2018

Tennessee's Roadmap to Securing the Future of Our Water Resources

Infrastructure Working Group

Current State

Within the State of Tennessee, there are clear differences as to level of service for water and wastewater by Grand Division, by county and even by community. It is difficult to make broad generalizations as to the adequacy of the system because for the most part, water and wastewater service is provided in so many ways by so many entities.

As part of evaluating both the condition of Tennessee's water and wastewater infrastructure system, a number of different approaches have been considered to determine infrastructure stress. Below summarizes a portion of the data considered, as well as the methodology used to quantify the level of stress and forecast of infrastructure needs.

Note that this plan does not focus on other water-related infrastructure that exists throughout Tennessee such as dams. Figure 12, page 28, provides some basic information regarding the status of those structures.

Evaluation Data

Water Treatment Plant Capacity

The Tennessee Department of Environment and Conservation (TDEC) maintains a database for each water treatment plant and distribution system in the State of Tennessee. This database includes information related to the number of people and connections served, the design capacity of the treatment works, and the average daily production of the treatment works.

From this, public treatment facilities were summarized and assigned to the county in which it resides. The sum of all capacity within each county was obtained and then compared to the average and estimated peak daily demands based on the county's population in both 2018 and 2040 to determine if adequate spare capacity remained.

This process is imperfect because there are a number of counties like Williamson County where most of the potable water service is provided by a neighboring county (Davidson) through consecutive distribution systems. It does, however, provide some insight as to the need for additional treatment and/or distribution of water service to provide for the anticipated population growth.

It is further noted that the process cannot adequately project the needs of current or future commercial and industrial entities in Tennessee. Unfortunately, many of these needs will have to be assessed at the county or municipal level.

Water System Sanitary Survey Scores

TDEC surveys public water systems on a biannual basis. These surveys identify deficiencies in treatment techniques, policies and procedures, equipment maintenance and record keeping. As this data primarily focused on water quality issues, rather than water quantity, it provided a limited look at stressed water systems in Tennessee.

Water System Notices of Violation

Notices of Violation (NOV) are issued to water systems for a number of different offenses ranging from failure to properly monitor or report constituents to violation of either Primary or Secondary Drinking Water Standards. The database of these NOVs was obtained from TDEC and summarized by county to indicate which counties might be experiencing stress that leads to violations of these standards.

Water Distribution System Water Loss

Recently, water system professionals across the United States have begun to place a higher emphasis on reducing both real and apparent water losses in public water systems. It is unfortunate that this emphasis did not begin decades ago; however, the prevailing sentiment was that water was cheap and not worth conserving. Tennessee has lead the nation in requiring the submission of water loss data on an annual basis by public water systems. This data is an element of the process used to determine the financial condition of a public water system.

As the cost of water production and distribution has increased and the availability of new water sources has decreased, the need to properly account for water and reduce losses to reasonable levels has come to the forefront. Stresses caused by recent droughts have further highlighted the need and importance of water loss control.

A database of self-reported water loss data was obtained from state sources and summarized by county. This data indicates area where higher levels of waterloss are occurring and where substantial investment in repair, replacement and rehabilitation of infrastructure is needed to reduce those losses.

Wastewater Treatment Plant Capacity

TDEC maintains a database of all National Pollutant Discharge Elimination (NPDES) permits across the State of Tennessee. This database contains myriad types of dischargers including commercial, industrial and mining operations. The database was filtered to only include those systems that convey and treat domestic wastewater either at Publicly Owned Treatment Works (POTWs) or to decentralized wastewater systems that operate under a Tennessee State Operating Permit (SOP). These entities were summarized by county.

The database did not include average daily flows to each of these treatment systems, so an average usage rate had to be assumed for each person served. The actual number of people served was compiled from a database created by George Kurz of Sewer Capacity Management, Inc. This database was compiled from Waste Water Treatment Plant (WWTP) Monthly Operating Report (MOR) files as well as NPDES permit application files.

The accuracy of this compiled database is understood to be limited but provides a glimpse into the surplus capacity remaining in Tennessee's POTWs both currently and based on the projected population growth by 2040.

Wastewater System Notices of Violation

Like water systems, Notices of Violation (NOV) are issued to wastewater systems for a number of different offenses ranging from failure to properly monitor or report constituents to violation of their NPDES permit requirements. The database of these NOVs was obtained from TDEC and summarized by county to indicate which counties might be experiencing stress that leads to violations of these standards.

Wastewater System Overflows

Infiltration and Inflow (I/I) is a significant challenge to most of the wastewater collection systems across the State of Tennessee. Both the United States Environmental Protection Agency (EPA) and TDEC have taken action against numerous municipalities and utility districts across the State who have reported excessive number of chronic sanitary sewer overflows (SSOs) or combined sewer overflows (CSOs) from their collection systems. The Kurz database included a summary of collection system overflows without indicating whether they were SSOs or CSOs. These overflows were summarized by county and then illustrated to indicate which counties are experiencing the highest levels of occurrence.

The summaries below are presented by Grand Division (Rural and Urban). It is emphasized that the data included in the 2018 TN H_2O effort was developed as a tool for forecasting statewide needs, with the level of detail intended to be limited to urban versus rural needs within each Grand Division.

Figure 1. Summary of TN Water System Surplus Capacity and Water Loss

Row Labels	Sum of 2018 Population	Sum of 2040 Population	Sum of Current PDF Surplus	Sum of Future PDF Surplus	Sum of Water Supplied	Sum of Water Lost	Waterloss
East	**2,441,794**	**2,868,735**	**191,216,283**	**105,018,719**	**99,780**	**24,987**	**25.0%**
Rural	390,285	449,694	15,900,784	15,224,329	12,658	4,742	37.5%
Urban	2,051,509	2,419,041	175,315,499	89,794,391	87,122	20,245	23.2%
Middle	**2,766,101**	**3,779,216**	**227,731,109**	**39,619,265**	**112,582**	**29,426**	**26.1%**
Rural	633,532	728,084	35,184,748	35,739,434	22,508	6,718	29.8%
Urban	2,132,569	3,051,132	192,546,360	3,879,830	90,074	22,708	25.2%
West	**1,575,656**	**1,696,813**	**132,346,444**	**43,628,891**	**74,781**	**14,934**	**20.0%**
Rural	471,705	505,565	17,715,279	33,694,708	14,719	3,767	25.6%
Urban	1,103,951	1,191,248	114,631,165	9,934,183	60,061	11,167	18.6%
Grand Total	6,783,551	8,344,764	551,293,836	188,266,875	287,143	69,348	24.2%

Figure 2. Summary of TN Wastewater System Surplus Capacity and SSOs

Row Labels	Sum of 2018 Population	Sum of 2040 Population	Sum of 2017 ADF Surplus	Sum of 2040 Surplus	Sum of SSO's	Sum of Population Served	% Population Served
East	**2,441,794**	**2,868,735**	**170,547,597**	**115,045,267**	**815**	**1,213,670**	**49.7%**
Rural	390,285	449,694	(20,024,820)	(27,747,990)	123	98,778	25.3%
Urban	2,051,509	2,419,041	190,572,417	142,793,257	692	1,114,892	54.3%
Middle	**2,766,101**	**3,779,216**	**40,050,213**	**(91,654,738)**	**1,219**	**1,685,187**	**60.9%**
Rural	633,532	728,084	(20,767,585)	(33,059,345)	347	140,681	22.2%
Urban	2,132,569	3,051,132	60,817,798	(58,595,393)	872	1,544,506	72.4%
West	**1,575,656**	**1,696,813**	**156,394,080**	**140,643,670**	**648**	**1,292,833**	**82.1%**
Rural	471,705	505,565	17,273,410	12,871,610	309	209,514	44.4%
Urban	1,103,951	1,191,248	139,120,670	127,772,060	339	1,083,319	98.1%
Grand Total	6,783,551	8,344,764	366,991,890	164,034,200	2,682	4,191,690	61.8%

Other non-State resources were incorporated into assessing the status of Tennessee's water and wastewater infrastructure. This included the American Society of Civil Engineer's (ASCE) "Infrastructure Report Card" for Tennessee, as well as supporting documentation collected by ASCE.

Water

Tennessee's drinking water infrastructure is composed of multiple raw water sources being treated by a variety of treatment methods and distributed through underground pipeline networks. These networks vary in size, length and age of the system itself.

There are acknowledged differences in the types of sources and treatment techniques not only by county but also by Grand Division. In general, the West Grand Division Counties utilize groundwater from either the Memphis Sands or Ft. Pillow Aquifers as the source water. Treatment for these systems generally entails aeration for the removal of carbon dioxide and the oxidation of dissolved iron. Some, but not all systems also settle and then filter the water prior to chemical stabilization, disinfection and in most cases fluoridation.

Most systems in the Middle and East Grand Divisions utilize surface water for their source due to the inadequacy of below grade aquifers. A majority of these are dependent upon reservoirs constructed and managed by either the US Army Corp of Engineers (USACE) or the Tennessee Valley Authority (TVA).

From a historical perspective, it is interesting to note that these federally funded reservoirs not only selected the location of the proposed impoundment based upon future flood control and hydrologic power production, but also due to an insufficient water source for the communities established as part of the dam construction. In most cases, groundwater was that source.

Most of these systems utilize conventional flocculation, sedimentation and filtration (traditional or membrane technology) to treat the water from the rivers and streams.

