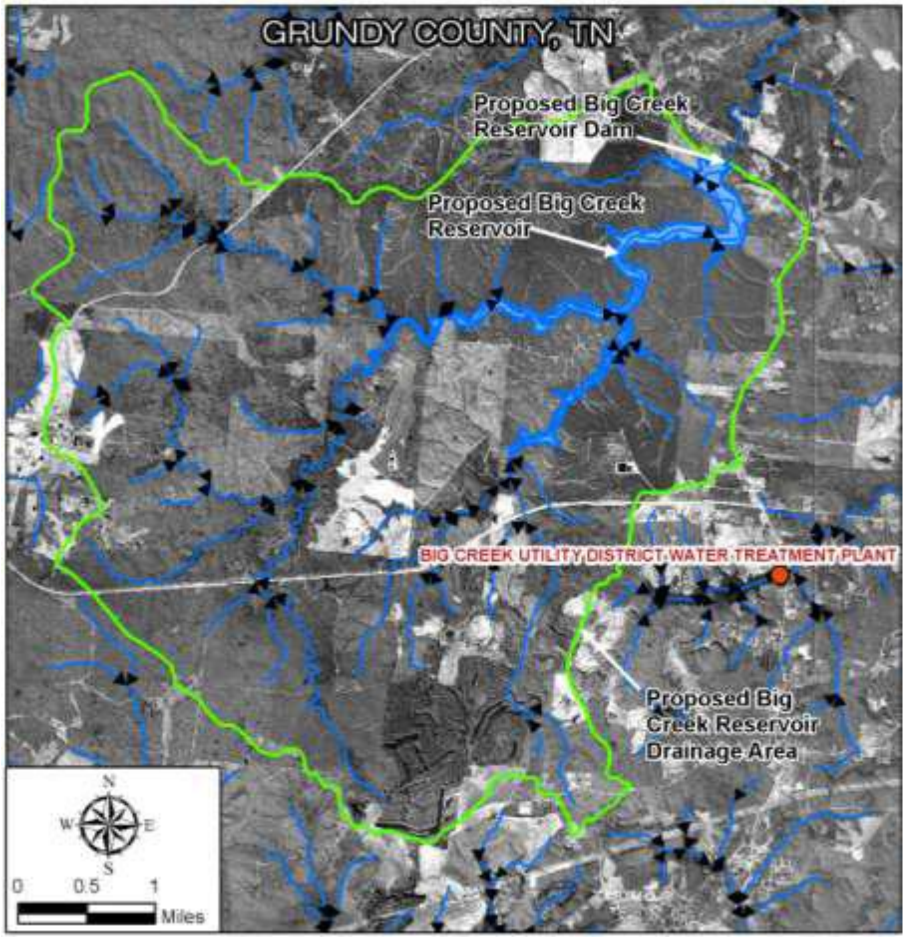


Figure X. Proposed Big Creek Reservoir drainage area map

Design of the Alternative. The proposed dam would have a concrete main spillway, an earthen auxiliary spillway, a hydraulic height of 60 feet, and a structural height of 80 feet. The reservoir's volume at normal pool elevation (1800 feet) is approximately 4,600 acre-feet. The dam would like be classified in the "hazard Potential Category1" (HPC1) because of the potential downstream impacts from a failure including Route 56, people and facilities in the Savage Gulf Natural Area, and private property. The top of the dam would be 25 feet wide and accessed from Old Route 56.

Additional design details can be found in Appendix X.

Raw Water Infrastructure, Lake Levels and Operation. The pump house and intake structure would be on top of the earthen embankment. The intake would have a vertical chamber that allows withdrawals at three levels to control downstream releases and manage water quality. Water from the reservoir would be pumped to the existing BCUD water treatment plant. This alternative does not include a new treatment plant even though one would be needed beyond the planning horizon. Alternatively, the transmission main could discharge raw water directly to Ranger Creek Reservoir, which is the current source for the BCUD water treatment plant. Figure X shows the proposed Big Creek Reservoir with a potential route for a pipeline to the BCUD water treatment plant or Ranger Creek Reservoir.

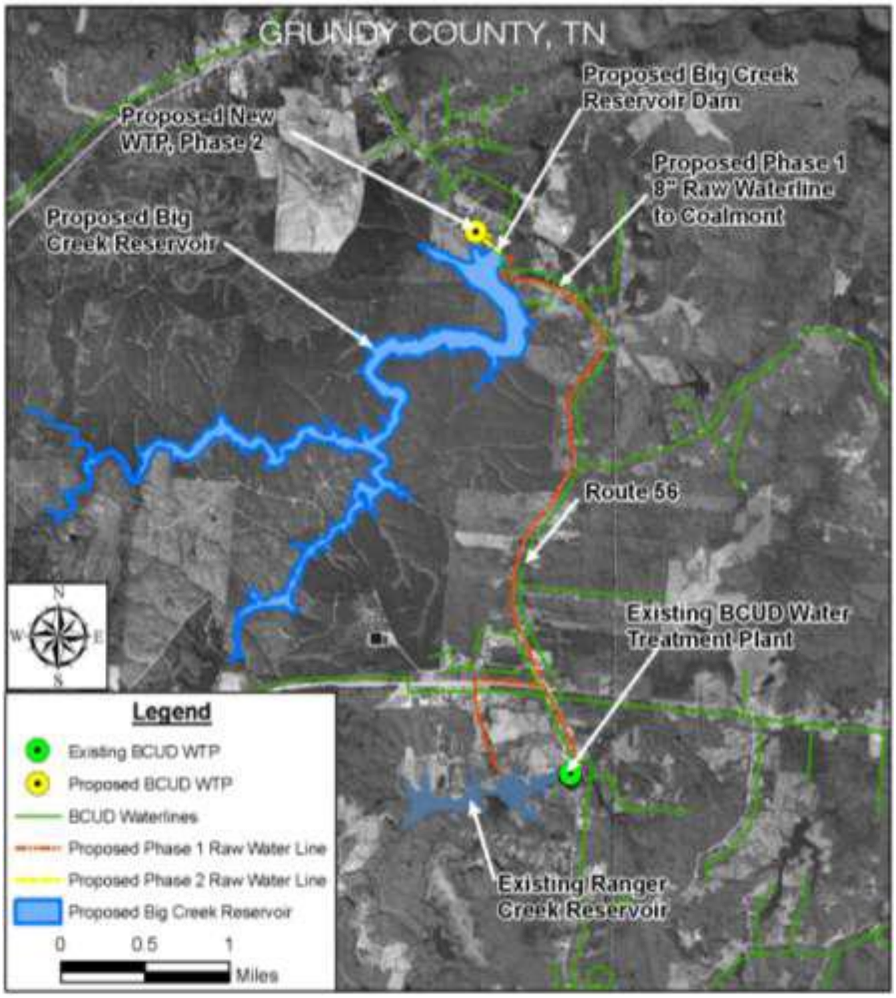


Figure X. Proposed Big Creek Reservoir, transmission main, and water treatment plant

Potential Costs. A breakdown of the quantities for the individual line items may be found in Appendix D. Total investment costs consist of the total present value of the first construction costs and the present value of the OMRR&R costs which include annual inspection and incidental repair and major replacement of one of the outlet tower gates, major servicing of the remaining gates at the midpoint of the design life and annual pumping electrical costs. The following table contains a summary of the major cost items for the Big Creek Reservoir. As shown in the table the total present value cost for the reservoir is $26.4 million including the present value of the OMRR&R cost.

Table X. Cost Summary for Proposed Big Creek Reservoir

Item	Cost
Mob/Demob	$ 624,635

Cofferdam - Phase I		$	791,793
Cofferdam - Phase II		$	334,838
Foundation Excavation and Grouting		$	1,478,502
Auxiliary Spillway		$	1,486,860
Earthen Embankment		$	2,159,698
Water Supply Intake Tower		$	256,817
Phase 1 - Intake to Big Creek Water Treatment Plant		$	1,347,955
Phase 2 - Intake to New Treatment Plant at Big Creek Reservoir		$	173,653
Outlet Structure		$	1,457,411
Access Road		$	63,620
Real Estate		$	1,830,000
Construction Subtotal		**$**	**12,005,782**
Contingency	25%	$	3,001,445
Supervision and Administration	10%	$	1,200,578
Planning Engineering and Design	10%	$	1,200,578
Total First Cost		**$**	**17,408,384**
Present Value OMRR&R Costs		$	3,022,757
Total Present Value		**$**	**20,431,141**

4.6.2 Ramsey Lake

This alternative involves purchase and conversion of an existing recreational lake into a water supply source. Ramsey Lake is in Grundy County, about 2.5 miles upstream of the confluence of Corn Branch and Cave Creek. It is in a sparsely populated area about two miles west of Coalmont and four miles north of Tracy City. At normal pool, the lake has a storage volume of about 185 MG (TARE, 1988) and a surface area of about 66 acres. Figure X shows Ramsey Lake's normal surface area and its watershed boundary (green line). There are about 900 acres draining to the lake. The contributing watershed is rural and much of it was strip-mined. Many of the mined areas have been rehabilitated. In 1960, Mr. George Ramsey constructed Ramsey's Dam, which impounds the lake. The earthen embankment dam has had no documented modifications since its initial construction and no original design plans are available. Currently, the lake is owned by the Ramsey family and used only for recreation.

On behalf of Big Creek Utility District, James C. Hailey and Company (JCH) investigated this water supply alternative. The intake structure proposed would operate only when water is flowing over Ramsey's spillway. A pipeline would transmit raw water from Ramsey to Ranger Creek Reservoir (also called Big Creek Lake), which is BCUD's raw water source. The design information and conceptual plans were presented in BCUD's *Application for Aquatic Resource Alteration Permit & State 401 Water Quality Permit: Water Harvesting and Source Capacity Drought Management* (BCUD, 2008a), which was submitted to TDEC to gain approval for the Ramsey Lake alternative.

Description of the Alternative. The alternative would include a floating dock intake and a raw water pipeline with a pump to transfer water to Ranger Creek Reservoir, about 3 miles away. The existing dam is a 560-foot long embankment with a 21-foot structural height, 16-foot hydraulic height, and a top elevation of 1879.5. The embankment has a 2.7H:1V upstream slope and a varied 2.7H:1V to 3.3H:1V downstream slope. The dam crest width varies from 20 to 90 feet, with the widest portions of the crest located at the abutments. A combined principal/emergency earthen spillway maintains the normal pool at elevation 1874.2, and routes flow exiting the lake through a natural channel to a confluence with the original stream channel of Corn Branch. Ramsey Lake is composed of two hydraulically connected pools. A roadway embankment separates the north end of the lake. It has an estimated storage volume of 569 acre-feet (185 MG). Using the lake for water supply would change its Safe Dam classification to HPC 1 because three residences and one country road downstream of the dam could be flooded if the dam broke. Upgrades to the dam including modification of the existing spillway to increase its safety and potentially the addition of a low flow outlet would be needed.

