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Water Resources District

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RWRD REGIONAL WATER MASTER PLAN STUDY

Carollo Engineers was responsible for the assessment of existing water infrastructure and cost estimates in this report.

FINAL REPORT
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Section 1.0
EXECUTIVE SUMMARY

1.1 PROJECT BACKGROUND

The purpose of the Riverbend Water Resources District (Riverbend WRD) Regional Water Master Plan Study was to evaluate the feasibility of a regional water system to replace and/or supplement the multiple systems currently in service; investigate the water management strategies in the *2016 TWDB Region D Water Plan* as they apply to Riverbend WRD; and to evaluate treatment options and existing facilities to provide a cost-effective and reliable water supply (potable and raw) to meet the future demands of municipal and industrial customers. Additionally, this master plan includes a high-level condition assessment of the existing water treatment facilities in the study area and provides information on the population and water demand projections for the project participants located in Bowie, Cass, and Red River Counties through year 2070.

Below is a complete list of Riverbend WRD's participating entities included in the study:

- Central Bowie County Water Supply Corporation*
- City of Annona
- City of Atlanta
- City of Avery
- City of Clarksville*
- City of De Kalb
- City of Hooks
- City of Leary
- City of Maud
- City of Nash
- City of New Boston
- City of Red Lick*
- City of Redwater
- City of Texarkana (Texas)
- City of Wake Village
- TexAmericas Center

Through Interlocal Agreements with the above entities except for Central Bowie County WSC, City of Clarksville, and City of Red Lick, Riverbend WRD formally represents the water supply interests for most of the northeast region of Texas. While Central Bowie County WSC and the City of Red Lick are not currently members of Riverbend WRD, both entities hold MOUs (Memorandum of Understanding) with Riverbend WRD for the collaboration and partnership of developing the region's water resource needs. Similarly, the City of Clarksville is participating in the study in order to acquire additional options regarding infrastructure projects needed to address their water quality and quantity needs.

Susan Roth Consulting, LLC and her team ('Roth Team'), including Carollo Engineers, Inc., identified and evaluated several options for regional water transmission and treatment facilities in the described service area. This report serves as a summary of those options to meet the region's future water supply and infrastructure needs. Detailed information regarding the study area and available water supply; projected population and water demands; existing water treatment facilities; regional distribution and treatment alternatives; planning-level cost estimates; and potential funding options are included in this study.

1.2 POPULATION AND WATER DEMAND PROJECTIONS

This study focused on a 50-year planning period versus a shorter period for a variety of reasons: (1) the state's water plan evaluates a 50-year planning period; (2) a 50-year snapshot of projections for Riverbend WRD is critical to reflect the most accurate data and water demands when addressing permitting issues with the TCEQ and U.S. Army Corps of Engineers (USACE); and, (3) Riverbend WRD will likely be applying for funding with Texas Water Development Board (TWDB) and exhibits and information need to meet all TWDB planning criteria.

The population in the study area has increased steadily over the past 10 years and is projected to continue to increase over the next 50 years. Section 3.0 presents a detailed discussion on the development of population projections. The population of participants is projected to grow from 87,215 in 2020 to 111,218 in 2070. A complete summary of population projections for the project participants is included in **Appendix B**. The methodology and revised projections were approved by the TWDB Board on April 16, 2018.

Based on these population projections, per capita water usage and annual consumption was developed and is presented in Section 3.0. Water demands for each entity were determined in five-year increments through year 2070. Reference **Appendix D** for a complete summary of municipal water demand projections for the project participants.

In addition to the municipal water demands, this study also identifies future industrial and manufacturing water demands for Riverbend WRD. TAC possesses a significant amount of utility infrastructure; however, an adequate supply of raw and treated surface water is not currently available. From 2011-2017, TAC received numerous requests from potential industrial and commercial customers for potable and raw water supply. An additional 30 MGD of water demand is needed within the next several years at TAC and is projected to double to 60 MGD in the next 20+ years. A lack of current water supplies to the footprint has detrimentally impacted the growth and development of the industrial park. Section 3.0 provides additional background information and projected water demands through 2070 for TAC.

1.3 WATER SUPPLY ASSESSMENT

The Riverbend WRD study area is located in the Piney Woods and East Texas Timberlands Regions of Texas along the Interstate 30 corridor between the Cities of Dallas, Texas and Little Rock, Arkansas. This study area serves as a transportation, commercial, and industrial center for the Texas-Arkansas corridor, as well as a hub for portions of Oklahoma and

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Louisiana. The primary source of water supply for Riverbend WRD Member Entities is Wright Patman Lake; however, supplemental supply is intermittently provided from Millwood Lake (reference Section 5.0 regarding the operation details). Section 4.0 discusses these two reservoirs and how they could be utilized to meet the Riverbend WRD Member Entities' future water needs.

The congressional authorization for Wright Patman Lake was provided pursuant to the Flood Control Act of July 24, 1946 (Public Law 526, 79th Congress, 2nd Session). Subsequent contracts, when fully implemented, between the USACE and the City of Texarkana, Texas, make available a minimum of 120,000 ac-ft of water storage space as defined by the Ultimate Rule Curve under the Permanent Contract for water supply purposes.

The City of Texarkana's water right (on behalf of the surrounding entities) provides for a maximum diversion of 180,000 ac-ft/yr. However, the Permanent Contract provides in Article 2 that the "City shall have the right…and make such diversions as granted to the City by the Texas Water Rights Commission, or its successors, to the extent such storage will provide." As a result, water in addition to the currently authorized 180,000 ac-ft/yr may be available under the Ultimate Rule Curve.

The two 1968 USACE contracts established two operating curves, an Interim Rule Curve and the Ultimate Rule Curve. Upon execution of the various contingencies and payments required per the Permanent Contract with USACE, the conservation storage available for water supply from Wright Patman Lake becomes that of the Ultimate Rule Curve. Region D planning recites 294,000 acre-feet of available water supply under the Ultimate Rule Curve in 2020. Riverbend WRD is currently conducting an update of the Water Availability Model for the Sulphur River Basin (previous update in 1998) that will further determine the water supply availability in Wright Patman Lake under the Permanent Contract, as well as under various future reallocation levels.

1.4 DETERMINATION OF ALTERNATIVES

Several important study factors were identified in the planning process: (1) treatment and distribution capacity and water demand; (2) regulatory compliance; and (3) conservation and firm water supply availability. Based on engineering recommendations and feedback received from the project participants, 16 initial alternatives were developed and presented to the project participants for consideration. Subsequent discussions were held and feedback was gathered from the project participants; the goal was to select the top alternatives for further evaluation. Based on the feedback, four final alternatives were selected for further evaluation. These alternatives are summarized below and described in greater detail in Section 6.4.

- **Alternative 1, Construct a New Intake Structure and Raw Water Pipeline on Wright Patman Lake** – This alternative involves constructing a new complete raw water conveyance system on Wright Patman Lake, which includes a new raw water intake structure, equalization tank, pigging station, pipeline, and pump station.

Alternative 1 includes two subcomponents for the design of the raw water conveyance system:

- Alternative 1A – new raw water conveyance system constructed at recommended intake location as noted in CH2M HILL study; and,

- Alternative 1B – construct new raw water conveyance system outlined in Alternative 1A but branch off of the line and extend the pipeline over to the existing transmission line at the New Boston Road WTP.

- **Alternative 2, Modify the Raw Water Delivery System at New Boston Road WTP** – Alternative 2 involves the modification of the existing raw water conveyance system at the New Boston Road WTP in order to utilize the entire permitted treatment capacity of the existing WTP. The design capacity of the existing intake structure at New Boston Road WTP is 24.5 MGD; however, currently the hydraulic capacity is limited to 18.0 MGD due to sediment build-up in the conduit. During the infrastructure assessment component of this project, interviews with TWU operators suggested that the existing New Boston Road WTP had a permitted treatment capacity of 24-25 MGD and that the existing raw water delivery system was the limiting factor. After receiving additional information from TWU and confirmation from TCEQ that the treatment capacity of the New Boston Road WTP is currently limited to 18.0 MGD, this alternative was removed from further consideration due to the initial capital cost estimates.

- **Alternative 3, Construct a New WTP at TexAmericas Center (TAC)** – For this alternative, a new surface water treatment plant is proposed and would be constructed at two possible locations on TAC property within Riverbend WRD's water CCN area. The two possible sites for the location of the new WTP on the TAC footprint were identified by the 2012 CH2M HILL study for Riverbend WRD (reference **Figure 6-6**) and were voted the highest by the project participants:

  - Alternative 3A – location of site at TAC at Bowie County Parkway ('Site 3' in CH2M HILL study); and,

  - Alternative 3B – location of site at TAC at southwest corner of former Ammunition Plant ('Site 4' in CH2M HILL study)

- **Alternative 4, GPI WTP Expansion or a New WTP for Cass County** – This alternative includes either expanding the existing IP (now GPI) WTP or constructing a new WTP to serve the City of Atlanta and the other neighboring cities in Cass County. Recently, the International Paper (IP) Texarkana Mill was acquired by Graphic Packaging International (GPI). The majority of the Riverbend WRD Member Entities are currently served by the New Boston Road and Millwood WTPs; however, the City of Atlanta, Texas is currently served by the GPI WTP. The GPI WTP provides potable water to the mill, as well as the neighboring cities of Atlanta, Domino, and sometimes

Queen City:

- Alternative 4A – Expand the existing GPI WTP; and,
- Alternative 4B -- Construction of a new 2.5 MGD Conventional WTP, located in Cass County, to serve the municipal needs of the Cities of Atlanta, Domino and Queen City.

1.5 ECONOMIC ANALYSIS AND FINANCIAL EVALUATION

The economic and financial analysis in Section 7.0 is used as a way of comparing each alternative on an even level, based on capital and operations and maintenance (O&M) costs. The analysis includes a high level estimate of capital costs for new water treatment plants, a raw water conveyance system, booster pump stations, and transmission pipelines. The scope of this project did not include a detailed treatment or piping design. Planning level unit costs were developed and based on either defaults from the Unified Cost Model (UCM) prepared by the TWDB or, where noted, industry standards and experience. The capital cost analysis for each alternative assumed that the phasing of the construction projects would be initiated to meet the timing of the projected water demands. Reference Section 7.0 for a complete summary of cost estimates prepared for each of the final alternatives further evaluated.

Alternative 3A (Phase 1 and 2) entails the construction of a new intake structure at Wright Patman Lake, a raw water pipeline, a booster station with storage, a pigging station to address potential sedimentation effects, and a terminal equalization tank for the conveyance of up to 90 MGD of raw water for industrial purposes and 25 MGD of raw water for municipal purposes to a new 25 MGD WTP to be constructed on the TAC footprint at Bowie County Parkway.

The infrastructure proposed in Phase 1 of Alternative 3A, which includes utilizing existing distribution lines where feasible (i.e. existing pipeline along U.S. Highway 82), has a total project cost of approximately $178.5 million and annual debt service payments of approximately $9.4 million based on an interest rate of 4.0 percent and a 30-year financing term. It is noted that a more detailed evaluation should occur to integrate existing distribution lines into the design during the preliminary and final engineering design phase of the project since this activity was not within the scope of work for this study. Phase 2 project cost for Alternative 3A is estimated to be $111.8 million, with an estimated annual debt service of approximately $5.9 million. Phase 1 and Phase 2 costs are summarized in **Tables 7-15** and **7-16** in Section 7.0. Based on the phased approach, the total 'combined' project cost of Phases 1 and 2 of Alternative 3A is estimated to be $290.3 million, as shown in **Table 7-17**.

Alternative 4B entails the construction of a new 2.5 MGD conventional water treatment plant located in Cass County near Domino, Texas. A new raw water pipeline would be connected to the existing raw water pipeline that currently serves the existing GPI WTP, with the connection located upstream of the GPI pre-chlorination facility. The new raw water pipeline would run parallel to the existing raw water line to the proposed new Cass County WTP. The project cost for Alternative 4B is estimated to be $14.3 million, with an estimated annual debt service of approximately $0.7 million, as shown in **Table 7-19** in Section 7.0.

1.6 FINAL RECOMMENDATIONS

The Roth Team recommends immediately implementing Alternatives 3A and 4B within the next 3 to 5 years with planning beginning within the next year in order to serve the projected municipal and industrial water demands in the study area. The recommended alternatives for Riverbend WRD are based on the following key factors: availability of regional water infrastructure to meet the existing and future demands of the municipal, industrial/manufacturing, and agricultural sectors; the availability of firm water supply; the impact of the cost of water to participating customers; and, the need for meeting the TCEQ's regulatory requirements and minimum treatment capacity criteria of 0.6 gpm per connection. The recommended facility proposal is also based on an implementation plan that allows the recommendations to be permitted, constructed, and operational in a reasonable amount of time, as well as including adequate operations, maintenance, and management criteria.

- **Alternative 3A:** Construction of a new raw water intake at Wright Patman Lake, raw water conveyance system, terminal equalization tank, new Advanced Treatment WTP (15 MGD constructed in Phase 1; 10 MGD constructed in Phase 2) located on Bowie County Parkway at the TexAmericas Center, and regional transmission mains from the new WTP to Riverbend WRD Member Entities' distribution systems in Bowie and Red River Counties. Phase 1 consists of a 42-in. diameter raw water pipeline designed to carry a maximum of 50 MGD; Phase 2 includes a second parallel 54-in. diameter pipeline to bring the total pipeline capacity to 115 MGD. This alternative involves construction in a two-phase approach and provides advanced treatment capabilities for the participants' in a cost-effective manner.

- **Alternative 4B:** Construction of a new 2.5 MGD Conventional WTP, located in Cass County, to serve the municipal needs of the Cities of Atlanta, Domino and possibly Queen City.

Alternative 3A provides the most flexibility for all project participants, as well as the opportunity for a phased construction approach to allow for 'growth to pay for growth.' This project would also address the regulatory issues regarding the current alternative capacity requirement and water production limitations, which in turn has impacted the Member Entities' ability to serve their growing population and expand their water CCN service areas.

The new raw water intake and conveyance system to deliver raw water to TAC would be constructed initially, and municipal demands of the Member Entities presently met by the existing New Boston Road WTP would be transferred to the new regional WTP. The City of Texarkana's (TX) municipal demands from the new WTP would be phased-in during the decommissioning process of the New Boston Road WTP.

The project participants' 2070 maximum day demands were used as the basis for sizing the capacity of the intake structure, raw water conveyance system, water treatment plant and transmission lines; this infrastructure would be constructed in two separate phases.

The infrastructure proposed in Phase 4B involves constructing a new 2.5 MGD conventional surface water treatment plant in Cass County to serve the Cities of Atlanta, Domino, and Queen City. The conventional package treatment plant would be sized for 2.5 MGD and would utilize the existing GPI intake; however, a new raw water pipeline would tie into the existing GPI raw water pipeline immediately upstream of the GPI pre-chlorination system to avoid the TTHM and HAA5 issues due to the high concentration of chlorine injected at that point in the system. Raw water and treated water lines would be constructed to ultimately tie into the existing distribution line that currently serves the City of Atlanta.

Section 2.0 INTRODUCTION

Riverbend Water Resources District (Riverbend WRD) was created by the Texas Legislature in 2009 to conserve and develop water resources in order to control, store, preserve, and distribute water to their Member Entities. Water resources are abundant in Riverbend WRD's service area in Northeast Texas; however, their water infrastructure systems need significant attention to keep operations and supply availability on pace with the growing water demands of their municipal and industrial customers.

Planning for regional water distribution and treatment facilities creates the necessary road map in order to provide a reliable and safe water supply, system redundancy, as well as efficient sharing of resources. As a result, Riverbend WRD has undertaken this study to evaluate the feasibility of developing a regional water master plan to serve existing and future populations of their participating entities through 2070 located within Bowie, Cass, and Red River Counties in Texas.

Susan Roth Consulting, LLC and her team ('Roth Team'), including Carollo Engineers, Inc., identified and evaluated several options for regional water transmission and treatment facilities in the service area of the project participants. This report serves as a 'road map' and summarizes the findings of this evaluation. Information regarding the study area and water supply; projected population and water demands; existing water treatment plants; regional distribution and treatment alternatives; preliminary cost estimates; and potential funding options are also included in this study.

2.1 PROJECT BACKGROUND

On May 1, 2016, Riverbend WRD acquired the 'wet utilities' (both water and wastewater infrastructure) from TexAmericas Center (TAC) and took responsibility for the wet utility contract with the Red River Army Depot. Based on a revised contractual agreement, Riverbend WRD is required to construct the necessary infrastructure to deliver to the TAC footprint not less than 30 million gallons per day (MGD) of raw, non-potable water by May 1, 2026 and then an additional 60 MGD of raw, non-potable water thereafter for a total of 90 MGD (**Appendix A**). TAC showed a commitment to the delivery of raw water to its footprint when it transferred the wet utility system ($14 million asset) and wet utilities contract with the Red River Army Depot ($129 million over 30 years) to Riverbend WRD; the negotiation of the transfer took approximately two years to complete.

The terms of the agreement included Riverbend WRD purchasing the wet utilities for $10,000; TAC also agreed to loan Riverbend WRD $900,000 in cash (interest free for a year) and had to restrict $3,000,000 in cash for two years on a Performance Bond with the Red River Army Depot to guaranty Riverbend WRD's performance under the wet utilities contract. The original contractual agreement with TAC provided that Riverbend WRD supply a total of 25 MGD by 2070 (**Appendix A**).

Since the transfer of the wet utilities, several stakeholders are committed to working with Riverbend WRD to develop a meaningful plan to address the area's needs for water supply and infrastructure in order to support economic growth. Therefore, Riverbend WRD is conducting this Regional Water Master Plan Study to help further quantify their current and future water demands and identify in a comprehensive manner the available resources and infrastructure needed to meet those demands. The Riverbend WRD Regional Water Master Plan serves as a road map for the organization and establishes the vision for the region as a whole in terms of source water, infrastructure, and future economic needs. By developing a road map that feeds into the Texas Water Development Board Region D and state water planning process, Riverbend WRD on behalf of all of its member entities will be well-positioned for various grants and low-interest financing alternatives, as needed.

Riverbend WRD formally represents through Interlocal Agreements the interests in water supply for the most northeast region of Texas; including the counties of Bowie, Cass, and Red River, as well as TexAmericas Center and the cities of Annona, Atlanta, Avery, DeKalb, Hooks, Leary, Maud, Nash, New Boston, Redwater, Texarkana (TX) and Wake Village. Central Bowie County WSC and the City of Red Lick are not currently members of Riverbend WRD; however, both entities hold MOUs (Memorandum of Understanding) with Riverbend WRD for the collaboration and partnering together on the development of the region's water resources. Similarly, the City of Clarksville is participating in the study to provide additional options regarding infrastructure projects needed to address their water quality and quantity needs. In addition, Riverbend WRD holds an MOU with the Southwest Arkansas Water District to work in cooperation regarding various water issues. Together, these utilities make up the 'project participants'.

This planning study allows the project participants the opportunity to adequately evaluate and determine the following:

- Feasibility of developing a regional water system to replace and/or supplement the multiple systems currently in service;
- Investigation in more detail the water management strategies in the *TWDB 2016 Region D Water Plan* as they apply to Riverbend WRD;
- Evaluation of various treatment options and existing facilities to provide a cost-effective reliable water supply (raw and potable) to municipal and industrial customers;
- Interconnections of existing water systems, where needed, to provide redundancy in case of system failures;
- Collection of available information and data from previous planning activities for and by Riverbend WRD;
- Evaluation of present and future water supply and needs; along with a defined approach

for Riverbend WRD moving forward; and,

- Options for smaller water systems that do not want to be in the ‘water business’ to connect to a larger water system.

The study area primarily includes Bowie County, as well as portions of adjacent areas in Cass and Red River Counties; all of the project participants are currently using surface water supplies from Wright Patman Lake and Millwood Lake. Reference the overview map in **Figure 2-1** for a detailed summary of the entities included in the evaluation of this study; this map notes the water CCN (Certificate of Convenience and Necessity) boundaries for each of the project participants.

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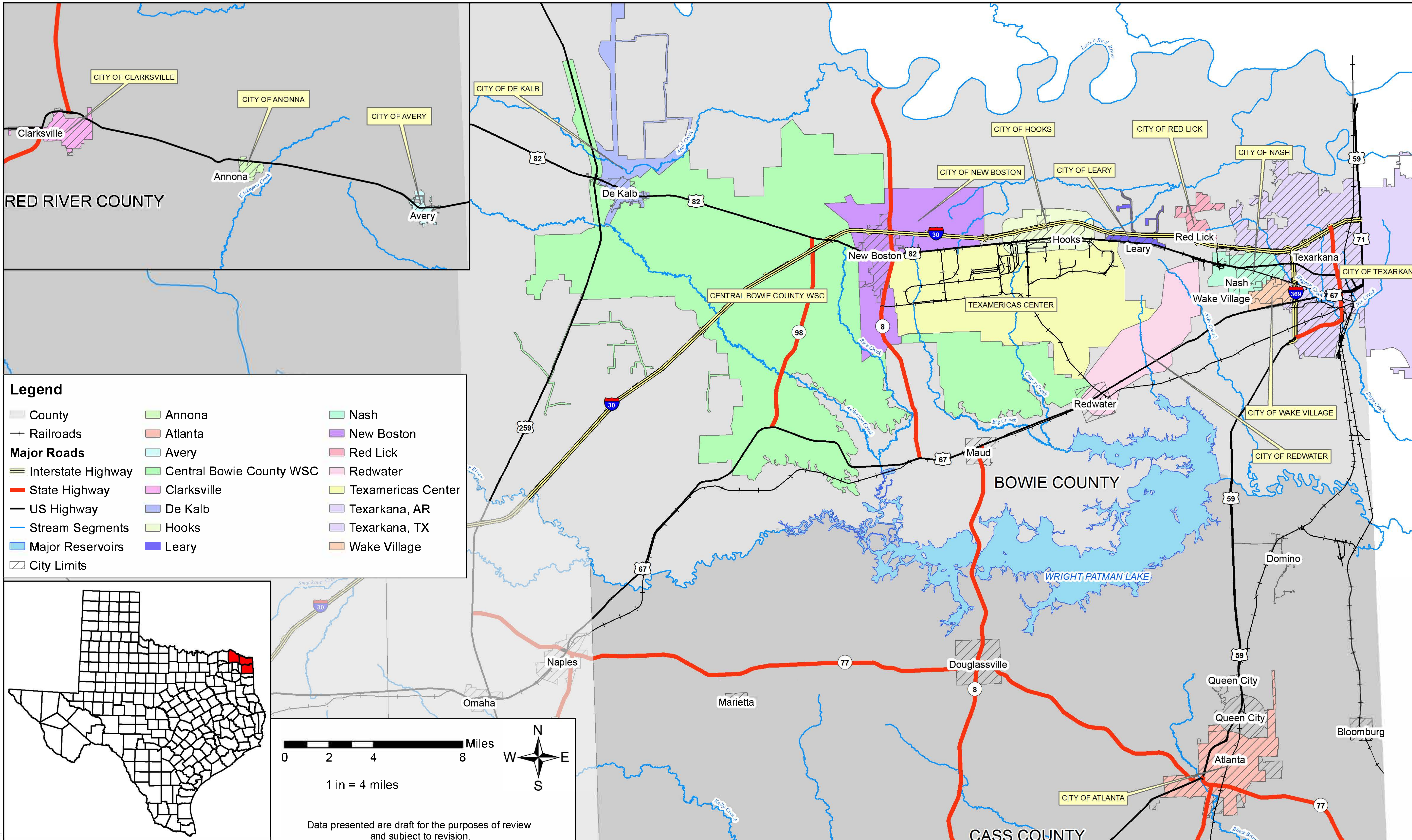
Figure 2-1: Participating Entities in Regional Water Master Plan Study



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2.2 SCOPE OF WORK

The scope of work for this study involves evaluating the feasibility of developing regional water distribution and treatment facilities to serve existing and future development for the Riverbend Member Entities located in Bowie, Cass and Red River Counties. The following items were included in the study to meet the planning needs of Riverbend WRD:

- ***Population and Water Demand Projections*** – Thorough examination of population and growth projections; number of existing water connections; utility development agreements; and additional water system information were collected from each of the entities. This data was used to develop population and water demand projections for each entity in five-year increments through year 2070.
- ***Water Supply Assessment*** – Detailed evaluation of the present and future water supply and water quality (raw and finished) provided from Wright Patman Lake and Millwood Lake.
- ***Existing Water Infrastructure Assessment*** – High-level condition assessment was conducted of the Millwood WTP, New Boston Road WTP and Graphic Packaging International WTP.
- ***Regional Distribution Alternatives*** – Options were developed for connecting existing water systems participating in the study into an overall regional water distribution system.
- ***Regional Water Treatment Alternatives*** – Various options were developed that included expanding existing infrastructure, as well as constructing new regional infrastructure to serve the study area.
- ***Implementation Schedule*** – An implementation plan was developed for the phased construction of regional distribution and treatment facilities for the study area through 2040. This plan takes into consideration the existing distribution and treatment capacities, water quality issues, future developments, anticipated growth and cost-effectiveness.
- ***Cost Estimates and Recommendations*** – An economic analysis including the capital and O&M costs for each identified entity for the various options was performed. The capital and O&M costs for the final regional distribution and treatment system alternatives were combined and converted to present worth.
- ***Funding Options*** – Potential funding sources and traditional financing programs were explored for the construction of regional water infrastructure.
- ***Water Conservation and Drought Contingency Plans*** – TWDB requires project participants receiving funding through their financial programs to prepare and implement water conservation and drought contingency plans.

Information about each of the items listed in the scope of work are presented in the following sections of the report.

2.3 IMPORTANT STUDY FACTORS

Several important study factors were identified early in the planning process: (1) capacity and demand; (2) regulatory; and (3) conservation and firm water supply availability. The Riverbend WRD study area is located in the Piney Woods Region and the East Texas Timberlands of Texas along the Interstate 30 corridor between the Cities of Dallas, Texas and Little Rock, Arkansas. This study area serves as a transportation, commercial, and industrial center for Texas-Arkansas corridor, as well as a hub for portions of Oklahoma and Louisiana. The two primary reservoirs in the area, Wright Patman Lake and Millwood Lake, have the capability of providing an abundant surface water supply.

Planning for the responsible conservation and management of water resources in the area is a top priority for Riverbend WRD. Identifying future infrastructure needs are also of importance to Riverbend WRD in order to keep operations and availability on pace with the growing municipal and industrial demands of their current and future member entities. As presented in Section 3.0 of this report, the population of Bowie County, where a majority of the Member Entities are located, is projected to reach over 100,000 by 2050. Riverbend WRD also currently serves two key industry areas: TAC and the Red River Army Depot (RRAD). TAC is the largest contiguous industrial footprint in the state of Texas with over 12,000 acres available for development. RRAD is currently the largest employer in the area with an 18,000-acre facility located near Texarkana that produced $2.4 billion in revenue last year. TAC has received numerous requests from potential industrial and commercial customers for potable and raw water supply over the past five years. This list of potential prospects identified an additional 30 MGD of water demand from today through the next several years at TAC and is projected to double to 60 MGD by 2050.

Other key industries in the area include the manufacturing and marketing of lumber and paper products, both of which require a reliable water supply for their production needs. The forest sector produced $1.8 billion worth of goods and services according to the 2012 Texas A&M Forest Service (TFS) Report for the Texas Forestry Association. The International Paper coated paperboard mill in Cass County, which was acquired by Graphic Packaging International in January 2018, produced $630 million in revenue in 2017. With a workforce of 825 employees, the GPI mill also supports an estimated additional four area residents for every mill employee through contractors and services. Although the primary agricultural crop is timber; wheat, soybeans, and livestock are also of importance. **Figure 2-2** shows the study area is targeted for high-growth development due to the availability of high-quality farmland.

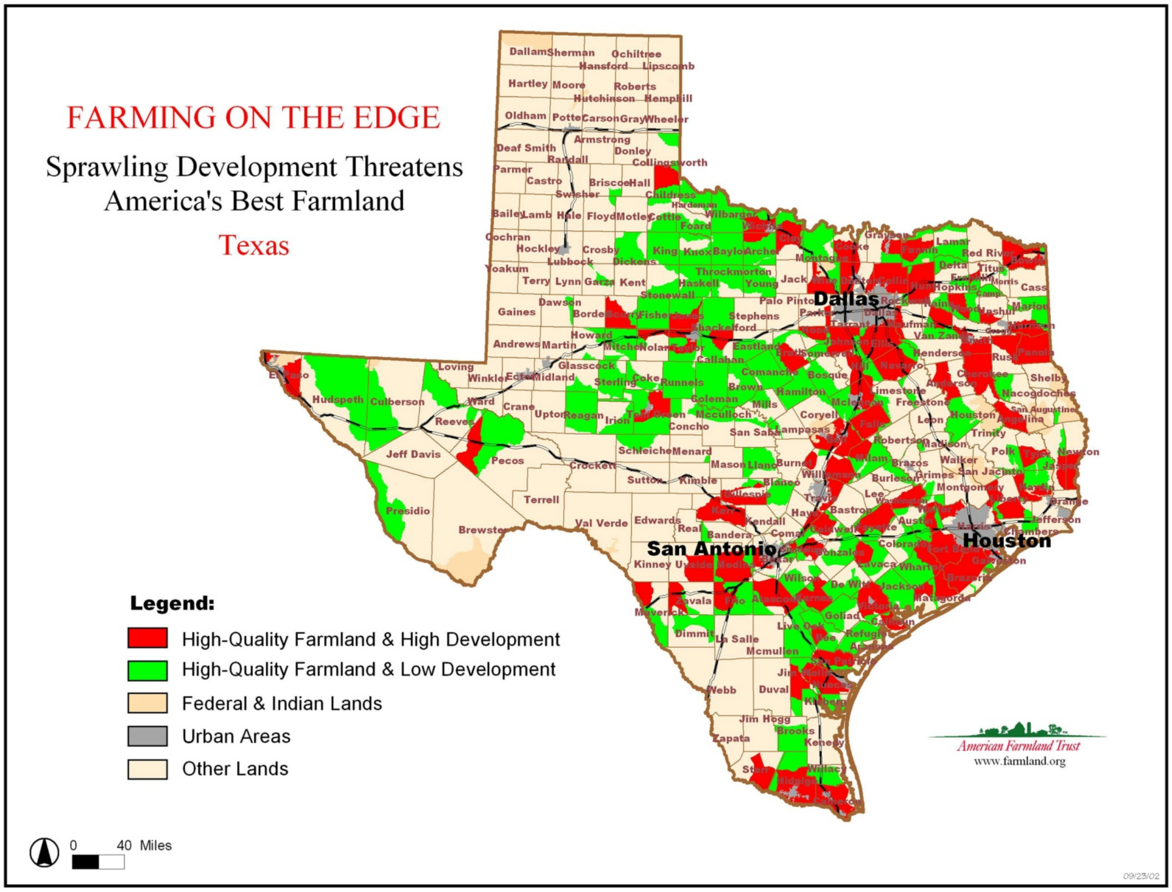

Figure 2-2: RWRD – High Growth Development & High Quality Farmland

Regarding regulatory issues, Texarkana Water Utilities (TWU) has had an alternative capacity requirement (ACR) from the TCEQ of 0.49 GPM per connection since November 2014 for all of the wholesale systems who receive water under direct pressure from them. The granted ACR is in lieu of the minimum statewide treatment plant capacity requirements of 0.6 GPM per connection under normal rated design flow for surface water supplies, as specified in Title 30 of the Texas Administrative Code (30 TAC) §290-45(b)(2)(B). All of the Riverbend WRD Member Entities purchase treated water on a wholesale basis from TWU. As a result, the water supply availability has been reduced due to TWU's production limitations, which in turn has affected the Member Entities' ability to serve their growing water demands and expand their water CCN service area.

In addition, conservation and firm water supply availability was also identified to have a direct impact on the sustained growth and infrastructure planning for the study area. The viability of Wright Patman Lake as a reliable water resource for regional water user groups and for use by other potential corporate or water user entities for the planning period is a key factor. Significant impacts to the available storage in Wright Patman Lake due to sedimentation issues in the Sulphur River Basin have been identified but are unsubstantiated and require further sedimentation and volumetric analysis. As presented in Section 4.0 of this report, the characterization and assessment of the current water supplies from Millwood Lake and Wright

Patman Lake are addressed in terms of firm yield based on U.S. Army Corps of Engineer (USACE) data. Finally, implementation of existing water contracts with the USACE regarding Wright Patman Lake was identified as an ongoing issue impacting available water supplies.

Section 3.0
GROWTH PROJECTIONS

The Riverbend Water Resources District (Riverbend WRD) Regional Water Master Plan Study provides information on the population and water demand projections (municipal and manufacturing) for the project participants located in Bowie, Cass, and Red River Counties through year 2070. Riverbend WRD is looking at a 50-year planning period versus a five-year period for a variety of reasons: (1) the state water plan evaluates a 50-year planning period; (2) it is important to have a 50-year snapshot of projections for Riverbend WRD regarding permitting issues with the TCEQ and U.S. Army Corps of Engineers (USACE); (3) Riverbend WRD will be applying for water rights with TCEQ and need to reflect the most accurate data and water needs for the permitting process; and, (4) Riverbend WRD will be applying for funding with Texas Water Development Board (TWDB) and exhibits a need to meet all TWDB planning criteria.

3.1 POPULATION PROJECTIONS

The municipal population in the study area has increased steadily over the past 10 years and is projected to continue to increase over the next 50 years. In order to accurately capture the population growth of the study area, the following information was collected from each participant:

- CCN maps of existing water infrastructure;
- Current population and growth projections;
- Historical data - number of meters/water connections (2010-2016);
- Water system information;
- Monthly, average and maximum day water demand data (2010-2016);
- Utility development agreements and build-out schedules of future developments in the service area; and,
- Recent and future annexation activities.

During the project kick-off meeting on July 21, 2016, a data request handout was provided to the project participants to collect detailed information about their service areas and water systems to initiate the engineering analysis. Project participants provided their 2015 population, historical data of annual meter counts and water usage (2010-2016), average annual growth rate including supporting data, and information on residential and commercial developments planned for their area or its vicinity. Project participants also provided population projection data prepared by or for their entity. In addition, previous planning documents prepared for Riverbend WRD by HDR Engineering (November 2008) and CH2M HILL, Inc. (August 2012, Phases 1-3) were referenced, as appropriate.

This information, along with population and growth projection data obtained from the U.S. Census Bureau, *TWDB 2011 Region D Water Plan,* and *TWDB 2021 Draft Region D Water Plan* was used to develop population projections for each entity in five-year increments through a 2070 planning horizon. For each of the three counties represented by the entities, population projections were also compiled using information from the *TWDB 2011, TWDB 2016,* and *Draft 2021 Region D Water Plans*, Texas Demographic Center (TDC), Arkansas-Texas Council of Governments, and Rice University – Hobby Center for the Study of Texas; **Table 3-1** summarizes the population and growth projections from these sources and was used for comparison purposes. The period of the average annual growth rate of the TDC and TWDB are both calculated through 2050 since the TDC data is only available through 2050.

Table 3-1: Riverbend WRD Counties – Population & Growth Projections

Reference	Year 2010	Year 2050	Annual Growth Projection
BOWIE COUNTY			
2010 U.S. Census Bureau	92,565	---	---
TWDB 2011 Region D Water Plan	92,565	99,263	0.17%
TWDB 2021 Draft Reg. D Water Plan	92,565	99,263	0.17%
Rice University-Hobby Center*	92,565	99,190	0.17%
Texas Demographic Center*	92,565	100,503	0.21%
CASS COUNTY			
2010 U.S. Census Bureau	30,464	---	---
TWDB 2011 Region D Water Plan	30,464	31,229	0.06%
TWDB 2021 Draft Reg. D Water Plan	30,464	31,229	0.06%
Rice University-Hobby Center*	30,464	30,123	-0.03%
Texas Demographic Center*	30,464	31,326	0.07%
RED RIVER COUNTY			
2010 U.S. Census Bureau	12,860	---	---
TWDB 2011 Region D Water Plan	12,860	12,976	0.02%
TWDB 2021 Draft Reg. D Water Plan	12,860	12,976	0.02%
Rice University-Hobby Center*	12,860	11,707	-0.23%
Texas Demographic Center*	12,860	12.064	-0.16%

* Population projections represent 0.5 Migration Scenario

The *TWDB 2016 Region D Water Plan* and *TWDB Draft 2021 Region D Water Plan* is based on 2012 TDC data; however, TDC has since released the 2014 data, which has a more accurate and higher growth rate for the entire county of Bowie. Although the projections for the Riverbend WRD entities located in Bowie County do not represent the entire county, the 2014 TDC data is used for comparison purposes. The reason for including this information is to support the projected growth for the planning area by showing the slight increase in growth rate between the 2012 TDC data and 2014 TDC data for Bowie County.

In **Figures 3-1** through **3-3**, targeted areas for population growth identified by the U.S. Census data forecast for Bowie, Cass, and Red River Counties are shown below. The area representing the highest population density in 2010, Bowie County, is highlighted in orange in **Figure 3-1**. In **Figure 3-2**, the greatest amount of change in population density from 2010 to 2020 is represented by the yellow shaded area (Bowie County). The greatest increase in population density from 2010 to 2050 is highlighted in Red for Bowie County in **Figure 3-3**. The population density shown in these figures was used for information purposes only as a visual representation for the participants during the project meetings.

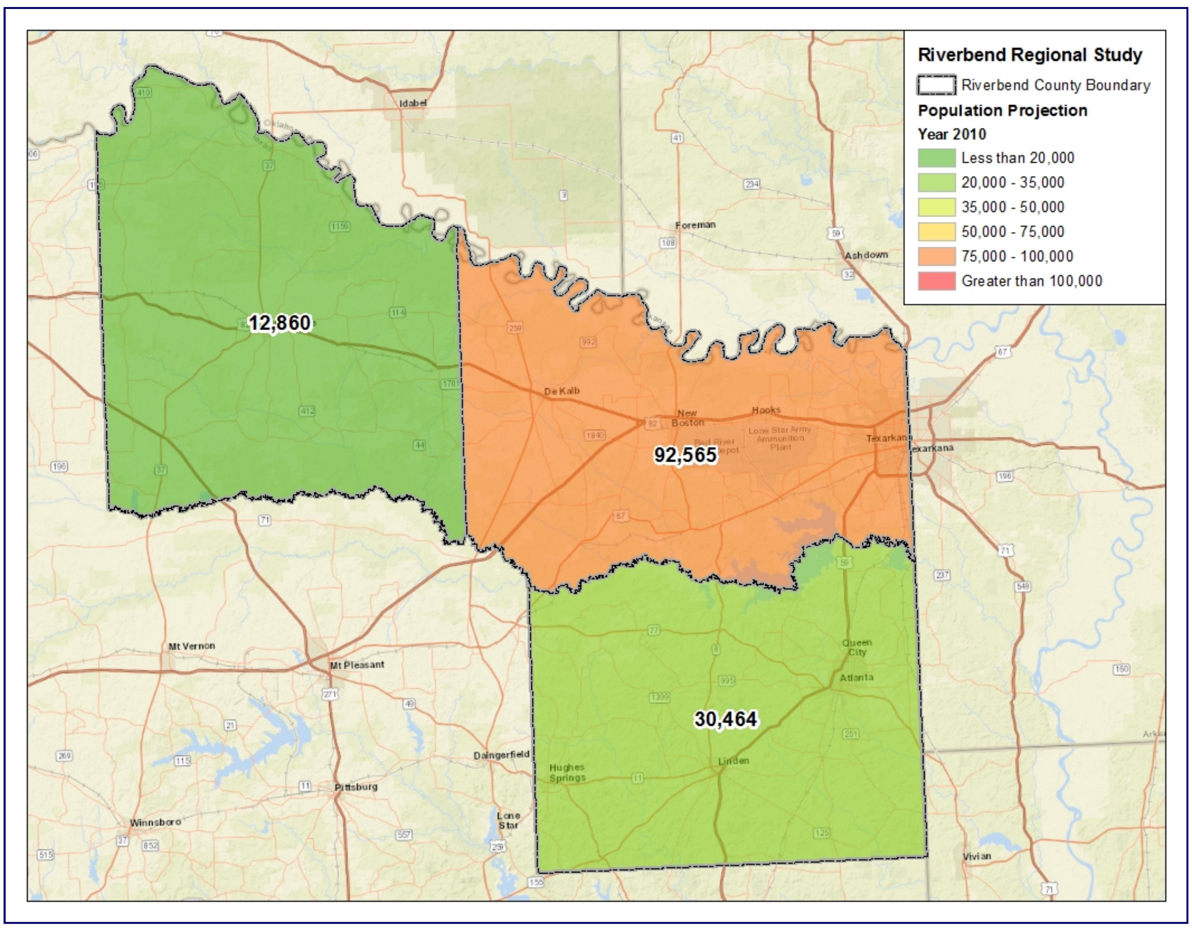

Figure 3-1: Riverbend WRD Counties – 2010 Population Density

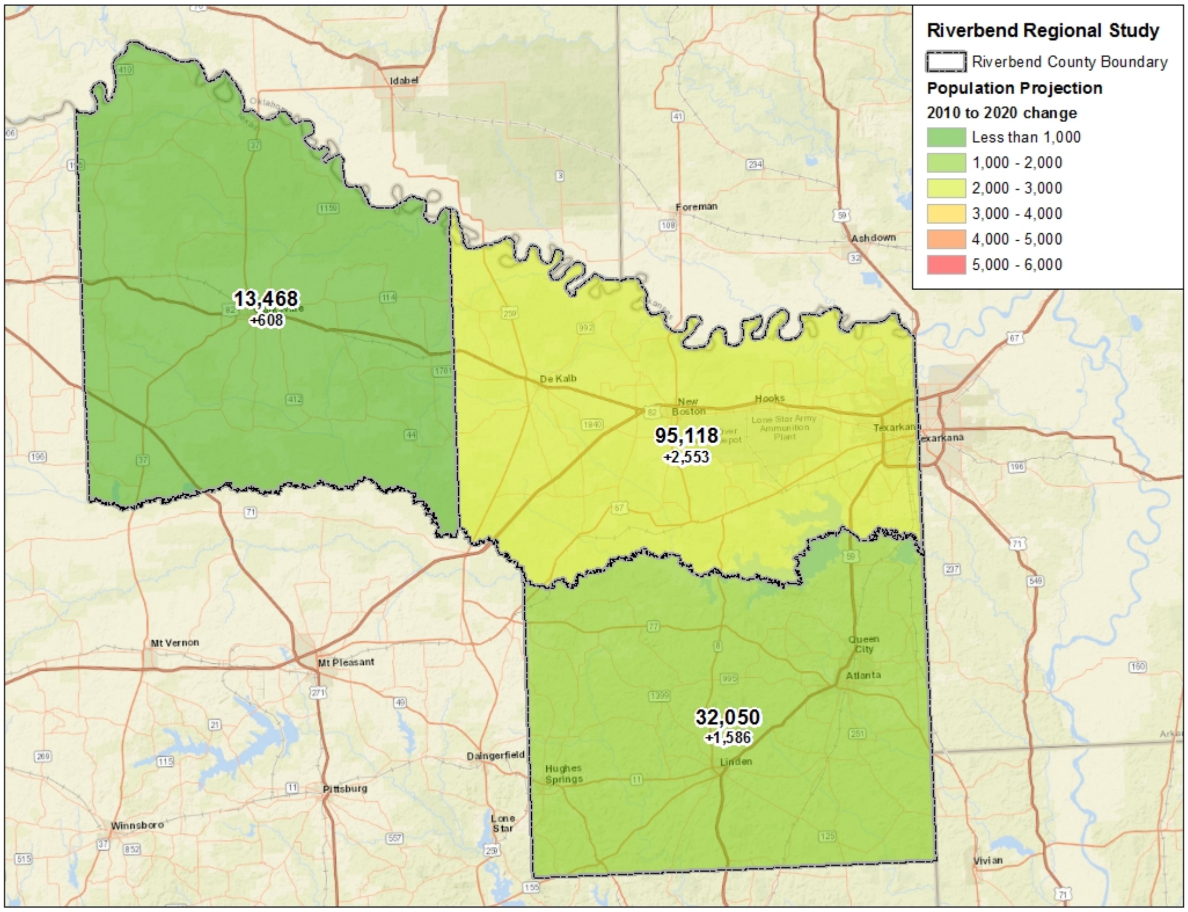

Figure 3-2: Riverbend WRD Counties – Change in Population Density (2010-2020)

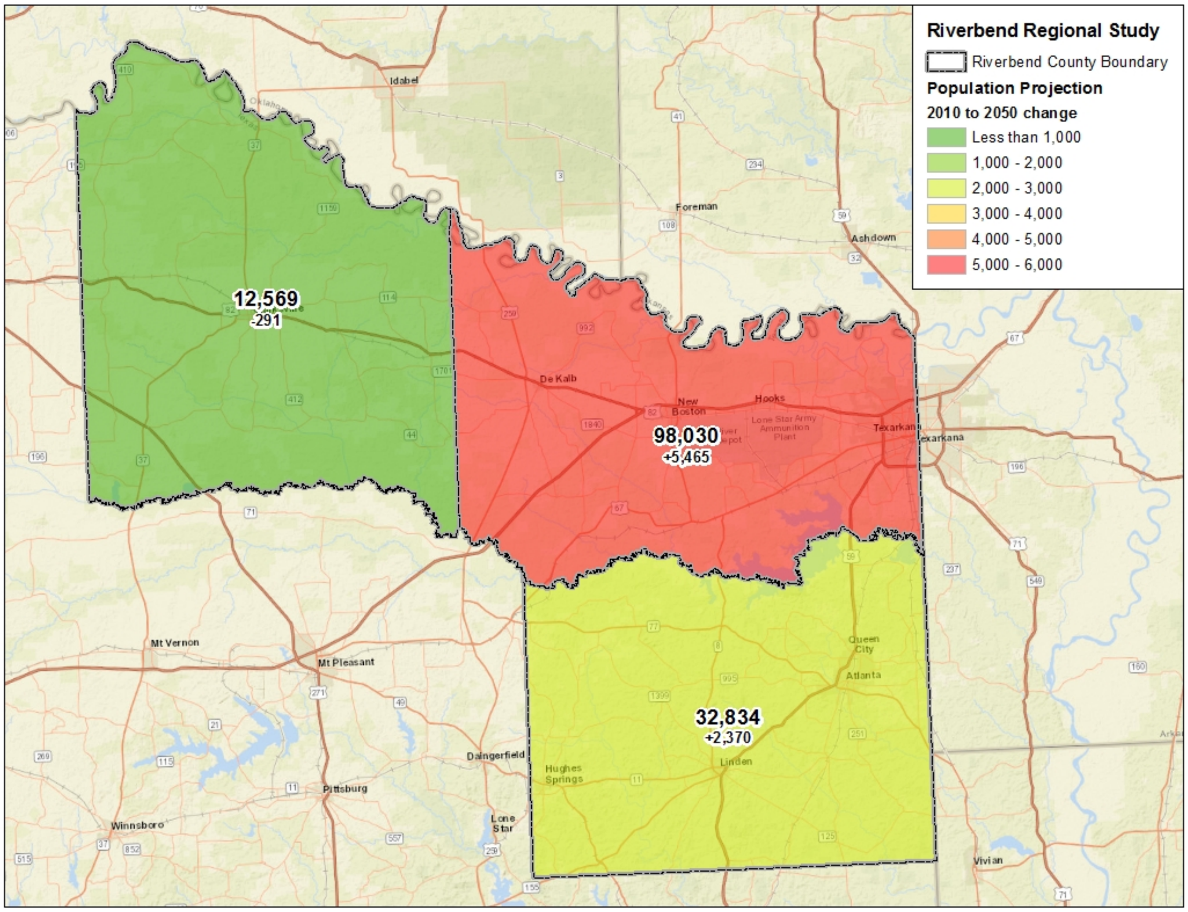

Figure 3-3: Riverbend WRD Counties – Change in Population Density (2010-2050)

Based on the information collected, population projections have been developed from 2020 through 2070 for each of the participating entities located in the study area and are summarized in **Table 3-2.** Since the state water plan covers a 50-year planning period through 2070, Riverbend WRD wanted their local water master planning efforts to align with the TWDB and provide the most accurate information regarding population and water demand projections to be included in the *2021 TWDB State Water Plan*. Reference **Appendix B** for a complete summary of the final population projections in five-year increments from 2015 through 2070 for the project participants.

