

Topographic Water Study

for

Cannon County, Tennessee

June 2023

Prepared by:



Water Management Service, LLC
Engineering · Planning · Operations

2 International Plaza Suite 401
Nashville, Tennessee 37217

TABLE OF CONTENTS

I.	Background Information and Purposed of Report	1
II.	Population Projection and Water Demand for Cannon County	3
III.	Review of Existing Water Service Areas	12
IV	Estimate of Future Water Demand within Cannon County	14
V.	Topographical Review and Proposed Expansion of Service	24
VI.	Water Service at County Level	39

Appendix

Map 1- Water Service by Utility

Map 2 – Consolidated Utility District

Map 3 – Dekalb Utility District

Map 4 – Warren County Utility District

Map 5 – West Warren – Viola Utility District

Map 6a and 6B – Woodbury Water Department

Map 7 – 24” x 36” Cannon County Pocket Map

Map 7 – 24” x 26” Cannon County Pocket Map (with representative properties)

2022 Memorandum to Cannon County Commission for ARP related projects

I. BACKGROUND INFORMATION AND PURPOSE OF REPORT

A. General

Cannon County was formed by the Tennessee State legislature in 1836. Cannon County was initially formed from portions of Rutherford, Smith, Wilson, and Warren counties and became a community known for farming, livestock, and thoroughbred horses.

Today, Cannon County is included in the Metro Nashville statistical area along with 14 other counties. A metropolitan statistical area is defined by the United States Census Bureau as “that of a core area containing a substantial population nucleus, together with adjacent communities having a high degree of economic and social integration with that core”. In summary, the residents of Cannon County are in a commuting distance to Nashville, and a portion of Cannon County’s residents depend on Nashville based businesses for employment.

The City of Woodbury, Tennessee was incorporated in 1838 and serves as Cannon County’s County seat. Woodbury is centrally located in Cannon County and is home to the County’s only Water Treatment Plant, which according to local officials, was originally owned by the County and turned over to the town of Woodbury decades ago. Woodbury Water Department is presently the largest water utility provider in the County and generally serves the central portion of Cannon County.

In addition to Woodbury Water, multiple other utilities provide water service to portions of Cannon County. These utilities include: Consolidated Utility District located in Rutherford County, Dekalb Utility District located in Dekalb County, TN, West Warren-Viola Utility District, and Warren County Utility District.

Each of the neighboring utilities primarily focus on supplying for their respective service areas; therefore, significant extension projects into Cannon County have understandably not been extensively explored. Through this study, the utilities do not have defined areas of service within the County, leaving County officials without an understanding of water supply which potentially hinders economic development within the County.

B. Purpose of Report

The purpose of this document is to provide an objective overview for Cannon County’s goal of extending potable drinking water service to all residents in the County. This document provides a population projection to best estimate the future water needs within the county, an overview of the topographical challenges within the county, and a look at each utility’s ability

to best serve the residents of Cannon County. In addition, this document seeks to provide high level planning level guidance to County officials on identifying projects which will best achieve the County's goals and aid in prioritizing collaborative projects with the various utilities providing service within the County. However, the neighboring utility's willingness to extend services, and the County government's willingness to collaborate with all utilities are important to the achievement of the County's goals.

Detailed design and sizing of water systems require intimate knowledge of the operation of all systems involved in the treatment, transmission, and storage of water within a given system. As such, this document does not provide detailed design but rather highlights each water systems role within Cannon County, and the potential role they will share moving forward to allow Cannon County to be a community capable of continued economic growth with safe, reliable potable drinking water for its residents.

II. POPULATION PROJECTION AND WATER DEMAND FOR CANNON COUNTY

A. General

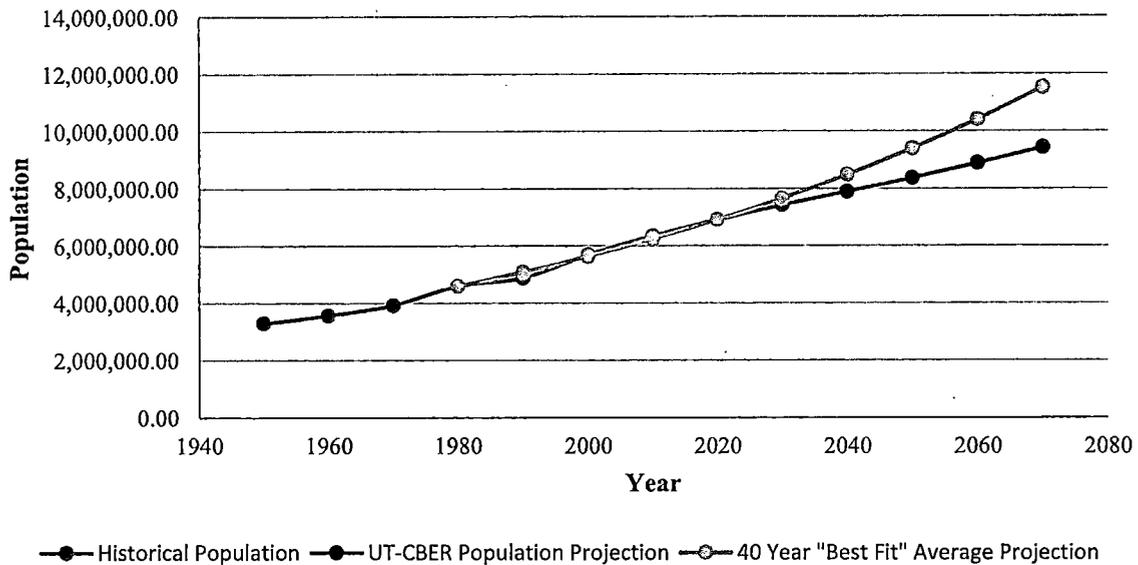
In order to provide a water service plan to best suit the present and future needs of Cannon County, an analysis of the population growth for the State of Tennessee, Cannon County and its communities, as well as, population analysis for neighboring communities which may provide potential development pressures to Cannon County should be considered. The projection included in this document is based on United States Census Bureau Data, the University of Tennessee Center for Business and Economic Research (UT-CBER), and a consideration of local trends within the Middle Tennessee area. Present and future Cannon County elected officials may adopt policies that could accelerate or decelerate growth within the area. This population projection seeks to serve as a guide for planning level discussion.

B. Population Projection for the State of Tennessee

The state of Tennessee has positioned itself for continued growth in the coming years. It is widely understood that migrations to the state are occurring at a rapid pace, particularly to Tennessee's metropolitan areas. The University of Tennessee – Center for Business and Economic Research (UT-CBER) routinely completes and updates population projections for the state and its 95 counties. In addition to this forecast, a commonly used method of projecting population growth is using a “best fit” rate for historical population growth and extending this “best fit” rate of historical population growth to future years. This document includes a 40 year average growth rate calculated from 1980-2020 US Census data, and projected forward.

Figure II-1 below displays the historical US Census Bureau population for the State of Tennessee, the 40 year “best fit” average projection, as well as the UT-CBER projection.

Figure II-1
Population Projection for the State of Tennessee



The population for the State of Tennessee from 1980 through 2020 increased by approximately 2.32 million people for an annualized growth rate of approximately 1.03%. For the last two decades, Tennessee has experienced a growth of approximately 1.22 million people, representing an annualized growth rate of approximately 0.98%. This demonstrates that the State of Tennessee population growth rate as a percentage is slowing; however, still displaying consistent growth. Using the 0.98% annualized growth rate and projecting forward indicates that population for the state of Tennessee will increase by 1.49 million persons between 2020 and 2040.

C. Population Growth in Neighboring Communities

As previously mentioned, Cannon County is in the Metro Nashville statistical area. This categorization is indicative that at least some of Cannon County and its resident's economic contribution is due to the proximity of Cannon County to Nashville. An upward economic and growth trajectory in Nashville has at least some impact within Cannon County.

Additionally, perhaps a more significant impact to Cannon County than the growth of Nashville, is the growth of Murfreesboro. Murfreesboro and Rutherford County have experienced exponential growth in the last few decades. Murfreesboro is a close commuting distance for Cannon County residents; therefore, as Murfreesboro continues to grow and expand, it is reasonable to assume that satellite communities to Murfreesboro will begin to experience increased

growth rates. In order to understand the potential impacts, historical and projected population growth for Rutherford County and the City of Murfreesboro is displayed below in **Table II-1**.

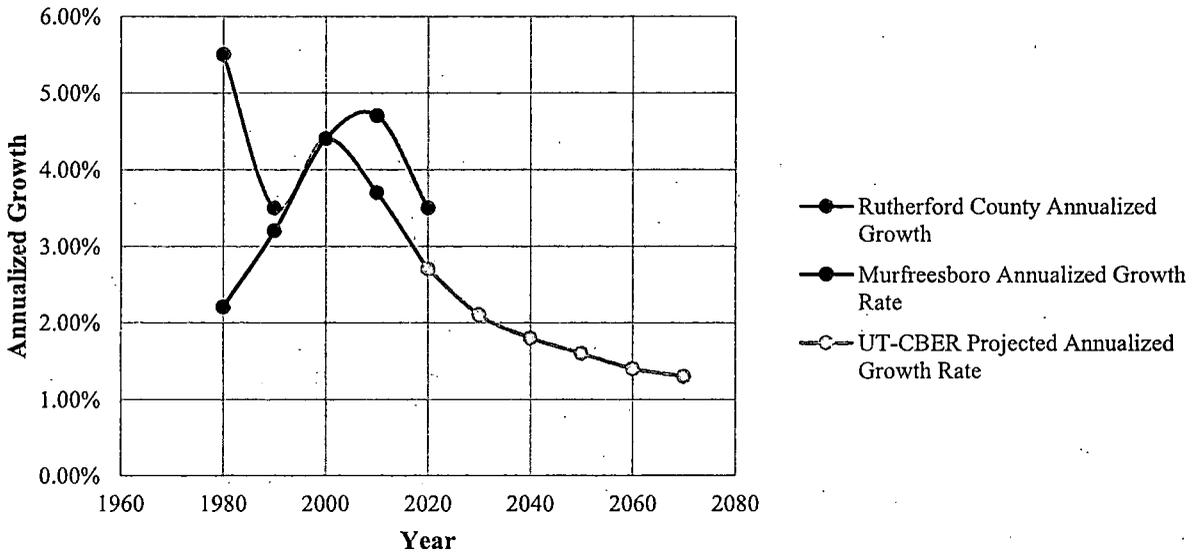
**TABLE II-1
US CENSUS HISTORICAL POPULATION AND UT-CBER PROJECTED POPULATION
FOR RUTHERFORD COUNTY AND MURFREESBORO**

