North Central 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 North Central study area consists of all of Sumner County except the Hendersonville area that is served by the Hendersonville Utility District and the eastern part of Robertson County that is served by the White House Utility District. The area has experienced a large amount of population growth and accompanying land development over the last fifty years. Sumner County grown more and faster, but Robertson County has also grown.

The study area is situated in two physiographic provinces, the Central Basin and the Highland Rim. The transition area between the two provinces in known as the ridge, a line of steep hills that divides Sumner County and that runs in an arc from the southwestern part of the county at Millersville to the northeastern part near Westmoreland. All of the Robertson County part of the study area is on the Highland Rim.

The climate of the region is temperate and humid. Average annual precipitation is a little over 54 inches per year, but wide ranges in rainfall can occur. The severe drought of 2007 and 2008 brought the Portland area to a drastically low level of water supply, while the spring of 2010 say severe flooding.

No large natural areas or state parks are located within the study area; but a small state park, Bledsoe Creek, is located on the banks of Old Hickory Lake in the eastern part of the county. A small natural area is located in the eastern part of Sumner County that is owned by the Nature Conservancy. There are several rare animal and plant species listed in the area. A number of challenges to maintaining sensitive species populations, natural habitats, clean drinking water and productive farms and forests exist in the region. These include further land conversion to more suburban and urban land uses, increased pressures on drinking water supplies, and environmental uncertainties because of climate change.

Population growth has been significant. Sumner County's population has grown by over 85 percent from 1980 to 2009. While Robertson County's overall size was smaller, the growth rate over the same period was over 80 percent.

The region has a diversified economy. When growth began to occur rapidly in the 1950s and 1960s, commuting to Nashville was the major economic influence. Over time, there has been more local economic development with job centers being located in Gallatin, Hendersonville and Portland. Commuting, however, is still a factor in the local economy.

Land development in Sumner County followed Old Hickory Lake between Davidson County and Gallatin. Growth also occurred in both counties bordering the corridor of I-65 as it was extended northward from Nashville. In Sumner County more development has recently occurred west of Gallatin and north of Hendersonville toward Goodlettsville and Millersville. In Robertson County in addition to the I-65 corridor, new development has occurred in the Ridgetop, Greenbrier and Springfield area.

The governments of the study area are well situated to engage in planning for water supplies. All have planning commissions and enforce land use controls, and several have recently adopted new long-range plans. Identifying the areas water needs and incorporating a strategy into the long-range plan can be done as a matter of policy. Each jurisdiction should also evaluate the impact of the land development pattern and the adopted plan upon the protection of the watersheds in the area.

2 The city of Portland and the surrounding area of Sumner County extending toward Westmoreland is the only area where the supply of water can be a challenge. This area does not have direct access to the waters of Old Hickory Lake as does the remainder of the study area.

2.1 Introduction

Background

The North Central study area is one of contrasts for water supply planning and presents an excellent opportunity to demonstrate how to plan effectively to address long-range issues of supply and demand. Those utilities with access to the Cumberland River and Old Hickory Lake have a reliable and plentiful source of water. Those utilities without access to this source—the area comprising most of the northern part of the county—have more challenges and are much more severely affected by drought. Their lack of an adequate water supply 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 North Central study area, defined by the boundaries of the water utilities included in it, comprises most of Sumner County and the eastern part of Robertson County. All of Sumner County except the southwestern areas that are served either by the Hendersonville Utility District or by Gallatin Water Department are included. Portions of Robertson County that are served by the White House Utility District, including the cities of Cross Plains, Orlinda, Ridgetop, and White House, as well as areas annexed by the cities of Portland and Millersville are also considered in the study area.

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.

2.2 The Geography of the Region

Geographically, Sumner County lies within the Central Highlands Province and is further divided into two major regions. A sharply defined line, known locally as "the ridge," divides the county roughly in half between two physiographic provinces, the Central Basin and the Highland Rim with the southern part of the county being within the Basin and the northern half being upon the Rim. Elevations vary across the county from 450 feet above sea level in the southwestern part to over 1,000 feet above sea level on the Highland Rim. The highpoint in the county is located in the Bethpage area with an elevation of 1,085 feet.[1] In the Central Basin, the land is relatively flat to gently rolling hills. The Highland Rim, which surrounds the Central Basin, is characterized by hilly uplands. Gallatin is located in the basin at an elevation of 526 feet. White House and Portland are located on the transition between the Central Basin and the Highland Rim and have elevations of 745 and 805 feet respectively. Westmoreland is located on the Highland Rim at an elevation of 911 feet.

Slopes across the county with the exception of the ridgeline are generally less than 12%. The drainage pattern south of the ridge is to the south toward the Cumberland River-Old Hickory Lake. To the north of the ridge, the streams drain to the north and west. The Robertson County portion of the study area also is situated on the Highland Rim.

The ridge is not a separate geographic province but it has significance as a landform. It extends from the southwestern part of the county in Millersville and Goodlettsville to the northeast in gentle arc and is the transition from the Central Basin to the Highland Rim. The elevations at the base of the ridge average 600 feet above sea level while those at the top will range from 850 to 950 feet. Slopes along the ridge range from 20% to 30% and can reach 50%. The significance of such slopes is that they present severe limitations to development or infrastructure construction, and in some situations, the side slopes are prone to landslide.[2]

[1] Tennessee Landforms, County Highpoints, viewed at www.cs.utk.edu/~dunigan/cohp/.

[2] Tennessee State Planning Office, *Land Use Plan, Sumner County, Tennessee,* 1977.

The drainage pattern of the county is split by the ridge. South of the ridge, a number of creeks drain to Old Hickory Lake (the Cumberland River). These include Mansker Creek, Drakes Creek, Station Camp Creek, East Camp Creek, and Bledsoe Creek. North of the ridge, the drainage pattern goes to the north and west. The Red River flows west out of Sumner County into Robertson County, and several creeks flow north into Kentucky including Caney Fork Creek, Sulphur Fork Creek, West and Middle Forks Drake Creek and Trammel Creek. All of these creeks are a part of the Barren River watershed. The river itself is located in adjoining Macon County and flows to the north into Kentucky.

The Planning Region

Areas in Sumner County

- Gallatin
- Goodlettsville*
- Mitchellville
- Westmorland

Areas in Robertson County

- Cross Plains*
- Orlinda*
- Ridgetop*

Areas in Both Counties

- Millersville*
- Portland
- White House*

* Served by the White House Utility District.

2.3 The Ecology of the Region

The climate of Middle Tennessee is temperate, warm, and humid. Precipitation in the form of short thunderstorms occurs from late spring through early fall. Winter storms in January and December can last two to three days and produce large amounts of rainfall. Most recently in Middle Tennessee, unusual changes in climate produced moderate to extreme drought in spring, summer, and fall of 2007 and moderate to extreme flooding in the spring of 2010.

Average annual precipitation in the North Central study area is 54.4 inches, with the wettest month being May with 5.6 inches and the driest month being October with about 3.4 inches (U.S. Department of Commerce, 2001). Annual average temperatures for the North Central study area are 57.7^{o}F. Typically, the coldest and the warmest months are January and July.[3]

The predominantly limestone geology of the region historically supported a variety of grassland plant communities, woodlands and forest types. Fire, both natural and human-caused played an important role in maintaining of these vegetation types and their distribution across the landscape. Today the land cover is a mix of agricultural lands (mainly pasture) and oak-hickory forest and woodland types, with a small percentage in urban development. The patchy distribution of forest types and their higher prevalence along the slopes and ridges is partly the result of lowland forest conversion to agriculture, but also because of the historical prevalence of fire across the landscape. Many of the grasslands and savannas originally found in lowland areas have been converted to agricultural uses.[4]

There are no large natural areas or state parks located within the study area. A small state park, Bledsoe Creek, is located on the banks of Old Hickory Lake in the eastern part of the county. There is one small natural area located on the Highland Rim that is owned by the Nature Conservancy. It is considered unique to the Middle Tennessee area because of its

[3] United States Geological Survey.

[2] Tennessee Wildlife Resources Agency, State Wildlife Action Plan.

botanical and biological diversity and undisturbed character. It consists of 173 acres, and access to the area is restricted.[5] Bledsoe Creek State Park is located in Sumner County on Old Hickory Lake.

The study area encompasses portions of three major watersheds, the Barren River, Old Hickory Lake, and the Red River. The Barren River flows north to Kentucky and is part of the Ohio River watershed. Old Hickory Lake is a reservoir on the main stem of the Cumberland River. The Red River originates in Tennessee, drains portions of southern Kentucky, then meets the Cumberland River near the city of Clarksville. These watersheds are not only significant resources for Tennessee, but for the state of Kentucky as well.

The Tennessee Department of Environment and Conservation's Natural Heritage Program maintains a list of rare species of all kinds for all counties. There are 31 rare species on the list for Sumner County including 4 invertebrate animals, 15 vertebrate animals, 11 vascular plants, and 1 other type.[6]

Figure 1 provides an overview of the most significant, smaller scale watersheds for the protection of native fish and mussel populations in the region as identified in the Tennessee Wildlife Resources Agency's state wildlife action plan. Several very sensitive fish and mussel species are located in these watersheds.

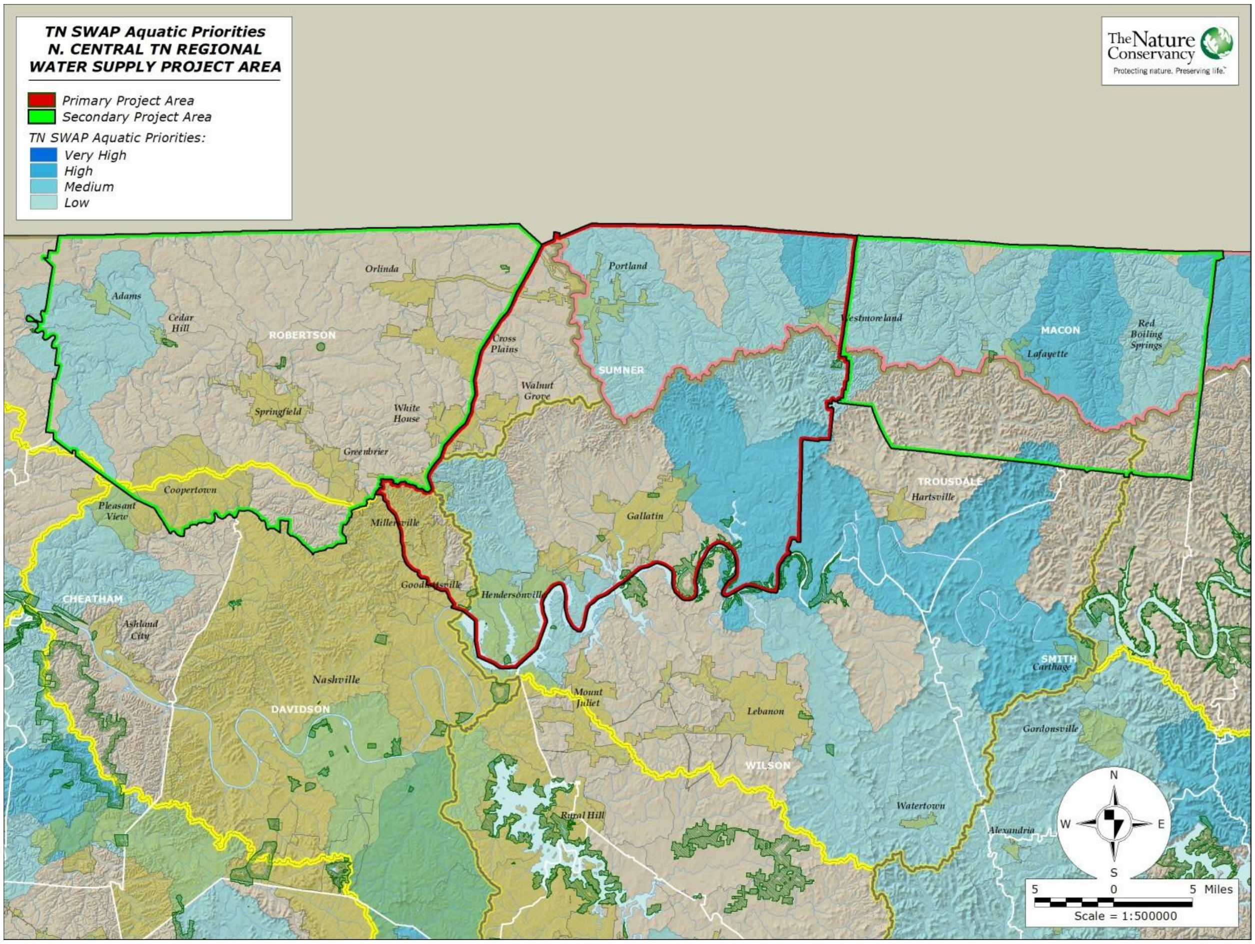
Several future challenges to maintaining sensitive species populations, natural habitats, and important ecological benefits such as clean drinking water and productive farms and forests exist in the region. These include further land conversion to more suburban and urban land uses, increased pressures on drinking water supplies, and environmental uncertainties because of climate change. 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 will occur.[7] These challenges require a thoughtful approach to land and water management in the North Central Tennessee region to achieve a balance that conserves resources and improves the resilience of natural systems.

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

[6] Ibid.

[7] Tennessee Wildlife Resources Agency, *Climate Change and Potential Impacts to Wildlife in Tennessee.*

Figure 1. Priority freshwater habitats in the North Central Study Region identified in the Tennessee Wildlife Action Plan.



2.4 The Population of the Region

Because the region includes some but not all of two counties, it is impossible to determine its exact population. But population data for the main county (Sumner) and the various incorporated areas of the region are indicative of the character of the study area. Sumner County experienced significant population growth over the last fifty years. A largely rural county in the mid-20th Century, it has more than quadrupled in size since 1960 when only 22% of its population lived in urban areas. By the 2000 federal census, 69% of Sumner's population was considered urban, making the county the 11th most urban in the state; it is the 10th most densely populated county in the state. Robertson County, with 42% of its population considered urban, was the 28th most urban of the state's 95 counties; it is the 23rd most densely populated county in the state.

While Sumner County's most rapid growth occurred in the 1960s and 1970s, it continues to grow faster than the state as a whole. From 1980 to 2000, the county population grew by 52%. And its population is estimated to have grown 22% from 2000 to 2009. The county grew 85% over that entire period (1980 through 2009). Robertson County did not grow nearly as rapidly as Sumner County until the 1990s, and its growth rate has been on par with Sumner's since then.

Table 1. Population Growth in Robertson and Sumner Counties
1960 to 2009

County	1960	1970	1980	1990	2000	2009*
Robertson	27,335	29,102	37,021	41,492	54,433	66,581
Growth Rate	*1.2%*	*6.5%*	*27.2%*	*12.1%*	*31.2%*	22.3%
Sumner	36,217	56,256	85,790	103,281	130,449	158,759
Growth Rate	*8.0%*	*55.4%*	*52.5%*	*20.4%*	*26.3*	*21.7%*

*Estimated.

Source: U.S. Bureau of the Census.

The fastest growing cities in the Sumner County part of the study area were, in order, White House (364%), Portland (183%) and Goodlettsville (150%). Goodlettsville is on the border of the area and lies mainly in Davidson County; only the portion in Sumner County is included in the study area. All of Goodlettsville's territorial growth has been in Sumner County since the governments of Davidson County and Nashville consolidated in the 1960s. Three cities in the study area have grown by more than 30% just since the 2000 Census: White House (43%), Portland (35%), and Gallatin (31%). During the 1960s. Hendersonville was the fastest growing area and was one of the fastest growing suburban areas in the country.[8]

Robertson County is also experiencing rapid growth, but the numbers are smaller than those for Sumner County. The eastern part of Robertson County is more rural than the Springfield-Greenbrier-Ridgetop area, where more of the new growth is occurring, and the cities in the eastern part of the county (Cross Plains and Orlinda) are smaller although the two cities had high rates of growth. Ridgetop, also a small city, had a growth rate from 1990 to 2009 of 58%. Almost half of the population of the city of White House is in Robertson County, and while Portland, originally incorporated in Sumner County, has annexed territory in Robertson County, few people reside in that area. The city of Millersville, also located in both counties, has had substantial growth since its incorporation in the early 1980s.

[8] Timothy Takas, *The City by the Lake, A History of Hendersonville, Tennessee, 1780-1969,* p. 324, 1992.

Table 2. Population Growth in the Study Area
1980, 1990, 2000 & 2009*

	1980	1990	2000	Growth Rate, 1980 to 2000	2009*	Growth Rate, 1980 to 2009
Tennessee	**4,591,120**	**4,877,203**	**5,689,283**	23.9%	**6,296,254**	37.1%
Cross Plains	655	1,255	1,381	110.8%	1,699	159.4%
Gallatin	17,191	18,794	23,230	35.1%	30,504	77.4%
Goodlettsville (pt)	1,850	3,042	4,625	150.0%	n/a	n/a
Hendersonville	26,561	32,188	40,620	52.9%	47,032	77.1%
Millersville	--	3,449	5,308	n/a	6,412	n/a
Mitchellville	209	189	207	-1.0%	208	-0.5%
Orlinda	382	488	594	55.5%	687	79.8%
Portland	4,030	5,731	8,458	109.9%	11,391	182.7%
Ridgetop	--	1132	1084	n/a	1785	n/a
Westmoreland	1,754	1,655	2,093	19.3%	2,236	27.5%
White House	2,225	2,987	7,220	224.5%	10,316	363.6%
Unincorporated Robertson County (pt)**	4,798(?)	7,250	8,558	78.4%		
Unincorporated Sumner County	33,012	36,357	42,751	29.5%	74,194	124.7%

*Estimated.

** The figures for the part of Robertson County in the study are were derived from the Orlinda and Cross Plains Census County Divisions and Census Tract 806.02, less the municipal populations. There are no census reporting areas that exactly coincide with the service are of the White House Utility District.

Note: The City of Millersville was not an incorporated municipality in 1980. The growth rate from 1990 to 2009 was 85.9%.

Source: U.S. Bureau of the Census.

Table 3 illustrates some additional characteristics of the population in Sumner and Robertson Counties as well as state totals. Sumner County's population is slightly older than the state median but is better educated and has a much higher median household income and has lower poverty rates. Robertson County is more comparable to the state totals except that the median household income is much higher and, interestingly, has a higher poverty rate.