The 2015 population numbers are based on current 2015 residential meter counts (single and multi- family) times the average household size (further derived from 2010 U.S. Census Data). The formulation of the population projections aligns with water utility service areas instead of political boundaries/city limits based on recent changes to the TWDB rules for the *2021 State Water Plan*. The residential meter counts from 2010 through 2015 were used for determining the average annual growth rate and/or future growth projections. Riverbend WRD's population projections were calculated by multiplying the 2015 population values by the average annual growth rates and then projected through 2070. The methodology and details regarding the calculation of the population projections is outlined in further detail in a memorandum along with supporting documentation in **Appendix C**.

Table 3-2: Population Projections – Project Participant Data+

Entity	Population Projections					
	2020	2030	2040	2050	2060	2070
Central Bowie Co. WSC	7529	8037	8903	9862	10924	12101
City of Annona*	318	321	325	328	331	334
City of Atlanta	5877	6394	6910	7427	7427	7427
City of Avery*	487	492	497	502	507	512
City of Clarksville	3315	3315	3315	3315	3315	3315
City of De Kalb	1711	1748	1769	1780	1803	1827
City of Hooks	3049	3173	3303	3303	3303	3303
City of Leary*	595	694	794	893	943	943
City of Maud	1358	1500	1642	1642	1642	1642
City of Nash	4070	4751	5431	6111	6111	6111
City of New Boston	5960	6129	6180	6180	6180	6180
City of Red Lick*	1221	1435	1600	1600	1600	1600
City of Redwater	3749	4229	4709	5189	5429	5429
City of Texarkana (TX)	38007	39674	41413	43229	45124	47102
City of Wake Village	6150	6850	7550	8250	8950	8950
TexAmericas Center (RWRD)	542	558	563	563	563	563
TOTAL	***83,938***	***89,300***	***94,904***	***100,174***	***104,152***	***107,339***

*Entities not classified as TWDB Water User Groups (WUGs) and included in 'County Other' category.
+Population projections approved by the TWDB Region D Water Planning Group on October 25, 2017.

Figure 3-4 represents a comparison of the annual growth rate projections for the sixteen participating entities located in the study area based on data provided by the entities and TWDB. The growth rate of the entities is higher than TWDB's projections based on revised data and showing growth continuing beyond 2040. Although Riverbend WRD member entities' Draft 2021 Region D municipal population projections are held constant from 2040 through 2070 with the exception of City of Atlanta (held constant starting in 2030) and City of Clarksville (held constant starting in 2020), each entity was able to justify the increase in population data and average annual growth rate for their area. The methodology and revised projections were approved by the TWDB Board on April 16, 2018. The final population projections for each of the entities were used to calculate water demands for the study area and to size the proposed regional water infrastructure.

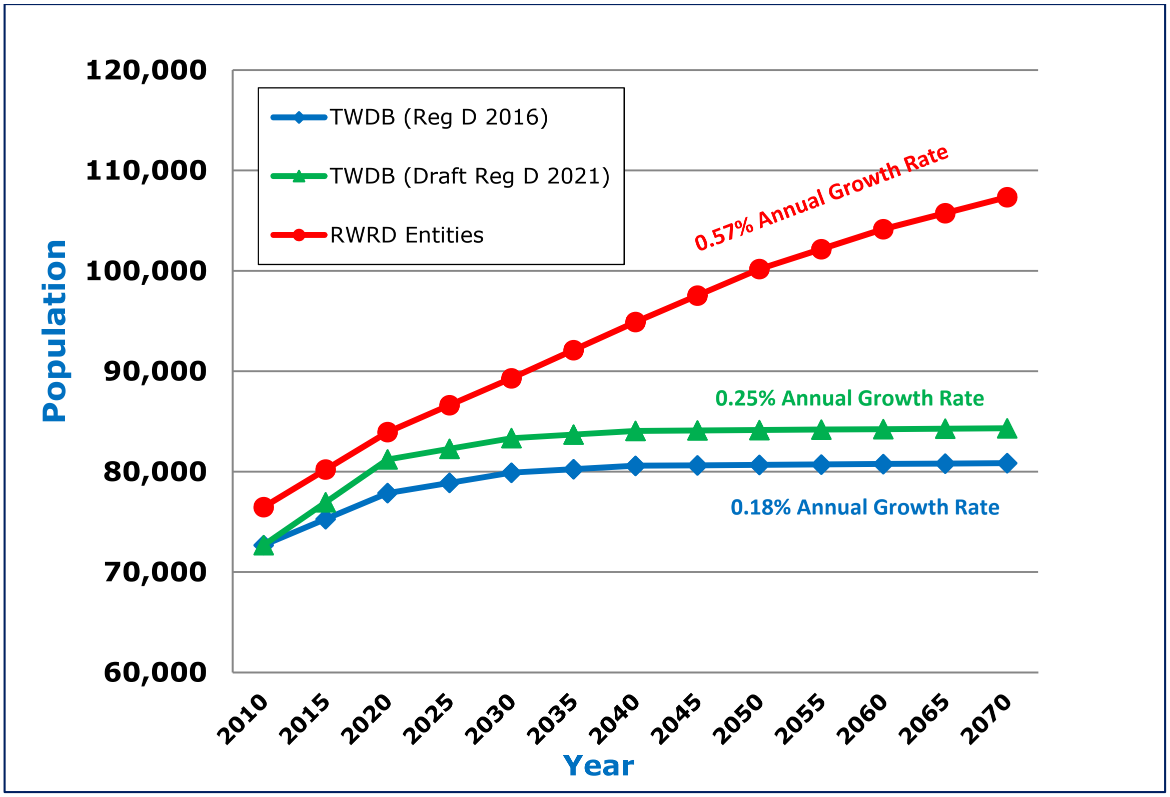

Figure 3-4: Comparison of Entity and TWDB Annual Growth Rates

3.2 PLANNING AND DESIGN CRITERIA

Primary design criteria used for planning and evaluating water supply systems are listed below, along with a description of how these criteria are used in the sizing of the various water system components:

- *Average yearly water demand:* Used for estimating long-term surface water and groundwater withdrawal rates and for estimating yearly operational costs.
- *Maximum daily demand:* Used for sizing raw water intakes, treatment plants, and major transmission mains (for example, between treatment plants and storage facilities).
- *Peak hour demand:* Used for sizing pumps and hydro-pneumatic tanks that supply water directly into the distribution system, and for distribution piping. Peak hour demands are also involved in sizing elevated water storage tanks.
- *Minimum and maximum pressures:* Used to dictate the elevations of elevated storage tanks, pipe sizing, service areas for each elevated or hydro-pneumatic tank, and pumping heads.
- *Minimum water storage requirements:* Used to size clearwells, ground storage tanks and elevated tanks.

As presented below, not all of the above criteria are applicable when planning a regional water system, as most apply primarily to the planning of the local storage and distribution system. This is especially true if the regional system primarily provides wholesale treated water to the participating entities.

The Texas Commission on Environmental Quality (TCEQ) establishes minimum values for most of the criteria listed above and 30 TAC 290 Subchapter D requires that a system be designed to meet the minimum criteria or better unless the system can provide data that their water usage is consistently lower than the TCEQ minimum criteria.

3.2.1 Average Yearly Water Demand

The average yearly water demand is used to determine the long-term water needs of a community. This demand is used as a basis for acquiring surface water contracts. Average yearly demands are seldom used for sizing the infrastructure of a water system but they are used for estimating yearly operational costs, such as the cost of chemicals, energy, and solids hauling and disposal.

3.2.2 Maximum Day Water Demand

The maximum day water demand is the most important criteria in an infrastructure planning study since it is used to determine the required capacities of intakes, water treatment plants, transmission mains, and most of the pumping stations found in a regional water system. The TCEQ minimum design standard is 0.6 GPM per connection for maximum day water demands. This design standard was used to size the infrastructure in each of the alternatives considered in this study.

3.2.3 Peak Hour Demand

Peak hour demands dictate the sizing and layout of the distribution network within a water system and the sizing of pumps and hydro-pneumatic tanks that supply water directly into a distribution system. Peak hour demands are also involved in sizing both ground and elevated storage tanks.

Most water systems do not monitor peak hour demands due to the difficulty of measuring these water demands. For this reason, the TCEQ minimum design criterion of 2.0 GPM per connection is typically used when planning and designing new infrastructure.

Peak hour demands are not applicable to a regional water system whose purpose is to provide treated water to existing entities that already have their local water distribution systems in place or to future entities that will be constructing their own local water distribution infrastructure.

3.2.4 Maximum and Minimum Pressures

Maximum and minimum pressures impact pipeline sizes, storage tank elevations, and booster pump locations regarding the planning and design of regional water facilities. According to

TCEQ design criteria, the minimum pressure to use in laying out regional alternatives is 35 pounds per square inch (psi). Transmission main pressures are typically designed for operating pressures not to exceed 200 psi; but in some cases, higher pressures may be allowed in order to avoid the additional costs of installing a booster pumping station for example.

3.2.5 Minimum Water Storage Volume

TCEQ's water storage requirements vary with source water type and system size. Systems with surface water sources must have a clearwell(s) with a volume of at least 50 gallons per connection or a volume equal to 5 percent of the daily plant capacity, whichever is greater. TCEQ requires all water systems to provide a total storage of no less than 200 gallons per connection. At a minimum, 100 gallons of elevated storage must be provided for larger groundwater systems and surface water systems. For smaller systems, pressure (hydro-pneumatic) tanks may be used in lieu of elevated storage tanks but the total storage must equal 200 gallons per connection.

Regional storage facilities are usually provided where booster pumping stations are required due to the length of a regional transmission main or where significant elevation increases occur along the main. These tanks are either ground storage or elevated storage tanks depending on the topography along the transmission main.

3.2.6 Recommended Criteria for Projecting Regional Water Demands

In summary, a maximum day demand or 0.6 GPM per connection was selected for sizing future facilities in this study. As previously mentioned, the maximum day demand has the largest impact on the sizing and cost of regional water facilities. Additional design criteria used are as follows:

- *Average daily water demand:* 0.30 GPM per connection;
- *Minimum transmission main pressure:* 35 pounds per square inch (psi);
- *Maximum transmission main pressure:* 200 psi;
- *Maximum velocity in water transmission mains:* 5.0 feet per second (fps); and
- *Water storage for booster pumping stations:* 30 minutes of storage at the design pumping rate of the booster station.

3.3 MUNICIPAL WATER DEMAND PROJECTIONS

The first step in defining water treatment alternatives is to determine future demands for the study area. The assessment of water demands for the participating entities includes evaluating historical water usage (average day, maximum day and peak hour demands), as well as projected population growth and water consumption data (municipal) and non-municipal water demand projections for manufacturing needs. A summary of each project participating entity's water consumption data based on gallons per capita per day (GPCD) that is listed in the *TWDB 2021 Draft Region D Water Plan* is provided in **Appendix D**. TWDB has a water conservation goal of 140 GPCD, and entities need to be aware of and strive to meet this goal.

Central Bowie County WSC, City of Nash, and City of Texarkana made requests to revise their respective base GPCD with the Region D Water Planning Group and TWDB. Central Bowie County WSC currently provides water to additional customers located outside of their water CCN, resulting in a higher GPCD. TWDB staff has approved the request to use the 2015 historical GPCD of 83 as a base amount for Central Bowie County WSC.

The City of Nash recently underwent extensive annexation activities in 2015, as well as at the end of 2013, impacting their GPCD. TWDB staff has also approved the request to use the 2015 historical GPCD of 86 as a base amount for the City of Nash.

For many years, the City of Texarkana inaccurately reported its base GPCD by using a total amount of water usage in the entire TWU system, which supplies water to both Texarkana, TX and Texarkana, AR, but only dividing by the Texarkana, TX population. The City of Texarkana now requests corrections to their base GPCD for 2011 to-date. The 2011 per capita water usage for the City of Texarkana (TX) is calculated to be 177 GPCD. This calculation is based on their 2011 metered water usage of 2,359,926,122 gallons and the 2011 City of Texarkana (TX) population of 36,569. TWDB staff has also approved this request as a base GPCD for the City of Texarkana, TX.

Average day water demand projections for each of the entities are calculated using their 2015 annual consumption data, population projections (as shown in **Table 3-2**), and average annual growth rate to project demands through 2070.

Maximum water demand projections are calculated by multiplying a peaking factor of 1.46 to each entity's Average Day Demands to project water demands through 2070; the peaking factor is based on the maximum day and average day water demand ratio for the New Boston Road and Millwood WTPs. **Table 3-3** below summarizes the average and maximum day water demand projections for the participating entities (also reference **Appendix D**).

Since November 2014, Texarkana Water Utilities (TWU) has had an alternative capacity requirement (ACR) from the TCEQ of 0.49 GPM per connection for all of the wholesale systems, including all of the project participants in this study, who receive water under direct pressure from TWU. The granted ACR is in lieu of the minimum capacity requirements specified in Title 30 of the Texas Administrative Code (30 TAC) §290-45(b)(2)(B). TWU's rated capacity of Millwood Water Treatment Plant and New Boston Road WTP are 15.12 MGD and 18.0 MGD, respectively; both of these WTPs have a combined rated capacity of 33.12 MGD.

Table 3-3: Municipal Water Demand Projections – Project Participants

Entity	Average Day Water Demands (MGD) / Maximum Day Water Demands (MGD)										
	2020	2025	2030	2035	2040	2045	2050	2055	2060	2065	2070
Central Bowie Co. WSC	0.621	0.654	0.688	0.724	0.762	0.802	0.844	0.888	0.935	0.984	1.036
	0.907	0.954	1.004	1.057	1.112	1.171	1.232	1.297	1.365	1.437	1.512
City of Annona	0.030	0.030	0.030	0.031	0.031	0.031	0.031	0.031	0.031	0.032	0.032
	0.044	0.044	0.044	0.045	0.045	0.045	0.045	0.046	0.046	0.046	0.046
City of Atlanta	1.061	1.098	1.135	1.171	1.207	1.244	1.280	1.280	1.280	1.280	1.280
	1.549	1.603	1.657	1.710	1.763	1.816	1.868	1.868	1.868	1.868	1.868
City of Avery	0.050	0.051	0.051	0.051	0.051	0.052	0.052	0.052	0.052	0.053	0.053
	0.073	0.074	0.074	0.074	0.075	0.075	0.076	0.076	0.076	0.077	0.077
City of Clarksville	0.560	0.560	0.561	0.561	0.561	0.561	0.562	0.562	0.562	0.562	0.563
	0.818	0.818	0.819	0.819	0.819	0.820	0.820	0.820	0.821	0.821	0.821
City of De Kalb	0.211	0.213	0.214	0.216	0.217	0.218	0.220	0.221	0.223	0.224	0.226
	0.309	0.311	0.313	0.315	0.317	0.319	0.321	0.323	0.325	0.327	0.330
City of Hooks	0.290	0.306	0.324	0.342	0.361	0.361	0.361	0.361	0.361	0.361	0.361
	0.423	0.447	0.473	0.499	0.527	0.527	0.527	0.527	0.527	0.527	0.527
City of Leary	0.053	0.055	0.058	0.061	0.064	0.067	0.071	0.075	0.075	0.075	0.075
	0.077	0.081	0.085	0.089	0.094	0.098	0.104	0.109	0.109	0.109	0.109
City of Maud	0.133	0.136	0.139	0.142	0.145	0.145	0.145	0.145	0.145	0.145	0.145
	0.194	0.198	0.203	0.207	0.212	0.212	0.212	0.212	0.212	0.212	0.212
City of Nash	0.272	0.284	0.297	0.311	0.325	0.340	0.356	0.356	0.356	0.356	0.356
	0.397	0.415	0.434	0.454	0.475	0.497	0.520	0.520	0.520	0.520	0.520
City of New Boston	0.964	0.978	0.993	1.008	1.023	1.023	1.023	1.023	1.023	1.023	1.023
	1.408	1.428	1.450	1.471	1.493	1.493	1.493	1.493	1.493	1.493	1.493
City of Red Lick	0.136	0.147	0.159	0.171	0.178	0.178	0.178	0.178	0.178	0.178	0.178
	0.198	0.215	0.233	0.250	0.259	0.259	0.259	0.259	0.259	0.259	0.259
City of Redwater	0.302	0.315	0.329	0.343	0.357	0.372	0.388	0.405	0.405	0.405	0.405
	0.441	0.460	0.480	0.500	0.522	0.544	0.567	0.591	0.591	0.591	0.591
City of Texarkana (TX)	6.641	6.785	6.932	7.082	7.236	7.393	7.553	7.717	7.884	8.055	8.230
	9.696	9.906	10.121	10.340	10.565	10.794	11.028	11.267	11.511	11.761	12.016
City of Wake Village	0.499	0.519	0.540	0.562	0.585	0.608	0.633	0.658	0.685	0.685	0.685
	0.729	0.758	0.789	0.821	0.854	0.888	0.924	0.961	0.999	0.999	0.999
TexAmericas Center (RWRD)	0.763	0.766	0.769	0.772	0.775	0.775	0.775	0.775	0.775	0.775	0.775
	1.114	1.118	1.122	1.127	1.131	1.131	1.131	1.131	1.131	1.131	1.131
TOTAL	***12.586***	***12.899***	***13.219***	***13.547***	***13.878***	***14.170***	***14.470***	***14.726***	***14.969***	***15.191***	***15.419***
	18.376	***18.832***	***19.300***	***19.779***	***20.262***	***20.689***	***21.127***	***21.500***	***21.854***	***22.179***	***22.512***

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All alternative capacity requirements are now subject to periodic review by the TCEQ. The ACR may be revised or revoked if water demand conditions change or if evidence is found that the alternative capacity requirements have resulted in the degradation of potable water quality or quantity. Many of Riverbend WRD's member entities have plans to expand their water service areas as shown in the supporting documentation (reference **Appendix C**); however, they are currently not able to expand due to the water infrastructure limitations of TWU, which in turn has affected their ability to revise their water CCN boundaries through the Public Utility Commission (PUC). Therefore, the TCEQ capacity requirement of 0.6 GPM per connection, and not the alternative capacity exemption of 0.49 GPM per connection, is used for sizing the proposed Riverbend WRD regional water infrastructure alternatives.

3.4 MANUFACTURING WATER DEMAND PROJECTIONS

Founded in 1997, TexAmericas Center (TAC) owns and operates one of the largest mixed-use industrial parks in the United States. With approximately 12,000 acres of contiguous and shovel-ready land, TAC is prime for development. TAC is located in the Texarkana metropolitan area and serves the Arkansas, Louisiana, Oklahoma, and Texas markets. The Texas Economic Development Council has designated acreage on the TAC Central Campus as the first S.T.A.R. Site in Texas (sites that are ready for construction to be initiated), which provides private businesses and corporations with flexible and cost-effective alternatives. After an extensive analysis of Texas' eligible tracts and using a multi-step process to identify eligible areas, Governor Greg Abbott chose TAC as one of 628 census tracts in 145 counties as an Opportunity Zone. The Opportunity Zone program was created by the 2017 Federal Tax Cuts and Jobs Act and will encourage businesses to develop and invest in low-income communities in Texas.

TAC possesses a great amount of utility infrastructure, including recently added gas and fiber service; however, the primary utility service they are lacking is an adequate supply of raw and treated surface water. From 2011-2016, TAC received numerous requests from potential industrial and commercial customers for potable and raw water supply. The list of potential prospects identifies an additional 30 MGD of water demand from today through the next several years at TAC and is projected to double to 60 MGD in the next 20+ years. Additional potential industries continue to contact TAC; however, TAC is not able to fulfill their raw water requests. A lack of current water supplies to the footprint has detrimentally impacted the growth and development of the industrial park. Riverbend WRD's request for revision of the non-municipal water demand projections for the 2021 Draft Region D Water Plan for TAC was approved by TWDB. Table 3-4 below provides a summary of the projected raw water demands for TAC.

Table 3-4: Water Demand Projections – TexAmericas Center

Year	Raw Water Demand (MGD)	Raw Water Demand (AC-FT)
2020	30.0	33,604
2030	53.3	59,928
2040	59.4	66,509
2050	66.7	74,735
2060	74.1	82,961
2070	90.0	100,813

TAC is located in one of the most heavily traveled corridors in the country with access to Union Pacific Railroad and Interstates 30, 49, and 69. The US Highway 59 (US 59)/Interstate 69 (I-69)/Interstate 369 (I-369) transportation route is a major corridor for through commerce for many types of industries in Northeast Texas, including the timber/forest products industry. As a result of the recently expanded Panama Canal in 2016, the I-69/I-369 transportation route largely follows the current route of US 59 and runs from the most southern part of Texas to the most northeastern part of Texas, directly through Cass and Bowie Counties and the City of Texarkana, Texas. The Bowie County Judge has also been actively involved with coordination efforts to augment I-69/I-369 with a high-speed freight rail system that will come north from the Gulf of Mexico ports.

Texarkana Union Station is located in downtown Texarkana and has daily Amtrak service west to Los Angeles through Dallas, San Antonio and El Paso, and service east to Chicago through Little Rock and St. Louis. Texarkana Regional Airport provides general aviation service to the DFW International Airport.

In addition to the availability of contiguous land and the transportation corridor, TAC has access to a skilled workforce and laborers. Texarkana is home to Texas A&M University-Texarkana, a four-year branch of the Texas A&M University System, as well as Texarkana College, a community college, which provides Associates Degrees and vocational education.

3.4.1 Background and Ongoing Efforts of TexAmericas Center

TAC was created in 1997 after a base realignment and closure process that allowed the area to accept land from the federal government at Red River Army Depot when the government downsized the installation. As a result, TAC, a State of Texas redevelopment authority, was formed and charged with the responsibility of developing the footprint's land for industrial and commercial uses.

In early 2016, the TAC Central Campus was close to reaching full occupancy of available building and site space for lease, which prompted TAC to create a Construction Operations Trailer Park from an unutilized area of campus property. The new trailer park site offers a total of fifteen 12-ft pads and provides tenants a move-in ready option for locating trailers for operations and administration to the footprint. This operations site has created a viable and cost-effective option for businesses doing contract work for the Red River Army Depot. TAC then received an Economic Development Administration (EDA) Grant for $150,000 in November 2016 to develop a Master Plan that involves property assessments and planning services outlined in the grant. This comprehensive planning strategy positions TAC to strategically redevelop selected portions of their 12,000 acres with targeted industries in mind.

In 2016, TAC partnered with a Colorado firm, McCarthy-Blansett Group (MBG) to complete the final phase of the Office of Economic Adjustment (OEA) grant, awarded to Workforce Solutions Northeast Texas, to conduct an analysis of the Greater Texarkana region. As the grant administrator, TAC worked with Workforce Solutions Northwest Texas to identify and reach out to regional leaders to help with the assessment. The results from this study identified an urgent need for the Texarkana region to move forward with establishing a regional economic development program. The three priority recommendations within the plan include:

1. Establish a new regional entity as the Greater Texarkana Corporation (GTC) under the Texarkana Chamber of Commerce;
2. Hold a vision to create a pre-determined, aggressive amount of primary jobs for the region in 10 years and place the Texarkana Metropolitan Statistical Area (MSA) back in the top half of MSAs nationally on the Policom index of economic strength; and,
3. Support regionalization on all fronts and levels through a collaborative professional network of municipal, county, and regional economic and workforce development professionals.

Following completion of the study, TAC received their HUB Zone designation in May 2017 during Economic Development Week by the International Economic Development Council (IEDC). Congressman John Ratcliffe also announced an important economic development initiative during Economic Development Week. He stated that having access to defense industry support tools for our local companies will only enhance the attractiveness of the Greater Texarkana area, especially should the White House administration be successful at growing the defense budget over the coming years.

In addition, the Foote Consulting Group (FCG) recently released their report, *Texarkana Region Workforce Target Analysis* and also announced that the Greater Texarkana region is attractive and ready for business growth. According to their analysis, the Greater Texarkana region displays overall strength in every criteria used by site selectors internationally to identify locations for new or expanding businesses. Such criteria include the following: Transportation/Logistics, Labor Costs, Labor Availability and Quality, Electric Power, Sites and Buildings, Incentives/Taxes, Quality of Life/Cost of Living, and Education/Training. The report states that the Greater Texarkana region is not only ready for business growth but competitive among similar benchmark locations.

Despite the limited supply of treated and raw water, TAC continues attracting new industry to the area. Jackson Melons, Inc., headquartered in Henderson, Texas, occupies warehouse space on the TAC East Campus, consisting of 22,500 square feet. 4X Industrial LLC, headquartered in Greeley, CO will occupy 1400 square foot of office space and 2 acres of hardstand on TAC East. TAC also has a new tenant on their Central Campus, El Dorado Glass and Mirror Co., Inc., with a lease for approximately 4,750 square feet. In 2017, Expal moved onto the TAC footprint. Expal is a manufacturer of products, systems, and services for the Defense and Security sectors. More recently, TAC announced an agreement with Lionchase Holdings, Inc. to build a 200,000-square foot cold storage facility on the TAC footprint.

3.4.2 Methodology and Example Model Entities

In order to determine TAC's future growth and water demands for the *2021 Region D Water Plan*, this report evaluates other industrial parks as potential models for comparison purposes to TAC. It is important to note that the methodology for industrial and commercial demands are typically developed on a case-by-case basis. Factors, similar to those of TAC, include the following:

- Land availability;
- Contiguous land availability;
- Shovel ready availability;
- Skilled laborers availability;
- Low-attainment issues and air quality availability;
- Transportation corridor availability;
- Interest of past and current industry;
- Any contracts in-place currently and for future needs;
- Previous industry located on the footprint;
- Similar projects in other areas within our own region and growth rates and water demand needs; and,
- Similar projects in other areas outside of this region and their growth rates and water demand needs.

Other community factors considered in the evaluation process include the following:

- High ranked schools;
- Community and four-year colleges;
- Trade schools;
- Family-oriented community; and,
- Care for young and elderly.

In developing the methodology, projections, and justification of future water needs for TAC in the Texarkana area, this plan identifies two existing industrial parks as example models to follow for planning purposes: MidAmerica Industrial Park and Chaffee Crossing.

3.4.2.1 MidAmerica Industrial Park (Pryor, Oklahoma)

Based on research and extensive discussion with Larry Williams (General Manager), MidAmerica Industrial Park serves as an excellent and conservative model to follow for projecting TAC's future growth and water demands due to the numerous similarities between the two entities (reference **Appendix E**).

MidAmerica Industrial Park was developed by the Department of Defense in World War II during 1940 to serve as an ammunitions facility. By 1978, the army depot downsized and left a footprint of 9,000 acres. At that time, the footprint of the park started with three industrial and commercial customers with a water demand of 30 MGD. Currently, MidAmerica Industrial Park is Oklahoma's largest industrial park. The park is located approximately 148 miles outside of Oklahoma City in Pryor Creek, Oklahoma. Today, MidAmerica Industrial Park has 80 companies on site, including operations of seven Fortune 500 companies.

As shown below in **Table 3-5**, this industrial park possesses numerous similarities comparable to the TAC footprint and serves as a direct model for the development of TAC, further supporting the numbers that are being projected for future water demands for TAC from 2020 through 2070.

Table 3-5: Similarities between TAC and MidAmerica Industrial Park

Comparison Factors	TexAmericas Center (TAC)	MidAmerica Industrial Park
Largest Industrial Park	Texas	Oklahoma
Size of Park (Acres) for Industrial Customers	12,000	9,000
Distance from Similar Size Metropolitan Area	Located approx. 145 miles from Little Rock (AR) along I-30 Corridor	Located approx. 148 miles from Oklahoma City (OK)
Origin of Development	Developed in early 1940s as a military ordnance depot; later served munitions produced & military vehicle maintenance	Developed by Dept. of Defense in 1940 to serve Ammunitions Facility
Beginning of Growth/WTP Expansion History	Riverbend WRD acquired wet utilities on May 1, 2016	1978 (20 to 30 MGD Exp.); 1983 (30 to 40 MGD Exp.) Early 1990s (40 to 50 MGD Exp.)
Number of Industrial Companies at Park	3	80 (Initially 3 in 1978)

3.4.2.2 Chaffee Crossing Industrial Park (Fort Smith, Arkansas)

Chaffee Crossing would be another conservative model for projecting TAC's future growth and water demands due to the numerous similarities between the two entities. Like portions of Red River Army Depot (RRAD) in 1995, the Base Realignment and Closure Commission (BRAC) recommended the closure of Fort Chaffee. Several ranges and training areas were kept as a sub-installation of Fort Sill. The federal government identified 7,192 of Fort Chaffee's 76,075 acres as surplus property and turned them over for redevelopment. The remaining acreage was given to the Arkansas National Guard. As a result, the Fort Chaffee Redevelopment Authority was established in September 1997 to redevelop approximately 7,000 acres for non-military use known as Chaffee Crossing. The City of Fort Smith is the primary utility provider for water and wastewater services to Chaffee Crossing.

Redevelopment of Chaffee Crossing started to occur with construction of the extension of Interstate 49. Since then, companies with large facilities, such as Rowe Sheet Metal, Walter Arms, Phoenix Metals, Mars Pet Care, Affinity Chemical, Graphic Packaging, and Glatfelter have relocated at Chaffee Crossing. In addition, the industrial and manufacturing growth has spurred residential growth in the Fort Smith area; 24 new subdivisions and neighborhood developments have been completed along with 2,300 additional housing units planned for construction. Chaffee Crossing now markets itself as the economic engine of western Arkansas and is viewed as a model across the U.S. regarding the redevelopment of closed military bases.

This industrial park also has numerous similarities to the TAC footprint and serves as a direct model for the development of TAC, if ample water supply is developed to the TAC footprint, as shown below in **Table 3-6**. The case study of Chaffee Crossing further supports the projected future water demands for TAC from 2020 through 2070.

Table 3-6: Similarities between TAC and Chaffee Crossing

Comparison Factors	TexAmericas Center (TAC)	Chaffee Crossing
Industrial Park Location	Texarkana, Texas	Fort Smith, Arkansas
Size of Park (Acres) for Industrial Customers	12,000	7,000
Origin of Development	Developed in early 1940s as a military ordnance depot; later served munitions produced & military vehicle maintenance	Developed in 1941 for military combat training; established as U.S. Army Training Center for Field Artillery in 1956
Beginning of Growth/ Water Demand History	Riverbend WRD acquired wet utilities on May 1, 2016	2005 (1.0 MGD); 2010 (21.5 MGD) 2017 (68.2 MGD)
Number of Industrial Companies at Park	3	9 (Initially 1 in 2005)

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Section 4.0
WATER SUPPLY ASSESSMENT

Riverbend Water Resources District's (Riverbend WRD) water demands directly correlate to both municipal and industrial demands within the service area. The viability of Wright Patman Lake as a reliable water resource for regional water user groups and other potential corporate or water users across Texas, cannot be overstated. For that reason, this study includes a characterization and assessment of the current water supplies from Millwood Lake and Wright Patman Lake with the following broad objectives:

- Build upon previous work conducted by Riverbend WRD and characterize the viability of Millwood Lake and Wright Patman Lake as reliable water resources to meet the projected water demands of the Member Entities;
- Characterize available supplies in terms of firm yield considering available USACE data, previous studies, and potential costs;
- Summarize the past and existing water supplies available from the two lakes as those supplies relate to requirements to provide continuous delivery of raw and potable water supplies;
- Address and identify potential future water supplies to meet the needs of the Riverbend WRD Entities; and,
- Identify and address actions necessary to secure those water supplies.

Information gathered from this effort positions Riverbend WRD to determine the best way to incorporate these supplies into regional plans for future improvements to the reliability and quantity of the Member Entities' water supply.

4.1 EXISTING WATER SUPPLY

Infrastructure and water supply go hand-in-hand when developing a regional water master plan. This section evaluates regional water supply alternatives and available water supplies from those alternatives. This section addresses the history and characteristics of meeting the existing water needs, as well as creates a path forward to fully utilizing existing contracts and permits.

The Lake Texarkana Water Supply Corporation (LTWSC) was created in 1966 as a cooperative effort between the City of Texarkana, Texas, and seven other surrounding municipalities (Annona, Avery, DeKalb, Hooks, Maud, New Boston, and Wake Village) for the development and maintenance of projects to provide the required water supply for municipal and industrial needs. Collectively, these eight are known as the "Original Member Cities" (reference **Table 4-1**). At some point in between these two dates, LTWSC became dormant. Through water supply contracts, the Original Member cities are guaranteed a maximum amount of treated water per year and each pay a minimum “at-cost” amount to ensure adequate funding for the operations of water supply facilities. The remaining municipalities, TAC and Riverbend WRD also have water supply contracts with the City of Texarkana but at a separate contract rate (reference **Table 4-2**). Currently, Member Entities make payments for water supplied through Texarkana Water Utilities (TWU) who operates and maintains the jointly-owned facilities. Additionally, TWU provides retail services to the City of Texarkana, TX, City of Texarkana, AR as well as a number of other large water users (reference **Table 4-3**).

The City of Texarkana, Texas, through its TWU department, operated and maintained the jointly-owned facilities. In 2009, Riverbend WRD was created as a conservation and reclamation district by the 81st Texas Legislature to conserve and develop water resources in order to control, store, preserve and distribute water to their Member Entities. Specifically, the authority includes, but is not limited to:

> *"acquire any and all storage rights and storage capacity in a reservoir or other water source inside or outside the boundaries of the district, and acquire the right to take water from that reservoir or source, subject to the rights or permits held by municipalities or other persons, and in accordance with any contract or contracts that the district may make with the United States, any state of the United States, or any political subdivision of any state of the United States, in reference to those rights;"* and,
>
> *"construct, acquire, own, finance, operate, maintain, sell, lease as lessor or lessee, dispose of, or otherwise use any work, plant, or other district facility as defined by Section 49.001, Water Code, inside or outside the boundaries of the district, that the board determines is necessary or useful for the exercise of a district power…"*
>
> -Special Districts Local Laws Code 9601.102(3)&(4)

Members Entities of Riverbend WRD include the Original Member Cities plus Atlanta, Leary, Nash, Redwater as well as TexAmercias Center and Bowie, Cass, and Red River counties. In 2011, Riverbend WRD was reconstituted to reduce the size of the Board of Directors to its current five-member board: two members appointed by the City of Texarkana; one member appointed by the City of New Boston; one member appointed by TAC; and one member appointed at-large by the remaining municipalities. All municipal member entities pay a rate of $0.045/1000 gallons in exchange for future water credits to support the administrative functions of Riverbend WRD as detailed in interlocal agreements.

Table 4-1: Original Member Cities

City of Annona
City of Avery
City of DeKalb
City of Hooks
City of Maud
City of New Boston
City of Wake Village

Table 4-2: Other Contract Water Customers

Macedonia Eylau WSC	Central Bowie WSC
City of Nash	Oak Grove WSC
City of Redwater	Red River County WSC
Day & Zimmerman, Inc.	Miller County WSC
Riverbend WRD	City of Leary

Table 4-3: City of Texarkana, TX Largest Regional Retail Water Users

City of Texarkana, AR	Bowie County Correctional Facility
Cooper Tire & Rubber Co.	The Ridge/The Pointe/Park Ridge Apartments
Federal Correctional Institute	Texarkana Independent School District
Wadley Hospital	Town North Apartments
Christus St. Michael Hospital	Arkansas Department of Community Corrections
Texas A&M – Texarkana	Graphic Packaging International*

Graphic Packaging International (formerly International Paper) is not classified as a retail water user by TWU; they are a large water user for manufacturing purposes. The City of Texarkana, Arkansas, is a separate and distinct entity from the City of Texarkana, Texas and is not currently a formal Member Entity of the Riverbend WRD; however, both municipalities are served by the same water supply and distribution system operated by TWU. The City of Texarkana, Texas, as a member of Riverbend WRD, includes accounts for the City of Texarkana, Texas System, the Texarkana, Arkansas Water Utilities System, and the Lake Texarkana Water Supply Corporation (precursor to Riverbend WRD). This system utilizes two primary sources of surface water supply: Wright Patman Lake and Millwood Lake. The location of these reservoirs in relation to the Riverbend WRD Member Entities is presented in **Figure 4-1**.

4.1.1 Wright Patman Lake

The Cities of Texarkana, Texas, and Texarkana, Arkansas, hold an original contract (dated May 28, 1953), with the U.S. Army Corps of Engineers (USACE) for the right to withdraw up to 13 mgd (equivalent to 14,562 ac-ft/yr) from Texarkana Reservoir (now Wright Patman Lake) (**Appendix F**-USACE Contract No. DA-16-047-eng-2033). Language in Article 1 of the contract states in part "…*This agreement…shall remain in full force and effect for a period of fifty years thereafter or until termination of the useful life of the Project, or as otherwise provided herein, whichever shall first occur*." Since this contract is more than 50 years old and it is not otherwise provided in the document for its continuation, Riverbend WRD is working with the USACE to determine whether it is still in effect.

Through an order of the Texas Commission on Environmental Quality (TCEQ) dated September 6, 1966, the City of Texarkana, Texas, is designated as the cooperating local sponsor for purposes of negotiating for the acquisition of rights to storage space in Wright Patman Lake (along with the TWDB). In 1968, the City of Texarkana, Texas, in cooperation and with the support of its neighboring cities, entered into two contracts with the USACE for the conversion of portions of the flood control pool for water supply storage and use from Wright Patman Lake. The first contract with the USACE in April 1968 (Contract No. DACW29-68-A-0103; reference **Appendix F**) provides for the reallocation of water storage for municipal and industrial use to the City of Texarkana, Texas, pending completion of Lake Jim Chapman (formerly Cooper Reservoir); the term is for the life of the reservoir.

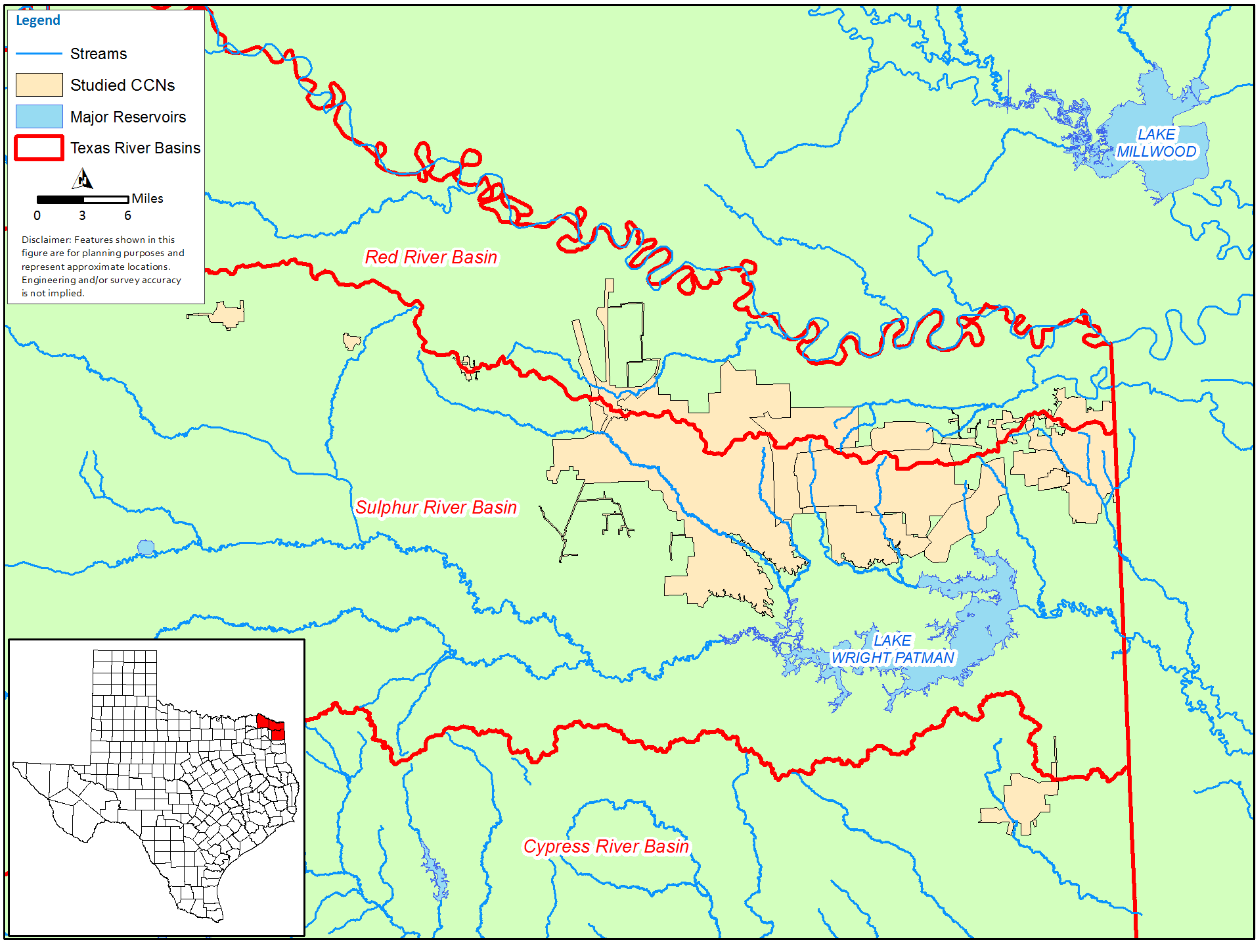

Figure 4-1: Wright Patman Lake and Millwood Lake in relation to RWRD Member Entities

The permanent contract establishes conservation storage for water supply at varying monthly elevations between 224.89-ft and 228.64-ft msl, with the bottom of the conservation pool set at 220-ft msl. This total operational rule curve, often referred to as the Ultimate Rule Curve, is discussed in more detail below. This contract also establishes a repayment schedule for the storage and becomes effective upon whichever is the later date between the completion date of Lake Jim Chapman for flood control or the completion date of all modifications to Wright Patman Lake required to affect the conversion of additional storage in Wright Patman Lake to municipal and industrial use. The contract also provides in Article 2 that the City of Texarkana, TX "shall have the right to utilize…from the effective date for water withdrawal, the total operating rule curve storage space as deemed necessary by the City to impound water in the Texarkana Reservoir [Wright Patman Lake] for its municipal and industrial water supply use, and make such diversions as granted to the City by the TCEQ, or its successors, to the extent such storage will provide." Ultimately, little or no modifications to Lake Jim Chapman, which was constructed in 1991, were made to further implement the Ultimate Rule Curve.

Today, the modifications and efforts required to fully implement this contract are quite extensive due to passage of National Environmental Policy Act (NEPA) and the 50-year execution delay. Beginning in 2015, Riverbend WRD and the City of Texarkana, Texas re-initiated efforts with the USACE, both with the Fort Worth District Office and the Dallas Southwest Division Office, to move forward with implementation of this contract. The NEPA studies associated with contract implementation; water storage fees required by the contract; funding agreements; Project Management Plans; Letter Report for contract implementation; and Legal Opinions associated with contract implementation are all items Riverbend WRD is working with the USACE in order to ensure a fair implementation of this contract. Plus, efforts are ongoing to ensure the USACE makes implementing this contract a high priority. Implementation of this contract is key to providing the required future water needs identified for this region.

During the interim period prior to the completion of Lake Jim Chapman, the City of Texarkana, Texas, entered into a second Interim Contract with USACE in September 1968 (Contract No. DACW29-69-C-0019). This contract is considered a surplus water contract. This second contract establishes an "Interim" operating rule curve for conservation storage between elevations 220.6-ft msl and 227.5-ft msl, with accordantly modified payments for the smaller conservation storage available under this Interim Rule Curve. This contract also states that “under certain exceptional conditions, provisions of the quantities of water described… [herein] may require that storage space in [Wright Patman Lake] below the normal minimum pool elevation of 220 feet above mean sea level be utilized" (reference contract in **Appendix F**). This interim contract remains in effect today, more than 50 years later, due to the fact that the permanent contract has not yet been implemented.

The City of Texarkana, Texas’ surface water right (reference **Appendix F**-Certificate of Adjudication 03-4836) in Wright Patman Lake permits 45,000 ac-ft/yr for municipal uses and 135,000 ac-ft/yr for industrial uses, for a total of 180,000 ac-ft on an annual basis. However, actual supply and water demands for Bowie, Red River and Cass Counties are impacted by contractual and infrastructure constraints on reservoir operations, as well as effects of sedimentation on the reservoir's storage and capacity.

In 1969, the City of Texarkana, Texas, executed water supply contracts (see example in **Appendix G**) and more recent water supply contract extensions (see example in **Appendix G**) for the provision of potable water to Member Entities. In 1971, the City of Texarkana, Texas, and International Paper Company (IP) entered into an agreement under which the City of Texarkana, Texas agreed to furnish raw water (120,000 ac-ft/yr) from Wright Patman Lake in connection with the IP paper mill facility. Recently, the International Paper (IP) Texarkana Mill was acquired by Graphic Packaging International (GPI). The City of Texarkana, Texas, further entered into a novation agreement with GPI to transfer all contracts with International Paper (reference **Appendix G**). GPI diverts raw water from an intake structure on the south side of the reservoir and delivers it to a treatment plant operated by GPI under contract with TWU.

Currently, GPI treats and delivers approximately 2 mgd of water for municipal use to the Cities of Atlanta and Domino; the City of Queen City previously received treated water from the GPI facility but the city relies on groundwater to meet their water needs and also has a connection for redundancy if needed. This connection for redundancy was recently utilized when lightning struck one of the groundwater well pumps, rendering it inoperable.

In July 2012, the City of Texarkana, Texas, entered into a contract with the TexAmericas Center (TAC) to transfer the TAC-East Water System (located on TAC property) to TWU. This included the transfer of any TAC customer accounts for those customers receiving water from the TAC-East System (excluding the U.S. Army/Red River Army Depot). Since that time, Riverbend WRD as acquired ownership of all we utilities on the TAC footprint; including all water for the RRAD (on May 1, 2016) and TAC-East water infrastructure (January 1, 2018); wastewater operations for the entire TAC footprint were acquired May 1, 2016. As previously mentioned in this report, the acquisition of the wet utilities from TAC was done in exchange for $10,000 and Riverbend WRD's contractual commitment to construct a new raw water intake/conveyance system and also to provide raw water to the TAC footprint by May 1, 2026. The timeline to provide this raw water is highly dependent upon Riverbend WRD's success in implementing the Ultimate Rule Curve under the Permanent Contract.

4.1.2 Millwood Lake

Initially, the City of Texarkana, Arkansas, holds contracts with the Southwest Arkansas Water District (SWAWD) reserving 50 mgd (~56,000 ac-ft/yr) from Millwood Lake as additional water supply. First on May 14, 1986, prior to the Millwood WTP coming online, the City of Texarkana, Arkansas, entered into an agreement with SWAWD to use 5 mgd (5,600 ac-ft/yr) of the 50 mgd reserved in Millwood Lake; then on July 2, 2012, the City of Texarkana, Arkansas, entered into a new contract with SWAWD to increase their amount an additional 10 mgd (11,200 ac-ft/yr). Finally, in 2016, the City of Texarkana, Arkansas entered into another agreement to use the remaining 35 mgd (of the 50 mgd originally reserved), bringing the total contracted use up to the full 50 mgd originally reserved. More recently, the City of Texarkana, Arkansas contracted for an additional 94.8 mgd (~106,200 ac-ft/yr) of water supply from Millwood Lake. Today, the current total contracted supply from SWAWD to the City of Texarkana, Arkansas is 144.8 mgd (~162,200 ac-ft/yr). SWAWD has indicated that an additional 50–60 mgd (56,000–67,200 ac-ft/yr) may be available from the Tri-Lakes Water District upstream of Millwood Lake.

Since 1994, the City of Texarkana, Arkansas, through TWU has operated the Mandeville and Union Water Utilities under terms of operating agreements with these entities. Both of these utilities provide water to mostly rural customers located east of the city limits of Texarkana, Arkansas. In the late 1990's, the City of Texarkana, Arkansas, annexed areas east of the city that encompassed significant portions of both utilities' service areas. The City of Texarkana, Arkansas obtained all the assets and liabilities of these utilities in 2004.

4.1.3 Wastewater Utilities

Although not presently used as a water supply, permitted discharges from the City of Texarkana's three primary wastewater treatment plants that serve the Texarkana metropolitan area are possible options but are presently an unlikely, limited source of supply. The design capacities of each of these WWTPs are presented in **Table 4-3** (Texarkana Comprehensive Plan, 2011).

Table 4-3: Texarkana Wastewater Treatment Plants

Name	Design Capacity (mgd)
South Regional Wastewater Treatment Plant	16.5
Wagner Creek Wastewater Treatment Plant	2.0 (potentially expandable to 3.0)
McKinney Bayou Wastewater Treatment Plant	1.0

4.2 REGIONAL STUDY WATER SUPPLIES

The primary source of water supply for all other Riverbend WRD Member Entities is Wright Patman Lake; however, supplemental supply is intermittently provided from Millwood Lake (reference Section 5.0 regarding the operation details from the infrastructure assessment).