Distribution is very similar among all the systems across Tennessee. Pipelines of varying sizes are routed throughout the service area either under streets, in public rights of way, or on easements through citizen's property. Storage is generally provided in water storage tanks to either buffer flow variations or to provide volume for firefighting at appropriate points throughout the systems. TDEC currently requires systems to maintain 24 hours of average daily demand in water storage.

The number and size of interconnections to nearby water system varies considerably throughout the State. Generally, the more densely populated urban counties are better connected to neighboring utilities than the more remote rural counties. Concerns about water quality degradation in long stagnant waterlines coupled with the high cost of running long pipelines hinders most rural water systems from connecting with their neighbors.

<u>Urban</u>

There are most certainly differences as to level of service for water by Grand Division, by county and even by community. It is unwise to make broad generalizations as to the adequacy of the system as a whole because for the most part, water service is provided in so many ways by so many entities.

Potable water is provided within most Tennessee urban counties by either municipal entities, utility districts, authorities, or other public entities. However, there are still many Tennesseans who have their own private wells within areas designated as "urban".

Where a formal public entity is responsible for providing such service, treatment and distribution of water is consistent with that described in the section entitled, "Infrastructure Management and Financing" which begins on page 7. It is further noted that, particularly in the larger population centers, these urban systems have many components that have far exceeded their intended design life.

It is further noted that many of the areas designated as "urban water service" were originally classified as "rural". This is important to note given the upgrades that many of such area expansions have historically required and will continue to require these upgrades in the future.

Rural

Similar to urban areas, there are a large number of Tennesseans who have private wells, the percentage of which on a per capita basis being greater than those served by a public source.

These private sources are mostly found in the rural counties of the West Grand Division and to a lesser degree in the southeastern quadrant of the East Grand Division where there are sand aquifers within reasonable depths. There are individual wells sporadically placed in the Middle Grand Division; however, the underlying geology does not favor their use in most cases.

Sources for raw water in rural areas are similar to that for urban. There is also an increasing dependence on public utilities in urban areas being the source of water for rural utilities, where proximity justifies this approach.

Where a rural public source is independent of another utility, treatment and distribution may be similar to that of its urban counterpart. Rural systems were typically established to provide drinking water to its customers with little, if any, consideration to other needs such as fire flows. Therefore, it was not uncommon for expansion of the rural system to include smaller line sizes, with the further use of in-line boosters to extend service to other customers.

With the growth of population centers in designated rural areas, coupled with recent Building Code requirements, many rural utilities are upgrading by increasing line sizes and establishing water storage facilities. It is further noted that such upgrades are limited due to “costs to serve” limitations.

Likewise, a continued growth in private wells has also coincided with rural community growth due to prohibitive “costs to serve” considerations in many areas. Although it is also understood that the expansion of private wells is becoming more challenging due to aquifer quantity and quality at depths that are economical. Adding to this challenge is the increased use of irrigation from private wells in agricultural-based businesses.

Wastewater

Tennessee’s wastewater infrastructure varies considerably across the state. Approximately 60% of Tennesseans are served by centralized wastewater collection and treatment systems. There is a great degree of difference in the means of collection and treatment among these systems.

Traditionally, most utilize a combination of gravity collection mains and pumping stations to convey flow to a treatment works of some sort. It is worth noting that, due to terrain/topographic constraints in population growth areas, there is increased use of pressurized systems with individual pumping facilities, in lieu of gravity systems, because of both their economic benefits as well as growing dependability.

Treatment works can vary from simple lagoon treatment to membrane filtration depending primarily upon the level of treatment necessary to comply with the discharge permit issued by TDEC.

The remaining 40% of Tennesseans are served by decentralized collection and treatment systems. These generally involve either household septic tank and leachate field systems or in some cases community wastewater collection and treatment at a small decentralized unmanned packaged

treatment unit. Disposal for these systems usually involves drip dispersal of the treated water into a dedicated plot of land.

Urban

Tennesseans in urban counties have access to wastewater collection systems that convey flow to POTWs. The treatment methods used at these POTWs varies considerably across and even within the Grand Divisions, as the level of treatment is based primarily upon the need to protect the individual receiving streams.

The use of decentralized wastewater collection and treatment systems has increased markedly in both rural and urban counties to allow development of areas that would not otherwise have reasonable access to a public sewer system. The ownership and operational responsibilities of these facilities range across Tennessee. In some cases, the systems are both owned and operated by municipalities or utility districts. In other cases, private corporations or homeowner's associations both own and operate the treatment and disposal works.

It should be noted that there are still a large number of urban public customers, primarily in older/more-rural areas of urban counties that remain on privately owned wastewater systems like septic tanks. In developing urban counties, these are largely being replaced with service to centralized POTWs.

Rural

It is not uncommon for more densely populated areas of rural counties to provide public centralized wastewater collection and treatment services. Areas receiving such service are justified by their economic feasibility and/or their needed service to facilitate industrial jobs and growth.

The predominate means of wastewater service still relies upon owned wastewater systems like septic tanks. However, the use of decentralized wastewater collection and treatment systems has increased markedly in rural counties thereby allowing more densely developed rural areas that would not otherwise have this opportunity due to limited soil absorption rates. This has directly facilitated the increase in a given county's county tax base.

Where decentralized systems have been constructed, the ownership and operational responsibilities may fall under municipalities or utility districts. As is the case with urban areas, private corporations or homeowner's associations may also both own and operate the treatment and disposal works.

Infrastructure Management and Financing

Effective management of Tennessee's public systems are critical to the financial condition of the State of Tennessee as well as ensuring the quality of life for its citizens. To that end multiple state oversight agencies are in place to maintain financial, managerial, and regulatory compliance. These agencies include the Water and Wastewater Finance Board (WWFB), Utility Management Review Board (UMRB), Tennessee Public Utility Commission (TPUC), TDEC, and the EPA.

Additionally, multiple state and non-governmental organizations (NGO) exist to assist public systems in their financial, management, and regulatory compliance. TDEC Fleming Training Center, the Tennessee

Association of Utility Districts, the Municipal Technical Advisory Service (MTAS), the County Technical Assistance Service (CTAS), Communities Unlimited, and several other organizations provide services to these systems via onsite, classroom, and remote methods.

Funding opportunities for public systems are available through a multitude of sources including: USDA Rural Utility Service, EPA SRF Clean Water and Drinking Water Programs, Community Development Block Grants, Appalachian Regional Commission, Economic Development Administration, and other governmental agencies. Public finance sources are also available including: public bond markets, bank programs, and bond funds such as the TML Bond Fund. Each of these programs have their own requirements and structural components, as well as incentives and concerns. Regardless of the funding methodology (except for direct grants from federal and/or state agencies), the ability to fund the needed improvements and resulting debt service is a critical element of the decision-making process for a system's governing body. Balancing the demands of system maintenance and growth with the community's ability to pay is often the most difficult charge for a governing body.

Projected Future State of Tennessee's Infrastructure

The State of Tennessee forecasts an overall growth in population of 23% between 2018 and 2040; reflecting a total population increase of 1,561,213.

Of this, it is projected that 90% (1.4 Million people) will locate in urban counties, with rural counties seeing growth of 10% (or, approximately 200,000 people) in this 23-Year period. With this growth comes a reasonable obligation to make public water and wastewater services available to the growing public. At the same time, attention must be given to maintaining, repairing and replacing an aging infrastructure system.

In consideration of this, forecasting the future infrastructure needs comes down to the dollars that must be invested to meet these needs, regardless of the funding source. To refine this effort, it was appropriate to allocate these needs into two key categories: "Cost to Serve" and "Repair and Replacement".

"Costs to Serve"

First, an analysis identifying" Costs to Serve" has been undertaken, which basically reflects the investment needed to extend water and/or wastewater services to this growing population. Using System Development Charge data on a "per connection" basis, thereby establishing a "per capita" costs adjusted using Woods & Poole population projections, a "Total Costs to Serve" was established for water and wastewater projects, under urban (greater than 50,000 population) and rural (50,000 and less population) county classifications. The unadjusted "Total Costs to Serve" represent the "Total Investment Needs" for water and wastewater projects.

A generally accepted ratio within the utility communities was then applied for water and wastewater projects to reflect contributed capital from private funding sources. The "Total Investment Needs" have been multiplied by 35% for water improvements, and 45% for wastewater, establishing a contributed capital amount that private sources are anticipated investing into public water and wastewater infrastructure improvements. The difference between the "Total Investment Needs" and the

contributed capital represent a "Total Funding Need" to serve anticipated growth. The "Total Funding Need" would be carried by the public water and wastewater providers. These costs are further segregated by the State's Grand Divisions, as well as into "urban" versus "rural" categories.

In consideration of these factors, the projected **"Water Project Costs to Serve"** investment needed for statewide population increases between 2018 and 2040 is **$1.14 Billion.** For the same time period, **"Wastewater Costs to Serve"** projections indicate a need of just under **$3.0 Billion.** These projected costs are as shown in Figure 4.

While projected investment needs can be further refined to a county-by-county basis, caution must be exercised in considering this level of detail. It is emphasized that the data included in the 2018 Tennessee Water Plan was developed as a tool for forecasting statewide needs, with the level of detail intended to be limited to urban versus rural needs within each Grand Division.