Table 3. Other Demographic Characteristics of the Study Area

	Sumner County	Robertson County	State
2000 Median Age	36.1	35.4	35.9
2000 Average Household Size	2.6	2.7	2.5
2000 Education Attainment			
Pop Without HS Diploma	20.3%	25.2%	23.1
Pop With College Degree	18.6%	11.9%	12.8
2007 Income and Poverty			
Median Household Income	$51,247	$50,528	$36,360
Poverty, All Ages	9.4%	11.6%	10.3%
Child Poverty (Ages 0 to 17)	13.4%	16.7%	17.6%

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

2.5 The Land Use and Development Patterns of the Region

The development pattern in Sumner County is typical of an area on the edge of a major city. As noted by Bruegmann in his book, *Sprawl: A Compact History,* "Throughout [urban] history, as cities have become economically mature and prosperous, they have tended to spread outward at decreasing densities."[9] In the 1950s when suburban development started to spill out of Nashville and Davidson County, Sumner County was basically an agricultural county with Gallatin being a small city. The only other incorporated cities were Portland, Mitchellville, and Westmoreland, and all were very small. For example, Gallatin, the largest city in the county at that time, had a 1960 population of 7,901 according to the Tennessee Statistical Abstract. In 1960, the county was only 22 percent urban.

The impoundment of Old Hickory Lake in the mid 1950s was the catalyst for new development in the as yet unincorporated Hendersonville community and was a magnet for growth. After impoundment, suburbanization marked Hendersonville, and in a span of 30 years, it evolved from a southern farm village into a suburb similar to many others across the country. Another factor in the growth was the creation of the Hendersonville Utility District, which developed a water system. Once potable water became available, about two dozen subdivisions were developed, thus starting the trend. Hendersonville's population increased from 800 to more than 4,000 in the 1960s, while the county was adding over 20,000 people. No other county in Tennessee added people at such a rate. Three out of four of the new residents of the area moved into Sumner County, most of them from Davidson County.[10] Most of the city of Hendersonville is not in the study area; however, some parts of the city are, the areas that are served by the White House Utility

> The amount of land developed in Sumner County since 1950 represents 26% of the total land area in the county.

[9] Robert Bruegmann, *Spraw.: A Compact History,* The University of Chicago Press, 2005.

[10] See Takas pages 177, 319 and 324.

District. Hendersonville is significant to the study area because as the city has become larger in both population and area, growth and development has spread northward and to the east of the original city area into the service area of the White House Utility District.

Other nodes of urban development (clusters of houses or businesses) existed in small numbers at locations that are now incorporated such as White House and Millersville. Growth accelerated through the 1960s and set the pattern for the rest of the 20th Century. The dominant form of development was low-density residential sprawl, and it occurred rapidly in Hendersonville, which became a city in 1963 with a very small population base. During the 1970s, growth expanded in the Goodlettsville, Millersville, and White House areas, and these areas were subsequently incorporated as municipalities. Goodlettsville, already incorporated in Davidson County, annexed across the county line to take in territory in Sumner County. White House was incorporated in both Sumner and Robertson Counties. Millersville was incorporated in the early 1980s and subsequently annexed across the county line into Robertson County.

Currently, urban and suburban development that was once separated by open land and farmland has grown together. The cities of Gallatin, Hendersonville, Goodlettsville and Millersville have city limit lines that touch at various points, and White House touches Millersville in the Robertson County part of the cities. The pattern of development started out following the lakeshore from Davidson County to Gallatin. When I-65 was extended north out of Nashville along the Sumner and Robertson County borders, growth pushed along that corridor toward the Portland area. In the northern part of Sumner County, Portland has also experienced growth. In addition to population growth a great deal of the industrial growth in the county, has taken place in Portland, and the city has expanded westerly to the I-65 corridor along state highways 109 and 52 annexing into Robertson County. Westmoreland remains a small community in the more remote northeastern corner of the county.

Development has also occurred outside of the incorporated cities. Small rural communities such as Cottontown, Bethpage, and Castalian Springs, and subdivisions have been developed along the major highway corridors. A great deal of development has occurred over the last ten years west of Gallatin and north of Hendersonville along the Long Hollow Pike corridor into Goodlettsville. The area north of Gallatin between the cities of Portland and White House and the city of Westmoreland is basically rural with scattered pockets of subdivisions.[11]

The amount of land developed over time and the percentage breakdown by land use category can be derived from tax data. In 2009, developed land in Sumner County represented 25.9% of the total land area; developed land includes residential, commercial, industrial, and public and semi-public land use categories but does not include vacant, agricultural or timber tracts of land. It also does not include road and railroad rights-of-way, but there are over 10,000 acres of land or 3.1% of the county acreage consumed by rights-of way. The number of acres of land converted to residential, commercial, industrial, and public and semi-public land during the 2000s decade amounts to 14,831 acres. The total number of acres converted to a developed use in the 1990s was 14,406 acres and in the 1980s was 12,154 acres. Over that 30-year span, a total of 40,701 acres of land were developed. Since 1950 when the era of suburbanization began in earnest, a total of 89,982 acres of Sumner County has been developed. It should be noted here that these figures are for the total county including the Hendersonville area where much of the county's development has occurred.[12,13]

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[11] Field observations, 1980 through 2005.

[12] Tennessee Department of Economic and Community Development, Office of Local Planning Assistance, 2009. The Local Planning Assistance Office derived this land-use data by associating digital

Table 4 shows the acreage for each type of land use in Sumner County in 2009 broken down by the year in which a structure was first placed on it. For example, during the 1950s, structures were built on 2,816 acres of land now classified as residential. During the 2000s, structures were built on 12,932 acres that are currently residential. We cannot say for certain that these acreages were converted to residential development during those decades because their classification could have changed in the interim. But we can surmise that development of the kind indicated by its current land use classification occurred at about that time. If we do, then the data indicates that a total of 68,796 acres was converted to residential between 1950 and 2009, the year from which the data were drawn. It should be noted that this is a picture of one point in time and that interim changes in those categories could have occurred. Residential properties can be converted to commercial and commercial to industrial. Even so, the data do give an indication of how much land was developed each decade and that, as noted above, during the period covered by the table; a total of 89,982 acres of land was developed. Although many agricultural and timber tracts contain houses, mobile homes, or other improvements, these uses are not included in the "developed lands" category because of the low intensity of these uses. Consequently, agricultural and timberland along with vacant lots and small parcels are not included in the table. The total acreage consumed for these categories is 234,926 acres.

Table 4. Sumner County Acreage by Decade of Construction and by Land Use Type in 2009

Land Use	1950s	1960s	1970s	1980s	1990s	2000s	No AYB*	AYB Prior to 1950*	Total
Residential	2,816	6,349	9,789	10,072	12,091	12,932	9,980**	4,767	68,796
Commercial	105	418	302	586	492	763	165	205	3,036
Industrial	60	353	519	565	610	325	4	38	2,474
Public/Semi-Public	18	41	139	101	61	121	7,497	266	8,013
Unavailable***							73	--	73
Unclassified****	381	798	839	830	1,152	690	1,542	1,358	7,590

* 'AYB' refers to the field in the property assessment database: "Actual Year Built". This column in the table indicates the area included in each land use category for which a year of construction is not available. Parcels with structures that have been torn down and removed are not included in this total. The actual year built is reported only for parcels with existing structures.

** Of the nearly ten thousand residential acres for which an actual year built is not reported, 76 percent (7,626 acres) have one or more mobile homes located on the property. It is for this

parcel boundaries from the Tennessee Base Mapping Program with parcel attribute data maintained in the Comptroller of the Treasury's Computer Assisted Appraisal System database. Each parcel was assigned to one of the land use classes based on attributes contained in these two data sources or from examination and assignment by the planning staff. The Base Mapping Program parcel dataset was obtained on December 30, 2009 and Computer Assisted Appraisal System database on December 2, 2009."

[13] Note: This data was not generated for Robertson County because only a small amount of the eastern part of the county is included in the study area.

reason that they are included in the residential category. The remaining 24 percent (2,353 acres) of the residential area with no year built reported comprise developed lots with accessory structures and uses, such as garages, pools, and pool houses on separate lots but for which no year built is reported. Because of their nature as ancillary uses to residential properties these parcels are included in the residential category.

*** This category includes parcels that are not classified by the land-use model because data is not available in the Computer Assisted Appraisal System for those parcels.

**** This category refers to parcels that are not classified by other sections of the land use model.

As population has grown and land has developed, land in farms has declined. This is a long-term trend, but Table 5 shows the trend between 2002 and 2007, the dates of the most recent Census of Agriculture. During that five-year period, Sumner County lost almost 10,000 acres of farmland, a decline of 5.2%, and 284 farms, a decline of 14.5%. This figure generally correlates with the figures in Table 4 that show a total of 14,831 acres being developed during the 2000s decade and with the population growth from 2000 to 2009 of 28,310. The average size of farms increased from 99 to 110 acres. Robertson County experienced similar loses. Over 6,000 acres of farmland was lost, a decline of 2.6%, and the number of farms dropped by 213, a loss of 13.1% while the average size of farms increased from 144 to 161 acres.

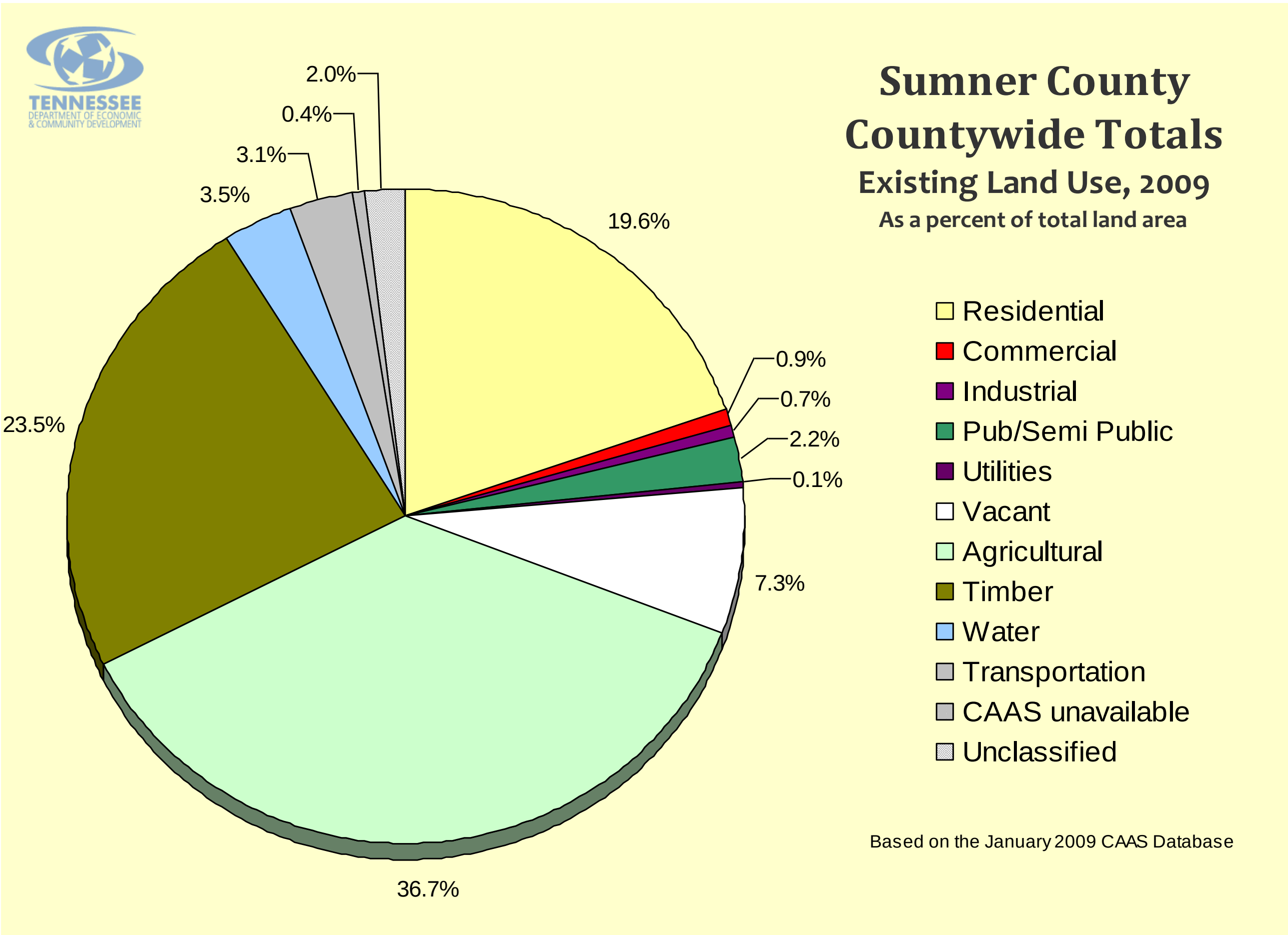
Table 5. Trends in Farmland, Sumner and Robertson Counties 2002 and 2007

	Sumner County	Percent Change	Robertson County	Percent Change
Number of Farms				
2007	1,673	-14.5%	1,408	-13.1%
2002	1,957		1,621	
Land in Farms (Acres)				
2007	183,419	-5.2%	227,298	-2.6%
2002	193,386		233,317	
Average Size of Farms (Acres)				
2007	110	11.1%	161	11.8%
2002	99		144	

Source: U.S. Department of Agriculture, *Census of Agriculture, 2002, Census of Agriculture-County Data, 2007.*

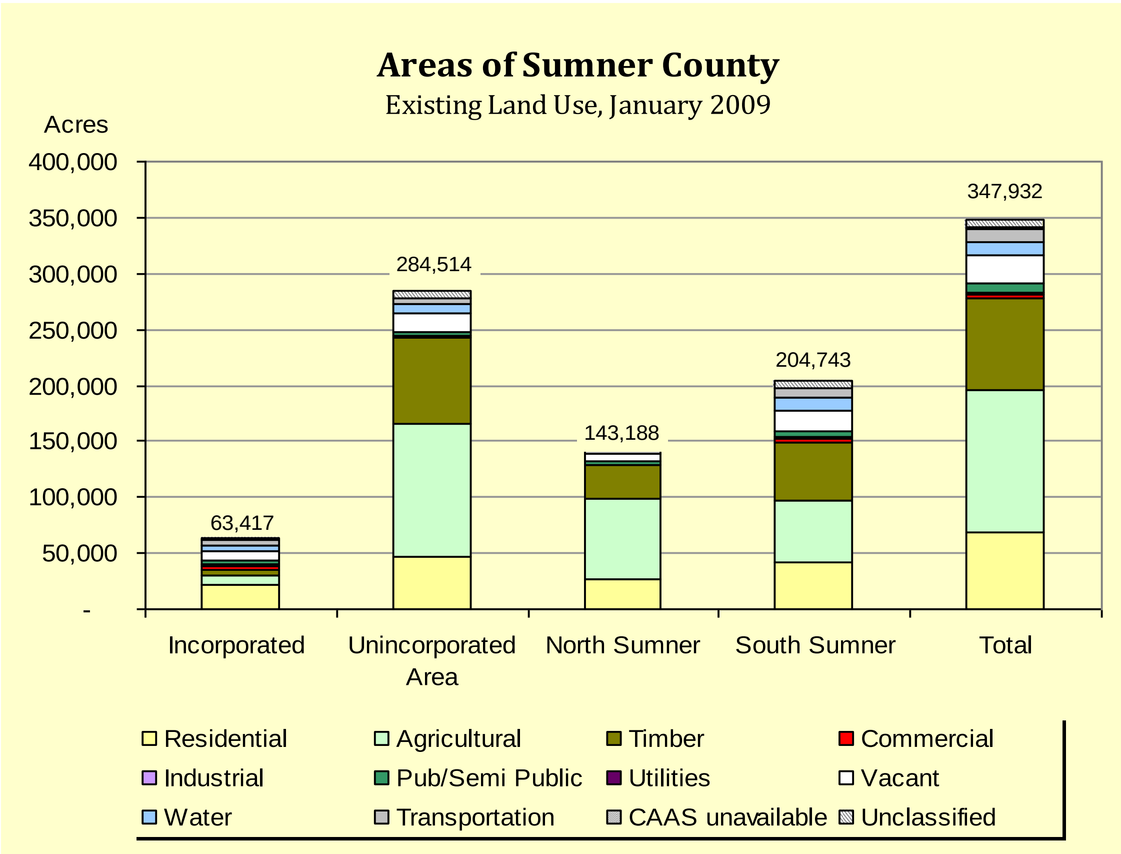
Figure 2 below shows existing land use in 2009 for Sumner County. The three largest categories of individual land uses are, in order, agricultural, timber and residential. Agricultural and timber lands still cover 60.2% of the county. An additional 7.3% is vacant land. As noted previously, over 25% of the total county is in a developed category.

Figure 2.



The next chart below shows the land use categories for 2009 and illustrates the differences in North Sumner and South Sumner as well as the unincorporated area of the county and the incorporated municipalities.

Figure 3.



Figures 4 and 5 illustrate those differences showing the more rural nature of the North Sumner area.

Figure 4.

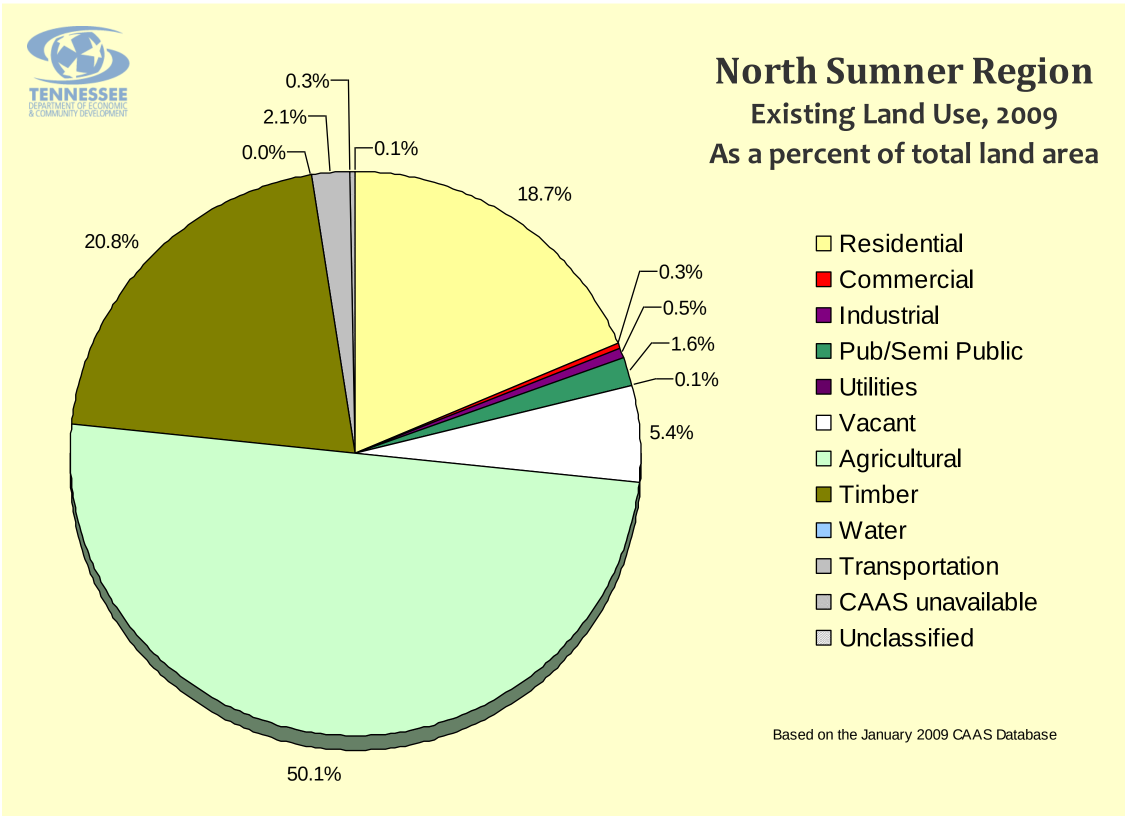

TENNESSEE
DEPARTMENT OF ECONOMIC & COMMUNITY DEVELOPMENT
North Sumner Region
Existing Land Use, 2009
As a percent of total land area
18.7%
0.3%
0.5%
1.6%
0.1%
5.4%
50.1%
20.8%
0.0%
2.1%
0.3%
0.1%
Residential
Commercial
Industrial
Pub/Semi Public
Utilities
Vacant
Agricultural
Timber
Water
Transportation
CAAS unavailable
Unclassified
Based on the January 2009 CAAS Database

Figure 5.