As mentioned previously, the present efforts build upon previous work conducted by Riverbend WRD to characterize the viability of Millwood Lake and Wright Patman Lake as reliable water resources, specifically in terms of firm yield, past, and existing availability, and other considerations. This section discusses these available water supplies in the study area and how they could be utilized to meet the Riverbend WRD Member Entities' water needs.

4.2.1 Surface Water Source -- Wright Patman Lake

The Certificate of Adjudication (COA) 03-4836 authorizes the City of Texarkana, Texas, to impound water in Wright Patman Lake according to an identified impoundment schedule (see **Table 4-4** below) for diversion and use for municipal and industrial purposes (see **Appendix F**). The total authorized use permitted within COA 03-4836 is 180,000 ac-ft/yr, comprised of 45,000 ac-ft/yr for municipal use and 135,000 ac-ft/yr for industrial use. The permit further authorizes the interbasin transfer of the waters diverted above for 4,500 ac-ft/yr for municipal use and 4,500 ac-ft/yr for industrial use to the Cypress Creek Basin; 6,500 ac-ft/yr for municipal use and 5,000 ac-ft/yr for industrial use to the Red River Basin.

Three diversion locations are authorized in the permit at a maximum combined rate of 320 cfs (144,000 gpm). Priority dates of the diversions and types of use are presented below in **Table 4-5**. It should be noted that no minimum flow releases are specified for the maintenance of

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minimum flow in the Sulphur River below Texarkana Dam in COA 03-4836. There are no other permitted withdrawals from the Texarkana Dam to the state line.

Table 4-4: Maximum Impoundment Volume and Elevation Schedule for Wright Patman Lake (COA 03-4836)

Month	Maximum Impoundment and Elevation
January	(265,300 ac-ft) 224.9 ft
February	(265,300 ac-ft) 224.9 ft
March	(265,300 ac-ft) 224.9 ft
April	(325,300 ac-ft) 226.8 ft
May	(385,800 ac-ft) 228.6 ft
June	(385,800 ac-ft) 228.6 ft
July	(380,800 ac-ft) 228.5 ft
August	(355,700 ac-ft) 227.8 ft
September	(324,900 ac-ft) 226.8 ft
October	(302,000 ac-ft) 226.1 ft
November	(282,600 ac-ft) 225.5 ft
December	(273,600 ac-ft) 225.2 ft

Table 4-5: Priority Dates and Type of Use (COA 03-4836)

Priority Date	Description
March 5, 1951	14,572 ac-ft/yr (Municipal)
February 17, 1957	10,428 ac-ft/yr (Municipal) 35,000 ac-ft/yr (Industrial)
September 19, 1967	20,000 ac-ft/yr (Municipal) 100,000 ac-ft/yr (Industrial)
May 18, 1981	Interbasin transfers

Of particular importance to the consideration of water supply is the impoundment schedule identified in **Table 4-4**. This schedule derives from the "total operating rule curve," often referred to as the Ultimate Rule Curve established for Wright Patman Lake in the aforementioned April 1968 contract with the USACE (reference **Appendix F**, Contract No. DACW29-68-A-0103).

In 1969, International Paper Company (now Graphic Packaging International) received Permit CP-57 from the Texas Water Rights Commission authorizing the coated paperboard mill that was planned to be constructed in Cass County to divert and use 120,000 acre-feet of water per year from Lake Texarkana (now Wright Patman Lake); reference **Appendix I** for copies of the permit. When the mill was completed in 1971, IP (now GPI) contracted with the City of Texarkana, Texas to have the city provide the mill up to 84 MGD from Wright Patman Lake during the city's Interim Contract No. DACW29-69-C-0019 and then up to 105.4 MGD under the city's Permanent Contract No. DACW29-68-A-0103.

The congressional authorization for Wright Patman Lake provides for flood control through flood control storage space in the reservoir, which was constructed and has been operated and maintained by the USACE pursuant to the Flood Control Act of July 24, 1946 (Public Law 526, 79th Congress, 2nd Session). The contracts when fully implemented between the USACE and the City of Texarkana, Texas, make available a minimum of 120,000 ac-ft of water storage as defined by the Ultimate Rule Curve. The City of Texarkana's water right (on behalf of the surrounding municipalities) provides for a maximum diversion of 180,000 ac-ft/yr. However, the contract provides in Article 2 that the "City shall have the right…and make such diversions as granted to the City by the Texas Water Rights Commission, or its successors, to the extent such storage will provide." As a result, water in addition to the currently authorized 180,000 ac-ft/yr may be available under the Ultimate Rule Curve.

As noted previously, the two 1968 USACE contracts established two operating curves, an Interim Rule Curve and the Ultimate Rule Curve. Upon execution of the various contingencies and payments required per the Permanent Contract with USACE, the conservation storage available for water supply from Wright Patman Lake becomes that of the Ultimate Rule Curve. Currently, Region D water planning recites 294,000 acre-feet of available water supply under the Ultimate Rule Curve in 2020. Riverbend WRD is currently undergoing an update of the Water Availability Model for the Sulphur River Basin (last done in 1998) that will further determine the water supply availability in Wright Patman Lake under the Permanent Contract, as well as under various future reallocation levels.

4.2.1.1 <u>Storage Conditions</u>

While beyond the scope of the present effort, it is important to note that some studies in the Sulphur River Basin suggest reduced available storage in Wright Patman Lake due to sedimentation issues. Sedimentation and volumetric surveys performed by the TWDB identify an increasing rate of sedimentation; however, there exists significant uncertainty in the results of the surveys. Therefore, multiple regional entities and water providers have indicated support for the performance of a new sedimentation and volumetric survey of the reservoir. Riverbend WRD considers the completion of a new sedimentation and volumetric survey of utmost importance to ensuring that the most reliable data is available for decision makers, especially Region D and TWDB. Information concerning the volumetric and sedimentation study is forthcoming in a current ongoing study being conducted by Riverbend WRD.

4.2.1.2 Source Availability and Modeling

Various methodologies (and modeling approaches) for evaluating surface water availability have been used for decades by regulators, planners, and water users as a basis for decisions regarding water availability, permitting, and the future use of water for existing and new users. The application of such methods in Texas has evolved over time, and in 1997 with the passage of Senate Bill 1 by the 75th Texas Legislature, the state formally adopted the surface water modeling approach still in use today.

The principal tool used by the State of Texas for the determination of surface water availability is the official Water Availability Model (WAM). The Texas Commission on Environmental Quality (TCEQ) is the State's regulatory agency responsible for the permitting and regulation of surface water supplies in accordance with the Texas Water Code. The TCEQ administers water rights in Texas, issues new and amended water rights and certificates of adjudication, and cancels water rights. WAMs have been developed for each river basin in Texas for evaluating water availability, firm supply, and reliabilities for existing and proposed water projects throughout the state.

The Sulphur Basin WAM was developed in 1998. There are numerous studies in which the WAM, or variations thereof, has been employed to evaluate water availability in the Sulphur River Basin, particularly with regard to the firm yield of Wright Patman Lake.

The Full Authorization WAM (referred to as WAM Run 3) is the WAM model scenario most typically employed by TCEQ for evaluating surface water availability for permitting. Within this scenario, all water rights utilize their maximum authorized amounts, as-built reservoir area-capacity information, and no return flows (i.e., discharges). Run 3 is used by TCEQ to evaluate the availability of water for new or modified perpetual allocations.

Table 4-6 below presents the modeled firm yields for Wright Patman Lake from various identified studies compared to the currently permitted diversion amount of 180,000 ac-ft/yr from COA 03-4836.

Table 4-6: Modeled Firm Yields of Wright Patman Lake from Various Studies

Description	Firm Yield (ac-ft/yr)
03-4836 Current Permitted Diversion	180,000
WAM Run 3, Junior Permit up to Ultimate Rule Curve	464,300
2016 Region D Water Plan (Year 2020), Ultimate Rule Curve and flat distribution of sediment rate from construction to 2010	294,000
2016 Region D Water Plan (Year 2070), Ultimate Rule Curve and flat distribution of sediment rate from construction to 2010	123,000

The assumptions underlying the individual WAM play a significant role in the resultant calculations of firm yield. With the presently available Sulphur WAM Run 3, if a new junior permit is added for Wright Patman Lake (Under the Prior Appropriation Doctrine utilized in Texas, any new allocation would be junior in time to existing water rights in the basin), the calculated firm yield for Wright Patman Lake is approximately 464,000 ac-ft/yr.

This model scenario assumes the full, original constructed storage of the reservoir and does not take into account sedimentation effects, since it is the assumption of TCEQ for permitting purposes that a water rights holder with storage could elect to completely dredge and restore their permitted reservoir capacity at any point in time; however, dredging is a highly unlikely and not economically feasible scenario. This assumption is adequate for permitting but may affect the interpretation of the modeled results. In addition, the WAM is constructed to reflect only the water rights in the basin. This assumption may also affect the results for Wright Patman Lake, as the USACE's 10 cfs minimum flow releases at Texarkana Dam are not in the WAM, because those releases are not specified in the water right. This assumption also does not include minimum cfs releases to meet GPI’s requirement for the dam diversion point (reference **Appendix I**).

The current *TWDB 2016 Region D Water Plan* accommodates some of the above considerations as TWDB regulations require consistency with the WAM Run 3 assumptions; however, variations are allowed to accommodate verifiable changes where appropriate. For example, sedimentation rates were estimated using the original area/capacity of Wright Patman Lake to the surveyed capacities developed in the 2010 TWDB Volumetric Survey of Wright

Patman Lake and a simple straight-line assumption regarding the distribution of the sediment was adopted to reflect the order of magnitude of potential impacts of sedimentation to the area/capacity of the reservoir. With these assumptions, the resultant 2020 yield of the reservoir was reported to be 294,000 ac-ft/yr. Region D recently adopted a more complex formula developed by the USACE and Bureau of Reclamation to estimate sediment inflows and locations for use in Region D's portion of the *2020 State Water Plan*. Riverbend WRD is unsure how this newly adopted methodology will impact sedimentation rates if the same inaccurate data is utilized in process. Ultimately, accurate determinations of sediment inflow and resulting reservoir capacities is critical. A new sedimentation and volumetric study must be conducted to ensure that internal distribution in the reservoir is not being counted towards the sedimentation rate. Thereafter, the most reliable information would come from periodic, accurate volumetric and sediment surveys.

4.2.1.3 Source Availability and Demands

A high-level comparison of the permitted and contractual demands for the Riverbend WRD entities in relation to permitted supply from Wright Patman Lake is presented in **Table 4-7**. Inspection of the projected municipal uses indicates that the presently permitted municipal use is sufficient in magnitude to meet both 2020 and 2070 projected municipal demands.

Table 4-7: Comparison of Projected Industrial Demands to Permitted Water Supply

Category	Description	Detail	Volume (ac-ft/yr)	
			Municipal	Industrial
Water Right	Certificate of Adjudication 03-4836	Permitted Annual Diversion	45,000	135,000
Industrial	Graphic Packaging International	Contracted, 1979		120,000
		Maximum 5-yr Use (2010 - 2015)[1]		32,723
	TAC	Contracted 30 mgd, 2019		33,604
		Contracted 90 mgd, 2018		100,813
Municipal	All RWRD Member Entities	Projected 2020 (MDD)	21,649	
		Projected 2070 (MDD)	25,925	

[1] As reported through TWDB Surface Water Use Surveys.

Consideration of current industrial demands proves more complex, as contractually obligated usage must be considered as well. As noted previously, COA 03-4836 authorizes 135,000 ac-ft/yr of supply from Wright Patman Lake for industrial uses. The two major contracts for water supply for industrial uses are for Graphic Packaging International (120,000 ac-ft/yr) and TAC, which is initially contracted with Riverbend WRD for 33,604 ac-ft/yr (30 mgd) of raw water supply and up to 100,813 ac-ft/yr (90 mgd) by the next expansion of water supply infrastructure by Riverbend WRD. The total contracted demand solely considering these two industrial users thus ranges from 153,604 ac-ft/yr up to 220,813 ac-ft/yr by the first expansion per the Riverbend WRD/TAC contract (as amended). Both of these amounts exceed the presently authorized 135,000 ac-ft/yr for industrial use under the current TCEQ permit for withdrawals. However, consideration of the maximum reported use over the 2010 – 2015 period, using reported data from the TWDB surface water use surveys, suggests the maximum use for GPI has been approximately 33,000 ac-ft/yr from the lake pumps diversion point, as shown in **Table 4-7** above. If this amount is assumed and added to either the 30 and 90 mgd contractual amounts for TAC, the resultant demand ranges from 66,327 ac-ft/yr to 133,536 ac-ft/yr, both within the authorized 135,000 ac-ft/yr for industrial use in COA 03-4236.

In addition, water can be provided to the mill through both the lake and the dam diversion points up to 105.4 MGD. The lake diversion point delivers water to the mill to be treated for both production and drinking water use, not to exceed a total of 30.2 MGD. The dam diversion point delivers water directly into the Sulphur River, to enable the mill to discharge its treated wastewater lower down into the Sulphur River in accordance with the requirements of its state wastewater permit, up to 65.1 MGD. In 1976, the capacity of the mill was expanded; although the maximum quantity of 84 MGD/105.4 MGD was not changed, the total that could be delivered to the mill via the lake diversion point was increased up to 47 MGD.

For planning purposes, Riverbend WRD believes that use of the contracted amounts is necessary to ensure an adequate supply of water. Therefore, Riverbend WRD has collected resolutions in 2017 and 2018 from all of its Member Entities that support Riverbend WRD applying for future water rights that will become available once the Ultimate Rule Curve is implemented under the Permanent Contract.

4.2.1.4 Source Availability and Firm Yield

Finally, it is important to not only consider contractual and actual demands but to also consider the reliability and firm yield of the supply during critical water supply conditions, including drought. The aforementioned firm yields of Wright Patman Lake, as shown in **Table 4-7** above, provide the context for water supply availability in relation to the projected and contractual demands for the Riverbend WRD Member Entities and customers. The modeled firm yield of Wright Patman Lake using the WAM Run 3 scenario with the Ultimate Rule Curve and no sedimentation effects is 464,300 ac-ft/yr, sufficient in size to meet all future demands discussed above.

If sedimentation effects are considered, as represented by the high sedimentation rates reported by TWDB and used in the *TWDB 2016 Region D Water Plan*, a different picture emerges. Using those sedimentation assumptions, the firm yield for Wright Patman Lake remains sufficient under modeled 2020 sedimentation conditions; however, in 2070, the modeled sedimentation conditions decrease the firm yield significantly to 123,000 ac-ft/yr. This 2070 volumetric amount is less than the currently permitted amount (180,000 ac-ft/yr) and less than the total contractual and projected demands developed in this plan. While these WAMs were developed using simplified assumptions for regional planning purposes, their results do offer some insight regarding the future availability of supply.

In addition to sedimentation, firm yield in the Sulphur River Basin and Wright Patman Lake could also be affected by a potentially new drought of record in the 2000-2010 timeframe. However, the State of Texas has not investigated for a new drought of record at this time in the Sulphur River Basin. The potential identification of a new drought of record warrants significant consideration due to its potential impact on both existing and future water supplies in the basin.

As previously mentioned, Riverbend WRD is currently coordinating an update to the Sulphur River Basin WAM, providing an additional 20-years of data to the model. This effort will provide decision-makers with the best information available to know how much water is or would be available from Wright Patman Lake under differing circumstances, and data provided in the updated WAM will further confirm or disaffirm any new drought of record. This will enable the region to know how much water is reliably available under the Ultimate Rule Curve; as well as what additional water might be available from storage above the Ultimate Rule Curve. Additional options for analysis will be available for considerations once the model is updated.

4.2.1.5 Potential Invasive Species Considerations in Wright Patman Lake

Fish populations in Wright Patman Lake were surveyed in 2016, while vegetation surveys were conducted from 2013-2016 by the TPWD Inland Fisheries Division (TPWD 2017). According to a report, important sport fish include Blue and Channel Catfishes, Largemouth Bass, and Crappie, which are managed with statewide harvest regulations. The stocking of Florida Largemouth Bass in Wright Patman Lake has been performed to improve the quality of the fishery. Hydrilla, water hyacinth, and giant salvinia were discovered in the reservoir in 2000, 2005, and 2012, respectively. At present, giant salvinia has been eradicated, while water hyacinth and hydrilla are not presently posing management issues. Monitoring of aquatic plants is annually performed to monitor the spread or introduction of invasive aquatic plant species which could impact water supplies from the lake.

4.2.2 Surface Water Source – Millwood Lake

Millwood Dam is located on the Little River, 16 river miles upstream of its confluence with the Red River based on the USACE publication, *Millwood Lake Natural Resourc*es. In addition to flood control, Millwood Lake is used for water supply and recreation and to improve fish and wildlife. Construction of the dam commenced in 1961 and was completed for flood control in 1966. The City of Texarkana, Arkansas, has contracted water rights (162,200 ac-ft/yr) from the Southwest Arkansas Water District (SWAWD) from Millwood Lake.

4.2.2.1 Source Availability in Millwood Lake

Based on recent discussions with SWAWD, the total lake storage of Millwood Lake is approximately 1,858,000 ac-ft, with flood control storage of 1,644,000 ac-ft and a sediment pool volume of approximately 64,000 ac-ft. The *Institute for Water Resources 2014 Water Supply Database Report* indicates that the firm yield of Millwood Lake is 296,800 ac-ft/yr. CDM Smith (2014) reports excess surface water available for interbasin transfer or non-riparian use on an average annual basis from Millwood Lake to be 379,000 ac-ft/yr. Arkansas state law, however, prohibits the transfer of raw water across state lines.

4.2.2.2 Potential Invasive Species Considerations in Millwood Lake

The Arkansas Aquatic Nuisance Species Management Plan (2013) states that hydrilla is being spread in Millwood Lake by wind and wave action from the southeast corner of the lake (where it was introduced) to the northwest corner. Also, double-crested cormorants are birds that were designated by the Arkansas Game and Fish Commission (AGFC) as an invasive aquatic species in 2004. The 2013 Management Plan indicates that in 1999 a large cormorant rookery of over 100 active nests were found.

The USACE has further noted that several non-native invasive species have been introduced to Millwood Lake during the past fifteen years, including hydrilla and alligator weed. The USACE continues to research methods to manage such invasive plants.

4.2.3 Potential Water Supply Strategies for Consideration

This section contains a brief, high-level discussion on preliminarily identified regional water supply strategies for consideration by Riverbend WRD, its Member Entities, and regional stakeholders. A discussion on each alternative is presented in order to appropriately characterize the strategy. No quantitative analyses have been performed to characterize the amount of supply potentially available from each strategy, nor should priority be inferred or ascribed from the order of the presentation of these potential alternatives.

- **Implementation of Interim to Ultimate Rule Curve at Wright Patman Lake** - Presently, the upper elevation of the conservation pool (water supply storage) is established through a contractually defined Interim Rule Curve specified in the current interim water storage contract between Texarkana, Texas and USACE. This contract further envisions the establishment of a larger conservation pool, the Ultimate Rule Curve, which increases the amount of conservation storage available for water supply in Wright Patman Lake. The current surface water permit for Wright Patman Lake (COA

03-4836) utilizes this Ultimate Rule Curve in the establishment of permitted storage capacity for the City of Texarkana, Texas; however, Riverbend WRD believes that more water is available under the URC and plans to seek future water permits from the State of Texas for its use. Negotiating and paying the contractual fees to USACE; and conducting cultural and environmental studies and mitigation; and securing necessary federal and state permits are the primary steps required for achieving the additional supply made available from going from the Interim to the Ultimate Rule Curve.

- **Reallocation of Wright Patman Lake** - Reallocation of storage from flood control or sediment storage to water conservation storage at Wright Patman Lake has the potential to substantially increase the firm supply available from the reservoir. Reallocation of a portion of the flood storage is possible and could provide a substantial source of additional supply to first address in-basin needs and then possibly out-of-basin needs.

  With respect to federal considerations, USACE[1] defines reallocation as "the reassignment of the use of existing storage space in a reservoir project to a higher and better use."[2] The USACE provides water supply storage in multipurpose reservoirs under authority of the Water Supply Act of 1958. This Act affirms that water supply is primarily a non-federal responsibility and directs the federal government to cooperate and support local efforts. Section 301(d) states that the "Modifications of a reservoir project heretofore...planned or constructed to include storage as provided in subsection (b), which would seriously affect the purpose for which the project was authorized…or which would involve major structural or operational changes, will be made only upon the approval of Congress as now provided by law." Currently, reallocations of up to 15% of the total storage capacity allocated to all authorized project purposes, or 50,000 ac-ft (whichever is less) may fall within the discretion of the Chief of Engineers. As noted above, reallocations larger than this would require Congressional approval.

  In order for reallocation to occur at Wright Patman Lake, a Reallocation Study would need to be performed and a report submitted to the USACE. This study would need to address the amount to be reallocated; identify the purpose and need for the "new" water; specify users; address impacts on flood control (including evaluating downstream flood risks); and identity possible impacts to cultural and environmental resources. The study would also need to address dam safety concerns, determine storage prices, and identify potential appropriate compensation for existing users. Compliance with Section 404 and Section 401 of the Clean Water Act would also need to be demonstrated. Ultimately, a new, and/or additional water supply agreement would need to be executed with Riverbend WRD. Currently, there are reallocation efforts under way by the USACE and

[1] USACE guidance on policies about reallocation can be found in Engineer Regulation 1105-2-100.

[2] U.S. Army Corps of Engineers, Institute for Water Resources; Water Supply Handbook; IWR Report 96-PS-4, 1998; p. 4-1.

the Sulphur River Basin Authority on behalf of five metroplex entities (Dallas, Tarrant County Regional Water Authority, North Texas Municipal Water District, City of Irving, and Upper Trinity Regional Water District) and other interests to evaluate reauthorization of Wright Patman Lake water storage. Participation by Riverbend WRD in such efforts is an option to identify future water supplies to meeting in-basin needs.

With regard to state considerations, Riverbend WRD would seek a new permit for additional water supply. The new permit would reflect the additional diversion capability, diversion location, and storage capacity with a new junior priority date subject to possible environmental flow standards. An additional water-right permit would require a state analysis to determine the availability of unappropriated water.

- **Contract for Additional Millwood Lake Supply** - The current total contracted supply from SWAWD to the City of Texarkana, Arkansas, is 144.8 mgd (~162,200 ac-ft/yr) and is part of the TWU system. Depending upon the projected demands from Texarkana, Arkansas and its customers, there might be available supply to be contracted as an additional source to Riverbend WRD but only with approval from the State of Arkansas. This strategy could potentially be used in conjunction with other regional supply and infrastructure strategies to optimize the use of available supply to the Riverbend WRD. Significant consideration would need to be given to regulatory and legal challenges, given the transfer of water across state lines in such a strategy.

- **Contract for Additional Supply Upstream of Millwood Lake** - SWAWD has indicated that approximately 50–60 mgd (56,000–67,200 ac-ft/yr) may be available from supplies from the Tri-Lakes Water District upstream of Millwood Lake. Again, significant consideration would need to be given to regulatory and legal challenges, given the transfer of water across state lines envisioned in such a strategy.

- **Increase the GPI Intake and/or Treatment Capacity** - Given the location of the current GPI intake and its reported good functionality in terms of accessing the full conservation pool of Wright Patman Lake, this infrastructure strategy may also be considered as a water supply strategy, specifically in the context of potential demands south of Wright Patman Lake in Cass County. The provision of a raw water supply from Wright Patman Lake to meet these future Cass County manufacturing needs could prove to be a necessary strategy. This strategy would require consideration of projected demands in Cass County and would not address water supply needs for the rest of the region.

- **Indirect Reuse** - It is unlikely that direct reuse would be necessary, or cost effective, given the availability of surface water supplies in the region. However, several indirect reuse strategies to meet industrial or irrigation needs may merit consideration. Such strategies would need to be identified based on the location, use type, and magnitude of projected regional demands, along with consideration of the location, magnitude, and water quality characteristics of the region's wastewater utilities. This strategy is also very feasible when considered in conjunction with other strategies for water supply.

- **Sediment Reduction Best Management Practices** (adapted from *TWDB 2016 Region D Water Plan*) -- The firm yield of Wright Patman Lake decreases over time due to sedimentation in the reservoir, reducing the total volume of conservation capacity. Previous studies of the Sulphur River Basin have identified and discussed the benefit of establishing sediment reduction best management practices (BMPs) in the Sulphur River Basin. A potential water management strategy is to implement and construct such BMPs to significantly reduce the sedimentation load to Wright Patman Lake. BMP's include vegetative filter strips, conversion of crop land to pasture, construction of channel grade control structures to reduce the hydraulic grade line of the channel, and construction of riparian buffer strips along the stream channel.

  Concerns with this strategy include the effectiveness of the application of the BMP's and the assumed implementation of conversion of crop land to pasture. There exists substantial uncertainty in this approach, and as such, should be further evaluated in future regional and local planning efforts.

- **Dredge Wright Patman Lake** (adapted from the *TWDB 2016 Region D Water Plan*) – As described above, the firm yield of Wright Patman Lake decreases over time due to sedimentation in the reservoir; thus, reducing the total volume of conservation capacity. This strategy would dredge sediment from Wright Patman Lake to restore storage capacity within the reservoir lost due to sedimentation. This project utilizes a 24-in. dredge to remove an estimated 3,000 ac-ft per year of sediment from the reservoir for an operational period of 20 years. The project, as envisioned in the *2016 Region D Water Plan*, is estimated to yield a maximum of 18,000 ac-ft of additional firm supply by dredging a total of 60,000 ac-ft of sediment from Wright Patman Lake over a 20-year period.

  Concerns with this strategy include environmental; water quality; land disposition; transportation; overall effectiveness; and the significant cost associated with dredging. For the removal of sediment, dredging reservoirs particularly at the shallow headwaters and reservoir margins can destroy habitats and affect wetland birds, etc. If the water sustains flora or fauna of particular value, or if fish issues are important, then issues exist regarding lowering the water level. Dredging may also result in a temporary loss of reservoir water quality, through removal of organic material, although there may be long-term improvements in the reservoir water quality through removal of such organic material. Downstream water quality may also be temporarily impacted due to dredging. There may also be a loss of land for containment areas to drain/treat the sediment.

Regarding transportation, reservoirs are often in remote areas. The impact of additional transportation during dredging can place pressure on local communities (e.g., noise/air pollution and physical damage to roads), although these impacts may be reduced if the sediment can be effectively dewatered at or near the reservoir site using, for example, a hydrocyclone and/or a filter bed press. The viability of disposal to land depends on the level of contaminants, whereby there may be risks to groundwater supplies from contamination by leaching. There is also concern about the potential need to repeat the effort in the future due to the sedimentation issues in contributing watersheds. Lastly, the overall cost of dredging at this magnitude is considerably burdensome and almost prohibitive.

- **Utilization of Additional Dam/Reservoir Upstream** – A new dam/reservoir and/or techniques associated with “flood scalping” could provide additional water supply to the region. At this time, these options are not economically or politically feasible for the region due to a number of concerns, including but not limited to:

  Questions remaining about ownership and operation of a new water source; environmental imports; downstream imports; mitigation and sufficiency of available lands; stakeholder input/participation; local/state industrial and agricultural imports; availability and utilization of already committed land and readily available surface water supplies.

In conclusion, this plan envisions utilizing all available best resources to supply clean affordable water to the region’s citizens. Those options most feasible will be those which are cost-effective with the greatest potential for a life span over 50 years. This region is extremely rich with surface water supply but generally needs to focus on infrastructure that is reliable and redundant to meet its municipal and industrial demands.

Section 5.0
EXISTING WATER INFRASTRUCTURE ASSESSMENT

A number of factors can influence and impact what changes need to be implemented for public water systems, including new regulations and projected customer growth and water demands. Prior to making alternative recommendations, the Roth Team evaluated the existing water treatment plants (Millwood, New Boston Road and Graphic Packaging International) within the study area to perform a high-level condition assessment. In addition, the Roth Team identified state and federal regulatory/permitting requirements and emerging issues in a planning context with respect to each of the WTPs. This section of the report further describes the assessment and findings.

5.1 WATER QUALITY AND REGULATIONS

TWU serves the City of Texarkana, TX and the City of Texarkana, AR and other member cities of the Riverbend Water Resources District (Riverbend WRD), owning (or jointly owning with original Member Cities) and operating infrastructure using two primary water sources: Wright Patman Lake and Millwood Lake. To treat the source water into drinking water from Wright Patman Lake, two separate intakes, pump stations, and raw water conveyance systems are utilized. The largest contracted use comes from the TWU intake providing industrial and municipal water supply to the Graphic Packaging International (GPI) WTP for use at the GPI facility and contracted treated water to several local municipalities. The primary municipal supply comes from the TWU intake on Wright Patman Lake providing raw water supply to the New Boston Road WTP, which supplies treated water supplies on a wholesale basis to the Riverbend WRD Member Entities and other wholesale customers. This distribution system is comingled with the surface water supply from Millwood Lake, whereby raw water from Millwood Lake is treated at the TWU Millwood WTP then connected to the TWU distribution system. To treat the source water into drinking water, each of the facilities use conventional treatment

The U.S. Environmental Protection Agency (EPA) and the Texas Commission on Environmental Quality (TCEQ) enforce federal and state regulations to ensure that drinking water quality meets basic health standards after treatment. The Arkansas Department of Health (ADH) also enforces the State of Arkansas' regulatory requirements for production and distribution of drinking water. In addition to these standards, industry leaders establish best practices and voluntary standards to optimize the health, safety, and usefulness of municipal drinking water. This chapter details the quality of source water and finished water from the facilities and describes applicable industry regulations and standards.

5.1.1 Water Supply Characteristics

Raw water quality and treated water objectives determine the criteria used to select and design treatment processes. As indicated above, member city supplies are derived from two major surface water reservoirs: Wright Patman Lake and Millwood Lake. **Table 5-1** summarizes the source water quality for these reservoirs based on reported operating data and prior engineering studies.

Table 5-1: Summary of Raw Water Quality for Major Surface Water Reservoirs[1]

Parameters (units)	Wright Patman Lake Average (Range)	Millwood Lake Average (Range)
Turbidity (NTU)	12 (2 - 160)	10 (3 - 70)
Alkalinity (mg/L as $CaCO_3$)	67 (20 - 108)	20 (6-38)
TDS[1] (mg/L)	148 (--)	--
Temperature (deg F)	71 (42 - 97)	71 (44-89)
Hardness (mg/L as $CaCO_3$)	74 (45 - 104)	22 (13-60)
pH	7.5 (6.5 - 9.5)	6.7 (5.8 - 7.7)
TOC(2)(mg/L)	9.5 (5.0 - 13.0)	< Wright Patman(5)
SUVA(3)	-- (1.88- 2.98)	< Wright Patman(5)
Bromide(3) (mg/L)	-- (0.06- 0.10)	--
Iron(3) (mg/L)	-- (0.15 - 0.45)	--
Manganese(3) (mg/L)	0.12 (--)	--
MIB(4) (ng/L)	-- (10.8 - 100)	< Wright Patman(5)
Geosmin(4)(ng/L)	-- (3.9 - 3100)	< Wright Patman(5)
Chloride (mg/L)	21 (10-60)	13 (4-30)

Notes:
(1) Data compiled from previous engineering reports by HDR (2008) and CH2M (2012), plant operational data, and SWMORs.
(2) Data reproduced from CH2M Hill (2009) and CH2M Hill et. al. (2012).
(3) CH2M Hill et. al. (2012), pp. 31-32
(4) CH2M Hill et. al. (2012), pp. 28.
(5) CH2M Hill (2009), pp. 2.

Previous engineering reports indicate that Wright Patman Lake water is high in organics and is subject to seasonal taste and odor events from the algae related compounds methylisoborenol (MIB) and geosmin. Taste and odor issues were encountered as recently as January 2017 due to heavy rains that triggered the release of geosmin from the sediment on the bottom of the lake. The organic loading makes the water susceptible to disinfection-by-product (DBP) formation during chlorination; as a result, extended periods of free chlorine contact time should be avoided during treatment. Chloramines, instead of free chlorine, and TOC removal prior to disinfection reduce DBP formation potential. Specific UV Absorbance (SUVA) is often used as a surrogate for disinfection-by-product formation potential. SUVA levels above 2 indicate a high potential for DBP formation. A single Wright Patman Lake sample had a SUVA value of 2.98.

For Wright Patman Lake, the alkalinity was found to be moderate to low indicating a moderate level of buffering capacity against pH change in the water. Turbidity was found to be moderate for a lake source of supply. Dissolved solids were low. High levels of iron and manganese have also been observed.[1] Water quality for Lake Millwood, located in Arkansas, is reported to be different than Wright Patman Lake water with lower TOC and fewer taste and odor issues.[2]

The raw water quality that governs process performance is based on the surface water impoundments above. **Appendix H** provides more detailed information about raw water quality with historical and frequency distributions at Wright Patman Lake and Millwood Lake, and is referenced throughout the analyses within this report.

5.1.2 Water Treatment Regulations

The U.S. Environmental Protection Agency (EPA) has established multiple rules and regulations for treating drinking water. The State of Texas has adopted and codified these rules, along with several state-specific requirements in Title 30, Chapter 290 of the Texas Administrative Code (TAC). The TCEQ administers and enforces these rules. For the State of Arkansas, the Arkansas Department of Health (ADH) enforces the State of Arkansas' regulatory requirements for production and distribution of drinking water. Generally, TWU staff indicates that operations are designed to meet whichever regulations are more restrictive in those instances where both states' rules might apply.

Each of the Riverbend WRD Member Entities receives wholesale treated water from TWU and must meet the applicable requirements of these regulations. Regulations fall into one of two categories - primary or secondary. The primary regulations are enforceable at both the state and federal level. Although secondary regulations are voluntary standards at the federal level, the TCEQ secondary standards may be enforced at the state level, on a case-by-case basis. Relevant treatment regulations that apply to these member entities include:

- Safe Drinking Water Act (Primary Drinking Water Standards);
- Surface Water Treatment Rule (SWTR);
- Lead and Copper Rule;
- Total Coliform Rule (TCR);
- Stage 1 Disinfectants/Disinfection Byproducts Rule (Stage 1 D/DBPR);
- Stage 2 Disinfectants/Disinfection Byproducts Rule (Stage 2 D/DBPR);
- Interim Enhanced Surface Water Treatment Rule (IESWTR);
- Long-Term 1 Enhanced Surface Water Treatment Rule (LT1ESWTR);
- Long-Term 2 Enhanced Surface Water Treatment Rule (LT2ESWTR);

[1] CH2M Hill, et. al., (2012), pp. 30-31.
[2] CH2M (2009), pp. 2.

- Filter Backwash Rule;
- Arsenic Rule;
- Unregulated Contaminant Monitoring Rule (UCMR);
- Pharmaceutical and Personal Care Products (PPCPs);
- Secondary Drinking Water Regulations; and,
- Distribution System Rule.

5.1.3 Existing Primary Drinking Water Regulations

Primary standards are set for contaminants that when consumed can harm human health. These standards are enforced by the EPA and set a limit on the amount of each contaminant that can be present in the drinking water supplied by a public water system. This limit is called the maximum contaminant level (MCL). **Table 5-2** lists specific treatment requirements that apply to the Millwood, New Boston Road, and GPI WTPs with references to each rule.

Table 5-2: Primary Drinking Water Regulations

Contaminant	EPA MCLG (mg/L)	EPA MCL or TT (mg/L)	Regulation	Notes
Microorganisms				
Cryptosporidium	0	TT(1)	IESWTR	
Giardia lamblia	0	TT(1)	SWTR	
Heterotrophic plate count (HPC)	--	TT(1)	SWTR	
Legionella	0	TT(1)	SWTR	
Total Coliforms	0	< 5.0%	TCR	See Note 2
Turbidity	--	TT(1)	IESWTR	
Viruses (enteric)	0	TT(1)	SWTR	
Disinfection Byproducts				
Bromate	0	0.010	Stage 1 D/DBPR	
Chlorite	0.8	1.0	Stage 1 D/DBPR	
Total haloacetic acids	--	0.060	Stage 1 D/DBPR	RAA(3)
Total trihalomethanes	--	0.080	Stage 1 D/DBPR	RAA(3)

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Disinfectants	MRDLG (mg/L)	MRDL (mg/L)		
Chloramines (as Cl_2)	4	4.0	Stage 1 D/DBPR	
Chlorine (as Cl_2)	4	4.0	Stage 1 D/DBPR	
Chlorine dioxide (as Cl_2)	0.8	0.8	Stage 1 D/DBPR	
Organic Contaminants	--	--	SDWA	See Note 5
Inorganic Chemicals	--	--	SDWA	See Note 5
Filter Backwash Recycle		TT	Filter Backwash Recycle Rule	See Note 6

Notes:

(1) EPA SWTRs require systems using surface water to:
 a. Disinfect their water.
 b. Filter their water or meet criteria for avoiding filtration to control these contaminants at the identified levels:
 Cryptosporidium: 2-log removal.
 Giardia lamblia: 3-log removal.
 Viruses*:* 4-log removal.
 Legionella: No limit, but EPA believes that if *Giardia* and viruses are removed/inactivated, *Legionella* will also be controlled.
 Turbidity: ≤ 0.3 NTU 95 percent of the time, never to exceed 1 NTU.
 HPC*:* No more than 500 bacterial colonies/mL.

(2) For TCR, Texas regulations further require maintaining a disinfectant residual of 0.2 mg/L free chlorine or 0.5 mg/L chloramines at all times throughout the distribution system.

(3) Levels based on running annual average (RAA) of four quarterly sample events.

(4) MLCG = Maximum Contaminant Level Goal
 MCL = Maximum Contaminant Level
 TT = Treatment Technique
 SWTR = Surface Water Treatment Rule
 IESWTR = Interim Enhanced Surface Water Treatment Rule
 TCR = Total Coliform Rule
 D/DBPR = Disinfectants/Disinfection Byproducts Rule
 SDWA = Safe Drinking Water Act and Amendments

(5) Full list of constituents not included. Full list of all regulated constituents available from EPA.

(6) Includes self-assessment, monitoring, recycle returned to the head of the plant.

Lead and Copper Rule

Lead and copper enter drinking water primarily through plumbing materials. Exposure to lead and copper may cause health problems ranging from stomach distress to brain damage. In 1991, EPA published a primary drinking water regulation to control lead and copper in drinking water. The treatment technique for the rule requires water systems to monitor drinking water at customer taps. If measured lead concentrations exceed an action level of 15 ppb or measured copper concentrations exceed an action level of 1.3 ppm in more than 10% of customer taps sampled, the water system must undertake additional actions to control corrosion. If the action level for lead is exceeded, the water system must also inform the public about steps they should take to protect their health and may have to replace lead service lines. The Lead and Copper Rule (LCR) applies only to water utilities while the Reduction of Lead in Drinking Water Act sets standards for pipe, plumbing fittings, fixtures, solder and flux. In accordance with the LCR and with a service population exceeding 100,000 individuals, the Riverbend WRD Member Entities are required to sample for lead and copper at customer taps in their respective distribution systems. Depending on whether consecutive prior sampling events have shown lead and copper concentrations below the action level, the Riverbend WRD Member Entities may be required to collect as many as 100 samples every 6 months or as few as 10 samples every 3 years.

Current and Revised Total Coliform Rule (TCR)

The TCR, as well as the Revised Total Coliform Rule (RTRC), requires a PWS to collect samples to test for coliform bacteria at sites representative of a distribution system's water quality. This rule aims to reduce potential pathways of entry for fecal contamination in distribution systems to protect public health.

Per the rule, a PWS must develop a written sampling site plan that identifies the system's sample collection schedule and sampling sites, including sites for routine and repeat monitoring. Compliance is based on the presence or absence of total coliforms and is determined each month.

The rule assigns violations that lead to one of two levels of assessments. If more than five percent of the routine/repeat samples in a month are total coliform-positive (TC+), a monthly MCL violation is triggered, which leads to a Level 1 assessment. A Level 1 assessment is also triggered if a PWS fails to take every required repeat sample after a single TC+ sample.

If sampling indicates coliform contamination, meaning there's an occurrence of a total coliform sample or the presence of *E. coli*, a PWS must assess the problem and take corrective action. Repeat samples are required if a routine sample is TC+. This violation triggers a Level 2 assessment. A Level 2 assessment could also be triggered if a PWS has a second Level 1 assessment in a rolling 12-month period.

Disinfection Byproduct Precursor Removal

The Stage 1 D/DBPR requires that the total organic carbon (TOC) reductions listed in **Table 5-3** be achieved by enhanced coagulation or softening unless certain raw water or finished water quality criteria are met. Conventional treatment plants are required to monitor TOC concentrations by taking one "paired sample" per month, which involves measuring the TOC in a treated water sample and a source water sample before treatment. One source water alkalinity sample per month is also taken at the same time and location as the source water TOC sample.

Compliance with the TOC requirement is calculated by running the annual average computed quarterly. If the average annual treated water TOC is <2.0 mg/L for two consecutive years or is <1.0 mg/L for one year, monitoring can be reduced to once per quarter.

Table 5-3: Stage 1 D/DBPR TOC Removal Requirements

Raw Water TOC (mg/L)	TOC Reduction Requirements (%) for Given Raw Water Alkalinity <60 mg/L	60 – 120 mg/L	>120 mg/L
>2 to 4	35	25	15
>4 to 8	45	35	25
>8	50	40	30

Based on the available raw water quality data, a minimum of 35 percent and a maximum of 50 percent TOC must be removed, depending on raw water TOC and alkalinity at the time. Seasonal variations in raw water quality will dictate how much TOC removal is required.

The IESWTR also provides alternative compliance criteria independent of the Step 2 enhanced coagulation procedure and the enhanced softening alternative performance criteria. The alternative compliance criteria can be used if any of the following conditions are met:

- Source water TOC <2.0 mg/L based on monthly monitoring calculated quarterly as a running annual average of all measurements.
- Finished water TOC <2.0 mg/L based on monthly monitoring calculated quarterly as a running annual average of all measurements.
- Source water TOC <4.0 mg/L; source water alkalinity >60 mg/L as $CaCO_3$; TTHM <0.040 mg/L; HAA5 <0.030 mg/L based on monthly monitoring for TOC and alkalinity or quarterly monitoring for TTHMs and HAA5, calculated quarterly as a running annual average of all measurements.
- TTHM <0.040 mg/L; HAA5 <0.030 mg/L based on monitoring for TTHMs and HAA5, calculated quarterly as a running annual average of all measurements; the system uses chlorine for primary disinfection and maintenance of a residual in the distribution system.
- Source water specific ultraviolet absorption (SUVA) <2.0 L/mg-m based on monthly monitoring calculated quarterly as a running annual average of all measurements.
- Finished water SUVA <2.0 L/mg-m (measured before disinfection) based on monthly monitoring calculated quarterly as a running annual average of all measurements.

After a one-year monitoring period, systems that do not satisfy the TOC removal requirements or the alternative compliance criteria must conduct jar testing (Step 2 enhanced coagulation protocol) to determine alternative compliance criteria for TOC removal. Under the Step 2 enhanced coagulation protocol, the alternative enhanced coagulation compliance criteria for TOC removal are defined either as:

1. The dose of coagulant that achieves the percent removal dictated by the TOC removal matrix; or

2. The percent TOC removal occurring at the point of diminishing return (PODR) for the coagulant. The PODR is defined as the point on the TOC removal-vs.-coagulant addition plot where the slope changes from greater than 0.3/10 to less than 0.3/10 and stays at less than 0.3/10 until the target pH is reached.

Filter Performance

The IESWTR strengthened combined filter effluent (CFE) turbidity performance standards and individual filter turbidity provisions. For CFE, measured every 4 hours, turbidity limits were lowered to the following:

- Average turbidity less than 0.3 NTU in 95 percent of samples.
- Maximum allowable turbidity of 1.0 NTU.

Individual filter effluents must be monitored for process control every 15 minutes. Reporting to the state may be required under the following criteria:

- Any filter with an effluent turbidity greater than 1.0 NTU based on two consecutive measurements taken 15 minutes apart.
- Any filter with an effluent turbidity greater than 0.5 NTU 4 hours after the individual filter is returned to service after backwash or shutdown based on two measurements taken 15 minutes apart.
- Any filter with an effluent turbidity greater than 1.0 NTU, based on two measurements taken 15 minutes apart any time in three consecutive months, requires self-assessment in conformance with EPA published guidelines.
- Any filter with an effluent turbidity greater than 2.0 NTU, based on two consecutive measurements taken 15 minutes apart in each of two consecutive months, requires Comprehensive Performance Evaluation (CPE) in conformance with US EPA published guidelines.

Long-Term 2 Enhanced Surface Water Treatment Rule

This rule applies to all public water systems that use surface water. As a supplement to previous surface water treatment rules, it targets systems at greater risk from the protozoan *Cryptosporidium*. Its goals are to improve the control of microbial pathogens in drinking water, particularly *Cryptosporidium*, and to address the risk trade-offs with DBP formation.

Filtered systems serving a population of 10,000 or greater, including the three WTPs considered herein, are required to conduct monthly sampling of *Cryptosporidium*, *E. coli*, and turbidity for 24 months at each raw water intake. Based on the monitoring results, filtered systems are classified into one of four possible risk categories called "bins."

As **Table 5-4** shows, a filtered system's bin classification determines the extent of additional *Cryptosporidium* treatment requirements beyond current regulations. The EPA expects that most filtered systems will be classified in Bin 1, meaning they do not require additional treatment. Conversely, systems that comply with the IESWTR but are classified in Bins 2, 3, or 4 will be required to provide between 1.0- and 2.5-log of additional *Cryptosporidium* removal.

The additional treatment requirements for Bins 2, 3, and 4 are based, in part, on the assumption that conventional treatment plants that comply with the IESWTR achieve an average of 3-log removal of *Cryptosporidium*. Therefore, the total *Cryptosporidium* removal requirements for action bins with 1-, 2-, and 2.5-log additional treatment correspond to total *Cryptosporidium* removals of 4-, 5-, and 5.5-log, respectively. Additional *Cryptosporidium* treatment requirements can be achieved with one or more treatment or control steps from several options.

Table 5-4: Bin Classifications and Additional Treatment Requirements for Filtered Systems Under LT2ESWTR

Bin Classification	Average *Cryptosporidium* Concentration (oocysts/L)	Additional Treatment Requirements(1) Conventional Filtration Treatment	Additional Treatment Requirements(1) Direct Filtration(2)
1	< 0.075	No additional treatment	No additional treatment
2	≥ 0.075 - < 1.0	1-log removal(3)	1.5-log removal(3)
3	≥ 1.0 - < 3.0	2-log removal(4)	2.5-log removal(4)
4	≥ 3.0	2.5-log removal(4)	3.0-log removal(4)

Notes:
(1) Additional treatment assumes full compliance with SWTR, IESWTR, and LT1ESWTR (as applicable). Conventional treatment, including lime softening, and direct filtration treatment in compliance with these rules will receive 3.0- and 2.5-log *Cryptosporidium* removal, respectively, before the additional treatment required by LT2ESWTR.
(2) Direct filtration systems use coagulation, flocculation, and filtration processes similar to a conventional filtration treatment, but lack a sedimentation or equivalent clarification process.
(3) Any individual or combination of technologies from the microbial toolbox may be used to achieve this treatment.
(4) At least 1-log removal must be achieved using ozone, chlorine dioxide, UV, membranes, bag filters, cartridge filters, or bank filtration.

New Boston Road and GPI WTPs, which draw water from Wright Patman Lake, are in Bin Classification 1.[3]

Stage 2 Disinfectants and Disinfection Byproduct Rule

The EPA established the Stage 2 D/DBPR on January 4, 2006, at the same time as the LT2ESWTR to address risks from microbial pathogens and DBPs. The Stage 2 D/DBPR applies to water systems that add or deliver water treated with a primary or residual disinfectant other

[3] CH2M Hill, et. al., (2012), pp.30, states that monitoring of Wright Patman water under the LT2ESTWR has shown low concentrations of Cryptosporidium and has been placed in Bin Classification 1.

than ultraviolet light. Its key provisions consist of an Initial Distribution System Evaluation (IDSE) and a change in compliance calculation to a locational running annual average.

Initial Distribution System Evaluation (IDSE) and Compliance Monitoring

The IDSE is the first step in Stage 2 D/DBPR compliance. Its purpose is to identify sampling locations for Stage 2 D/DBPR compliance monitoring representing distribution system sites with high THM and HAA levels. Once the IDSE is completed, treatment must be installed within two years.

For cities with populations between 50,000 and 99,999, compliance monitoring began on October 1, 2012, with up to a two-year delay for capital improvements. After compliance monitoring is complete, the Stage 2 D/DBPR requires the Public Water System (PWS) to calculate operational evaluation levels (OEL) after every quarterly sample. The OEL is meant to prevent Maximum Contaminant Levels (MCL) violations by providing an early warning of possible future violations. If the OEL exceeds the MCL, the PWS must report to the administering agency detailing changes it will make to avoid an MCL violation.