It should be further noted that "Costs to Serve" in areas that currently are not served by a public system may vary greatly due to area specific considerations. These numbers represent the ability to extend current services within the system's footprint.

"Repair & Replacement"

The second category is identified as "Repair and Replacement Costs". Much of Tennessee's water and wastewater infrastructure system is aging, operating well beyond its intended design life. Through proactive maintenance and monitoring, the Tennessee public utilities are to be commended for protecting the integrity of these systems, thereby protecting the public's safety and welfare.

There is also unanimous consensus throughout all professions dealing with infrastructure's integrity that more dollars must be invested to maintain what has already been constructed. "Repair & Replacement Costs" is a systematic approach to forecast these needs based upon current trends, and technologies.

For "Repair & Replacement" projections, a compilation of 5-Year capital water and wastewater improvement project needs was assembled on a county basis, sorting the data on both a Grand Division and urban versus rural basis. It should be noted that the data available for this process was incomplete in that systems have voluntarily reported the information to various state entities. Furthermore, there seems to be a lack of comprehensive long-range planning and capital budgeting by a significant number of systems. Prorating this data to an annual basis, and then applying a 60% multiplier to reflect those portions of the Capital Improvement Plans that are directly repair/replacement oriented, a "per capita" costs was established adjusting those projections using Woods & Poole population data over the Plan period. A "Total Costs to Serve" has then been established for water and wastewater projects.

Similar to the approach outlined in the section entitled, "Costs to Serve," these costs were then adjusted to reflect water and wastewater-specific projects, establishing a "Total Repair and Replacement Needs". These costs are further segregated by the State's Grand Divisions, as well as into "urban" versus "rural" categories.

In consideration of these factors, the projected **"Water Repair & Replacement Project"** investment needed statewide through 2040 is **$5.6 Billion.** For the same time period, **"Wastewater Repair & Replacement Project"** projections indicate a need of **$5.9 Billion**.

These costs are included in the following section for both “Costs to Serve” and “Repair & Replacement” and as shown in Figure 4.

As was noted for “Costs to Serve” projections, the “Repair & Replacement” investment needs could be further refined to a County-by-County basis. However, it is again emphasized that caution must be exercised in considering this level of detail.

The data included in the 2018 Tennessee Water Plan was developed as a tool for forecasting statewide needs, with the level of detail intended to be limited to urban versus rural needs within each Grand Division.

Total Investment Needs

As outlined below, the projected total investment necessary to address adequate water and wastewater service requirements for Tennessee’s growing population through 2040 is **$15.6 Billion**.

Figure 3. TN Repair & Replacement (R&R) Investment Needs

Developing State of TN Water/Wastewater
REPAIR & REPLACEMENT (R&R) INVESTMENT Needs

Planning Horizon (yrs)			23					
Repair & Rehab % Funding Needs			60%					
Geography	2018	2040	Total Pop Change (2018-2040)	Percent Change (2018-2040)	Water & Wastewater Project Funding Needs (per capita per year	Water to Wastewater Project Ratio (%)	Water Projects R&R Funding Needs (Pop 2018 times Planning Horizon)	Wastewater Projects R&R Funding Needs (Pop 2018 times Planning Horizon)
Statewide	6,783,551	8,344,764	1,561,213	23%				
Urban Counties	5,288,029	6,661,421	1,373,392	26%				
Rural Counties	1,495,522	1,683,343	187,821	13%				
East	2,482,690	2,921,179	438,489	18%				
Urban Counties	2,051,509	2,419,041	367,532	18%	$106	45%	$1,351,092,046	$1,651,334,722
Rural Counties	431,181	502,138	70,957	16%	$103	85%	$522,553,159	$92,215,263
Middle	2,725,205	3,726,772	1,001,567	37%				
Urban Counties.	2,132,569	3,051,132	918,563	43%	$185	40%	$2,182,571,261	$3,273,856,892
Rural Counties	592,636	675,640	83,004	14%	$154	80%	$1,005,784,328	$251,446,082
West	1,575,656	1,696,813	121,157	8%				
Urban Counties	1,103,951	1,191,248	87,297	8%	$54	35%	$287,163,903	$533,304,391
Rural Counties	471,705	505,565	33,860	7%	$50	75%	$245,826,198	$81,942,066
TOTAL							$5,594,990,895	$5,884,099,416

TOTAL R&R FUNDING Needs **$11,479,090,311**

Figure 4. TN Water/Wastewater Total Investment Needs

Developing State of TN Water/Wastewater **TOTAL INVESTMENT** Needs (*R&R plus Costs to Serve Population Growth*)

Household per capita		2.54								
Planning Horizon (yrs)		23								
Repair & Rehab % Funding Needs		60%								
Geography	2018	2040	Total Pop Change (2018-2040)	Percent Change (2018-2040)	Water Project Costs to Serve (per capita)	Water Project Costs to Serve (Pop increase 2018-2040)	Water Projects R&R Funding Needs (Pop 2018 times Planning Horizon)	Wastewater Project Costs to Serve (per capita)	Wastewater Project Costs to Serve (Pop increase 2018-2040)	Wastewater Projects R&R Funding Needs (Pop 2018 times Planning Horizon)
Statewide	6,783,551	8,344,764	1,561,213	23%						
Urban Counties	5,288,029	6,661,421	1,373,392	26%						
Rural Counties	1,495,522	1,683,343	187,821	13%						
East	2,482,690	2,921,179	438,489	18%						
Urban Counties	2,051,509	2,419,041	367,532	18%	$430	$157,937,472	$1,351,092,046	$1,220	$448,417,980	$1,651,334,722
Rural Counties	431,181	502,138	70,957	16%	$419	$29,705,592	$522,553,159	$3,150	$223,486,614	$92,215,263
Middle	2,725,205	3,726,772	1,001,567	37%						
Urban Counties	2,132,569	3,051,132	918,563	43%	$919	$844,427,010	$2,182,571,261	$2,009	$1,845,624,516	$3,273,856,892
Rural Counties	592,636	675,640	83,004	14%	$762	$63,266,482	$1,005,784,328	$3,150	$261,429,921	$251,446,082
West	1,575,636	1,696,813	121,157	8%						
Urban Counties	1,103,951	1,191,248	87,297	8%	$406	$35,468,702	$287,163,903	$1,154	$100,703,169	$533,304,391
Rural Counties	471,705	505,565	33,860	7%	$380	$12,862,262	$245,826,198	$2,756	$93,314,961	$81,942,066
TOTAL INVESTMENT NEEDS						**$1,143,667,520***	**$5,594,990,895****		**$2,972,977,160***	**$5,884,099,416****
									TOTAL $15,595,734,992	

* TOTAL INVESTMENT NEEDS Costs to Serve projects include contributed capital by private sources

** Repair and Rehabilitation costs use TACIR per capita funding needs applied to Woods & Poole population increases times % applied to R&R times planning horizon (yrs)

Historically, some means of Contributing Capital (private party contributions, often the development community) has been available to most communities, which has helped to offset the total investment needs. For purposes of projecting actual funds needed that would fall under a given County's responsibility, it is reasonable to assume that some level of Contributing Capital would continue to be made available.

Figure 5. TN Water/ Wastewater Total Funding Needs

Developing State of TN Water/Wastewater **TOTAL FUNDING** Needs

	Water Project Costs to Serve (Pop Increase 2018-2040)	Water Projects R&R Funding Needs (Pop 2018 times Planning Horizon)	Wastewater Project Costs to Serve (Pop increase 2018-2040)	Wastewater Projects R&R Funding Needs (Pop 2018 times Planning Horizon)	**TOTALS**
TOTAL INVESTMENT NEEDS	$1,143,667,520*	$5,594,990,895**	$2,972,977,160*	$5,884,099,416**	**$15,595,734,992**
Contributed Capital %	35%		45%		
TOTAL CONTRIBUTED CAPITAL	400,283,632		1,337,839,722		**$1,738,123,354**
TOTAL FUNDING NEEDS	743,383,888	$5,594,990,895**	1,635,137,438	$5,884,099,416**	**$13,857,611,638**

Note: **TOTAL FUNDING** Needs is defined as Total Investment Needs minus Contributed Capital
Contributed Capital is only applied to "Costs to Serve" or growth related investment needs

In consideration of these assumptions, the "Total Funding Needs" (i.e., that falling under a given community's and/or utility's responsibility) to address water and wastewater infrastructure improvements/expansions through 2040 is estimated at **$13.9 Billion**.

As has been noted throughout each Section of this Plan, the unique differences in Tennessee's resources is considerable for each Grand Division. This is all the more true when consideration is given to the State's infrastructure needs, and when urban and rural needs are assessed separately.

In developing a plan to address the overall funding requirements through 2040, an Annual Investment & Funding Needs forecast must take into account (a) the uniqueness to each Grand Division; and, (b) the unique differences between the State's urban and rural service areas within these Divisions.

The following exhibits reflect those needs for the Divisions on an urban and rural basis, with the annual forecasts divided into "Costs to Serve" and "Repair & Replacement" projects.