<u>Location</u>	<u>1980</u>	<u>1990</u>	<u>2000</u>	<u>2010</u>	<u>2020</u>	<u>2030</u>	<u>2040</u>	<u>2050</u>
Rutherford Co	84,058	118,570	182,023	262,604	341,486	421,070	503,911	589,051
Murfreesboro	32,845	44,922	68,816	108,755	152,769			

It is common for exponential growth to slow; however, the growth projections by the UT-CBER indicates a growth of over 160,000 people from 2020 to 2040 in Rutherford County, and over 425,000 people from 2020 to 2070. Therefore, it is reasonable to assume that this growth will have an effect on Cannon County population, if Cannon County is positioned to accommodate growth.

Historical annualized growth for decades from the 1970's through the 2010's are included below along with the expected growth rate projected by the UT-CBER through 2070. **Figure II-2** demonstrates a common initial spike in growth rate and then a general slowing into the future.

**Figure II-2
Annualized Growth Rate for Rutherford County and the City
of Murfreesboro**



The growth occurring in Rutherford County is representative of an additional 64,000 housing units between 2020 and 2040 assuming an occupancy of 2.5 persons per unit. As density increases in

Rutherford County and Murfreesboro, it is reasonable to assume that this could have an effect on growth within Cannon County.

D. Population Projection for Cannon County

The US Census Bureau reports a Cannon County 2010 population of 13,801 and a 2020 population of 14,506. This ten year increase of 705 persons represents an average annualized growth of approximately 0.50%. During the same decade, Tennessee experienced an increase 564,735 persons representing an annualized growth rate of approximately 0.86%.

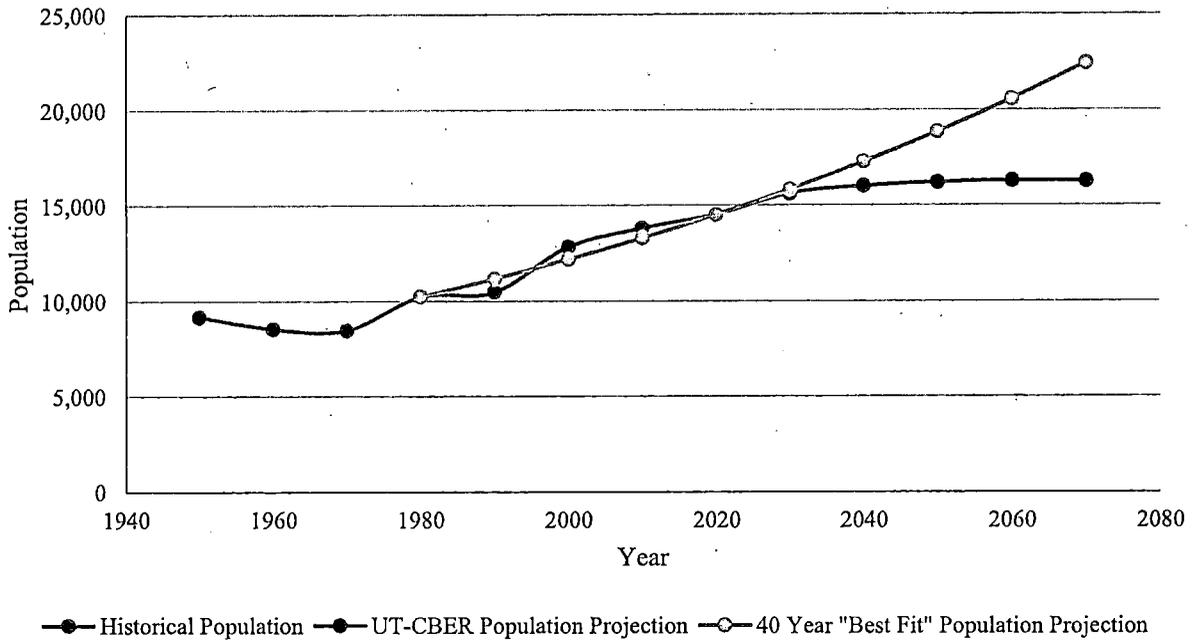
US Census Bureau population projections are not available for Cannon County; however, a publication prepared by the UT-CBER contains population projections for Cannon County through 2070.

Indicated below in **Figure II-3** are the UT-CBER's population projection for Cannon County. As presented therein, UT-CBER's estimate for 2030 is 15,606, for 2040 its 16,007, and for 2050 its 16,198. These projections are representative of 0.73% growth from 2020 through 2030, 0.25% growth from 2030 to 2040, and 0.12% growth from 2040 through 2050.

Relative to UT-CBER population projections, the UT-CBER has previously acknowledged that local officials may have "*specific knowledge or understanding of the events and factors that may affect their communities that result in a more complete understanding of the growth dynamic affecting their community.*" In summary, local officials local may need to modify projections by UT-CBER if they believe conditions require different population figures.

Also included in **Figure II-3** is a "best fit" projection using historical data from 1980 through 2020. This "best fit" equates to an annualized average rate of approximately 0.88% which is similar to the growth rate for the State of Tennessee. Using the "best fit" approach, the population projection for Cannon County are 15,828 in 2030, 17,270 in 2040, 18,844 in 2050, and 22,435 in 2070.

Figure II-3
Population Projection for Cannon County, Tennessee



Due to the expansive growth of the metro-Nashville area, Cannon County's inclusion in the metro Nashville statistical area, and the growth which has occurred in Murfreesboro, this document will use an estimated growth rate projection of 0.70% for planning purposes within this document. A 0.7% average rate represents a more aggressive growth rate than the UT-CBER projection; however, it also represents a slightly less aggressive growth rate than the historical "best fit" average. Therefore, for the purpose of this document, the population for Cannon County is projected to be 15,554 by 2030, 16,678 by 2040, and 17,883 by 2050.

These projections serve as a guide for planning level purposes. While dramatically increased growth has yet to occur within Cannon County, an aggressive economic development agenda could cause these estimates to shift drastically. In contrast, an inability to provide utility service can drastically impact the ability of a community to accommodate increasing population, and development could stall. Should aggressive growth occur within Cannon County or its communities, a reevaluation of the population and the location of growth may occur to maintain an awareness for County officials.

While a population projection for countywide growth is important, it is of more importance to understand where the growth within the County is occurring. High density development often occurs in the areas best suited to provide utility service: water, sewer, and to a lesser extent, gas.

A community can achieve low to medium density development with access to potable water service. In order for high density residential development or large industrial development, access to sewer service is generally required to accommodate the development. Therefore, this document also reviews population data for individual communities within Cannon County where data is available.

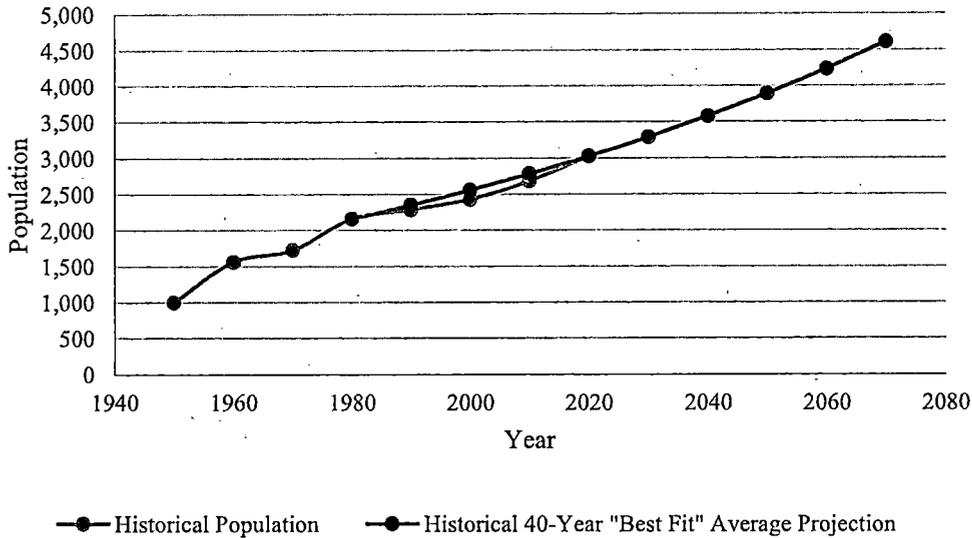
E. Population Projection for the Town of Woodbury

The town of Woodbury is centrally located within Cannon County and serves as the county seat. Woodbury is home to Cannon County's only water treatment plant and wastewater plant. According to the US Census Bureau, the population for Woodbury in the 2010 Census was 2,680 and for the 2020 Census was 3,024 persons. This represents an annualized growth rate from 2010 to 2020 of 1.22%.

The UT-CBER does not post population projections for individual towns or cities; however, the 40 year historical "best fit" average may be utilized for estimated future populations for the Town of Woodbury. The population for Woodbury in 1980 was 2,160. This represents a population increase of 864 over 40 years and an annualized growth rate over those 40 years of 0.84%. This indicates that recent growth has accelerated compared to the last 40 years within Woodbury.