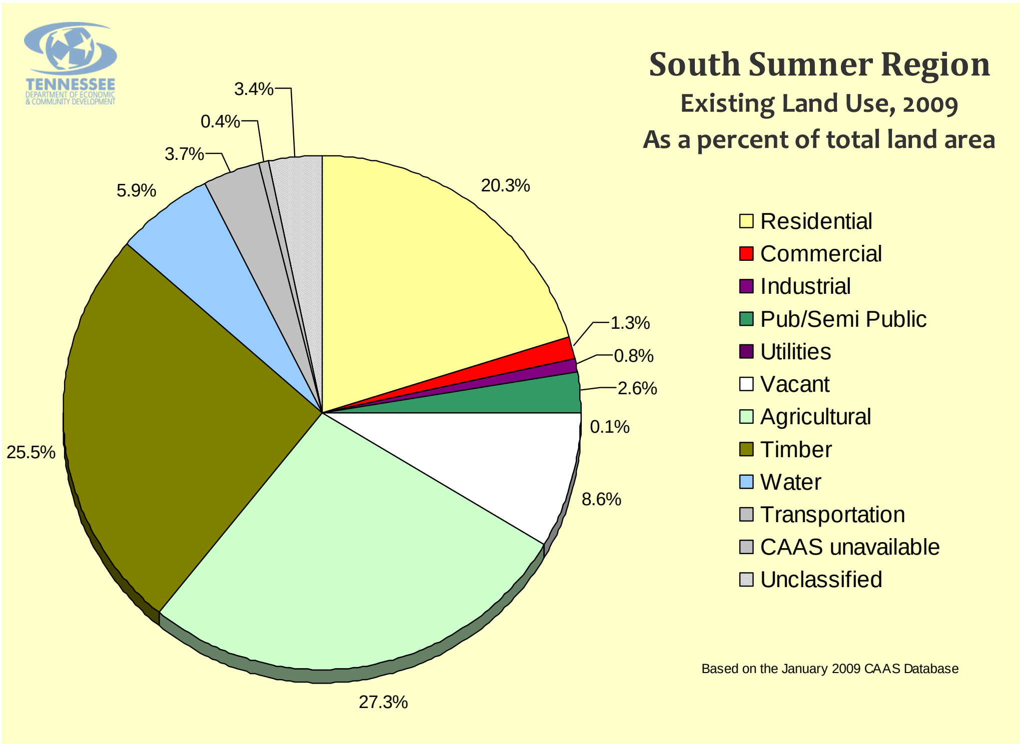
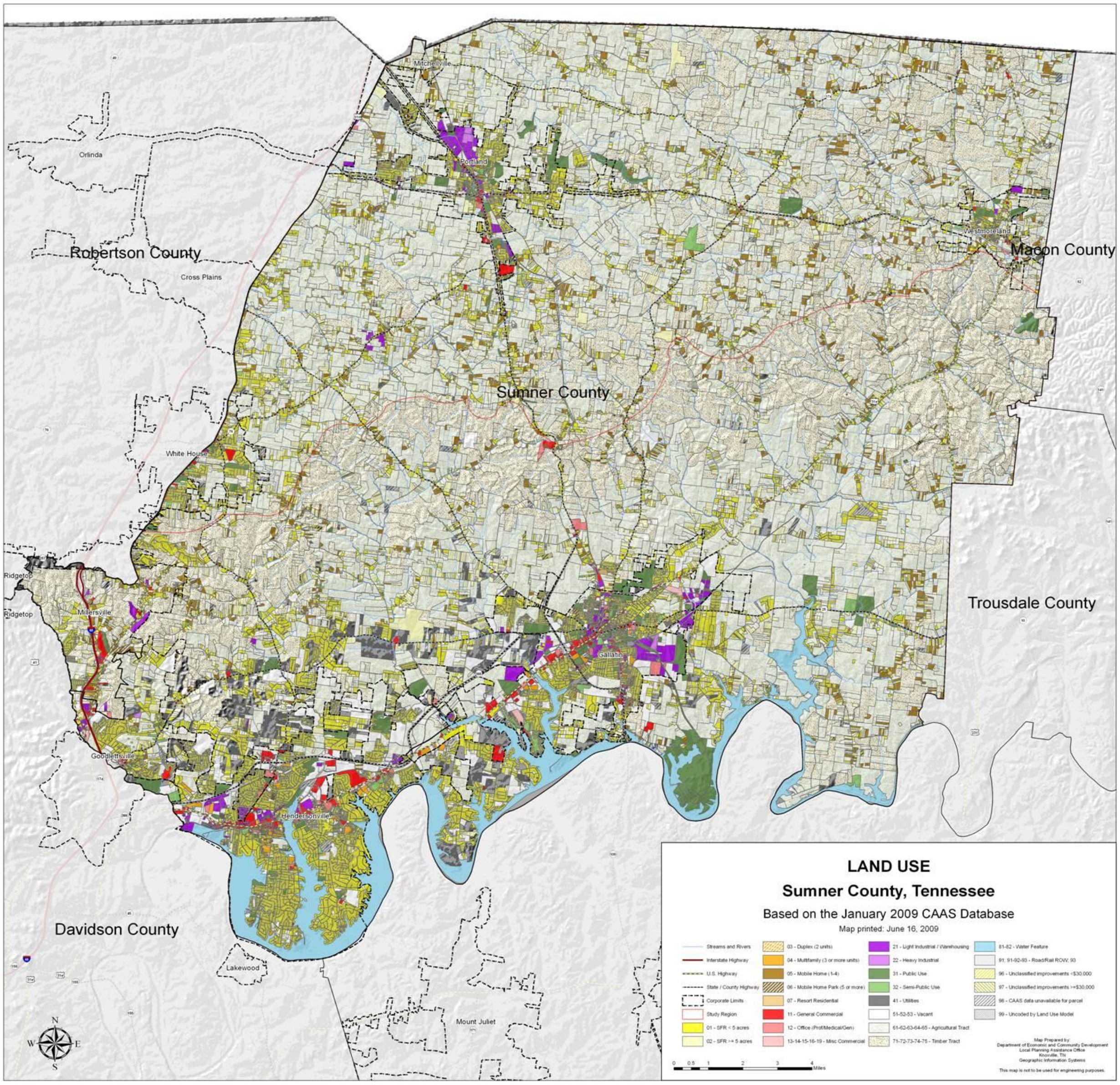


Figure 6 is a land use map that shows the spatial pattern of the different land uses across Sumner County. The concentration of development in the southern part of the county is plainly evident. The map also shows the development of the Portland area and the I-65 corridor along the Robertson County line.

Figure 6.



The recession of 2008-2009 slowed land development in Sumner County as well as in other areas. Even so, there are a number of vacant residential building lots available in the county. When the housing market picks up again, these lots could be a source of further population growth. According to information provided by the Office of Local Planning Assistance, Sumner County had 6,984 vacant recorded lots of record in 2009, 4,919 in the southern section of the county and 2,065 in the northern section. At Sumner County's average household size of 2.6 persons per household (see Table 3), this number of vacant lots translates into a population of 12,789 and 5,369 respectively.

2.6 The Economy of the Region

Sumner County has a diversified economy much like the other counties in the Nashville Metropolitan area. While there are many local employment opportunities, a large amount of the labor force commutes into Davidson County. During the last five to seven years, retail development has become much more prominent in the county with the development of major retail centers in Gallatin and Hendersonville.

Historically, Gallatin was the center of economic activity in the county with a retail center and a complement of basic old-line southern industries. Over time, that has changed, as has the character of the local economy. During the 1970s, the City of Portland began an aggressive industry recruiting program that was very successful, and Portland developed a large industrial base. The types of industries changed with the location of more technologically diverse firms along with fabrication and distribution activities. During the 1990s and into the early 2000s, commercial development became to be a more important part of the economy as manufacturing jobs began to decline with the relocation of industry to other parts of the world. Table 6 shows employment by major industrial groups for selected years of 2001, 2004, and 2007 and highlights the changes in the local economy that have taken place over time. The biggest changes are in the decline in manufacturing jobs from 18% of total employment to 12.0% and the introduction of health care, social assistance services, accommodation, and food services as major sources of employment. Table 7 shows the top five employers in the county.

Table 6. Employment by Place of Work and by Sector
2001, 2004 and 2007

Empl. By Place of Work	2001	% of Total	2004	% of Total	2007	% of Total
Farming	2,288	4.6	2,217	4.1	2,023	3.5
Forestry, Fishing & other	166	0.3	157	0.3	180	0.3
Mining	22	0.03	18	0.03	20	0.03
Utilities	D	---	D	---	D	---
Construction	3,918	7.8	4,228	7.8	5,396	9.2
Manufacturing	9,034	18.0	7,917	14.7	7,032	12.0
Wholesale Trade	2,100	4.2	2,012	3.7	D	---
Retail Trade	5,526	11.0	5,992	11.1	6,483	11.1
Transport & Warehousing	D	---	D	---	2,513	4.3
Information	458	0.9	400	0.7	614	0.1
Finance & Insurance	1,685	3.4	1,772	3.3	1,912	3.3
Real Estate	1,369	2.7	1,683	3.1	2,391	4.0
Professional, Scientific & Technical Services	1,989	4.00	2,419	4.5	2,232	3.8
Management of Companies	161	0.3	356	0.6	425	0.7
Administrative & Waste Services	3,096	6.2	2,810	5.2	2,807	4.8
Education Services	291	0.6	365	0.7	479	0.8
Health Care & Social Assist.	4,063	8.1	4,827	9.0	5,719	9.8
Arts, Entertainment & Recreation	643	1.3	744	1.4	855	1.5
Accommodation & Food Service	398	4.8	2,798	5.2	3,528	6.0
Other Services except Public Admin.	3,104	6.2	3,634	6.7	3,987	6.8
Government & Government Enterprises	6,667	13.3	7,055	13.1	7,517	12.9
Federal						
Civilian*	467	0.9	483	0.9	473	0.8
Military*	505	1.0	490	0.9	510	0.9
State & Local*	5,705	11.4	6,082	11.3	6,534	11.2
Total	50,155	**	53,890	**	58,480	**

Source: Regional Economic Information System, Bureau of Economic Analysis, U. S. Department of Commerce.

D means the data was not reported.

*Included under Government & Government Enterprises

** Percent will not total 100% due to unreported data.

Table 7. Major Employers in Sumner County, 2009

Business	BusinessActivityType	City	NumberofEmployees
SumnerRegionalMedicalCenter	HealthCare	Gallatin	1,326
Gap,Inc.	ClothingDistribution	Gallatin	1,250
VolunteerStateCommunityCollege	Education	Gallatin	800
HendersonvilleMedicalCenter	HealthCare	Hendersonville	500
Macy's/Bloomingdale's	OnlineDistributionCenter	Portland	500
Peyton'sMid-South	SupermarketDistributionCenter	Portland	475
FDS,Inc.FederatedDepartmentStores	DistributionCenter	Portland	409
RRDonnelley&Sons	Binding	Gallatin	320
ABCFuelGroupSystems	AutoFuelSystems	Gallatin	305
Unipress	PressedMetalParts	Portland	300
Thomas&BettsCorporation	ElectricalBoxes	Portland	270
KirbyBuildingSystemsCo.	PrefabricatedSteelBuildings	Portland	270
SERVPROIndustries,Inc.	Cleaning&Restoration CorporateHeadquarters	Gallatin	254
Walmart	RetailMerchandise	Hendersonville	200
DigitalConnections,Inc.	DataCommunications	Hendersonville	200
Lowe'sMillwork	Door/WindowManufacturing	WhiteHouse	200
HoeganaesCorporation	PowderedMetal	Gallatin	197
TVAGallatinFossilPlant	ElectricPower	Gallatin	175
AladdinGroupAdministrators	InsulatedFood	Hendersonville	175
AlbanyInternationalFabrics	PaperMachineClothing	Portland	165

Source: Sumner Country Construction and Development Department, *2035 Comprehensive Plan, Sumner County's Blueprint to the Future,* 2009.

Note: This table does not include the Sumner County government, which employs 3,900, mostly within the school system.

Commuting to work across county lines is a growing phenomenon on the study region. Both counties with areas in the study region have been growing faster than the state as a whole, and commuting to other counties is increasing even more rapidly. According to the 1970 federal census, most working residents of both counties held jobs in their home counties. While that has changed, it has changed more in Robertson County than in Sumner County. Across the state, around three quarters of workers reside in the same county where they're employed, but in Sumner County about half work outside their home counties, and in Robertson County, more than half do. (See Table 8.)

Table 8. Commuting by Residents of Study Area Counties, 1970 and 2000

	Residents working . . .				
	in Home County		***Elsewhere***		
		Percent of Total		**Percent of Total**	**Total**
Robertson County					
1970	6,432	60.6%	4,181	39.4%	10,613
2000	11,860	43.9%	15,149	56.1%	27,009
Growth	84.4%		262.3%		154.5%
Sumner County					
1970	11,506	52.7%	10,319	47.3%	21,825
2000	31,920	49.8%	32,224	50.2%	64,144
Growth	177.4%		212.3%		193.9%
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.

Most of the study region's working residents who do not work in their home county work in Davidson County. This was as true in 1970 as it was in 2000. Nearly as many new residents of Sumner County found work in Davidson County as did in their home county, and more new residents of Robertson County found work in Davidson County (see Table 9). This trend toward living in one county and working in another presents challenges for the home county.

Table 9. Year 2000 Work Location of New Study Area Residents Since 1970

	in Home County	Davidson County	Elsewhere	Total
Robertson County				
Increase 1970 to 2000	5,428	8,692	2,276	16,396
Percent of Total	33.1%	53.0%	13.9%	100.0%
Sumner County				
Increase 1970 to 2000	20,414	19,085	2,820	42,319
Percent of Total	48.2%	45.1%	6.7%	100.0%

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 two counties work in Davidson County is that the number of working residents in those counties outnumbers the number of jobs there based on data from the 2000 federal census:

- Robertson County: 27,009 workers (see Table 8) versus only 16,154 jobs (see Table 10) or 1.7 working residents per job in the county.

- Sumner County: 64,144 workers (see Table 8) versus 43,340 jobs (see Table 10) or 1.5 working residents per job.

While a number of workers commute into Robertson and Sumner 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 10.)

Table 10. Commuting Into and Out of Counties in the Study Area
1970 and 2000

	Workers Commuting Out	Workers Commuting In	Number of Jobs in County*
Robertson County			
1970	4,181	395	6,827
2000	15,149	4,294	16,154
Growth	262.3%	987.1%	136.6%
Sumner County			
1970	10,319	1,704	13,210
2000	32,224	11,420	43,340
Growth	212.3%	570.2%	228.1%

*Based on number of workers reported in the Census.

Source: U.S. Census Bureau.

Personal income in the study region has grown faster than in the state as a whole, but so has population. Consequently, personal income per capita has grown at about the same rate as it has for all of Tennessee. Job growth in the two counties has been faster than it has statewide, and because wages have grown faster than in the state as a whole, the average wage in the two counties studied has grown slightly faster than it has for the entire state. But jobs have grown only about as fast as the population in the area, while they have grown faster statewide, so the number of jobs per 100 people living in the area remains much lower than for the state as a whole. (See Table X.)

Table 11. Income and Wages in the Study Area
2008 and Growth Since 1969

	Tennessee		Robertson		Sumner	
	2008	**Annual Growth Since 1969**	**2008**	**Annual Growth Since 1969**	**2008**	**Annual Growth Since 1969**
Personal income ($000)	$217,372,834	7.8%	$2,105,869	8.7%	$5,413,477	9.2%
Population	6,240,456	1.2%	65,424	2.1%	155,704	2.8%
Per capita personal income (dollars)	$34,833	6.5%	$32,188	6.4%	$34,768	6.2%
Wage and salary disbursements ($000)	$114,036,158	7.1%	$626,567	8.7%	$1,637,146	9.3%
Wage and salary employment	2,889,264	1.7%	19,791	3.2%	46,570	3.7%
Wage and salary disbursements per Job	$39,469	5.2%	$31,659	5.4%	$35,155	5.5%
Jobs per 100 Persons	60.2	0.7%	45.4	0.5%	37.5	0.4%
Proprietors' income ($000)	$26,393,948	8.0%	$254,718	7.1%	$396,251	7.5%
Proprietors employment	870,305	2.7%	9,915	1.8%	11,742	1.8%
Proprietors' income per Proprietor/Partner	$30,327	5.1%	$25,690	5.2%	$33,746	5.6%
Farm income ($000)	$127,627	-1.8%	$45,453	3.4%	-$4,363	n/a
Farm proprietors' income	-$70,605	n/a	$36,401	3.1%	-$7,458	n/a

Source: U.S. Bureau of Economic Analysis.

With more study area residents working outside their home counties than inside them, the planning region can aptly be described as a bedroom community. Based on data from the last federal census (2000), the largest job sectors for area residents were manufacturing and services, followed by wholesale and retail trade, and then state and local government in Sumner County and self employment in Robertson County. The sector most likely to provide substantially more jobs outside the area than inside it was the information, finance and insurance, and real estate sector followed by the utilities and transportation/warehousing sector.