Figure 6. TN Water/Wastewater Projected Investment and Funding Needs – East Urban

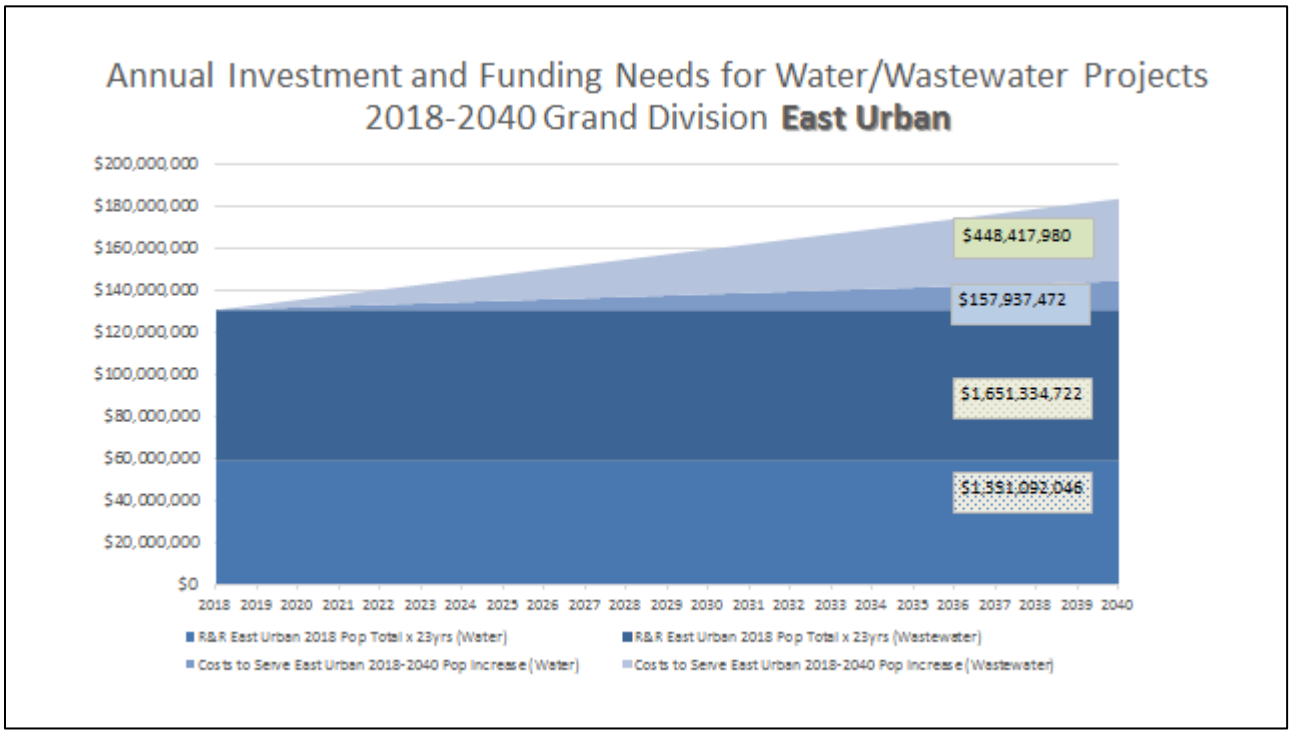


Figure 7. TN Water/Wastewater Projected Investment and Funding Needs – East Rural

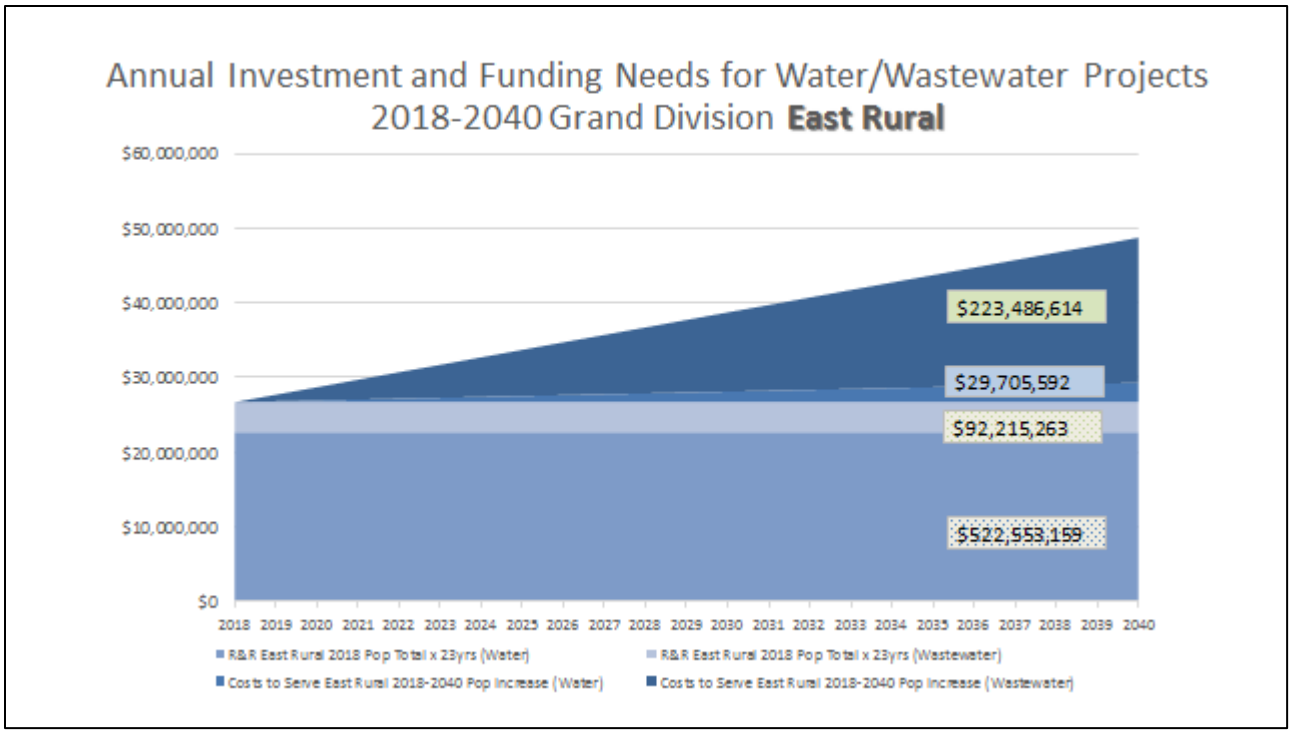


Figure 8. TN Water/Wastewater Projected Investment and Funding Needs – Middle Urban

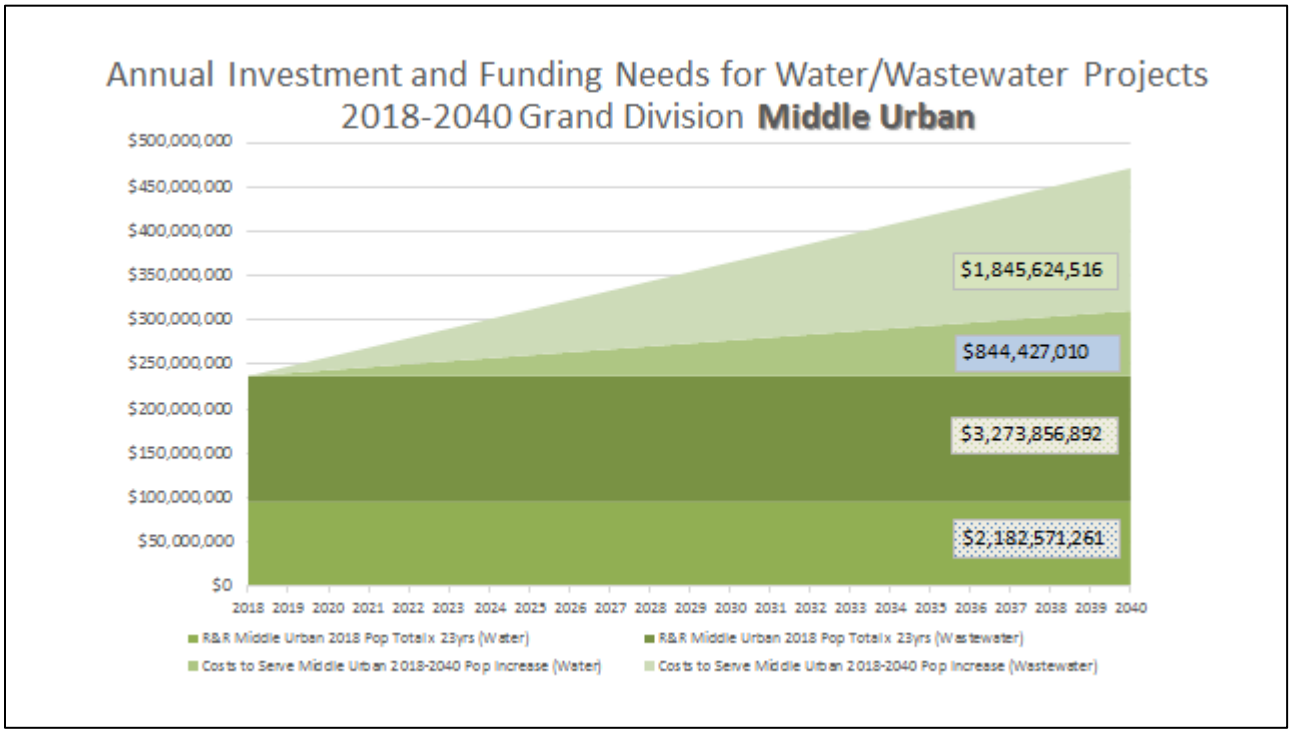


Figure 9. TN Water/Wastewater Projected Investment and Funding Needs – Middle Rural