Due to the small population of the town of Woodbury, a single pocket of development may drastically skew the percentage growth for the town. Therefore, for the purpose of this document, the 40 year historical average will be utilized for planning level purposes at this time. The historical and "best fit" projection are displayed in **Figure II-4**.

**Figure II-4
Historical Population and "best fit" Projection
for Woodbury, Tennessee**

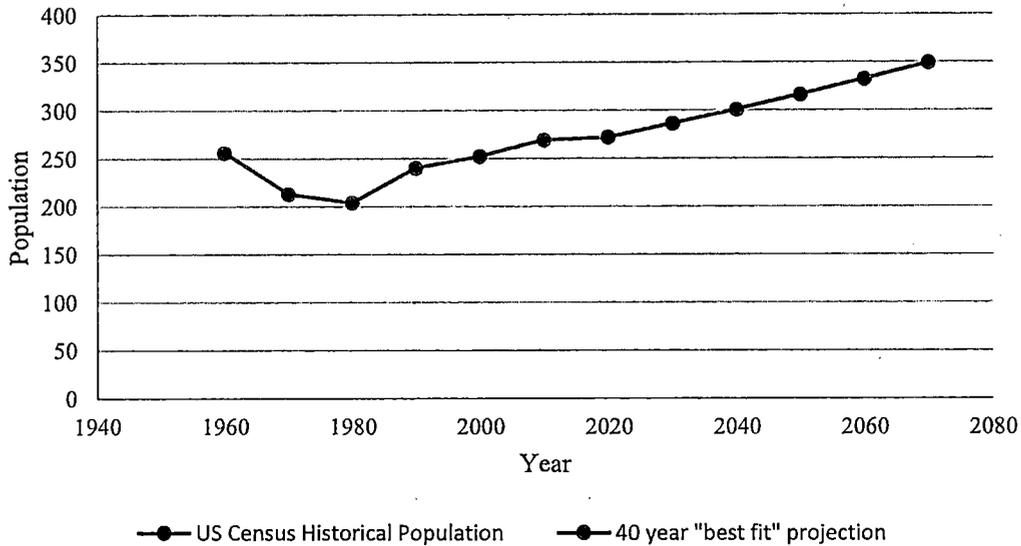


The above graphic displays a linear growth pattern. A shift in development climate is required to significantly accelerate growth in the community. Therefore, for the purpose of this document, population is projected to be 3,289 by 2030; 3,578 by 2040; and 3,892 by 2050.

F. Population Projection for Auburntown

Auburntown is located in the Northern portion of Cannon County. According to the US Census Bureau, the population in 2010 was 269 people and in 2020 was 272 people. This represents a 0.11% growth rate over the last decade. The population in 1980 was 204 persons, resulting in an annualized growth rate for the 40 year "best fit" average of 0.72%. This is slightly less than the growth rate for the County and the Town of Woodbury over that same review period. For the purpose of this document, a growth rate of 0.5% will be used for future population projections. This represents a greater growth than the recent decade but a lower growth rate than what has been observed over the last 40 years. Therefore, for the purpose of this document, the population of Auburntown will be projected to be 286 by 2030, 300 by 2040, and 316 by 2050. The historical and "best fit" population is displayed in Figure II-5 below.

**Figure II-5
Historical and Projected Population of Auburntown**



G. Population Projection for Unincorporated Cannon County

The remaining portions of Cannon County will be considered unincorporated and will accommodate the remaining countywide growth not experienced in Woodbury or Auburntown. **Table II-2** displayed the future population projections for Woodbury, Auburntown, Unincorporated Cannon County, and Cannon County.

**Table II-2
Compilation of Projected Population for Cannon County**

<u>Location</u>	<u>2020</u>	<u>2030</u>	<u>2040</u>	<u>2050</u>	<u>2060</u>	<u>2070</u>
Woodbury	3,024	3,288	3,575	3,887	4,226	4,394
Auburntown	272	286	301	316	332	349
Unincorporated	11,210	11,980	12,803	13,680	14,617	15,617
Cannon County	14,506	15,554	16,678	17,883	19,175	20,560

While there are communities within Cannon County which have measurable populations, the US Census Bureau does not provide Census data for unincorporated towns. Therefore, as part of this study, a manual review of properties and their elevations was conducted. Discussion of this review is conducted in **Section V** of this document.

H. Estimate of Population Served versus Population Unserved:

Customer service information was collected from the five utilities providing service within Cannon County. **Table II-3** displays each utility and their Cannon County customer base from largest to smallest.

**Table II-3
Water Utility Providers Customer Base Located within Cannon County**

Utility	Number of Customers in Cannon County
Woodbury Water	3,898
Dekalb Utility District	473
Warren County Utility District	191
West Warren – Viola Utility District	171
Consolidated Utility District	59
Total	4,774

In total, there are approximately 4,774 water customers which have water service in Cannon County. Of these, it is estimated just over 4,500 are residential customers. Based on the US Census estimate of 2.55 persons per home multiplied by the approximate residential customer estimate of 4,500 results in approximately 11,475 people having access to water in Cannon County of the total population of 14,506, or 79%.

III. REVIEW OF EXISTING WATER SERVICE AREAS

A. General

Cannon County residents receive water service from five water utility providers. These utility are Dekalb Utility District which serves a considerable portion of the northern portion of the County, Woodbury Water Department which is more centrally located in the County and houses Cannon County's only water treatment plant, Consolidated Utility District whose service area borders nearly the entirety of the western border of Cannon County, West Warren – Viola Utility District which provides water service to some residents in the southern portion of Cannon County, and Warren County Utility District which serves a small portion of residents in the eastern portion of the County. Requests for information were sent to the utilities or their Engineers and maps of the respective systems were collected. From this, the maps were consolidated into one county wide map which is representative of where water access is presently available. To understand the present location of each utilities service area within Cannon County, the five water systems pipelines are color coded by utility and displayed in **Map 1**.

B. Consolidated Utility District.

Consolidated Utility District is chartered in Rutherford County, Tennessee, and abuts the western side of Cannon County. Consolidated Utility District presently serves approximately 59 customers within Cannon County. Due to Consolidated Utility District being chartered for the residents of Rutherford County, Consolidated Utility District does not actively pursue expanding water service within Cannon County. Consolidated Utility District does however share a water connection with Woodbury's water system and presently sells water to Woodbury to supplement their customers. **Map 2** provides a more focused view of Consolidated Utility District's present water service within Cannon County.

C. Dekalb Utility District

Dekalb Utility District serves the northern portion of Cannon County. There are no set service area boundaries between Dekalb Utility District and the Woodbury Water System; however, Dekalb Utility District did provide a proposed service area which they are generally working toward. Dekalb Utility District has a water plant which was constructed within the last decade. The water plant is designed to treat 3 million gallons per day (MGD), presently permitted for 2 MGD, and currently has an average demand of approximately 0.9 MGD. Dekalb Utility District does intend to continue expansion of service within Cannon County as projects become financially viable. **Map 3** displays the existing Dekalb Utility District water system within Cannon County and the

preliminary service area boundary identified by Dekalb Utility District. A more detailed discussion of the facilities located within Dekalb Utility District's water system is included in Section 5 of this document.

D. Warren County Utility District

Warren County Utility District serves approximately 191 customers in a small portion of Eastern Cannon County. Warren County Utility District also maintains a 500,000 gallon water storage tank on half acre road. At present, Warren County Utility District does not maintain a connection with Woodbury Water Department; however, Woodbury Water department has proposed a water main which would allow for a connection to the Warrant County Utility District water system and allow for more water supply to Woodbury's water system. Warren County Utility District's water system located within Cannon County is displayed in **Map 4**.

E. West Warren – Viola Utility District

West Warren – Viola serves a small southern portion of Cannon County. In addition to serving approximately 171 customers, West Warren – Viola maintains a metered connection with Woodbury Water Department which can provide supplemental water to the Woodbury Water system. West-Warren Viola's water system within Cannon County is displayed in **Map 5**.

F. Town of Woodbury Water Department

Woodbury is home to Cannon County's only water treatment plant which is centrally located in the County. The Woodbury Water Treatment plant has a present design capacity of 1.7 MGD and a withdrawal permit of 1.7 MGD. From the town of Woodbury, the Woodbury water system serves west to the Rutherford County line, East to near the Warren County line, and South to the Coffee County line. The Woodbury Water system maintains connections with both Consolidated Utility District and West Warren – Viola Utility district and seeks to establish a connection with the Warren County Utility District. The Woodbury water system is the most expansive water system in the County, maintains the service of three water storage tanks and pressure sustaining booster stations, and is positioned in such a way to provide a majority of future service to County residents. Woodbury's service area is displayed in **Map 6a and 6b**.

IV. ESTIMATE OF FUTURE WATER DEMAND IN CANNON COUNTY

This section seeks to estimate the future water demand within Cannon County and provide a background of federal and state requirements and guidelines to utilities. This discussion is intended to provide an understanding to Cannon County officials of factors that utilities must consider when expanding services of water systems.

A. General Guidelines for Estimating Water Usage in a System

Typical municipal water demands can be divided into four (4) major categories: 1) domestic, 2) industrial or commercial, 3) public service such as fire protection and system maintenance, 4) unaccounted for system loss and leakage. Table IV-1 shows the typical water uses from the U.S. Department of Housing and Urban Development document entitled Residential Water Conservation Project, Summary Report – June 1984. These percentages provide a general guide for the allocation of water demands in a water system.

Table IV-1
Typical Water Uses on Municipal Water System
Flow, Gallons per Capita

<u>Use</u>	<u>Range</u>	<u>Average</u>	<u>Percentage</u>
Domestic	40 - 130	60	36.4
Industrial /	10 - 100	70	42.4
Public Service	5 - 200	10	6.0
Unaccounted System	<u>10 - 40</u>	<u>25</u>	<u>15.2</u>
	65 - 290	165	100.0

Commonly, the basis for evaluating the capacity of water systems utilizes a per capita usage rate along with population projections to develop estimates of future water demands. Because future growth within a given service area is likely to remain similar to that of existing development, this methodology accounts for commercial and industrial water usage as a component of the per capita domestic usage rate. This provides an estimate for future demands that is proportionate to the population growth within the service area. Any additional water needs for large industrial or commercial users is in addition to the demands developed using population projections.