Locational Running Annual Average

The MCLs for total trihalomethanes (TTHMs) and the five regulated haloacetic acids (HAA5) remain unchanged from the Stage 1 D/DBPR at 80 and 60 µg/L, respectively. However, instead of system-wide running annual averages (RAAs), site-specific locational running annual averages (LRAAs) will be used to calculate compliance data. LRAAs are intended to strengthen public health protection by preventing customers from consistently receiving elevated levels of DBPs.

The MCLs for bromate and chlorite also remain unchanged at 10 µg/L, as RAAs, and 1.0 mg/Lm, as a monthly average. The MRDLs for free chlorine, chloramines, and chlorine dioxide are also unchanged: 4.0 mg/L for free chlorine and chloramines as annual averages and 0.8 mg/L for chlorine dioxide as daily samples.

Unregulated Contaminant Monitoring Rules

The EPA uses the Contaminant Candidate List (CCL) to prioritize research and data collection efforts for future regulations. The most recent version of the CCL was published in November 2016.

The listed contaminants are currently unregulated but are either known to occur or are anticipated to occur in public water systems. The current list includes 97 chemicals or chemical groups and 12 microbiological contaminants. The list includes, among others, chemicals used in commerce, pesticides, biological toxins, disinfection byproducts, pharmaceuticals and waterborne pathogens.

To develop the list, the EPA employed a new classification process based on National Drinking Water Advisory Council (NDWAC) recommendations. The process began by identifying 7,500 potential chemical and microbial contaminants. The preliminary CCL (PCCL) was then developed by narrowing the 7,500 contaminants to 560 potential contaminants based on their potential to occur in public water systems and to become a public health concern. Next, the PCCL was pared down to a final list the EPA can use to prioritize research and data collection efforts and to determine whether it needs to regulate specific contaminants.

The primary source of occurrence data used to identify emerging contaminants is collected via the Unregulated Contaminant Monitoring Rule (UCMR). The data support regulatory decisions for the contaminants. In 1999, the EPA identified and published unregulated contaminants for the first direct implementation of UCMR (UCMR 1), requiring some PWSs to monitor unregulated contaminants between 2001 and 2005.

The second implementation of this rule (UCMR 2) required some PWSs to monitor additional unregulated contaminants for a 12-month period between 2008 and 2010. UCMR 3 required sampling between 2013 and 2015 for two viruses and 28 unregulated chemical contaminants. The most recent update (UCMR 4) will require monitoring for 30 chemicals between 2018 and 2020.

5.1.4 Proposed Future Drinking Water Regulations

The EPA continuously reviews water quality vulnerabilities to ensure that public drinking water protects human health. To achieve this goal, the EPA has identified concerns and possible regulations associated with pharmaceuticals and personal care products (PPCPs), emerging disinfection by-products (DBPs), perchlorate, and fluoride.

Pharmaceutical and Personal Care Products

For over 20 years, certain physiologically active compounds, such as caffeine, aspirin, and sex steroids, have been known to enter the environment through a variety of routes, primarily treated and untreated sewage effluents. Although these compounds and pharmaceutical and PPCPs in the environment have been researched since the 1990s, the exposure risk to humans and wildlife is not yet defined. Some view antibiotics and natural/synthetic steroids to the environment as pollutants. Many other drug classes, bioactive metabolites, and transformation products, as well as personal care products, have yet to be examined.

The EPA is studying the effects of PPCPs and has not proposed any regulations. However, as more information emerges over the next five to ten years, it might regulate these products. Research suggests that advanced oxidation processes, such as ultraviolet irradiation with peroxide (UV/H_2O_2), effectively remove many PPCPs.

Emerging Disinfection Byproducts

Over the last decade, more research has been done on DBPs and HAA5 and TTHMs associated with chloramine disinfection. For example, both iodo-substituted HAA5 and TTHMs, as well as *N*-nitrosodimethylamine (NDMA), were shown to form under certain conditions when drinking water is disinfected with chloramines.

The EPA and other researchers are studying the formation pathways and toxicity of emerging DBPs. Although no regulations have been proposed, the EPA might regulate some of these emerging DBPs as more information emerges. Recent research indicates that the formation of some of these compounds may be limited by using a period of free chlorination or ozonation before forming chloramines.

Perchlorate

Perchlorate is both a naturally occurring and manmade chemical used to manufacture fireworks, explosives, flares, and rocket propellant. The EPA has decided to regulate perchlorate under the SDWA and has initiated the process of proposing a national drinking water regulation. The EPA has established an Interim Lifetime Drinking Water Health Advisory of 15 µg/L, which is a concentration of perchlorate in drinking water that is not expected to cause any adverse effects over a lifetime of exposure.

Fluoride

In January 2011, the U.S. Department of Health and Human Services (HHS) and the EPA released the results of new scientific assessments on community water fluoridation. Based on these assessments, the HHS proposed changing the recommended level of fluoride in drinking water to the lower end of the current optimal range of 0.7 to 1.2 mg/L.

In response, the EPA announced a review of the maximum level of fluoride allowed in drinking water. Alum coagulation may be optimized to achieve partial removal and reduction of fluoride. Other treatment technologies, such as reverse osmosis (RO), activated alumina adsorption, ion exchange, and optimized softening, can also effectively remove fluoride.

5.1.5 Secondary Drinking Water Regulations

Secondary Drinking Water Regulations, referred to as "secondary standards," are non-enforceable at the federal level while states may set their own enforceable secondary standards, which is the case with TCEQ. Secondary guidelines regulate contaminants that may cause cosmetic or aesthetic effects such as taste, odor, or color in drinking water. The TCEQ has adopted most of these standards according to the EPA (as shown in **Table 5-5**, which summarizes EPA secondary standards and alternative TCEQ secondary standards listed in parenthesis for reference). However, the TCEQ considers them regulatory guidelines and requests that any system failing to meet these requirements contact them. The Arkansas Department of Health (ADH) adopts and enforces the EPA standards per federal guidelines.

Table 5-5: Secondary Drinking Water Regulations[1]

Contaminant	Secondary Standard
Aluminum	0.05 to 0.2 mg/L
Chloride	250 mg/L (300 mg/L TCEQ)
Color	15 (color units)
Copper	1.0 mg/L
Corrosivity	Non-corrosive
Fluoride	2.0 mg/L
Foaming Agents	0.5 mg/L
Iron	0.3 mg/L
Manganese	0.05 mg/L
Odor	3 Threshold Odor Number
pH	6.5-8.5 (> 7 TCEQ)
Silver	0.10 mg/L
Sulfate	250 mg/L (300 mg/L TCEQ)
Total Dissolved Solids	500 mg/L (1000 mg/L TCEQ)
Zinc	5 mg/L
Hydrogen Sulfide	(0.05 mg/L TCEQ)

Note:
(1) Compiled from EPA and TCEQ secondary standards. ADH adopts and enforces the EPA standards per federal guidelines.

In addition to the EPA and TCEQ, the Partnership for Safe Water and other agencies establish treatment goals as voluntary standards. One of the goals is to achieve a combined filter turbidity of less than 0.1 NTU 95 percent of the time. AWWA establishes a treated water hardness goal of 80-100 mg/L as $CaCO_3$.

5.2 WATER QUALITY SUMMARY

In a previous engineering study[4] prepared for Riverbend WRD, finished water quality goals identified treatment benchmarks so that treatment technology options could be evaluated and compared to each other for the initial planning and design stages. The goals represent water quality parameters of particular interest to the Riverbend WRD Member Entities based on

[4] CH2M Hill, et. al., (2012), pp. 26.

customer preference, health and safety, raw water quality limitations, and industry best practices. These goals are summarized below in **Table 5-6**.

Table 5-6: Finished Water Quality Goals[1]

Contaminant	Internal Standard
Turbidity	< 0.15 NTU 95% of the time
TTHMs	< 60 µg/L
HAA5	< 45 µg/L
TOC	35-50 % removal
Color	< 10 color units
MIB	< 10 ng/L
Geosmin	< 10 ng/L

Note:
(1) Reproduced from CH2M HILL, et. al., (2012), pp. 26.

The goals listed in the report meet or exceed the requirements of federal and both states (TX and AR) primary standards and are consistent with standard industry practice.

5.2.1 New Boston Road WTP

For the New Boston Road WTP, finished water quality data reported in available SWMORs and internal TWU records for recorded parameters are summarized and compared to treatment regulations and industry standards. **Table 5-7** below summarizes finished water quality at the New Boston Road WTP.

Table 5-7: Treated Water Quality at the New Boston Road WTP(1)

Parameter	Units	Ave	Goal/Std	Range	Percentiles 5th	50th	95th
Turbidity	NTU	0.13	0.3(2)	0.08 - 0.37	0.09	0.12	0.18
pH	--	8.2	>7	7.4 - 8.9	7.9	8.2	8.5
Temperature	deg F	72	--	50 - 98	53	72	93
Hardness	mg/L as $CaCO_3$	103	150	50 -163	57	101	156
Alkalinity	mg/L as $CaCO_3$	67	--	36 - 100	45	68	87
Chloride	mg/L	21	<250	10 - 60	13	20	30
TTHM	µg/L	--	<80(3)	--	--	--	--
HAA5	µg/L	--	<60(3)	--	--	--	--
Iron	mg/L	--	< 0.3(4)	--	--	--	--
Manganese	mg/L	--	< 0.05(5)	--	--	--	--
Color	color units	--	< 15(6)	--	--	--	--

Note:
(1) Based on operating reports from the New Boston Road WTP Jan 1999- Jun 2016.
(2) TCEQ primary standard is <0.3 NTU 95% of the time. Partnership for Safe Water establishes a voluntary standard of <0.1 NTU 95% of the time.
(3) Per the CH2M Hill, et. al., (2012), pp.2, the New Boston road WTP does not produce water that reliably meets the Disinfection-by-Product Rule, exceeding the MCL for TTHM and HAA5.
(4) TCEQ and EPA secondary standard is <0.3 mg/L to mitigate the risk of rusty color, sediment, metallic taste, and red orange staining. CH2M Hill, et. al., (2012), pp. 30 states that typical water quality issues experienced at the New Boston Road WTP include seasonal iron episodes.
(5) TCEQ and EPA secondary standard is <0.05 mg/L to mitigate risk of black to brown color, black staining and bitter metallic taste. CH2M Hill, et. al., (2012), pp. 30 states that typical water quality issues experienced at the New Boston Road WTP include seasonal manganese episodes.
(6) TCEQ and EPA secondary standard is < 15 color units. CH2M Hill, et. al., (2012), pp. 30 states that typical water quality issues experienced at the New Boston Road WTP include high color levels.

Previous engineering reports have stated that typical water quality issues at the existing New Boston Road WTP include high disinfection-by-product formation, taste and odor issues, seasonal iron and manganese episodes, high color levels, and difficulty in maintaining a chloramine residual.[5] High DBPs are likely the result of extended free chlorine contact time with high raw water TOC.

Turbidity

Turbidity measures the light-scattering or light-absorbing properties of water. In drinking water supplies, turbidity is commonly caused by suspended matter such as clays, silts, finely divided

[5] CH2M Hill, et. al., (2012), pp.30.

organic and inorganic matter, plankton, and other microorganisms; turbidity is an indicator of drinking water quality and of the effectiveness of its coagulation and filtration processes. Because pathogens may be embedded in suspended particles, which limit their contact with disinfectants, turbidity removal is an important part of ensuring adequate disinfection. **Figure 5-1** summarizes the historical finished water turbidity at the New Boston Road WTP from 1999 to 2016.

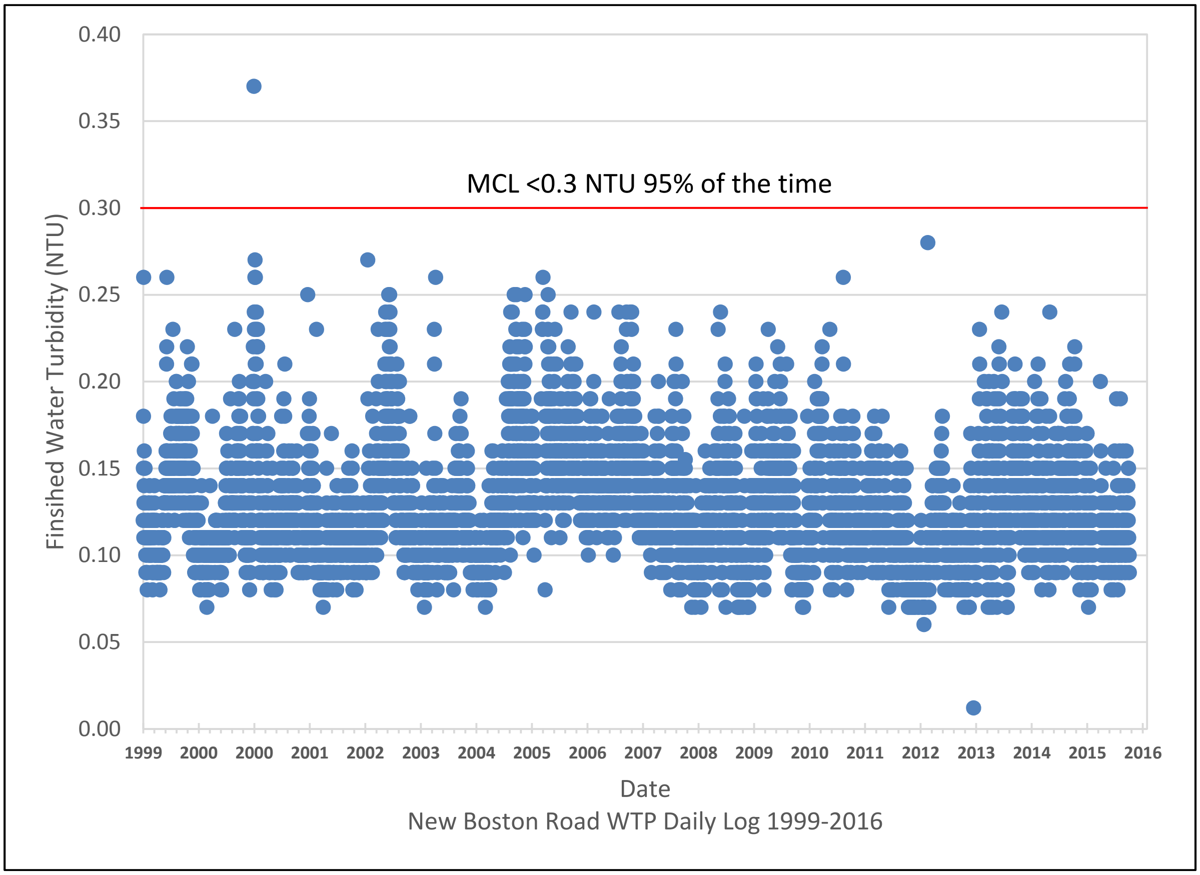

Figure 5-1: Historical Finished Water Turbidity at the New Boston Road WTP

As shown in **Figure 5-1**, the finished water turbidity meets or exceeds the primary standard of less than 0.3 NTU in 95% of all samples reported. In fact, the average turbidity is 0.13 NTU, and the primary standard benchmark value of 0.3 NTU was exceeded only rarely for all reported samples. **Figure 5-2** shows a frequency distribution of the average daily turbidity measured at the New Boston Road WTP from 1999 to 2016.

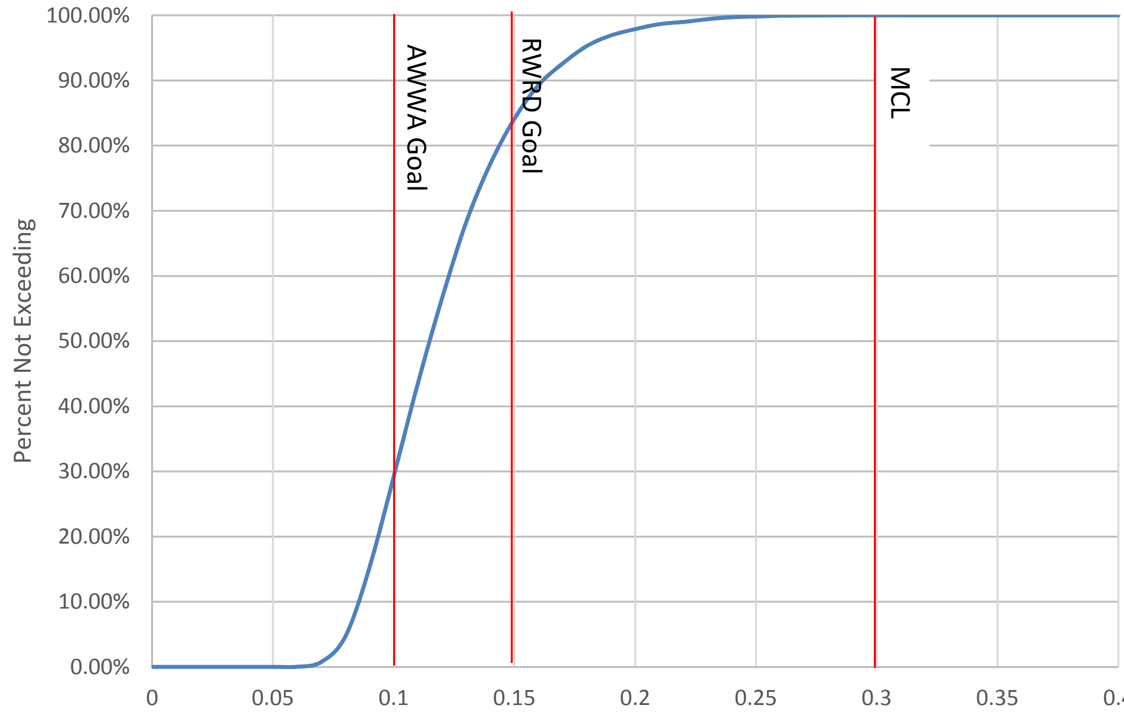

Figure 5-2: Finished Water Turbidity Frequency Distribution at New Boston Road WTP

Although the finished water turbidity meets the primary standard according to **Figure 5-2**, it exceeds the benchmark of 0.15 NTU in nominally 15 percent of all reported samples. Further, the finished water turbidity at the New Boston Road WTP exceeds the voluntary AWWA benchmark of 0.1 NTU in nominally 70 percent of all reported samples. Thus, there is still room for improvement for turbidity removal at the New Boston Road WTP.

A full filter media evaluation including sieve analysis, L/d characterization, mudball analysis, floc retention analysis and backwash profile are recommended for the New Boston Road WTP if it is to remain in service or enhanced in the future. This evaluation would provide TWU with needed information for robust, data-driven decisions on how long the existing filters can remain in service, possible modifications to optimize filter performance, benchmarking the existing conditions, and identifying a need for improvements, if any. Standard filter evaluation procedures are detailed in the AWWA Guidance Manual, *Filter Evaluation Procedures for Granular Media*[6], and in Susumu Kawamura's book, *Integrated Design of Water Treatment*

[6] Nix, Daniel and John Scott Taylor, P.E. Filter Media Evaluation Procedures for Granular Media. American Water Works Association. 1st edition. Denver, CO. 2003

Facilities[7]. With the proper planning, a filter media evaluation can be performed with relatively minimal capital expense.

Disinfection By-Products (DBP)

During disinfection with chlorine, harmful byproducts may form. However, these by-products can be mitigated with proper disinfection strategies.

DBPs are measured at various point throughout the distribution system. The primary standard for DBPs limits the total trihalomethanes to less than 0.080 mg/L and the five regulated haloacetic acids to less than 0.060 mg/L.

DBPs are an issue in the distribution system near the New Boston Road WTP[8] and are discussed in more detail in Section 5.3. The source water (Wright Patman Lake) has high DBP formational potential due to high TOC and SUVA. Disinfection strategies, such as chloramination and pH control, can be used to mitigate DBP formation at the New Boston Road WTP.

Taste and Odor

Previous engineering reports have indicated that the New Boston Road WTP has had seasonal taste and odor issues related to algae blooms. One report noted extremely high concentrations of known taste and odor compounds, MIB and geosmin, in Wright Patman Lake. As shown in **Table 5-1**, MIB and gesomin concentrations have been measured as high as 100 ng/L and 3100 ng/L, respectively. MIB and geosmin can add an earthy, musty taste to drinking water at concentrations as low as 10 ng/L. Further, if chloramines are not managed properly, different taste and odor issues can occur whereby di- and tri-chloramines are generated.

Common treatment techniques to control taste and odor include a combination of chemical oxidation and activated carbon adsorption (either PAC or GAC). Common chemical oxidants include chlorine, chlorine dioxide, ozone, and permanganate. Among common chemical oxidants, chlorine is the least effective and ozone is the most effective agent for oxidizing MIB and geosmin. Other technologies used in taste and odor control are biologically active carbon filtration and irradiation with ultraviolet (UV) light combined with hydrogen peroxide.[9]

Accordingly, free chlorine is limited in its ability to treat Wright Patman Lake water considering both its propensity to form DBPs and ineffectiveness in oxidizing MIB and geosmin. On the other hand, ozone in theory would prove to be a more effective chemical for treatment than chlorine and would likely be proposed for a new advanced water treatment plant, which corresponds to the recommendations presented in the CH2M Hill report (2012) to Riverbend WRD.

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[7] Kawamura, Susumu. Integrated Design of Water Treatment Facilities. John Wiley and Sons, Inc. 1st edition. 1991.
[8] APAI (2011), Figures 7.3 through 7.4.
[9] AWWA. *Water Quality and Treatment: A Handbook of Community Water Systems.* 5th ed. Mcgraw-Hill. 1999. pp. 12.26

Iron and Manganese

The primary concern with elevated levels of iron and manganese in drinking water is that they become oxidized to form solids of reddish-orange and black color, respectively, that are found in plumbing fixtures and create stains on laundry. Iron and manganese are relatively soluble under reducing conditions in stagnant surface water and hypolimnetic waters of eutrophic lakes, like Wright Patman Lake. Iron and manganese are insoluble under oxidizing conditions. During and immediately following lake overturn - that is, when the iron and manganese rich hypolimnetic water is mixed with the remainder of the lake water - dissolved iron and manganese levels in the upper portions of the lake tend to increase significantly[10], causing seasonal iron and manganese episodes.

Dissolved iron, Fe (II), and manganese, Mn (II), are usually removed from water by oxidizing them to form solids and then removing the solids through sedimentation and filtration. Common oxidants used are oxygen, chlorine, permanganate, chlorine dioxide, and ozone. It should be noted that since ozone is such a strong oxidant, it is capable of producing permanganate from dissolved manganese, resulting in a pink tint to the water if excess ozone is added.

Color

Color in water tends to be associated with the presence of polyaromatic compounds arising from natural vegetative decay producing compounds often referred to as humic acids or humic substances. They impart a yellowish hue to the water. The most common process for the removal of natural organic color from the water is chemical oxidation and coagulation. In the past, chlorine was widely used for color removal, but it became apparent that reactions between chlorine and color-causing compounds can lead to the formation of harmful disinfection-by-products.

Ozone and chlorine dioxide are also effective for color removal. However, ozone and chlorine dioxide are so strong that they tend to react with natural organic matter to produce readily biodegradable organic material, which may cause microbial regrowth in the distribution system. As a result, ozone treatment is often followed by biologically active carbon (BAC) filtration to stabilize the water by allowing the biological metabolism in the filters to consume the readily biodegradable organic material created during ozonation. The combination of ozone and BAC filtration allows water systems to maintain a lasting disinfection residual in distribution. [11]

Hardness

Hardness measures the amount of calcium and magnesium dissolved in water. Hard water may cause adverse effects like clogged pipelines, residue on dishes, difficulty getting soap to lather, and accumulation of deposits in home appliances that use hot water.

[10] AWWA. *Water Quality and Treatment: A Handbook of Community Water Systems.* 5th ed. Mcgraw-Hill. 1999. pp. 12.24

[11] AWWA. *Water Quality and Treatment: A Handbook of Community Water Systems.* 5th ed. Mcgraw-Hill. 1999. pp. 12.26-12.27

Hardness is measured in mg/L as calcium carbonate ($CaCO_3$) and can be classified as carbonate hardness or non-carbonate hardness. Carbonate hardness is the hardness that can be combined with the carbonate (CO_3^{2-}) or bicarbonate (HCO_3^-). Non-carbonate hardness is the difference between the total hardness and carbonate hardness. Non-carbonate hardness is more expensive to remove because it requires adding alkalinity.

The Unites States Geological Survey (USGS) defines very hard water as greater than 250 mg/L as $CaCO_3$ and defines moderately hard water as 120-250 mg/L as $CaCO_3$. The AWWA definition and goal for soft water is 80-100 mg/L as $CaCO_3$.

The average total hardness of the New Boston WTP's source water is 74 mg/L as $CaCO_3$; with a portion of hardness being non-carbonate. As shown in Figure H-11 (**Appendix H**) and **Table 5-7**, the average finished water hardness is 103 mg/L as $CaCO_3$. Based on these measurements, the New Boston Road WTP produces soft to moderately soft water for its end users.

Alkalinity

A water supply's alkalinity (or buffering capacity) moderates changes in pH. In general, the higher the alkalinity, the more resistant the water is to a pH change.

Higher alkalinity also affects the dosage requirements for the final pH adjustment of the finished water for distribution system corrosion control. Sufficient alkalinity is required for complete hydrolysis of inorganic coagulants, such as alum or ferric salts.

Operational data indicate that the raw water of Wright Patman Lake has sufficient alkalinity for coagulation under typical coagulant doses. The average alkalinity in the raw and finished water is 67 mg/L as $CaCO_3$, as shown in **Table 5-1** and **Table 5-7**.

Total Dissolved Solids

Total Dissolved Solids (TDS) represent the dissolved cations (positively charged ions) and anions (negatively charged ions) in water. TDS is affected by the presence of inorganic dissolved solids such as calcium, magnesium, chloride, nitrate, sulfate, potassium, sodium and others.

Although an elevated TDS concentration is not a health hazard, it may result in taste, scaling, or corrosion issues, depending upon the nature of the TDS. Water that contains high levels of dissolved salts is typically unpalatable.

At the New Boston Road WTP, the source water's average TDS is around 148 mg/L (reference **Table 5-1**). Although finished water quality data were not made available for the present analysis, it is highly unlikely that more than 250 mg/L of TDS is added through treatment.

Chloride

Chloride ions are constituents of TDS. High chloride concentrations can impart a salty taste to the water. In addition to the water quality concerns, high chloride concentration in the water is a liability because it tends to corrode ferrous metals. The New Boston Road WTP produces finished water with an average chloride concentration of 21 mg/L, well below the secondary standard of 250 mg/L.

pH

pH is a mathematical expression of the hydrogen ion concentration in water. A pH value of 7.0 represents a neutral condition; a pH value greater than 7.0 represents a basic (alkaline) condition; and a pH value of less than 7.0 represents an acidic condition. A water's pH governs many chemical reactions for water treatment, including coagulation, disinfection, and DBP formation.

pH also impacts the effectiveness of inorganic coagulants such as aluminum sulfate and ferric sulfate, since the solubility of metal hydroxides formed during coagulation is pH dependent. For example, the solubility of aluminum hydroxide floc formed during coagulation with alum is lowest, or most favorable, when the coagulation pH is maintained between 6.0 and 7.0.

In order to meet the TCEQ secondary standard and assist in complying with the Lead and Copper Rule (LCR), the finished water should have a pH at the higher end of the range between 6.5 and 8.5. As shown in **Table 5-7**, the New Boston Road WTP consistently maintains a finished water pH between 7.9 and 8.5, with an average of 8.2.

Temperature

Temperature affects many water processes. For physical processes, viscosity and density increase as temperature decreases. In chemical processes, solubility and reaction kinetics change with temperature. Temperature also affects pathogen inactivation. For example, virus inactivation decreases as the temperature decreases.

Cooler temperatures decrease the effectiveness of chlorine and chloramine disinfectants and, in general, reduce DBP formation because of slower reaction kinetics. As a result, disinfection CT requirements are more difficult to meet in the winter when the water temperatures are lower. During the winter months, irrigation demands decrease which result in an overall decrease in water demands from the WTP. As a result, lower plant flows allow longer residence times in the settling basins and clearwell.

As shown in **Appendix H**, the water temperature at the New Boston Road WTP varied from less than 50°F to greater than 97°F. On average, the water temperature was approximately 72°F according to **Table 5-7**.

5.2.2 Millwood WTP

For the Millwood WTP, finished water quality data reported in available SWMORs and internal TWU records for recorded parameters are summarized and compared to treatment regulations and industry standards. **Table 5-8** below summarizes finished water quality at the Millwood WTP.

Table 5-8: Treated Water Quality at the Millwood WTP(1)

Parameter	Units	Ave	Goal/Std(2)	Range	Percentiles 5th	Percentiles 50th	Percentiles 95th
Turbidity	NTU	0.07	0.3(3)	0.03 - 0.22	0.05	0.07	0.12
pH	--	8.4	>7	7.0 - 9.5	8.0	8.5	8.8
Temperature	deg F	70	--	44 - 92	48	72	88
Hardness	mg/L as $CaCO_3$	49	<150	33 - 93	36	48	63
Alkalinity	mg/L as $CaCO_3$	23	--	15 - 50	19	23	28

Note:
(1) Based on operating reports from the Millwood WTP Jan 2002- Jun 2016.
(2) Millwood WTP operations guidelines follow the strictest water quality standards of those enforced by federal, Arkansas, and/or Texas agencies. The listed guidelines represent the strictest among the three regulating agencies. Arkansas Department of Health (ADH) adopts the federal standards. Texas Commission on Environmental Quality (TCEQ) adopts federal standards but also may enforce their own secondary standards on a case-by-case basis.
(3) Primary standard is <0.3 NTU 95% of the time. TWU goal is <0.15 NTU 95% of the time. Partnership for Safe Water establishes a voluntary standard of <0.1 NTU 95% of the time.

From the available finished water quality data, the Millwood WTP has shown the ability to comply with applicable federal primary standards, especially for turbidity. **Appendix H** provides additional finished water quality information including historical and frequency distributions for available operations data. In this report, water quality data was made available for the Millwood WTP to sufficiently provide a high-level evaluation of plant performance. However, a detailed evaluation as a next step is recommended, which would include an additional water quality evaluation for disinfection, TOC removal, filtration, taste and odor, iron, manganese, and color - similar to the evaluations completed for the New Boston Road WTP. Such evaluations provide useful information to aid in benchmarking current performance, determining useful life of existing treatment processes, blending finished waters from multiple plants, planning for maintenance and/or expansion of existing facilities, and optimizing operations.

Turbidity

Turbidity measures the light-scattering or light-absorbing properties of water. In drinking water supplies, turbidity is commonly caused by suspended matter such as clays, silts, finely divided organic and inorganic matter, plankton, and other microorganisms. Thus, turbidity is an indicator of drinking water quality and of the efficacy of its coagulation and filtration processes. Because pathogens may be embedded in suspended particles, which limit their contact with disinfectants, turbidity removal is an important part of ensuring adequate disinfection. **Figure 5-3** summarizes the historical finished water turbidity at the Millwood WTP from 2002 to 2016.

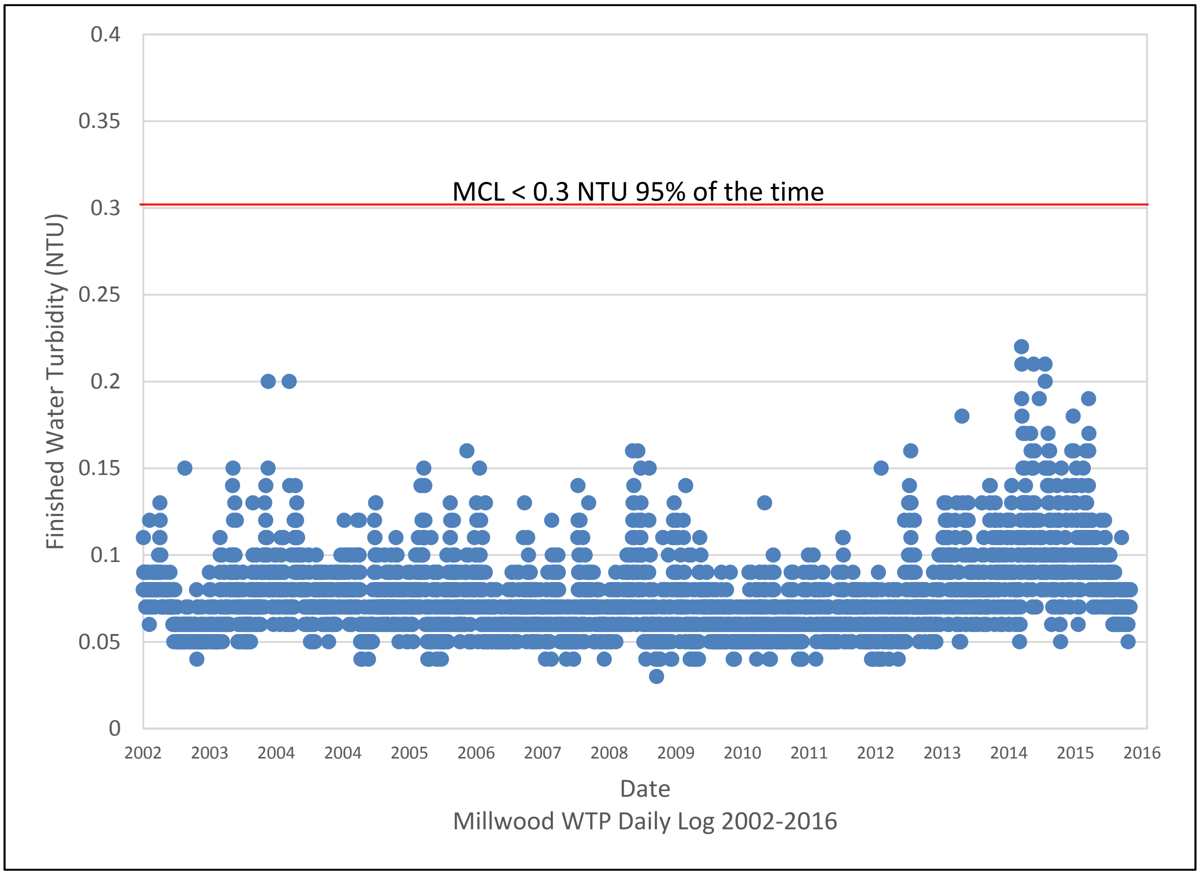

Figure 5-3: Historical Finished Water Turbidity at Millwood WTP

As shown in **Figure 5-3**, the finished water turbidity meets or exceeds the primary standard of less than 0.3 NTU in 95% of all samples reported for the Millwood WTP. In fact, the average turbidity is 0.07 NTU, and the primary standard benchmark value of 0.3 NTU was never exceeded for all reported samples. **Figure 5-4** shows a frequency distribution of the average daily turbidity measured at the Millwood WTP from 2002 to 2016.

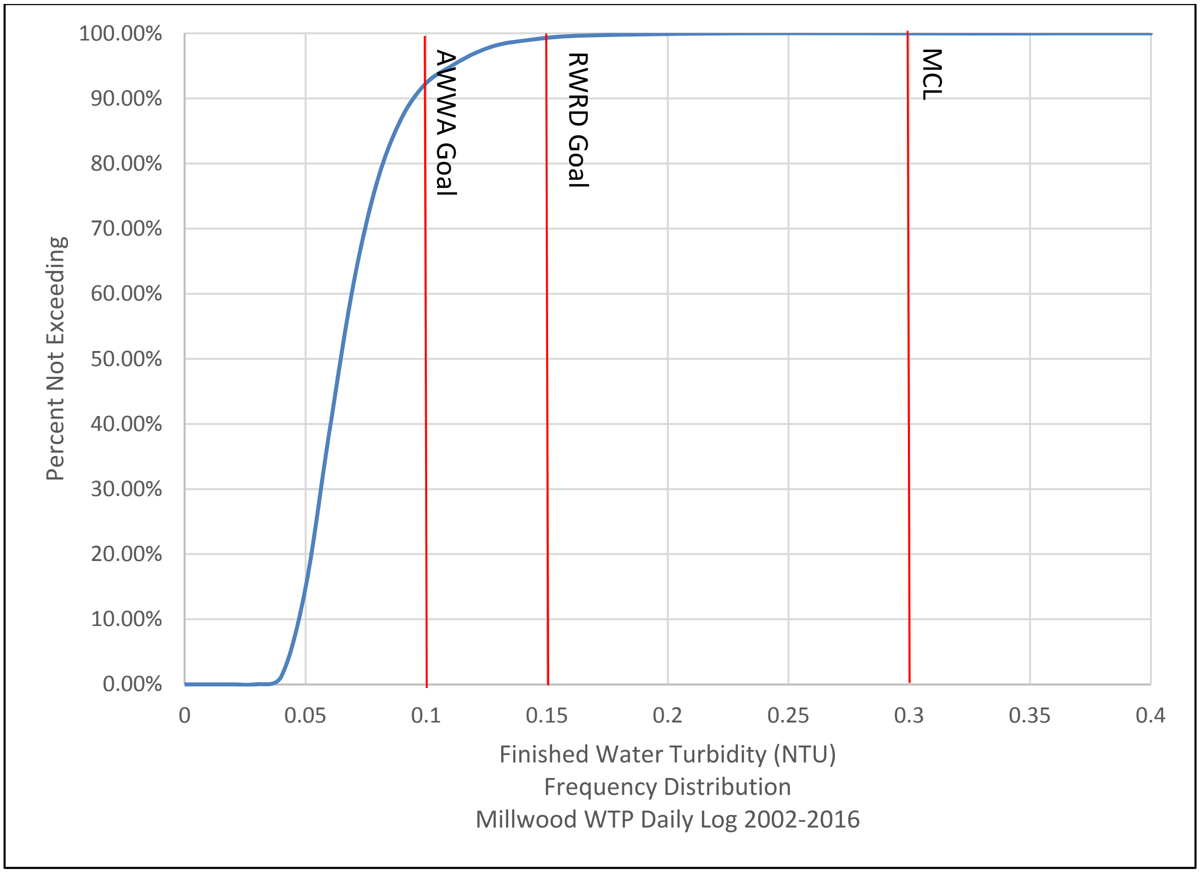

Figure 5-4: Finished Water Turbidity Frequency Distribution at Millwood WTP

According to **Figure 5-4**, the finished water turbidity meets the primary standard, and it meets or exceeds the benchmark of 0.15 NTU in greater than 95 percent of all reported samples. Further, the finished water turbidity at the Millwood WTP exceeds the voluntary AWWA benchmark of 0.1 NTU in excess of 90 percent of all reported samples. Turbidity removal at the Millwood WTP consistently meets the treatment goals. Nonetheless, a full filter media evaluation including sieve analysis, L/d characterization, mudball analysis, floc retention analysis and backwash profile are recommended to be developed for the Millwood WTP if it is to remain in service or be expanded or enhanced in the future. Such filter evaluations are good industry practice and useful for comparison with other WTPs in the study area. Standard filter evaluation procedures are detailed in the AWWA Guidance Manual, *Filter Evaluation Procedures for Granular Media*[12], and in Susumu Kawamura's book, *Integrated Design of Water Treatment Facilities*[13].

[12] Nix, Daniel and John Scott Taylor, P.E. Filter Media Evaluation Procedures for Granular Media. American Water Works Association. 1st edition. Denver, CO. 2003

[13] Kawamura, Susumu. Integrated Design of Water Treatment Facilities. John Wiley and Sons, Inc. 1st edition. 1991.

Hardness

Hardness measures the amount of calcium and magnesium dissolved in water. Hard water may cause adverse effects like clogged pipelines, residue on dishes, difficulty getting soap to lather, and accumulation of deposits in home appliances that use hot water.

Hardness is measured in mg/L as calcium carbonate ($CaCO_3$) and can be classified as carbonate hardness or non-carbonate hardness. Carbonate hardness is the hardness that can be combined with the carbonate (CO_3^{2-}) or bicarbonate (HCO_3^-). Non-carbonate hardness is the difference between the total hardness and carbonate hardness. Non-carbonate hardness is more expensive to remove because it requires adding alkalinity.

The United States Geological Survey (USGS) defines very hard water as greater than 250 mg/L as $CaCO_3$ and defines moderately hard water as 120-250 mg/L as $CaCO_3$. The AWWA goal for soft water is 80-100 mg/L as $CaCO_3$.

The average total hardness of the Millwood WTP's source water is 20 mg/L as $CaCO_3$; with a portion of hardness being non-carbonate. As shown in **Appendix H** (Figure H-22) and **Table 5-8**, the average finished water hardness is 49 mg/L as $CaCO_3$. Based on these numbers, the Millwood WTP produces soft water for its end users.

Alkalinity

A water supply's alkalinity (or buffering capacity) moderates changes in pH. In general, the higher the alkalinity, the more resistant the water is to a pH change.

Higher alkalinity also affects the dosage requirements for the final pH adjustment of the finished water for distribution system corrosion control. Sufficient alkalinity is required for complete hydrolysis of inorganic coagulants, such as alum or ferric salts.

Operational data indicate that the raw water from Millwood WTP may not have sufficient alkalinity for coagulation under all coagulant doses. In fact, some alkalinity is added during treatment. The average alkalinity in the raw water is 20 mg/L as $CaCO_3$, while the average finished water alkalinity is 23 mg/L as $CaCO_3$, as shown in **Table 5-1**, **Table 5-8** and **Appendix H** (Figure H-19).

pH

pH is a mathematical expression of the hydrogen ion concentration in water. A pH value of 7.0 represents a neutral condition; a pH value greater than 7.0 represents a basic (alkaline) condition; and a pH value of less than 7.0 represents an acidic condition. A water's pH governs many chemical reactions for water treatment, including coagulation, disinfection, and DBP formation.

pH also affects the effectiveness of inorganic coagulants such as aluminum sulfate and ferric sulfate, since the solubility of metal hydroxides formed during coagulation is pH dependent. For example, the solubility of aluminum hydroxide floc formed during coagulation with alum is lowest, or most favorable, when the coagulation pH is maintained between 6.0 and 7.0.

In order to meet the TCEQ secondary standard and assist in complying with the Lead and Copper Rule (LCR), the finished water should have a pH at the higher end of the range between 6.5 and 8.5. As shown in **Table 5-8**, the Millwood WTP consistently maintains a finished water pH between 8.0 and 8.8 with an average pH of 8.4.

Temperature

Temperature affects many water processes. For physical processes, viscosity and density increase as temperature decreases. In chemical processes, solubility and reaction kinetics change with temperature. Temperature also affects pathogen inactivation. For example, virus inactivation decreases as the temperature decreases.

Lower temperatures decrease the effectiveness of chlorine and chloramine disinfectants and, in general, reduce DBP formation because of slower reaction kinetics. As a result, disinfection CT requirements are more difficult to meet in the winter when the water temperatures are lower. However, winter flow rates are typically less, allowing longer residence times in the settling basins and clearwell.

As shown in **Appendix H** (Figure H-12), the water temperature at the Millwood WTP varies from less than 44°F to greater than 92°F. On average, the water temperature is approximately 70°F according to **Table 5-8**.

5.2.3 Graphic Packaging International WTP

For the Graphic Packaging International (GPI) WTP, finished water quality data reported in available SWMORs and internal TWU records for recorded parameters are summarized and compared to treatment regulations and industry standards. **Table 5-9** below summarizes finished water quality at the GPI WTP.

Table 5-9: Treated Water Quality at the GPI WTP(1)

					Percentiles		
Parameter	**Units**	**Ave**	**Goal/Std**	**Range**	**5th**	**50th**	**95th**
Turbidity	NTU	0.12	0.3(2)	0.06 - 0.38	0.09	0.12	0.18

Note:
(1) Based on operating reports from the GPI WTP Jan 2002- Dec 2015.
(2) TCEQ primary standard is <0.3 NTU 95% of the time. TWU Goal is < 0.15 NTU 95% of the time. Partnership for Safe Water establishes a voluntary standard of <0.1 NTU 95% of the time.

From the available finished water quality data, the GPI WTP has shown the ability to comply with applicable federal primary standards for turbidity. **Appendix H** provides additional water quality information including historical and frequency distributions for available operations data. In this report, enough water quality data is available for the GPI WTP to provide a high-level evaluation of plant performance. However, additional water quality data is needed for a detailed evaluation which captures the full picture of the individual treatment processes, interaction between related treatment processes and overall plant performance. Accordingly, it is recommended to perform an additional water quality evaluation for disinfection, TOC removal, filtration, taste and odor, iron, manganese, and color - similar to the evaluations completed for the New Boston Road WTP. Such evaluations provide useful information to aid in benchmarking current performance, determining useful life of existing treatment processes, blending finished waters from multiple plants, planning for maintenance and/or expansion of existing facilities, and optimizing operations.

Turbidity

Turbidity measures the light-scattering or light-absorbing properties of water. In drinking water supplies, turbidity is commonly caused by suspended matter such as clays, silts, finely divided organic and inorganic matter, plankton, and other microorganisms. Thus, turbidity is an indicator of drinking water quality and of the efficacy of its coagulation and filtration processes. Because pathogens may be embedded in suspended particles, which limit their contact with disinfectants, turbidity removal is an important part of ensuring adequate disinfection. **Figure 5-5** summarizes the historical finished water turbidity at the IP (now GPI) WTP from 2002 to 2016.

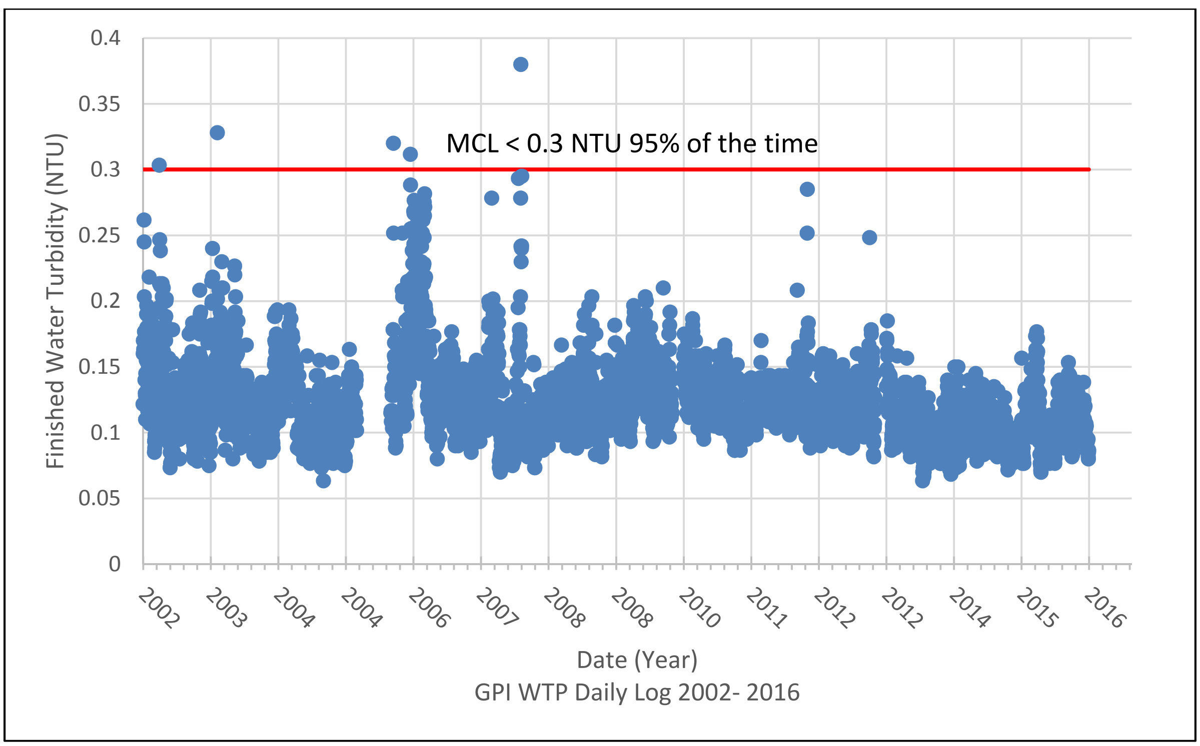

Figure 5-5: Historical Finished Water Turbidity at the IP (now GPI) WTP

As shown in **Figure 5-5**, the finished water turbidity at the GPI WTP meets or exceeds the primary standard of less than 0.3 NTU in 95% of all samples reported. In fact, the average turbidity is 0.12 NTU, and the primary standard benchmark value of 0.3 NTU was exceeded only occasionally for all reported samples. **Figure 5-6** shows a frequency distribution of the average daily turbidity measured at the GPI WTP from 2002 to 2016.