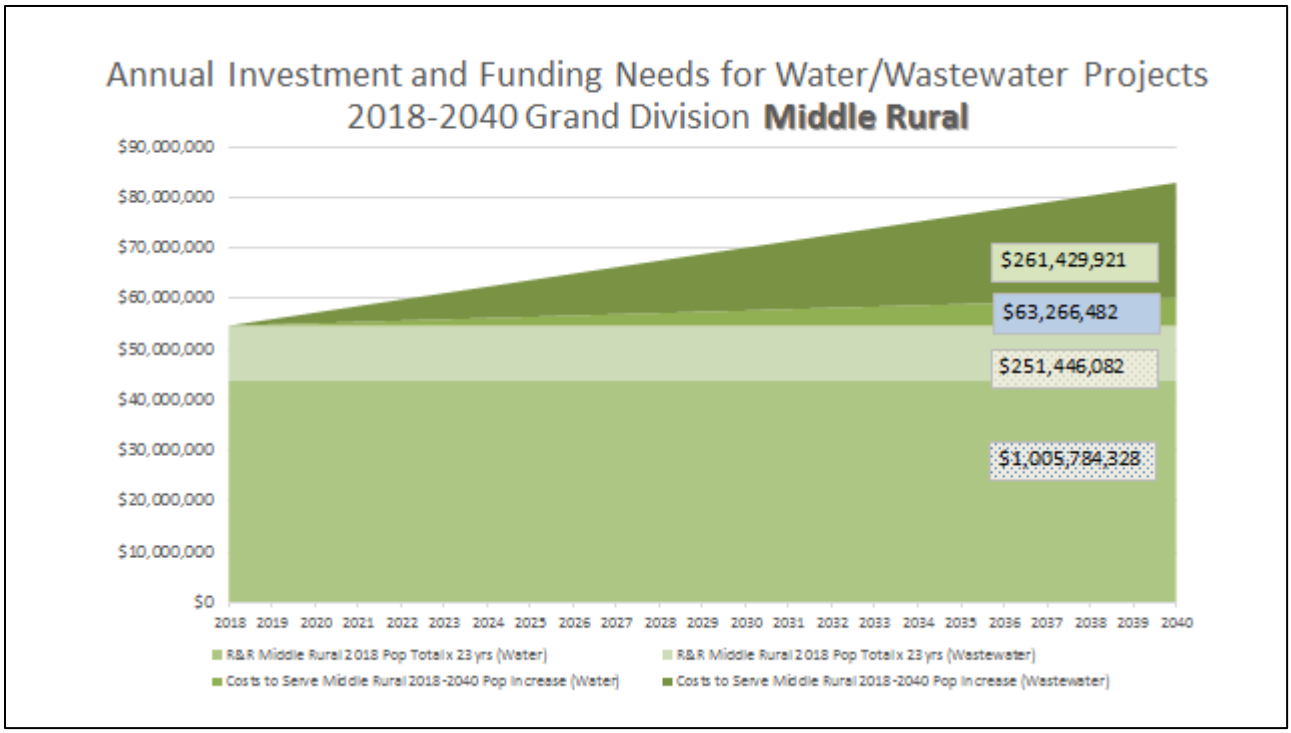


Figure 10. TN Water/Wastewater Projected Investment and Funding Needs – West Urban

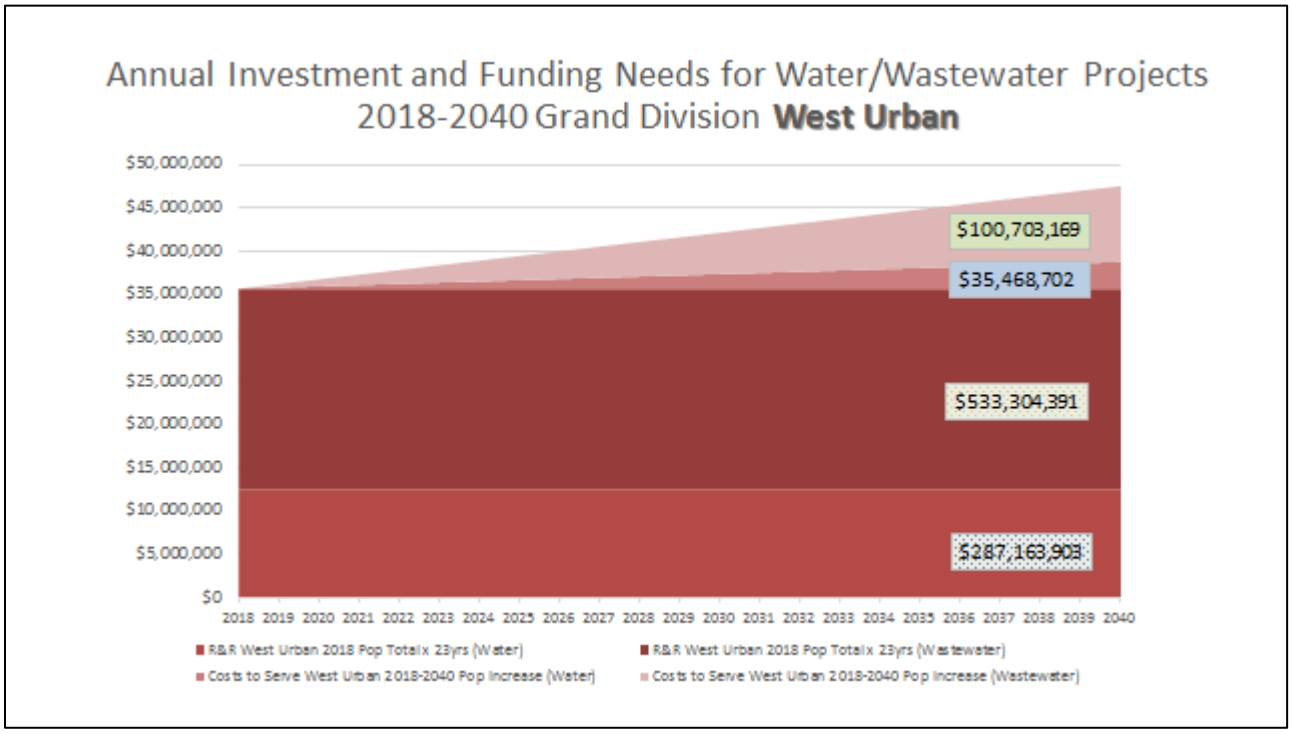
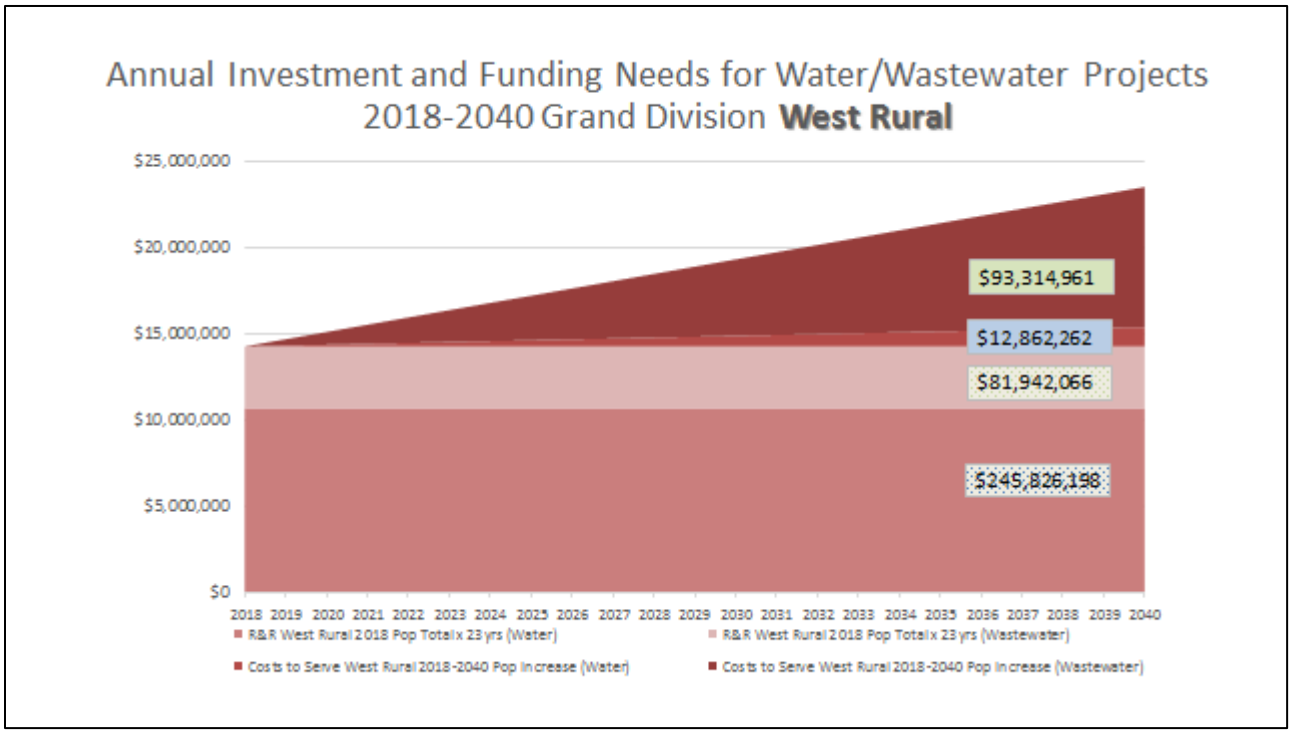


Figure 11. TN Water/Wastewater Projected Investment and Funding Needs – West Rural



Water Reuse

Water reuse, as defined by the WateReuse Association, is the process of intentionally capturing wastewater, stormwater, saltwater or graywater and cleaning it as needed for a designated beneficial freshwater purpose such as drinking, industrial processes, surface or ground water replenishment, and watershed restoration. While we often discuss water reuse as a novel approach to the management of our planet's most important resource, the fact is that water reuse has occurred since the beginning of our planet's history. Nature continually replenishes water through evaporation from our surface water supplies that will eventually fall again as rainfall to replenish both our groundwater and surface water supplies. The fact of the matter is that there is no truly "new" water on earth, and so we must appropriately reuse what we have.