Table 12. Where Study Area Residents Worked in 2000

	In Home County		Elsewhere		Total	
Job Sector and County	**Number**	**Percent**	**Number**	**Percent**	**Number**	**Percent**
Sumner Residents	**31,920**	**100.0%**	**32,224**	**100.0%**	**64,144**	**100.0%**
Forestry + Fishing + Ag support + Farms + Mining	175	0.5%	64	0.2%	239	0.4%
Utilities + Transportation and Warehousing	860	2.7%	1,564	4.9%	2,424	3.8%
Construction	1,745	5.5%	1,808	5.6%	3,553	5.5%
Manufacturing	6,115	19.2%	4,853	15.1%	10,968	17.1%
Wholesale Trade + Retail Trade	4,875	15.3%	6,608	20.5%	11,483	17.9%
Information + Finance and Insurance + Real Estate	2,050	6.4%	3,293	10.2%	5,343	8.3%
Services (except private households)	8,000	25.1%	8,976	27.9%	16,976	26.5%
Private households	35	0.1%	-	0.0%	35	0.1%
Federal civilian + Military	430	1.3%	687	2.1%	1,117	1.7%
State and local government	3,895	12.2%	2,603	8.1%	6,498	10.1%
Self-employed (part) + Unpaid family workers	3,740	11.7%	1,768	5.5%	5,508	8.6%
Robertson Residents	**11,860**	**100.0%**	**15,149**	**100.0%**	**27,009**	**100.0%**
Forestry + Fishing + Ag support + Farms + Mining	200	1.7%	79	0.5%	279	1.0%
Utilities + Transportation and Warehousing	220	1.9%	758	5.0%	978	3.6%
Construction	610	5.1%	1,301	8.6%	1,911	7.1%
Manufacturing	3,040	25.6%	2,476	16.3%	5,516	20.4%
Wholesale Trade + Retail Trade	1,645	13.9%	2,637	17.4%	4,282	15.9%
Information + Finance and Insurance + Real Estate	425	3.6%	1,491	9.8%	1,916	7.1%
Services (except private households)	2,455	20.7%	3,700	24.4%	6,155	22.8%
Private households	40	0.3%	14	0.1%	54	0.2%
Federal civilian + Military	90	0.8%	481	3.2%	571	2.1%
State and local government	1,410	11.9%	1,206	8.0%	2,616	9.7%
Self-employed (part) + Unpaid family workers	1,725	14.5%	1,006	6.6%	2,731	10.1%

Source: Regional Economic Information System, Bureau of Economic Analysis, U.S. Department of Commerce.

1.8 The Governments of the Region

Within Sumner County, there are eight municipalities in addition to the county government. These include the county seat of Gallatin, Hendersonville, Goodlettsville, Millersville, Mitchellville, Portland, Westmoreland, and White House. (include map) Within Robertson County, there are eleven municipalities, six of which are located in the study area where water services are provided by the White House Utility District. These are Orlinda, Cross Plains, Ridgetop, and parts of Portland, White House, and Millersville.

With the exception of Mitchellville, all of the cities and the county have a planning commission and a planning program of some kind, and some have full-time planning staffs. Additionally, the Cities of Gallatin, Hendersonville, Goodlettsville, White House, and Portland have planning regions outside of, but adjoining, the city. All governmental entities in the planning area have an approved growth plan as required by state law.

Table 13 shows that all governmental entities in the study area have a planning commission and have adopted subdivision regulations and zoning ordinances. The importance of this is that each government has the ability to plan for their future population and land development and link into this water supply plan for an assessment of long-term water needs. 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. The table also shows that some of the entities have a long-range plan. It is not known if those plans include sections on water supply and growth issues or whether the plans are used in making policy decisions.

Table 13. Status of Planning, 2009

County/City	Planning Commission	Long-Range Plan*	Subdivision Regulations	Zoning
Sumner County	Yes	Yes	Yes	Yes
Gallatin	Yes	Yes	Yes	Yes
Goodlettsville	Yes	Yes	Yes	Yes
Hendersonville	Yes	Yes	Yes	Yes
Millersville	Yes	Yes	Yes	Yes
Portland	Yes	Yes	Yes	Yes
Westmoreland	Yes	No	Yes	Yes
White House	Yes	No	Yes	Yes
Robertson County	Yes	No	Yes	Yes
Cross Plains	Yes	No	Yes	Yes
Orlinda	Yes	No	Yes	Yes
Ridgetop	Yes	No	Yes	Yes

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

* Based on local interviews.

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.[14]

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.[15] 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.[16]

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.[17] All of the governments and their planning programs should explore how they can use these techniques for development to protect their water supplies.

1.9 The Utilities of the Region

There are five major water systems in the study area. Some of these systems serve as both suppliers and distributors, while others are wholesale water providers:[18]

- The Castalian Springs-Bethpage Water Utility District serves the towns of Castalian Springs, Bethpage, and portions of Sumner County. Castalian Springs and Bethpage are located in the Cumberland River Basin.
- Gallatin Public Utilities provides water, natural gas, and wastewater services to residential, business, and industrial customers in the City of Gallatin and areas outside the City's corporate limits. The Department also sells water to the Town of Westmoreland and the Castalian Springs-Bethpage Utility District. The Department has

[14] 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,
[15] 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.
[16] 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.
[17] See http://www.epa.gov/owow/NPS/lid.
[18] Except as otherwise indicated, the information presented here is from the U.S. Army Corps of Engineers Phase 1 report in Appendix B of this report.

a total of 80 employees in the water, natural gas, and sewer divisions.[19] Gallatin is located in the Cumberland River Basin.

- The city of Portland's Public Works Department operates the city's water and wastewater systems and serves its own residents, as well as portions of northwest Sumner and northeast Robertson Counties.[20] Portland's service area lies in both the Cumberland River Basin and the Barren River Basin.

- The city of Westmoreland's public works department operates the city's water and wastewater systems and residents of Westmoreland, as well as portions of Macon and Sumner Counties.[21] Westmoreland's service area lies in both the Cumberland River Basin and the Barren River Basin.

- The White House Utility District is one of the largest water and sewer utilities in the state, serving a population of 78,000 with 29,000 connections over a 600-square-mile area that includes portions of Sumner, Davidson, and Robertson counties. The largest water district in the state by geographic area, it serves areas extending from White House north toward Portland, south toward the cities of Gallatin and Hendersonville and west to the eastern portions of Robertson County. They also provide wholesale service to Simpson County, Kentucky. Staff comprise a 75-member team of technicians, customer service representatives, engineers, and treatment plant personnel.[22] White House Utility District is located in the Cumberland River Basin.

According to information from two recent surveys of water prices in Tennessee,[23] Gallatin has the lowest water prices in the study region for residential customers living inside the city. A customer using 5,000 gallons per month, which is close to average, paid $18.58 in 2009, the year of the study. Residents of Portland paid a similar price for 5,000 gallons per month ($18.93). Residential customers living outside the city of Gallatin, but served by its water department paid the next lowest price at $29.76 for 5,394 gallons.[24] The highest residential water prices in the region were paid by customers of the Castalian Springs-Bethpage Utility District ($42.05 for 5,000 gallons), customers of Portland living outside the city limits ($46.90 for 5,394 gallons), and customers of Westmoreland living outside the city limits ($55.22 for 5,394 gallons). Residents of Westmoreland living inside the city and customers of the White House Utility District paid prices that fell in the middle of the range for the region. (See Table 14.)

A comparison of water prices to income indicates that water in the region is priced affordably 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. Water prices for customers in Gallatin and Portland are well below that threshold. They are close to that threshold for customers of Gallatin living outside the city, for residents of Westmoreland, and for customers of the White House Utility District who live in Sumner County.

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[19] http://www.gallatinutilities.com/. Accessed on 14 September 2010.

[20] http://www.cityofportlandtn.gov/ContentPage.aspx?WebPageId=14830&GroupId=3443. Accessed on 14 September 2010.

[21] http://www.westmorelandtn.com/city_of_westmoreland.htm. Accessed on 14 September 2010.

[22] http://www.whud.org/about_us.htm. Accessed on 14 September 2010.

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

[24] Ibid. The survey of "outside" rates was based on an "average" bill of 5,394 gallons.

Prices White House customers living in Robertson County have slight lower median household incomes and fall slightly above that 0.75% threshold. Residential customers of the Castalian Springs-Bethpage Utility District and those of Portland and Westmoreland, but living outside those cities, pay water prices that are considerably higher than that threshold, suggesting that water service in those areas of the study region are less "affordable" by that standard. (See Table 15.)[25]

[25] Ibid, Table 6 and related text.

Chapter 2. Assessment of Current Sources and Capacity

2.1 Overview

The North Central Tennessee study region relies on few water supply sources. Old Hickory Lake is by far the largest water supply source in the region, and is directly or indirectly the source of water for most public utilities in the area. Gallatin and White House Utility Districts withdraw water directly from the Lake. Castalian Springs and Westmoreland meet the majority of their demand by buying water from Gallatin. The City of Portland, which relies on small surface water sources for water supply, is the exception in the study area, and is the most susceptible to drought impacts. Several of the utility districts have emergency supply contracts with other utility districts outside of the study area.

Water Quality. Generally, the water quality of the North Central study area is good, but not without contaminants. Disinfection by-products were common in the water samples from all of the area's utilities, with bromodichloromethane and total haloacetic acids (HAA5) being the most common. The area includes several types of small industrial businesses and hazardous waste generators, such as gas stations, dry cleaners, and tool and dye working shops. In addition, highways, rails, and boat traffic provide some pollution risk. Gallatin, however, was the only utility that expressed concern about meeting drinking water standards.

Perhaps the biggest potential threat to source water quality is the Tennessee Valley Authority's Gallatin Fossil Plant, which burns coal to produce electricity. Under normal circumstances, the plant's surface impoundments should not pose a risk to drinking water in Old Hickory Lake, but a failure or breach of one of the plant's impoundments, or a sudden and catastrophic flood could release collected waste.

Supply. The Cumberland River and Old Hickory Lake provide adequate water supplies for most of the North Central study area, except for the City of Portland which lacks access to these sources. Portland relies on West Fork Drakes Creek with an emergency connection to Portland City Lake, used only in the summer months. ***Add summary info on WFDC here when known.See later note.***

Based on the U.S. Army Corps of Engineers' hydrologic modeling system, Portland City Lake has an average inflow of approximately 1.09 million gallons per day. Using the sequent peak algorithm for the period of record simulation, the calculated firm yield was 0.417 MGD for the storage estimate of 88.6 MG. The critical drought sequence began in April of 1963 and reached the peak cumulative deficit in March of 1964, for approximately 11 months.

Water Conservation Programs. The North Central Study area has few initiatives to actively reduce demand by consumers. The utilities do not manage any retrofit, rebate, or fixture replacement programs, and were generally unfamiliar with the concept. Some of the utility districts have large water users, and though they have not performed any water audits, most managers suggested that they had considered or would be receptive to ways to better manage demand by large users.

Most of the utilities do not yet use automated meters for customer connections. Water treatment plant operators closely monitor pumping rates, tank levels, and flow through the master meters. This monitoring, in addition to customer calls and complaints, is the primary manner in which leaks are detected. Some of the utility districts (Gallatin and White House) have made initial investments to improve leak detection by using better information systems and installing more sensing devices (e.g. zone meters) throughout the distribution system. The region has an opportunity to upgrade monitoring of all types of water usage (including flushing and fire usage), and could improve monitoring and detection of leaks. Leak detection surveys, and eventually, real-time leak monitoring could significantly reduce the total water lost to leaks. Many of the utilities expressed interest in reducing their leakage rates. Capital improvements, such as those being implemented by White House Utility District, can play a role in reducing UAW by improving the hydraulics of the system, replacing older pipes, and improving circulation to reduce the need for flushing.

Educating consumers about water conservation is a strategy used by several of the utilities. At a minimum, the utilities include water saving tips with official mailings to customers such as bills or newsletters. In addition, some of the utilities have 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 enactment of plumbing codes and water conservation ordinances in areas that do not currently have them.

2.2 Introduction

Background

The initial study area for the North Central regional water supply planning pilot study covered five counties: Robertson, Sumner, Macon, Trousdale, and Wilson counties, including the towns of Portland, Gallatin, Hartsville, Castalian Springs, Bethpage, White House, Lafayette, and Westmoreland. This geographical region includes parts of the Barren River Basin, the Red River Basin, and the Lower Cumberland River-Old Hickory Lake Basin. The Barren River discharges directly into the Ohio River Basin; the Red River and Old Hickory Lake are both in the Cumberland River Basin, which is a part of the Ohio River Basin. The study area was narrowed to include only the cities of Portland, Westmoreland, and Gallatin, and the White House and Castalian Springs-Bethpage utility districts because of their many inter-connections and because they buy from and sell water to each other in significant quantities daily.

Lafayette was not included for further study because its inter-connections with the other utilities are limited to emergency connections. Lafayette also has three of its own water supply sources, one being the Barren River. Lafayette plans to purchase water from Hartsville's new water plant when it is operational, which will eliminate the need to purchase water from Westmoreland during emergencies. Hartsville was not studied further because it relies directly on the Cumberland River-Old Hickory Lake and, consequently, does not face future water shortages. Hartsville also has only one non-emergency inter-connection within the study area (to Castalian Springs-Bethpage Utility District), and the water Hartsville supplies is an insignificant portion of the total water demand in the region.

Water sources in the North Central study area include groundwater, surface water, and connections to other utilities, but the Cumberland River and Old Hickory Lake supply most of the water used by public utilities. Some parts of the area, however, rely on smaller sources and face challenges in times of drought. The Barren River also supplies some parts of the study area.

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, but the driving forces behind the study were the risk and effects of extreme drought and the high rate of growth in the area. Because of the area's heavy reliance on surface water, drought is one of the biggest risks to the region's water supplies. 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.

Table 2-1 lists the primary water supply sources and storage capacities for the five major utilities in the North Central study area.

Table 2-1. Water Supply Sources

Utility	**Water Supply Source**	**Storage Capacity** (million gallons)
Gallatin	Cumberland River-Old Hickory Lake	152,000
Portland	West Fork Drakes Creek (Primary)	-
	Portland City Lake (Emergency)	88.6
White House Utility District	Cumberland River-Old Hickory Lake	152,000
Bethpage-Castalian Springs Utility District	Buys water from Gallatin, Hartsville, and Westmoreland	N/A
City of Westmoreland	Buys water from Gallatin	N/A

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" (for only the Portland City Lake), and current conservation and demand-management efforts.

Water Quality. In addition to susceptibility to drought, the North Central study area's reliance on surface water makes it more vulnerable to water quality problems than areas that rely primarily on groundwater. Potential threats to water sources in the region were examined by identifying local activities that may have a detrimental effect on water quality and by investigating EPA-regulated facilities in the watershed that may pose a risk to water sources. The EPA's Envirofacts mapping program was utilized and includes data compiled from the National Pollutant Discharge Elimination System (NPDES). 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 were 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. Firm yield estimates for this study are based on the hydrologic modeling system developed by the U.S. Army Corps of Engineers Hydrologic Engineering Center.

Firm yield cannot be calculated for a stream source because there is no significant storage on which to base the calculations. Instead, the stream flow is analyzed to determine the number of days per year that flow is less than a specified amount at various time intervals.

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 section outlines their responses and describes current conservation programs. In the North Central Tennessee 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 North Central study area's water come primarily from small business and residential users.

2.3 Old Hickory Lake—The Region's Main Water Source

Old Hickory Lake, the water source for all of the utilities in the study region except Portland, is one of several lock and dam projects on the Cumberland River and is located in portions of Davidson, Sumner, Wilson, Trousdale, and Smith Counties. The primary purpose of Old Hickory is for navigation and hydropower. Additional operating purposes include recreation, fish and wildlife, water quality, and water supply. Although storage space is not allocated for water supply either permanently or temporarily, water is withdrawn for municipal and industrial purposes. During drought, consideration is given to keeping the lake level above supply pipe intakes. The average storage capacity of Old Hickory Lake is 467,000 acre-feet (152,000 million gallons). The minimum and normal tail-water surface elevations are 382 feet and 385 feet respectively. The minimum and normal headwater surface elevations are 442 feet and 445 feet. The water surface elevation behind Old Hickory Dam is normally maintained within the hydropower pool limits, and all normal releases are made through the turbines. Flood flows pass through gates atop the 355-foot long spillway. Because of the complexity of operations and for legal and policy reasons, the firm yield of Old Hickory Lake was not determined.

2.4 White House Utility District

White House Utility District withdraws its water supply from Old Hickory Lake. The utility has three intakes located on the lake in Hendersonville, Tennessee. On peak days in the summer, White House purchases water from Gallatin and Springfield. On average, they purchase 1 MGD from Gallatin and 0.25 MGD from Springfield during this time to fulfill their water demand. White House sells, on average, 1.6 MGD of water to Simpson County, Kentucky, during dry summer months. White House has a 14 million gallon storage capacity, which provides 33.6 hours of supply based on average gross water use.

White House has an inter-basin transfer permit that allows it to sell water to Portland and to Simpson County, Kentucky. The permit is necessary because both utilities provide services in the Barren River watershed. The transfer rate for White House is a total of 1.751 MGD, which includes 1.001 MGD that was grandfathered in when the permitting system was established and 0.75 MGD by permit.

White House has no constraints on expansion and plans to expand both treatment and distribution. When the utility district reaches 90% of capacity, it will upgrade its water treatment plant, which is currently at 80% of capacity. In 2013, a new plant is expected to be online and increase capacity by 4 MGD.

White House has a small package wastewater treatment system located in the Tanasi Shores development in Gallatin. The treatment plant has a capacity of 40,000 GPD. It discharges an average of 18,000 GPD to Old Hickory Lake. The majority of White House's wastewater is pumped to Metro Nashville or to the City of Gallatin, an average of 250,000 and 200,000 GPD, respectively.

System Water Quality. White House generally provides high quality water, however, the National Tap Water Quality Database lists 15 contaminants detected in a majority of samples taken. Four of the contaminants are individual or composite measures of disinfection by-products and have average concentrations greater than the health-based limit. Notably, concentrations of bromodichloromethane and total haloacetic acids (HAA5) exceeded the maximum contaminant level goals. Some samples of total trihalomethanes also approached maximum allowable levels. The most common contaminants include metals, and nitrates, and sulfates. White House has detectable concentrations of metals (i.e. barium, manganese, and selenium), all in minimal quantities.

Source Water Quality. White House Utility District draws its water from Old Hickory Lake just upstream of the dam at the head of a cove northeast of the dam. The cove's drainage area is small, but includes several Environmental Protection Agency (EPA) regulated facilities. Three are regulated as minor dischargers to air, two facilities have National Pollutant Discharge Elimination System (NPDES) permits, and ten facilities are catalogued as hazardous waste sites under the Resource Conservation and Recovery Act (RCRA). The facilities include gas stations, dry cleaners, printers, automotive shops, tool and metal working shops, a furniture and upholstery shop, and a sporting goods store. None of these facilities poses major risks on its own, but all handle hazardous materials, so proper material handling is important.