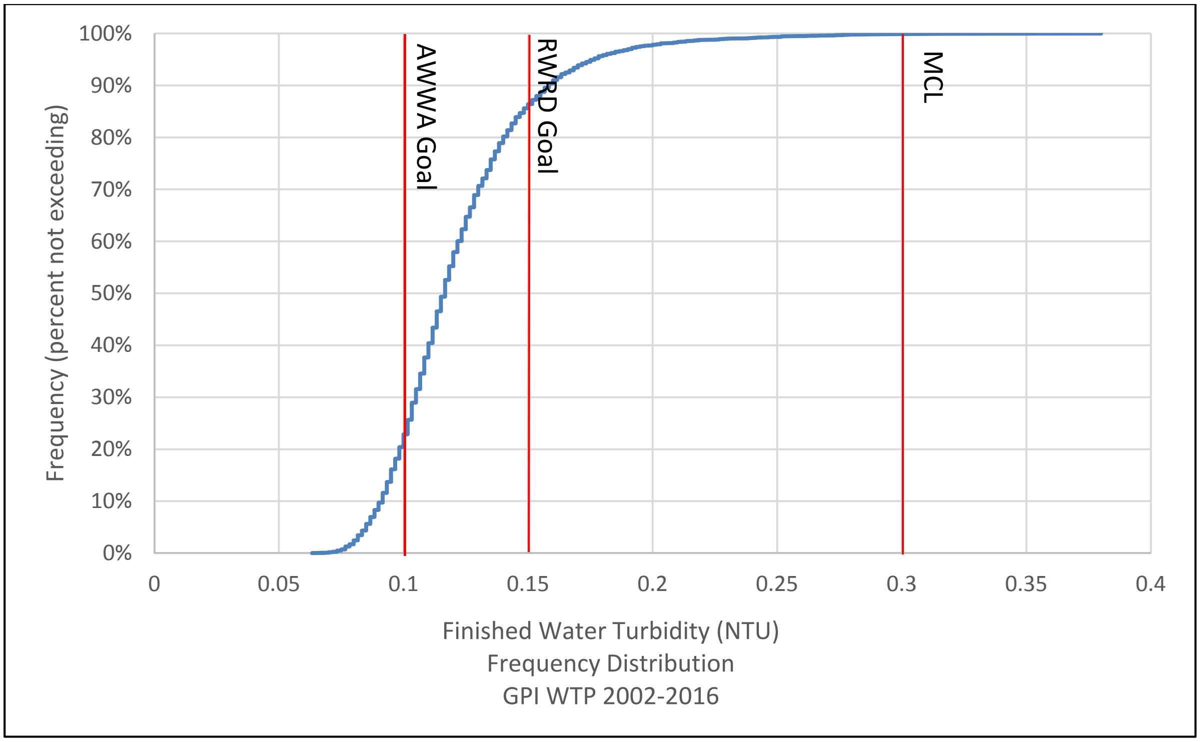

Figure 5-6: Finished Water Turbidity Frequency Distribution at the GPI WTP

Although the finished water turbidity meets the primary standard, according to **Figure 5-6**, it exceeds the benchmark of 0.15 NTU in nominally 15 percent of all reported samples. Further, the finished water turbidity at the GPI WTP exceeds the voluntary AWWA benchmark of 0.1 NTU in nominally 75 percent of all reported samples. Thus, there is still room for improvement for turbidity removal at the GPI WTP. GPI states that they continuously monitor and periodically sample turbidity to ensure compliance with all regulatory requirements, and this information is also used to determine when and what type of filter media maintenance is needed.

5.3 DISINFECTION BY-PRODUCTS – DISTRIBUTION SYSTEM

Chlorine has been the primary drinking water disinfectant in the US for more than 90 years. Other major disinfectants include chlorine dioxide, chloramines and ozone. During disinfection with chlorine, harmful byproducts may form. However, these by-products can be mitigated with proper disinfection strategies.

DBPs are measured at various point throughout the distribution system. The primary standard for DBPs limits the total measured trihalomethanes to be less than 0.080 mg/L and the total measurement of the five regulated haloacetic acids to be less than 0.060 mg/L. Locational Running Annual Average Data (LRAA) data for DBP compliance available from the utility was evaluated for compliance with MCLs and utility goals.

Figure 5-7 and **Figure 5-8** show historical distribution of various sampling points for TTHMs and HAA5 within the potable water distribution system. Since the data available did not specify the exact geographic location of the sampling points, it is assumed that these data represent the primary (non-GPI WTP) portion of the potable water distribution system served by the NBR WTP and Millwood WTP. Wherever extended contact times with free chlorine are encountered, such as in the transfer pipe from the raw water source to the plant, it is likely that DBPs are forming.

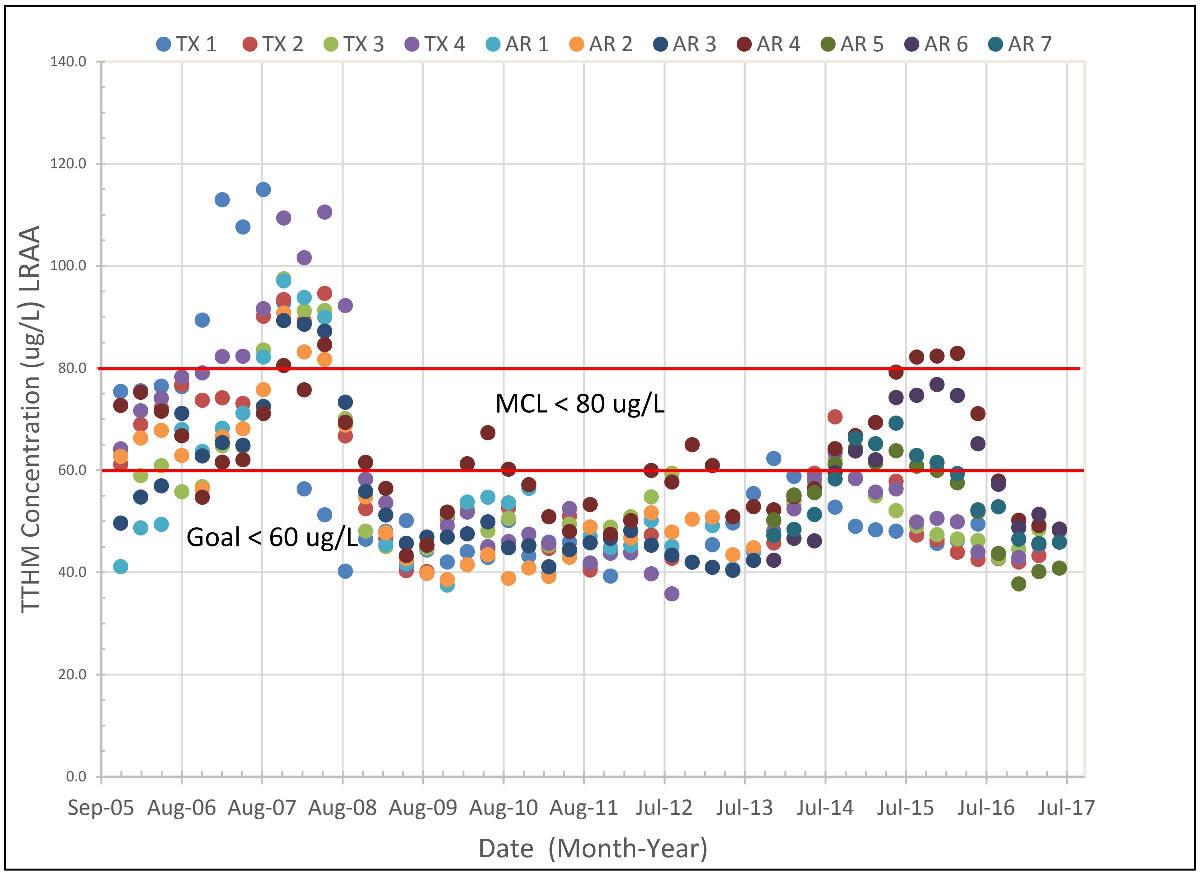

Figure 5-7: Historical Distribution TTHM Data from Utility LRAA Monitoring Points

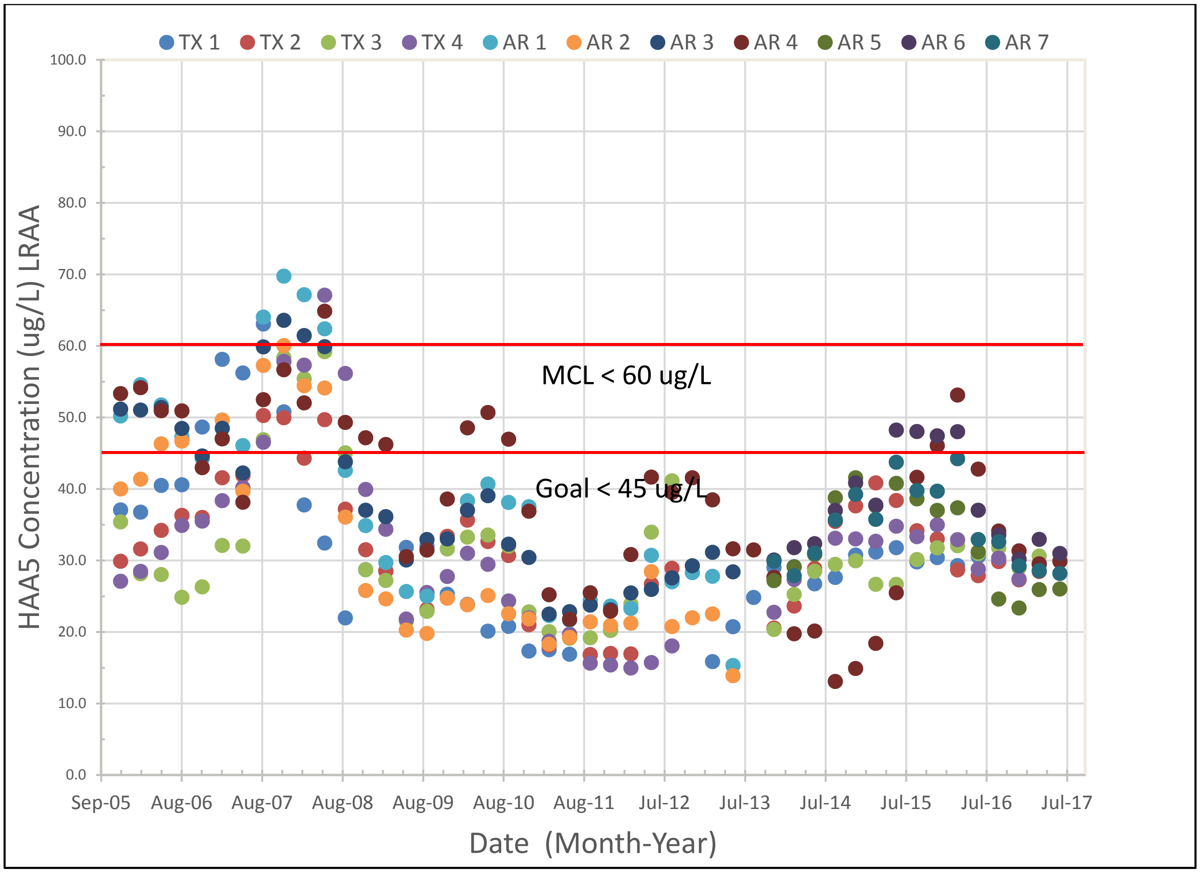

Figure 5-8: Historical Distribution of HAA5 from Utility LRAA Monitoring Points

As shown in **Figures 5-7** and **5-8**, MCLs and TWU goals have been exceeded for both TTHMs and HAA5. The periods from August 2007 to August 2008 and July 2015 to July 2016 were the worst cases in which MCLs and utility goals were violated.

In previous studies, it was reported that operational changes were made at the WTPs in 2008 to mitigate DBP formation; the report was general in nature and did not specify the exact location. The change was successful in reducing DBPs; however, several MCL and treatment goal exceedances occurred after that time, indicating additional room for improvement. Due to the health concern associated with high DBPs, immediate action should be taken to address elevated DBPs in the distribution system, up to and including a detailed disinfection study, CT evaluation, piloting, design, and construction of new water treatment plant infrastructure for enhanced TOC removal and disinfection chemical optimization. To control DBP formation, contact time between free chlorine and high TOC water should be minimized and disinfection using ozone and/or chloramines should be considered.

5.4 WATER INFRASTRUCTURE CONDITION ASSESSMENT

The water supply systems currently under analysis include raw water supplied from Wright Patman Lake, a raw water intake and pump station on Wright Patman Lake, and the New Boston Road Water Treatment Plant (WTP); raw water supplied from Wright Patman Lake, a second raw water intake and pump station on Wright Patman Lake, and Graphic Packaging International (GPI) WTP; and raw water supplied from Millwood Lake, a raw water intake and pump station on Millwood Lake, and the Millwood Lake WTP. Each of these facilities have accordant treated water distribution systems serving various member cities and customers within Bowie, Red River, and Cass Counties. Reference **Appendix I** for copies of each of the WTP permits.

Texarkana Water Utilities (TWU), includes the wholesale distribution from Wright Patman Lake and Millwood Lake to surrounding municipalities and other wholesale customer; as well as the retail distribution for the City of Texarkana, TX and the City of Texarkana, AR. TWU provides treated water on a wholesale (not retail) basis to the Riverbend WRD Member Entities. The GPI systems are not considered part of the joint system known as TWU; however, the City of Texarkana, Texas, funded through several issued bonds in the 1970's the construction and expansion of the GPI water facilities pursuant to contracts between GPI and the City of Texarkana, TX. For the GPI contract, TWU operates the system's water intake and distribution infrastructure and performs other services towards administration of the GPI contracts.

The condition assessment is organized according to each of the three WTPs (New Boston Road, Millwood, and GPI), along with their respective intake, pumping, and conveyance facilities as evaluated. This high-level plant condition assessment was performed with the following objectives:

- focus upon individual processes, structural, and electrical aspects of the facilities;
- identify process expansions/upgrades and/or repairs/replacements needed;
- assess the existing conditions and limitations, including remaining life expectancy of existing facilities and major equipment; and
- consider the feasibility for plant improvements and/or expansion versus construction of a new plant.

During the site visits conducted in October and November 2016, registered professional engineers were present, representing the following disciplines: Structural, Process/Mechanical, and Electrical/Instrumentation and Control (I&C). The high-level condition assessment of the structures and equipment were based on visual observations during the site visits. During the site visits, interviews with plant staff were conducted to discuss maintenance efforts, operational preferences, areas of concern, and desired upgrades or improvements to the treatment facilities. This condition assessment does not qualify as an environmental survey identifying the presence of hazardous materials such as asbestos, lead paint, or PCBS. Special inspection and testing procedures are required to identify these materials, which is beyond the scope of the present effort.

Three site visits were conducted by the Roth Team, accompanying Riverbend WRD and TWU staff to each of the three WTPs and their associated raw water conveyance systems. The dates of these site visits occurred on October 26-27, November 1-2 and November 8, 2016.

5.4.1 New Boston Road WTP

The New Boston Road WTP and raw water conveyance facilities were constructed in 1957. The plant was expanded in the 1970s and has not had any major upgrades since that time. The New Boston Road WTP has a design and permitted capacity of 18 MGD; however, the raw water intake system is designed for 24.5 MGD but is limited to 18 MGD in capacity due to the build-up of sedimentation. The plant is operated 24 hours per day, seven days a week with two full-time employee equivalents (FTEs) per shift (four daily shifts). The plant is also located in a floodplain, which would require special construction provisions and would be exposed to an increased risk of damage to buildings and infrastructure due to flooding. In addition, limited land is available at the site for an expansion.

The New Boston Road WTP and raw water conveyance system are jointly owned through an undivided interest by the Original Member Cities; Annona, Avery, DeKalb, Hooks, Maud, New Boston, Texarkana, TX and Wake Village. TWU operates the plant and the raw water conveyance system. A high-level condition assessment discussing plant processes and conditions is presented below. A schematic of the New Boston Road WTP is presented in **Figure 5-9**.

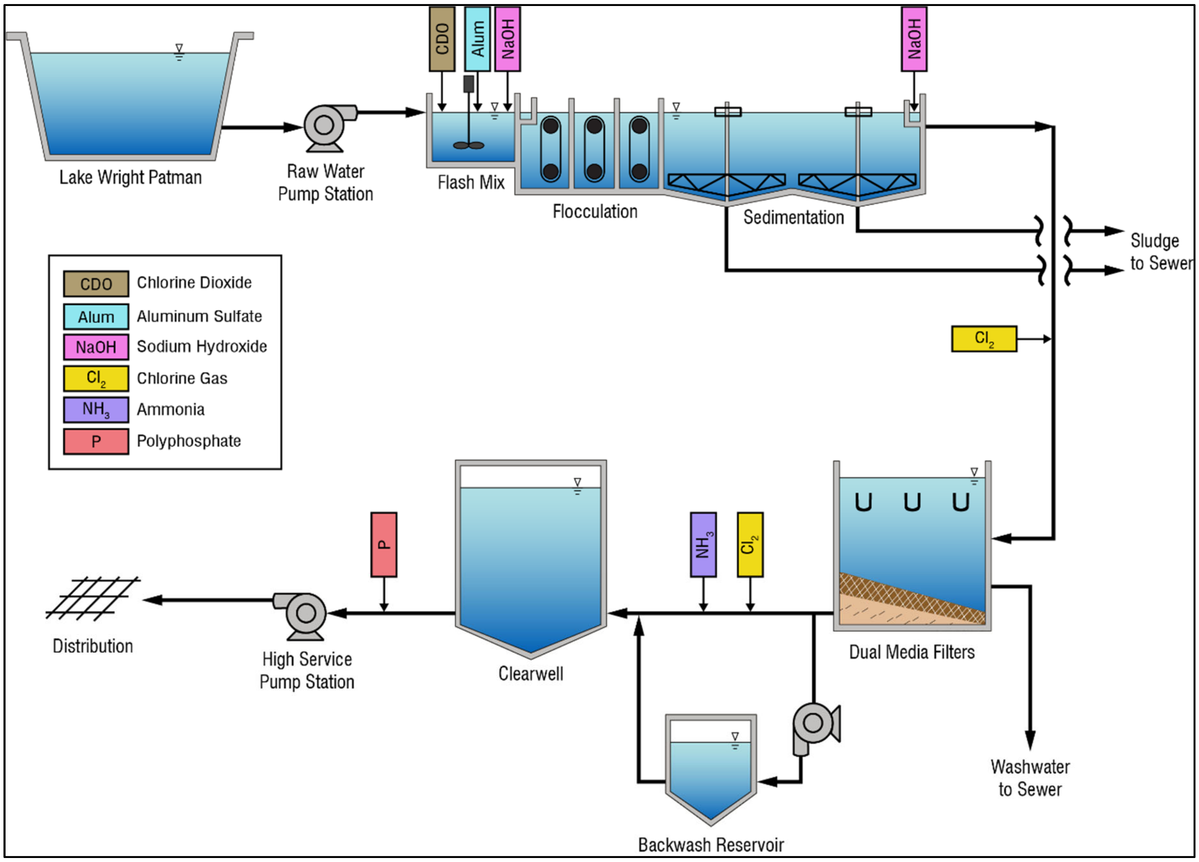

Figure 5-9 - New Boston Road WTP Plant Schematic

5.4.1.1 Observations

The New Boston Road WTP is over 65 years old and still uses many of the facilities and equipment that were part of the original plant construction and expansion. Much of the mechanical equipment has aged beyond its typical life expectancy. As indicated previously, past reports have suggested the plant struggles with meeting disinfection by-product and effluent filter turbidity regulations and has seasonal taste and odor issues. However, due to proactive and rigorous management, operators manage to optimize the plant to meet current water quality regulations and standards.

5.4.1.2 Raw Water Conveyance Facilities

5.4.1.2.1 *Process at Intake*

The New Boston Road WTP intake and pumping facilities were constructed in 1957. The facilities are aged with very little upgrades since they were constructed. The facilities consist of a crib-type intake constructed from reinforced concrete (top of structure elevation at 220.0 ft. MSL and bottom elevation of approximately 210.0 ft. MSL) and four vertical turbine low service pumps and a 9.28-mile long, 33-inch diameter concrete cylinder pipeline. There is a 250 HP 3600 GPM pump, a 400 HP 6,000 GPM pump, and two 500 HP 7,000 GPM pumps. The facilities were designed to convey raw water from Wright Patman Lake to the WTP. Previous reports indicate that the pump station capacity has decreased from 24.5 MGD to 19.6 MGD[14]. Plant staff also indicated the current capacity of the transmission system is currently around 18 MGD.[15] Plant staff indicated that the pumps undergo regular maintenance to keep them operational. The *2012 CH2M Hill Report* attributed this loss of capacity to increased pipe friction and silt/sediment build-up in the pipeline. This report cited a 2010 HDR report indicating the pumping capacity could be restored and even increased by cleaning and inspection of the pipeline and installing new pumps.[16]

In order to verify the impact of restoring/increasing pumping capacity, an in-situ analysis of the pipeline is needed to determine the cause of the decreased pipeline capacity. If the roughness of the internal pipeline surface is the true cause of the capacity reduction, cleaning the pipeline is a possible solution. However, if corrosion is the cause of the pipeline capacity reduction, further insight on pipeline life expectancy will need to be determined. Beyond testing of the pipeline, other system elements which could be further investigated for improvement include the intake conduit and pump station. Inspection of the intake conduit for a condition assessment and for sedimentation effects could inform upon possible causes of decreased capacity, as well as performing field pump tests to assess actual pump performance.

The raw water pump station shows visible signs of age and a lack of routine maintenance, as depicted in **Figures 5-10**, **5-11**, and **5-12**.

Raw Water Pump Station Operating Criteria

Pump Type	Vertical Turbine
Number of Pumps: 500 HP 400 HP 250 HP	 2 1 1
Design Capacity	24.5 MGD[17]
Present Actual Capacity	18.0 MGD

[14] CH2M Hill, et. al., (2012).
[15] Pers. comm., 10/26/2016.
[16] CH2M Hill, et. al., (2012).
[17] CH2M Hill, et. al., (2012).

Figure 5-10: Vertical Turbine Pump Motors inside the Raw Water Pump Station showing exposure to moisture and other elements

Figure 5-11: Discharge Piping in Raw Water Pump Station showing moist environment and lack of coating.

Figure 5-12: Discharge Piping in Raw Water Pump Station showing coating in need of repair and other wear and tear

Specifically, the pump station is in need of the following:

- Maintaining the pump station ventilation.
- Cleaning to keep the floors/equipment free of dirt, grime, corrosion, cobwebs, insects, etc.
- Replacing the coatings on piping and equipment.
- The shell of the prefabricated building is rusted, corroded, and has several openings as shown in **Figure 5-13**.

5.4.1.2.2 *Structural at Intake*

Figure 5-13: Front of Prefabricated Building at Wright Patman Lake (to New Boston Road WTP); Raw Water Intake and Pump Station

Figure 5-14: Stairs to Prefabricated Building at Wright Patman Lake (to New Boston Road WTP); Raw Water Intake and Pump Station

- The roll-up door, grating, stair landings, windows, and window frames are all corroded (reference **Figure 5-14**).
- For the short term and long term, this intake facility needs to be replaced with a non-corrosive building, such as a masonry building.

5.4.1.2.3 *Electrical at Intake*

No concerns have been initially identified.

5.4.1.3 <u>Treatment Plant</u>

5.4.1.3.1 *Process*

The primary assets of the plant are the structures and the equipment (mechanical, electrical, instrumentation, etc.). Structures are a high-valued asset and are very important when considering the life expectancy of the plant and whether or not to upgrade/expand a facility. As a result, investing considerable capital in new processes (structures) to optimize or expand the plant is recommended if the existing structures are to have a reasonable life expectancy. Although the structural facilities of the New Boston Road WTP have been maintained well, the true value of the infrastructure assets are approaching their useful life and are not highly valued due to the age of the plant. As a result, it is not recommended that the plant undergo any major expansion to add processes or expand capacity significantly.

On the other hand, the structures remain in good shape due to intense maintenance and only require minor rehabilitation. Thus, it is recommended to continue to use the plant, as long as it can continue to meet state and federal treated water quality requirements. Costs to maintain this facility will continue to grow as aged equipment will continue to need to be replaced to ensure plant reliability. TWU has recently upgraded some equipment (i.e., filter valves, chlorinator, and some chemical systems) and is in the process of making other upgrades (i.e., filter controls, filter valves, filter media, and baffle walls). These upgrades will increase the treatment plant reliability and are necessary for continued operation of the plant. During the inspection, the Roth Team noted a technical cross connection in the utility water for the chlorinators; this was a common utility water supply manifold that feeds the chlorine injectors for both filtered and non-filtered chlorine solution pipelines. Additional equipment (i.e. flash mix equipment, flocculators, redwood baffles, sludge collectors, etc.) should be prioritized for replacement and part of a capital improvements plan. Even then, the process utilized at the New Boston Road WTP is antiquated; the costs associated with continued repairs and upgrades should be weighed against new, forthcoming regulations that could cause these processes to become obsolete.

<u>Chemical Addition and Coagulation</u>

The plant adds chlorine dioxide and aluminum sulfate prior to coagulation. Chlorine dioxide is used to oxidize dissolved iron and manganese in the raw water. Aluminum sulfate is used as a coagulant to remove particulates from the raw water. Both chemicals are injected into the rapid mix basins. Currently, these injection systems appear to work well and should continue to be regularly inspected and maintained.

Flash Mix, Flocculation and Sedimentation

The plant contains two rapid mix basins; however, only one of them is operable and the other is not equipped with any mixers. Plant staff indicated that a single rapid-mix basin can be used to provide flow to all five sedimentation basins. This rapid-mix basin is equipped with three vertical shaft mixers. The mixers are original to the 1970s plant expansion and have reached the end of their useful life. Currently, plant staff indicated that slide gates and mixers work well.

The plant contains five rectangular flocculation and sedimentation basins. Flocculation in each basin consists of three stage flocculation using horizontal paddle wheel flocculators. Each flocculation stage is separated with redwood baffle walls. The flocculators and baffle walls have not been updated since plant construction and are beyond typical useful life of such equipment. Currently, plant staff indicates this equipment is operating well.

Each sedimentation basin is separated into two halves, each containing a circular rotating rake collection system to scrape solids to a center sump for removal. Each of the ten rake systems is original to the plant and beyond its typical useful life. Currently, plant staff indicated the rake systems are operating well.

Overall, the flash mix, flocculation, and sedimentation basin and components continue to operate well. Plant staff optimizes the processes to meet water quality standards and operate the facility at its rated capacity of 18 MGD. However, the age of the mechanical equipment should be of concern. Continuing to operate equipment beyond its typical useful life increases the risk of equipment failure. With this aged equipment, plant reliability can be classified as low because of the increased potential for failure of multiple pieces of equipment. With these risks aside, the plant should be able to continue to operate at its rated capacity of 18 MGD.

Flash Mix, Flocculation, and Sedimentation Operating Criteria

Flash Mix Basins:	
Number	2
Mixer Type	Vertical Shaft
Number of Mixers (per basin)	3
Volume (per basin)	20,000 gallons
Flocculation Basins:	
Number	5
Stages (per basin)	3
Flocculator Type	Horizontal, Paddle Wheel
Volume (per stage)	43,000 gallons
Volume (per basin)	129,000 gallons
Sedimentation Basins:	
Number	5
Length	120
Width	60
Depth	15
Volume (each basin)	808,000 gallons
Surface Area (each basin)	7,200 sf
Cross Sectional Area (each basin)	900 sf
Criteria with 4 Basin Online	
Surface Loading Rate (18 MGD)	0.43 gpm/ft^2
Surface Loading Rate (24 MGD)	0.58pm/ft^2
Detention Time (18 MGD)	4.3 hours
Detention Time (24 MGD)	3.2 hours
Horizontal Velocity (18 MGD)	0.46 ft/min
Horizontal Velocity (24 MGD)	0.62 ft/min

Figure 5-15: New Boston Road WTP Flash Mix Basin showing mixers that are aged past their useful life

Figure 5-16: New Boston Road WTP Flocculation/Sedimentation Basins showing baffles and sludge collectors that are past their expected useful life

Figure 5-17: New Boston Road WTP Flocculators that are past their expected useful life

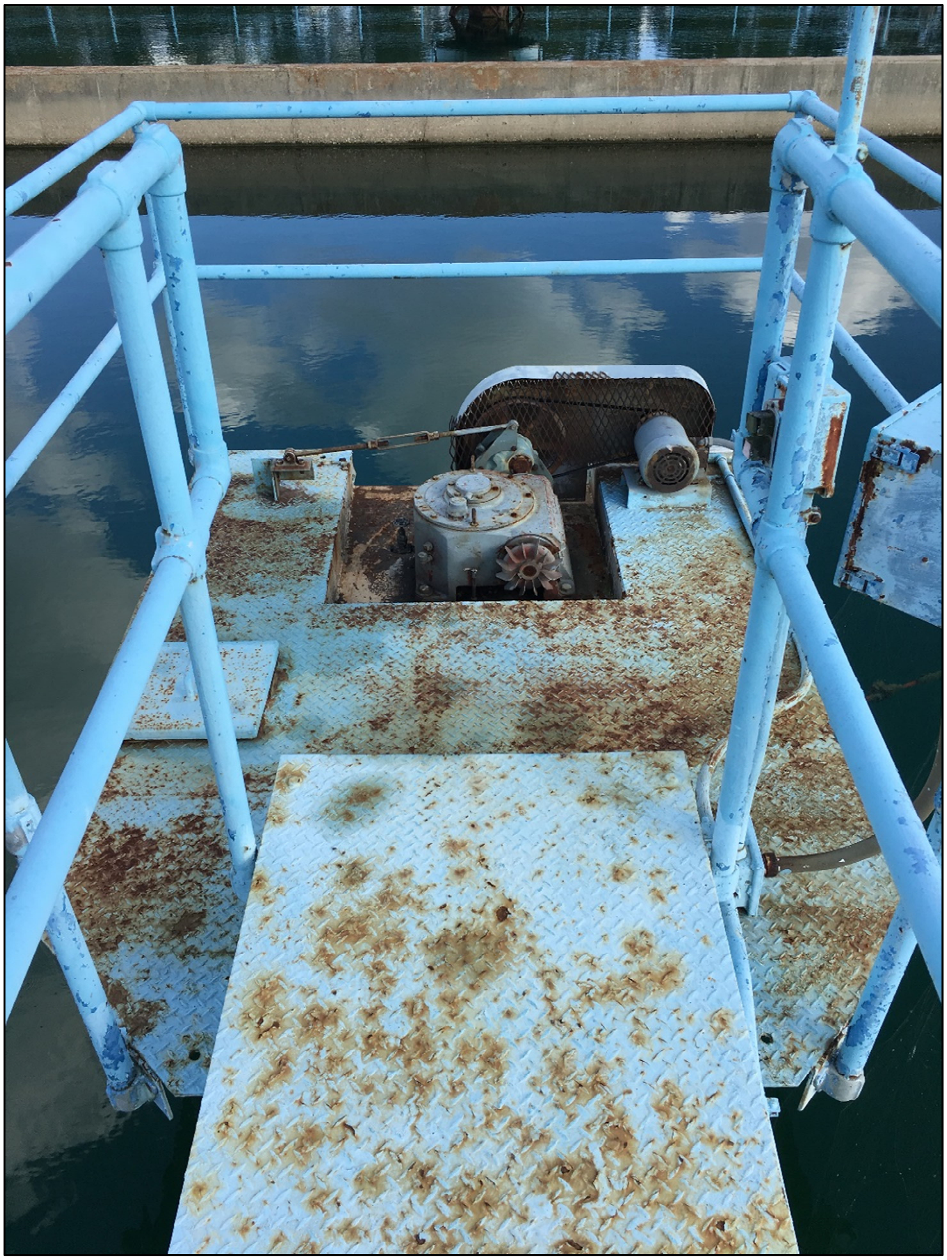

Figure 5-18: New Boston Road WTP Sedimentation Basin Rake Collector Bridge and Motor showing evidence of age

Filtration

The plant contains eight dual media gravity filters. These filters appear to be in good condition and work well. The plant staff operate them within acceptable parameters for filtration rates, filter run time, and backwashing rates, and the plant is able to meet its filtered water turbidity regulations. However, the filters do not currently have the capability to operate in filter-to-waste mode. Such a mode helps ripen a newly backwashed filter such that turbidity spikes are reduced once the filter is placed back into service. If desired, the filter backwash header could be integrated with a filter-to-waste mode. Further investigation on the need for filter-to-waste is recommended to determine its efficacy on filtered water turbidity goals.

The plant staff are in the process of making upgrades to the filters. Half of the filter control stations have been upgraded and the other half will be completed within the next one to two years. All filter inlet and outlet valves have recently been replaced. The plant has been working on recoating filter piping. In addition, the plant started replacing filter media and filter launders in 2017 at a rate of two or more filters per year.

Backwash water is stored onsite in an aboveground tank. The tank has a reported volume of 250,000 gallons which is enough volume for 1.7 to 2.5 filter backwashes. The backwash tank is filled from the finished water pipeline using a single pump. There is no redundant pump in place; however, if needed, the plant can fill the backwash tank from the potable water system.

Based on current operation of the filters, the plant should be able to continue operations at its rated capacity of 18 MGD. The filters could continue to operate for many years with the following improvements:

- Finish replacing all of the filter control stations and filter control valves;
- Finish upgrading filter media and launders; and,
- Maintaining piping and equipment coating systems.

Additional capacity would require expansion of the filters.

Dual Media Filter Operating Criteria

Type:	Dual Media, Constant Rate
Number of Filters:	8
Filter Area (Each)	714 ft^2
Filter Area (Total)	5,712 ft^2
Filtration Rate (18 MGD) All in Service One out of Service	 2.2 gpm/ft^2 2.5 gpm/ft^2
Filtration Rate (24 MGD) All in Service One out of Service	 2.9 gpm/ft^2 3.3 gpm/ft^2
Backwash Type:	Elevated Tank
Backwash Rate	15 gpm/ft^2
Backwash Storage Volume	250,000 gallons
Washwater Volume (per backwash)	100,00-140,000 gallons

Figure 5-19: New Boston Road WTP Filters showing aged launders

Figure 5-20: New Boston Road WTP Backwash Tank where Outside Condition of Tank Appears Good

Figure 5-21: New Boston Road WTP Backwash Pump

<u>Disinfection</u>

The plant uses gas chlorination system in combination with a gas ammoniator system. Chlorine is fed just upstream of the filters and in the combined filtrate line to get a free chlorine residual. Ammonia is fed into the combined filtrate line just downstream of chlorine injection to produce chloramines. The plant typically doses 2.5 - 3.0 mg/L of free chlorine upstream of the filters and enough to maintain a 3.5 mg/L free chlorine concentration downstream of the filters.

The plant operates to provide disinfection contact time for 0.5 log removal of Giardia and 2 log removal of virus. The plant does not require disinfection for Cryptosporidium removal. The plant has 9 MG of clearwell capacity and does not have trouble meeting disinfection requirements at max flows and minimum temperatures (worst case conditions).

Chemical Storage and Feed

The New Boston Road WTP utilizes a number of chemicals for treating the raw water. Some of these chemicals have been indicated in previous paragraphs. All of the chemicals are highlighted below.

Chlorine Dioxide
Chlorine dioxide is used to oxidize dissolved iron and manganese in the raw water for removal in the sedimentation and filtration processes of the WTP. Chlorine dioxide is generated onsite using sodium chlorite and chlorine gas. It is injected in the rapid mix basin at a typical concentration of 0.5 mg/L. The chlorine dioxide system was rebuilt in 2016 and is in new condition. It has a capacity of 250 lbs/day. The system uses gas chlorine and sodium chlorite to generate chlorine dioxide. Currently, the sodium chlorite system is a temporary system using totes. It is recommended that a permanent tank and metering pumps be provided for the long-term operational needs.

In addition, the chlorine dioxide system does not have redundant utility water pump or other components. Plant staff maintains spare parts for the chlorine dioxide systems, so that it can be repaired quickly.

Chlorine Dioxide Operating Criteria

Chlorine Dioxide Generator:	
Type:	Two Chemical (sodium chlorite/chlorine gas)
Capacity:	250 lb/day
Sodium Chlorite Storage Number Chemical Pumps	 Totes 1
Chlorine Gas Capacity	500 lb/day

Figure 5-22: New Boston Road WTP Chlorine Dioxide System

Aluminum Sulfate

Aluminum sulfate is used as a coagulant and injected into the rapid mix basin. The system consists of two storage tanks, a day tank, and two metering pumps. The storage tanks were replaced within the past ten years. The metering pumps are relatively new and in good working condition. The day tank is likely original to the 1970s upgrades and should be replaced based on its age. Plant staff reported all components to be in good condition and working order.

Aluminum Sulfate Operating Criteria

Storage Tanks:	
Number	2
Capacity (each tank)	2,250 gallons
Day Tanks:	
Number	1
Capacity (each tank)	250 gallons
Metering Pumps:	
Type	Diaphragm
Number	2
Duty	1

Figure 5-23: New Boston Road WTP Primary Coagulant Feed System

Sodium Hydroxide

Sodium hydroxide is used at the plant for pH adjustment. Water typically enters the plant at pH around 7.5. The addition of alum decreases the pH to around 6.0. Sodium hydroxide is added at the sedimentation basin outlet channel to increase the pH to approximately 8.1. The system can also add sodium hydroxide to the rapid mix basin, but this is not normally done.

The sodium hydroxide system consists of two insulated storage tanks, a day tank, and two metering pumps. The storage tanks and day tank are all new within the past 10 years. The metering pumps are 3 to 4 years old. The plant staff reported this chemical system to be in good working order. The system has adequate redundancy unless sodium hydroxide must be injected at both the sedimentation basin and the rapid mix basin. The plant has adequate spare parts and pumps for the system.

Sodium Hydroxide Operating Criteria

Storage Tanks:	
Number	2
Capacity (each tank)	6,700 gallons
Day Tanks:	
Number	1
Capacity (each tank)	565 gallons
Metering Pumps:	
Type	Diaphragm
Number	2
Duty	1

Figure 5-24: New Boston Road WTP Sodium Hydroxide Feed System

Chlorine Gas

The plant contains two chlorine gas systems. One system provides chlorine gas to the chlorine dioxide generator with capacity up to 500 pounds per day. The second system provides free chlorine to the filter influent and filter effluent at a rate up to 2,000 pounds per day. Both systems are new and in working condition. However, both systems lack proper backflow prevention with the utility water system, which creates a cross connection between the filtered and non-filtered chlorine solution pipelines. It is recommended that a proper backflow device be installed.

Chlorine Gas Operating Criteria

Type:	Ton Cylinders
Number Systems	2
Capacity: Chlorine Dioxide System Disinfection System	 500 lb/day 2,000 lb/day

Figure 5-25: New Boston Road WTP Chlorine Dioxide Feed System

Ammonia

The plant contains a single gas ammoniator for injecting ammonia in the filter effluent line. The system consists of an anhydrous ammonia storage tank and ammoniator. Ammonia is dosed based on free chlorine concentration to produce chloramines. The system has a maximum capacity of 400 pounds per day and was replaced in the last two years. Plant staff indicated they maintain the system regularly and keep all spare parts on the shelf; however, there is no redundancy with the system.

Ammonia Operating Criteria

Type:	Anhydrous Ammonia
Capacity	250 lb/day
Storage Volume	850 gallons

Figure 5-26: New Boston Road WTP Ammonia Tank

Figure 5-27: New Boston Road WTP Ammoniator

Polyphosphate

Polyphosphate is used as a corrosion inhibitor in the distribution system. It is injected into the finished water line just upstream of the high-service pump station. The polyphosphate system consists of a metering pump mounted on a chemical tote. A tote lasts approximately one to three months. Plant staff reported the system is in good working condition. Spare chemical pumps are kept on the shelf to provide redundancy.

Polyphosphate Operating Criteria

Storage	Totes
Metering Pump: Type Number	 Diaphragm 1

Figure 5-28: New Boston Road WTP Polyphosphate Feed System

Residuals

Residuals from the sedimentation basins and from filter backwashes are discharged to the sewer. No further analysis was given to this system and plant staff indicated there were no issues with the system.

Figure 5-29: New Boston Road WTP Residuals Collection Vault

WTP High-Service Pump Station

The WTP High Service Pump Station located in the Filter Building contains five vertical turbine pumps. Two pumps can provide 10 MGD each and the other three can provide approximately 2, 5.5, and 6.5 MGD each. The plant staff indicated that these pumps are routinely maintained and in good operating condition. The pump station can pump up to 30 MGD with all pumps in service.[18] The firm capacity of the pump station (largest pump out of service) is 18 MGD.

High Service Pump Station Operating Criteria

Pump Type	Vertical Turbine
Number of Pumps: 10 MGD 6.5 MGD 5.5 MGD 2 MGD	 2 1 1 1
Nameplate Capacity	34 MGD
Firm Capacity	18 MGD

Figure 5-30: New Boston Road WTP High Service Pump Station

[18] Personal Communication, 10/26/2016.

5.4.1.3.2 *Structural*

Although this is an old facility, it is in good structural condition compared to the other facilities discussed in this report. Minor leaks are observed at very few locations along the basin walls (**Figures 5-30** and **5-31**), but these could be effectively repaired at minimal cost.

Figure 5-30: Observed Effects of Water Leakage along Basin Wall at New Boston Road WTP

Figure 5-31: Observed Effects of Water Leakage within New Boston Road WTP

Figure 5-32: Observed Corroding of Metals in Bay at New Boston Road WTP

- Corroding grating and metals are observed but could be easily coated or replaced (**Figure 5-32**).
- The structural observations at this plant do not warrant a major structural repair. The minor leaks could be repaired easily by means of epoxy injection or urethane injection. Coating could also be applied to all corroding members. If the WTP is maintained on a consistent basis, the WTP could easily last another 20 years; however, additional and more stringent treatment requirements may not warrant the plant to remain in operation for an extended period of time as additional state and federal regulatory requirements evolve. Additionally, life of the plant assumes no additional capacity requirements.

5.4.1.3.3 *Electrical*

- The main service gear is a medium voltage lineup which serves the high service pumps and a single 480V MCC. The main switchgear was replaced recently and is in good condition **Figure 5-33**). The MCC located in the chemical building (**Figure 5-34**) serves all of the 480V loads at the facility and supplies power to all of the low voltage transformers located throughout the plant (example in **Figure 5-35**).
- The MCC is beyond the end of its useful life and has some severe corrosion due to its proximity to chemicals, water damage, working space code violations, modifications that could violate the UL listing of the equipment, and damage to front panels. This MCC is a severe safety hazard. It has no physical room to support expansion of plant facilities.

Due to the small transformer, that feeds the MCC and the 600A bus rating, it has no electrical capacity for expansion. At a minimum, the existing MCC should be replaced.

- To support any expansion of the facilities, the upstream transformer and cables would need to be replaced as well.

Figure 5-33: Main Switchgear at New Boston Road WTP

Figure 5-34: Main MCC at New Boston Road WTP

Figure 5-35: Example of a 480V Transformer (at Caustic Building) at New Boston Road WTP

5.4.2 Millwood WTP

The Millwood WTP receives water from Lake Millwood. Water is conveyed from a raw water pump station at the lake to a canal through three parallel pipelines (two 60" diameter, one 48" diameter) pipelines that are approximately one mile long. The raw water pump station is operated by the Southwest Arkansas Water District (SWAWD). Water in the canal then travels approximately five miles to the plant intake, which is a sluice gate from the SWAWD canal.

The Millwood WTP was constructed in 1986, and the plant has not had any major upgrades or expansions since that time. Typical operation of the plant by TWU is at approximately 10 MGD for 8 hours per day on Monday through Friday (15 MGD in the summer). The plant is rated at 15 MGD and also has a design and permitted capacity of 20 MGD. The plant is located on a 90-acre site and is also designed for an additional 20 MGD mirrored expansion.

The Millwood WTP serves both Texarkana (TX) and Texarkana (AR), as well as the other Riverbend WRD Member Entities. The Millwood WTP is jointly owned by Texarkana (TX) and Texarkana (AR). TWU operates the plant, and SWAWD owns and operates the raw water conveyance system. Texarkana (AR) has contracted water rights (162,200 acre-ft/year) from the SWAWD from Lake Millwood (pers. comm., SWAWD, 2018). A process schematic is included in **Figure 5-36**.

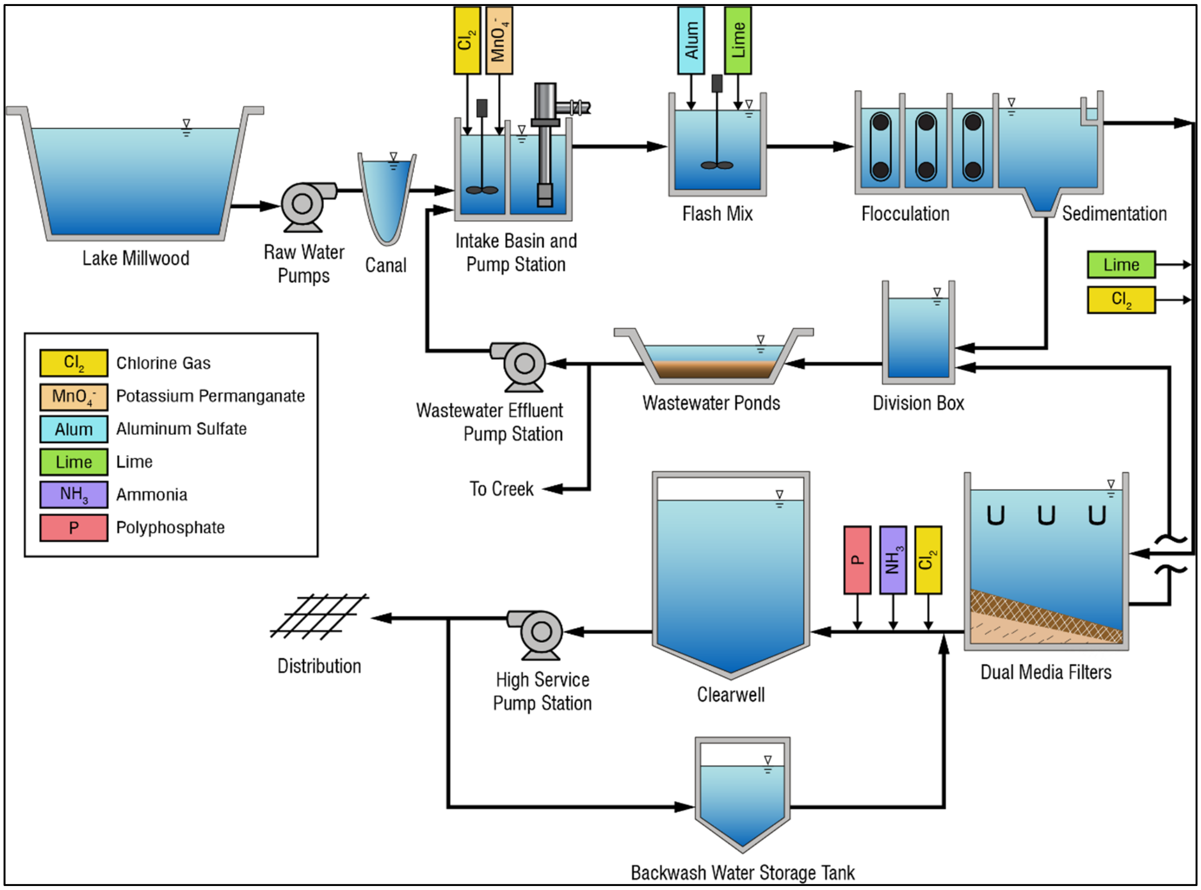

Figure 5-36: Schematic of Millwood WTP

5.4.2.1 Observations

The plant is approximately 30 years old and is mostly original with very few upgrades. Plant mechanical components have a typical useful life of 15 -25 years. The plant is able to meet treated water quality standards. When treatment requirements/standards differ between the State of Texas and State of Arkansas, TWU staff operate the facility according to the more stringent requirements.

5.4.2.2 Raw Water Conveyance Facilities

The raw water intake and pump station consists of six electrically driven 450 HP pumps and one diesel driven pump. The pump station supplies water to many different water users in the area. The intake and pump station are owned and operated by the SWAWD, who holds the surface water right for supply from Lake Millwood. A portion of the SWAWD water rights are contracted from SWAWD to the City of Texarkana, AR.