Precisely estimating or measuring water consumption for Cannon County residents for each utility is not necessary for a planning level document of this scope. Previous engineering Reports for other municipalities were compared for an establishment of an estimate for Cannon County.

- Lebanon, TN - 176 gallons per persons per day
- Winchester, TN - 105 gallons per person per day
- Lexington, TN – 115 gallons per person per day

Both Lexington and Winchester represent a more rural and residential customer base which would more closely resemble the Cannon County community, whereas Lebanon is a more urbanized community with significant industrial and commercial development which results in the per capita demand to escalate.

To further support the above assumptions, **Table IV-2** presents published data for typical fluctuations in municipal water demands. Maximum water demands occur in summer months when irrigation and swimming pool activities are the highest.

Table IV-2
Typical Fluctuations in Water Use ¹

Design Conditions	Percentage of Average for Year	
	Range	Typical
Average Day – Average Month	110 – 140	120
Average Day – Maximum Month	120 – 170	140
Maximum Day – Maximum Month	160 – 220	180
Maximum Hour	225 – 320	270

Using the above assumptions and published data, an estimate of 120 gallons per capita per day will be utilized for the purpose of this document. This will allow for planning level discussions between County officials and the various utilities providing water service within Cannon County.

An essential requirement in the design of water treatment facilities is the need to provide facilities that will meet “*maximum day – maximum month*” water demands. While storage reservoirs enable water systems to meet peak hourly demands, typically storage facilities do not have capabilities to meet peak demands beyond a 24-hour period. After supplying water to meet peak hourly demands, proper operation of storage tanks require daily replenishment to restore adequate water levels. If not replenished, water levels in the storage tanks will drop to levels inadequate for maintaining proper water pressures and water reserves for fire protection. For these reasons, a prudent design of water facilities require capabilities to meet projected “*maximum month – maximum day*” demands for given design period. For the purpose of this document, a peak demand factor of 1.5 is applied to the average demand.

Using the population projections from **Section II** of this document, an estimate for the total amount of water required to serve the population of Cannon County may be made. The water demand projection is displayed in **Table IV-3**. Average and Peak demands are noted in MGD.

¹ Metcalf & Eddy, Inc. Water and Wastewater Engineering, Third Edition, McGraw-Hill, Inc. New York, 1991

Table IV-3
Population Projection vs Estimated Water Demand for Cannon County

<u>Location</u>	<u>2020</u>	<u>2030</u>	<u>2040</u>	<u>2050</u>	<u>2060</u>	<u>2070</u>
Cannon County	14,506	15,554	16,678	17,883	19,175	20,560
Average Demand	1.74	1.87	2.00	2.15	2.30	2.47
Peak Demand	2.61	2.80	3.00	3.22	3.45	3.70

The above estimates seek to provide a rule of thumb water demand calculation for Cannon County as a whole. Industrial development, particularly industries requiring large amounts of water would most certainly locate near Woodbury due to access to sewer service. All high density, and most commercial development are most likely to occur within Woodbury due to the access of sewer service. High density development or heavy industrial growth would most likely shift the growth projections to a more aggressive path; therefore, requiring more water within the system.

B. Water Storage

General

Many factors contribute to the reliability of a water system, with water storage being one of the most critical. Water storage reservoirs provide equalization of the water pressure within the distribution system; provide reserves for fire protection; and emergency storage for times when treatment facilities or booster stations are inoperable.

The Tennessee Division of Water Supply design criteria states that, “the purpose of system storage is to have sufficient water available to provide adequate flow and pressure at peak demand as well as to provide for fire flows when needed.” According to the Division of Water’s rules, a “rule-of-thumb” is for water systems to provide a minimum storage equal to the 24-hour demand for the average day.

Further complicating this issue is the fact that water systems routinely operate with multiple pressure zones. This is necessary to provide water service to areas with high elevations within a distribution system without over pressurizing the majority of the distribution system. In Section V of this Report, the County is broken down into “pockets”. These identified “pockets” generally represent major pressure zones within Cannon County. Additional “pockets” of unserved area are also included with a discussion on which utility could be best suited to provide water service to the area.

Another factor in the reliability of a system is the design of the reservoir itself. In general, ground storage reservoirs provide less usable storage capacity than elevated reservoirs. This is because,

the Tennessee Division of Water Supply requires that water systems maintain a minimum pressure of 20 psi at all times throughout the distribution system. Therefore, the usable amount of water in a storage reservoir is limited to an elevation that maintains this minimum pressure.

Equalization of distribution system pressure is the primary function of any water storage tank. The Ten State Standards, a widely used design standard, recommends a maximum variation between high and low pressures of 13 psi (30 ft level change within the tank). For the purpose of pressure equalization, only the portion of a water tank that is above the height required to provide the minimum system pressure is useful storage.

Compliance with the suggestion of the Ten State Standards requires operation of storage tanks within the top 20 feet of water storage tanks. A 20-foot limitation in water levels in storage tanks allows another 10-foot loss in distribution losses to stay within the recommended 30-foot variation in system pressures. By maintaining storage volumes above minimum requirements for equalization ensures that adequate amounts of water will be available for emergencies, while minimizing the effects of peak demands on system pressures.

How Water Storage Relates to Cannon County's Goals:

It is the goal of every water system to provide safe, reliable service to its customers. This includes water quality, which is monitored by the utility; however, what is measured by the public is reliability. This reliability comes in the form of being able to physically access drinking water 24 hours a day; however, the second measurable metric is water pressure. Unless a customer is served via mechanical means (a booster pump), the elevation of a water storage tank is directly related to the maximum amount of pressure that a customer may receive. Tanks that are unable to operate efficiently or properly may create pressure swings within the area it serves. A tank that is undersized for the area it serves, pressure swings can become prevalent. Therefore, a utility must have adequate storage volume within its distribution system to provide extensions of service.

a. Reserves for Fire Protection

The basic technique utilized by fire departments to control and extinguish fires is the application of water. In most cases, the source of water is the public water supply. In order for the efforts of the fire department to be successful, the water system must be capable of supplying an adequate amount of water to neutralize the threat. The American Water Works Association (AWWA) defines the required fire flow as, *"the rate of water flow, at a residual pressure of 20 psi and for a specified duration that is necessary to control a major fire in a specific structure."*

The factors that affect the design of storage facilities, for fire suppression needs, are the design flow rate, and the duration that the water system must be capable of delivering that flow rate. This establishes the volumetric requirement for the storage system to ensure that adequate water is available for fire protection.

National fire control organizations such as the National Fire Protection Association (NFPA) and the Insurance Services Office (ISO) have provided formulas in past years to determine water storage requirements for fire suppression needs. The American Insurance Association (AIA) developed a formula, which used population, to calculate the needed fire reserve. Today these groups, due to liability concerns, no longer recommend such formulas.

In regards to the issue of fire protection, AWWA published the *“Manual of Water Supply Practices M31 – Distribution System Requirements for Fire Protection”*. This manual details widely accepted methods to calculate the fire flow requirements for a water system. The manual recommends both the needed fire flow and durations for residential developments. The recommended duration for flows less than 2,500 gpm is two (2) hours, three (3) hours for flows up to 3,500 gpm and four (4) hours for flows greater than 3,500 gpm. A reproduction of that listing for recommended fire flows is as follows in **Table IV-4**.

Table IV-4

<u>Needed Fire Flow for One and Two-Family Dwellings</u>	
<u>Distance Between Buildings</u>	<u>Needed Fire Flow</u>
More than 100 ft	500 gpm
31-100 ft	750 gpm
11-30 ft	1,000 gpm
Less Than 11 ft	1,500 gpm

The manual states that, *“All fires are basically different because of random variations in the structure and contents of the burning building...”* For this reason, responsibility for determining fire flows for individual structures is the responsibility of local fire officials. However, for planning purposes, utilities can determine representative fire flows and storage volumes needed for the residential portions of the water system using the values from the table.

Fire protection requirements are dependent on a number of criteria such as type, size, and the density of development. Therefore, the fire flows derived for residential developments are not appropriate for commercial and industrial developments. Current building planning methods from the ISO, NFPA, and International Fire Code (IFC) rely on formulas to determine the minimum required flows to meet the needs of a single fire. Depending upon the layout and design of existing

facilities within a water system the fire flow requirements may vary greatly from one structure to another.

Fire protection needs are sporadic, and fire departments are normally able to confine the fire within the structure of origin. Therefore, when planning for the volumetric needs for fire storage water systems should, at a minimum, provide storage to meet the worst-case scenario. If containment of the fire is possible then the amount of water required should be equal to or less than that need for the worst-case scenario within the water system.

The Division of Water Supply design criteria states that, "*when fire protection is to be provided, system design should consider the recommendations of the state Insurance Service Office.*" The ISO method calculates the flow rate necessary to control a major fire for a specific building. The calculated flow is the needed fire flow (NFF). The ISO does not recommend use of this method as a design criterion for water systems. However, documentation has shown that in real life situations the NFF reasonably coincides with actual flows to suppress fires. Therefore, for the purpose of this Report, the basis for the calculation of fire reserves will be ISO guidance.