As WateReuse defines the term, however, water reuse is an "intentional" process of recycling water. Many have attempted to further categorize the practices that make up water reuse, and the following categories presented by the WateReuse Association are generally accepted:

1. De facto, Unacknowledged, or Unplanned Potable Reuse occurs when water intakes draw raw water supplies downstream from discharges of clean water from wastewater treatment plants, water reclamation facilities, or resource recovery facilities. For example, if you are downstream of a community, that community's used water gets put back into a river or stream and is delivered downstream to your community and after further treatment becomes part of your drinking water supply.

2. Nonpotable Reuse refers to reclaimed water that is not used for drinking, but is safe to use for irrigation, industrial uses, or other non-drinking water purposes.

3. Potable Reuse refers to recycled water you can drink. The reclaimed water is purified sufficiently to meet or exceed federal and state drinking water standards and is safe for human consumption.

4. Planned Potable Reuse is publicly acknowledged as an intentional project to reclaim water for drinking water. It is sometimes further defined as either direct or indirect potable reuse. It commonly involves a more formal public process and public consultation program than is observed with de facto or unacknowledged reuse.

5. Indirect Potable Reuse (IPR) water is blended with other environmental systems such as a river, reservoir, or groundwater basin, before the water is reused.

6. Direct Potable Reuse (DPR) water is distributed directly into a potable water supply distribution system downstream of a water treatment plant or into the source water supply immediately upstream of the water treatment plant.

(Source: Water Reuse Primer, Water Environment Federation)

In Tennessee, de facto reuse has essentially always occurred whether we chose to acknowledge it or not. Nonpotable reuse is a relative newcomer to Tennessee, and the various forms of potable reuse are still currently on the horizon in our State. Other states with considerable water supply challenges like California, Texas, Florida and Georgia are currently in various stages of adopting and regulating potable water usage, and it is just a matter of time before Tennessee faces the same challenge.

Nonpotable Reuse in Tennessee

The determination of who is beneficially reusing reclaimed wastewater is trickier than it seems. The practice of using drip fields to distribute treated water from septic tanks has been around for over one hundred years. While the grass above these collection lines undoubtedly benefits from the supply of water below, this would more accurately be defined as restricted nonpotable reuse. This practice continues across Tennessee both on individual homesites with septic tanks as well as smaller communities that use technologies like recirculating sand filters, and even smaller communities like Thompson's Station that do not have adequate surface water to receive treated waste water effluent.

For this State Water Plan, however, Nonpotable Reuse specifically relates to those systems that have implemented Unrestricted Nonpotable Reuse systems for the dual purpose of reducing their discharge of effluent into surface waters as well as to offset potable water demands for situations where potable water is not required. These generally include irrigation of both public and private properties as well as commercial and industrial uses like makeup water for cooling towers and washdown water for cleaning purposes. While there are other regulations in place, the State of Tennessee generally allows unrestricted nonpotable reuse of wastewater effluent if the water is properly treated and disinfected to remove harmful pathogens. There are currently six entities permitted in the State of Tennessee for Unrestricted Nonpotable Reuse, including Murfreesboro, Franklin, Pigeon Forge, Spring Hill, Smyrna and the Water and Wastewater Authority of Wilson County. Each of these communities originally implemented their Nonpotable Reuse systems to reduce effluent discharge rates into the nearby surface water supplies, however they have each received the secondary benefit of reducing demands upon their drinking water systems and sources.

Potable Reuse in Tennessee

Currently, there are no Planned Potable Reuse systems in the State of Tennessee. There are several water systems that are interested in the practice either due to their limited access to sufficient source water or challenges disposing of treated wastewater effluent. The significant challenges to Planned Potable Reuse are the lack of current regulations on the practice, and the perceived public relations challenges associated with the practice.

Regulatory Challenges

There are also no current federal regulations pertaining to Planned Potable Reuse. States that have permitted the practice have had to develop their own regulations accordingly. The degree of treatment required to ensure public health varies considerably among those states, and it remains to be seen what level of treatment TDEC would require. Many of the advanced treatment technologies currently required by other states are both expensive to install and expensive to operate and maintain. One of the common technologies used for Planned Potable Reuse treatment is reverse osmosis. This technology has been used successfully in coastal communities around the world, however noncoastal communities like those in Tennessee would struggle to dispose of the brine waste generated by the process. Planned Potable Reuse in Tennessee would almost certainly have to be treated by alternative processes accordingly.

Public Relations Challenges

Negative press associated with the term "Toilet to Tap" and the corresponding "Yuck Factor" it generated when San Diego California introduced the idea of Planned Potable Reuse in the 1990's

unfortunately still pervades the public opinion of many Americans. Interestingly enough, San Diego was able to educate its citizens on the need for and safety of Planned Potable Reuse, and the practice is currently occurring and being expanded across the entire State of California. As with most paradigm shifts, a concentrated and dedicated program of education is required to mold the hearts and minds of any population of people. The same will be true for Tennessee.

Case Study- Murfreesboro

The City of Murfreesboro is one of the fastest growing communities both in Tennessee and in the United States. Unfortunately, the receiving stream for its water resource recovery facility, the West Fork Stones River, is a very small surface water that is designated as impaired by the TN Dept of Environment and Conservation. Due to compliance issues in the late 1980s, the City converted its water resource recovery facility to tertiary treatment in 2001. While the water quality entering the West Fork Stones River improved dramatically and stream bioassessment monitoring demonstrates it is meeting regional goals, Murfreesboro was told that an increased discharge into the stream would not be permitted in the future. In order to allow continued growth of the City, the Murfreesboro Water Resources Department decided to invest in and develop an Unrestricted Nonpotable Reuse system.

Since 2002, the Department has invested approximately $19M into this reuse system. The system includes 24-inch distribution mains that run both north and south from the Murfreesboro Water Resource Recovery Facility (MWRRF), two elevated storage tanks and two farms totaling over 600 acres for dedicated spray irrigation. The entire distribution system includes almost 25 miles of waterlines that convey the high quality “repurified” water to approximately 170 customers. These customers include three golf courses, the world class Siegel Soccer Complex, the new hospital and associated medical office complexes as well as numerous other commercial entities who use the produce for irrigation. One residential development has also “dual

piped” their apartment complex to allow flushing of toilets with repurified water. Several other industrial and commercial entities have expressed interest in using repurified water for cooling tower makeup water.

Since its inception in 2004, the Murfreesboro repurified water system has continually grown both in terms of its physical expansion and the number of customers using the resource. Looking backwards over that time, it is now evident that the repurified system has essentially offset all of the explosive growth that the City of Murfreesboro has experienced over the last 16 years. The MWRRF is currently discharging less effluent into the West Fork Stones River than it was in 2004, despite an increase of over 33% in the influent flow into the facility. It is the largest and most successful system of its kind in Tennessee, and it serves as a model to other communities who will soon find themselves in a similar situation.

Workforce Needs

Current Status

The State of Tennessee requires a person in charge of a water treatment plant, wastewater treatment plant, a water distribution system, or a wastewater collection system to have a certificate in a grade or higher than the grade of the treatment plant, distribution, or collection system he/she operates. In Tennessee water and wastewater treatment plants can range from Grade I-IV with IV being the largest and most sophisticated. Plants are graded on a point system based on the size, treatment process, equipment, chemicals used, and laboratory control by plant personnel.

Water Treatment Plants are classified in accordance with these point totals:

Grade IV	61 or more points
Grade III	35 to 60 points
Grade II	16 to 34 points
Grade I	15 or less points

Wastewater Treatment plants are classified with these point totals:

Grade IV	76 or more points
Grade III	56 to 75 points
Grade II	55 points or less
Grade I	This classification is for a wastewater treatment plant with a capacity of seventy-five thousand (75,000) gallons per day or less. This classification serves as a Collection System certification for Grade I Collection Systems with less than fifteen (15) service connections.

Distribution and collection systems are either Grade I or II depending on the number of connections a system has. Systems with less than 5,000 connections are a Grade I and systems with 5,000 and over are a Grade II.