Though unregulated, several other activities in the area pose some threat to the intake. A rail line and a four-lane highway each pass within one half mile from the intake. A major train derailment or truck crash that releases hazardous materials could very quickly endanger the intake. A rather large marina also is located on the same cove as the intake. Boat repair, fueling, and accidents can all create situations in which a release of fuel or other contaminant could affect the intake. Finally, heavy shipping passes through the Old Hickory Lock and Dam. Though unlikely, a significant accident at the lock by a ship carrying hazardous materials could affect the intake.

The Tennessee Source Water Assessment for the Old Hickory Watershed highlights several facilities and activities around a DuPont facility as areas of concern, even though they are located on the other side of the lake. The DuPont facility is engaged in plastics material and resin manufacturing. The facility discharges to air, water, and offsite disposal. The greatest risk to the White House intake probably comes from barge transport of chemicals, fuels, and finished products to and from the facility.

Current Water Conservation Programs. White House Utility District's primary water conservation efforts focus on improving the distribution system and treatment processes, to a lesser extent, to reduce water usage. The utility district has modified engineering specifications and designs for the distribution system, improved metering and resource monitoring, and is committed to active leak detection programs.

The utility's biggest conservation effort involves its own distribution system. White House's large distribution system (over a thousand miles of distribution mains), high pressure variations, rocky soils, and breaks in old cast iron and PVC pipes contributed to an unaccounted water percentage of 50% in 2002. A combination of water main replacements, pressure relief and surge valve installations, zone metering, and a team of two full time leak detectors had reduced the unaccounted for water percentage to 26% in 2009.

White House also has a few education programs. Paper billing statements include tips for conservation, as well as detecting and preventing leaks. The website includes a frequently asked questions section that also includes some conservation tips. Additionally, the website provides links to H_2OUSE.org, a water conservation website that provides guidance on the most effective ways for consumers to save water and money.

White House does not have conservation pricing. The utility district has few large users and does not audit their water usage. The White House distribution area covers several municipalities; most likely lack plumbing codes that specifically encourage conservation.

2.5 Castalian Springs-Bethpage Utility District

Castalian Springs-Bethpage Utility District is a wholesale water purchaser and does not have a water treatment plant. It buys most of its water from Gallatin, but also purchases water from Hartsville and Westmoreland. The district serves approximately 10,000 people and has a 1.45 million gallon storage capacity that provides 38.9 hours of supply based on average gross water use. Utility district officials are not certain of the ultimate capacity of the district's interconnections to other utility districts. Castalian Springs-Bethpage most recently expanded its distribution system in 2009 when it extended lines to Phillips Hollow off U.S. Highway 231. Utility managers say money, not water source constraints, is the limiting factor for expansion of their existing distribution system.

System Water Quality. The National Tap Water Quality Database contained no records for this utility. The utility presently has no current violations and does not anticipate difficulty meeting drinking water regulations.

Source Water Quality. [See information for Gallatin Public Utilities and City of Westmoreland, the main wholesale providers to Castalian Springs-Bethpage Utility District.]

Current Water Conservation Programs. The utility has focused primarily on controlling unaccounted for water as a conservation measure and has very limited public outreach. All accounts are metered, and all meters are two years old or less, but are not automated. The utility has several master meters in the distribution system that record water purchased from Gallatin and other utilities. By monitoring meters and tank levels, utility officials keep a close watch on water flow to identify potential leaks. Most leaks are spotted and repaired by utility district crews. Castalian Springs/Bethpage's billing structure consists of a base charge amount followed by a single block rate. There are no special meter rates for irrigation or other uses.

2.6 Gallatin Public Utilities

Gallatin Public Utilities draws all of its water supply from the Cumberland River-Old Hickory Lake. Gallatin has two intakes built in 1954 located in the original channel of the Cumberland River before the lake was impounded. The intakes are 13 feet and 28 feet below the normal lake elevation of 445 feet. The withdrawal location for both is just downstream of the Hwy 109 bridge over the Cumberland River. The original intake, built in 1925, still exists but is not used. Gallatin sells water daily to Castalian Springs-Bethpage Utility District and to Westmoreland. White House Utility District is also connected to Gallatin, but purchases water only during emergencies, up to 1 MGD during dry summer months to meet water demand. The capacities of the inter-connections from other utilities to Gallatin are 0.75 MGD to Westmoreland, 1.5 MGD to Castalian Springs-Bethpage, and 1 MGD to White House. Gallatin has a 13.5 million gallon storage capacity, which provides 56.8 hours of supply based on average gross water use.

Gallatin has an inter-basin transfer permit allowing for the sale of a maximum of 0.75 MGD to Westmoreland, which is in the Barren River watershed.

System Water Quality. Gallatin Public Utilities generally provides high quality water. The Tap Water Quality Database reports detection of 12 contaminants in water provided by the utility during the testing period (1998 to 2002). Of the 12 contaminants found, five had levels above the health-based limits. None tested above legal limits. Four of the five contaminants that tested above health-based limits were disinfection by-products. The average concentrations for all four of these (bromodichloromethane, chloroform, haloacetic acids [HAA5], and total trihalomethanes) exceeded the maximum contaminant level limits. The only other contaminant with a concentration above that limit was arsenic, which has a maximum limit of zero. Arsenic is a metal that enters water by erosion of natural deposits or from runoff from industrial sources such as the TVA Gallatin Fossil plant located upstream of the intake Gallatin discharges into the Cumberland River.

Gallatin anticipates having trouble meeting drinking water regulations, specifically because of stage two disinfection by-products, haloacetic acids, and total trihalomethanes requirements. Gallatin plans to expand its water treatment plant when gross water use reaches 10 MGD (estimated to be sometime in the next 20 to 30 years). Its wastewater treatment plant is being upgraded to treat 11.5 million gallons per day. The plant has a 25 million gallon hydraulic capacity and discharges into the Cumberland River (Old Hickory Lake).

Source Water Quality. Perhaps the biggest potential threat to source water quality is the Tennessee Valley Authority's Gallatin Fossil Plant, which burns coal to produce electricity. The plant is located just a few miles upstream of the Gallatin intake, so discharges to water have the greatest potential to affect water quality. The plant is regulated under several federal and state programs. According to EPA's Toxic Release Inventory data, the plant's major releases into Old Hickory Lake and the Cumberland River are metal compounds including barium, vanadium, copper, and zinc. Smaller quantities of chromium, nickel, and manganese are also released.

The plant's air emissions should not pose a large risk to water quality but the plant's on-site disposal of waste is a serious potential threat. The plant has several on-site impoundments where the majority of the heavy metals and other contaminants are settled out from wastewater before water is discharged to the stream. The compounds processed through on-site surface impoundments include all of the compounds that are documented in the releases to water but in much larger quantities.

Under normal circumstances, these surface impoundments should not pose a risk to drinking water in Old Hickory Lake, but a failure or breach of one of the plant's impoundments, or a sudden and catastrophic flood could release this collected waste. Since these ponds are just a few miles from Gallatin's intake, a large release could pose a significant danger to Gallatin's water supply.

EPA regulated facilities cause some additional minor concerns for water quality. The majority of the sites are clustered in an industrial zone southwest of Gallatin. These sites include furniture makers, metal working facilities, and boat builders. All the waste is discharged to air or off-site processing, but the chemicals of potential concern include styrene, toluene, xylene, methanol, N-butyl alcohol, chromium, copper, manganese, lead, nickel, zinc, and trivial amounts of a few other compounds.

The Gallatin area has a large number of air emitters, but the depth of the intakes probably limits the threat. The largest emission source by far is the coal-burning plant, but there are at least 30 sites in the AIRS database within five miles of the intake.

Nearby transportation facilities also pose minor risks to the Gallatin intakes. A bridge collapse, a vehicle falling off the bridge, or a spill from a vehicle on the bridge could pose physical or chemical risks to the water intake just downstream. There is also a marina (Cherokee Resort) on the opposite shore of Old Hickory Lake directly upstream of the intake. Finally, much of the coal to fire the TVA Gallatin plant is brought either by rail through the indicated watershed zone or by barge to a dock just a few miles upstream of the intake. A major train derailment, or worse, a major spill off a barge could contaminate the river with coal waste.

Current Water Conservation Programs The primary conservation strategies for Gallatin Public Utilities include attention to leakage and UAW and some educational outreach, but there are no established active conservation programs.

Gallatin has all accounts metered with manually read meters. Meters are tested yearly for accuracy. The utility has separate meters for swimming pools and irrigation, but they are billed at the same rate as other usage. Flushing of the mains is metered; firefighting usage is estimated.

Utility staff monitors the distribution system for leakage through customer complaints and reports of surfacing water. The tanks and pumps are monitored for abnormal flow rates, and some areas within the system are monitored for dropping pressure. Gallatin periodically tests some of its largest distribution mains for leaks. The utility estimates current leakage to be roughly 10%, and reports overall UAW at 22%.

Gallatin Public Utilities has implemented some limited educational outreach. Its website includes several water tips to consumers including leak detection, summertime outdoor watering guidance, and other general household water conservation suggestions. Additionally, staff make infrequent visits to schools to encourage conservation.

The billing structure is a single block rate structure. In the future, Gallatin is likely to improve its leak monitoring program by performing leakage surveys. If mandated, Gallatin would change its rate structure to promote conservation.

2.7 Westmoreland Public Water Department

Westmoreland purchases all of its water supply from Gallatin. The city regularly sells water to Castalian Springs-Bethpage Utility District and to Portland only during emergencies. Westmoreland buys and sells with Lafayette during emergencies. Portland has not bought water from Westmoreland in more than four years. Westmoreland has two 500,000 gallon tanks for water storage, which provide a total of 62.7 hours of supply based on average gross water use. The city's most recent water line extension was 26,000 feet of 6 inch pipe to Dutch Creek Road.

System Water Quality. Westmoreland has a capacity of 300,000 GPD. According to the National Tap Water Quality Database, two contaminants were detected in a majority of samples taken. Both were composite disinfection by-products (HAA.5 and TTHM.) These two contaminants were found to have average concentrations greater than the MCL. The HAA5 exceeded the MCL by 22 ppb and TTHM exceeded the MCL by 5.1 ppb. These values are based on a single sample concentration (not an average concentration).

Westmoreland does not add additional disinfectant to the water it buys before reselling, so the presence of the disinfection by-products in high concentrations likely results from the age of the water in the Westmoreland system. This is a common problem for systems that purchase finished water from other suppliers. Westmoreland discharges an average of 250,000 GPD to Little Trammel Creek.

Source Water Quality. [See Gallatin Public Utilities, which is the main source of supply for Westmoreland.]

Current Water Conservation Programs. Westmoreland did not respond to inquiries about its current water conversation programs.

2.8 Portland Public Water Department

Portland draws the majority of its water from West Fork Drakes Creek. Portland City Lake is used as an emergency supply when flow in West Fork Drakes Creek is too low to support withdrawals. On average for two months during the summer, the utility withdraws water from Portland City Lake to meet its requirements. Portland cannot draw water from both sources at the same time. Portland City Lake is well above the surface level of the creek, and releasing water from the lake into the treatment-plant pump station causes backflows through the intake into the creek. Portland City Lake and West Fork Drakes Creek are located in the Barren River Basin. Portland also has an emergency connection to White House Utility District, the south and west end of the system, and Westmoreland. Portland has a 500,000 gallon clear well at the water plant and has 2.45 million gallons of tank storage, which provides 35.4 hours of supply based on average gross water use.

During the 2007 and 2008 droughts, Portland issued a mandatory cutback on water usage and used its emergency connections to White House Utility District. Utility officials evaluated their lake source daily to determine whether declaration of emergency status was necessary. They came close to determining it was an emergency, but ultimately did not have to.

The limiting factors for expansion of Portland's water system are limited raw water supply and small rural line sizes. Portland was denied a permit by TDEC in 2007 because the proposed impoundment of Caney Fork Creek and the consequent degradation of high quality waters was not justified by necessary economic or social development and practicable alternatives were available.

Portland's wastewater treatment plant has a capacity of 3.8 MGD and treats 1.9 MGD on average and 3.8 MGD for peak flow. Portland discharges into Sumner Branch, which flows into the Red River.

System Water Quality. The Portland Water Department generally provides high quality water. According to the National Tap Water Quality Database, 14 contaminants were detected in samples taken between 1998 and 2002. Of the 14 contaminants, five were found at levels above the health based limit (EPA Human Health Criteria). Four of the five contaminants above health based limits were individual or composite measures of disinfection by-products (Bromodichloromethane, Chloroform, Total HAA5, and TTHM). None of the average contaminant concentrations exceeded legal limits, and only HAA5 exceeded the maximum contaminant level goal.

Additional contaminants can likely be attributed to natural sources, general development runoff, or industrial sites in the watershed included arsenic, barium, chromium, mercury, nutrients (including nitrates and sulfates), asbestos, and alpha particle radiation. None of these contaminants were detected in drinking water at concentrations of much concern.

When the flow in West Fork Drakes Creek drops too low to meet demand, Portland relies on a secondary source, a small reservoir called Portland City Lake. Both sources are located in the headwaters of the Barren River watershed.

Portland City Lake's watershed is roughly circular and has an area of slightly more than one square mile. The lake's watershed is quite small, but has mixed development. The western portion of the watershed is dominated by low to medium density residential development and farms. Closer to the lake, the land use is characterized by small plots of forest among larger fields. A small buffer of forest grows on the lake shore.

The City of Portland supports a considerable number of small and medium industrial facilities. Numerous facilities have potential air emissions, discharge to water, and handle or produce hazardous materials. Most types of EPA regulated sites are considered as a threat only if they are within the watershed of the Portland water sources. The sites discharging to the air (regulated by the AIRS database) can affect the source whether or not they lie within the watershed, but since most of the air emitters are relatively small, a range limit of 5 miles from the Portland intakes has been imposed.

The Resource Conservation and Recovery Act information system records 13 sites, the greatest number of facilities in the study area. They represent a mix of industries including metalworking and machining, specialty tool manufacturing, vehicle parts manufacturing, furniture making, printing, dry-cleaning, light fixture manufacturing, and trucking.

The EPA's Toxic Release Inventory reports three sites operating within the watershed that must dispose of toxic materials—copper compounds, nickel compounds, and xylene. All are disposed of through transfers to off-site waste handling and treatment facilities.

Two sites in the watershed, a school and a nursing home, have NPDES discharge permits. Both have onsite sewage treatment with potential contaminants of coliform bacteria, suspended solids, and dissolved solids.

The watershed has no Superfund sites, but two Superfund sites lie approximately ten miles of the Portland water supply sources. Neither site is on the National Priorities List for clean-up.

Several sites regulated under the Clean Air Act, and monitored through the AIRS database, are located within five miles of Portland's intakes. There are 17 regulated sites, though at least three have shut down or are currently inactive. Of the remaining fourteen, ten are considered minor sources. Four are major emissions sources—two natural gas facilities, a metal working plant releasing glycol ethers, and a fiberglass boat building facility.

The other potential risks to water quality in the area come from transportation and small-scale agriculture. The Portland Municipal Airport is very close to West Fork Drakes Creek, and accidents and fuel leaks have the potential to endanger the water supply. No major interstate highways pass through the watershed, but smaller state highways do. Additionally, small-scale agriculture in the eastern portions of watershed may contribute to runoff, potentially including fertilizers, pesticides, and animal waste.

Current Water Conservation Programs. Portland's conservation efforts have been primarily targeted at reducing system loss. The city is upgrading its metering to better understand and control its non-revenue water. All accounts are being converted to automated meters. Flushing is monitored by timing the flow, and using a hydraulic model of the system to estimate flow rate. Firefighting, however, is not metered. In the next few years, eight zone meters will be placed in the distribution system. These meters should help to quickly identify leaks and reduce losses.

Leakage reduction has been another significant effort for the City of Portland. Two years ago, Portland applied for and received a grant to rehabilitate its water system. It replaced galvanized lines that were prone to leakage. Leakage, previously estimated at 25% of total production, was reduced by 10%. In the next two to three years, Portland plans to implement a leakage monitoring system.

Portland's rate structure is a two-stage increasing block rate structure and is not specifically designed to promote conservation. Portland has no conservation education programs, although during water shortages, the utility has communicated conservation suggestions to consumers through flyers and cable television messages.

The City of Portland had adopted the 2006 International Plumbing Code and has a policy to manage water use during droughts, but has no other codes or ordinances targeting water conservation during non-drought periods.

2.8.1 West Fork Drakes Creek

Source Water Quality. In general, West Fork Drakes Creek flows from south to northwest. The intake is located roughly 2.5 miles to the northeast of downtown Portland. The watershed has a total area of roughly 62.5 square miles and extends southward to the hills that make up the northernmost portion of the Highland Rim.

The watershed is characterized by a mix of land uses. The northwestern portion of the watershed includes the central and southern portion of the City of Portland, characterized by residential and commercial development. The majority of the industrial development is located to the north and outside of the watershed. The central and eastern portions of the watershed have a mix of light residential, rural, and agricultural development. The more southern portions (headwaters) of the watershed have similar land use, but have a more significant percentage of forested land.

Flow. West Fork Drakes Creek, though not a large river as it flows past the City of Portland, has enough flow to be used as a water source. The portion of the stream included in this study area is a headwater area, and the stream is largely unregulated by any control structures. As a result, the streamflow experiences a large range of flow variation, both in terms of high and low flows.

Although there is no streamflow gage exactly at Portland's intake location, a long-record USGS gage approximately ten miles downstream near Franklin, Kentucky recorded continuous daily average flow between 1968 and 2004. In order to extend the resulting streamflow record, an HEC-HMS hydrology model of the intake basin was created, using some adjustments to reach an acceptable level of similarity between the modeled and gaged streamflow sequences.

Figure X shows that there is a 20% chance in any year of being able to provide approximately .6 MGD of yield every day of the year. At the same time, there is a 1.2% chance in any year of the streamflow being less than approximately .15 MGD for 12 days during the year. The present average daily raw water demand for Portland, TN is approximately 2 MGD. Figure X shows that for a demand of 2 MGD there is a 20% chance the demand will not be met in 30 days of any given year, and a 2 % chance of the demand not being met in 75 days of the year.

2.8.2 Portland City Lake

Source Water Quality. Since water quality in Portland City Lake is generally poorer than water quality in Drakes Creek, it is used only as an emergency supply during droughts.

Firm Yield. Portland City Lake is used in emergencies by the City of Portland to augment flows in West Fork Drakes Creek, but for the purpose of this analysis the firm yield was evaluated as though it were a constant use water supply reservoir. Neither long-term reservoir operations data nor stream flow gage data are available for Portland City Lake, so for this study hydrologic (HEC-HMS) models were used to estimate the historical reservoir inflow based on precipitation. The precipitation record as assembled covered the period from January 1, 1928 to July 31, 2009.