How Fire Protection Relates to Cannon County's Goals:

Much of Cannon County is considered rural development. Additionally, there are not a significant number of high density developments outside of the Town of Woodbury. Due to the rural nature of much of Cannon County's development, achieving fire protection for all county residents is cost prohibitive. Fire suppression is generally reserved for areas that risk spreading fire to more than one structure due to proximity. Therefore, achieving fire protection throughout the entire county at this time is not feasible, nor should it be considered as a near term achievable goal. As higher density development occurs within the county, fire suppression capabilities may be extended to portions of the county; however, it is anticipated this will be growth driven.

b. Emergency Reserves

The emergency reserve is dependent upon an established operational period for the water system without the capacity of the water treatment plant or associated booster stations. Because of the aging of water in storage leads to decline in water quality, the permanent establishment of large emergency reserves in water storage can cause non-compliance with state and federal requirements. Therefore, water systems should avoid large emergency reserve storage. For this Report, emergency reserve is considered to be the amount of water storage that is over and above that needed for operational and fire suppression reserves.

Therefore, because of these considerations, investment in backup provisions for treatment and transmission redundancies and interconnection with adjacent water utilities are the recommended procedures for providing for emergencies rather than providing excessive water storage.

Water quality degradation in reservoirs has become an important consideration over the past decade. Recent regulations result in a need to limit the age in the water distribution system to minimize water quality concerns. The EPA document entitled “*Finished Water Storage Facilities – August 15, 2002*” classifies water quality problems caused by excessive water age to be microbiological, chemical, or physical. Relative to this issue, the paper contains a listing of water quality problems associated with storage facilities. A reproduction of that listing is as follows in **Table IV-5**.

Table IV-5

Summary of Water Quality Problems Associated with Finished Water Storage Facilities

<u>Chemical Issues</u>	<u>Biological Issues</u>	<u>Physical Issues</u>
Disinfectant Decay	Microbial Regrowth*	Corrosion
Chemical Contaminants*	Nitrification*	Temperature/Stratification
DBP Formation*	Pathogen Contamination*	Sediment*
Taste and Odors	Taste and Odors	

* Water quality problem with direct potential health impact.

For water systems to maintain the quality of water in storage tanks requires that the water system provide for adequate tank *turnover*. *Turnover* is defined as the age (days) of water in the tank calculated by dividing the volume of water contained in the water tank by the amount of water withdrawn from the water. For adequate turnover to be achievable, management of water systems must be with an emphasis on integrated operation optimizing the relationship between storage and pumping facilities. Relative to the issue of acceptable *turnover* rate, an EPA document entitled “*Finished Water Storage Facilities – August 15, 2002*” contains a listing of guidelines² for water “turnover” in storage tanks. A reproduction of that listing is in **Table IV-6**.

² Kirmeyer, G.J., L Kirby, B.M. Murphy, P.F. Noran, K.D. Martel, T. W. Lund, J.L. Anderson, and R. Medhurst, 1999. *Maintaining and Operating Finished Water Storage Facilities*, Denver, Colo.: AWWA and AwwaRF

Table IV-6

Guidelines on Water Turnover Rate

Source	Guideline	Comments
Georgia Environment Protection Division	Daily turnover goal equals 50% of storage facility volume; minimum desired turnover equal 30% of storage facility volume	State regulators were interviewed by telephone
Virginia Department of Health, Water Supply Engineering Division	Complete turnover recommend every 72 hours	State regulators were interviewed by telephone
Ohio EPA	Required daily turnover of 20%; recommended daily turnover of 25%	Code of state regulation; turnover should occur in one continuous period rather than periodic water level drops throughout the day.
Baur and Eisenbart 1988	Maximum 5 to 7 day turnover	German source, guideline for reservoirs with cement-based internal surface.
Braid 1994	50% reduction of water depth during 1 24 hour cycle	Scottish source
Houlmann 1992	Maximum 1 to 3 day turnover	Swiss source

TDEC design guideline contained in the *Community Public Water Systems Design Criteria - 2008* states in Part 8.0.15 the following: *“If there is more than 2 days storage, provisions shall be made for turnover of the water in the tank and/or booster chlorination.”* The design guideline document further states that water storage reservoir structures should be equipped with taps for sampling.

Expectations are that Tennessee regulations will evolve to require verifications that the quality of water in storage is suitable for distribution. Therefore, maintaining acceptable water quality in water storage tanks requires meeting minimum turnover rates and mixing standards. Regardless of the status of current regulations, mixing and turnover rates are important water quality issues

How this Relates to Cannon County’s Goals:

Water storage tanks are critical in maintaining enough storage in the event of catastrophic events like fire or treatment plant outages; however, constructing water storage tanks too large result in the reduction of water quality that the public rely on. Therefore, utilities must carefully consider capital improvements that balance the ability to support customers in the event of a catastrophic events, providing volume for additional growth in the community, and maintaining water quality standards to meet State of Tennessee and federal EPA requirements.

c. Pressure Requirements

One of the most observable characteristics of water by customers is pressure. A lack of pressure can be frustrating for customers and create operational issues within the water system for the utility. Any water line additions to a system are required to adhere to the criteria set forth by TDEC and the EPA. Below are a few of the state criteria in sizing water main additions.

- Size of water mains shall be justified by hydraulic analysis. 2-inch water mains will only be considered for short cul-de-sacs and permanent dead ends where future growth is not feasible. The length of 2-inch water mains shall be restricted to 3000 feet in any one direction.
- ...”The system shall be designed to maintain a minimum pressure of 20 psi at ground level at all point in the distribution system under all conditions of flow.”
- Wide variations in pressure above the minimum requirement of 20 psi may be inherent in the design of a distribution system but pressures no greater than 100 psi should be delivered to the customer (unless higher pressures are requested)...Where water pressures over 100 psi are necessary to the operation of the distribution system, customers must have individual pressure reducing valves.
- Water distribution lines should be designed and sized for an instantaneous peak demand of 2 gpm per connection for water lines serving up to 100 residential connections: Peak design demands can be reduced to 1.5 gpm per connection for 150 residential connections, 1.0 gpm per connection for 300 residential connection, 0.75 gpm per connection for 500 residential connections, and 0.5 gpm per connection for 1000 or more residential connections.
- Dead ends shall be minimized.
- Where dead-end mains occur they should be provided with a fire hydrant, when fire flows are available, or blow-off for flushing purposes. The blow off shall be at least 2 inches in diameter but should provide flushing velocities of 2 feet per second or greater.
- Ordinarily fire hydrants shall not be connected to water mains which are not capable of providing a flow of 500 gpm at 20 psi.

How this Relates to Cannon County’s Goals:

Pressure and line sizing requirements set forth by TDEC and the federal EPA, combined with Cannon County’s challenging topography hinder easy expansion of water service within portions of the County. Water storage tanks must be set at an elevation that provides efficient service to the greatest number of residents. Due to topography and flushing requirements, many dead end water lines would likely require pressure sustaining booster stations to supply water. This increases the operational cost of the water system, increasing monthly water bills. Further, pressure sustaining booster stations are subject to power outages unless they are equipped with backup power generation which further increases costs. Unfortunately, expansion of service isn’t simply extending a water line for much of the unserved population in Cannon County. However, strategic

initiatives and coordination with the various utilities providing water service offers an ability for expansion of service to achieve the County's ultimate goal.

V. TOPOGRAPHICAL REVIEW AND PROPOSED EXPANSION OF SERVICE

A. General

The proposed expansion of service within this document is based on typical norms observed within the municipal water industry. Therefore, for the purpose of this document, where a utility has established water service, it will be generally accepted that another utility isn't likely to extend service to that immediate area. In addition, a review of the utility's established hydraulic service elevations versus the topography of the service area is discussed.

Detailed design of water distribution systems require intimate knowledge of a system's treatment, transmission, and storage of potable water. Any pipe sizing suggested in this document is preliminary in nature and the controlling utility will ultimately be responsible for determining final required facilities. This document seeks to propose facilities to serve as discussion points between County officials, economic development agencies, and the various water utilities providing potable water within Cannon County.

As part of this study, the elevation of all properties were manually reviewed for a planning level review to facilitate discussion of service areas within the County. A more detailed plan of expansion of service, including line sizing for every road, or every home is not financially beneficial to the County as the service provider will have the responsibility for design and operation of the proposed facilities. The proposed expansion of service primarily focuses on existing infrastructure within the County and how to best expand.

This topographical review utilized information provided by the various utility providers or their consulting engineers. From the information provided, existing major service areas or pressure zones were generally established from the information provided. Each service area or pressure zone has its own unique hydraulic elevation. The primary source of a hydraulic service elevation is the overflow elevation of a water storage tank. Static pressure for a system is derived by taking the overflow elevation of a water storage tank, subtracting the elevation of the home, and dividing by 2.31. However, a static pressure calculation does not account for friction losses within the system which occur due to water moving through water mains. The further water is conveyed away from its source of hydraulic elevation (storage tank), greater friction losses can occur, and as a result, pressure become more volatile.

For Cannon County planning level discussion, it is assumed that any water storage tank is dropped a minimum of 10 feet to replicate typical operation of a water storage tank, and the desired static

pressure to be considered potentially serviceable is 45 psi. This allows for dynamic pressure fluctuations within the system while also maintaining a minimum average pressure of 30 psi.

There are pockets in the system which rely on a booster station for service. A booster station will have a set discharge pressure to maintain which can then be converted to a hydraulic service elevation. This report does not include the pressure settings of all booster stations. However, assumptions may be made based on the service elevation of homes within the existing service area.

In order to facilitate discussion of Cannon County's topography, each utility was broken down into pockets of service. Each pocket displayed generally represents a different hydraulic service elevation; which dictates the elevation a customer may be in order to be provide service. Each "pocket" is discussed below by the following:

- Utility providing service
- Estimated hydraulic service elevation
- Estimated number of properties within the identified pocket
- General discussion of plausibility of expanding service

In order to facilitate this discussion, a 24"x36" labeled **Map 7** has been included with this document which displays the identified pockets as discussed below. Each pocket was drawn based on existing utilities present service area, proposed projects, expressed interest in expanding service within Cannon County, and an attempt at minimizing dead end water mains.