The requirements to obtain the various certifications are a high school diploma or GED and varying experience and educational requirements to qualify to take the certification exam. Grades I through III require 12 months of experience/education while a grade IV requires up to 60 months of experience with a high school education. The tables below summarize experience/educational eligibility requirements for the various operator classifications.

Water Treatment Plant Operators

Classification	Experience			Maximum Training or College Classwork Substitution	Maximum Related Work Substitution
	Experience needed with:	HS Education	BS Degree		
Grade IV	Gained at a Grade III or IV Water Plant	*60 months	12 Months	36 Months	36 Months
*Regardless of the substitution allowances, a minimum of 1 year of actual work experience is required					
Grade III	Gained at a Grade III Water Plant	12 Months	[redacted]	3 Months	[redacted]
	Gained at a Grade II and Gained at a Grade III	12 Months 6 Months		3 Months	
Grade II	Gained at a Grade I or II Water Plant	12 Months	[redacted]	3 Months	[redacted]
Grade I	Gained at a Grade I Water Plant or SWS	12 Months	[redacted]	3 Months	[redacted]
Grade SWS	Gained at a Small Water System (SWS)	3 Months	[redacted]	[redacted]	

Distribution System Operators

Classification	Experience		Maximum Training or College Classwork Substitution	Maximum Related Work Substitution
	Experience needed with:	HS Education		
Grade II	Gained at a Distribution I or II System	12 Months	3 Months	[redacted]
Grade I	Gained at a Distribution I or II System	12 Months	3 Months	[redacted]

Wastewater Treatment Plant Operators

Classification	Experience			Maximum Training or College Classwork Substitution	Maximum Related Work Substitution
	Experience needed with:	HS Education	BS Degree		
Grade IV	Gained at a Grade III or IV Wastewater Plant	*60 months	12 Months	36 Months	24 Months
*Regardless of the substitution allowances, a minimum of 1 year of actual work experience is required					
Grade III	Gained at a Grade II or III Wastewater Plant	12 Months	[redacted]	3 Months	[redacted]
Grade II	Gained at a Grade I or II Wastewater Plant	12 Months	[redacted]	3 Months	[redacted]
Grade I	Gained at a Grade I Wastewater Plant	12 Months	[redacted]	3 Months	[redacted]
	Gained at Biological/Natural and Grade I Wastewater Plant	12 Months 6 Months			
Grade BNS	Gained at a BNS Wastewater Plant	12 Months	[redacted]	3 Months	[redacted]

Collection and Distribution System Operators

Classification	Experience		Maximum Training or College Classwork Substitution	Maximum Related Work Substitution
	Experience needed with:	HS Education		
Grade II	Gained at a Collection I or II System	12 Months	3 Months	[redacted]
Grade I	Gained at a Collection I or II System	12 Months	3 Months	[redacted]

There are currently approximately 6,100 certifications in Tennessee spread among some 4,100 operators, some holding multiple certifications. The annual mean wage for water and wastewater operators across the State is $40,480. Breakdown of mean wages by region are as follows:

Annual Mean Wages by Areas	
	Annual Mean
Area	**Wage**
West TN Non Metro area	$36,020
Nashville, Davidson County, Murfreesboro	$42,400
South Central TN	$37,050
N. Central Non Metro	$41,190
Chattanooga	$40,390
Knoxville Area	$45,000
Morristown Area	$43,220
Tri- Cities Area	$41,000
Source: https://www.bls.gov/oes/current/oes518031.htm#st	

The Bureau of Labor Statistics predicts a 6 percent job growth for certified operators. What is not shown in the BLS statistics is the extent of the aging workforce for certified operators. Various industry experts predict that up to 50 percent of the workforce will reach retirement age within the next ten years.

	Workforce Demographics	
	Percentage distribution of employment, by age group	
Age Group	Water/Wastewater Operators	All Industries
16 to 19	0.00%	3.18%
20 to 24	4.49%	9.42%
25 to 34	13.48%	22.00%
35 to 44	25.84%	21.00%
45 to 54	31.46%	21.93%
55 to 64	20.22%	16.78%
65 and older	4.49%	5.69%
Source: Bureau of Labor Statistics, http://www.bls.gov/cps/cpsaat11b.htm		
Water Environment Federation Gray Hair Syndrome Training Newbies in a Wave of Retirements		

The Fleming Training Center is responsible for issuing, renewing and tracking operator licenses in Tennessee. The following table shows a breakdown of the average age versus the type of license held. The average age ranges from the upper forties to the mid-fifties in each of the certificate categories. This indicates that many operators are either at or nearing retirement age. What is not known is how many of the operators are still actually working versus those that may already be retired but have chosen to keep their license active.

Workforce Demographics Tennessee

Certificate	Number of Certificates	Average Age
BNS	139	51
CS1	212	52
CS2	1113	48
DS1	324	54
DS2	1762	47
SWS	155	58
WT1	45	53
WT2	170	54
WT3	398	50
WT4	799	52
WW1	98	52
WW2	79	54
WW3	254	49
WW4	590	52
	Total 6138	

Source: Fleming Training Center

Projected Workforce Needs and Challenges

Within the industry, approximately 56 percent of the workforce is currently above the age of 45. Twenty five percent is above 55 years old. This presents a problem in that there will be a severe shortage of qualified operators to replace those that are either at or will be reaching retirement age in the very near future. This problem has been a topic of discussion for many professional organizations like the American Water Works Association (AWWA), the Water Environment Federation (WEF), the Association of Metropolitan Water Agencies (AMWA), and the National Association of Clean Water Agencies (NACWA) for more than a decade. Most of these agencies have predicted the shortage of trained operators to begin in 2015.

As the trained workforce retires, there will be a need to replace them with a new supply of qualified operators. Traditionally municipalities and utility districts have provided on the job training with the employees qualifying to take the exam after 1 to 5 years of experience. There are several problems with

this model. First, on the job training is expensive and risky. Not all employees are capable of passing the exam. Second, as the pool of operators declines, older employees are asked to work more overtime which is expensive and temporary. Third, once an employee is trained at a smaller utility or municipality they are often hired away by larger utilities that have a higher pay scale. As a result, the burden of training employees is often born by the entities that can least afford it. Last, increasing regulatory compliance, reporting, and plant management demands necessitate that plant operators have knowledge and skills beyond the technical skills gained through experience working in a treatment plant. The ability to do critical skills like technical writing, understanding scientific theory, and applying engineering principles is enhanced with secondary education.

As previously stated not everyone that receives on the job training can pass the certification exams. In 2012 Tennessee changed from a self-developed and administered test to a nationally standardized test, Association of Boards of Certification (ABC). The implementation was staggered. The wastewater/collections implementation began May 2012 and the water/distribution was November 2012. Since that time the pass rates for the higher plant certifications have dropped dramatically. Review of the following tables show cumulative pass rates of 33 and 34 percent for Water Treatment III and IV. Pass rates for Wastewater III and IV are lower at 28 and 28 percent respectively.

Water Treatment III & IV Results

Date	WT3 # Examinees	WT3 # Passing	WT3 % Passing	WT4 # Examinees	WT4 # Passing	WT4 % Passing
Nov-12	33	5	15.15	36	10	27.78
May-13	33	3	9.09	29	6	20.69
Nov-13	51	22	43.14	41	9	21.95
May-14	44	13	29.55	33	10	30.30
Nov-14	44	17	38.64	48	23	47.92
May-15	44	15	34.09	46	19	41.30
Nov-15	53	24	45.28	47	20	42.55
May-16	46	13	28.26	35	10	28.57
Nov-16	59	16	27.12	38	15	39.47
May-17	55	25	45.45	39	11	28.21
Nov-17	43	14	32.56	35	14	40.00
Total	**505**	**167**	**33.07**	**427**	**147**	**34.43**

Source: Fleming Training Center

Wastewater Treatment Part III and IV Results

Date	WW3 # Examinees	WW3 # Passing	WW3 % Passing	WW4 # Examinees	WW4 # Passing	WW4 % Passing
May-12	26	0	0.0	29	3	10.3
Nov-12	28	1	3.6	24	3	12.5
May-13	40	9	22.5	32	9	28.1
Nov-13	45	15	33.3	35	11	31.4
May-14	43	18	41.9	28	7	25.0
14-Nov	27	14	51.9	33	11	33.3
15-May	25	10	40.0	32	13	40.6
15-Nov	28	15	53.6	36	13	36.1
16-May	28	8	28.6	35	12	34.3
16-Nov	32	5	15.6	36	9	25.0
17-May	36	10	27.8	48	8	16.7
17-Nov	44	8	18.2	50	17	34.0
Total	402	113	**28.1**	418	116	**27.8**

Source: Fleming Training Center

Workforce Development Areas

Replacing retiring operators with people that have both the technical and soft skills needed will be a challenge that will have to be met to successfully operate the water and wastewater systems throughout the State. There are several approaches that should be considered.

First, the industry needs to inform and recruit high school students. Most young people are unaware of the number of available jobs as water or wastewater operators. Even if they are aware that jobs in the industry exist most do not understand the job complexity along with the rigorous technical skills and soft skills required to perform at a high level. Partnering with or using the Science, Technology Engineering, and Mathematics (STEM) model should be considered. In addition to high students another possible recruitment base would be veterans. Many veterans would have been trained with strong technical skills that can be converted to the water and wastewater industry. A recruiting point that should be emphasized is that many of the water and wastewater jobs are recession proof. No matter how the economy is performing people will always need water and sewer service.