The lake has an average depth of 30 feet, a surface area of 12 acres, a capacity of 355 acre-feet (115.7 million gallons), and a drainage area of 5.4 square miles. The lake has an uncontrolled emergency spillway.

Based on the HEC-HMS modeling, Portland City Lake has an average inflow of approximately 1.09 MGD. Using the sequent peak algorithm for the period of record simulation, the calculated firm yield was 0.417 MGD for the storage estimate of 88.6 MG. The critical drought sequence began in April of 1963 and reached the peak cumulative deficit in March of 1964, for approximately 11 months. At the storage estimate of 115.7 million gallons, the firm yield was determined to be .480 MGD. The critical drought sequence began in May 1930 and reached its peak in November 1931, lasting approximately 18 months.

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

3.1. Overview

Future water demand was estimated for the North Central 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 North Central 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. Based on this computation, commercial and industrial use rates increase more rapidly than residential use for the North Central Pilot area.

From 2010 to 2030, raw water withdrawals for systems located in the North Central Pilot area are projected to increase from 22 to 33 MGD, or about 46 percent. The projected increases in raw water withdrawals, totaling 10.2 MGD in the North Central Pilot area, by category, are: finished water sold to residential customers 31 percent (3.2 MGD); finished water sold to commercial and industrial customers 23 percent (2.4 MGD); and treatment and non-revenue water 37 percent (3.6 MGD).

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. Five public water supply systems included in the analysis for water demand projections in the North Central Pilot area are located in Sumner County, Tennessee and are; Portland Water System, Castalian Springs-Bethpage Utility District, Gallatin Water Department, Westmoreland Water System, and White House Utility District. White House Utility District also provides water to two public water supply systems located outside the study area.

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).

Sumner County, which is primarily the North Central Pilot area, was among the top ten fastest growing counties in Tennessee from 2000 to 2009 with a 21.7 percent change in population. Population projections in the North Central Pilot area are 155,925 in 2010 and 190,388 in 2020, representing a percent change of 22 percent. Population projections in the North Central Pilot area are 190,388 in 2020 and 211,946 in 2030 representing a percent change of 11 percent. Counties in Tennessee that surround the North Central Pilot area experienced positive percent changes in population from 2000 to 2009 ranging from about 9 percent in Trousdale County to about 27 percent in Wilson County. From 2000 to 2009 Robertson County's percent change in population was 22.3 percent. (See Appendix X for supporting tables.) Percent changes in population projections from 2010 to 2030 for Robertson County are expected to be 42 percent. Robertson County receives water from public water supply systems in Sumner County. Simpson County, Kentucky, which also receives water from the North Central Pilot area, experienced positive percent changes in population from 2000 to 2009 of 3.7 percent (U.S. Census Bureau, 2010).

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 North Central, Tennessee 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 North Central 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 and the single water department that may have had the greatest amount did not differentiate commercial and industrial uses in its 2005 survey response (Gallatin Water Department). 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 (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). The result of this computation is that commercial and industrial use rates increase much more rapidly than residential use for the North Central Pilot area which is a reasonable expectation because of the population density. 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

Five public water supply systems included in the analysis for water demand projections in the North Central Pilot area are located in Sumner County, Tennessee and are; Portland Water System, Castalian Springs-Bethpage Utility District, Gallatin Water Department, Westmoreland Water System, and White House Utility District. White House Utility District also provides water to two public water supply systems located outside the study area.

From 2010 to 2030, raw water withdrawals for 3 of the 5 systems located in the North Central Pilot area are projected to increase from 22 to 33 MGD, or about 46 percent (table 8). The projected increases in raw water withdrawals, totaling 10.2 MGD in the North Central Pilot area, by category, are: finished water sold to residential customers 31 percent (3.2 MGD); finished water sold to commercial and industrial customers 23 percent (2.4 MGD); and treatment and non-revenue water 37 percent (3.6 MGD). Drakes Creek, City Lake and Old Hickory Lake are the primary source of water for public water supply systems in the study area.

Table 8. Water demand projections for public water supply systems in the North Central 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
North Central Pilot Area																			
Sumner, 097 Castalian Springs-Bethpage Utility District	Hartsville WD (seller)	13,482	0.537	0.030	0.587	1.15		16,461	0.656	0.093	0.776	1.52		18,321	0.730	0.144	0.904	1.78	
	Westmoreland WS (seller)	--	--	--		--		--	--	--		--		--	--	--		--	
	Gallatin WD (seller)	--	--	--		--		--	--	--		--		--	--	--		--	
Sumner, 253 Gallatin Water Department	Cumberland River	32,612	2.251	1.78	1.471	5.50	7.11	39,819	2.749	2.23	1.816	6.79	8.92	44,319	3.06	2.51	2.035	7.61	10.10
	Castalian Springs-Bethpage Utility District (buyer)	--	--	--		--		--	--	--		--		--	--	--		--	
	Westmoreland Water System (buyer)	--	--	--		--		--	--	--		--		--	--	--		--	
Sumner, 559 Portland Water System	City Lake/Drakes Creek	15,948	0.910	0.318	0.822	2.05	2.05	19,472	1.111	0.455	1.048	2.61	2.61	21,673	1.24	0.553	1.197	2.99	2.99
Sumner, 738 Westmoreland Water System	Gallatin (seller)	4,135	0.252	0.008	0.197	0.458		5,049	0.308	0.037	0.262	0.607		5,620	0.343	0.061	0.306	0.710	
	Castalian Springs-Bethpage Utility District (buyer)	--	--	--		--		--	--	--		--		--	--	--		--	
Sumner, 745 White House Utility District	Cumberland River	75,842	4.983	1.323	4.763	11.1	13.1	92,603	6.084	2.03	6.127	14.2	16.9	103,067	6.77	2.54	7.037	16.4	19.4
	Simpson County, Ky (buyer)					2.1						2.6						3.0	

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 North Central Tennessee planning region was developed in conjunction with stakeholders through a series of meetings with local government officials, utility managers, and the general public. The alternatives selected for additional study were in the broad categories of conservation and demand management, regionalization or water sharing among utilities, and new source development.

In general, the utilities in the region have already implemented management practices to avoid significant water losses; however, they largely have not taken the next step to implement conservation practices and programs. Several conservation and demand management strategies could be implemented in the region, including

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

A concept level regionalization alternative was developed and preliminary engineering and design activities have been completed to define the scope of one structural alternative for water supply, the construction of a new reservoir on Caney Fork Creek. Preliminary cost estimates have been developed for a potential pipeline from the Cumberland River to Portland, Tennessee; a potential connection between Portland and the White House Utility District, and a prior evaluation, conducted for the City of Portland, of the potential for groundwater supply development in the region has been summarized as a part of this study.

4.2 Introduction

Background

The principle water source for North Central Tennessee is Old Hickory Lake. Raw water withdrawn by White House and Gallatin Utilities satisfies approximately 90% of the demand in the pilot area region. The overall raw water demand for the North Central Tennessee pilot area is projected to increase from approximately 19 to 28 million gallons per day (MGD) by 2030. Currently there is sufficient raw water to meet this demand, and there are no physical limitations on finished water production for meeting mean-day use as a region. The City of Portland, however, satisfies its raw water demand through withdrawals from small surface water sources, and its average annual demand of approximately 2.1 MGD exceeds the firm yield of these sources. Portland purchases finished water from neighboring utilities as needed, but with no formal contracts for this outside supply, security for the system is not ensured.

The list of potential water supply source alternatives for the North Central Tennessee planning region was developed in conjunction with stakeholders through a series of meetings with local government officials, utility managers, and the general public. The alternatives selected for additional study were in the categories of conservation and demand management, regionalization, and new source development.

Why This Topic Matters

Considering a wide range of potential alternatives ensures that less obvious measures are not overlooked and that the best plan is 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 (sharing sources), 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 in the North Central Tennessee region 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.

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. The need to flush long distribution lines with low flows is one of the greatest impediments to serving customers in sparsely populated areas. Looping systems can reduce the need to flush lines, 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 the 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 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),

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

- 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 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

Regionalization as an alternative involves increased water sharing among utilities using existing or improved connections and formalized agreements. Optimizing the way in which utilities in the region share water resources, limited supplies have the potential to be extended. Regionalization is often the most publicly acceptable and least environmentally damaging means of providing additional water to a utility. In the North Central region, many of the utilities are already connected. Some provide water on a permanent basis such as Gallatin to Westmoreland and some only on a periodic basis such as White House Utility District to Portland. Both types of connections are needed to ensure a system is resilient to not only drought, but also to flooding. Water treatment plants can be damaged during floods and taken complete out of production for weeks or months. Having agreements in place for water is needed helps to ensure the water will be available during emergencies.

As discussed in Chapter 3, only Portland needs additional supply during the planning horizon. While both the White House Utility District and Gallatin Public Utilities could satisfy the increased water demand in the region, White House is better suited to meet the needs of Portland because existing connections would require fewer upgrades than a connection to Gallatin, which as a practical matter, would most likely be through Westmoreland. The connection between Portland and Westmoreland is small and would require extensive upgrades. While the connection between Gallatin and Westmoreland is sufficient to meet Westmoreland's need throughout the planning horizon, it is not sufficient to meet the combined need and would also need to be upgraded.

Establishing a formal contract between the City of Portland and WHUD for the sale of treated water to Portland has several advantages. With a direct connection to the Cumberland River, and implementation of piping and pumping improvements, White House has the ability to provide Portland with the water supply needs not met by their limited existing sources. WHUD is a large utility and could provide water to Portland in many ways. For this study, one potential routing was modeled (as discussed in Chapter 5) and costs were estimated.

Potential Costs. Gresham, Smith and Partners working for the Tennessee Association of Utility Districts (TAUD) developed potential costs for this alternative. They incorporated an existing WHUD model into a regional model by adding the basic core network of other systems including essential pipe, pump and tank infrastructure. The demands generated by the USGS were distributed over each water system. WHUD projections for 2027 peak day demands were inflated to the 2030 planning horizon. This scenario is only a concept and a more complete and calibrated model would be needed to determine actual capital improvements. However, the methodology is sufficient for alternative comparison.

Assuming that a constant transfer from WHUD would occur at the designated drought trigger points discussed in Chapter 5, 0.582 MGD would be required to be transferred to Portland from WHUD. Minimum and maximum potential transfer rates were used to evaluate infrastructure needs and develop conceptual capital improvements. Since some of the infrastructure would also serve other customers, Portland's estimated costs were proportioned based on their share of the total daily flow in a particular section of pipe. This capital cost or "capacity fee" represents a portion of the infrastructure required to withdraw, treat, pump, store, and deliver water to Portland. It would require about 6,500 linear feet of 30-inch pipe along Center Point Road, 16,000 feet of 24-inch pipe from Tyree Springs to New Hope Road, 26,000 feet of 20-inch pipe from New Hope to Shun Pike, 40,300 feet of pipe from Shun Pike to Mulloy Tank and 12,000 feet of 16-inch pipe from Mulloy Tank to the US 31 connection. In addition, a new tank, 2 booster stations and expansion of the WHUD treatment plant would be needed before 2030. The total capital cost allocated to Portland is about $4.5 million. It should be noted that there are many potential routes for the connection and methodologies that can be used to calculate the capacity fee. In addition, the expansion and upgrades could occur over time as Portland's demand grows. The cost estimates developed do not include operation and maintenance costs and feasibility study costs that may be associated with moving this alternative from planning to design and construction.

The estimated cost is shown in the Table below.

Table XXX. Regionalization Infrastructure Improvement Costs

	Description	Quantity	Unit	Estimated Unit Price	Estimated Unit Cost	Percent Capacity	Percent Cost
1	**New Water Lines Required**						
a	30-in DIP Center Point Road	6,500	LF	$350	$2,275,000	4.1%	$93,991
b	24-in DIP Tyree Springs to New Hope	16,000	LF	$300	$4,800,000	7.8%	$374,553
b	20-in DIP New Hope to Shun Pk.	26,000	LF	$225	$5,850,000	9.3%	$541,761
c	18-in DIP Shun Pk to Mulloy Tank	40,300	LF	$200	$8,060,000	14.4%	$1,164,144
e	16-in DIP Mulloy Tank to 31 Connection	12,000	LF	$150	$1,800,000	19.1%	$344,152
g	Shun Pike Tank (1.5 M Elevated)	1	LS	$2,500,000	$2,500,000	5.0%	$125,000

h	Mud Hollow Booster Station	1	LS	$3,000,000	$3,000,000	8.1%	$242,500
i	Hwy 31 MM Booster Station	1	LS	$200,000	$200,000	100.0%	$200,000
	OPINION OF PROBABLE CONSTRUCTION COST				**$28,485,000**	**21.0%**	**$3,086,102**
WHUD WTP 4MGD Expansion							
4	MGD Plant Expansion	$10,000,000					
0.6	Portland Requirement	$1,455,000					
Portland WTP Portion		**$1,455,000**					
Total Infrastructure Cost		**$4,541,102**					

4.5 New Source Development

Three new sources were considered as alternatives to meet projected water supply needs of the region. These alternatives are presented in detail in the following sections.

4.5.1 Caney Fork Creek Reservoir

Initial planning for a new water supply reservoir to serve the City of Portland began when John Coleman Hayes (JCH), P.C., completed a *Preliminary Engineering Report for Water System Improvements*, dated 1996 and revised in 1997 (JCH 1997). The report proposed a 15 to 20 foot high dam on the West Fork Drakes Creek at the existing mill dam immediately downstream of the City of Portland's intake. This initial site was rejected by the State of Tennessee, which led to an effort to define a new location for a new dam. A site on Caney Fork Creek, roughly 750 feet upstream of the confluence with West Fork Drakes Creek, was selected in 2003.

The City retained Camp Dresser McKee Inc. (CDM) in association with Barge Waggoner Sumner & Cannon Inc. (BWSC) to design several dam alternatives at the Caney Fork Creek location, which were submitted in a report titled *Feasibility Study of Dam Alternatives* dated April 2005. A year later, in April 2006, contractors began the preliminary design of the Caney Fork Creek Reservoir Dam and submitted the *Caney Fork Reservoir Project–Preliminary Engineering Report* (CDM 2006), which is the basis for the details of the alternative considered in this study.

Description of Alternative. The dam on Caney Fork Creek would be in a rural area to the east of the City of Portland. The preliminary design would impound about 483 million gallons at a normal pool elevation of 687 feet. (All elevations are referenced to the North American Vertical Datum of 1988, NAVD88.) Of that volume, approximately 468 million gallons would be available for water supply. The proposed normal pool elevation would inundate a surface area of roughly 135 acres. Figure X shows the location of the proposed reservoir in relation to the existing water supply sources for the City of Portland.

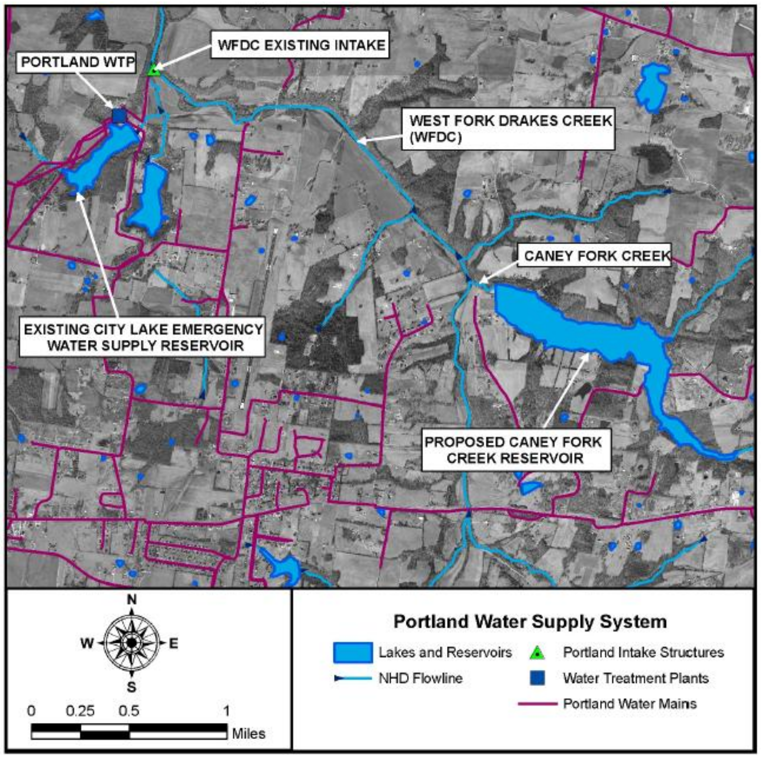


Figure X. Portland water supply system vicinity map

Figure Y shows the drainage to the proposed reservoir, the existing Portland City Lake, and the West Fork Drakes Creek intake. The 17.3 square mile drainage area contributing to the proposed reservoir lies within the 62.5 square mile drainage area of the existing intake. The new reservoir would change the hydrology to the intake structure. Discharge from the Caney Fork Creek Dam would be used to provide flow above the existing West Fork intake.

Description of the Design. The dam would consist of a non-uniform compacted earthen embankment and roller compacted concrete dam. The roller compacted concrete section of the dam would include two spillways to control the normal pool elevation and pass significant flood events. Caney Fork Creek reservoir's primary purpose is to ensure adequate water supply during low flow conditions in the West Fork Drakes Creek. The reservoir is designed to meet both a minimum daily release rate to maintain environmental conditions in the receiving channel and water supply needs.

Additional design details, site location and inundation maps, and tables of the lake and dam characteristics can be found in Appendix X.