Pocket 1 – Auburntown Pressure Zone

Pocket 1 is primarily served by the Auburntown water storage tank. The Auburntown water storage tank has an overflow elevation of 870'. There are approximately 615 identified homes within this pocket. In order to establish a serviceable elevation for the pocket, it is assumed that the existing water storage tank would typically operate in a range of approximately 10 feet, meaning the tank should only be considered to have an overflow of 860 feet. Additionally, for the purpose of this document, a minimum static pressure of 45 psi is assumed. This allows for two story homes and friction losses which occur as water moves through the system. This results in a maximum serviceable elevation of approximately 755 feet. In general, elevations higher than this have an increased likelihood of needing a booster station for service, which can require significant capital cost. Slightly higher elevations may be served in closer proximity to the tank; however, that requires more detailed hydraulic analysis which is not part of this Report. Of the homes identified in this pocket, approximately 268 are in a serviceable elevation range.

Dekalb Utility District, as part of the project identification process in 2022, indicated a desire to build a new water storage tank in Auburntown which would be larger, and at a higher elevation to expand its customer base in Cannon County. Additional storage capacity also contributes to the utilities future plans of extending further South in the county and potentially be in a position to wholesale water to Woodbury Water Department. Dekalb Utility District also proposed water main extensions in this area, indicating they are willing to expand their system in this portion of the County. A memorandum to the County Commission completed in 2022 provides a more detailed description of the proposed projects by Dekalb Utility District. That memorandum is located in the **Appendix** of this Report.

Pocket 2 – Snowhill Pressure Zone

Pocket 2 is primarily served by the Snowhill water storage tank. The Snowhill water storage tank has an overflow elevation of 1150'. Within Pocket 2, approximately 270 homes have been identified for potential service by Dekalb Utility District within this pocket. The pocket is largely serviceable from the elevation of the existing tanks with the exception of the southernmost portion of the pocket, which is an area of higher elevation. This southern area contains approximately 60 homes which could not be serviced by the existing water storage tank.

As part of the project identification process undertaken in 2022, Dekalb Utility District proposed water line extensions within this pocket. A memorandum to the County Commission completed in 2022 provides a more detailed description of the proposed projects by Dekalb Utility District. That memorandum is located in the **Appendix** of this Report.

Of additional note, the southern area represents a near high point between the Dekalb Utility District and the Woodbury Water Department. Topography in Pocket 2 represents a 600 foot elevation difference which would equate to 260 psi of water pressure difference, an impossibility in the water system. Therefore, if Dekalb will want to serve this area, the creation of an additional pressure zone will be required. The hydraulic service elevation for the Pleasant Ridge pressure zone will have a higher service elevation than the Snowhill Water Storage tank. This can be accomplished by either a pressure sustaining booster station or a water storage tank. A water storage tank would provide more stable pressures in the area, and provide a potential source for Woodbury to access an additional source of water.

Pocket 3 – Warren County Utility District / Half Acre Pressure Zone

Pocket 3, located on the Eastern boundary of Cannon County represents the approximate present service area of Warren County Utility District within Cannon County. Warren County Utility

District maintains the 500,000 gallons Half Acre water storage tank within Cannon County located on Goundry Road. The water storage tank has an overflow elevation of 1382', which sets the hydraulic service elevation for this area. This area represents all of Warren County Utility District's presently served area within Cannon County. Through correspondence with WCUD's consulting engineer, WCUD presently serves approximately 191 customers within Cannon County.

A review of property information in the area generated approximately 330 addresses in the area. These addresses include vacant land, homes that are proposed or under construction, and existing homes. A manual review of elevation data for the generated addresses was then performed to determine water service viability. This review indicates that most, if not all fall within a reasonable elevation for service by the Half Acre water storage tank, with the exception of a handful of homes which may require individual booster stations. While there are small extensions that may occur, Warren County Utility District must prove the financial viability of a project before it is undertaken. If residents in this area seek water service, they should contact Warren County Utility District for more information regarding potential barriers to extension of service.

Of additional note, the proposed Short Mountain Road Water Line proposed by Woodbury Water Department as part of the 2022 project identification process will ultimately tie into this pressure zone and the half acre water storage tank. This will allow Woodbury to wholesale purchase water and provide additional water source within their water distribution system and potentially serve areas of higher elevation, particularly East of Woodbury. A memorandum to the County Commission completed in 2022 provides a more detailed description of the proposed projects by Woodbury Water Department. That memorandum is located in the **Appendix** of this Report.

Long term, this area can be a significant contributor to water service within Cannon County. Warren County Utility District withdraws its water from the Collins River. The treatment plant has a capacity of 4 MGD and the present average daily flow pumped is 1.7 MGD for 2022. Warren County Utility District has established assets located within Cannon County which can provide assistance to Woodbury Water Department. Typical norms within the municipal water industry, and the location of Woodbury Water Departments existing water lines, expansion of Warren County Utility District's service area is limited; however, by the construction of the Short Mountain Road water line and establishing an interconnection with Woodbury Water Department, WCUD becomes a potential long term partner and water source for Woodbury Water Department and the further expansion of water service within Cannon County.

Pocket 4 – West Warren – Viola Utility District / Hoodoo2 Pressure Zone

Pocket 4 is located in the Southern portion of Cannon County. The water lines shown in this pocket are served by the West Warren – Viola Utility District and the tank elevation provided for this area is the Hoodoo 2 water storage tank is a 400,000 gallon water storage tank located in Coffee County with an overflow elevation of 1400 feet. At present, West Warren – Viola provides service to approximately 171 customers within Cannon County.

The general service area drawn in the attached map was chosen based on proximity of existing water lines, as well as, topography. For the purpose of this document, a line was drawn in the vicinity of Duke Creek. This suggestion is made in an effort to reduce creek crossings which can significantly contribute to capital costs in water line extension projects and allow for water line loop connections within West Warren – Viola Utility District’s water distribution system. It is of note that the new Woodbury Water Storage tank, which Cannon County contributed toward could also serve a significant amount of these elevations as well; however, Woodbury Water Department is under moratorium due to water loss and lack of treated water supply to the system. Therefore, at least in the short term, West Warren – Viola Utility District is better positioned to provide service to this area than Woodbury Water Department. The property information for the suggested area was compiled and a manual review of elevations was completed. The suggested area represents up to 360 potential water customers.

The topographical review of this area shows high elevations to the western portion of this pocket. This area is generally along Dickens Hill Road and more so along Frank Holt Road. This area of higher elevation would have to be served by a pressure sustaining booster station to increase pressures along Frank Holt Road. As part of the project identification process in 2022, West Warren – Viola Utility District proposed a potential booster station and water main extension along Frank Holt Road. The primary barrier to this project is the limited expansion of service it provides versus a significant capital cost and long term operating cost. A memorandum to the County Commission completed in 2022 provides a more detailed description of the proposed projects by West Warren – Viola Utility District. That memorandum is located in the **Appendix** of this Report.

Pocket 5 – Consolidated Utility District – Milton Pressure Zone / Metered Connection with Woodbury Water Department

Consolidated Utility District maintains its water system along the western border of Cannon County with three pressure zones. Consolidated Utility District serves an estimated 59 customers within Cannon County and maintains a connection with Woodbury Water Department to

supplement water to the western portion of Woodbury's water system. The primary pressure zones providing service to Cannon County are the Milton pressure zone and the Wilson Hill pressure zone. Pocket 5 displays the Milton Pressure zone which is the pressure zone that maintains a connection with Woodbury Water department.

At the metered location along Porterfield Road, the static pressure is approximately 90 psi and the ground elevation is approximately 725 feet, creating a hydraulic elevation of approximately 930 feet. Pocket 5 represents the majority of CUD's customers within Cannon County.

In establishing the connection with Woodbury Water Department, homes accessible by Dement Hollow road become easiest served by Consolidated Utility District. This area includes properties along Robert Butler Lane, Singer Lane, Williams Lane. A water booster station would be required for some homes in the area, particularly on the furthest extents of Dement Hollow Road; however, homes along Singer Lane, Williams Lane, and Robert Butler Lane appear to be at serviceable elevations. A few options exist in this instance to provide service this area. One is for CUD to service the area because they are the nearest water access. A second alternative is for the metered connection with Woodbury to be relocated further North and Woodbury extend service to this area. With coordination between Woodbury and Consolidated Utility District, a secondary metered connection could be established and Woodbury extend the service.

Pocket 6 – Consolidated Utility District - Wilson Hill Pressure Zone

An additional pocket of service that CUD provides in Cannon County is along North Lassiter Barker Road, served by the Wilson Hill Pressure Zone. This pressure zone operates off of a pressure sustaining booster station. Presently, Consolidated Utility District provides water service along North Lassiter Road, North of John Bragg Highway. In talks with Consolidated Utility District, a booster station upgrade would be required to serve these areas of higher elevation to add approximately 10-15 total customers.

Pocket 7 – Town of Woodbury – Base Pressure Zone

Woodbury Water Department's water treatment plant is located within this base pressure zone. The high service pumps at the water treatment plant pump water to two tanks which are located on the Northern side of town, which have overflow elevations of 899 feet.

Pocket 8 – Bradyville

Pocket 8 is sourced via a booster station located in the vicinity of Claude Gaither Road. The operating conditions of the booster station were not provided. A review of property maps in the area indicate there are approximately 311 properties in this pocket.

The booster station for Bradyville pumps from the Woodbury Water Department (Base Pressure Zone) and is solely sourced from the Murfreesboro Road water main, which is aged and in need of repair. While Woodbury Water Department purchases water from Consolidated Utility District, it has very little impact on this area.

Due to the area presently being sourced from one location, it is likely subject to high variations in pressure. As part of the project identification process in 2022, Woodbury Water Department proposed a water main extension along Petty Gap Road. This water main extension seeks to provide a secondary source of water and stabilize pressures in the Bradyville area. This project was recommended after the Short Mountain Road water main project, due to a lack of treated water supply presently being experienced by Woodbury Water Department. A memorandum to the County Commission completed in 2022 provides a more detailed description of the proposed projects by Woodbury Water Department. That memorandum is located in the **Appendix** of this Report.