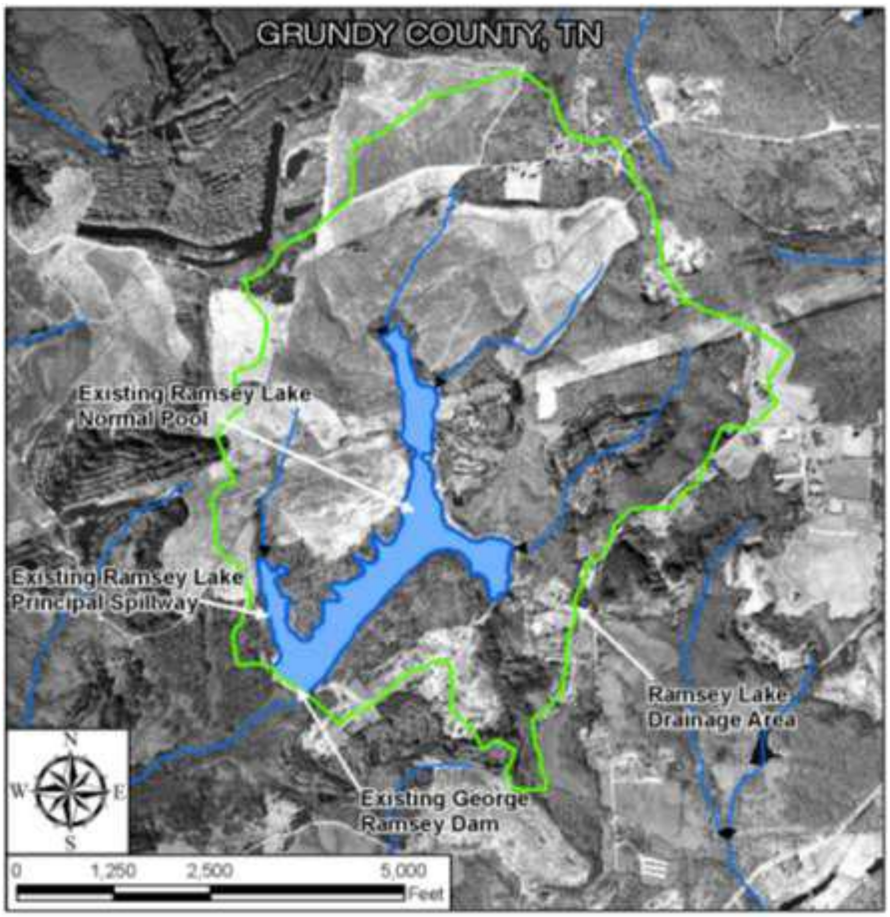


Figure X. Ramsey Lake drainage area map

Potential Costs. Total investment costs consist of the total present value of the first construction costs and the present value of the operations, maintenance, repair, replacement, and rehabilitation (OMRR&R) costs. The cost of electricity assumed a constant delivery of 1 MGD. The OMRR&R costs were estimated for the 50-year project life and the present value was calculated using an annual interest rate of 4.375%. OMRR&R costs for the water intake at Ramsey Lake include annual inspection and incidental repair, annual pumping power requirements, and the assumption that major replacement of the flexible pipe connecting the floating intake pump to shore and replacement of the intake pump occurring at 10- and 25-year intervals respectively. Costs include a water intake and pipeline. The cost to acquire Ramsey Lake was taken from a proposal by the current owners

(KJT Enterprises) of the lake and surrounding property. The proposed price for Ramsey Lake by KJT Enterprises was $4,680,000 and was received on April 25, 2010.

Standard construction methods would be used for construction of the water intake and pipeline for Ramsey Lake. Construction methods were not fully determined. The key elements of the pipeline route need further design and specification, specifically specific areas of concern are possible utility and road crossings. The following Table X contains a summary of the major cost items for the acquisition and construction of water intake and pipeline at Ramsey Lake. As shown in the table the total present value of the cost for the reservoir is about $9.6 million including the present value of the OMRR&R cost. This estimate does not include upgrades to the spillway required for dam safety.

Table X. Cost Summary for Proposed Ramsey Lake Purchase

Item		**Cost**	
Mob/Demob		$	64,382
Site Preparation		$	159,238
Floating Raw Water Intake Pump		$	158,966
Valve Pit		$	26,551
Pipeline to Ranger Creek Reservoir		$	1,071,640
Real Estate		$	4,680,000
Construction Subtotal		**$**	**6,160,776**
Contingency	25%	$	1,540,194
Supervision and Administration	10%	$	616,078
Planning Engineering and Design	10%	$	616,078
Total First Cost		**$**	**8,933,126**
Present Value OMRR&R Costs		$	667,372
Total Present Value		**$**	**9,600,498**

4.6.3 South Pittsburg Pipeline

This alternative, proposed by Grundy County, is to construct a pipeline to deliver treated water from South Pittsburg to Monteagle through roughly 26 miles of 16-inch diameter pipe, and distribute the water to other plateau utility districts through an additional 15 miles of 8-, 12-, or 16-inch pipe. The water would be withdrawn from the Tennessee River, and treated at South Pittsburg's water treatment plant. The alternative's preliminary design was developed by James C. Hailey & Company (JCH), who prepared a *Preliminary Engineering Report and Feasibility Study, Southern Cumberland Plateau: 2008 Permanent Water Source Project,* (JCH, 2008).

Description of the Alternative. Construction would occur in three phases and include new pipelines, storage tanks, and pumps. Phase 1 proposes building a pipeline from the end of South Pittsburg's distribution system to the Town of Monteagle, constructing a new water storage tank, building a new booster pump station and upgrading the existing South Pittsburg pumps to provide 0.6 MGD of treated water. Though not officially part of the Phase 1 tasks, JCH also notes that the South Pittsburg Board of Water Works plans to increase their water treatment's plant capacity from 2 MGD to 4 MGD. Phase 2 would involve upgrading and installing new water supply facilities to increase the pipeline's pumping capacity to 3.0 MGD.

Phase 3 would extend a network of smaller pipelines across the plateau from Monteagle to BCUD and TCPU. The distance between the City of South Pittsburg and Big Creek is approximately 40 miles with a 1300 to 1800 foot difference in elevation between the valley and the two distribution points on the plateau. Figure XX shows an overview of the proposed water transmission pipeline route.

Additional details and a description of the design are provided in Appendix X.

Figure X. South Pittsburg Pipeline alternative proposed route and phases

Potential Costs. While the initial construction cost estimate for the South Pittsburg Pipeline was developed by JCH, the operations, maintenance, repair, replacement, and rehabilitation (OMRR&R) costs for the pipeline were not. The OMRR&R costs for the South Pittsburg Pipeline are based on available information and a preliminary design of the pipeline. The costs represent the operation and maintenance costs associated with the alternative over an assumed 50-year project life. A breakdown of the line items for the OMRR&R cost estimate is found in Appendix D. Total investment costs consist of the total present value of the first construction costs and the present value of the OMRR&R costs. The cost of electricity was developed using assumptions on design head of the intake and booster pumps and assumed a constant delivery of 0.6 MGD for the first 5 years and 3 MDG thereafter as Phase 2 and 3 come online. The OMRR&R costs were estimated for the 50-year project life and the present value of the annualized OMRR&R cost was calculated using an annual interest rate of 4.375%.The construction of the South Pittsburg Pipeline consists of the following construction items over three phases:

Phase 1 – Construction of 0.6 MDG Transmission line

- Construct 95,500 ft of 16” transmission pipeline
- Misc road crossings
- Upgrading existing South Pittsburg pumping stations to 0.6 MGD capacity
- Construction of new booster pump station of 0.6 MGD capacity

Phase 2 - Upgrade to 3 MGD to Monteagle

- Construct 26,000 ft of 16” transmission pipeline
- Misc road crossings
- Upgrading existing South Pittsburg pumping stations to 3 MGD capacity
- Upgrade booster pump station to 3 MGD capacity

Phase 3 - Upgrade to 3 MGD to Tracy City and BCUD

- Construct 47,000 ft of 16” transmission pipeline
- Construct 27,000 ft of 12” transmission pipeline
- Construct 7,200 ft of 8” transmission pipeline
- Misc road crossings
- Construction of new booster pump station of 3 MGD capacity
- 2.0 MG Elevated Water Storage Tank

The following tables contain a summary of the major cost items for the South Pittsburg Pipeline as developed for the 2008 study updated to August 2010 price levels. Table XX shows the costs of all three phases, Table XXX shows the costs of Phases 1 and 2 and Table XXX shows the cost of only Phase 1. All three tables include the present value of the OMRR&R and the cost of electricity needed to pump the water from the river to the plateau.

Table XX – Estimated Costs of South Pittsburg Pipeline all Phases

	Feb-08	Aug-10
Item	**Cost**	**Cost**
Phase 1 - 0.6 MGD Transmission Line	$ 9,606,500	$ 9,874,568
Phase 2 - Upgrade to 3 MGD to Monteagle	$ 2,986,250	$ 3,069,581
Phase 3 - Upgrade to 3 MGD to Tracy City and BCUD	$ 8,548,058	$ 8,786,590
Total Construction Cost for Phases 1-3	**$ 21,140,808**	**$ 21,730,740**
Engineering Design	$ 1,074,900	$ 1,104,895
Inspection	$ 483,600	$ 497,095
Legal Services	$ 70,000	$ 71,953
Site Surveys, Permits and Fees	$ 75,000	$ 77,093
Appraisals	$ 15,000	$ 15,419
Acquisition	$ 90,000	$ 92,511
Administration	$ 105,000	$ 107,930
Project Contingencies	$ 1,749,443	$ 1,798,261
Total Estimated Project Cost	**$ 24,803,751**	**$ 25,495,897**
Present Value OMRR&R Costs		$ 58,188,437
Total Present Value		**$ 83,684,334**

Table XXX – Estimated Costs of the South Pittsburg Pipeline Phases 1 and 2

	Feb-08	Aug-10

Item		Cost		Cost
Phase 1 - 0.6 MGD Transmission Line		$ 9,606,500		$ 9,874,568
Phase 2 - Upgrade to 3 MGD to Monteagle		$ 2,986,250		$ 3,069,581
	0	**$ 12,592,750**		**$ 12,944,149**
8" Gate Valves		$ 644,900		$ 662,896
Steel Casing		$ 290,100		$ 298,195
Crushed Stone		$ 45,000		$ 46,256
Pavement Replacement		$ 50,000		$ 51,395
Class "B" Concrete		$ 10,000		$ 10,279
Telemetry & Controls		$ 60,000		$ 61,674
2.0 MG Elevated Water Storage Tank		$ 70,000		$ 71,953
Booster Pump Station & Meter Pits		$ 1,041,000		$ 1,070,049
Subtotal		**$ 14,803,750**		**$ 15,216,847**
Present Value OMRR&R Costs				$ 57,775,684
Total Present Value				**$ 72,992,531**

Table XXX – Estimated Cost of the South Pittsburg Pipeline Phase 1

		Feb-08	Aug-10
Item		**Cost**	**Cost**
Phase 1 - 0.6 MGD Transmission Line		$ 9,606,500	$ 9,874,568
	0	**$ 9,606,500**	**$ 9,874,568**
Engineering Design		$ 483,200	$ 496,684
Inspection		$ 217,400	$ 223,467
Legal Services		$ 25,000	$ 25,698
Site Surveys, Permits and Fees		$ 25,000	$ 25,698
Appraisals		$ 5,000	$ 5,140
Acquisition		$ 30,000	$ 30,837
Administration		$ 35,000	$ 35,977
Project Contingencies		$ 772,900	$ 794,468
Total Estimated Project Cost		**$ 11,200,000**	**$ 11,512,535**
Present Value OMRR&R Costs			$ 13,574,037
Total Present Value			**$ 25,086,571**

Chapter 5. Evaluation and Selection of Alternatives

5.1 Overview

A thorough evaluation of the alternatives to provide additional water to the Southern Cumberland Plateau was completed. A 2 tier evaluation was conducted on the alternatives discussed in chapter 4. Three alternatives were advanced for Tier 2 screening including raising Big Fiery Gizzard Dam and modifying its release schedule, conversion of Lake Ramsey to water supply and a pipeline to the Tennessee River at South Pittsburg. Any of these final three alternatives could provide the 0.6 MGD necessary for a reliable water supply in the entire region. However, the costs of each vary. Raising Big Fiery Gizzard Dam along with modification of downstream releases was selected as the recommended plan for several reasons. It is the least costly plan and provides more than enough water for the region. One unknown exists that could change that recommendation. A detailed study of what the new downstream release requirements should be is needed. That is the ultimate key to whether this alternative can meet the capacity requirements at the estimated costs.