To combat the extremely low pass rates on certification exams secondary education and training should be considered. National Rural Water Association (NRWA) has recently launched its WaterPro Apprenticeship Program. This program is tailored to train future water and wastewater treatment operators on the skills required to do their jobs. Another similar avenue is to provide this training through community colleges. A two-year Associates of Applied Science (AAS) degree in Environmental Science Technology (EST) would provide a robust technical background, the practical skills for day to day job performance, and the theoretical understanding of the treatment process. Students would also receive education on many soft skills such as technical writing, spreadsheets, computer office software, and other management expertise to meet and exceed the demands of the job. Classes would include English Composition and Technical Writing, Mathematics, Chemistry, Microbiology, Fluid Mechanics, Programmable Logic Controllers (PLC's), Industrial Safety Management, and a heavy concentration in water and wastewater operator classes. Many of these classes would include actual field and laboratory experience on site at an actual water or wastewater treatment plant. The final semester would include a capstone experience in which the student will be an intern at a water/wastewater utility for an entire semester. Pellissippi State Community College in Knox County was awarded a three-year long grant in May 2018 from the National Science Foundation for such a program and expects to have students enrolled in fall semester 2019.

The final consideration is salary. Average annual salary ranges are between $36,000 to $45,000 with an average of $40,480 for the State. The table below shows the average wages in Tennessee for various trades and two-year degree professions. The average salary is below electricians, plumber/pipefitters, HVAC technicians, and two engineering technician degrees. Consideration should be given to increased pay for certified operators especially those that have completed an apprenticeship or two-year degree program.

Average Annual Salaries in Tennessee		
Profession	**Average Annual Salary**	
Water/Wastewater Operator	$	40,480.00
Electrician	$	47,830.00
Carpenter	$	38,760.00
Plumber/Pipefitter	$	49,150.00
HVAC Tech	$	44,170.00
Construction Worker	$	25,730.00
Painter	$	28,870.00
Mason	$	30,530.00
Environmental Eng. Tech	$	56,600.00
Industrial Eng. Tech.	$	47,530.00

Source: Bureau of Labor Statistics

Recommendations

The Administration is to be commended for proactively initiating a 23-Year planning effort to address comprehensive water quantity needs across the State. This tool provides the critical starting point needed for individual communities and utilities to establishing both prioritization of their capital needs over this time period, as well as to proactively plan/pursue funding opportunities that will finance these improvements.

It is recommended that the State continue this effort by educating these communities and utilities of the Plan's findings, as well as establish a mechanism that promotes the necessary planning to address the 2040 needs.

In the midst of recommending State's actions looking ahead, there are seven (7) concerns that must be acknowledged in both this Plan as well as any actions implemented in the future.

1. The State through its Department of Environment & Conservation (TDEC) provided much of the data used in preparing this Section. It is therefore encouraged that TDEC continues to monitor aspects of the public water and wastewater systems that must continue for these recommendations to have success.
2. As part of the education process, a means of conveying the true "**Value of Water**" must be developed and shared with the public.
3. Attention must continue to be given to water and wastewater plant capacity, a continued monitoring and proactive approach to reduce water loss, adequate water storage facilities, while balancing this with fire flow needs and maintaining sanitary conditions; the monitoring and elimination of wastewater systems overflows, including the continued reduction in inflow/infiltration. When necessary, Notice of Violations must include addressing the 'root cause' of these violations.
4. Water and wastewater systems, particularly those with smaller service and rural areas, may not have the financial resources necessary to develop, and implement, a comprehensive long-term plan. This will prove particularly true as services are extended into currently unserved areas.

   The reality that all communities and utilities must have Contributed Capital to meet the anticipated needs must be acknowledged, and such funds proactively made available, regardless of the size of a given system.

5. Just as this Plan gives attention to the physical needs that each system has today and into the future, the planning effort moving forward must address the critical need for qualified operators of these systems. As included in Section 4.9.5 of this Plan, the State is quickly reaching the disturbing point of not having a sufficient number of operators to manage and maintain these systems into the future.

6. The impacts of individual and customer growth must be weighed in such a way to maintain/protect the infrastructure and water-related resources. This is particularly true as recruitment of both development and industry is being considered.

7. It is understood that technology, including alternate science-based approaches, are constantly developing to address water and wastewater issues. To that end, a cooperative approach between the communities/utilities and the regulatory authorities must be implemented. This approach must also weigh potential unintended consequences of these alternatives, while foundationally focusing on both public health as well protection/enhancement of our water-related resources.

8. Because the vast differences in available water-related resources, consideration should be given to more inner-connectivity between communities, utilities, and regions. This approach reinforces the State's desire for its people to receive dependable water and sanitary services, particularly in periods of resource system stress that can and will occur. NACWA states that the unsupported narrative by some that public utilities – especially small ones – are not capable of being well-run is false. At the same time, Tennessee must acknowledge that there are some lower capacity, lower performing systems with compliance concerns and that it is the responsibility of the public water sector to help assist these lower capacity systems. Regionalized infrastructure resource efforts should be encouraged by the State of Tennessee. Consolidation, merger, cooperative management, and public partnerships are examples of the various alternatives for consideration but the final decisions should be locally determined.

9. No plan can be successful without regular monitoring and updating where required. The State is encouraged to develop such a mechanism comprised of State, Local, Utility and Public Representatives charged with this responsibility

The State of North Carolina's water and wastewater infrastructure master plan identifies some areas of concern that their water and wastewater utilities face that are universal and very applicable to the State of Tennessee. The primary mission of water and wastewater utilities is to protect public health and the environment, but the challenges listed below can make that primary mission increasingly complex:

- Competing needs that are often more visible in the community
- Handling unexpected critical infrastructure repairs
- Changing regulations
- Prioritizing competing projects
- Knowing infrastructure condition
- Setting appropriate rates
- Increasing customer rates and fees
- Governing boards with relatively short terms
- Communicating complex utility management issues
- Building customer support
- Workforce succession planning
- Evaluating partnerships and regionalization

- Losing large industrial customers
- Declining population in rural areas

Following in the same roadmap as North Carolina, the State of Tennessee can help utilities address these challenges by focusing on three (3) distinct areas:

- Infrastructure Management
- Organizational Management
- Financial Management

These three (3) areas can be summarized by ensuring –

- that utilities' physical assets are identified; properly assessing their current condition and risk and likelihood of failure and quantifying the efficiency through which they treat and deliver water and collect and treat wastewater.
- that utilities' organizations have trained and agile workforces that are set up for proper succession, that governing bodies understand priorities and have the underlying or foundational material to make informed decisions, and that customers and stakeholders understand the value of water and have confidence that their utilities' rates are fair and equitable.
- that cost of service is properly assessed to operate and maintain utilities' water treatment and distribution and wastewater collection and treatment systems, that commensurate revenues are being generated through affordable monthly rates and system capacity buy-in fees to fund the immediate and long-term repair and replacement needs of the utility as well as finance all capital improvements to support anticipated growth in a utilities' service area.

Foundationally, the State must also implement the recommendations included in other sections of this Plan which focus on the protection, and enhancement, of our State's raw water resources. Without this, water and wastewater infrastructure will have a limited lifespan, directly correlated to that of Tennessee's resources. In turn, this will directly impact the opportunity for its citizens to be afforded safe drinking and recreational water in the years ahead.

Figure 12. Other Water-Related Infrastructure

Structure	Associated organizations	Comments
Small watershed dam structures	Soil Conservation Districts	Created starting in the 1940s and 50s to provide many benefits for local communities. Many of the USDA-built structures were sponsored by local conservation districts. Small watershed dams create reservoirs of water that mitigate the effects of drought, provide recreational opportunities, and prevent flooding by retaining and regulating floodwater. The majority of these structures are approaching, or are at, the end of their lifespans, so maintenance and rehabilitation are top priorities.
Under the Tennessee Safe Dams Act, a dam is defined as any structure that is at least 20 feet high or that can impound at least 30 acre-feet of water.	TN Department of Environment and Conservation	• According to the 2016 ASCE TN Infrastructure Report Card, the average age of TN's dams is about 50 years. • Operations and maintenance is performed by the dam owner. 65% of TN dams are owned by private entities with the

		balance owned by State, Federal (TVA, USACE) or local governments or utilities • About 93% are earth dams, 3% concrete dams, remaining 4% are gravity, masonry arch and rockfill. • Used for hydropower generating, drinking water, flood control, agriculture, recreation • Dams are assigned hazard potential categories that reflect the threat to life and property in the event of a failure. These categories are: 1. High Hazard 2. Significant Hazard 3. Low Hazard • Safety inspections of dams are performed by TDEC Safe Dams staff every one, two, and three years, respectively, for these categories of dams. • As of 2013, there were a total of 1223 TN dams identified in the National Inventory of Dams: 273 considered “high hazard potential”, 354 in “significant hazard potential” and 596 in “low hazard potential”
Farm Ponds	Exempt from regulation under the Safe Dams Act	Farm ponds are defined in the regulations as "...any impoundment used only for providing water for agriculture and domestic purposes such as livestock and poultry watering, irrigation of crops, recreation, and conservation, for the owner or occupant of the farm, his family, and invited guests, but does not include any impoundment for which the water, or privileges or products of the water, are available to the general public."