Pocket 9 – Hollow Springs Road 750,000 gallon tank Pressure Zone

Pocket 9 is primarily served by the new Woodbury Water Department tank constructed along Hollow Springs Road. The new tank has an overflow elevation of 1365', replacing the old tank which had an overflow pressure of 1325'. This represents an immediate 17 psi pressure boost to customers served by this tank.

The tank is sourced via a booster station located at the edge of the southern town limits of the Town of Woodbury. Due to supply chain issues, the pumps for the booster station were delayed, delaying the commissioning of the new water storage tank.

At present, the water storage tank will serve the southern and eastern portion of Woodbury Water Departments service area, extending as far as Short Mountain Road. By electing to install the Short Mountain water line and establishing a connection with Warren County Utility District, some demand may be taken off of this water storage tank, allowing for additional expansion in the system.

A review of property map data for the tanks service indicates there are approximately 2,340 properties served or potentially served by this water storage tank.

Pocket 10 – An area of low pressure

County officials indicated an inability for water service in this vicinity in discussions. This pocket represents a subdivision of approximately 60 homes. The subdivision has elevations of up to 845 feet. All indications are that this area operates on the base pressure zone from the downtown Woodbury tanks which have overflow elevations of 899 feet. Allowing 10 feet of normal operation in the tank would create low pressures for some of the higher elevation homes in this neighborhood. Individual private booster stations, or a larger pressure sustaining booster station would be required for homes with undesirable low pressures. It was indicated that at least one individual had requested water and was denied. This could be due to the current moratorium. Otherwise, boosting may be required to achieve minimum pressure.

Pockets 11

Pocket 11, located on the southeastern portion of the limits of the Town of Woodbury is served by a pressure sustaining booster station. A review of property information indicates there are approximately 35-40 homes served in this pocket up to an elevation of approximately 950 feet; however, stops short of serving the area of Phillips Hill. A review of elevations in the vicinity of Phillips Hill show elevations of approximately 1220 feet in that area. Therefore, it is most efficiently sourced from the Warren County Utility District water connection and the new 750,000 gallon water storage tank. Once water service is established along Phillips Hill, the booster station for Pocket 11 may be able to be eliminated and pressures boosted in the current service area.

B. Unserved Areas

General

Unserved areas were broken down along major thoroughfares within Cannon County and evaluated based on the existing and potential hydraulic elevations of the areas surrounding them. The unserved areas are discussed in a potential order of expansion within the system.

Pocket 12 – Unserved Area Between Hollow Springs and Bradyville Area

Pocket 12 represents an area of higher elevation between the new 750,000 gallon water storage tank along Hollow Springs Road and the Bradyville area. The pocket represents approximately 190 homes with elevations up to 1270 feet. Woodbury Water Department intends to install interconnections from the new water tank to the Bradyville Area. This is demonstrated by the proposal of the Petty Gap Road water line extension which provides a secondary water supply to the Bradyville area and increases pressures.

A review of elevation profiles along George Scott Road, Cove Hill Road, and Burt Burgeon Road indicate they are also candidates for future extensions from Hollow Springs Road toward Bradyville; however, they represent significantly longer extensions than the proposed Petty Gap Road extension. All three roadway elevations trend downward toward the Burgen community.

Further, elevation profiles for Claude Gaither and Bradyville Hill Road were reviewed. After the above extensions are completed, extensions along Claude Gaither and Bradyville Hill Road become more viable. It is estimated that there will not be significant boosting requirements to achieve service extension for residents in this area; however, topography and high pressures may make extensions challenging in certain portions of the system and require pressure reduction.

The extension of these lines are moot unless Woodbury is able to increase its access to water, be that wholesale purchasing from a neighboring utility, significant decrease in water losses in the system through investigative studies and water line replacements, the expansion of the Woodbury Water Treatment Plant, or some combination of the three.

A memorandum to the County Commission completed in 2022 provides a more detailed description of the proposed projects by Woodbury Water Department. That memorandum is located in the **Appendix** of this Report.

Pocket 13 – Unserved Area Between Dekalb Utility District Proposed Extent and Woodbury

Pocket 13 represents an unserved area between Short Mountain Road and Woodbury, generally along Stones River Road and Parchcorn Hollow Road. Property information for this area indicates that there are approximately 121 properties within this pocket. This area is largely unserved due to a large portion being unserviceable from the Woodbury Water base pressure zone and the systems inability to convey water from the tank at Hollow Springs to this extent of the system while servicing the additional population. The addition of the Short Mountain Road water line and

establishing a connection with Warren County Utility District allows for this area to potentially be served by Woodbury Water Department.

Elevation profiles along Stones River Road and Parchcorn Road indicate elevation decline along both roads from Short Mountain road toward the Town of Woodbury. Some areas of higher elevation, particularly along Sally Parton Road will still be required; however, the majority of this area could potentially be served in the future by the hydraulic service elevation coming from Warren County Utility District.

Pocket 14 – Unserved Area between Dekalb Utility District Proposed Extent and East of Woodbury

Pocket 14 is representative of an unserved area between the Pleasant Ridge area and the previously identified unserved area of Pocket 13. A review of property information indicates there are approximately 160 homes in this unserved area. The primary roadways through this area run from Stones River Road at the Southern portion to Pleasant Ridge at the northern extent. These primary roadways include Cavender Road, Gassaway Road, and Sugar Tree Knob Rd – Mason Hollow Road.

A review of roadway elevations for these three corridors indicate a falling elevation from Pleasant Ridge to Woodbury along both Gassaway Road and Cavender Road. The elevations over those spans range from 1230 feet at Pleasant Ridge and Cavender Road, falling to around 720 feet as the boundaries of the Town of Woodbury are reached. Along Sugartree Knob, there is an area of higher elevation that would require a booster pumping station to achieve service. All secondary roads would generally feed from one of these three thoroughfares and be subject to pressure reduction or boosting as required.

The establishment of service in this area can happen in phases. As Woodbury Water department is able to extend service along Stones River Road (Pocket 13), Woodbury could begin extending service northward along all three thoroughfares. Dekalb Utility District indicated they would like to extend service as far south as Pleasant Ridge. Once a servicing hydraulic elevation has been established for Pleasant Ridge by Dekalb Utility District, Woodbury and Dekalb could then work on a wholesale purchase agreement which would then connect the two utilities and extend service the full length of Gassaway Road and Cavender Road.

Due to the extensive length of the required water mains, for Woodbury to serve to Pleasant Ridge would also require boosting. The complicating factor is the need for Woodbury to increase its water supply to its system. Therefore, at this time, Woodbury establishing service at Pleasant Ridge

is not the best solution. However, it is recommended that Woodbury ultimately install and maintain the water mains from Pleasant ridge back to Woodbury. This reduces the extent of Dekalb's system beyond Pleasant Ridge, which limits the additional operations and maintenance costs that would be undertaken by Dekalb Utility District to respond to service calls.

Pocket 15 – Unserved Area – Between Woodbury and Pleasant Ridge.

Pocket 15 represents an unserved area between Woodbury and Pleasant Ridge. A review of property information indicates there are approximately 150 properties in this identified area. Major roadways through this area are Locke Creek Road, Auburntown Road, and Doolittle Road. All three roadways have falling elevation from Pleasant Ridge toward Woodbury. In order to serve this area efficiently will require the establishment of water service along Pleasant Ridge.

Again, it is suggested that Woodbury own and operate the water lines in this general corridor; however, it is not likely that Woodbury will be establishing water service along Pleasant Ridge at this time without the ability to expand their water treatment plant or establish large wholesale purchase agreements with Warren County Utility District. Therefore, expansion of service in this area are significantly hindered at this time.

Pocket 16 – Unserved Area of Short Mountain

Pocket 16 and Short Mountain represents the highest elevations in Cannon County. The highest elevations within this pocket are higher than all tank levels of all utilities providing water service within Cannon County. Due to proximity of existing utilities and hydraulic elevation, Warren County Utility District is currently the best positioned to serve this area; however, a series of booster stations would be required to get water service to the highest elevations making it cost prohibitive.

A review of property information within the pocket indicates approximately 51 properties. A review of the elevation profile along North Short Mountain Road reveals a peak elevation of approximately 1,490 feet along the roadway. Additionally, elevation climbs rapidly coming from the existing utilities of Warren County Utility District at Big Hill Road, making roads like Gunter Lane and Blueberry Lane presently unserviceable.

C. Supply of Water

Typically, planning documents project needs through a 20 year planning window. Therefore, if the projected population for 2040 is extended water service by the year 2040, an average daily water demand of approximately 2.0 MGD will be required with a peak demands in the range of approximately 3.2 MGD

While the most positioned for growth, the Woodbury water system is presently restricted to allow for substantial growth due to a number of reasons. The first reason cited by Woodbury Water and their engineers is the significant amount of water losses which were occurring within the system. At one point, water loss in the Woodbury Water system was over 40%, meaning 4 of every 10 gallons of water produced at the treatment plant wasn't sold to a customer.

In 2013, the Tennessee Utility Management Review Board began requiring Utility districts to use a water loss calculator established by the American Water Works Associated (AWWA). The calculator aids in establishing a water loss percentage with a calculated certainty. The goal of this calculator was to press utilities to reduce unbilled water to a rate of 20% or lower in order to conserve source water.

Recently, Woodbury Water Department contracted with Rye Engineering, a leak detection specialist in the State of Tennessee to identify locations of water leaks in the system. Rye Engineering combed the water system for approximately one month and Woodbury personnel fixed leaks as they were identified and located. As a result, it is now estimated that water loss for Woodbury Water Department is approximately 28%. While this is significant improvement, it still does not achieve a water loss below the target rate of 20%.