Introduction

Background

Before evaluating alternatives to increase the supply of water, conservation measures to reduce water demand were considered. The Southern Cumberland Plateau can reduce the demand for water both everyday and during times of drought. As discussed in Chapter 2, each utility was interviewed regarding existing and potential conservation measures. Potential measures are generically discussed in Chapter 4. Since most conservation measures have only been used in Tennessee during times of drought or other emergency situations, the alternative analyses below assume they would be in place only during specific drought emergencies. The addition of any of the conservation measures could postpone some of the need for additional water, but would not eliminate the need itself.

In the Southern Cumberland Plateau region, most utilities have programs to reduce water loss, but could benefit from upgrading monitoring of all types of water usage (including flushing and fire usage), and can improve leak detection. Surveys, and eventually, real-time leak monitoring could significantly reduce the total water lost to leakage. Many of the utilities expressed interest in reducing their leakage rates.

Direct public outreach activities such as teaching short lessons at schools, community centers, and public events could improve water conservation in the region. The utility districts suggest that at least some of their users are aware of the importance of and methods for conserving water in their homes and businesses. However, as the memory of drought recedes, educational programs help remind users of the importance of conservation.

Specific audits of large water users can also help manage demand. Some of the utilities have large water users and there is a potential to reduce the demand through specific audits.

On a non-emergency basis, plumbing codes could specify that new fixtures meet specific efficiency rules. New water conservation codes or ordinances for new construction could help reduce rate of growth of water use even as population increases.

In general, the water utility managers interviewed in the region were open to considering almost any type of conservation program if it could be described in enough detail, could be demonstrated as effective in reducing water usage, and does not have a high implementation cost. The managers said they would be more inclined to implement programs if an external funding source were found to cover large portions of the initial implementation cost. Leakage reduction was a stated goal of all of the utility districts, and the utilities are likely to begin investigating a wider range of options for leak detection.

Due to high degree of interconnectivity between the various utility districts, it makes sense for utilities to pursue coordinated conservation programs. While infrastructure is managed independently, utilities may benefit from economies of scale in purchasing sensing equipment or contracting services such as leak detection. For public outreach and demand management programs, combining efforts could make more effective use of limited resources.

Why This Topic Matters

Only through a thorough examination and comparison of alternatives can the selection of the best alternative be made. A true comparison requires that each alternative is measured against the same criteria and that the criteria are appropriate. The Technical Working Group (TWoG) developed the criteria discussed below based largely on that used by the Duck River Agency in its regional water supply study. The criteria were thoroughly vetted during the Duck River process and the TWoG agreed that consideration of these factors was essential in making any recommendation. It is important to know how an alternative meets the goals of a study, expressed here in terms of reliable capacity. It is also important to be able to compare costs, discuss issues that affect implementability (any known obstacles or challenges), and discuss and compare the flexibility (phased implementation, drought resistance, and adaptability to changed conditions) of the alternatives.

A two tier process was used to compare all the alternatives. As presented in Chapter 4, the suite of alternatives included modification of Big Fiery Gizzard Reservoir, a new reservoir on Big Creek, purchase of Ramsey Lake and converting it to water supply, and a pipeline from South Pittsburg to Monteagle. The following sections describe how the evaluation factors were estimated for the alternatives presented in Chapter 4. Some of the evaluations, specifically the scenario modeling, included several variations of alternatives which helped to optimize individual alternatives and reduce the number of alternatives fully evaluated. If a measure or alternative did not pass one of the early screening criteria, it was not analyzed in further detail.

5.2 Evaluation Factors for Alternatives

5.3.1. Reliable Capacity and OASIS Modeling

If an alternative can be shown to meet the projected need for the period of analysis (2030) with minimal risk, or within some specified risk tolerance, it is considered to have reliable capacity. Capacities for this study were developed using the Operational Analysis and Simulation of Integrated Systems (OASIS) model. Models are useful to decision makers because they provide a framework within which scenarios can be represented and analyzed in a consistent and comparable manor. Data and assumptions can be developed and manipulated for evaluation. OASIS is a data driven, generalized program for modeling the operations of water resources systems. It allows specification of the features and operating rules of a system using nodes and arcs to simulate the routing of water through it. It uses a map-based schematic that includes nodes for withdrawals, discharges (municipal and industrial), reservoirs, and inflows. This generalized, mass balance model can assess the impacts of different water policies and facilities over the historic record of rainfall and inflows, from a source water perspective. It works on a daily basis and can be used for both drought management and capital expansion planning. It is not intended for the explicit modeling of distribution systems, hydraulic routing, or flood management, although it can be linked to other models for those purposes.

The capacity analysis and OASIS model for the alternatives required data from several sources including rainfall and runoff for the period being analyzed, the firm yield of existing sources, reservoir storage and yield curves, monthly peak demand, inflow data, minimum stream flow requirements, and other factors. Uncertainty, however, is associated with each data input into the model and every model introduces other potential sources of error.

Uncertainty. One major uncertainty is in the assumption that historic hydrologic conditions will be representative of the future. Just because a rainfall pattern occurred over the last 50 years does not guarantee it will occur over the next 50 years. Many things such as climate variability, the occurrence of droughts more severe than those in the period of record, the distance between where rainfall is measured and the location being modeled or simply poor record keeping introduce uncertainty. There could be errors in the inflow data used in the models for this study. The potential errors are magnified for small streams like those of the Southern Cumberland Plateau. The precipitation data for this study was developed using historical rainfall records and rainfall-runoff models. To account for uncertainty, the reliable capacity of a reservoir alternative was defined such that a 20% reserve of usable storage was maintained in each reservoir in the system, for all years of the hydrologic record. This insured that a system would not totally deplete this resource in the event of an occurrence of a drought more severe than any historical drought. It also accounts for inaccuracy in the historical rainfall records and other data.

Secondly, drought plans were included in some of the modeled scenarios. The plans are intended to reduce demands by a percentage during a drought and help reduce the risk of running out of water. Drought plans can be used in times of severe drought and to accommodate or account for uncertainty. A criterion was established for the OASIS modeling that an acceptable scenario or alternative would not trigger a drought plan more frequently than once every 7-8 years.

Firm Yield Estimates. Firm yield estimates for the proposed water supply alternatives presented in Chapter 4 were developed in the same manner as for the existing sources (Reference Chapter 2, Section ??). Inflow sequences to the reservoirs were generated using the Hydrologic Engineering Center's Hydrologic Modeling System (HEC-HMS), run with a daily time-step, and were parameterized and calibrated in much the same way as the models created for existing sources. Model calibration was focused on outflows, because the reservoirs would need to provide minimum releases to sustain instream flow requirements. Data developed during the firm yield studies including inflow sequences, evaporation estimates, stage-storage curves for the reservoirs, and minimum stream flow requirements were used in the OASIS evaluation of reliable capacity.

Instream Flow Requirements. To meet environmental objectives and obtain permits for construction, new dams in Tennessee would have to release a certain minimum flow to protect downstream aquatic life. The amount of flow required is site specific and depends on the type of aquatic habitat and downstream channel characteristics such as the cross section shape, bed material, and slope. In the absence of this type of site-specific information, a general picture of potential flow requirements was gained for each alternative by calculating minimum releases resulting from application of a range of instream flow criteria developed by the USGS. These criteria, developed through analysis of low flow gage records across Tennessee, represent a range of minimum flows (discharge per square mile of watershed) suitable to sustain aquatic life. The instream flow criteria considered were 0.05, 0.1, and 0.2 cubic feet per second (cfs) per square mile.

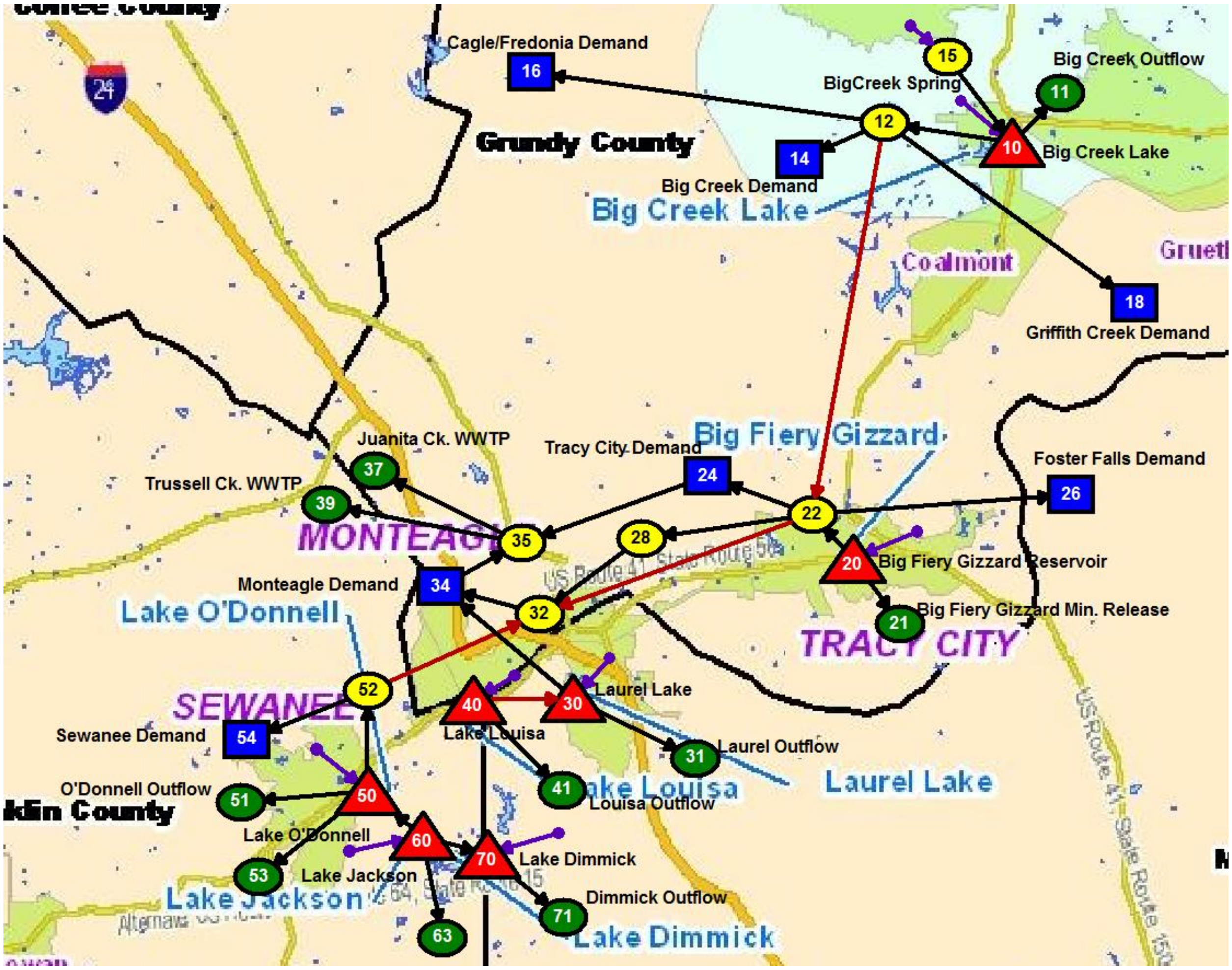
OASIS Schematic. Figure XXX displays the model schematics for the Southern Cumberland Plateau Region. It has various nodes and arcs to represent the systems. The red triangles represent storage nodes (reservoirs and lakes), the blue squares represent demand nodes, the yellow circles represent junction nodes where water is conveyed from one point to another, and the green circles represent terminal nodes where water is leaving the study area. Water conveyance is shown by arcs with the arrow indicating the direction of the flow; black lines represent normal flows and transfers, while red lines represent “emergency” transfers.