Figure 5-37: Millwood WTP

5.4.2.3 Treatment Plant

5.4.2.3.1 *Process*

The plant is located on a 90-acre site and has a large area available for future expansion. The treated water transmission pipeline has a design capacity of 45 MGD to accommodate an expansion of the WTP in the future. Expansion of the plant might be an option for providing treated water to meet the needs of Texarkana, AR and possibly Texarkana, TX if contracting of water across states lines can be negotiated[19].

TWU recently upgraded the filter control stations and has plans to upgrade the gas chlorinators. TWU should continue to upgrade the aged equipment at the plant to ensure reliability. This includes mixers, flocculators, sludge collectors, old pumps, old chemical tanks, etc. During the inspection a technical cross connection was observed in the utility water for the chlorinators; this was a common utility water supply manifold that feeds the chlorine injectors for both filtered

[19] Presently, treated water may be sold/conveyed across state lines by TWU; however, regulatory hurdles exist for the sale/conveyance of raw water across state lines.

and non-filtered chlorine solution pipelines. There is also a fair amount of piping showing corrosion.

Intake Basin and Pump Station

Water from the canal flows through an intake structure to the plant intake basin and pump station. The intake basin was designed to provide chemical addition, mixing, and contact time to assist with removal of iron, manganese, and taste and odor. This basin also provides a return for decant from the wastewater ponds. The intake basin contains a 25 HP vertical shaft mixer for chemical mixing. The mixer has not been used for many years, however, and the chemical piping has been disconnected such that chemical cannot currently be injected at the intake basin.

The intake basin provides a wet well for three vertical turbine pumps. There is space for a fourth pump, which has never been installed. These pumps provide the initial head for the rapid mix basin from which water flows by gravity through the remainder of the plant. Typical operation to deliver 15 MGD is with the 200 HP pump or both the 125 HP and 60 HP. Operators indicated the pump station is regularly maintained and in good working order.

Intake Pump Station Operating Criteria

Pump Type	Vertical Turbine
Number of Pumps:	
200 HP (15 MGD)	1
125 HP (10 MGD)	1
60 HP (5 MGD)	1

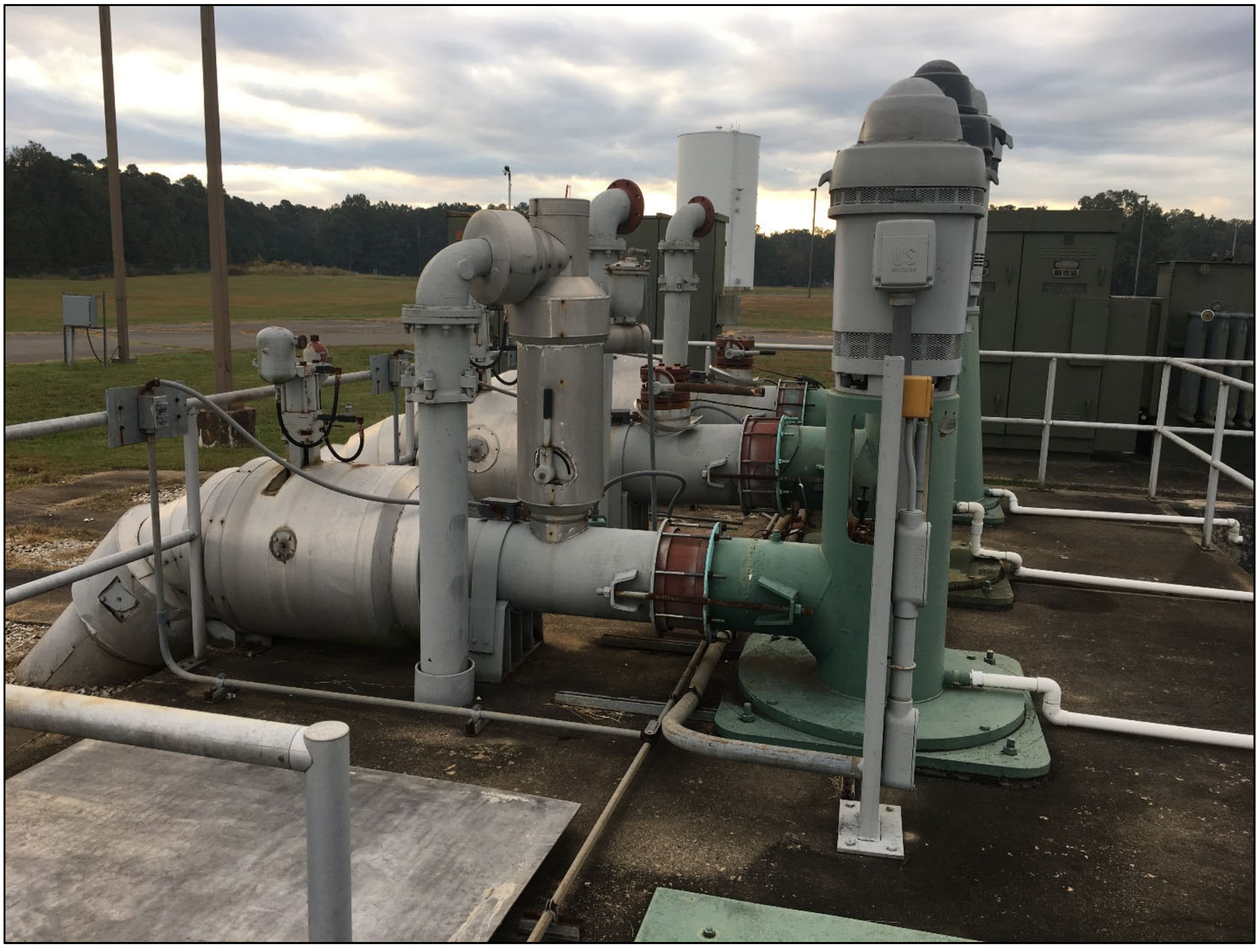

Figure 5-38: Millwood WTP Intake Pump Station

Figure 5-39: Millwood WTP Intake Basin

Flash Mix, Flocculation and Sedimentation

The plant contains a single rapid mix basin with two compartments, each containing a vertical shaft mixer. The mixers provide chemical mixing for both coagulant (aluminum sulfate) and lime addition. Lime is added to increase alkalinity of the water. Plant staff indicated that only one of the shaft mixers is presently operational. The shaft mixers are part of the original plant construction and have reached the end of their useful life.

The plant contains two flocculation basins and four sedimentation basins. Each flocculation basin feeds two sedimentation basins. Flocculation consists of three stage, tapered flocculation. Each stage contains horizontal, paddle-wheel flocculators and is separated by a concrete baffle wall. The horizontal flocculators are part of the original plant construction and have reached the end of their useful life. Plant staff indicated this equipment still operates well.

Each of the four sedimentation basins is long and narrow and contains two v-notch finger weirs for collection of the settled water. Solids are collected using a floating vacuum-style sludge collection system that suctions the settled sludge into a sludge collection channel from where it flows by gravity to the wastewater ponds. Plant staff have indicated the sludge collection system is in good working order. This system is original to the plant and such systems are known to last over forty years if properly maintained. It is recommended that mechanical parts (motors, drives, gear boxes, idlers, etc.) be maintained and replaced as needed.

Overall, the flash mix, flocculation, and sedimentation basin operate well. The plant continues to meet all of its water quality goals. Continuing to operate equipment beyond its typical useful life increases the risk of equipment failure. With this aged equipment, plant reliability can be classified as low because of the increased potential for failure of multiple pieces of equipment. With these risks aside, the plant should be able to continue to operate well at its rated capacity of 15 MGD.

Flash Mix, Flocculation, and Sedimentation Operating Criteria

Flash Mix Basins:	
Number	1
Mixer Type	Vertical Shaft
Number of Mixers (per basin)	3
Volume	27,000 gallons
Flocculation Basins:	
Number	2
Stages (per basin)	3
Flocculator Type	Horizontal, Paddle Wheel
Volume (per stage)	49,000 gallons
Volume (per basin)	147,000 gallons
Sedimentation Basins:	
Number	4
Length	150
Width	31
Depth	16
Volume (each basin)	556,500 gallons
Surface Area (each basin)	4,650 sf
Cross Sectional Area (each basin)	496 sf
Criteria with 4 Basin Online (15 MGD)	
Surface Loading Rate	0.56 gpm/ft^2
Detention Time	3.6 hours
Horizontal Velocity	0.70 ft/min
Criteria with 3 Basin Online (15 MGD)	
Surface Loading Rate	0.75 gpm/ft^2
Detention Time	2.7 hours
Horizontal Velocity	0.94 ft/min

Figure 5-40: Millwood WTP Flash Mixers

Figure 5-41: Millwood WTP Flocculation Basins

Figure 5-42: Millwood WTP Sedimentation Basin

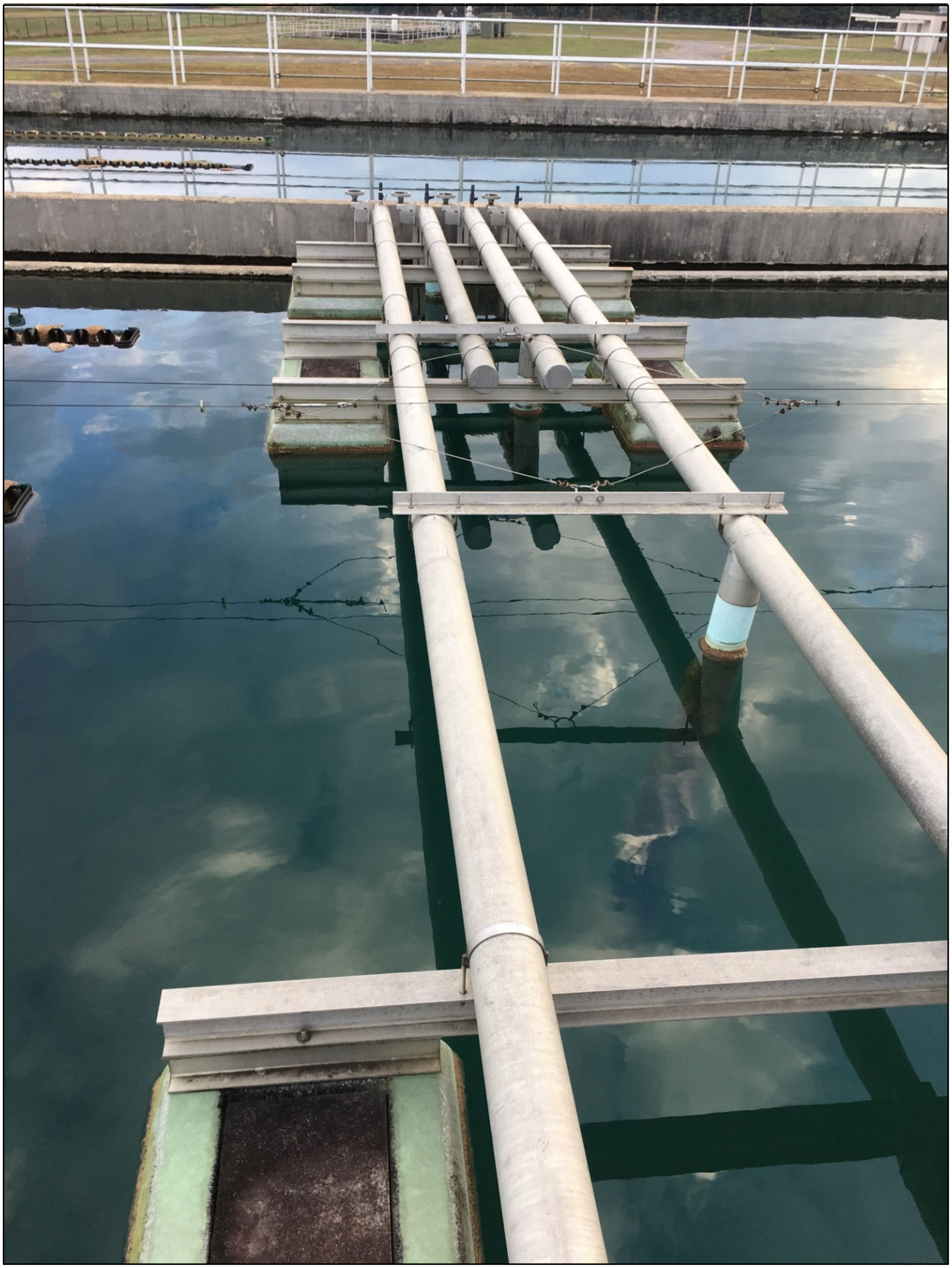

Figure 5-43: Millwood WTP Sedimentation Basin Vacuum Collection System

Filtration

The plant contains eight dual media gravity filters. These filters appear to be in good condition and work well. The operators operate them within acceptable parameters for filtration rates (Arkansas State maximum is 2.0 gpm/ft^2), filter run time and backwashing rates and the plant is able to meet the filtered water turbidity regulations. TWU is in the process of replacing all filter controls, including valve operators, instruments, and control stations. These upgrades should be completed within the next one to two years.

Backwash water is stored onsite in an aboveground tank. The tank has a reported volume of over 500,000 gallons which is enough for more than two filter backwashes. The backwash tank is filled from the finished water pipeline by an automatic control valve. Two filters are typically backwashed simultaneously.

It is expected that the filters could continue to operate reliably for many years once the control upgrades are made.

Dual Media Filter Operating Criteria

Type:	Dual Media, Constant Rate
Number of Filters:	8
Filter Area (Each)	744 ft^2
Filter Area (Total)	5,952 ft^2
Filtration Rate (15 MGD) All in Service One out of Service	 1.8 gpm/ft^2 2.0 gpm/ft^2
Backwash Type:	Elevated Tank
Backwash Rate	15 - 16 gpm/ft^2
Backwash Storage Volume	>500,000 gallons
Washwater Volume (per filter per backwash)	125,000 - 150,000 gallons

Figure 5-44: Millwood WTP Filters

Figure 5-45: Millwood WTP Filter Gallery Piping

Figure 5-46: Millwood WTP Filter Gallery Piping Showing Corrosion

Disinfection

The plant uses gas chlorination system in combination with a gas ammoniator system. Chlorine is fed just upstream of the filters to provide a residual through the filters. Additional chlorine is fed downstream of the filters in a chemical injection mixing vault. Ammonia is added just downstream of the chemical mixing vault to produce chloramines. TWU typically adds approximately 3.0 to 3.5 mg/L of free chlorine upstream of the filters to maintain a 1.2 to

1.5 mg/L residual downstream of the filters. More chlorine is added downstream of the filters to maintain a 3.5 mg/L free chlorine concentration downstream of the filters.

TWU operates to provide disinfection contact time for 0.5 log removal of Giardia and 2 log removal of virus. The plant does not require disinfection for Cryptosporidium removal. The plant has 3.25 MG of clearwell capacity and five miles of pipeline to provide disinfection contact time. The plant has no issues meeting disinfection requirements at max flows and minimum temperatures (worst case conditions).

Chemical Storage and Feed

The Millwood Lake WTP utilizes a number of chemicals for treating the raw water. Each of the chemicals is highlighted below.

Chlorine Gas

The plant chlorine building contains three chlorine regulator systems that can meet variable chlorination demands. The plant can feed up to 2,000 lb/day upstream of the filters and 1,000 lb/day downstream of the filters. The system is aged but remains functional. TWU is in the process of replacing it with a brand-new chlorination system. Plant staff indicated that they keep spare parts for the system, so they can keep it operational.

Chlorine Gas Operating Criteria

Type:	Ton Cylinders
Number Systems	3
Capacity: Intake Basin Upstream of Filters Downstream of Filters	 Not used 2,000 lb/day 1,000 lb/day

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Figure 5-47: Millwood WTP Chlorinators

Figure 5-48: Millwood WTP Chlorine Feed System

Aluminum Sulfate

Aluminum sulfate is used as a coagulant and injected into the rapid mix basin. The system consists of two storage tanks and two metering pumps. The storage tanks are original to the plant. The metering pumps are approximately one year old and in good working condition. Plant staff reported all components to be in good condition and working order. The storage tanks are beyond typical life expectancy and should be upgraded in the near future.

Figure 5-49: Millwood WTP Primary Coagulant Tank

Figure 5-50: Millwood WTP Primary Coagulant Feed Pumps

Aluminum Sulfate Operating Criteria

Storage Tanks: Number Capacity (each tank)	 2 10,000 gallons
Metering Pumps: Type Number Duty	 Diaphragm 2 1

Lime
The plant contains a hydrated lime slaking system to increase alkalinity and to provide pH control. Slaked, hydrated lime slurry is added to the rapid mix basin and downstream of the sedimentation basin (to a separate chamber that is attached to the rapid mix facility). Water typically enters the plant at pH around 6.8. The addition of alum and lime at the rapid mix basin provides a net decrease to around 6.1. Lime is added downstream of sedimentation to increase the pH to approximately 8.5.

The plant contains four lime slaking systems and the plant can operate to meet demands with two to three in operation. Flexibility is provided in the piping such that each system can feed to either of the two injection points.

The lime system is original to the plant. The system has been maintained, however, it is getting more difficult to locate replacement parts. The plant staff find the system challenging to operate, especially since it is difficult to change/control lime dose. TWU has budgeted to replace the lime system with a caustic soda system in 2018 or 2019.

Lime Slaking System Operating Criteria

Number Systems:	
Duty	3
Standby	1
Lime Silo:	
Number	2
Capacity	50 tons

Figure 5-51: Millwood WTP Lime Slakers

Figure 5-52: Millwood WTP Lime Injection

Ammonia

The plant contains a single gas ammoniator for injecting ammonia in the filter effluent line. The system consists of an anhydrous ammonia storage tank and ammoniator. Ammonia dosage is based on free chlorine concentration to produce chloramines. The system has a maximum capacity of 250 pounds per day. The system is relatively new and in good condition; however, there is no redundancy with the system. Plant staff indicated they maintain the system regularly and keep all spare parts on hand.

Ammonia Operating Criteria

Type:	Anhydrous Ammonia
Capacity	250 lb/day
Storage Volume	850 gallons

Figure 5-53: Millwood WTP Ammonia Tank

Figure 5-54: Millwood WTP Ammoniator

Polyphosphate

Polyphosphate is used as a corrosion inhibitor in the distribution system. It is injected into the finished water line just upstream of the clearwell. The polyphosphate system consists of a metering pump mounted on a chemical tote. A tote lasts approximately three to four months. Plant staff reported the system is in good working condition. Spare chemical pumps are kept in reserve to provide redundancy.

Polyphosphate Operating Criteria

Storage	Totes
Metering Pump: Type Number	 Diaphragm 1

Figure 5-55: Millwood WTP Polyphosphate Feed System

Residuals

Residuals from the sedimentation basins and from filter backwashes are discharged to wastewater ponds. The plant contains six earthen lagoons that are oriented into three parallel trains, each train consisting of two ponds in series. Solids settle out in the ponds, and the decant can be pumped back to the intake basin or discharge to a creek. Typical operation is discharging it to the creek. The pods are cleaned out every two to three years. Plant staff indicates that the ponds are working well with no issues.

Figure 5-56: Millwood WTP Wastewater Ponds

WTP High-Service Pump Station

The WTP High Service Pump Station consists of five pumps vertical turbine pumps. The two largest pumps are 500 HP and can deliver 10 MGD each. Two of the pumps are 250 HP and can deliver 5 MGD each. The fifth pump is a small 50 HP pump and is used to provide surface wash to the filters and is not factored into the pump station capacity. The plant operators indicated the pump station operates with one 500 HP and one 250 HP pump to provide 15 MGD flow. The pump station can deliver 30 MGD with all four pumps on. The firm capacity of the pump station (largest pump out of service) is 20 MGD.

High Service Pump Station Operating Criteria

Pump Type	Vertical Turbine
Number of Pumps: 500 HP, 10 MGD 250 HP, 5 MGD 50 HP, 516 GPM (for filter surface wash)	 2 2 1
Nameplate Capacity (emergency capacity)	20 MGD
Firm Capacity (typical capacity)	15 MGD

Figure 5-57: Millwood WTP High Service Pump Station

Figure 5-58: Millwood WTP High Service Pump Station Discharge Piping Shown in Good Condition

5.4.2.3.2 *Structural*

Several major cracks and major leaks were observed in the walls and slabs of the basins and other structures (examples in **Figures 5-59**, **5-60**, **5-61**, and **5-62**). This results in several wet areas causing corrosion.

Figure 5-59: Observed Cracking on Wall of Basin at Millwood WTP

Figure 5-60: Observed Cracking on Basin at Millwood WTP

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Figure 5-61: Observed Cracking on Basin Wall at Millwood WTP

Figure 5-62: Observed Cracking and Leakage on Basin Wall at Millwood WTP

There are no construction or expansion joints throughout the basins lending them to major cracks and extreme leaks (example in **Figure 5-63**).

Figure 5-63: Observed Cracking in Basin Walls; No Apparent Expansion Joints at Millwood WTP

- Metal structures such as stairs, pipe supports, grating, and connections are corroding.
- Cantilevered concrete portions of the basins have spalled concrete with extreme aggregate and corroding rebar exposure, waterstop exposure, and severe leaks and deflection (examples in **Figures 5-64**, **5-65**, **5-66**, and **5-67**).

Figure 5-64: Observed Extreme Concrete Spalling and Corroding Structure at Millwood WTP

Figure 5-65: Observed Exposed Rebar and Concrete Spalling on Structure at Millwood WTP

Figure 5-66: Observed Extreme Concrete Spalling and Erosion (note lack of rebar) on Structure at Millwood WTP

Figure 5-67: Observed Extreme Deflection on Basin Wall at Millwood WTP

TWU has previously requested an evaluation of the concrete settling basin, a report of which was submitted by Eikon Consultant Group on July 23, 2014. Two key elements from this report are:

- "It appears that these boxes have been repaired in the past. The concrete at the lower portion of the boxes appeared to be a previous repair. The existing drawings did not show a waterstop in the wall as shown in the photographs. It is possible that this was added during the repair to the boxes," and
- "The possibility always exists that conditions at the site may vary from those areas observed during visits…Recommendations contained herein are not considered applicable for an extended period after the completion date of this report."

Based on the statements quoted in the Eikon report dated July 23, 2014, it appears the basins have been repaired in the past, and while a new proposal is in place to repair the basins, these repairs do not appear to be permanent but rather temporary. The pictures below (**Figures 5-68**, **5-69**, and **5-70**) reflect a sample of the completed repairs to the basins done by others.

Figure 5-68: Example 1 of Completed Repairs

Figure 5-69: Example 2 of Completed Repairs

Figure 5-70: Example 3 of Completed Repairs

Based on evaluations by the Roth Team, it is recommended that for the near and long term, the basins of this facility need to be replaced, if they continue to be used. From the observations performed herein, there does not appear to be much life remaining in the basins and any repairs, although likely very expensive, would only be a temporary fix and would not completely resolve the observed issues.

For example, observations at the basins reveal major structural concerns that warrant a long-term fix. A short-term fix such as an epoxy repair will not address the structural concerns observed. Epoxy repairs are typically short term and are used for minor repairs on structures that do not have major structural concerns. The major structural concerns are summarized, as follows:

- The extensive cracking in the basins indicate that the walls and slabs may not have adequate minimum shrinkage and temperature reinforcement to meet the requirements of ACI 350, Code Requirements for Environmental Engineering Concrete Structures and Commentary. Walls and slabs of this nature typically have construction joints about every 40 feet and expansion joints about every 100 feet. No joints were observed in the walls and slabs at the current basins. It would be impossible to introduce additional steel and joints in an existing structure by an epoxy repair.

- Due to the observed deflection of the cantilevered portion of the basins, additional concrete thickness and extra reinforcing would be required to address the strength and serviceability concerns observed. Again, epoxy repair cannot correct this concern.

- The extensive spalling at the basins could mean that the original concrete mix used had some defects either in the materials used or did not meet quality control requirements for mixing and placing of concrete. Alkali aggregate reactivity potential, sulfate and chloride corrosion all appear to exist here. Any repair mortar or concrete including an epoxy repair is susceptible to spalling again.

- As noted in the Eikon report dated July 23, 2014, it appears the basins have been repaired in the past. As of early 2018, repairs made to the basins, although aesthetically pleasing, do not represent a permanent solution to the major structural concerns. The basins observed at Millwood WTP are a major structural concern and require extensive detailed analysis of the entire structure. It is recommended that such analysis be conducted in the near future, and it is anticipated that this analysis will result in a major structural retrofit, if feasible, or a complete replacement.

A few other observations concerning Millwood WTP are listed below as follows:

- The treated water conveyance pipeline is elevated to road level on a bridge crossing the Red River. There exists a risk that a traffic accident could compromise the pipeline and effectively cut off Millwood WTP supply to the TWU System. A plan should be in place in the event of this type of accident.

5.4.2.3.3 *Electrical*

This facility's main electrical gear is medium voltage, which serves the high service pumps, and a medium voltage loop throughout the plant with load centers to step the voltage down to 480V at each major process area (see **Figures 5-72** and **5-72**). The medium voltage loop of the facility is ideal for adding additional process areas with minimal impact to the rest of the plant during construction and the gear. Despite the age of the facilities, the overall condition of the electrical distribution is in fair condition due to the extensive care and maintenance provided by plant staff.

Figure 5-71: Chemical Building MCC at Millwood WTP in Fair Condition

Figure 5-72: High Service Switchgear at Millwood WTP

On a positive note, the large amount of land compared to the density of facilities will likely mean that the underground duct banks and piping will not be congested. Regular cleaning and maintenance should further be performed at the facilities to ensure that there are no internal problems with the gear and forecast any equipment failures.

A few of the existing panels have been subject to corrosive atmospheres, have broken doors, etc. and should be replaced to prevent potential catastrophic failures. The remaining equipment is serviceable but at the end of its life. If process or regulation changes require the upgrade or expansion of any particular facility, it is recommended that the associated load center and distribution system be replaced.

5.4.3 Graphic Packaging International WTP

Graphic Packaging International (GPI) WTP treats water from Wright Patman Lake. The GPI WTP, owned by Texarkana (TX) and operated by GPI, provides potable water to the mill and also serves the Cities of Atlanta, Domino, and Queen City (when requested). It was built in 1972 and expanded in 1978 (added flocculation basin, sedimentation basin, and three sand filters). In 2000, GAC contactors, potable water clearwell, and associated sodium hypochlorite system were added for potable water treatment. GPI states that they have an extensive schedule for short-term and long-term capital improvements and operates to all regulatory standards for drinking water.

The GAC contactors were added to address taste and odor and disinfection by-product concerns. The plant is permitted for 46 MGD; however, its rated capacity is 35 MGD. Most of the water produced at the plant (30 MGD average) is used as process water for the paper mill. A small amount of treated water goes through the GAC contactors (permitted up to 2.4 MGD for peak demands, 1.5 MGD average demand) and provides potable water to the mill and the neighboring cities of Atlanta and Domino. Queen City, currently supplied by groundwater, also has a connection to the water distribution system as a redundant water supply. More recently, Queen City experienced a power outage at one of its pump stations due to inclement weather. Queen City contacted TWU to receive potable water from the GPI WTP. As previously stated, Graphic Packaging International finances and operates the water treatment plant, while TWU owns the facilities, along with TWU owning and operating the raw water conveyance facilities. A process schematic is included in **Figure 5-73**.

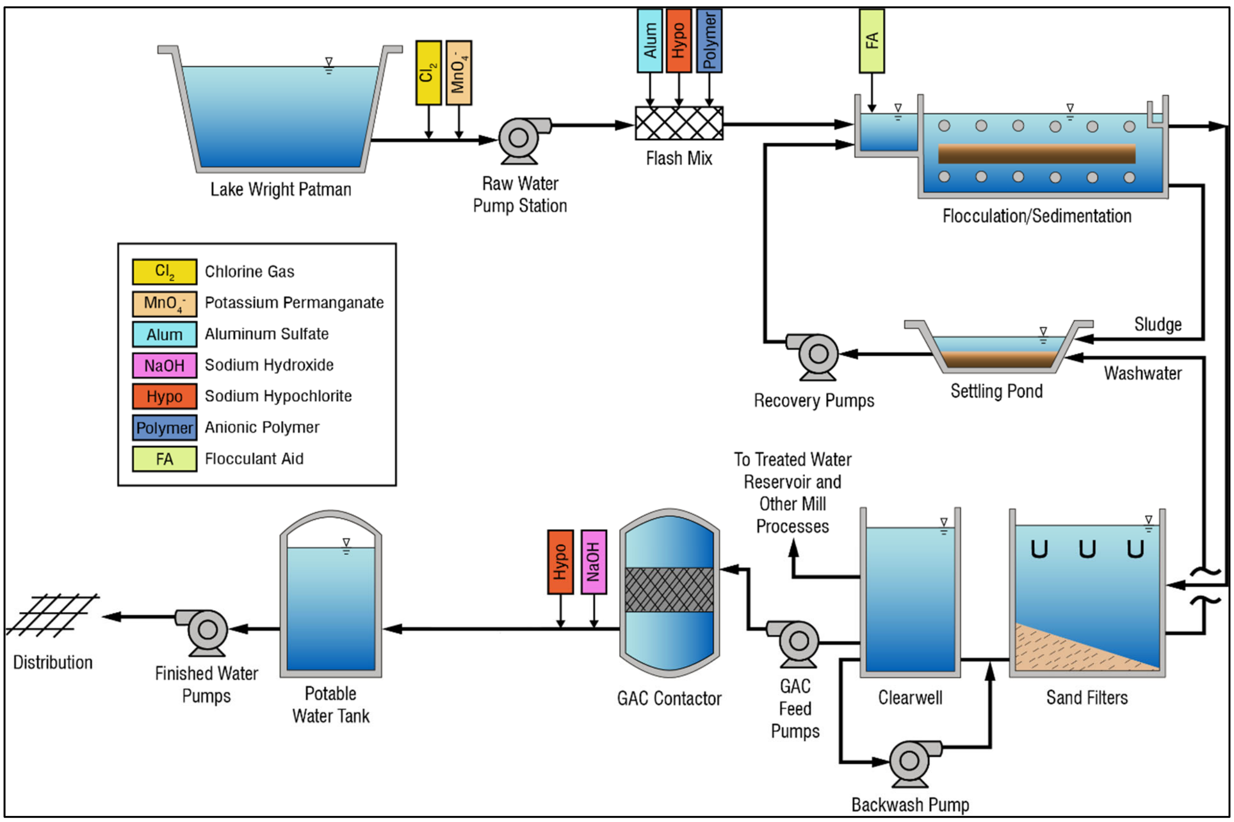

Figure 5-73: Schematic of the GPI WTP

5.4.3.1 Observations

The processes at the GPI facility (intake and plant) are listed as follows:

- Raw Water Intake;
- Preoxidation with chlorine;

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- Coagulation/Flocculation;
- Sedimentation;
- Filtration with sand filters;
- Clearwell;
- GAC filtration;
- Disinfection;
- Storage; and
- Distribution.

Residuals are listed as follows:

- Clearwell;
- Backwash pump;
- Backwash recovery pond;
- Decant to sedimentation basins; and
- Solids disposed.

The GPI WTP is aged, with many original plant components still active. However, the plant does have relatively new components associated with a second expansion that occurred in 2000 (specifically, the GAC contactors and Potable Tank) and those components appear to be in good condition. The GPI plant staff indicate the plant operates well, with their biggest challenge being manganese removal during the summer season.

5.4.3.2 Raw Water Conveyance Facilities

5.4.3.2.1 *Process*

Wright Patman Lake Intake, Pump Station, and Transmission Pipeline

The GPI WTP intake and pumping facilities were constructed in the early 1970s. The pump station consists of four 700 hp vertical turbine pumps and one 250 hp vertical turbine pump. The pumps are mounted on a platform over the lake. The pump bowls are submerged into the lake via a vertical stand pipe ("pump can") that extends from the platform to a depth below the lake surface. Two of the canned intakes are set at a shallow depth, and three are set at a deeper depth giving flexibility to remove water at two different depths.

At present, the 250 hp pump is not operational. All of the working pumps are typically in operation making it difficult for routine maintenance of the pumps to be conducted. The TWU staff indicated the pump station is operating well despite not being able to take a pump out of service for maintenance and repairs as frequently as needed. Observations made at the pump are listed as follows:

- Lack of pump redundancy does not allow for pumps to be regularly taken off line;
- The small 250 hp pump is not operational;
- Coating on motors, pump heads, and piping needs to be repaired/replaced; and,
- Grating on the walkway to the pump station is bowed creating raised edges.

Water is conveyed to the GPI WTP through a 15 mile, 42-inch steel pipeline lined with concrete on the interior and exterior of the line. This pipeline was constructed in the 1970s at the same time as the plant and the intake. The pipeline is thought to be in good condition.

Raw Water Pump Station Operating Criteria

Pump Type	Vertical Turbine
Number of Pumps: 700 HP 250 HP	 4 1

Figure 5-74: GPI WTP Intake Pump Station

Figure 5–75: GPI WTP Intake Pump Station Pumps and Piping Showing Deficient Coatings

Figure 5-76: GPI WTP Intake Pump Station Pumps and Piping Showing Deficient Coating

<u>Raw Water Chemical Addition</u>

Just downstream of the pump station, free chlorine and permanganate can be added to the raw water to assist with iron, manganese, and taste and odor removal. Gaseous chlorine is continually added at rates of up to 2,700 pounds per day. The goal of the operators is to maintain a chlorine residual at the plant influent.

The sodium permanganate system consists of a bulk storage tank, day tank, and two diaphragm pumps. The GPI plant staff indicate the system is still in good condition and operates well. The chlorine gas system consists of four regulators, each rated at 400 lb/day. The plant staff are able to optimize the system to achieve a maximum of 2,700 lb/day, which exceeds the rating of the system. At the maximum feed rate, operators are replacing the one ton cylinders every three to four days. This chlorination facility is undersized for current system demand. The system is also outdated and has reached the end of its useful life.

Chemical Pretreatment Operating Criteria

Sodium Permanganate:	
Storage Tanks:	
Number	1
Day Tanks:	
Number	1
Metering Pumps:	
Type	Diaphragm
Number	2
Duty	1
Chlorine Gas:	
Type	Ton Cylinders
Capacity	1,600 lb/day

Figure 5-77: GPI WTP Intake Pipeline Chlorination Handling System

Figure 5-78: GPI WTP Intake Pipeline Chlorinators

Figure 5-79: GPI WTP Intake Pipeline Sodium Permanganate Tank

Figure 5-80: GPI WTP Intake Pipeline Sodium Permanganate Feed System

At the GPI intake and pump station, it was observed that the 250 hp pump does not function properly. The chlorination system is outdated and undersized for the current application. The disinfection system should be replaced with an adequately sized system to provide plant reliability.

5.4.3.2.2 *Structural*

Structurally the intake appeared to be in good condition for the short-term and long-term (**Figure 5-81**).

Figure 5-81: GPI Raw Water Intake on Wright Patman Lake Shown in Good Condition

Figure 5-82: Prefabricated Chlorine Building at GPI Showing Rust and Corrosion

The shell of the prefabricated chlorine building is rusted and corroded (**Figure 5-82**).

Figure 5-83: Prefabricated Chlorine Building at GPI Showing Corrosion and Opening in Roof

The roof of the chlorine building is also corroded, with several openings observed which allow water to leak into the room (**Figure 5-83**). It appears that as a result of water leaks into the building, corrosion is occurring on all members and equipment inside the facility.

Figure 5-84: Prefabricated Chlorine Building at GPI Showing Corrosion in Gutters

The chlorine building roof gutters around the perimeter of the roof have corroded and have several openings in them rendering them ineffective (**Figure 5-84**). The chlorine building's roll-up door, windows, and window frames are all corroded (**Figure 5-85**).

Figure 5-85: Prefabricated Chlorine Building at GPI Showing Corrosion on Window

Following inspection and determining feasibility, the chlorine building may utilize the framework of the structure for a short term. The framework of the structure needs to be inspected, prepared, and coated if feasible. Replacement should be considered for the metal shell, roof, etc. Other needs such as capacity, however, may necessitate a new chlorine building/facility completely.

For the long term, consideration should be given to replacing the chlorine building with a non-corrosive building such as a masonry building.

5.4.3.2.3 *Electrical*

The switchgear and VFD were recently replaced due to recent equipment failures. This electrical equipment is all in excellent condition (**Figures 5-86 and 5-87**).

Figure 5-86: Main Switchgear at GPI Intake Recently Replaced

Figure 5-87: VFDs at GPI Intake Recently Replaced

Figure 5-88: Outside Motors at GPI Intake Showing Corrosion and Some Out-of-Service Motors

The electrical staff reported that the existing motors are very old and have been experiencing failures (**Figure 5-88**) which have required recent motor re-builds. During investigation, there was more than one motor out of service.

5.4.3.3 Treatment Plant

5.4.3.3.1 *Process*

Flash Mix, Flocculation and Sedimentation

Flash mixing is provided using an inline static mixer. The static mixer was installed in 1972 and is still in use. GPI plant staff indicate the mixer is cleaned every year and still in good condition. Alum, polymer, and sodium hypochlorite can be added during flash mixing. Polymer is not typically added, and hypochlorite is only used when needed to boost chlorine residual (typically during the summer months).

After flash mixing, water is conveyed approximately 0.25 miles in a pipeline to one of three high-rate sludge blanket clarifiers called pulsators. Flocculent aid is added just upstream of the sedimentation basins. A vacuum pump is used to create pulsations with the sludge blanket promoting flocculation and clarification in one step. Each clarifier contains a center launder that collects water from perforated pipe laterals that run across the width of the basin. Sludge is drained from each clarifier to a single Backwash Recovery Pond. The GPI plant staff indicated that the clarifiers work well with no issues. GPI is in the process of replacing the clarifier sludge extraction system.

Flash Mix, Flocculation, and Sedimentation Operating Criteria

Flash Mix: Mixer Type Number	 Static 1
Flocculation/Sedimentation Basins: Number Type	 3 High Rate, Pulsator

Figure 5-89: GPI WTP High Rate Clarifiers Shown Working Well.

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Filtration

The plant contains eight constant level, rapid sand filters. Each filter is 24 feet by 42 feet with 40 inches of sand and is rated for 5,000 gpm of flow (5 gpm/ft^2). Each filter is taken offline for maintenance on an annual basis and sand is replaced every five to eight years. GPI plant staff indicated that the filters work well and do not have any issues. The filter control valves and associated piping is corroded and in some places leaking. The GPI plant has begun rebuilding all of the filters, including underdrains, piping, and valves. One filter was recently completed and the remaining will be replaced over the next three to four years.

All filtered water goes to the rectangular, concrete clearwell from which it is transferred to a treated water reservoir and other mill processes (process water), GAC contactors (potable water), and the filters (backwash water). The filters are backwashed using a single backwash pump. Typical backwash rates are 3.5 - 3.6 gpm/sf and may be as high as 4.6 gpm/sf. Backwashing occurs based on effluent turbidity measurements and all filter waste washwater goes to the backwash recovery pond. The backwash pump is old and likely original to the plant. The GPI plant staff indicate the pump runs well and is routinely maintained. The GPI plant keeps all spare parts (motor, impeller, seals, etc.) on site so that repairs can be made quickly (within hours). The pump exterior and associated piping exterior show corrosion. It is recommended that the corrosion be removed to determine if there are structural integrity issues resulting from the corrosion. Any piping or equipment that is not structurally sound should be replaced. The equipment and piping should be recoated to provide protection.

Dual Media Filter Operating Criteria

Type:	Sand, Constant Level
Number of Filters:	8
Filter Area (Each)	1,008 ft^2
Filter Area (Total)	8,064 ft^2
Filtration Rate (46 MGD) All in Service One out of Service	 4.0 gpm/ft^2 4.5 gpm/ft^2
Filtration Rate (41 MGD) All in Service One out of Service	 3.5 gpm/ft^2 4.0 gpm/ft^2
Backwash Type:	Backwash Pump
Backwash Rate	5.0 gpm/ft^2

Figure 5-90: GPI WTP Sand Filters Shown Working Well.

Figure 5-91: GPI WTP Filter Effluent Piping Showing Corrosion

Figure 5-92: GPI WTP Filter Piping Showing Corrosion

Figure 5-93: GPI WTP Filter Piping Showing Corrosion

Figure 5-95: GPI WTP Backwash Pump Showing Corrosion

GAC Contactors

The GPI plant contains six pressurized GAC contactors for taste, odor, and disinfection byproduct (DBP) removal. The contactors are operated in series. On average, GAC media in each vessel is exchanged three times per year. The GPI plant staff indicated that the contactors work well and have eliminated all previous taste and odor complaints and DBP concerns, however, operation and maintenance cost to replace the spent media is expensive.

The feed to the GAC contactors is provided by two GAC supply pumps that pump from the clearwell based on water level in the potable water tank. The pumps operate as duty/stand-by. GPI plant staff indicated that the pumps operate well and are continually maintained. Coating on the piping and pumps has corroded and is in need of rehabilitation.

Caustic soda and sodium hypochlorite are added to the water downstream of the GAC contactors. The piping contains parallel static mixers to provide complete mixing. Caustic soda is added to increase the pH from around 7.5 to 8.0 - 8.2. Hypochlorite is added to raise the residual to 1.0 - 1.5 mg/L free chlorine. The potable water tank has a capacity of 385,000 gallons.

Figure 5-96: GPI WTP GAC Contactors Showing Potential Needs for Coating Repair

Figure 5-97: GPI WTP GAC Contactor Piping Shown in Good Condition

Distribution

Potable water to the mill and other nearby cities is provided out of the potable water tank using one of three pumps. All of the pumps have VFDs. Two of the pumps are electrically driven while the third is diesel driven (used for emergencies). Only one pump is needed to meet the distribution system demands. The pumps operate to maintain a distribution pressure set-point of (approximately 100 psi). GPI plant staff indicated the pump station works fine.

Figure 5-98: GPI WTP Potable Water Pumps and Piping Showing Corrosion

Disinfection

The plant uses sodium hypochlorite to provide a free chlorine residual of 1.0 to 1.5 mg/L to the Potable Water Tank. The plant is able to meet their 2-log virus and 0.5 log Giardia disinfection requirements using the potable water tank. At peak flows (2.4 MGD), minimum water temperature (10^0C) and a chlorine residual of 1.0 mg/L, the GPI plant can meet disinfection requirements with the potable water tank at 15 percent capacity. If free chlorine residual is maintained at 1.5 mg/L, only 10 percent tank capacity is needed.

Plant Residuals

Residuals from the GPI WTP include sludge from the clarifiers and waste washwater from the filters. These residual streams go to a backwash recovery pond. Decant from this pond is recycled to the influent of the clarifiers. The solids settle to the bottom of the pond. The pond is dredged every year.

<u>Chemical Storage and Feed</u>

The GPI WTP utilizes a number of chemicals for treating the raw water. Some of these chemicals have been indicated in previous paragraphs. All of the chemicals are listed below, as follows:

Aluminum Sulfate

Aluminum sulfate is used as a coagulant and injected into at the raw water static mixer. This chemical system consists of a storage tank and two chemical metering pumps. GPI plant staff indicated this chemical system is in good condition.

Aluminum Sulfate Operating Criteria

Storage Tanks: Number	 1
Metering Pumps: Type Number Duty	 Diaphragm 2 1

Figure 5-99: GPI WTP Sodium Hypochlorite Tank Shown in Good Condition

Sodium Hypochlorite

The plant has two sodium hypochlorite feed systems. The first is at the GPI plant inlet and consists of a storage tank and two chemical metering pumps. This system is typically only used in the summertime when iron and manganese are high. This system operates to maintain a residual of 5 - 7 mg/L of free chlorine. The second hypochlorite system was part of the year 2000 plant upgrades. It consists of a storage tank and three metering pumps. Two metering pumps provide chlorine downstream of the GAC Contactors. A third pump provides chlorine to the weir upstream of the filters. This third pump is used only when operators want to increase chlorine residual at the filters. The GPI plant staff indicated this system is in good working condition.

Sodium Hypochlorite

Raw Water	
Storage Tanks:	
Number	1
Metering Pumps:	
Type	Diaphragm
Number	2
Duty	1
Finished Water	
Storage Tanks:	
Number	1
Capacity (each tank)	10,000 gallons
Metering Pumps:	
Type	Diaphragm
Number	3
Duty (finished water)	1
Duty (filter influent)	1

Figure 5-100: GPI WTP Sodium Hypochlorite Feed System Enclosures

Flocculant Aid

Flocculant Aid is added just upstream of the clarifiers. It is added to improve flocculation performance in the clarifiers. This system consists of a single storage tank and three chemical metering pumps. Operators indicated this chemical system is in good condition.

Flocculant Aid Operating Criteria

Storage Tanks: Number	 1
Metering Pumps: Type Number Duty	 Diaphragm 3 2

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Polymer

Anionic Polymer can be added at the raw water static mixer to help improve settling in clarifiers. The system consists of a storage tank and two metering pumps. GPI plant staff indicated this chemical system is in good condition.

Polymer Operating Criteria

Storage Tanks: Number	 1
Metering Pumps: Type Number Duty	 Diaphragm 2 1

Sodium Hydroxide

Sodium hydroxide is used at the plant for pH adjustment. Typical water enters the GPI plant at pH around 7.5. Sodium Hydroxide is added downstream of the GAC Contactors to increase the pH to between 8.0 and 8.2. GPI plant staff indicated this chemical system is in good condition.

Sodium Hydroxide Operating Criteria

Storage Tanks: Number	 1
Metering Pumps: Type Number Duty	 Diaphragm 2 1

<u>Expansion and Other Infrastructure</u>

The GPI WTP is situated within the south endof the mill process area. As such, there is room around the south end of the plant for expansion. However, the economic viability of the expansion would need to be evaluated by GPI in coordination with TWU and/or the municipalities served.

Figure 5-101: Pump at GPI WTP Showing Leakage

Figure 5-103: Ineffective Coating at GPI WTP Showing Corrosion

Much of the piping and pumps at the plant have aged, and the coating is not intact. Consideration should be given to recoating piping and replacement/refurbishment of pumps (examples in **Figure 5-101 and 5-103; Figure 5-102** has been intentionally left blank). The mechanical components have reached the end of their useful life and consideration should be given to replacement.

5.4.3.3.2 *Structural*

Several cracks and leaks are noted in the walls of the basins. This results in several wet areas resulting in corrosion of bolts, members, and equipment/units (examples in **Figures 5-106 and 5-107; Figures 5-104 and 5-105** have been intentionally left blank**)**.

Figure 5-106: Cracks in Basin Wall and Resulting Leakage and Corrosion at GPI WTP

Figure 5-107: Crack in Basin Wall and Resulting Leakage and Corrosion at GPI WTP

An entire length of the basin wall is braced back for support. The interior walls also have some brace supports to hold them in place. There are no construction or expansion joints throughout the basins, lending it to cracking. Metal structures such as stairs, pipe supports, grating, and connections are also observed to be corroding (examples in **Figures 5-109, 5-110, and 5-111; Figure 5-108** has been intentionally left blank).

Figure 5-109: Example of Pipe Deflection at GPI WTP

Figure 5-110: Example of Corrosion of Stairs at GPI WTP

Figure 5-111: Example of Corrosion at Pipe Connections at GPI WTP

There are many overhead pipe-supports that show cracks and appear unstable. The Roth Team observed that there does not appear to be much remaining life for GPI WTP structures; repairs, although likely expensive, would only be a temporary solution and may not solve the observed issues completely. Overall, for the short and long term, consideration should be given to replacing this facility.

Management of an aging treatment facility is part of the operational and strategic planning for manufacturing facilities, such as GPI. In order for an expansion to occur, the existing facility would need to be retrofitted; however, an expansion to it might not be feasible, thereby negating the cost savings. The extra expense incurred from designing overhead structures and constructing them will also be a significant consideration. An extensive review, detailed study and analysis needs to be carried out if the option of locating a new basin at the existing site is pursued. Particular consideration should be given to utilizing the existing intake and chemical feed structures since they are outside the location of the existing process facilities.

Structural observations at the existing structures reveal major structural concerns that warrant a long-term fix. The major structural concerns are summarized and noted below:

- The extensive cracking in the basins indicate that the walls, slabs and overhead pipe supports may not have adequate minimum shrinkage and temperature reinforcement to meet the requirements of ACI 350, Code Requirements for

Environmental Engineering Concrete Structures and Commentary. Walls and slabs of this nature typically have construction joints about every 40 feet and expansion joints about every 100 feet. It would be impossible to introduce additional steel and joints in an existing structure by an epoxy repair.

- A major structural concern is typically addressed by an extensive detailed analysis of the structure which would lead to a recommendation for either a major structural retrofit if feasible or a complete replacement of an existing structure. The structures observed here are a major structural concern and need either a major structural retrofit if feasible or a complete replacement.