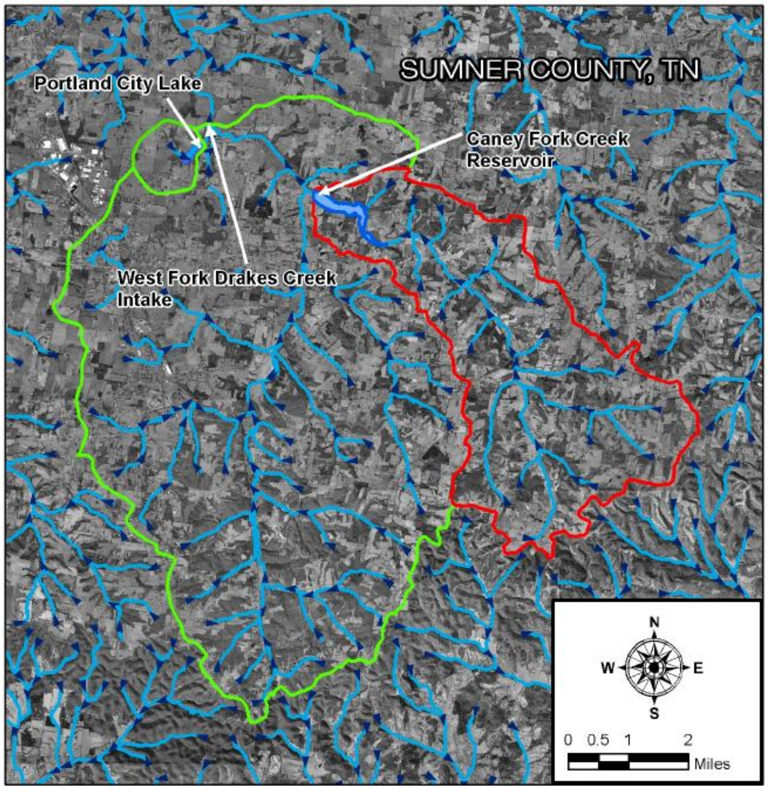


Figure Y. Drainage area map, existing and proposed City of Portland water sources

Raw Water Infrastructure, Lake Levels, and Operation. Water released from Caney Fork Creek reservoir would flow by gravity to West Fork Drakes Creek and the existing water intake. The primary spillway would allow normal flows to be passed downstream once the reservoir is filled. During periods of low inflow, the new reservoir's outlet structures would be used to supplement flow to West Fork.

Multi-source Operation Guidelines. To maintain use of the existing sources and infrastructure a priority of usage has been proposed. The priorities can be summarized as follows:

Priority 1: Demand can be satisfied with only the flow in the West Fork Drakes Creek.

Priority 2: If the flow in the West Fork is insufficient, water is released from the proposed reservoir on the Caney Fork Creek.

Priority 3: If the reservoir is empty, and flow in the West Fork still does not meet demand, flow is released from City Lake to the intake in the West Fork. While City Lake is being used, new reservoir is allowed to refill.

Priority 4: City Lake is used until the first 15-ft of storage is depleted, and then the source switches back to the West Fork intake and, potentially, further releases from new reservoir. Once depleted, City Lake cannot be used again until it has completely refilled.

While the new reservoir is designed almost entirely for water supply and ensuring adequate environmental flows, the controlled outlets would allow for more complex objectives to be met. The design recommends that the lowest 10 feet or so of the reservoir's pool remain permanently inundated to help preserve water quality and allow for sedimentation. In the future, it is possible the dam could be used in emergencies for minor flood control.

Potential Costs. The material quantities and construction methods for the Caney Fork Creek Reservoir were taken from the Aquatic Resource Alteration Permit (ARAP) – Alternative Analysis Update – Caney Fork Creek Reservoir submitted April 10th, 2006 by the City of Portland, Tennessee. No additions to the quantities or construction methods have been made for this report. The cost estimates do not include feasibility study costs that would be associated with moving from planning to design and construction. However, operation, maintenance, repair, replacement, and rehabilitation (OMRR&R) were developed using existing information and the preliminary design. The costs represent the operation and maintenance over an assumed 50-year project life, annualized at an interest rate of 4.375% with a 25% contingency. A breakdown of the line items for the OMRR&R cost estimate is found in Appendix xx.

The construction of the Caney Fork Creek Reservoir consists of the following items:

- Concrete and roller compacted concrete (RCC) mix design
- Existing condition survey
- Access roadway improvements
- Clearing of normal pool area
- Demolition of Martin Road Bridge
- Erosion control
- Stream diversion
- Construction of cofferdams
- Construction of an ogee spillway
- Construction of an outlet tower and low level outlet
- Construction of an RCC gravity dam
- Construction of an embankment dam
- Downstream overtopping protection for the RCC section
- Grading
- Site restoration

The following table contains a summary of the major cost items. The total present value cost for the reservoir is $13,179,000 including the present value of the OMRR&R cost.

Table X. Cost Summary for Proposed Caney Fork Creek Reservoir

Item		Cost August 2010
1. Temporary Site Access Improvements		$ 36,324
2. Stream and Surface Flow Diversion		154,838
3. Site Preparation		199,103
4. Dam Foundation Preparation/Improvement		1,951,244
5. Aggregate along Main Road		152,032
6. Dam		2,793,105
7. 7 - Dam Face Treatment		1,222,573
8. Spillway		2,342,464
9. Outlet Works		255,567
10. Site Restoration		12,313
11. Effect of Impoundment		1,095,912
Construction Subtotal		**$ 10,215,474**
Bonds, Insurance & Mobilization	5%	510,773.68
Contingency	20%	2,043,095
Total First Cost		**$ 12,769,342**
Escalation to Midpoint of Construction		**145,348**
Total Construction Cost		**$ 12,914,690**
Present Value OMRR&R Costs		264,078
Total Present Value		**$ 13,178,768**

4.5.2 Groundwater

The potential for development of groundwater sources in the region has been considered through numerous studies over the years. In 1979, the Corps, in the water supply component of their Metropolitan Region of Nashville, Tennessee, Urban Study, identified the potential for the City of Portland to meet future needs by constructing wells and treatment and transmission facilities to supplement its existing impoundment and treatment plant. In 1999, the City of Portland had 11 test wells drilled in the area. The results were disappointing, indicating that the limestone formations in the study area are less soluble and restrict ground water movement more than originally thought. The rock formations did not contain sufficient fractures to store large quantities of water. Although a few test wells did have yields of 0.22 MGD, they had poor water quality with a high sulfur content. Because this alternative could not meet the 1.0 MGD demand requirement, no costs were developed.

4.5.3 Pipeline Directly to Cumberland River

A raw water pipeline from Portland to the Cumberland River has been proposed as a potential means for meeting Portland's projected future need. The pipeline would be capable of delivering 1.0 MGD to the City of Portland's water treatment plant.

Description of Alternative. A raw water pipeline would be built from the City of Portland's water treatment plant to the Cumberland River. The intake for the pipeline would be in the backwater of the Cumberland River east of Douglas Bend Road and south of U.S. Highway 31E. The proposed route could follow existing road right-of-ways for approximately 21 miles. To meet 2030 needs, Portland would also have to expand their treatment plant. This alternative was developed to a conceptual level only; with no preliminary design. It is important to note that the 500-foot elevation difference between the Cumberland River and the Portland water treatment plan would add significantly to the operation and maintenance costs of this alternative.

Design of the Alternative. The pipeline would be ductile iron, 10 inches in diameter, and constructed primarily within existing road right-of-way using conventional, open-cut excavation, installation techniques. Approximately 110,000 linear feet of pipeline, an intake structure, and associated pumps and piping, would be constructed. The Portland raw water supply line conceptual routing would follow 31E, Harris Lane, Hwy 386, SR 109, Butler Road, Fountainhead Road, Old Gallatin Road, Tom Ferrell Road, cross country to Deasy Lane, Old Parkers Chapel Road, cross country to Portland Lake Road, ending at the existing water treatment plant.

Potential Costs. The estimated cost for the pipeline including construction, engineering, contingencies and booster stations is approximately $10,950,000. Including the expansion of Portland's water treatment plant brings the total to about $13 million. The cost estimates do not include operation and maintenance costs and feasibility study costs that would be associated with moving from planning to design and construction.

Table XXXX. Pipeline Directly to Cumberland River

Item	Description	Quantity	Unit	Estimated Unit Price	Estimated Unit Cost
1	**Intake 1 Million Gallons**	1	Ea	$1,050,000	$1,050,000
2	**Open Cut Installation of Raw Water Line**				
a	10-inch DIP	110,000	LF	$90	$9,900,000
	OPINION OF PROBABLE CONSTRUCTION COST				**$10,950,000**
Portland WTP Expansion to 4 MGD					
Construction/Eng./Other		**$2,000,000**			
Total Infrastructure Improvements Cost		**$12,950,000**			
Power Cost		$0.29/1,000 @ $0.09/kwh			

Chapter 5. Evaluation and Selection of Alternatives

5.1 Overview

After evaluation, the alternative recommended for implementation is regionalization. This would involve establishing a formal contract between the City of Portland and the White House Utility District for the sale of treated water to Portland. With its existing connection to the Cumberland River, its existing distribution network, and a few improvements to its system, the White House Utility District has the ability to provide Portland with the water supply needs not met by their limited existing sources. This alternative can be constructed in phases as the need for water grows and is also the most economical and environmentally sensitive means to reliably supply additional water to Portland.

5.2 Introduction

Background

Before evaluating alternatives to increase the supply of water, conservation measures to reduce water demand were considered. The North Central Region 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 discussed below could postpone some of the need for additional water, but would not eliminate the need itself.

The entire region could benefit from upgrading all types of water use monitoring (including flushing and fire use). The region could also benefit from improved leak monitoring and detection. Leak detection surveys, and eventually, real-time leak monitoring could significantly reduce the total water lost to leaks. Many of the utilities expressed interest in reducing their leakage rates. Capital improvements, such as those being implemented by WHUD and discussed in Chapter 2, can play a role in reducing unaccounted for water (UAW) by improving the hydraulics of the system, replacing older pipes, and improving circulation to reduce the need for flushing.

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.

Utilities in the region could offer retrofit, rebate, or fixture replacement programs. These programs are proven to reduce daily water demand. Specific audits of large water users can also help manage demand. Notably, Portland has a considerable industrial area with several large water users. 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. CSBWUD, which purchases all of its water (the majority of it from GPU) says it would be likely to implement whatever conservation measures GPU implements for its customer base. 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 regionalization, construction of a reservoir on Caney Fork Creek, and a pipeline from Portland to the Cumberland River. The following sections describe how these factors were estimated for each of the alternatives presented in Chapter 4.

5.3 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 can be developed and manipulated to 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 interval 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. Thus, there could be errors in the inflow data used in the model particularly for small streams such as West Fork Drakes or Caney Fork Creeks. The precipitation data for this study was developed using historical rainfall records and rainfall-runoff models. To account for uncertainty in these analyses, 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. Because the reservoirs would need to provide minimum releases to sustain instream flow requirements, the model calibration was focused on the low flow regime. 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. To some degree, 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)/square mile.

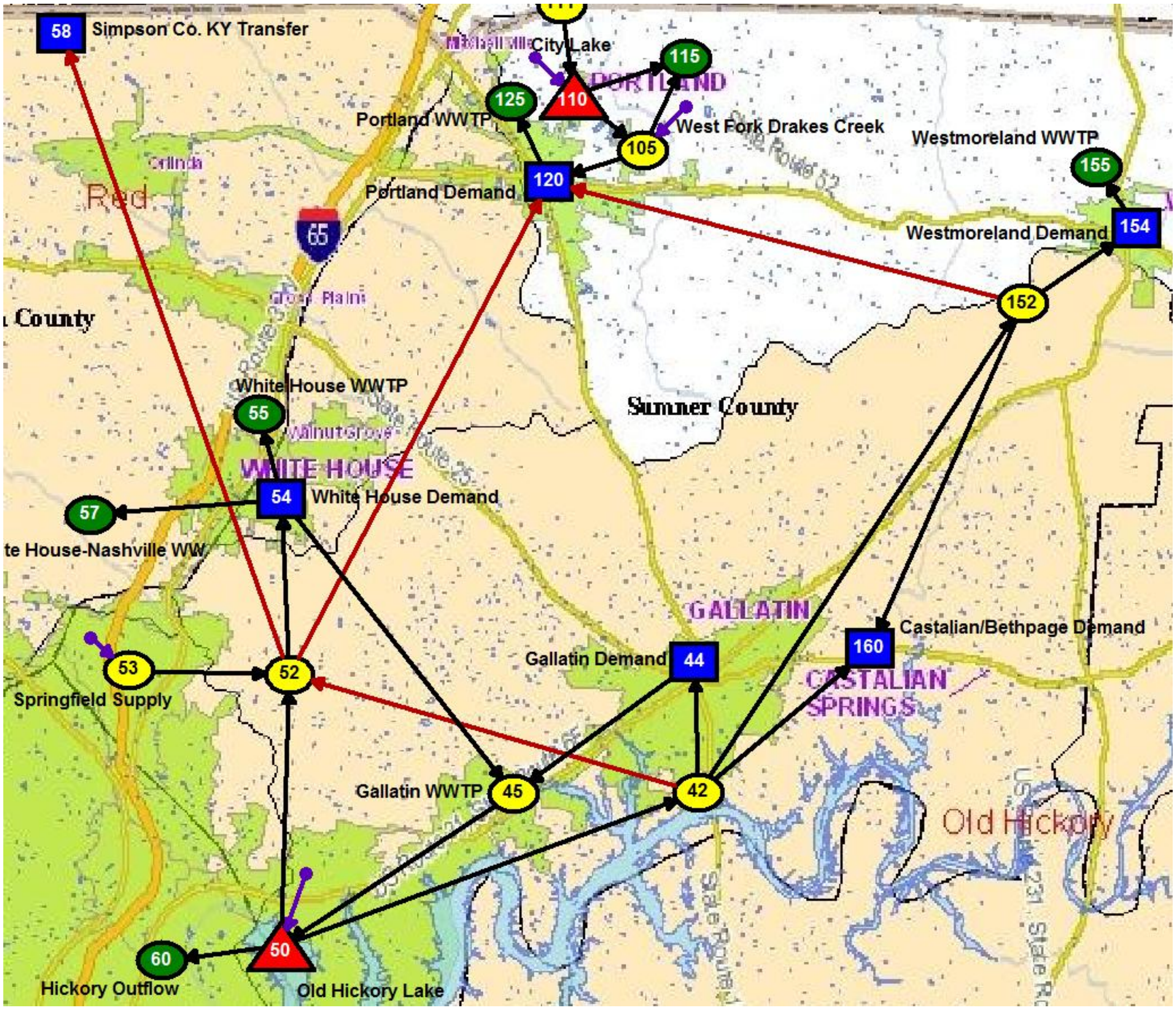
OASIS Schematic. Figure XXX displays the model schematics for the North Central Region. It has various nodes and arcs to represent the systems. The red triangles represent storage nodes (reservoirs and lakes), the blue squares represent demand nodes, the yellow circles represent junction nodes where 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 North Central study area.



Existing Conditions. The existing scenario represents current operations. All utilities except for Portland receive their water from Old Hickory Lake; Gallatin and White House from direct withdrawal, and Westmoreland and Castalian Springs / Bethpage from the purchases of water from Gallatin. White House also sells water to Simpson County, KY; 2.05 MGD as stipulated in their current contract. Old Hickory Lake was not modeled explicitly. An assumption was made that reservoir could provide enough water to meet water supply needs in all scenarios modeled. The City of Portland withdraws water from their intake on West Fork Drakes Creek, and supplements the flow at the intake when necessary using City Lake.

Existing with Drought Plan. Portland is the only utility in this study region without sufficient supply to meet their projected 2030 demands because all other utilities are supplied from Old Hickory Lake. A drought plan, based on the use of City Lake when certain triggers were met, was the first scenario to be modeled. The Stage 1 and State 2 triggers for initiation of drought restrictions are 70% and 40% of the remaining storage capacity, respectively. In other words, when only 70% of City Lake's reliable capacity remained, Stage 1 drought actions were triggered. The drought actions were assumed to reduce demand by 10%. Stage 2 actions reduced demand by 20% and were triggered when the reliable capacity reached 40%.

5.3.2 Reliable Capacity of Alternatives

Regionalization. The regionalization scenario involved Portland purchasing water from White House, thereby gaining access to the water available in Old Hickory Lake. The local drought plan was implemented for Portland, with the same triggers as mentioned above. Transfers are initiated from White House to Portland under two conditions; 1) Portland purchases all water above their current water treatment capacity, 3 MGD and 2) A transfer from White House of 20% of Portland's total demand would be triggered when the flow in West Fork Drake's Creek cannot supply the entire demand, and City Lake is below full. This alternative does provide sufficient reliable capacity to meet Portland's projected need through 2030.

Caney Fork Creek Reservoir. The final alternative modeled was the addition of the proposed Caney Fork Creek Reservoir to Portland's system. The reservoir would be located upstream of the intake on West Fork Drakes Creek, and releases from the reservoir would augment flows when needed. A 2 MGD constant release from the reservoir was modeled, to keep consistent with Portland's earlier analysis of the project. In addition to the constant release, extra releases are made when flows at the intake would not be sufficient to meet Portland's demand. In this scenario, City Lake is still used only as a backup source when the storage in Caney Fork Creek Reservoir is depleted to the preferred drawdown level. Based on the hydrologic modeling, the average inflow from the watershed of the proposed Caney Fork Creek Reservoir is 30.6 cfs (19.7 MGD). The range of potential minimum instream flow requirements for the 17.3 square mile watershed are 0.55 MGD (0.87 cfs), 1.12 MGD (1.73 cfs) and 2.24 MGD (3.46 cfs). The firm yield of the proposed Caney Fork Creek Reservoir was calculated to be 2.08 MGD, assuming the median minimum release of 1.12 MGD would be required to protect downstream aquatic life. Under this scenario, the Caney Fork Creek Reservoir does provide sufficient reliable capacity to meet Portland's projected need through 2030.

Pipeline Directly to Cumberland River. This alternative uses the Cumberland River as its water source. The treatment capacity of Portland Water System and the hydraulic capacity of pumps to push water through the pipeline establish the yield of this alternative for the purpose of this study. The overall, ultimate pipeline yield is established at 1.0 MGD based on the projected need for the City of Portland. The nature of this alternative precludes any need for a low-flow requirement and was not specifically modeled in OASIS. However, its reliable capacity would be similar to its firm yield and would provide sufficient reliable capacity to meet Portland's projected need through 2030.

5.3.3 Implementability of Alternatives

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 project completion.

Most of the alternatives being considered would require the permits listed below. Tennessee dams are regulated by the Division of Water Supply's Safe Dam Program, which is responsible for conducting certifications, inspections and approvals.

- 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
- USACE real estate lease
- Inter-basin Transfer Permit from TDEC Division of Water Pollution Control
- Real Estate Consent to Easement through USACE

Regionalization. There are no outstanding implementability concerns with regard to improving interconnections, installing new pumps, or constructing the additional storage tanks that would be needed to increase transfer of water between the City of Portland and WHUD. Structure, roadway, land, and environmental impacts would be consistent with those of any routine infrastructure improvement. Implementability concerns could be associated with the need for greater cooperation and coordination between the utilities. While not great, these concerns are related to issues such as agreement on equitable ways to share risk and fairly negotiate terms of contracts for water sales.