Municipal demand nodes use an annual average demand subject to a monthly pattern. This modeling focused on using projected 2030 annual average daily demand levels provided by the USGS. The monthly demand peaking factors computed as the average of recent years, also was provided by USGS. Further information on demand data can be found in Section XX.XX. The models use inflow data sets that extend from January 1, 1928 through July 31, 2009. These data sets were developed by the Army Corps of Engineers using a rainfall-runoff model as discussed in Section XXX. This data included all the inflow and net evaporation (evaporation less precipitation) data. Physical inputs to the models, such as reservoir storage and rule curves, were developed during the Corps firm yield analysis.

Model operations are achieved using two methods. The first, weighting, is a method of assigning relative value to each unit of water in the model, so the model can prioritize between competing uses. The node with the higher weight would be the first to receive available water; for example a utility’s demand node would be weighted higher than the usable storage in that utility’s reservoir node, which allows water to be withdrawn from the reservoir to meet demand needs.

More complex operations, such as the operation of utilities with multiple reservoirs, or for trigger based transfers, are modeled using operations control language (OCL). The OCL is specific to each region and to each scenario, and can be modified by the users as needed.

The figure below shows the model schematic for the Southern Cumberland Plateau study area.



Existing Conditions

The existing conditions scenario represents current operations. Each utility withdraws water from its primary source(s) of water. Normal transfers are allowed in this scenario, and include the sales from Big Creek to Cagle/Fredonia and Griffith Creek, and from Tracy City to Foster Falls and Monteagle. Sewanee withdraws water from Lake O'Donnell; when O'Donnell is drawn down four feet below the normal pool, pumping from Lake Jackson begins. Lake Dimmick is only used as an emergency source, and only the top two feet are available by contract. Considerations of leakage from Lake Jackson are also incorporated into the model. Monteagle withdraws water from its primary source, Laurel Lake, and pumps water from Lake Louisa (only the top two feet, by contract) when there is not enough water in Laurel to meet needs. They also purchase 50,000 GPD from Tracy City. Tracy City and Big Creek withdraw all of their water Big Fiery Gizzard Reservoir and Big Creek Lake, respectively. Under the existing conditions scenario, sufficient water was not available throughout the period of record for the entire system. As shown, in Table XXX, all the sources fell below the reliable capacity criteria at least once for the period of record. Monteagle fell below every 3 years and Tracy City every 16 years.

Table XXX – Reliable Capacity of Existing Sources

Utility	Reliable Capacity Below 20%	Max # days below 20%	Min. Storage

Big Creek	80 yrs	53	15 MG, 6%
Tracy City	16 yrs	47	21 MG, 11%
Monteagle	3 yrs	140	0 MG, 0%
Sewanee	80 yrs	22	25 MG, 16%

Existing with Local Drought Plans

The first scenario modeled was implementing local drought plans, based on the storage in each utility's system, which would offset demand when certain triggers are met. The Stage 1 / Stage 2 drought trigger levels used for each utility are as follows; Sewanee – 70%/40%, Monteagle – 70%/40%, Tracy City – 70%/40%, Big Creek – 55%/40%. For all utilities, demand reductions of 10% and 20% were assumed for Stage 1 and 2 drought restrictions, respectively. Table XX shows that even with the existing drought restrictions in-place, sufficient water was not available throughout the period of record. Big Creek and Sewanee never fell below the minimum storage. Tracy City would fall below about every 40 years and Monteagle would fall about every 4 years. Both would be under drought restrictions every year for a maximum of at least 244 days.

Table XXX – Reliable Capacity of Existing Sources with Drought Plans

Utility	Reliable Capacity Below 20%	Max # days below 20%	Min. Storage	Drought restrictions once every	Max # days in restrictions
Big Creek	Never	Never	52 MG, 20%	9 yrs	398
Tracy City	40 yrs	24	33 MG, 16%	~1 yr	258
Monteagle	4 yrs	121	0 MG, 0%	~1 yrs	244
Sewanee	Never	Never	36 MG, 23%	7 yrs	457

Existing with Local Drought Plans and Transfers

This scenario allows transfers to be made between the utilities in the region during drought events. The transfers are triggered by the storage levels in the purchasing utilities own system. In this scenario, the additional transfers needed would be from Tracy City to Monteagle, and from Big Creek to Tracy City. Transfers are triggered to Monteagle when their usable storage drops below 80%, and to Tracy City when their usable storage drops below 70%. The amount of the transfer assumed is equal to 55% of the purchasing utility's total demand. The same drought plan trigger levels and demand reductions mentioned above are also used in this scenario. Table XX shows that even with transfers Monteagle falls below the storage reserve about every 5 years and the transfers cause both Big Creek and Sewanee's drought tolerance to be significantly reduced. Only Tracy City's reliable capacity is increased. All the utilities would enact drought restrictions every 1 to 4 years. Transfers would occur about every 2 years from Sewanee to Monteagle and from Tracy City to Monteagle. They would occur about annually from Big Creek to Tracy City.

Table XXX – Reliable Capacity of Existing Sources with Drought Plans and Transfers

Utility	Reliable Capacity Below 20%	Max # days below 20%	Min. Storage	Drought restrictions once every	Max # days in restrictions

Big Creek	40 yrs	63	28 MG, 11%	4 yrs	474
Tracy City	80 yrs	20	26 MG, 13%	1.6 yrs	254
Monteagle	5 yrs	90	0 MG, 0%	1.3 yrs	206
Sewanee	9 yrs	110	6.6 MG, 4%	1.5 yrs	533

Transfer	# Transfer events once every	Avg/Max # days with transfers	Avg/Max amount transferred (MGD)
Sewanee to Monteagle	2 years	55/115	0.4 / 0.5
Tracy City to Monteagle	1.6 years	13/94	0.3 / 0.5
Big Creek to Tracy City	<1 years	15/153	0.6 / 1.3

5.3.2 Reliable Capacity of Alternatives

Regionalization. The regionalization scenario also involves drought plans and transfers; however instead of each utility having drought triggers based on their own system's usable storage, the triggers are regional and based on the total usable storage in the region. This scenario helps spread the risk during a drought to the entire region, and helps reduce the frequency of enacting demand restrictions for systems that are more frequently drawn down. The regional storage triggers used for Stage 1 and Stage 2 drought restrictions were 50% and 40%, respectively, with corresponding 10% and 20% reductions in demands. The triggers for transfers are the same as in the previously mentioned scenario. Table XX shows that placing the entire region under drought restrictions when one system is experiencing a water shortage does extend the regional supply of water. Drought restrictions would be required every 3 years for a maximum of 201 days for each system. This is more frequently than 7 year target. In addition, Monteagle would still be below the minimum reserve targets every 4 years and Tracy City would be below every 20 years. Transfers would occur about every 2 years from Sewanee to Monteagle and from Tracy City to Monteagle. They would occur annually from Big Creek to Tracy City. Because this alternative enacts restriction every 3 years it does not meet the reliable capacity objective for the system and was not evaluated further.

Table XXX – Reliable Capacity of Regionalization Alternative

Utility	Reliable Capacity Below 20%	Max # days below 20%	Min. Storage	Drought restrictions once every	Max # days in restrictions
Big Creek	Never	Never	61 MG, 23%	3 yrs	201
Tracy City	20 yrs	20	26 MG, 13%	3 yrs	201
Monteagle	4 yrs	140	0 MG, 0%	3 yrs	201
Sewanee	80 yrs	9	29 MG, 19%	3 yrs	201
Regional Total	80 yrs	22	117 MG, 16%	3 yrs	201

Transfer	# Transfer events once every	Avg/Max # days with transfers	Avg/Max amount transferred (MGD)

Sewanee to Monteagle	2 years	55/115	0.4 / 0.5
Tracy City to Monteagle	1.6 years	13/94	0.3 / 0.5
Big Creek to Tracy City	<1 years	15/153	0.6 / 1.3

Modification of Big Fiery Gizzard Dam and Reservoir. Raising the existing Big Fiery Gizzard Dam in Tracy City by 7 feet has been permitted. Two versions of this scenario were modeled; one using the existing outflow structures to make the required minimum release (Table XXX), and one using the proposed modified outflow structures that would reduce the maximum amount of the release, but allow the reservoir to release water longer into a drought (Table XXX). Both versions of this alternative were modeled using the local drought plan (transfer trigger levels of 40% and 30% for Stage 1 and 2 drought restrictions, respectively) and the regionalization scenarios (trigger levels were 50% and 40% for Stage 1 and 2 drought restrictions, respectively). Without modifying the outflow structure, only Tracy City would fall below the 20% reserve criterion. Drought restrictions were required for Sewanee and Monteagle every 7 years. Big Creek was under drought restrictions every 9 years. Modifying the release structure and protocol improved drought resistance. None of the utilities fell below the reserve, Sewanee and Monteagle enacted drought restrictions every 7 years. Tracy City would need to restrict use every 8 years and Big Creek every 9 years. Under either scenario, transfers would occur more often than annually from Tracy City to Monteagle.

Table XXX – Reliable Capacity of Modification of Big Fiery Gizzard Dam with No Outflow Changes

Utility	Reliable Capacity Below 20%	Max # days below 20%	Min. Storage	Drought restrictions once every	Max # days in restrictions
Big Creek	Never	Never	52 MG, 20%	9 yrs	398
Tracy City	20	68	34 MG, 9.2%	3 yrs	494
Monteagle	Never	Never	21 MG, 23%	7 yrs	165
Sewanee	Never	Never	36 MG, 23%	7 yrs	457

Transfer	# Transfer events once every	Avg/Max # days with transfers	Avg/Max amount transferred (MGD)
Tracy City to Monteagle	<1 years	88/237	0.25 / 0.27

Table XXX – Reliable Capacity of Modification of Big Fiery Gizzard Dam Outflow Changes

Utility	Reliable Capacity Below 20%	Max # days below 20%	Min. Storage	Drought restrictions once every	Max # days in restrictions
Big Creek	Never	Never	52 MG, 20%	9 yrs	398
Tracy City	Never	Never	75 MG, 20%	8 yrs	439
Monteagle	Never	Never	21 MG, 23%	7 yrs	165
Sewanee	Never	Never	36 MG, 23%	7 yrs	457

Transfer	# Transfer events once every	Avg/Max # days with transfers	Avg/Max amount transferred (MGD)
Tracy City to Monteagle	<1 years	88/237	0.25 / 0.27

Big Creek Reservoir. In this scenario the water would be withdrawn into Big Creek's treatment system, and then transferred down to Tracy City and Monteagle as needed.

Table XXX – Reliable Capacity of Big Creek Reservoir

Utility	Reliable Capacity Below 20%	Max # days below 20%	Min. Storage
Big Creek Lake (Proposed)	Never	Never	1454 MG, 82%

Purchase of Ramsey Lake. Converting Ramsey Lake into a water supply source was modeled with water withdrawn from the lake and pumped to the existing Big Creek Lake, where it can be withdrawn by Big Creek Utility District, treated, and transferred down to Tracy City and Monteagle as needed. This alternative was modeled using both the local drought plan with transfer scenarios (trigger levels were 40% and 30% for Stage 1 and 2 drought restrictions, respectively) and the regionalization scenarios (trigger levels were 48% and 40% for Stage 1 and 2 drought restrictions, respectively). Table XXX shows purchasing and converting Ramsey Lake would provide reliable capacity for all utility districts. Big Creek would only be under drought restrictions every 40 years and Tracy City, Monteagle and Sewanee would likely face drought restrictions every 7 years. Transfers would occur every year from Tracy City to Monteagle and from Big Creek to Monteagle.