Each utility is generally responsible for establishing its own tolerance for water losses. Some systems seek to achieve the target rate of 20%; while other utilities seek to achieve single digit water loss. Utilities that have aggressively low tolerance for water typically utilize high density polyethylene (HDPE) pipe. HDPE is considerably more expensive than traditional ductile iron or PVC water mains.

The Town of Woodbury, while centrally located in County, is presently permitted to a maximum 1.7 MGD withdrawal limit from their water source which is the East Fork Stones River. Additionally, the treatment plant capacity is presently designed for 1.7 MGD. Woodbury Water Treatment Plant is currently producing approximately 80% of its permitted design capacity (1.36 MGD). When a treatment plant reaches 80% capacity, it typically triggers a review from the Tennessee Department of Environment and Conservation. This review generally includes a

discussion between the utility and the governing authority (TDEC) on how the utility intends to provide service to its area, particularly if it is growing. Treatment plant expansions and withdrawal permit limits can take years to negotiate, design and construct. TDEC and Woodbury Water Department has already begun such discussions to increase the amount of water withdrawn from the East Fork Stones River from approximately 1.7 MGD to 2.7 MGD. However, TDEC does not have the authority to authorize the additional withdrawal. This process will require Woodbury to go the US Army Corps of Engineers to request a withdrawal permit increase, design an expansion project with their engineer, and construct the expansion. It's reasonable to estimate that this process in total could take 2-5 years to complete once initiated. Therefore, Woodbury's ability to treat and supply water for development within the County is restricted at this time.

While the treatment plant is a restrictive barrier to facilitate substantial growth within Cannon County, the water system piping network has the ability to provide expansions in service area if the water can be supplied by a neighboring utility. Presently, Woodbury Water maintains connections with both Consolidated Utility District of Rutherford County and West Warren – Viola Utility District. In addition, Woodbury has a proposed project which would allow for a connection with Warren County Utility District. These connections provide for the ability for water to enter Woodbury's water system from the West, South and East. Woodbury would purchase water from the neighboring utilities at a wholesale rate and then charge a customer a retail rate which would include costs for maintaining the piping network required to move the water. This is becoming common practice among utilities to provide some safety net in the event of unforeseen circumstances within a single utility.

In the case of Woodbury, increasing the number of connections with neighboring utilities allows Woodbury to utilize its existing piping network within Cannon County to permit growth while the process of increasing a withdrawal permit for Woodbury Water Treatment Plant is undertaken. The increase to a withdrawal permit is not guaranteed. Therefore, establishing the joint connections with neighboring utilities allows for a "backup plan" if the request for a withdrawal permit increase is prolonged or denied. In addition, it provides redundancy to Woodbury's water system in the circumstances of a catastrophic event which may temporarily disable the water treatment plant.

Further, due to the established, or proposed connections of Woodbury Water and neighboring utilities it is not anticipated the neighboring utilities will make significant moves to expand service within Cannon County beyond what has already occurred. Instead, the neighboring utilities are likely to serve as aids to Woodbury Water in accomplishing expanded service in Cannon County.

Dekalb Utility District is positioned to continue expanding within its self-identified service area. Communication with Dekalb Utility District revealed a desire to ultimately extend further South. If an expansion to the South occurs, Dekalb Utility District indicated that it would be interested in connecting with Woodbury Water system. This would allow for additional supply of water to Cannon County residents supplied by Woodbury. The Dekalb Utility District water treatment plant has remaining capacity of over 1.0 MGD with the ability to expand further. Therefore, Dekalb Utility District achieving expansion of service to the South provides potential future benefit to Woodbury Water Department. Through the above topographic review of the County, Dekalb Utility District could be a viable servicer of the higher elevations along Pleasant Ridge. It is the opinion of this document that would best be established by creating an additional pressure zone along Pleasant Ridge, sourced by the Snowhill Pressure zone. The Pleasant Ridge pressure zone would then be able to feed West to service the unserved areas between Pleasant Ridge and Woodbury, as well as, feed back north to Auburntown. Expanding the system this extensively would require a more detailed hydraulic study on maintaining water age and quality within the system. If the County were to move forward in aiding Dekalb Utility District in completing a hydraulic study, it would be worth including a look at the above in that study.

Based on the pockets discussed previously in this Report, theoretical estimates of water demand may be considered. As part of this Report, property data was reviewed. Every property in Cannon County is not anticipated to have a home. However, based on the pockets discussed, upper range average water demands may be estimated. The total demand estimated below totals approximately 2.3 MGD, which is above the 2.0 MGD projection from population alone. However, this demonstrates the potential development area for each utility and the necessity of water volume within each utilities service area.

<u>Utility</u>	<u>Present Customers in Cannon County</u>	<u>Existing Estimated Average Demand (MGD)</u>	<u>Estimated Properties without service Customers</u>	<u>Estimated Average Future Demand (MGD)</u>
Woodbury Water	3,898	1.2	1,800	1.8
Dekalb Utility District	473	.15	425	.30
Warren County Utility District	191	.06	140	.1
West Warren – Viola Utility District	171	.05	200	.1
Consolidated Utility District	59	.02	35-40	.03

As demonstrated in the table above, Woodbury Water's distribution system is geographically positioned to add the greatest number of additional customers. However, Woodbury Water faces an impending challenge in increasing its withdrawal permit to be able to provide treated water to the residents of Cannon County. Dekalb Utility District is also positioned to provide expansion of service within the County, as well as, being able to provide supplemental volumes of water to Woodbury Water system if it installs a booster station or establishes service in the area of Pleasant Ridge.

In electing to construct the Short Mountain Water line and establish a connection with Warren County Utility District, Woodbury Water Department is working to increase its supply of water within its system while it works to increase the capacity at its plant. Controlling water losses will be an integral component in expansion potential of the water system.

VI. WATER SERVICE AT A COUNTY LEVEL

As mentioned in this document, the County does not own a water system. Therefore, as the County is able to secure grant funding for infrastructure projects related to water, an overall growth approach should be observed. By aiding the multiple service providers within the County, the County will best position itself for growth. Access to water service is a critical component of spurring growth within a community. A utility unable to provide water due to lack of availability of water is a detriment to the growth of the County.

After availability of water, another critical component is serviceability. The County should want its utilities to be able to provide water service to areas believed to be poised for growth. The most significant growth in a community will occur where there is access to sewer service as well as fire protection. These additional services promote industrial and higher density residential growth. The second tier of growth is created in areas with large tracts of land with topography suitable for low to medium density housing developments. These developments occur in more rural areas and have lots large enough to accommodate the use of septic tanks. Fire protection may or may not be available for this type of development.

In 2022, Cannon County voted to allocate funds to Woodbury Water Department for the construction of a new water line from Warren County Utility District along Short Mountain Road. This project established Woodbury's third utility connection for the supply of water into Cannon County. This project was identified as the best chance for Woodbury water system to suspend its self imposed moratorium on customer additions within its system and allow limited growth to begin again. Additionally, in establishing interconnection with Warren County Utility District, WCUD could potentially become a viable option for significantly increasing water volume within Cannon County. However, this initiative will likely require capital improvements within Warren County Utility Districts system and become a joint effort between Woodbury Water Department and Warren County Utility District.

A second project, The Petty Gap Road water line extension was also proposed as good use of County level funds because it extended service to residents that did not presently have water. Additionally, it provided a secondary feed of water to the Bradyville community which relies on a single feed of water along Bradyville Road. County officials believe that the western portion of the County may develop first as growth expands from Murfreesboro and Rutherford County. This project seeks to potentially assist that growth.

As noted in this Report, Woodbury has struggled with water loss within their system. While they have contracted with firms which specialize in reducing water loss, additional water loss reduction is needed to maintain the ability for growth. Due to withdrawal permit limits for Woodbury's water plant, the County should encourage further reduction in water loss as other projects are taken on.

It is the projection of this Report that Woodbury Water system will continue to be the largest supplier of water within the County. This means that Woodbury Water system will have to find a way to increase potable water to supply to residents. The process of increasing the withdrawal permit for the Woodbury Water Plant could be a long one. If Woodbury is able to secure an increase to the withdrawal permit, then a treatment plant expansion will be required which will be a large capital project. Assuming the process moves flawlessly, it is estimated the process could take a minimum of three to five years. During this three to five years, growth will continue within the system making the margins which the Woodbury Water system operates even tighter.

Because Woodbury Water system has established its willingness to connect on with neighboring utilities, as well as, the Dekalb Utility District's expressed willingness to connect on with Woodbury Water system as part of this process, the County should be open to utilizing future available grant funds to aid Dekalb Utility District in establishing a connection with Woodbury Water System. This involves the construction of a new and larger Auburntown water storage tank at a higher elevation.

Dekalb Utility District has expressed a desire to extend its water system down as far as Pleasant Ridge Road. As discussed in the topographic review, this will likely require the establishment of an additional pressure zone along Pleasant Ridge. Maintaining a water system to this area allows Dekalb Utility District to have multiple interconnected feeds to Woodbury Water Department. As part of the project identification process in 2022, Dekalb Utility District proposed the creation of a hydraulic model of their service area to best serve its customers. This is something Cannon County could contribute toward to aid in the future connection of the Dekalb Utility District and Woodbury Water systems and getting the two systems working toward interconnection and expanded service.

The metered connection between Woodbury Water System and Dekalb Utility District will be a significant capital expense that may involve the participation of the County, Dekalb Utility District, and Woodbury Water System to achieve.

The future water lines displayed in **Map 7** represent approximately 244 miles of water main. Cost future water main varies by size and material decided on by the utility providing service. It is

important to note that as Cannon County continues to grow, the neighboring utilities providing service continue to grow as well. Therefore, during the continual process of expanding water throughout Cannon County, the service areas of neighboring utilities are growing as well. Therefore, this does not include storage, pumping, or treatment facility improvements that utilities may deem necessary during the expansion process.