Caney Fork Creek Reservoir. Impacts to existing structures, roadways, and land were evaluated. The proposed lake will cover about 135 acres at normal pool elevation, of which 51 acres are residential. Other land uses that will be affected by inundation include agricultural, public use, road and timber land use coverage. Three buildings, including one private residence and two barns, would be affected. Approximately 640 feet of Martin Road, including the bridge over Caney Fork Creek, as well as an unnamed farm road, would be inundated. Figure XXX displays some of the environmental issues/impacts related to the watershed and inundation of the proposed reservoir. Although some of the smaller streams in the area have not been assessed, there are 9,922 feet of streams classified as "Fully Supporting" in the inundation zone. There are no streams classified by TDEC as "Not Supporting" (i.e. 303d classified streams) or "Not Assessed" in the entire watershed. The National Wetlands Inventory indicated that about 1.85 acres of wetland area would be inundated.

An ARRAP permit for the dam has been denied by TDEC.

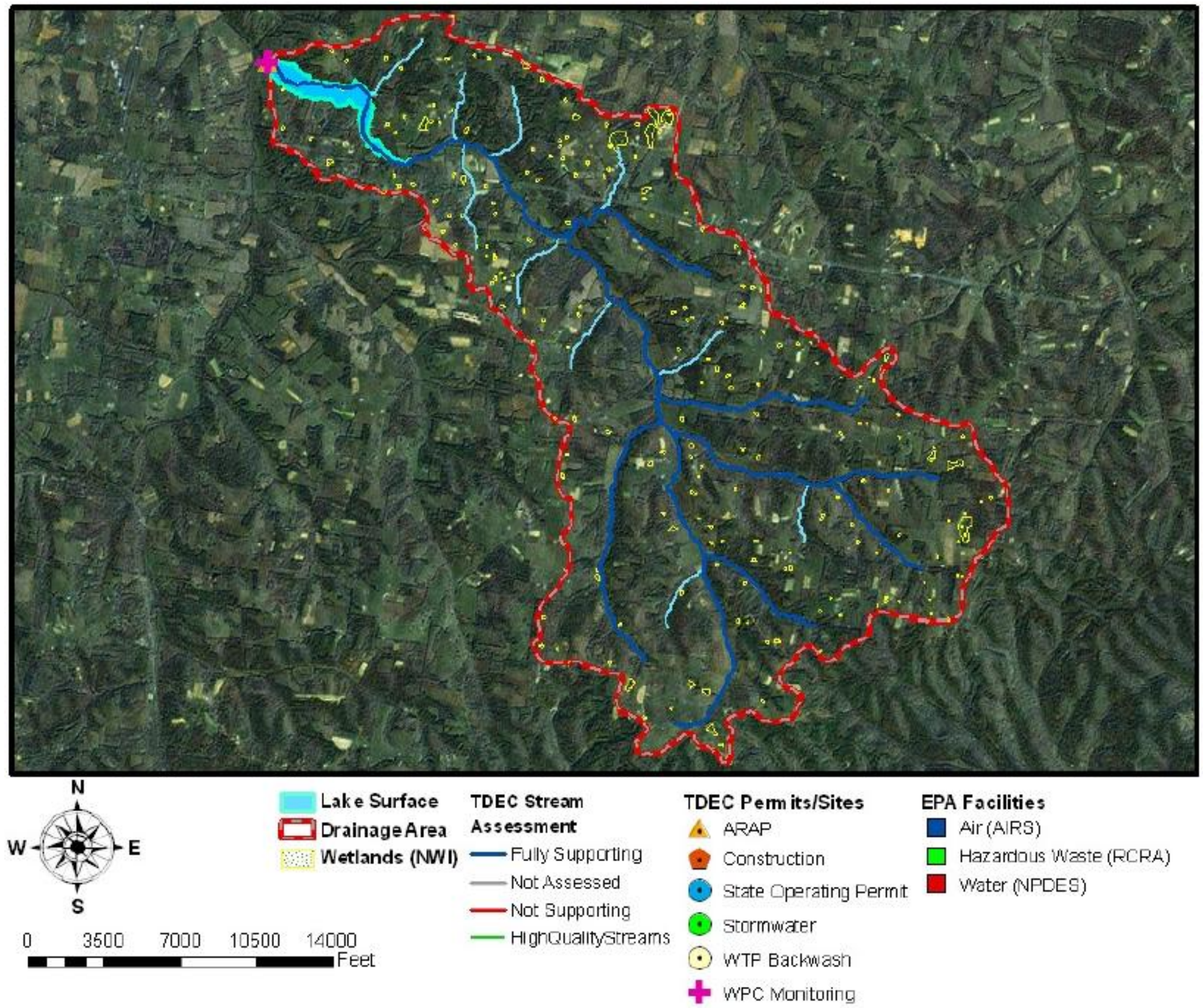


Figure X. Watershed and Inundation Environmental Impacts

Pipeline to Cumberland River. The proposed 21-mile long pipeline from Portland to the Cumberland River has one major implementability concern. There is currently a moratorium on the establishment of new water supply withdrawals from the Cumberland River at Old Hickory Lake. The purpose of the moratorium is to allow the Corps of Engineers to conduct an assessment of the impact of existing water supply withdrawals on navigation and hydropower at Old Hickory, to determine whether charges should be instituted for water supply withdrawals, and, if so, to determine an equitable method for establishing those charges. If the reallocation study results in fee assessment, charges for water supply withdrawals may affect water rates across the region, and will have an impact upon the costs associated with this alternative, or any other involving withdrawals from the Cumberland River.

Lesser implementability concerns include difficulty obtaining easements or purchasing property to construct the pipeline, but these issues would not be unique to this particular project and should not be difficult to overcome. Most of the project construction is along existing road right-of-ways with no significant environmental impacts anticipated.

5.3.4 Flexibility of Alternatives

The flexibility of an alternative is a measure of its ability to be phased, with costs spread over time, while still reliably meeting projected regional water supply needs. This criterion also addresses an alternative's resistance to drought and its ability to be expanded to meet demands beyond the period being studied (2030). This section describes in general terms the flexibility considerations for each alternative, which are based in part upon the evaluation factors already described in Section 5.3.

Regionalization. The regionalization alternative is perhaps the most flexible alternative. It can be implemented in phases and the costs can be spread over time. Improvements can be made to existing infrastructure as demands grow. New infrastructure can be brought on line as needed also. In addition, the alternative can be expanded if the demand is greater than projected or contracted if demands are less. The proposed formal contract and water service connection between the City of Portland and WHUD would reliably meet projected water supply needs. Connecting to the Cumberland River through WHUD would improve Portland's resistance to drought and allow expansion of service when needed (beyond the limited supply provided by other alternatives such as a new reservoir or groundwater).

Caney Fork Creek Reservoir. The Caney Fork Creek Reservoir would be accomplished in a single phase. It cannot be phased or built in increments. As proposed, the reservoir reliably meets projected needs and is highly resistant to drought. Expansion beyond the current planned capacity is not a consideration for this alternative, as the proposed reservoir is capable of reliably meeting projected needs. The dam could potentially be raised in the future, but further evaluation would be required to determine the cost effectiveness and implementability.

Pipeline to Cumberland River. A pipeline to the Cumberland River, and associated pumps and storage tanks, cannot be phased or built in increments. A second pipe could, however, be added at a later time to add additional capacity. There is some flexibility in determining a route for the pipeline. The connection to the Cumberland River makes this alternative highly resistant to drought and allows for capacity expansion beyond the current projected need.

5.4 Alternative Evaluation

The information gathered on each of the alternatives was used to screen the initial array. One alternative Groundwater did not even make through the full Tier 1 screening. It was eliminated based on its inability to meet the reliable capacity requirement of 1.0 MGD. It is unlikely that groundwater sources could supply much good quality water to Portland. It is also important to note that at the shallow depths groundwater is known to occur, it would not be reliable during droughts.

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 (WHUD Connection)	+	$$	+	+
Caney Fork Creek Reservoir	+	$$$	-	-
Portland Raw Water Pipeline to Cumberland	+	$$$	+/-	-

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. Whether an alternative allows for economic growth or meets water needs for the study area beyond the planning horizon, whether the alternative is financially affordable to the utilities, whether it makes financial sense and its ultimate costs to the consumers are also important criteria. The team also considered any updates or additional detail obtained on the Tier 1 criteria. Table XXXX summarizes the evaluation.

Table XXX.

Alternative	Cost*	Finished Water Quality	Environmental Benefits or Impacts	Other Factors
Regionalization (WHUD Connection)	$4.8 M	Potential Improvement	Slight impacts from infrastructure construction	Requires Cooperation Between Entities
Caney Fork Creek Reservoir	$13.2 M	No Change	Substantial alteration of aquatic resources	Conflicts with Clean Water Act Compliance
Portland Raw Water Pipeline to Cumberland River	$13.4 M	No Change	Slight impacts from pipeline construction	Treatment plant operations

* Includes estimate of potential infrastructure costs and future charge for withdrawals from Old Hickory, where applicable. It does not include a the rate that would be charged by WHUD which must be negotiated.

Cost. The regionalization alternative is by far the cheapest to implement and the most economically feasible. The costs shown are for the full projected need in 2030; however, there is the potential to phase the implementation and spread the costs over time as demand increases. It should also be noted that the costs of this alternative does not include the costs to purchase water from WHUD. It is only the cost of the infrastructure improvements needed to meet the demand in 2030. The cost includes an assumed charge for withdrawals from the Cumberland River over the 30 life of the project. Currently there is no charge and no anticipated date for the charge to begin. This charge would also apply to the raw water pipeline to the Cumberland River.

Water Quality. There is no expected substantial change to finished water quality with the Caney Fork or Portland Raw Water alternatives (both are surface water sources treated at Portland's Water Treatment Plant using existing treatment processes).

The WHUD currently uses a combination of conventional and membrane filtration processes, future upgrades are anticipated to be membrane filtration. There is an expected potential improvement to finished water quality for Portland as a result of purchasing water from WHUD.

Environmental Benefits or Impacts. There is a potential for slight impacts due to construction of the Regionalization and Raw Water Pipeline alternatives. Both would be constructed within existing road right-of-ways with minimal new disturbance and Old Hickory Lake would be the raw water source for both.

Substantial alteration of aquatic resources is expected with the Reservoir on Caney Fork Creek. Caney Fork Creek is a tributary to West Fork Drakes Creek which is a high quality Tennessee water with populations of sensitive species.

Other Factors. WHUD and Portland must agree on terms of Contract for capital improvements and operational costs to be shared between utilities and the cost of purchased water. There is the ability to evaluate the regional growth and development plans of each utility at regular intervals so improvements can be planned to meet those intermediate needs.

Environmental impacts of Caney Fork are not acceptable with apparently feasible alternatives available. ARAP has already been denied for Caney Fork based upon the extent of alteration to the existing aquatic resources and the availability of apparently feasible alternatives.

Water chemistry and quality of the Cumberland River is different than existing sources for Portland. These may require adjustments of treatment processes for Portland WTP. Operation and maintenance costs for Raw Water Pipeline have the potential to be significant (further study needed).

5.5 Selection of Preferred Alternative

Regionalization (WHUD Connection) is the preferred alternative. It was selected because it can meet the needs of Portland at the lease cost. It is also the most easily implemented and flexible alternative. It can grow with Portland well beyond the 2030 planning horizon.

Chapter 6. Next Steps

6.1. Overview

The recommended alternative for the North Central region is regionalization. A number of steps are required to successfully implement that alternative, not the least of which is establishing a water purchase agreement between White House Utility District and the City of Portland. Engineering studies will be needed to optimize the amounts and timing of Portland's water purchases. Rate studies are needed to determine how costs will affect customers. The parties will need to determine the best means of financing the required infrastructure improvements.

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 future droughts.

One of the most critical next steps is developing a plan for informing affected customers of the need to purchase of water from White House by the City of Portland. It is critical to educate all customers in the region about the importance of, and opportunities for, conservation.

6.2. Introduction

Background

The Water Resources Technical Advisory Committee (WRTAC) initiated this regional study to assess the North Central 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 has summarized the water needs for the next twenty years into a concise water needs statement:

> *The overall raw water demand for the North Central Tennessee pilot area is projected to increase from approximately 22 to 33 million gallons per day by 2030. Currently there is sufficient raw water to meet this demand, and there are no physical limitations on finished water production for meeting mean-day use as a region. The City of Portland's needs, which average demand of approximately 2.1 million gallons per day, exceeds the firm yield of its small surface water sources. Portland purchases finished water from neighboring utilities as needed, but with no formal contracts for this outside supply; consequently, security for the system is not ensured.*

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 North Central Tennessee's water supply needs. This process and the results were described in Chapter 5.

The results of this work strongly suggest that, of the five water supply systems in the region, only Portland will experience water demands over the next twenty years that will exceed their current sources of supply. Evaluation of several alternatives for providing a safe, secure water source to meet Portland's future needs resulted in selection of purchasing finished water from White House Utility District (WHUD) as the preferred alternative.

Portland's population is projected to be 45% greater in 2030 than it is in 2010. Portland's projected growth rate is three times the rate projected for the state as a whole. Portland's raw water demands are expected to grow from 2.05 MGD in 2010 to 2.99 MGD in 2030, a 46% rate of growth in water demand. Nearby White House is expected to have similar growth, and the unincorporated portions of Sumner and Robertson counties in the Portland area will growth 33% and 40%; respectively, during the same period.

With Portland's current needs for water, the city is approaching a point of unacceptable risk of water shortages. As the city's population and water demands continue to grow, the reliable yield of its raw water sources will remain the same. This means that today's unacceptable risk of water shortage will become increasingly more acute as each year passes. Water can be purchased from White House Utility District in quantities that will reduce the risk of water shortage to acceptable levels or even eliminate it with a high degree of certainty. Further, infrastructure improvements can be implemented on a schedule that closely tracks the projections of increasing water demands. For these reasons, the study team recommends that White House Utility District and the City of Portland develop a water purchase agreement.

In addition to the work done by the study team to evaluate water needs and potential sources, one utility, White House Utility District, received an energy conservation study conducted by the University of Memphis as part of this pilot study at no cost to the utility. The results of that study are included in Appendix X and could provide useful guidance for other utilities to identify cost-saving steps that could improve their 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 North Central Tennessee'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 and beyond. 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 Portland and White House Utility District to develop a cooperative water agreement and for the entire region to enhance its 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 Portland and White House; 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 the 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. 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 water customers or the water supply 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 drought. Regional drought 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, in this case Portland and White House Utility District, 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 full cost of water service includes the costs of production, treatment, storage, distribution, debt service, capital expenditures, regulatory compliance, and other operation and maintenance costs.

The costs of accessing a new water supply source 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 the line flushing necessary 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 water conservation practices. Implementing sound conservation and re-use practices can help reduce overall water consumption, saving both water and money. TDEC would be willing to work with Portland and WHUD to develop an effective community engagement plan that addresses all these issues.

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. Engineering Studies

Optimizing the amounts and timing of Portland's water purchases will require engineering studies. The main goal will be to determine the costs of (1) continuous, base water demand purchases, where water would be purchased even during periods of abundance, and (2) seasonal and emergency purchases, where capacity charges for standby infrastructure would continue even during periods when no water is purchased. Each of those strategies involves different infrastructure upgrades and, therefore, different costs. Some combination of the two could be chosen. Determining the optimal schedule will be an iterative process in which the capital and operating costs—and their effects on water rates—will be estimated. Scenarios tested by the engineers working for the parties will need to consider ways to

- fit capital improvements into existing capital improvement plans;
- avoid dramatic increases in water bills;
- phase improvements to avoid paying for excess capacity; and
- increase the capacity of interconnections in response to commercial or industrial development.

Portland and White House Utility District will be have access to OASIS, the hydrologic model provided as part of this pilot, to model various scenarios in order to determine which one or combination will best meet the needs of both parties. Both utilities will need to work together to determine appropriate capital improvement plans and how best to fund and phase them. Water system managers and engineers for both utilities will need to agree on a work plan for completing the necessary engineering studies.

6.7. Rate Studies

Although some funding assistance may be secured as described in the next section of this chapter, Portland water customers must expect to pay a significant portion of costs to expand their water supply. Probable project costs will be determined initially through the engineering studies, but Portland water system managers will determine whether those 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, both utilities 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:

- Dedicated-Capacity Charges

  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.

- System-Development Charges

  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.

- <u>Seasonal Rates</u>

  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.

- <u>Zonal Rates</u>

  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.

6.8. Water Purchase Contract

While the engineering and rate studies are being done, the utilities should be working out the details of the water purchase agreement they will need to implement the preferred alternative. White House Utility District's recent experience negotiating an agreement with Simpson County Utility District (Kentucky) could serve as a model for their discussions. White House and Portland should begin by reviewing the Simpson County contract and its implementation to determine which provisions they want to replicate and which they want to revise. Portland and White House water managers will need to meet regularly to work on the contract and may want to consider enlisting the services of a neutral facilitator. If they decide that would be useful, TDEC will assist with identifying sources for those services. The terms of the long-term water purchase contract will put Portland on the path to a safe and secure water supply that will meet its current and future needs.

6.9. Project Financing

The study team views a water sales agreement between Portland and WHUD as far more sustainable than some of the other water supply alternatives that were examined; moreover, it may be more easily funded. TDEC will fully explore opportunities for additional federal funding assistance which might result from the October 1, 2010, U.S. Environmental Protection Agency (EPA) announcement of a new Drinking Water and Drinking Water Sustainability Policy. Since the EPA funding policy currently prohibits Drinking Water State Revolving Fund (DWSRF) funding for building water supply dams and reservoirs, selection of the water transfer option as the preferred alternative certainly provides a greater range of project funding opportunities than the other options studied.

There are a number of potential funding sources for the design and construction work required. The project may be eligible for consideration for U.S. Department of Agriculture Rural Development or U.S. Army Corps of Engineers funding. Last year, TDEC created a two-year pilot program to help Tennessee communities fund "watershed enhancement projects" as part of the DWSRF loan program at no additional cost. Communities applying for DWSRF loans can increase the principal of their loan up to 10% (to a maximum of $500,000) in order to finance watershed enhancement projects. With an approved watershed enhancement project, the principal amount is increased and the interest rate is decreased (no lower than 0%) so that the monthly and total loan payments are no greater than they would have been prior to the increase in principal. Eligible watershed enhancement projects would include

- restoration of an impaired section of a stream within the watershed;
- acquisition of conservation easements that protect riparian buffer areas;
- source water protection;
- completion of low impact development projects resulting in greater storm water infiltration or filtration in public buildings and spaces such as green roofs, permeable pavement, vegetated swales and rain barrels; and
- any effective "green infrastructure" project that improves the management of wet weather runoff.

In addition, TDEC is in the process of modifying the DWSRF scoring criteria to give more priority to projects that support a regional planning effort. TDEC will work with White House Utility District and Portland to identify potential funding sources for the next steps of this project.

As mentioned earlier, costs also can be financed on a pay-as-you-go basis. Since the alternative can be phased over the next twenty years, the costs can be addressed through internal rate increases or through development or capacity fees for new customers added to the system.