Table XXX – Reliable Capacity of Modification Purchase of Ramsey Lake

Utility	Reliable Capacity Below 20%	Max # days below 20%	Min. Storage	Drought restrictions once every	Max # days in restrictions
Big Creek/Ramsey	Never	Never	141 MG, 31%	40 yrs	99
Tracy City	Never	Never	57 MG , 29%	7 yrs	143
Monteagle	Never	Never	21 MG, 23%	7 yrs	165
Sewanee	Never	Never	36 MG, 23%	7 yrs	457

Transfer	# Transfer events once every	Avg/Max # days with transfers	Avg/Max amount transferred (MGD)
Tracy City to Monteagle	<1 years	88/236	0.25 / 0.27
Big Creek to Tracy City	<1 years	84/236	0.44 / 0.53

Purchase of Ramsey Lake and Raising of Big Fiery Gizzard Dam. In addition to modeling the Ramsey Lake and Raised Big Fiery Gizzard dam alternatives separately, scenarios were developed that combined the two alternatives. This would create additional storage to meet future demands, and reduce the reliance on transferring water down from Big Creek when compared to purchasing Ramsey alone. This alternative was modeled using both the local drought plan with transfers and the regionalization scenarios, with the same trigger levels as in the Ramsey scenario. Table XXX shows the combination makes little improvement on the reliable capacity because Ramsey Lake alone met the criteria. Even transfers and the frequency of drought restrictions does not change.

Table XXX – Reliable Capacity of Modification Purchase of Ramsey Lake Combined with Raising Big Fiery Gizzard Dam

Utility	Reliable Capacity Below 20%	Max # days below 20%	Min. Storage	Drought restrictions once every	Max # days in restrictions
Big Creek/Ramsey	Never	Never	176 MG, 39%	40 yrs	65
Tracy City	Never	Never	79 MG, 22%	7 yrs	454*
Monteagle	Never	Never	21 MG, 23%	7 yrs	164
Sewanee	Never	Never	36 MG, 23%	7 yrs	457

Transfer	# Transfer events once every	Avg/Max # days with transfers	Avg/Max amount transferred (MGD)
Tracy City to Monteagle	<1 years	88/236	0.25 / 0.27
Big Creek to Tracy City	<1 years	84/236	0.44 / 0.53

Results

Table XXX summarizes the modeled scenarios by showing whether they meet one or both of the previously mentioned reliability criteria: that a 20% reserve of usable storage must be maintained in each reservoir in the system, for all years of the hydrologic record and a drought plan would not be triggered more frequently than once every 7-8 years. The scenarios that meet the reliability objectives are the purchase of Ramsey Lake, the raising of Big Fiery Dam with a modification of the minimum release, the two alternatives combined, and the impoundment of new reservoir on Big Creek. Note that these criteria only indicate whether the scenario is viable from a source water perspective. For scenarios involving transfers, further analysis was also done to assess the hydraulic needs and costs of those scenarios, factoring in considerations such as peak-day and peak-week demands.

Table XXX Oasis Capacity Results

Scenario	Meets storage objective?	Meets frequency objective?
Existing	No	n/a

Proposed local drought plans	No	No
Proposed local drought plans & transfers	Yes	No
Regionalization	Yes	No
Ramsey Lake, proposed drought plans & transfers	Yes	Yes
Ramsey Lake, regional operation	Yes	Yes
Raised Big Fiery Gizzard, proposed drought plans & transfers	No	No
Raised Big Fiery Gizzard, regional operation	No	No
Raised Big Fiery Gizzard, proposed drought plans & transfers, modified minimum release	No	No
Raised Big Fiery Gizzard, regional operation, modified minimum release	No	No
Raised Big Fiery Gizzard + Ramsey Lake, proposed drought plans & transfers	Yes	Yes
Raised Big Fiery Gizzard + Ramsey Lake, regional operation	Yes	Yes
New Big Creek Reservoir	Yes	n/a

*Alternatives shaded in red were not carried forward for further evaluation while those shaded in green were carried forward for further evaluation.

5.3.3. Implementability

The implementability of an alternative is a measure of the relative ease of accomplishing the proposed improvements in time to meet projected demands. This criterion considers the degree to which regulatory permitting (including environmental considerations), public acceptance, property acquisition, or constructability issues could delay implementation of the measure or project. .

Permitting is a large part of implementability. Tennessee dams are regulated by the Division of Water Supply's Safe Dam Program, which is responsible for conducting certifications, inspections and approvals. Issuance of the following permits/documents may be required for any of the alternatives.

- Aquatic Resource Allocation Permit for reservoir alteration through TDEC
- Section 401 Water Quality Certification through USACE
- Safe Dams Section (SDS) of the Division of Water Supply through TDEC
- Storm Water Runoff Permit from the Division of Water Pollution Control through TDEC Section 404 Permit and/or TVA Section 26-A Permit through USACE or TVA
- Inter-basin Transfer Permit from TDEC Division of Water Pollution Control

Regionalization

Although regionalization alone is not sufficient to reliably meet the projected need for the region, many of the other proposed alternatives will require improvements to interconnections and greater cooperation and coordination between the utilities of the region. There are no outstanding implementability concerns with installing new pumps, or constructing the additional storage tanks that may be needed to facilitate increased transfer of water between utilities. Structure, roadway, land, and environmental impacts associated with those activities would be consistent with infrastructure improvements that are normally conducted on a routine basis.

Implementability concerns could be associated with the need for greater cooperation and coordination between utilities. While not great, these concerns relate to agreeing on equitable ways to share risk and fairly negotiate terms of contracts for water sales, among other things. These concerns are not unique to the implementation of any of the alternatives proposed for the region however. They must be addressed and overcome by the utilities, as they maintain and improve their ability to share water which is paramount to meeting demand during droughts. The small drainage areas of the South Cumberland Plateau's water sources leaves them particularly vulnerable to drought.

Modification of Big Fiery Gizzard Dam and Reservoir

About 37 acres would be impacted by raising the dam. The majority (i.e. 19.6 acres) has a "public" land use designation, while the remainder is a mix of residential, timber tract, vacant, and road/right of way land use. Two structures, a private residence and storage shed, would be impacted. The larger lake would affect approximately 200 feet of Brown Road and 310 feet of Orchard Drive which includes a 6-in TCPU water pipe.

An ARAP permit has been granted for the proposed dam alteration without modifying downstream releases. The watershed has two significant tributaries, Big Fiery Gizzard Creek and Meeks Branch, and two smaller, unnamed tributaries that drain to the lake. Despite the impairment of the Big Fiery Gizzard Creek due to the dams, the creek is classified as an Outstanding National Resource Water (ONRW) as it flows into the Grundy Forest State Natural Area. For the ARAP permit, 3,018 feet of stream were assessed with1,044 feet classified as "Fully Supporting" and 1,974 feet classified as "Not Supporting" (i.e., 303d classified streams).

The effects of the proposed alternative on downstream flows will be largely mitigated by downstream release requirements of either the existing 1cfs release requirements or some modified release schedule. As discussed previously, modifying the release schedule of a raised Big Fiery Gizzard Dam could improve the reliable capacity of the dam such that each utility in the area never falls below the 20% reserve criterion. A modified release requirement can also reduce the frequency of drought restrictions for Tracy City to within the required parameters. Additional studies, however, would be needed to determine whether the modified release schedule modeled in this study would meet permit requirements.

Modification of Big Fiery Gizzard Dam and Reservoir with Modified Release Schedule
Implementability concerns are mostly due to potential downstream impacts. A study is required to more definitively evaluate existing downstream conditions and the potential impacts of changes to the current release schedule. The release schedule included in OASIS model for this alternative may or may not be the final requirement. Additional study may also lead to a change in the existing release requirement which was set without a detailed study of the potential impacts to the Outstanding National Resource Water downstream. Currently, a constant release of 1 cfs is required. However, releases from the existing outlet are dependent upon the elevation of the lake. In other words, the higher the lake the more water is released from the outlet.

Big Creek Reservoir
The proposed lake would cover about 306 acres at normal pool elevation. The area is mostly rural with a mix of wooded and farm use and about 16 acres of vacant residential land. Two unnamed bridges, about 200 feet of Old Highway 56, as well as 500 feet of unnamed farm road, would be inundated or affected. About 200 feet of a BCUD 6-inch waterline would also be inundated. Eagle Lake, southwest of the dam, could be affected. At normal pool, the proposed reservoir nearly extends to the Eagle Lake dam. Large storm events could cause Big Creek Reservoir to reach the downstream face of Eagle Lake dam. This potential impact requires further investigation. Two residential structures downstream of the auxiliary spillway would be affected by dam construction. Furthermore, property impacts would increase for the maximum proposed pool inundation (1820).

About 45,457 feet of stream would be newly inundated. About 7,707 feet are classified as “Fully Supporting” with none classified as “Not Supporting” or “Not Assessed” in the entire watershed. Big Creek is not classified as an Outstanding National Resource Water (ONRW) within the reservoir watershed. Therefore the newly inundated area would not affect any High Quality Waters. About 1.5 miles downstream of the proposed dam, Big Creek enters Savage Gulf and South Cumberland State Park. Within the park boundary, Big Creek is classified as an ONRW. Thus, the potential downstream impacts of the Big Creek Dam must be thoroughly investigated. A detailed study would be needed to develop potential minimum flow releases. The impacts of these potential releases on the reliable capacity are not known. No ARAP application has been received by TDEC.

Ramsey Lake
The existing lake covers 66 acres at normal pool elevation. There are no changes proposed to the height of the dam (i.e. pool elevations) and there would be no new inundation impact. However, the spillway would require modification to meet safe dam criteria. The proposed intake structure would require a permanent valve pit affecting a small portion of vacant land. The 15,100 foot long pipeline would cross 14 unique parcels of land with varied use, including six residential parcels and four roads, most notably crossing Lockhart Town Drive at two locations. Big Creek Utility District’s water treatment processes may require modification because Ramsey Lake’s water quality would be different than the existing supply. Ramsey Lake’s designated uses would change to water supply

and recreation would not likely be allowed. Upgrades to the embankment and spillway would also be needed to meet the added dam safety requirements of a water supply dam.

An ARAP has been pursued for the preliminary design. The proposed pipeline alignment crosses a redline basin boundary (from the Tennessee Western Valley River Basin to the Upper Cumberland River Basin), so an inter-basin transfer permit is may be required.

One wetland could be impacted during times of significant withdrawal and drawdown. Ranger Creek Reservoir, Big Creek Utility District's existing water source, would be affected by the downstream discharge of water. These impacts may be beneficial. Construction of the pipeline to the existing water treatment plan would have additional impacts. The pipeline crosses two streams: one a minor tributary of Ramsey Lake, and the other Ranger Creek upstream of Ranger Creek Reservoir. These streams could be affected during pipeline construction, and a construction permit may be required for the temporary impact. Properly constructed, the pipeline should have virtually no long-term impact on these streams.

The water quality impacts of mixing the existing Ranger Creek Reservoir raw water and Ramsey Lake raw water are unknown and would vary with the pumping frequency throughout the year. Water quality analysis, completed for the BCUD ARAP, documented high levels of Manganese and other metals due to former mining activities in the Ramsey Lake watershed. This is further supported by a water quality survey performed by TDEC and included in Appendix XXX. Differences in chemistry of the water supplies could cause taste changes and potentially lower potable water quality. BCUD may need to alter treatment processes periodically to account for the varying quality of Ramsey Lake water.

Downstream environmental impacts should be evaluated further as operating rules for the alternative are developed. The BCUD ARAP application (BCUD, 2008a) states that withdrawal would occur only when Ramsey Lake is overflowing to mitigate environmental impacts. Drawdown of Ramsey Lake could concentrate pollutants in a smaller volume of water and reduced downstream discharges could also reduce the water quality of Corn Branch and other receiving waters. Downstream flow requirement would likely be set by permit.

South Pittsburg Pipeline

The proposed pipeline alternative will bring water from South Pittsburg to Monteagle through roughly 26 miles of 16-inch diameter pipe, and distribute the water to other plateau utility districts through an additional 15 miles of 8-, 12-, or 16-inch pipe. The water would be withdrawn from the Tennessee River, and treated at South Pittsburg's water treatment plant before being pumped. According to (TCPU, 2008) the construction of the pipeline would disturb over 60 acres of land. The new lines would run along SR-156 for most of the section between South Pittsburg and Monteagle. The construction would require heavy trucks and machinery on the local roads. Some land would likely be purchased for the pipeline, storage tanks or pumping stations. Sections of the route run through Franklin Marion State Forest.