5.4.3.3.3 *Electrical*

Most of the distribution equipment for the plant is located within positive pressure conditioned spaces with carbon filters to scrub H2S out of incoming air. The electrical equipment is relatively new and in good condition. The facility does have several outdoor panels, transformers, junction boxes, etc. that have been struck by vehicle traffic or have been subject to severe corrosion. These are relatively easy to fix issues but should be done to maximize safety and reliability. Finally, the electrical distribution system appears to have plenty of spare capacity for expansion of facilities or to support changes in process requirements.

5.5 WATER CONSERVATION & DROUGHT CONTINGENCY PLANS

Senate Bill 1 (SB-1), passed by the Texas Legislature in 1997, increased the number of entities required to submit water conservation and drought contingency plans. As part of a regionalization strategy, all involved entities would need to draft and adopt Water Conservation and Drought Contingency Plans under the conditions of SB-1. In addition, the TWDB requires project participants applying for funding through their financial programs to prepare and implement water conservation and drought contingency plans. These plans must meet all minimum requirements outlined by the TCEQ. Copies of these plans available for each of the participating entities are provided in **Appendix J** for reference.

Section 6.0
DEVELOPMENT OF REGIONAL ALTERNATIVES

6.1 INTRODUCTION

Based on the important study factors identified in Section 2.3, regional water infrastructure alternatives were developed and screened for further evaluation through a collaborative process with Riverbend WRD and their project participants. This section focuses on the development of these infrastructure alternatives, including the methodology, evaluation process and screening of initial and final alternatives.

6.2 METHODOLOGY

The first step to developing potential regional water infrastructure alternatives for Riverbend WRD was to gather information from all the project participants on their water systems, projected population growth, water demands, and current and ongoing water infrastructure/system challenges. This was accomplished through a data request handout presented at the Project Kick-off Meeting on July 21, 2016 and followed up with individual discussions with each entity. Information regarding population and water demand projections, as well as existing water treatment plants can be found in Sections 3.0 and 5.0, respectively. Taking into account the information that was obtained, the following steps layout the process used by the project team for developing the regional alternatives:

- ***Step 1: Determine initial alternatives.*** Based on engineering recommendations and feedback received by the project participants, 16 initial alternatives were developed and presented to the project participants for consideration; and,
- ***Step 2: Screen initial alternatives.*** An interactive voting exercise was held along with a Q&A discussion during a working session with the project participants addressing the 16 initial alternatives. The goal was to select the top alternatives for further evaluation; and,
- ***Step 3: Select final alternatives for further evaluation.*** Based on the voting exercise during the working session of the screening phase, four final alternatives were selected for further evaluation; and,
- ***Step 4:*** Provide a path forward from the final alternatives and guidance on implementation.

6.3 EVALUATION PROCESS OF ALTERNATIVES

During the Riverbend WRD Town Hall Meeting held on January 31, 2017, project participants were presented with a wide variety of alternatives that were grouped according to each of the three existing water treatment plant facilities (New Boston Road WTP, Millwood WTP and Graphic Packaging International WTP). For each facility, multiple options were presented, along with the option to construct a new water facility to replace New Boston Road WTP. A summary of those options is provided below, as follows:

I. New Boston Road WTP

1. Decommission
2. Operate WTP As-Is: WTP rated at 18 mgd
3. Utilize Entire WTP Permitted Capacity*: Modify raw water delivery system
4. Expand Existing WTP
5. Build New WTP at New Boston Road Site

II. Millwood WTP

1. Decommission
2. Operate WTP As-Is: WTP rated at 15 mgd
3. Utilize Entire WTP Permitted Capacity: 20 mgd
4. Expand Existing WTP
5. Build New WTP at Millwood Site

III. Graphic Packaging International WTP

1. Decommission
2. Operate WTP As-Is: WTP rated at 35 mgd
3. Utilize Entire WTP Permitted Capacity: 46 mgd
4. Expand Existing WTP*
5. Build New WTP in Cass County*

The initial alternative of constructing a new water facility to eventually replace the New Boston Road WTP was also included as a possible option for consideration, as follows:

IV. New Water Facility

1. Phased approach of new WTP
2. Proposed WTP sites from CH2M Hill Study
   a. Site 1A – New Boston Road WTP
   b. Site 1B – Jarvis Parkway Corridor
   c. Site 2A – City of Wake Village (FM2148)
   d. Site 2B – Property Located North and West of Site 2A
   e. Site 3 – TexAmericas Center (Bowie County Parkway)*
   f. Site 4 – TexAmericas Center (SW corner of former Ammunition Plant)*

During the working session of the meeting, each individual in attendance had the opportunity to select their top four alternatives to be considered for further analysis. Also, an email poll was conducted afterwards, and each of the project participants had the opportunity to submit their vote for their top four ranked alternatives if they were not able to attend the town hall meeting. As a result, the list of preliminary alternatives was narrowed down to four final alternatives for further evaluation (noted with an asterisk in the list above). Below is a description of each of the final alternatives.

6.4 SCREENING AND SELECTION OF FINAL ALTERNATIVES FOR DETAILED ANALYSIS

The objective of the screening process was to consolidate, improve, and determine which of the final alternatives would be considered for further evaluation. During this screening period, modifications have been made to the initial alternatives and are summarized below, as follows:

6.4.1 Alternative 1 – Construct New Intake Structure and Raw Water Pipeline on Wright Patman Lake (2 Possible Locations)

Alternative 1 involves constructing a new raw water conveyance system on Wright Patman Lake, which includes a new raw water intake structure, equalization tank, pigging station, pipeline, and pump station. Based on the feedback from the project participants, Alternative 1 includes two subcomponents for the design of the raw water conveyance system:

- Alternative 1A – new raw water conveyance system constructed at recommended intake location as noted in CH2M HILL study; and,
- Alternative 1B – construct new raw water conveyance system outlined in Alternative 1A but branch off of the line and extend the pipeline over to the existing transmission line at the New Boston Road WTP.

Figure 6-1 shows the proposed alignment and location of the new intake structure and raw water pipeline presented in Alternatives 1A and 1B.

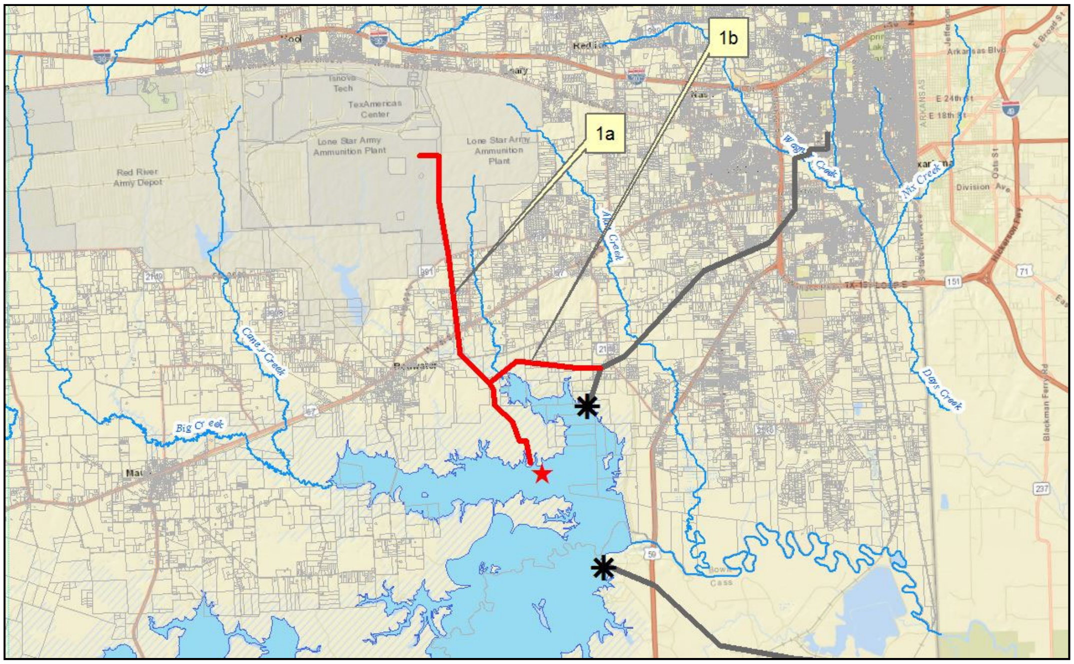

Figure 6-1: Proposed Alignment of New Intake Structure and Raw Water Pipeline

6.4.1.1 <u>TexAmericas Center (Alternative 1A)</u>

For Alternative 1A, a new raw water conveyance system, which includes a new raw water intake structure, equalization tank, pigging station, pipeline, and booster pump station with storage, would be constructed on Wright Patman Lake at the recommended intake location as shown in **Figure 6-2**; this deep-water intake location was identified during the work performed by CH2M HILL, Inc. for Riverbend WRD (2012 final report; Phases 1-3).

The infrastructure for this alternative would be sized and constructed in phases to deliver raw water to the footprint in order to meet TAC's raw water demands and municipal water demands of the project participants. The equalization tank would allow operational flexibility for the fluctuation of very low flows during the early years as the demands increase to the ultimate design capacity of 90 mgd. A pigging station would also be added to control biofilm growth, sediment and debris issues in the raw water pipeline; a cleaning 'pig' is placed inside the pipe and water pushes the pig through the pipeline to scour the pipe walls. Design details regarding the phased approach for this alternative are summarized below in **Table 6-1** and shown in **Figure 6-3**.

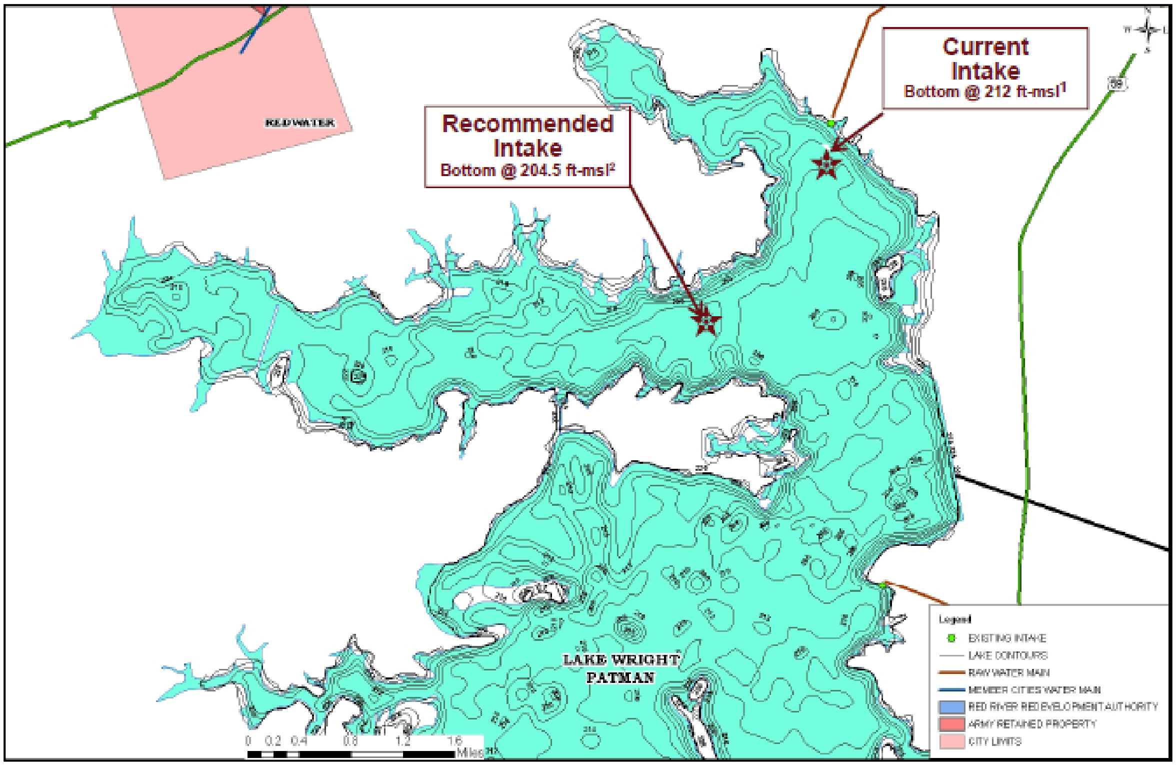

Figure 6-2: Recommended Location of New Raw Water Intake at Wright Patman Lake

Table 6-1: Infrastructure Required for Alternative 1A, Phased

Item Description	Phase 1	Phase 2
Intake Pump Station	30 MGD	60 MGD
Raw Water Pipeline	42-in. diameter; 44,000 LF	54-in. diameter; 44,000 LF
Transmission Pump Station(s) & Storage Tank(s)	*see Figure 6-3	* see Figure 6-3
Terminal Equalization Tank	10 MG	---
Pigging Station	Launching & receiving terminals	---

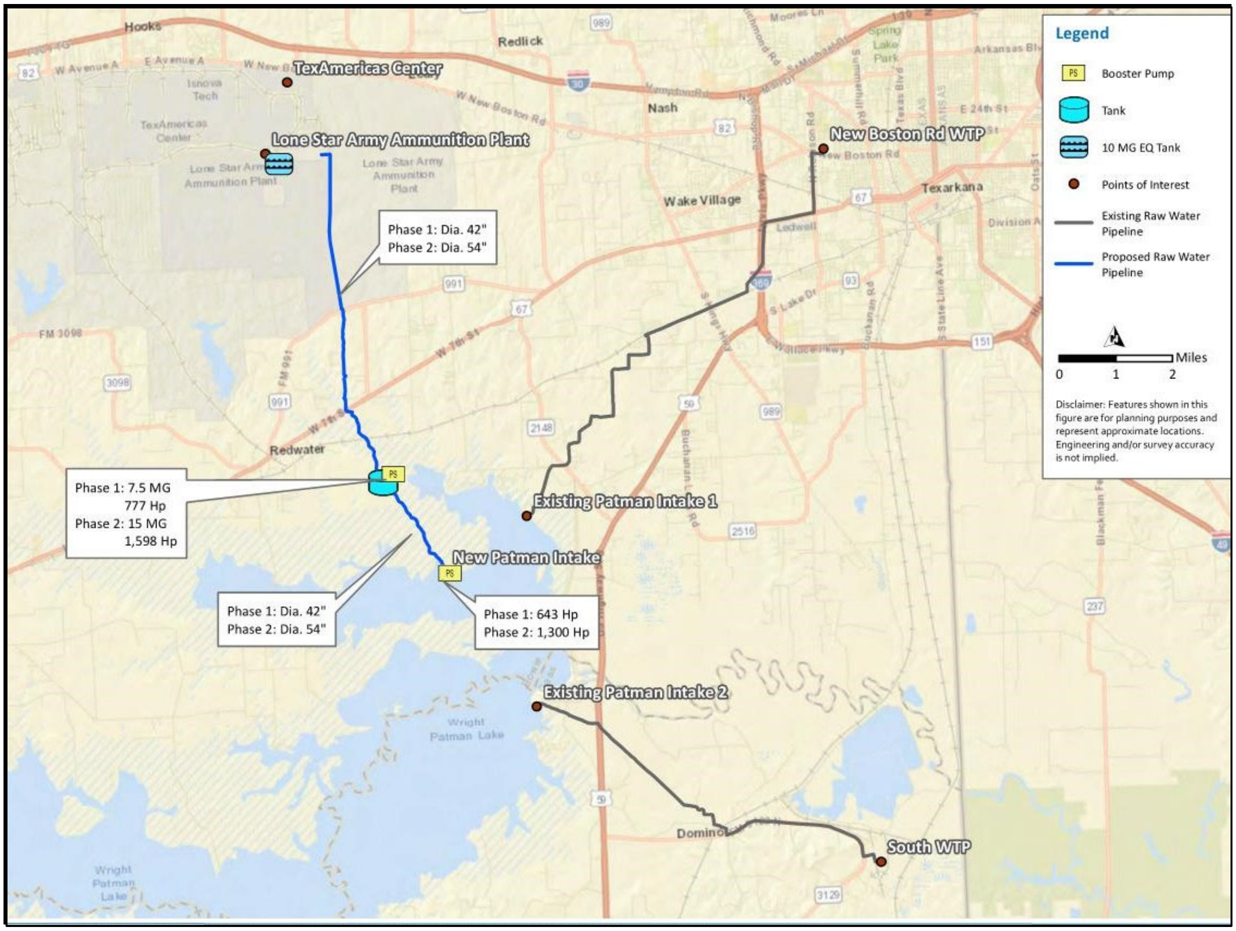

Figure 6-3: Alternative 1A – TAC Raw Water (Phased)

6.4.1.2 Connection to New Boston Road WTP (Alternative 1B)

Alternative 1B includes the same infrastructure proposed in Alternative 1A but also includes branching off of the main line and extending a separate pipeline over to the existing transmission line at the New Boston Road WTP. Design details regarding the phased approach for this alternative are summarized below in **Table 6-2** and shown in **Figure 6-4**.

Additional information from TWU provided that the treatment capacity of the New Boston Road WTP was limited to 18.0 MGD. Although the design capacity of the existing intake structure is 24.5 MGD, the hydraulic capacity is limited to 18.0 MGD due to sediment build-up in the conduit. In addition, the New Boston Road WTP site is located within a floodplain (reference **Figure 6-5**) and has limited land available for an expansion. Therefore, it is not recommended that project participants further pursue a new connection to nor expansion of the New Boston Road WTP.

Table 6-2: Infrastructure Required for Alternative 1B, Phased

Item Description	Phase 1	Phase 2
Intake Pump Station	48 MGD	60 MGD
Raw Water Pipeline	36-in. diameter; 16,500 LF	54-in. diameter; 44,000 LF
Raw Water Pipeline	42-in. diameter; 44,000 LF	
Transmission Pump Station(s) & Storage Tank(s)	*see Figure 6-4	* see Figure 6-4
Terminal Equalization Tank	10 MG	
Pigging Station	Launching & receiving terminals	

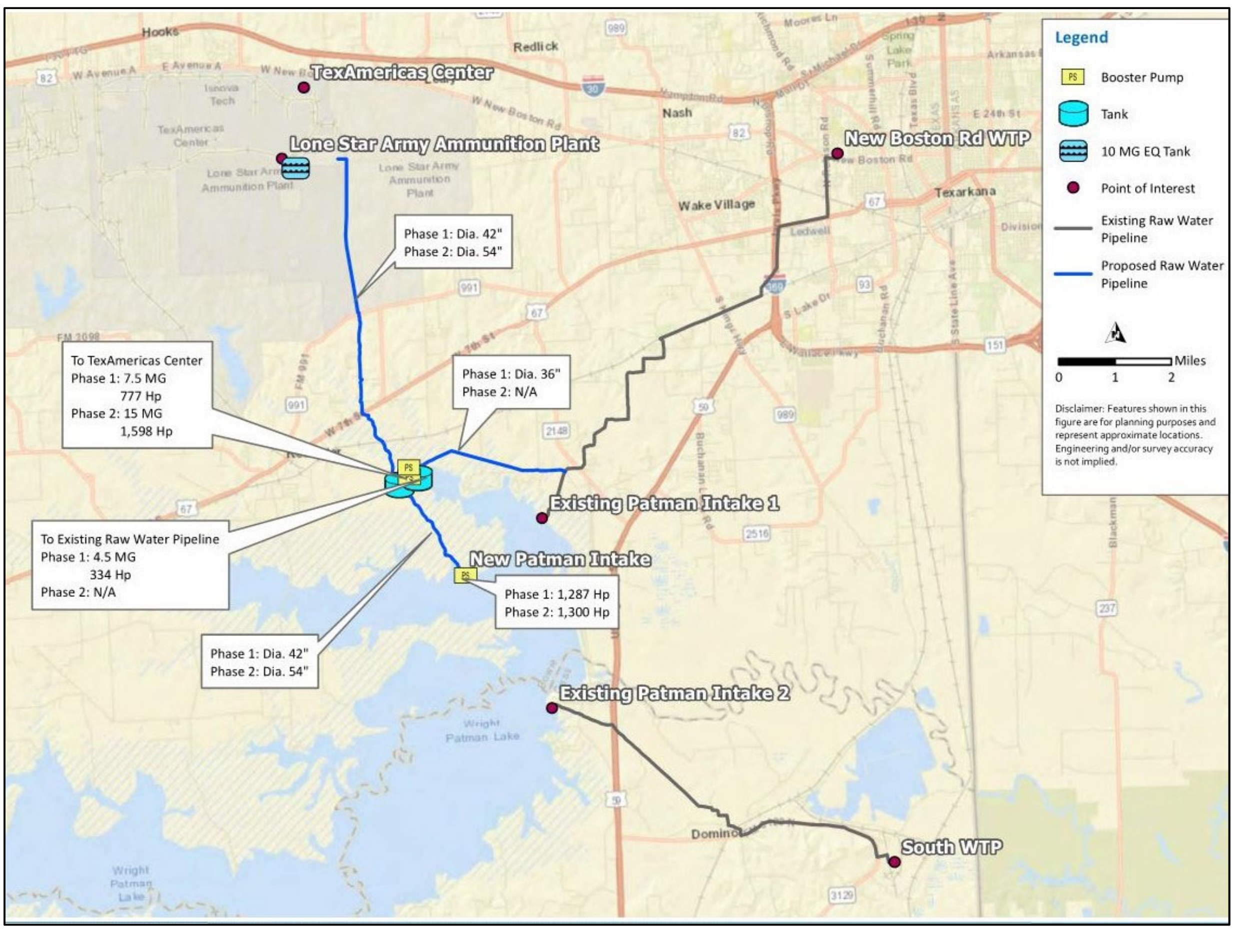

Figure 6-4: Alternative 1B – Raw Water to TAC & New Boston Road WTP (Phased)

6.4.2 Alternative 2 – Modify Raw Water Delivery System at New Boston Road WTP

Alternative 2 involves the modification of the existing raw water conveyance system at the New Boston Road WTP in order to utilize the entire permitted treatment capacity of the existing WTP. The design capacity of the existing intake structure at New Boston Road WTP is 24.5 MGD; however, currently the hydraulic capacity is limited to 18.0 MGD due to sediment build-up in the conduit. During the infrastructure assessment component of the project, interviews with TWU operators suggested that the existing New Boston Road WTP had a permitted treatment capacity of 24-25 MGD and that the existing raw water delivery system was the limiting factor. Several potential improvements to increase the capacity of the raw water conveyance system were identified as part of this effort and summarized in **Table 6-3**.

Table 6-3: Potential Improvements to Increase Hydraulic Capacity in Raw Water Conveyance System at New Boston Road WTP

System Element	Improvements	Description
Intake Conduit	Inspection of Conduit	Diver to inspect intake conduit for condition assessment and sedimentation
	Sediment Removal	Remove sediment from conduit
	Inlet Modifications	Modify conduit inlet to minimize passage of silt
Pump Station	Pump Field Testing	Perform field pump tests to assess actual pump performance
	Pump Replacement	Replace pumps including electrical upgrades
Pipeline	Flow Testing	Field measurement of inlet and outlet flows to identify leakage
	Pipeline Inspection	Remote inspection of pipeline to assess internal condition
	Leak Repair	Locate and repair leaks and joints
	Pipeline Pigging	Pig pipe to remove sediment and/or wall build-up

As previously mentioned, after receiving additional information from TWU and confirmation from TCEQ that the treatment capacity of the New Boston Road WTP is currently limited to

18.0 MGD, this alternative was removed from further consideration due to the initial capital cost estimates. In addition, the New Boston Road WTP site is located within a floodplain (reference **Figure 6-5**) and has limited land available for an expansion. For these reasons, this Alternative 2 is not recommended; however, cost estimate information has been developed for Alternative 2 and is presented in Section 7.0 as additional reference material for the Riverbend WRD Member Entities.

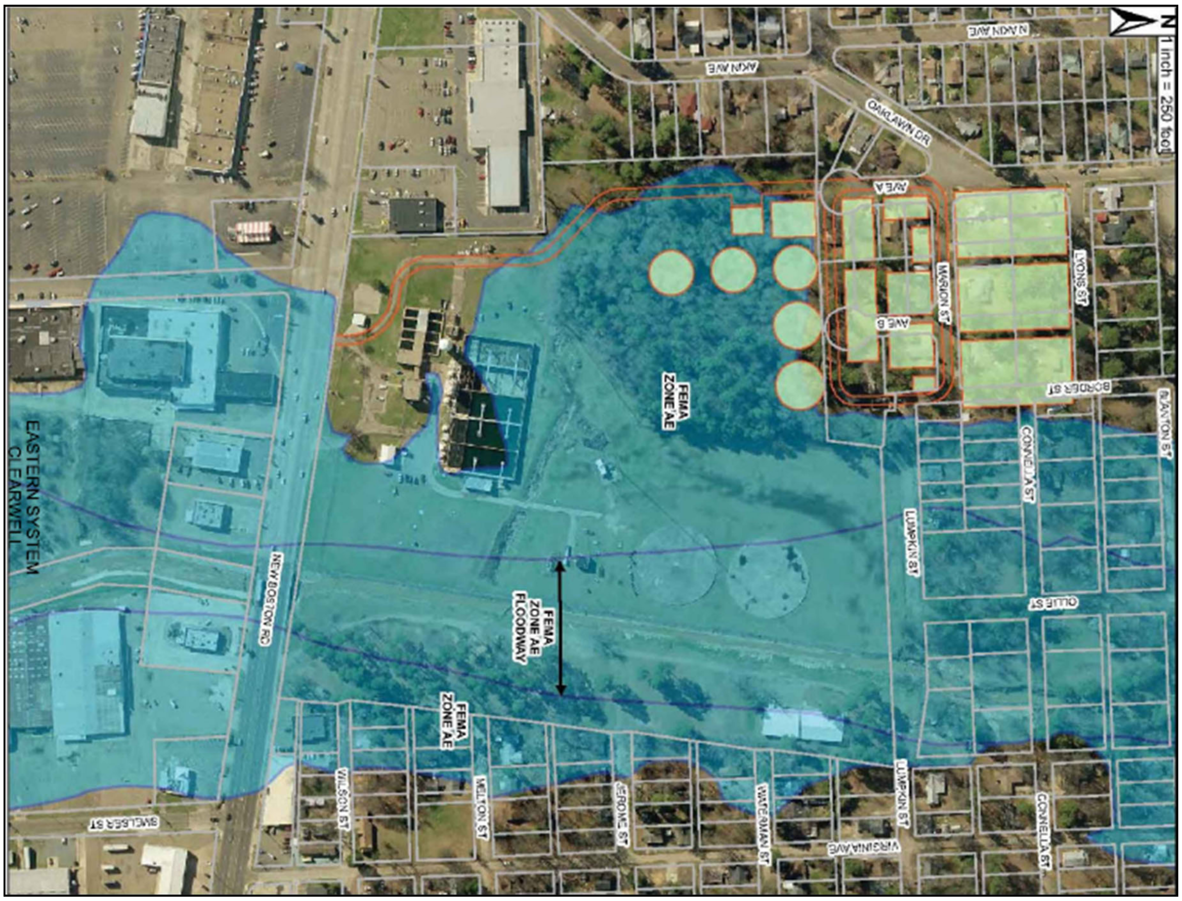

Figure 6-5: New Boston Road WTP Located within Floodplain

6.4.3 Alternative 3 – Construct New WTP at TAC (2 Possible Locations)

For Alternative 3, a new surface water treatment plant is proposed and would be constructed on TAC property within Riverbend WRD's water CCN area. The following two possible sites for the location of the new WTP on the TAC footprint were identified by the 2012 CH2M HILL study for Riverbend WRD (reference **Figure 6-6** below; sites marked with stars) and were voted the highest by the project participants:

- <u>Alternative 3A</u> – location of site at TAC at Bowie County Parkway ('Site 3' in CH2M HILL study)
- <u>Alternative 3B</u> – location of site at TAC at southwest corner of former Ammunition Plant ('Site 4' in CH2M HILL study)

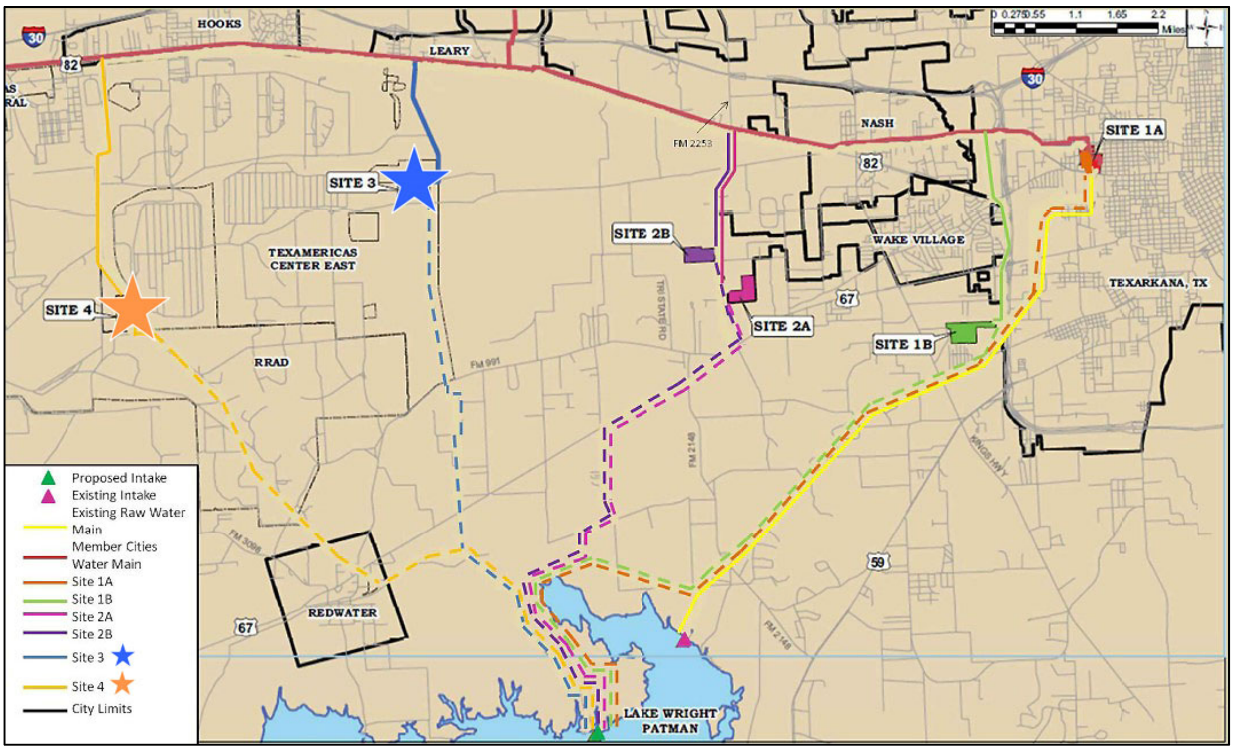

Figure 6-6: Options for New WTP Site at TAC

The results of the screening exercise for these two WTP sites (Alternatives 3A and 3B) are further detailed in this section. Alternative 3 involves constructing a new raw water intake on Wright Patman Lake, raw water pipeline, booster pump station with storage, equalization tank, and pigging station. The equalization tank would allow operational flexibility for the fluctuation of low flows during the early years and increasing demands to the ultimate design capacity of 115 mgd. A pigging station would also be added to control biofilm growth, sediment and debris issues in the raw water pipeline; a cleaning 'pig' is placed inside the pipe and water pushes the pig through the pipeline to scour the pipe walls. The raw water conveyance system is sized to convey up to 90 MGD of raw water for TAC's industrial demands and an additional 25

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MGD of raw water for municipal demands to the new WTP for treatment and distribution to the Riverbend WRD Member Entities.

The proposed new WTP would provide advanced treatment similar to the recommendations outlined in the CH2M HILL study (2012) for Riverbend WRD and would be capable of treating high levels of iron, manganese, and TOC in the raw water supply. The first phase of the new WTP would be 15 MGD, yet hydraulically designed for 25 MGD to accommodate the second phase of the 10 MGD plant expansion proposed in Phase 2. Although new regional transmission lines were included in the design, existing distribution lines were utilized as much as possible for additional cost savings (pending more detailed analysis during the preliminary design phase). Design details regarding the phased approach for this alternative are summarized below in **Table 6-4.**

Table 6-4: Infrastructure Required for Alternative 3, Phased

Item Description	Phase 1	Phase 2
Intake Pump Station	50.0 MGD	61.2 MGD
Transmission Line (treated)	8-in. diameter; 46,500 LF	
Transmission Line (treated)	10-in. diameter; 37,550 LF	
Transmission Line (treated)	18-in. diameter; 26,500 LF	
Transmission Line (treated)	30-in. diameter; 57,750 LF	
Raw Water Pipeline	42-in. diameter; 44,000 LF	54-in. diameter; 44,000 LF
Transmission Pump Station(s) & Storage Tank(s) – Raw & Treated	*see Figures 6-7 & 6-8	* see Figures 6-7 & 6-8
Terminal Equalization Tank	10 MG	
Water Treatment Plant	15 MGD	10 MGD
Pigging Station	Launching & receiving terminals	

6.4.3.1 <u>Bowie County Parkway Site at TAC (Alternative 3A)</u>

Following the overall screening of Alternative 3, Alternative 3A that shows the site at Bowie County Parkway (‘Site 3’ in **Figure 6-6**) was selected as the location for the proposed new WTP for the following reasons:

- One of two sites to receive highest votes;
- Ideal location to tie into existing transmission line along U.S. Highway 82 to all Riverbend WRD entities;

- Ideal location centered in middle of regional footprint but still closer to the greatest demands of the system;
- Property has been reserved by TAC for the new WTP site and is located within Riverbend WRD's Water CCN;
- Location is in close proximity to new raw water intake;
- Location is in close proximity to the new raw water pipeline that needs to be constructed to serve TAC; and,
- CH2M HILL study (2012 final report; Phases 1-3) identified environmental concerns on 'Site 4' (former Ammunition Plant Site).

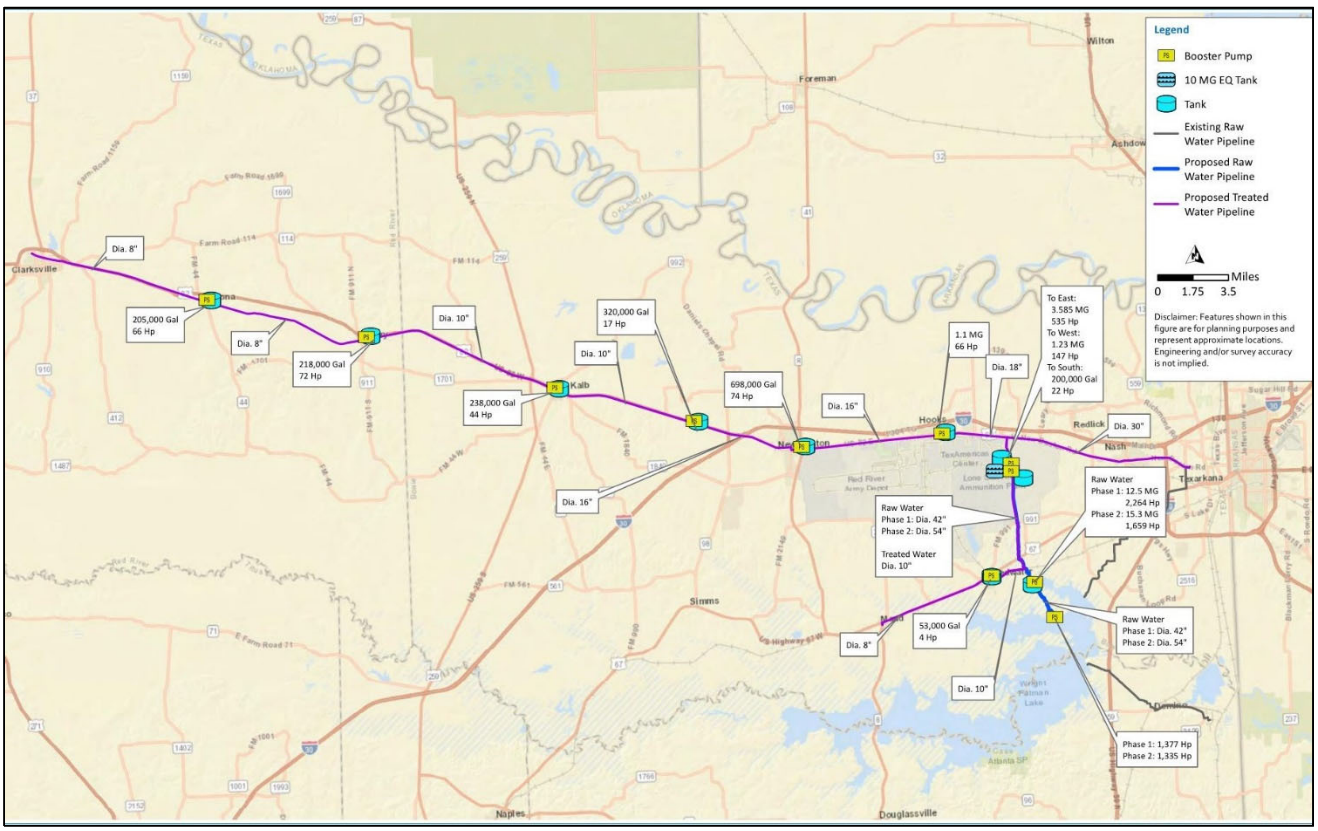

Figure 6-7: Alternative 3A - New WTP (Phase 1 - 15MGD; Phase 2 – 10 MGD expansion)

6.4.3.2 Southwest Corner of Former Ammunition Plant at TAC (Alternative 3B)

Alternative 3B represents the same scenario described previously for Alternative 3A; however, the new WTP would be constructed at the location of the former Ammunition Plant ('Site 4' in **Figure 6-6**) on TAC property. Although 'Site 4' was one of two sites to receive the highest number of votes, this option was removed from the prospective list primarily due to the environmental concerns identified in the CH2M HILL study (2012 final report; Phases 1-3). Following the screening of Alternative 3B, the new WTP located at the other site on Bowie County Parkway (Alternative 3A) would be the preferred approach based on the proximity to the proposed raw water conveyance system and the ability to improve the overall cost-efficiency of the project. As a result, no further analysis (i.e., sizing, costing, etc.) was conducted for this alternative.

6.4.4 Alternative 4 – GPI WTP Expansion or New WTP for Cass County

Recently, the International Paper (IP) Texarkana Mill was acquired by Graphic Packaging International (GPI). A majority of the Riverbend WRD Member Entities are currently served by the New Boston Road and Millwood WTPs; however, the Cities of Atlanta and Domino, Texas is currently served by the Graphic Packaging International (GPI) WTP. The GPI WTP provides potable water to the mill, as well as the neighboring cities of Atlanta, Domino, and sometimes Queen City. Until recently, Queen City was supplied by groundwater wells, although before groundwater Queen City received treated water from the GPI WTP and also has a connection for redundancy if needed. This connection for redundancy was recently utilized when lightning struck one of the groundwater well pumps, rendering it inoperable.

Due to the costs associated with the implementation of the Ultimate Rule Curve, such as the water storage fees, costs associated with modifications for cultural and environmental impacts, operating costs, etc., this regional water master plan includes additional treated water supply alternatives for the municipalities located in this segment of the study area. With particular respect to Alternative 4B, multiple opportunities can be compounded to provide a safe, secure water resource for the region for future generations.

6.4.4.1 Expand Existing Graphic Packaging International WTP (Alternative 4A)

Costs for the expansion of the existing Graphic Packaging International (GPI) WTP are based on issues identified during the condition assessment of the facility and previous experience in plant expansions. Due to the limited space available for staging construction activities within the existing paper mill operations, expanding the existing GPI WTP will be challenging. A more detailed discussion on the existing GPI WTP can be found in Section 5.4.

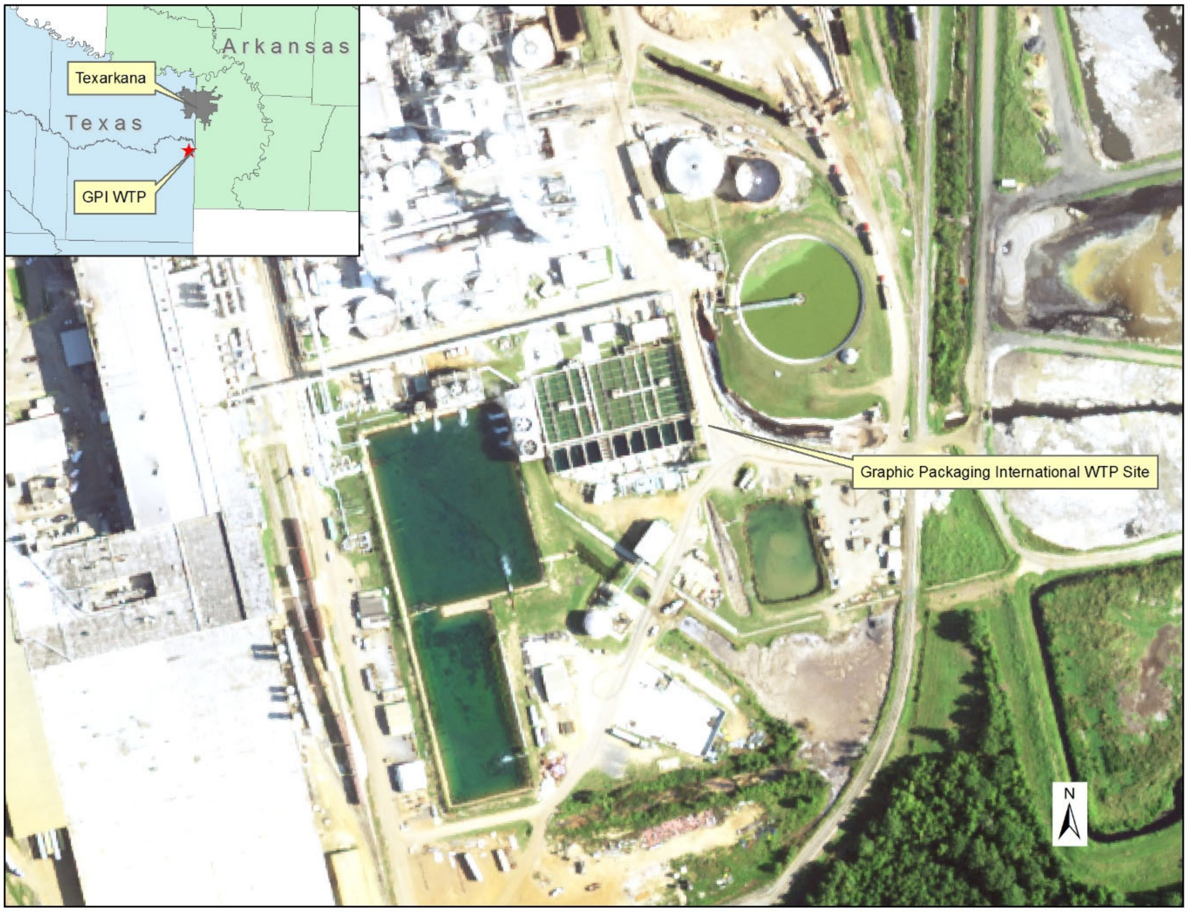

Figure 6-8: Expand Existing Graphic Packaging International WTP

6.4.4.2 Construct New WTP in Cass County (Alternative 4B)

In Alternative 4B, a new surface water treatment plant would be constructed in Cass County to serve the Cities of Atlanta, Domino, and Queen City. The conventional package treatment plant would be sized for 2.5 MGD based on maximum day water demands; the WTP would be located near the City of Domino. **Figure 6-9** presents an overview of the proposed infrastructure for this alternative.

The new Cass County WTP would utilize the existing GPI intake; however, a new raw water pipeline would tie into the existing GPI raw water pipeline upstream of the GPI pre-chlorination system to avoid the TTHM and HAA5 issues due to the high concentration of chlorine injected at that point in the system. This new raw water line would run parallel to the existing GPI raw water line and then south to the proposed new Cass County WTP (as shown in **Figure 6-10**); chloramines are proposed for disinfection at the upstream connection point on the proposed 16-inch raw water line.