No permits have been acquired for the proposed pipeline. An inter-basin transfer permit may be required. The majority of the proposed pipeline is contained within the Tennessee Western River Valley Basin, with only the very end of the Phase 3 pipeline connection to BCUD skirting the edge of the Lower Tennessee Hiwassee River Basin. Especially in the BCUD service area, there are a number of end use points, including customers and wastewater treatment facilities (or septic systems), that are not in the Tennessee Western Valley Basin.

The treated water from South Pittsburg and the plateau's utility districts would mix in the distribution system. The effects of this mixing are unknown and would likely vary throughout the year. The differences in water chemistry could cause taste problems and areas of lower potable water quality. The utility districts on the plateau may need to alter their treatment processes periodically to account for the variation in quality from the pipeline. The need to flush water mains may increase because of longer travel times. The additional water discharged at fire hydrants and other flushing locations could have very minor impacts (or benefits) on nearby streams and ecosystems.

This alternative proposes withdrawing up to 3.0 MGD from the Tennessee River, in addition to South Pittsburg's current withdrawal. The river's flow at South Pittsburg is largely regulated by the outflow from the Tennessee Valley Authority's (TVA) Nickajack Reservoir which serves multiple purposes including flood control, hydropower, recreation, water supply and other uses. A separate study would be needed to assess the impacts of river withdrawal on the Tennessee River and operation of the TVA reservoirs. The Tennessee River's drainage area at South Pittsburg is over 22,000 square miles and USGS gage records indicate the annual average discharge is equivalent to over 24,000 MGD.

The TCPU ARAP application (TCPU, 2008) reviewed the potential impacts of the increased river withdrawal. The documents predict that the removal of this volume of water could have a significant impact on the amount of hydropower generated along the Tennessee River. TCPU estimated that the increase in pumping from this project could cause an annual net loss of around 1.1 million kilowatt hours of power due to the net effect of reduced hydropower and increased energy use for pumping water through the pipeline. (The validity of the estimate has not been confirmed.) It is also possible that other downstream uses including water withdrawals by downstream communities, ecological water needs, and navigation could be affected.

Modification of Big Fiery Gizzard Dam and Reservoir plus Ramsey Lake
The implementability of this alternative is simply a combination of those discussed for the separate alternatives.

5.3.4. Flexibility

The flexibility of an alternative is a measure of the ability to phase implementation and spread the cost over time, while still reliably meeting projected regional water supply needs. This criterion also addresses an alternative's resistance to drought, ability to expand capacity beyond the projected need and meet demand beyond the 20 year planning horizon.

Regionalization
The regionalization alternative is perhaps the most flexible of alternatives from the perspective of the potential to phase implementation and spread costs over time. However, it has previously been shown not to reliably meet projected needs, and thus has no resistance to drought or any ability to expand capacity beyond the projected need.

Modification of Big Fiery Gizzard Dam and Reservoir
The modification of Big Fiery Gizzard Dam and Reservoir as permitted, would be constructed as a single phase. As with regionalization, this alternative does not reliably meet projected needs and has little resistance to drought, although the dam could potentially be raised further, expanding capacity.

Modification of Big Fiery Gizzard Dam and Reservoir with Modified Release Schedule

Modifying the release schedule for Big Fiery Gizzard Dam and Reservoir allows this alternative to reliably meet the projected regional needs; however, it would be constructed in one phase. It is fairly resistant to drought and could serve the area beyond the planning horizon.

Big Creek Reservoir
The construction of Big Creek Reservoir would be accomplished in a single phase. As proposed, the reservoir more than meets projected needs and is thus highly resistant to drought.

Ramsey Lake
The purchase of Ramsey Lake, and conversion from recreation to water supply would also be implemented in a single phase. It is highly resistant to drought and would serve the region well beyond the planning horizon.

South Pittsburg Pipeline
As described in Chapter 4, Section 4.6.3.2, the construction of the new water transmission lines, storage tanks, and pumps associated with the South Pittsburg pipeline would be completed in three phases, allowing costs to be spread over time. Establishing a connection to the Tennessee River, this alternative would be highly resistant to drought and allow for capacity expansion beyond the current projected need.

Modification of Big Fiery Gizzard Dam and Reservoir plus Ramsey Lake
Combining the modification of Big Fiery Gizzard Dam and Reservoir with the purchase and conversion of Ramsey Lake allows for a phased approach to reliably meeting the projected regional water supply needs. During a reoccurrence of the regional critical drought, this alternative preserves 91.6 million gallons of raw water supply above reserve. It is highly resistant to drought.

5.4 Evaluation of Alternatives

The evaluation of the suite of alternatives presented in Chapter 4, and expanded upon in Chapter 5 was conducted in a two tier process. The following sections describe those processes and how the evaluation factors developed in Chapter 5, Section 5.3, were used to select the preferred water supply alternative for the region.

5.4.1. Tier 1 Evaluation

The Tier 1 evaluation of alternatives was qualitative. The goal of the Tier 1 evaluation was to eliminate any alternatives that did not meet the reliable capacity objective or had other obvious fatal flaws. Tier 1 criteria were designed to identify the alternatives that best met the requirements of the study area. Alternatives that appeared relatively equal based upon the Tier 1 evaluation were subject to Tier 2 evaluation.

The following table presents the results of the Tier 1 evaluation of alternatives:

Table XXX Tier 1 Evaluation

Alternative	Reliable Capacity	Cost	Implementability	Flexibility
Regionalization	-	$[1]	+	+

Big Creek Reservoir	++	$$$$	- -	-
Raise Big Fiery Gizzard Dam	-	$	+	-
Raise Big Fiery Gizzard Dam + Modified Release Schedule	+	$	+/-	-
Ramsey Lake	+	$$	-	-
Raise Big Fiery Gizzard Dam + Ramsey Lake	+	$$$	+/-	+
South Pittsburg Finished Water Pipeline	++	$$$$	+/-	+/-

(1) Potential construction requirements and costs for these improvements were not developed as a component of this alternative

Any alternative that did not meet the reliable capacity criterion was eliminated from further evaluation. Neither regionalization nor modification of Big Fiery Gizzard Dam and Reservoir without a modified release schedule provided sufficient capacity and were eliminated from further study. Big Creek Reservoir was eliminated because of its relatively high costs ($26.4 million), its potential for downstream impacts to the Outstanding National Resource Water in the Savage Gulf portion of South Cumberland State Park, and its lack of flexibility (it cannot be constructed in phases). The combination of Ramsey Lake and Raise Big Fiery Gizzard Dam was also eliminated because it only performed marginally better than Ramsey Lake alone. Two alternatives appear to warrant Tier 2 evaluation: Raise Big Fiery Gizzard Dam with a Modified Release Schedule and Ramsey Lake. In addition another alternative, Phase I of the South Pittsburg Pipeline was developed. During evaluation the team noted that the entire pipeline to South Pittsburg did not have to be constructed at one time. Phase I alone of the pipeline would meet the reliability criteria for the 2030 planning horizon at only a fraction of the costs of the entire plan. Thus, Phase I of the South Pittsburg pipeline was carried forward into the Tier 2 evaluation.

5.4.2. **Tier 2 Criteria and Evaluation**

Tier 2 criteria included a more detailed look at costs where needed, consideration of the quality of the raw and/or water produced by the alternative, any potential environmental benefits or impacts and any other factors relevant to a decision. These other factors included whether an alternative could serve multiple purposes such as releases from a dam could add to the stability of downstream resources or the recreational attractiveness of the area. Other factors could also include whether an alternative allows for economic growth or provides for the study area beyond the planning horizon, whether the alternative is financially affordable to the utilities, whether it makes financial sense and the ultimate costs to the consumers. The team also considered any updates or additional detail obtained on the Tier 1 criteria. Table XXXX summarizes the evaluation. It is important to note that this study did not have the resources to completely answer many of the Tier 2 questions; however, enough information was available to further eliminate some alternatives and recommend others for more detailed study.

Table XXX – Tier 2 Evaluation

Alternative	Storage Remaining [1]	Cost	Water Quality	Environmental Benefits or Impacts	Other
Raise Big Fiery Gizzard Dam + Modified Release Schedule	5.4MG	$3.9 M	neutral	Release study required	Study could increase existing release requirements
Ramsey Lake	70.4 MG	$10 - 15 M [3]	Additional treatment may be needed	Release study required	Dam safety classification will change
Phase I South Pittsburg Finished Water Pipeline	Undefined [2]	$22 M	Long transmission could cause problems	None known	High energy use/costs could increase cost to consumers more than other alternatives

(1) Above 20% reserve storage
(2) Relies upon TN River, Highly drought resistant
(3) Includes a range of potential routing options, real estate costs, and costs to improve spillway.

Storage Remaining under Critical Drought

As discussed in Section XXX, the Southern Cumberland Plateau's need is relatively small, only 100,000 gallons per day or 0.1 MGD. Specifically, Tracy City Public Utilities' and the Monteagle Utility District's water supply is only sufficient when rainfall is plentiful. Their supplies do not meet the reliability criteria established in this study. Additional supply is needed to ensure that both utilities are able to supply their customers routinely. The other utilities on the plateau could also benefit from additional supply to increase their reliability. The potential for a water supply to be compromised is not limited to drought. The flood of May 2010 proved to several utilities in Middle Tennessee the vulnerability of their systems to flooding. The City of Nashville was only able to avoid severe water shortages because of previously established interconnections with neighboring utilities. Adding reliable capacity in the region and increasing interconnection capability will increase the security of all water systems. All three Tier 2 alternatives would supply that need. However, Ramsey Lake would supply much more than is needed over the planning horizon (2030) and even well beyond that period of time.

Cost

All costs were estimated at a conceptual level, although the alternatives differed in the level of detail of their design. Appraisals of potential real estate costs have not been done. The cost estimates do, however, provide an order of magnitude estimate of costs which can be used for comparison. The cost to purchase Ramsey Lake and convert it to water supply is one of the least defined; unknown costs include the actual purchase price of the lake and the costs of modifications required to meet dam safety standards and minimum release requirements. Despite the unknowns, Ramsey Lake appears to be the 2nd most expensive alternative. The Phase I pipeline has the greatest cost at $9.6 million for initial construction plus $1.6 million for engineering and design, construction supervision and inspection, legal fees and land acquisition for a total of $11.2 million. This cost is also conceptual and does not include the full costs to operate the pipeline. The present of the estimated OMRR&R costs are almost $13.6 million. Pumping water from South Pittsburg to the plateau would require significant energy and that cost would be passed on to consumers. Operational costs cannot be financed. Modification of the Big Fiery Gizzard Dam and Reservoir with a modified release is by far the least costly alternative.

Water Quality

The quality of the treated water of each alternative was also considered. Modification of Big Fiery Gizzard Dam and Reservoir would have little impact on existing drinking water quality and require no specific change in water treatment practices.

The water chemistry of Ramsey Lake is different than some of the other water sources in the region partly because of historic mining in the watershed upstream of the lake. Specific impacts would need to be studied in more detail. The alternative requires pumping water from Ramsey to Ranger Lakes where the raw water would mix lessening water quality impacts. It may, however, require some adjustment of Big Creek Utility District's current treatment practices.

The Phase I Pipeline could have some water quality issues arising from the use of treated water from South Pittsburg. Disinfection by-products increase as residence time in pipelines increase. This could be addressed by additional flushing. In addition, it is not known whether there would be impacts from mixing the water from the Tennessee River with water from the plateau. The differences in chemistry of the different water supplies could cause taste problems and potential areas of lower potable water quality. The utility districts on the plateau could be affected by having to alter their treatment processes periodically to account for the differences.

Environmental Benefits or Impacts

An ARAP application for the Modification of Big Fiery Gizzard Dam and Reservoir has been submitted. Because this alternative requires changing the existing downstream releases, a detailed study is needed to better define downstream needs and potential impacts. A new release schedule would need to be agreed upon. The results of this study could lessen or increase existing release requirements. A more detailed evaluation of downstream releases could actually improve downstream conditions for both recreational enjoyment and habitat.

Conversion of Ramsey Lake to water supply would also require a study of potential downstream impacts and definition of downstream release requirements. Currently there is no controlled release structure at Ramsey Lake. All releases are through overtopping of the spillway. The addition of mechanism to provide controlled releases is likely to have positive affects downstream.

The Phase 1 Pipeline alternative would have limited direct impacts to either the Tennessee River or its construction footprint. It would, however, be less environmentally sustainable than other alternatives because of its high energy requirements. A significant amount of energy would be needed to pump the water up to the plateau. In addition, because treated water will be pumped a long distance there is a greater potential for water loss and creation of disinfection by-products.

Other

All of the Tier 2 alternatives would provide for economic growth in the region and would meet the region's needs considerably beyond the 2030 planning horizon. Modification of the Big Fiery Gizzard Dam and Reservoir along with modifying the release requirements is the least costly alternative and thus would be the most affordable. The average annual Operation, Maintenance, Repair, Rehabilitation and Replacement (OMRRR) cost would have and estimated present worth of $436,000.

The Purchase and Conversion of Ramsey Lake would provide much more water than is needed well beyond 2030. It may be more water than the region can sustainably use. The present worth of its average annual OMRRR costs is estimated to be $667,000. Another very important consideration with this alternative is the change in its Dam Safety Classification. Upgrades to the dam and appurtenances would be needed and the utility making the purchase would be assuming liability for the dam without participating in its construction. However, the upgrades would make the dam safer and reduce the risk to those living or camping downstream of the dam.

Phase I of the Pipeline also meets the region's needs well beyond the planning horizon. The present worth of the average annual cost of OMRRR is estimated to be approximately $13.6. This includes the costs to operate and maintain the pumps and rehabilitate 1 pump at year 10 and replace 1 pump at year 25 and the cost of energy. It does not include the cost of purchasing water from South Pittsburg or the potential increase in energy costs.

5.5 Selection of Preferred Alternative - what we decided

The alternative selected is Modification of the Big Fiery Gizzard Dam and Reservoir in combination with modification of its downstream releases. It would provide enough water for the planning horizon of 2030. It is the least expensive by a significant margin and could be accomplished relatively quickly. An important factor given that there is not enough supply in the region to meet the reliability requirements defined for this region today. It would also be the most affordable to the region.

There is, however, one major unknown - downstream release requirements. Without changing the current release mechanisms and operating procedures, raising the dam does not provide enough water to reliably serve the region for the planning horizon. The raise could serve Tracy City's need through 2030, but could not meet the needs of both Tracy City and Monteagle without a change in the operating procedures for downstream releases. Additional studies are required to determine how downstream releases can be modified and what would be best for the ONRW downstream of the dam as it flows into the Grundy Forest State Natural Area.

Chapter 6. Next Steps

6.1. Overview

The recommended alternative for the South Cumberland region is raising the Big Fiery Gizzard reservoir with a modified release requirement. A number of steps are required to successfully implement that alternative, not the least of which is modified release study to determine the in-stream, environmental flow requirements downstream of the reservoir. This alternative would benefit all four major water systems in the region; therefore, it is recommended that the parties establish an inter-local agreement. In addition to addressing the optimal water-sharing arrangement between the systems, the agreement could also outline the financing plan.

This region established some level of communication during the 2007-08 drought. The inter-local agreement could include the communication and coordination plan for managing future drought occurrences.

There are also steps that should be taken by all the utilities in the region to manage future water demands. The region should pursue greater water-use efficiency within their systems and increased education about conservation for their customers. And the region should work toward establishing a communication and coordination plan for managing drought.

One of the most critical next steps is developing a plan for informing affected customers of the need to implement the recommended alternative, any effects on their water costs, and the planned inter-local agreement. It is also critical to educate all customers in the region about the importance and benefits of, and opportunities for, conservation.

6.2. Introduction

Background

The Water Resources Technical Advisory Committee (WRTAC) initiated this regional study to assess the South Cumberland region's ability to meet current and projected water needs and identify the most cost-effective alternatives for meeting them. The study focused on identifying sustainable regional water supply sources. While it was not intended to evaluate the feasibility of extending water lines to unserved households within each utility's service area, it did include the populations of those areas when analyzing demand to ensure sufficient supply for the region as a whole. Nevertheless, each utility must evaluate the cost and water quality implications of extending the public water supply to potential customers in its service area.

Dozens of data sets were analyzed by WRTAC members and their staff. A powerful software tool called OASIS was used to model the interactions of water flow and reservoir storage in the region to answer pivotal questions about what would happen if the worst drought recorded happened again during the study's twenty-year planning horizon. From these analyses, the study team summarized water needs for the next twenty years into a concise statement:

> *The current raw water supply in the South Cumberland region was perceived as barely sufficient during the recent drought (2007). Overall raw-water demand in the region is expected to grow only slightly through 2030, from approximately 2.1 million gallons per day to 2.2 million gallons per day. Demand projections for the Big Creek and Sewanee utility districts are well below the firm yields of their existing raw water sources. Existing and projected raw water demands for Monteagle and Tracy City, however, are currently greater than the firm yield of their primary sources. The composite firm yield of the region's existing raw water sources is barely sufficient to meet the projected demand, indicating a need for additional source development.*

This water needs statement is the yardstick for measuring the ability of proposed alternatives to meet the region's water needs. In addition, alternatives were subjected to a two-tiered set of performance criteria. The performance criteria were selected with the overall goal of determining the most sustainable way to meet the South Cumberland region's water supply needs. This process and the results were described in Chapter 5.

The results of this work strongly suggest one preferred alternative to satisfy twenty-year regional water needs, an alternative that is both cost-effective and can be implemented: raising the Big Fiery Gizzard dam. To meet the projected water supply needs of the region through 2030, the minimum water flow release required by the current permit for the dam will have to be reduced. The analyses also indicate an additional alternative for consideration beyond the twenty-year horizon of this study—conversion of Ramsey Lake from a recreational lake to a water supply lake. This long-term alternative would warrant further study if prompted by unforeseen, large-scale economic development in the region, unexpected changes in climatic conditions, or unanticipated regional population growth.

This study has shown that both Tracy City and Monteagle will have water demands in 2030 that exceed the drought-condition yields of their current raw water sources. Both cities could act independently to develop separate projects to address their own future water needs. However, the fundamental premise of this pilot study is that regional water supply planning will produce a more sustainable water supply to meet current and future needs. In addition, it should be more cost-effective for neighboring water systems to develop shared water supply sources. The existing water sales agreement between Tracy City and Monteagle demonstrates that the utilities in this region have already established a foundation for joint development of a new, shared, raw water storage project.

The study has produced other important findings indicating that a regional solution to meet future water demands would be preferable to individual water systems adopting a "go-it-alone" approach. This study's intensive examination of the South Cumberland region's hydrology underscores the fact that prediction of drought extremes carries a greater margin of error for the relatively small reservoirs and watersheds in this region. While the statistical analysis of firm yields for the Big Creek and Sewanee utility districts indicates that their sources will be adequate for the next twenty years, the greater margin of error for such small-watershed predictions suggests that other sharing arrangements would be prudent, such as a shared-storage project at Big Fiery Gizzard Reservoir.

Analysis of water system financial conditions in the region has revealed that Sewanee Utility District, Monteagle, and Tracy City customers pay significantly higher bills than customers of most other water supply systems across the state. Customers of the three smaller utility districts and customers that reside outside the town limits of Monteagle and Tracy City pay even higher water bills. The relatively high water bills in this region of relatively low median household incomes point to a need for a project financing approach that shares costs across the broadest possible set of water users. As part of this pilot study, one utility, Big Creek Utility District, received an Energy Conservation Study by the University of Memphis at no cost to the utility. The results of that study are included in a report in Appendix X and could provide useful guidance for other utilities to identify cost-saving steps that could put them in a more favorable financial position.

Why this Topic Matters

The study group sought to develop alternative methods to anticipate future water needs in two regions of the state so that other parts of the state might be able to use the group's work as a blueprint for their own regional planning efforts. For the most part, Tennessee has had plentiful water resources, but these may not be adequate in the future, particularly in areas that have already experienced water shortages. The study group has selected the preferred alternative to enhance the South Cumberland region's water supply, but numerous interim steps must be taken in order to implement it.

This chapter lays out the steps required to implement the preferred alternative for the twenty-year planning horizon. Identifying the preferred alternative was no small step, but neither is implementing it. Making it happen and making it affordable will require no small amount of cooperation and coordination. Many agencies will be involved, as will the entire community, which in the end, must bear the cost of meeting the region's water supply needs. Accomplishing all of this will require considerable planning. These next steps are offered as a starting point for that process. They will need to be evaluated by the community and adapted to their circumstances. To succeed, they will require the active participation of all communities and utilities in the region.

This study provides a roadmap for the South Cumberland region to develop cooperative water agreements, as well as enhance the use of available resources. By developing this model report, the study committee has sought to introduce a more regional approach to water management. Such models will almost certainly be needed in the coming years to meet the needs of Tennessee's citizens.

6.3. Conservation and Demand Management

The preferred alternative for this regional pilot study centers on Monteagle and Tracy City; however, the entire region will benefit from increased efforts to conserve water and manage water supply demands. All of the utilities in the area can extend the useful lives of their current water sources by taking further steps to reduce unbilled and unaccounted for water. Moreover, they may have to in order to meet the requirements newly placed on them in October 2010 by the Utility Management Review Board and the Water and Wastewater Financing Board. These boards adopted an excessive water loss threshold of 35%. Utilities reporting water losses of 35% or higher in their annual reports to the Office of the Tennessee Comptroller will be referred to the applicable board for further action.

The region's utilities could employ more cost-effective strategies to derive the maximum benefit from their current water sources. Many of these strategies can be implemented without inconveniencing their customers or the systems themselves. Adopting any of them, however, necessarily involves learning new ways of doing business. The potential to keep water bills low by postponing structural investments make them worth the effort. Among the options described in Chapter 4 are

- adopting active leak prevention, detection, and repair programs;
- metering unbilled water to better account for all types of water usage;
- informing and educating the public about conservation;
- pricing water to encourage conservation;
- providing incentives for retrofitting and replacing old fixtures and appliances; and
- adopting water efficiency codes and ordinances.

6.4. Communication, Coordination and Drought Management

As the 2007 experience in the region has shown, utilities can manage drought best by working together. Utilities in the region need a formal communication and coordination plan for managing future droughts. Regional droughts can be addressed most effectively when utilities establish uniform or complementary triggers and implement concurrent restrictions. As a result of this pilot, utilities in the region will be given access to the hydrologic model (OASIS) used to develop the preferred alternative, and they will be given the training they need to use it effectively to model water-sharing scenarios for cooperative drought management.

6.5. Community Engagement

Negotiations among the parties to a regional agreement will determine the financial responsibilities of the partners in implementing the preferred alternative. State law requires water utilities to operate on an enterprise basis, meaning that water customers pay for the full cost of water service. The costs of a regional shared-storage project will eventually affect water customers' monthly bills. They will need to understand the process that led to those changes and the benefits of a more secure water supply that is less susceptible to drought. A robust, multi-faceted public involvement program to inform water customers is needed.

Residents in unserved households need help understanding the factors that a utility must consider when determining whether to extend water supply lines. They need to be informed of the implications for themselves and the entire service area, both up-front and operational costs, including line flushing required to ensure that the quality of water they receive is the same as customers in less sparsely populated areas.

The utilities in the region also can work together to educate their customers about conservation practices. Implementing sound conservation and re-use practices can help reduce overall water consumption, saving both water and money. Appendix X describes water reuse projects proposed for Monteagle and Sewanee. These laudable conservation efforts require the understanding and acceptance of the community. TDEC will work with the parties to a regional agreement to develop an effective community engagement plan to make these practices possible.

Community engagement, however, is not a one-way street. Utilities also benefit from their customers' suggestions and comments about proposed changes. Customers may have valuable ideas about demand management, conservation methods, the availability of water conserving appliances, or incentives to reduce consumption. Engaging with the community is essential to successful demand and drought management.

6.6. Commitment to a Regional Approach

From the start, this regional study initiative has, included participation from the managers of the South Cumberland region's major utilities, as well as several elected leaders. Although these parties have been fully engaged in early study findings about water needs and the formulation of reasonable alternatives, they were not required to commit to work together to develop a regional project. For the reasons outlined above under *Why this Topic Matters* the regional study team believes that there are compelling reasons to justify development of a shared-water storage project at Big Fiery Gizzard Reservoir.

Local water systems and jurisdictions might organize themselves in various ways to discuss the pros and cons of a regional solution. This discussion should culminate in a written consensus about a shared regional approach. Tennessee Code Annotated, Title 12, Chapter 9, *Interlocal Cooperation*, is the legal framework for inter-local agreements. The content required for such an agreement is defined in detail in Chapter 9, including "the manner of financing the joint or cooperative undertaking . . ." and "provision for an administrator or joint board responsible for administering the joint or cooperative undertaking." Chapter 9 also sets out the requirements for the governing boards, commissions, or municipal legislative bodies of participating jurisdictions to ratify inter-local agreements.

The process of creating such an agreement for a shared water storage project will require extensive communication among the parties and a strong commitment to work through the details. Before beginning work on a formal agreement to be filed with the Comptroller, the interested parties should begin the process with a memorandum of agreement that, when signed by the appropriate local officials, will identify the steps to be taken to create the agreement and demonstrate the commitment among the parties to follow through with a regional project.

A document titled *Crafting Inter-local Water Agreements* prepared by the University of North Carolina Environmental Finance Center is included in Appendix X to guide the parties through the agreement process.

6.7. Modified Release Study

The success of the preferred alternative, raising the Big Fiery Gizzard Reservoir, depends on increasing the minimum water flow release required by the permit for the dam. Preliminary modeling indicates that the raised reservoir cannot support the water supply needs projected for

2030 if the current release requirement must be met. Modifying the permit to raise the dam, which was issued in June 2009, requires a technical study to determine the in-stream, environmental flow requirements downstream of the dam, something TDEC has indicated a willingness to do.

If the outcome of the study indicates that a lesser discharge is acceptable, Tracy City will have to apply to modify the existing permit to authorize the release supported by the study. If the study indicates that the currently permitted release of 1 cubic foot per second, or a greater release, is necessary to protect downstream resources, the conversion of Ramsey Lake would become the preferred alternative.

This chapter's remaining sub-sections assume a favorable outcome from the pre-requisite water release studies.

6.8. Preliminary Engineering and Refined Cost Estimates

6.8.1 Interconnections

No preliminary engineering of upgrades to water system interconnections has been done as a part of this study. While OASIS modeling indicates that regional system interconnection upgrades would not, by themselves, meet future water demands, they would be required for a shared, water-storage project and would be desirable for drought management regardless of whether any joint structural project were pursued. With Big Fiery Gizzard Reservoir modifications as the preferred alternative, the primary focus of initial interconnection engineering would be improved links between the Tracy City and Monteagle water systems. Capacities of other regional interconnections would be engineered as appropriate to the parties participating in a regional, water-supply sharing agreement.

6.8.2 Modification of Big Fiery Gizzard Dam and Reservoir

The cost estimate for modifying Big Fiery Gizzard Reservoir includes a 25% contingency. This relatively high contingency was used because some key engineering data is not yet available. Dam site soils and foundation information must be derived from soil borings. Also needed are a topographic survey, bathymetry (water depth studies), and other background data. The costs of further engineering work would be shared among the parties to a regional, water-supply sharing agreement.

6.9. Permitting

As stated earlier, if the outcome of the study indicates that a lesser discharge is acceptable, Tracy City should ask TDEC to modify the existing permit to reflect the release supported by the study. Implementation of these next steps will put Monteagle, Tracy City, and the region on the path to a safe and secure water supply that will meet current and future needs.

6.10. Rate Studies

As a result of the implementation of the recommended alternative, water customers must expect to pay a significant portion of costs to expand their water supply. The parties in a regional water-sharing agreement will determine whether the expected costs can be financed on a pay-as-you-go basis or whether they will have to borrow funds. Regardless, water customers will likely see some changes in their bills. In fact, parties to the agreement will need new rate studies to ensure that the customers of each pay only their fair share of the costs of expanding the region's water supply.

There are a number of guides that may be helpful, including the U.S. Environmental Protection Agency's *Setting Small Drinking Water System Rates for a Sustainable Future* and the University of Tennessee Municipal Technical Advisory Service's *How Any City Can Conduct a Utility Rate Study and Successfully Increase Rates*. MTAS suggests the following goals for a rate study:

- Generate additional revenues to fund needed infrastructure improvements and expansions. Funds would come from a combination of user fees, loans, and grants.
- Make water and sewer rate structures fair for all users.
- Comply with professional and regulatory requirements.
- Examine and modify (if needed) water and sewer policies, including extension policies, connection and tap fees, etc., to ensure that "new" customers were not being allowed to connect onto the system at the expense of existing customers.
- Develop rate and policy information that is easy to explain to ratepayers.
- Develop a communications plan to inform customers.

The EPA recommends evaluating the characteristics of the system, its customer base, and its options for maintaining predictable rates and rate increases. In addition to recovering all costs, the EPA suggests that utilities consider six factors:

1. **Rate Stability.** Customers are more likely to pay for rate increases if their rates are generally stable. Most systems know that the worst thing they can do is maintain a stable rate for many years, then increase it by 10% or more. A single, large increase can lead to "rate shock" and opposition to the increase. It is far better to increase rates by 2 percent per year for 5 years than 10 percent once every 5 years.

2. **Rate Predictability.** Managers need to know how much revenue to expect next year and in the years to come. However, predicting revenue can be difficult, as water use can vary from year to year. Water use can increase significantly during a dry year and decrease during a wet year. Promoting conservation can lead to a reduction in water use, which may require a rate increase. This lack of predictability should not discourage managers from experimenting with rate structures that promote a valuable public program like conservation. Instead, they should aim to generate and keep sufficient reserves so that their system can survive a significant decrease in water use.

3. **Number of Customers.** If the system serves fewer than 500 persons, the simplest approach to rate setting might be to take the revenue needed and divide it more or less equally among its customers. If it serves more customers, the system might choose an alternative rate structure, e.g., increasing block rates.

4. **Customer Classes.** Some systems may serve only residential customers, while others also serve industrial, commercial, or agricultural customers. Residential, industrial,

commercial, and agricultural customers may have very different patterns of water use. The cost of servicing these customers may be different as well. Utility managers may want to use different rates and rate structures for different classes of customers in order to meet their specific needs.

5. **Water Use.** Examine customers' water use habits during peak and off-peak seasons. If most customers use roughly the same amount of water, a flat fee might make the most sense. If customers use significantly different volumes of water, the utility should consider charging for the amount of water used. A family of four should not expect to receive the same water bill as a car wash or laundromat. Water is a scarce commodity. Rates can be structures rates so that they send a "price signal" to customers and encourage conservation. Customers who recognize the value of the service will be more likely to use that product in a way that reflects its true value.

6. **Customer Needs.** There may be differences among customers within a class that affect the cost of providing water service to them or their ability to pay for that service. For example, some residential customers may have low fixed incomes and, therefore, may have difficulty paying their water bills. Faced with these types of issues, utility managers may want to consider rate structures that allow for different rates for customers with different needs within a single customer class.

A good source of information about possible rate structures is the National Regulatory Research Institute's *Meeting Water Utility Revenue Requirements: Financing and Ratemaking Alternatives*, which describes six basic rate structures and the advantages and disadvantages of each:

- <u>Dedicated-Capacity Charges</u>

  Advantages

  - Both availability charges and demand charges promote cost sharing, adhere to the cost-causation standard, and provide revenue stability.

  Disadvantages

  - Availability charges may have problems associated with usage-sensitive costs, legal constraints, and equity.
  - Demand charges may require utilities to expand capacity and customer losses may result in stranded utility investment.

- <u>System-Development Charges</u>

  Advantages

  - They protect existing customers, preclude consideration of vintage rates, and reduce capital financing needs.

  Disadvantages

  - They can create revenue instability, discourage growth, and introduce forecasting error into cost estimation.
  - Their use can be constrained for tax, regulatory, and public policy reasons.

- Contract Rates

  Advantages

  - They provide utilities with adequate, stable, and guaranteed revenues, adhere to the cost-causation standard, and stimulate economic activity.
  - Large users benefit from assured water service at a guaranteed price.

  Disadvantages

  - They can create cross-subsidization and result in higher rates for other customers.
  - They can impede conservation, equity, and other regulatory and public policy goals.

- Conservation Surcharges

  Advantages

  - They can be used in conjunction with different costing approaches, least-cost planning, and incentive regulation.
  - They unbundle rates, and transmit a forward-looking and efficient pricing signal.

  Disadvantages

  - Implementation and administration can be difficult.
  - They raise revenues outside of traditional revenue requirement determination.

- Seasonal Rates

  Advantages

  - They can increase operational efficiency and reduce peak demands.
  - They can help utilities eliminate or postpone the need for capacity.

  Disadvantages

  - They make sense only for systems with seasonally variable demand.
  - Implementation can be difficult and may require changes in metering and billing.
  - Anticipated benefits do not always materialize.

- Zonal Rates

  Advantages

  - They may be consistent with the cost-causation standard, particularly with respect to costs driven by customer distance from supply and treatment facilities.
  - They unbundle rates and promote efficiency, as might occur in a competitive market.

Disadvantages

- They may subvert optimum system performance.
- They may accentuate, rather than mitigate, localized cost and rate shock.
- They can be arbitrary, discriminatory, and used for political purposes.
- Their use requires a careful analysis of tradeoffs among economies and diseconomies.

These six rate strategies and their pros and cons are fully explained in the National Regulatory Research Institute's report.

6.11. Project Financing

Tennessee local jurisdictions have created several successful examples of joint financing. Perhaps the best example is the Duck River Agency, which finances projects to benefit multiple utilities across several counties with a region-wide 5 cents per 1,000 gallon surcharge on water bills that is collected by the seven participating municipal water departments and utility districts. Regional water authorities have been created in other areas of the state to more broadly manage water supply needs, but that may or may not be desirable or necessary in the South Cumberland region.

While the regional water needs statement suggests that Monteagle and Tracy City would be the primary project beneficiaries, study results strongly suggest that all four of the major water systems, and quite possibly the three utility districts that buy water from Big Creek Utility District or Tracy City, could benefit from a regional, shared-storage project. For participants other than Monteagle and Tracy City, shared storage could improve access to multiple emergency water supplies during more localized extreme droughts.

With Big Fiery Gizzard reservoir under Tracy City's jurisdiction, Tracy City could administer the funds collected by the participating water systems, or another entity separate from the city could be formed. Since some parties will benefit more than others will from the project, the parties would need to agree on a system of water bill surcharges based on the varying benefits each receives from access to shared-storage at Big Fiery Gizzard. The joint project should be accounted for and audited separately from the individual utilities. Use of the funds would be authorized as needed by a joint governing board established by inter-local agreement.

There are a number of possible funding sources for the preferred project. TDEC will work with the region, the Southeast Tennessee Development District, and other study partners to identify and secure funding for the preferred alternative.