From the new Cass County WTP, treated water would be conveyed approximately 600-ft by a new treated water pipeline, where it would tie into the existing distribution line that currently serves the City of Atlanta. Design details for this alternative are summarized below in **Table 6-5.**

Table 6-5: Infrastructure Required for Alternative 4B

Item Description	Sizing
Transmission Line (treated)	16-in. diameter; 600 LF
Raw Water Pipeline	12-in. diameter; 20,560 LF
Transmission Pump Station(s) & Storage Tank(s) – Raw & Treated	*see Figures 6-10 & 6-11
Water Treatment Plant	2.5 MGD

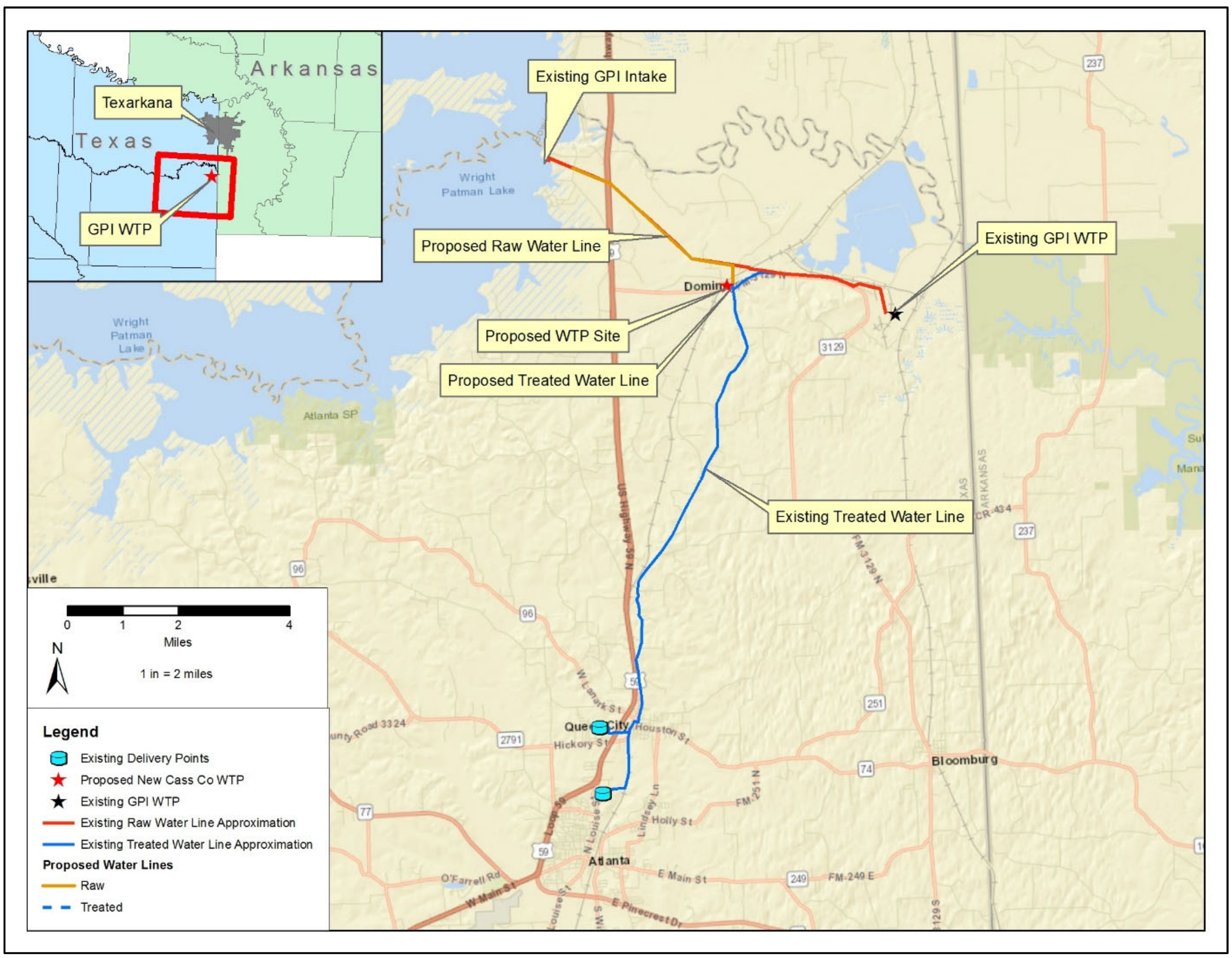

Figure 6-9: Overview of New WTP in Cass County

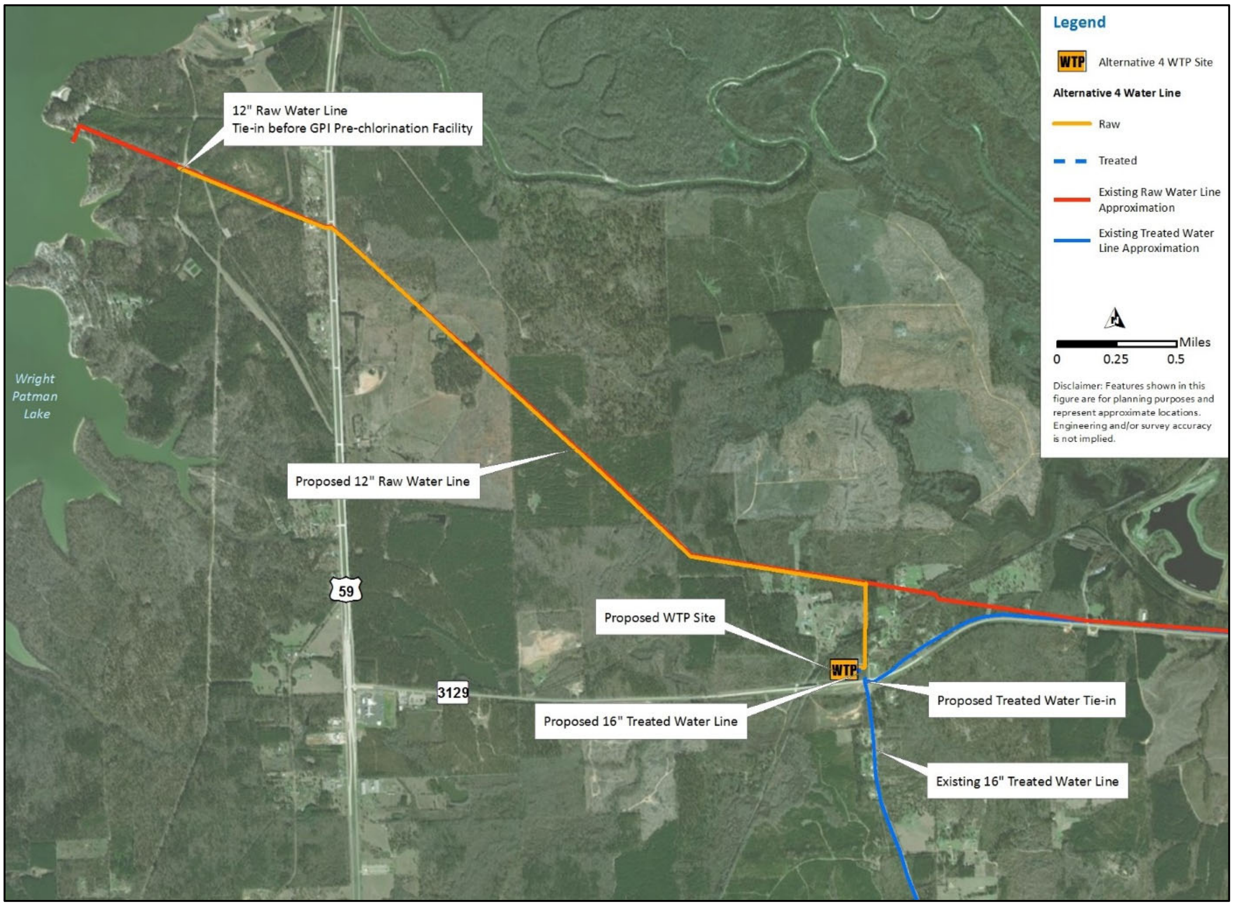

Figure 6-10: Alternative 4B – New WTP in Cass County

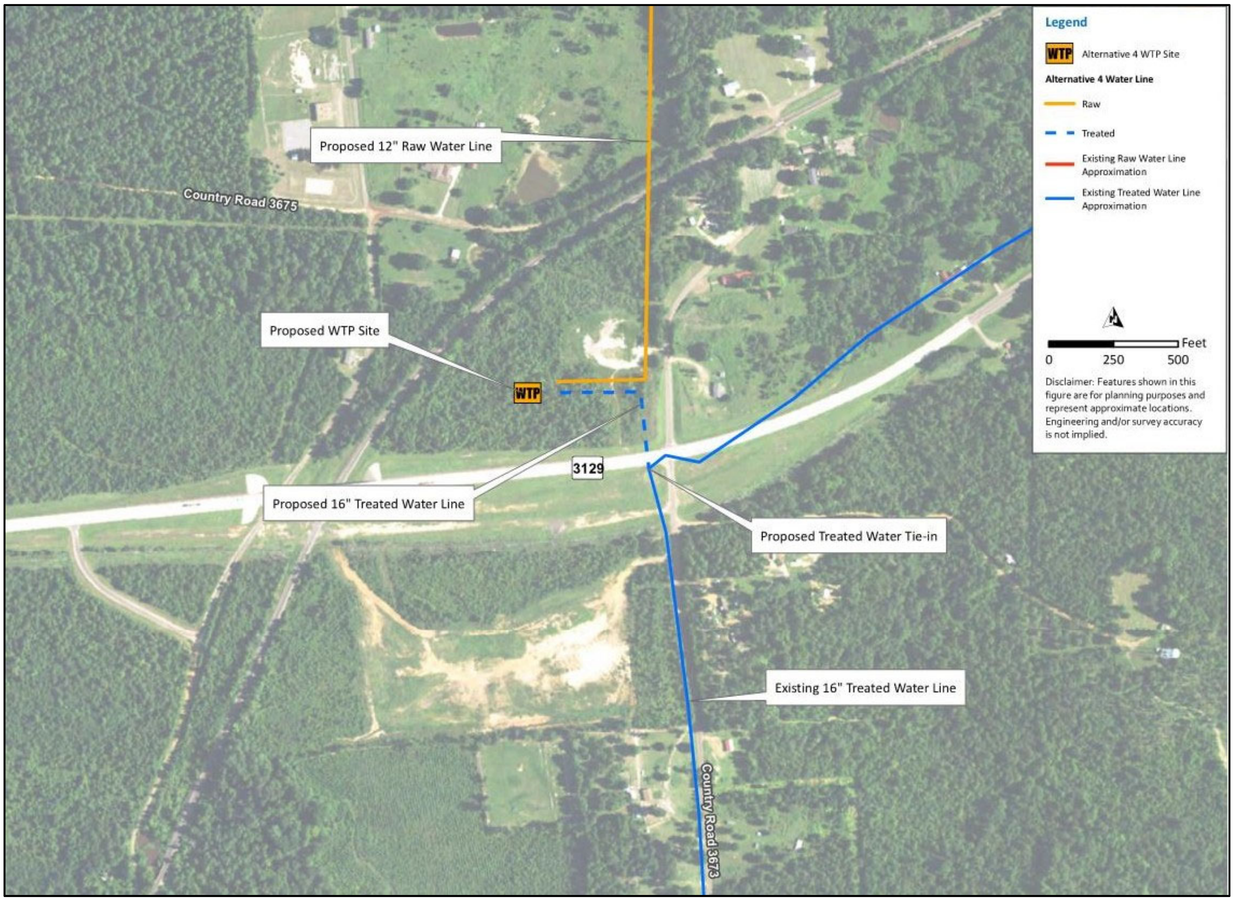

Figure 6-11: Alternative 4 B – New WTP in Cass County

6.5 SUMMARY

Each of the regional options has been described in detail in this section including the types and sizes of the regional facilities. In Section 7.0, the costs for constructing and operating the facilities associated with each alternative are presented along with cost comparisons.

Section 7.0
COST ESTIMATES

7.1 INTRODUCTION

Cost analyses on each of the alternatives described in Section 6.0 were performed by the Roth Team. These initial cost estimates were done at the broadest, planning level detail for the purpose of providing comparisons among the various alternatives. Two categories of costs were evaluated for each alternative: capital costs and operations and maintenance (O&M) costs and represent a high-level planning effort.

To provide consistency with TWDB's methodology used in the State and Regional water planning processes, the "Unified Costing Model User's Guide" (UCM) version 1.0 (HDR et. al., 2013) from TWDB was employed with modifications as needed to the methodology due to the built-in flexibility of the UCM. Supporting information is provided where the default information in the UCM was not used.

The steps to the costing process for each alternative included the following:

- Step 1: Determine the average and maximum day water demand required for each entity (municipal and industrial).
- Step 2: Determine the availability of water supplies in the study area.
- Step 3: Identify and size regional infrastructure, including additional phases to serve future growth and potential water demands.
- Step 4: Utilize the UCM to calculate:
  - Capital costs based on based on 2017 dollars for identified infrastructure and phasing (where applicable); and,
  - O&M costs based on 2017 dollars.

The methodology and assumptions used to determine the cost estimates are described in the sections below.

7.2 DESIGN AND COST ESTIMATE ASSUMPTIONS

The scope of this project did not include a detailed treatment or piping design; however, planning level unit costs were used in lieu of a more specific engineering design and based on either defaults from the UCM or, where noted, industry standards and experience. The capital cost analysis for each alternative assumed that the phasing of the construction projects would be initiated to meet the timing of the projected water demands. A summary of the assumptions incorporated into the cost estimate analyses are presented below in **Tables 7-1 and 7-2**.

Table 7-1: Cost Estimate Assumptions

Item	Factor	Unit
Interest During Construction	4%	%
Rate of Return on Investments	1%	%
Construction Period	3	Yr
Debt Service (Non-Reservoirs) Period	30	Yr
Debt Service (Reservoirs) Period	40	Yr
Annual Interest Rate (Non-Reservoirs)	4.0%	%
Annual Interest Rate (Reservoirs)	4.0%	%
Operations & Maintenance (Pipelines)	1.0%	% of Capital
Operations & Maintenance (Pump Stations)	2.5%	% of Capital
Operations & Maintenance (Dams)	1.5%	% of Capital
Power Costs	$0.09	per kilowatt-hour
Power Connection Costs - Pump Stations	$150	per HP
Unit Land Cost	$2,457*	per acre
Program Management	0.0%	% of Capital
Surveying	10.0%	% of Land Acquisition cost
Environmental & Archaeology Studies and Mitigation (Pipeline)	$25,000	per mile
Environmental & Archaeology Studies and Mitigation (Other)	10.0%	% of Land Acquisition cost
Mobilization/Demobilization	5%	%
Contingency	20%	%
Professional Services	15%	%

* Unit cost from TAMU Real Estate Center for Northeast Texas Region (January 2018)

Table 7-2: Design Assumptions

Item	Roth Team Assumption	Unit
Construction Period	3	Yr
Recommended Crossing Length (2-Lane Roads)	115	LF
Recommended Crossing Length (4-Lane Divided Highway)	210	LF
Booster Pump Station Land Area	2	acre
Recommended Crossing Length (6-Lane Divided Highway)	240	LF
Recommended Crossing Length (Railways)	100	LF
Permanent ROW Width	20	ft
Downtime for Maintenance (Uniform Delivery Only)	5%	%
Target Flow Velocity in Pipes	2 -8	fps
Hazen-Williams C Factor (Roughness)	130	
Minimum Static Head	35	ft
Maximum Pipeline Pressure	200	psi
Pump Efficiency (Mechanical & Electrical)	75%	%
Peaking Factor	1.4*	
Detention Time	6	Hr
Ground Type (Rural - Soil, Urban - Soil, Rural - Rock, Urban - Rock)	Rural - Soil	

7.3 UNIT CAPITAL COSTS – REGIONAL WATER INFRASTRUCTURE ALTERNATIVES

The capital cost analysis for each regional water infrastructure alternative included the following cost categories, where applicable:

- Surface water intake;
- Transmission system piping;
- Booster pump stations and storage;
- Pigging station;
- Terminal equalization tank;
- Water treatment construction/expansion;
- Distribution (regional pipelines); and
- Easement/land acquisition.

As noted above in **Table 7-1**, the following cost factors were included in addition to the unit costs:

- 5 percent mobilization and demobilization;
- 20 percent contingency; and,
- 15 percent professional services fee, which can include costs for surveying, legal services, engineering services, financial advisors, etc.

Where applicable, the cost analysis incorporated infrastructure for the main distribution pipelines for conveyance of treated water to the Riverbend WRD Member Entities' distribution systems but did not include upgrades of the individual distribution systems, existing pipelines, pump stations, etc. A high-level evaluation of the distribution system was performed to identify the potential cost savings if existing treated water transmission pipelines were to be utilized. It has been assumed that a more detailed assessment and modeling of the treated water distribution system will be performed during preliminary design for each elected project, which will provide a more accurate evaluation of the potential for utilizing existing distribution infrastructure and resultant cost savings.

The methodology used to determine the capital costs is described in the sections below.

7.3.1 Surface Water Intake Structure and Raw Water Pump Station

The default application of the UCM tool uses pumping horsepower as the basis for determining pump station costs. While such an assumption can be informative for regional planning purposes, it can underestimate larger pump stations, particularly those as complex as raw water intakes. These types of projects contain a large number of uncertainties that are very site specific, including the configuration of the intake, lake bathymetry, and shoreline conditions, amongst others.

With these factors in mind, the capital costs for a surface water intake structure were derived by utilizing construction cost estimates from similar projects. The resultant cost of the intake structure facility for each applicable alternative (reference **Table 7-3**) was then evaluated and confirmed to be reasonable based on experience and industry standards. These costs were then incorporated into the UCM and disaggregated for individual intake and pump station line items, whereby the default UCM calculation for power connection costs was then applied for subsequent analyses.

Table 7-3: Raw Water Intake and Pump Station Capital Costs by Alternative

Alternative	Intake Size (mgd)	Estimated Cost
1A Total Build	90	$34 M
1B Total Build	108	$40 M
3A Total Build	112	$41 M
1A Phase 1	30	$14 M
1A Phase 2	60	$23 M
1B Phase 1	48	$19 M
1B Phase 2	60	$23 M
3A Phase 1	50	$20 M
3A Phase 2	62-65	$24 M

A consideration for deferring these costs would be to size all of the pump station facilities for the future demand, and stage the mechanical installation to meet future demand as it comes online. This provides an economy of scale for the facility construction and limits future costs due to escalation and inflation.

7.3.2 Water Transmission System

The costs for the raw water and treated water transmission pipelines include the costs of furnishing and installing the pipelines to convey the raw water from the intake structure to the designated delivery locations (specific to each regional infrastructure alternative) or to a WTP for those alternatives including a WTP, and then to convey treated water from the WTP to individual RWRD Member Entities' systems. This does not include the cost for transmission through the individual systems.

The new pipelines for this analysis were based on the following assumptions:

- Pipeline diameter was based on a targeted velocity between 2.0 and 5.0 feet per second (fps), although Maximum Day Demand (MDD) was considered allowable up to 8 fps. Generally, the faster the flows, the higher the friction factor, which increases pumping and pipeline costs, as a higher pressure class is necessary. The lower flow velocity of 2.0 fps is the velocity generally necessary to keep sediments suspended.
- Pipeline alignments were not based on a detailed study of the topography and soil conditions as this was not part of the scope. Alignments were assumed to follow highways and county road right of ways within the area. Alignments from CH2M HILL (2012) previously developed for RWRD were incorporated as much as possible.
- Pipeline costs used were based on the “Unified Costing Model User’s Guide” version 1.0 (HDR et. al., 2013), assuming the pipelines would be in rural areas, buried within soil, and updated to 2017 costs.

7.3.3 Booster Pump Stations

Capital costs for the booster pump stations were also based on the "Unified Costing Model User's Guide." Costs for sizes not presented in the UCM were based on interpolation/extrapolation from the published costs available. Planning level unit costs used are presented in **Table 7-4**.

Table 7-4: Booster Pump Station Unit Costs

Horsepower (hp)	Unit Cost
0	$0
10	$770,000
50	$890,000
100	$940,000
500	$1,880,000
1000	$3,610,000
2000	$4,890,000
3000	$6,170,000

It was assumed that each booster pump station would include a ground storage tank sized for the daily diurnal flow variation. The ground storage tank will simplify pumping operations by providing equalization and by hydraulically separating the customer city systems. Capital costs for the storage capacity associated with each booster station is also based on the "Unified Costing Model User's Guide." Planning level unit costs for the ground storage tanks are presented in **Table 7-5**.

Table 7-5: Ground Storage Tank Unit Costs

Tank Volume (MG)	Capital Cost ($) (July 2017)*
0.05	201,392
0.1	217,689
0.5	465,645
1.0	789,269
1.5	1,093,102
2.0	1,396,936
2.5	1,513,347
3.0	1,629,758
3.5	1,862,581
4	2,095,404
5	2,328,226
6	2,677,460
7	3,143,105
8	3,608,751
10	4,515,595
12	5,644,493
14	6,800,749

*Cost estimate includes roof covering on tanks

7.3.4 Pigging Station

A pigging station was included in several of the regional water infrastructure alternatives related to the intake and raw water line to TAC. Pigging is a common maintenance practice used in long pipelines to control biofilm growth, sediment, and debris. A cleaning pig is placed inside the pipe and water pushes the pig through the pipeline to scour the pipe walls. Uncontrolled biofilm buildup can increase the wall roughness, resulting in reduced flow capacity and higher power consumption. Costs for the pigging station were based on professional experience in the construction and operation of such stations and interpolation of costs from other projects. The estimated cost for a pigging station (including both launching and receiving terminals) was $300,000 for a 36-in. to 42-in. diameter pipeline.

7.3.5 Terminal Equalization Tank

For infrastructure alternatives involving conveyance of industrial raw water, there is a greater uncertainty in the projected water demands than for municipal needs. Since the demand patterns will be dependent on the type of future industry attracted to the TAC industrial footprint and are unknown at this time, a terminal equalization tank was included in the design and located near the raw water intake and pump station. The recommended equalization tank can provide greater flexibility for operating and maintaining the pipeline due to the fluctuation of very low flows during the early years and until the demands increase to the ultimate design capacity of approximately 115 mgd. The unit cost for a terminal equalization tank (open top) would be approximately $0.21 per gallon. Thus, for a 10 million gallon (MG) tank, the cost would be approximately $2.1 million.

7.3.6 Water Treatment

Two new WTPs were proposed during the evaluation of regional water infrastructure alternatives for Riverbend WRD and its Member Entities, as follows:

1) A new WTP that would be an advanced treatment plant located on the TAC footprint and similar to the recommendations of the CH2M HILL study (2012) for Riverbend WRD. This plant would be capable of treating high levels of iron, manganese, and TOC. The plant recommended for this cost comparison would be initially constructed to hydraulically handle 25 MGD, but the treatment processes would be phased with an initial 15 MGD capacity in Phase 1 and a 10 MGD expansion in Phase 2.

2) A new 2.5 MGD WTP in Cass County that would be a conventional treatment plant with the capability of future expansion(s).

Capital costs for water treatment were based on a planning level unit cost per million gallons of water treated. These unit costs were based on an evaluation of similarly sized water treatment plants, professional experience, industry standards, and consideration of default UCM values. Costs also include high service pump stations and clearwell storage at the plant. These unit costs are presented below in **Table 7-6**.

Table 7-6: Water Treatment Plant – Planning Level Unit Costs

Item Description	Unit Cost ($/ MG)
15 MGD Advanced Treatment Plant	$ 2,650,000
10 MGD Advanced Treatment Plant Expansion	$ 2,250,000
2.5 MGD Conventional Treatment Plant	$ 3,250,000

Variations in unit cost occur due to economy of scale and processes specific to each alternative. It is assumed some infrastructure would be included in initial construction phase that would facilitate future expansion of the treatment facility and processes.

7.3.7 Easements and Land Acquisition

For easements and land acquisitions a unit cost of $2,457 per acre was assumed based upon data for the region obtained from the Texas A&M University Real Estate Center (2018). For pipelines, based on experience and industry standards, easement acquisition was estimated as a permanent right-of-way width of 20 feet per linear foot of pipeline. A land area of five acres was assumed for the intake pump station, and two acres was assumed for each booster pump station site. Approximately two acres was assumed for the terminal equalization tank site. As noted in the CH2M HILL study (2012) for Riverbend WRD, property has been identified and designated by TAC for the location of the new WTP site. Therefore, the acquisition costs are expected to be minimal.

7.4 OPERATIONS AND MAINTENANCE COSTS

Planning level consideration of operation and maintenance (O&M) costs have been included in the economic analysis. These costs are important elements to consider when evaluating regional alternatives. The estimated O&M costs include:

- Surface water intake operations;
- Booster pump station operations; and
- Treatment operations.

O&M costs for treatment operations are estimated using the default UCM procedure, whereby O&M costs for pipeline, tank, and distribution are assumed at 1.0% of the total capital cost for this project component.

7.4.1 Treatment Operations

The estimated cost for treatment operations at the proposed new WTP on the TAC footprint are approximately $0.60 per 1,000 gallons. This rate is based on industry standards and prior experience in the operation of surface water treatment plants. The cost estimates for treatment operations at the proposed Cass County WTP are based on the interpolation of the O&M costs for water treatment plants as published in the UCM for a 'Level 3-New Facility.'

7.4.2 Surface Water Intake and Pump Station Operations

Surface water intake and pump station operation costs include the electricity costs for pumping, as well as maintenance and labor costs associated with the equipment. The O&M cost is estimated at 2.5% of the cost of this project component based on the "Unified Costing Model User's Guide."

7.4.3 Booster Pump Station Operations

Booster pump station operation costs include the electricity costs for pumping, as well as maintenance and labor costs associated with the equipment. Similar to the surface water intake, the booster pump station O&M costs are estimated as 2.5% of the facility cost based on the "Unified Costing Model User's Guide."

7.5 ECONOMIC AND FINANCIAL ANALYSIS METHODOLOGY

The high-level economic analysis performed for this section of the study was used as a means of comparison between the regional infrastructure alternatives under consideration. Such a comparison includes both capital and operations and maintenance (O&M) costs. The analyses included capital costs for new water treatment plants, raw water intake, booster pump stations, raw water conveyance, new treatment facilities, and main transmission pipelines to Riverbend WRD Member Entities' individual distribution systems. Annual O&M costs were also incorporated. As indicated previously in **Table 7-1**, an interest rate of 4.0 percent and a 30-year financing term was used.

7.6 COST COMPARISON OF ALTERNATIVES

A summary description and cost comparison of each of the regional alternatives ranked by Riverbend WRD and the project participants for additional detailed analyses is provided below in **Table 7-7**. For the 'phased' implementation scenarios, cost analyses were performed individually for each phase and then totaled to show the overall 'combined' cost of the proposed alternative for consideration. Results of the cost estimates developed for each alternative are also presented below in **Tables 7-8 through 7-19**. There is no warrant or guarantee that actual bids will not vary from the costs presented herein. These cost estimates are based on the Roth Team's perception of current conditions in the northeast Texas region and is subject to change as variances occur in the cost of labor, materials, equipment, or other economic conditions.

Table 7-7: Summary of Regional Water Infrastructure Alternatives

Alternative	Description
1A	Construction of a new intake structure at Wright Patman Lake and a raw water pipeline to convey raw water from Wright Patman Lake to TexAmericas Center (TAC) for industrial use.
1B	Construction of a new intake structure at Wright Patman Lake, a raw water pipeline to convey raw water from Wright Patman Lake to TAC, as well as a separate raw water pipeline from the new intake structure to also convey raw water to the existing New Boston Road WTP.
2	Modification of the existing raw water conveyance system of the New Boston Road Water Treatment Facility to increase the rated capacity from 18 to 24 MGD.
3A	Construction of a new intake structure at Wright Patman Lake, a raw water pipeline to convey raw water from Wright Patman Lake to a new WTP located at TAC on Bowie County Parkway, and construction of regional transmission mains from the new WTP to Riverbend WRD Member Entities' distribution systems.
3B	Construction of a new intake structure at Wright Patman Lake, a raw water pipeline to convey raw water from Wright Patman Lake to a new WTP located at TAC at the former Ammunition Plant location, and construction of regional transmission mains from the new WTP to Riverbend WRD Member Entities' distribution systems.
4A	Rehabilitation of the existing Graphic Packaging International WTP in Cass County.
4B	Construction of a new 2.5 MGD conventional WTP in Cass County to serve the Cities of Atlanta, Domino, and Queen City; the new Cass County WTP would utilize the existing GPI intake; the new raw water pipeline would tie into the existing GPI raw water upstream of the GPI pre-chlorination system and run parallel to the existing GPI raw water line, then south to the proposed new Cass County WTP; the new treated water line would be constructed and tie into the existing City of Atlanta distribution line.

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7.6.1 Alternative 1A - Intake and Raw Water Pipeline to TAC

Alternative 1A entails the construction of a new intake structure at Wright Patman Lake, a raw water pipeline, a booster station with storage, a pigging station to address potential sedimentation effects, and a terminal equalization tank for the conveyance of raw water from Wright Patman Lake to TAC to meet projected industrial water demands.

If implemented in two phases, the Phase 1 project cost for Alternative 1A is estimated to be $52.3 million, with an estimated annual debt service of approximately $3.0 million. Phase 2 project cost for Alternative 1A is estimated to be $75.3 million, with an estimated annual debt service of approximately $4.4 million. Phase 1 and Phase 2 costs are summarized in **Tables 7-8 and 7-9**. Based on the phased approach, the total 'combined' project cost of Phases 1 and 2 of Alternative 1A is estimated to be $127.5 million, as shown in **Table 7-10**.

Table 7-8: Cost Summary for Alternative 1A – Phase 1

Item No.	Item Description	Quantity	Unit	Unit Cost	Total Cost	
1	Intake Pump Stations (30 MGD)	1	LS	$ 14,000,000	$ 14,000,000	Modified from UCM
2	Transmission Pipeline (42 in dia., 8 miles)	44,000	LF	$ 241	$ 10,599,000	
3	Transmission Pump Station(s) & Storage Tank(s)	1	LS	$ 6,728,000	$ 6,728,000	Modified from UCM
4	Terminal Equalization Tank (10 MG)	1	LS	$ 2,100,000	$ 2,100,000	Modified from UCM
5	Pigging Station	1	LS	$ 300,000	$ 300,000	Modified from UCM
				Construction Subtotal	$ 33,727,000	
	Engineering and Feasibility Studies, Legal Assistance, Financing, Bond Counsel, and Contingencies (40% for pipes & 40% for all other facilities)				$ 13,491,000	
	Land Acquisition and Surveying (29 acres)				$ 79,000	
	Interest During Construction (4% for 3 years with a 1% ROI)				$ 4,967,000	
				Project Total	**$ 52,264,000**	
Annual Costs						
	Debt Service (4 percent, 30 years)				$ 3,022,000	
	Operation and Maintenance Intake, Pipeline, Pump Station (1% of Cost of Facilities)				$ 595,000	
	Pumping Energy Costs (8822017 kW-hr @ 0.09 $/kW-hr)				$ 794,000	
				Total Annual Cost Associated with New Facilities	**$ 4,411,000**	

Table 7-9: Cost Summary for Alternative 1A – Phase 2

Item No.	Item Description	Quantity	Unit	Unit Cost	Total Cost	
1	Intake Pump Stations (60 MGD)	1	LS	$ 23,000,000	$ 23,000,000	Modified from UCM
2	Transmission Pipeline (54 in dia., 8 miles)	44,000	LF	$ 320	$ 14,087,000	
3	Transmission Pump Station(s) & Storage Tank(s)	1	LS	$ 11,544,000	$ 11,544,000	Modified from UCM
				Construction Subtotal	$ 48,631,000	
	Engineering and Feasibility Studies, Legal Assistance, Financing, Bond Counsel, and Contingencies (40% for pipes & 40% for all other facilities)				$ 19,452,000	
	Land Acquisition and Surveying (27 acres)				$ 19,000	
	Interest During Construction (4% for 3 years with a 1% ROI)				$ 7,151,000	
				Project Total	**$ 75,253,000**	
Annual Costs						
	Debt Service (4 percent, 30 years)				$ 4,352,000	
	Operation and Maintenance					
	Intake, Pipeline, Pump Station (1% of Cost of Facilities)				$ 894,000	
	Pumping Energy Costs (15438530 kW-hr @ 0.09 $/kW-hr)				$ 1,389,000	
				Total Annual Cost Associated with New Facilities	**$ 6,635,000**	

Table 7-10: Cost Summary for Alternative 1A – Combined Phases 1 & 2

Item No.	Item Description	Quantity	Unit	Unit Cost	Total Cost	
1	Intake Pump Stations (30 MGD)	1	LS	$ 14,000,000	$ 14,000,000	Modified from UCM
2	Intake Pump Stations (60 MGD)	1	LS	$ 23,000,000	$ 23,000,000	Modified from UCM
3	Transmission Pipeline (42 in dia., 8 miles)	44,000	LF	$ 241	$ 10,599,000	
4	Transmission Pipeline (54 in dia., 8 miles)	44,000	LF	$ 320	$ 14,087,000	
5	Transmission Pump Station(s) & Storage Tank(s)	2	LS	$ 9,136,000	$ 18,272,000	Modified from UCM
6	Terminal Equalization Tank (10 MG)	1	LS	$ 2,100,000	$ 2,100,000	Modified from UCM
7	Pigging Station	1	LS	$ 300,000	$ 300,000	Modified from UCM
				Construction Subtotal	$ 82,358,000	
	Engineering and Feasibility Studies, Legal Assistance, Financing, Bond Counsel, and Contingencies (40% for pipes & 40% for all other facilities)				$ 32,943,000	
	Land Acquisition and Surveying				$ 98,000	
	Interest During Construction (4% for 3 years with a 1% ROI)				$ 12,118,000	
				Project Total	**$ 127,517,000**	
Annual Costs						
	Debt Service (4 percent, 30 years)				$ 7,374,000	
	Operation and Maintenance					
	Intake, Pipeline, Pump Station (1% of Cost of Facilities)				$ 1,489,000	
	Pumping Energy Costs (24260547 kW-hr @ 0.09 $/kW-hr)				$ 2,183,000	
				Total Annual Cost Associated with New Facilities	**$ 11,046,000**	

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7.6.2 Alternative 1B - Intake and Raw Water Pipeline to TAC and Connection to New Boston Road WTP

Alternative 1B involves the construction of a new intake structure at Wright Patman Lake, a raw water pipeline to convey raw water from Wright Patman Lake to TAC, as well as a separate raw water pipeline from the new intake structure to also convey raw water to the existing New Boston Road WTP.

If implemented in two phases, the Phase 1 project cost for Alternative 1B is estimated to be $71.8 million, with an estimated annual debt service of approximately $4.2 million. Phase 2 project cost for Alternative 1B is estimated to be $75.3 million, with an estimated annual debt service of approximately $4.4 million. Phase 1 and Phase 2 costs are summarized in **Tables 7-11 and 7-12**. Based on the phased approach, the total 'combined' project cost of Phases 1 and 2 of Alternative 1B is estimated to be $147.1 million, as shown in **Table 7-13**.

Table 7-11: Cost Summary for Alternative 1B – Phase 1

Item No.	Item Description	Quantity	Unit	Unit Cost	Total Cost	
1	Intake Pump Stations (48 MGD)	1	LS	$ 19,000,000	$ 19,000,000	Modified from UCM
2	Transmission Pipeline (36 in dia., 3 miles)	16,500	LF	$ 189	$ 3,122,000	
3	Transmission Pipeline (42 in dia., 8 miles)	44,000	LF	$ 241	$ 10,599,000	
4	Transmission Pump Station(s) & Storage Tank(s)	1	LS	$ 11,248,000	$ 11,248,000	Modified from UCM
5	Terminal Equalization Tank (10 MG)	1	LS	$ 2,100,000	$ 2,100,000	Modified from UCM
6	Pigging Station	1	LS	$ 300,000	$ 300,000	Modified from UCM
				Construction Subtotal	$ 46,369,000	
	Engineering and Feasibility Studies, Legal Assistance, Financing, Bond Counsel, and Contingencies (40% for pipes & 40% for all other facilities)				$ 18,548,000	
	Land Acquisition and Surveying (31 acres)				$ 84,000	
	Interest During Construction (4% for 3 years with a 1% ROI)				$ 6,826,000	
				Project Total	**$ 71,827,000**	
Annual Costs						
	Debt Service (4 percent, 30 years)				$ 4,154,000	
	Operation and Maintenance Intake, Pipeline, Pump Station (1% of Cost of Facilities)				$ 831,000	
	Pumping Energy Costs (12947242 kW-hr @ 0.09 $/kW-hr)				$ 1,165,000	
				Total Annual Cost Associated with New Facilities	**$ 6,150,000**	

Table 7-12: Cost Summary for Alternative 1B – Phase 2

Item No.	Item Description	Quantity	Unit	Unit Cost	Total Cost	
1	Intake Pump Stations (60 MGD)	1	LS	$ 23,000,000	$ 23,000,000	Modified from UCM
2	Transmission Pipeline (54 in dia., 8 miles)	44,000	LF	$ 320	$ 14,087,000	
3	Transmission Pump Station(s) & Storage Tank(s)	1	LS	$ 11,544,000	$ 11,544,000	Modified from UCM
				Construction Subtotal	$ 48,631,000	
	Engineering and Feasibility Studies, Legal Assistance, Financing, Bond Counsel, and Contingencies (40% for pipes & 40% for all other facilities)				$ 19,452,000	
	Land Acquisition and Surveying (27 acres)				$ 19,000	
	Interest During Construction (4% for 3 years with a 1% ROI)				$ 7,151,000	
				Project Total	**$ 75,253,000**	
Annual Costs						
	Debt Service (4 percent, 30 years)				$ 4,352,000	
	Operation and Maintenance					
	Intake, Pipeline, Pump Station (1% of Cost of Facilities)				$ 894,000	
	Pumping Energy Costs (15438530 kW-hr @ 0.09 $/kW-hr)				$ 1,389,000	
	Total Annual Cost Associated with New Facilities				**$ 6,635,000**	

Table 7-13: Cost Summary for Alternative 1B – Combined Phases 1 & 2

Item No.	Item Description	Quantity	Unit	Unit Cost	Total Cost	
1	Intake Pump Stations (48 MGD)	1	LS	$ 19,000,000	$ 19,000,000	Modified from UCM
2	Intake Pump Stations (60 MGD)	1	LS	$ 23,000,000	$ 23,000,000	Modified from UCM
3	Transmission Pipeline (36 in dia., 3 miles)	16,500	LF	$ 189	$ 3,122,000	
4	Transmission Pipeline (42 in dia., 8 miles)	44,000	LF	$ 241	$ 10,599,000	
5	Transmission Pipeline (54 in dia., 8 miles)	44,000	LF	$ 320	$ 14,087,000	
6	Transmission Pump Station(s) & Storage Tank(s)	2	LS	$ 11,396,000	$ 22,792,000	Modified from UCM
7	Terminal Equalization Tank (10 MG)	1	LS	$ 2,100,000	$ 2,100,000	Modified from UCM
8	Pigging Station	1	LS	$ 300,000	$ 300,000	Modified from UCM
				Construction Subtotal	$ 95,000,000	
	Engineering and Feasibility Studies, Legal Assistance, Financing, Bond Counsel, and Contingencies (40% for pipes & 40% for all other facilities)				$ 38,000,000	
	Land Acquisition and Surveying				$ 103,000	
	Interest During Construction (4% for 3 years with a 1% ROI)				$ 13,977,000	
				Project Total	**$ 147,080,000**	
Annual Costs						
	Debt Service (4 percent, 30 years)				$ 8,506,000	
	Operation and Maintenance					
	Intake, Pipeline, Pump Station (1% of Cost of Facilities)				$ 1,725,000	
	Pumping Energy Costs (28385772 kW-hr @ 0.09 $/kW-hr)				$ 2,554,000	
	Total Annual Cost Associated with New Facilities				**$ 12,785,000**	

7.6.3 Alternative 2 – Modify Raw Water Delivery System at New Boston Road WTP

Alternative 2 involves the modification of the existing raw water conveyance system at the New Boston Road WTP in order to utilize the entire permitted treatment capacity of the existing WTP. During the infrastructure assessment component of the project, interviews with TWU operators suggested that the existing New Boston Road WTP had a permitted treatment capacity of 24-25 MGD and that the existing raw water delivery system was the limiting factor. Although the hydraulic capacity of the existing raw water conveyance system is limited to 18 MGD due to sediment build-up in the conduit, it was later determined that the WTP design capacity is only rated at 18 MGD. Additionally, the New Boston Road WTP has limited land available for an expansion. This WTP is currently located in the floodplain, which would require special construction provisions and correspond to an increased risk of damage to buildings and infrastructure due to flooding.

The design capacity of the existing raw water conveyance system is 24.5 MGD; several potential improvements to increase the capacity of this system were identified as part of this effort when the Roth Team thought that the design capacity of the WTP was greater than 18 MGD. **Table 7-14** includes high-level cost estimates associated with each of the improvements based on prior experience and professional judgement; however, without increased capacity at the New Boston Road WTP, there is no reason to implement these improvements to the raw water conveyance system and they are included here only for reference.

Table 7-14: Cost Summary for Alternative 2 – Potential Improvements to Increase Hydraulic Capacity in Raw Water Conveyance System at New Boston Road WTP

System Element	Improvements	Description	Budget
Intake Conduit	Inspection of Conduit	Diver to inspect intake conduit for condition assessment and sedimentation	$8,000
	Sediment Removal	Remove Sediment from Conduit	$19,000
	Inlet Modifications	Modify conduit inlet to minimize passage of silt	$27,500
Pump Station	Pump Field Testing	Perform field pump tests to assess actual pump performance	$38,500
	Pump Replacement	Replace pumps including electrical upgrades	$1,000,000
Pipeline	Flow Testing	Field measurement of inlet and outlet flows to identify leakage	$38,500
	Pipeline Inspection	Remote inspection of pipeline to assess internal condition	$11,500
	Leak Repair	Locate and repair leaks and joints	$29,000
	Pipeline Pigging	Pig pipe to remove sediment and/or wall buildup	$90,000

7.6.4 Alternative 3A - Intake and Raw Water Pipeline to TexAmericas Center, New TAC WTP, and Treated Water Main Distribution Pipelines to RWRD Member Entities

Alternative 3A (Phase 1 and 2) entails the construction of a new intake structure at Wright Patman Lake, a raw water pipeline, a booster station with storage, a pigging station to address potential sedimentation effects, and a terminal equalization tank for the conveyance of up to 90 MGD of raw water for industrial purposes and 25 MGD of raw water for municipal purposes to a new 25.0 MGD WTP to be constructed on the TAC footprint at Bowie County Parkway.

The infrastructure proposed in Phase 1 of Alternative 3A, which includes utilizing existing distribution lines where feasible (i.e. existing pipeline along U.S. Highway 82), has a total project cost of approximately $178.5 million and annual debt service payments of approximately $9.4 million based on an interest rate of 4.0 percent and a 30-year financing term. It should be noted, however, that a more detailed evaluation should occur to integrate existing distribution lines into the design during the preliminary and final engineering design phase of the project since this activity was beyond the scope of work for this study.

Phase 2 project cost for Alternative 3A is estimated to be $111.8 million, with an estimated annual debt service of approximately $5.9 million. Phase 1 and Phase 2 costs are summarized in **Tables 7-15 and 7-16**. Based on the phased approach, the total 'combined' project cost of Phases 1 and 2 of Alternative 3A is estimated to be $290.3 million, as shown in **Table 7-17**.

Table 7-15: Cost Summary for Alternative 3A – Phase 1

Item No.	Item Description	Quantity	Unit	Unit Cost	Total Cost	
1	Intake Pump Stations (50 MGD)	1	LS	$ 20,000,000	$ 20,000,000	Modified from UCM
2	Transmission Pipeline (8 in dia., 9 miles)	46,500	LF	$ 36	$ 1,693,000	
3	Transmission Pipeline (10 in dia., 7 miles)	37,550	LF	$ 39	$ 1,446,000	
4	Transmission Pipeline (18 in dia., 5 miles)	25,600	LF	$ 78	$ 2,004,000	
5	Transmission Pipeline (30 in dia., 11 miles)	57,750	LF	$ 173	$ 9,989,000	
6	Raw Transmission Pipeline (42 in dia., 8 miles)	44,000	LF	$ 241	$ 10,599,000	
7	Treated - Transmission Pump Station(s) & Storage Tank(s)	1	LS	$ 16,870,000	$ 16,870,000	Modified from UCM
8	Raw - Transmission Pump Station(s) & Storage Tank(s)	1	LS	$ 11,500,000	$ 11,500,000	Modified from UCM
9	Terminal Equalization Tank (10 MG)	1	LS	$ 2,100,000	$ 2,100,000	Modified from UCM
10	Water Treatment Plant (15 MGD)	1	LS	$ 39,750,000	$ 39,750,000	Modified from UCM
11	Pigging Station	1	LS	$ 300,000	$ 300,000	Modified from UCM
				Construction Subtotal	$ 116,251,000	
	Engineering and Feasibility Studies, Legal Assistance, Financing, Bond Counsel, and Contingencies (40% for pipes & 40% for all other facilities)				$ 46,500,000	
	Land Acquisition and Surveying (107 acres)				$ 269,000	
	Interest During Construction (4% for 3 years with a 1% ROI)				$ 15,448,000	
				Project Total	**$ 178,468,000**	
Annual Costs						
	Debt Service (4 percent, 30 years)				$ 9,401,000	
	Operation and Maintenance					
	Intake, Pipeline, Pump Station (1% of Cost of Facilities)				$ 1,310,000	
	Water Treatment Plant (2.5% of Cost of Facilities)				$ 2,950,000	
	Pumping Energy Costs (29125081 kW-hr @ 0.09 $/kW-hr)				$ 2,621,000	
				Total Annual Cost Associated with New Facilities	**$ 16,282,000**	

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Table 7-16: Cost Summary for Alternative 3A – Phase 2

Item No.	Item Description	Quantity	Unit	Unit Cost	Total Cost	
1	Intake Pump Stations (61.2 MGD)	1	LS	$ 24,000,000	$ 24,000,000	Modified from UCM
2	Raw Transmission Pipeline (54 in dia., 8 miles)	44,000	LF	$ 320	$ 14,087,000	
3	Raw - Transmission Pump Station(s) & Storage Tank(s)	1	LS	$ 12,251,000	$ 12,251,000	Modified from UCM
4	Water Treatment Plant (10 MGD)	1	LS	$ 22,500,000	$ 22,500,000	Modified from UCM
				Construction Subtotal	$ 72,838,000	
	Engineering and Feasibility Studies, Legal Assistance, Financing, Bond Counsel, and Contingencies (40% for pipes & 40% for all other facilities)				$ 29,135,000	
	Land Acquisition and Surveying (32 acres)				$ 87,000	
	Interest During Construction (4% for 3 years with a 1% ROI)				$ 9,772,000	
				Project Total	**$ 111,832,000**	
Annual Costs						
	Debt Service (4 percent, 30 years)				$ 5,947,000	
	Operation and Maintenance					
	Intake, Pipeline, Pump Station (1% of Cost of Facilities)				$ 934,000	
	Water Treatment Plant (2.5% of Cost of Facilities)				$ 2,880,000	
	Pumping Energy Costs (18600788 kW-hr @ 0.09 $/kW-hr)				$ 1,674,000	
	Total Annual Cost Associated with New Facilities				**$ 11,435,000**	

Table 7-17: Cost Summary for Alternative 3A – Combined Phases 1 & 2

Item No.	Item Description	Quantity	Unit	Unit Cost	Total Cost	
1	Intake Pump Stations (50 MGD)	1	LS	$ 20,000,000	$ 20,000,000	Modified from UCM
2	Intake Pump Stations (61.2 MGD)	1	LS	$ 24,000,000	$ 24,000,000	Modified from UCM
3	Transmission Pipeline (8 in dia., 9 miles)	46,500	LF	$ 36	$ 1,693,000	
4	Transmission Pipeline (10 in dia., 7 miles)	37,550	LF	$ 39	$ 1,446,000	
5	Transmission Pipeline (18 in dia., 5 miles)	25,600	LF	$ 78	$ 2,004,000	
6	Transmission Pipeline (30 in dia., 11 miles)	57,750	LF	$ 173	$ 9,989,000	
7	Raw Transmission Pipeline (42 in dia., 8 miles)	44,000	LF	$ 241	$ 10,599,000	
8	Raw Transmission Pipeline (54 in dia., 8 miles)	44,000	LF	$ 320	$ 14,087,000	
9	Treated - Transmission Pump Station(s) & Storage Tank(s)	1	LS	$ 16,870,000	$ 16,870,000	Modified from UCM
10	Raw - Transmission Pump Station(s) & Storage Tank(s)	2	LS	$ 11,875,500	$ 23,751,000	Modified from UCM
11	Terminal Equalization Tank (10 MG)	1	LS	$ 2,100,000	$ 2,100,000	Modified from UCM
12	Water Treatment Plant (15 MGD)	1	LS	$ 39,750,000	$ 39,750,000	Modified from UCM
13	Water Treatment Plant (10 MGD)	1	LS	$ 22,500,000	$ 22,500,000	Modified from UCM
14	Pigging Station	1	LS	$ 300,000	$ 300,000	Modified from UCM
				Construction Subtotal	$ 189,089,000	
	Engineering and Feasibility Studies, Legal Assistance, Financing, Bond Counsel, and Contingencies (40% for pipes & 40% for all other facilities)				$ 75,635,000	
	Land Acquisition and Surveying (139 acres)				$ 356,000	
	Interest During Construction (4% for 3 years with a 1% ROI)				$ 25,220,000	
				Project Total	**$ 290,300,000**	
Annual Costs						
	Debt Service (4 percent, 30 years)				$ 15,348,000	
	Operation and Maintenance					
	Intake, Pipeline, Pump Station (1% of Cost of Facilities)				$ 2,244,000	
	Water Treatment Plant (2.5% of Cost of Facilities)				$ 5,830,000	
	Pumping Energy Costs (47725869 kW-hr @ 0.09 $/kW-hr)				$ 4,295,000	
				Total Annual Cost Associated with New Facilities	**$ 27,717,000**	

7.6.5 Alternative 3B

Alternative 3B represents a scenario similar to Alternative 3A; however, the new WTP would be located at the former Ammunition Plant on TAC property. This alternative was removed from consideration due to possible environmental concerns at the proposed site as noted in the CH2M HILL study (2012) for Riverbend WRD. As a result, no further analysis (i.e. infrastructure sizing, costing, etc.) was performed for this alternative.

7.6.6 Alternative 4A - Expansion of the Existing Graphic Packaging International WTP

Costs for the expansion of the existing Graphic Packaging International (GPI) WTP are based on issues identified during the condition assessment of the facility and previous experience in plant expansions. A high-level estimation of potential effort associated with expansion to meet the projected needs based on the various processes distributed throughout the mill was performed. Due to the limited space available for staging construction activities within the existing paper mill operations, expanding the existing GPI WTP will be a challenging option. A more detailed discussion on the existing GPI WTP can be found in Section 5.4.

Alternative 4A has an estimated project cost of approximately $12.8 million and an annual cost of approximately $0.9 million. **Table 7-18** presents the cost summary of this project alternative.

Table 7-18: Cost Summary for Alternative 4A

Item No.	Item Description	Quantity	Unit	Unit Cost	Total Cost	
1	Replacement	1	LS	$ 3,000,000	$ 3,000,000	Modified from UCM
2	Repairs	1	LS	$ 4,000,000	$ 4,000,000	Modified from UCM
				Construction Subtotal	$ 7,000,000	
	Surveying				$ 1,000,000	
	Geotechnical, Excavation & Testing				$ 750,000	
	Demolition				$ 500,000	
	Mobilization and Demobilization				$ 1,000,000	
	Contingency				$ 2,500,000	
				Project Total	**$ 12,750,000**	
Annual Costs						
	Debt Service (5.5 percent, 30 years)				$ 877,269	
				Total Annual Cost Associated with New Facilities	**$ 877,269**	

7.6.7 Alternative 4B – Construct New WTP in Cass County

Alternative 4B entails the construction of a new 2.5 MGD conventional water treatment plant located in Cass County near Domino, Texas. A new raw water pipeline would be connected to the existing raw water pipeline that currently serves the existing GPI WTP, with the connection located upstream of the GPI pre-chlorination facility. The new raw water pipeline would run parallel to the existing raw water line to the proposed new Cass County WTP.

The project cost for Alternative 4B is estimated to be $14.3 million, with an estimated annual debt service of approximately $0.7 million, as shown in **Table 7-19**.

Table 7-19: Cost Summary for Alternative 4B

Item No.	Item Description	Quantity	Unit	Unit Cost	Total Cost	
1	Raw Water - Transmission Pipeline (12 in dia., 4 miles)	20,560	LF	$ 39	$ 806,000	
2	Treated Water - Transmission Pipeline (16 in dia., 600 ft)	600	LF	$ 167	$ 100,000	
3	Treated - Transmission Pump Station(s) & Storage Tank(s)	1	LS	$ 1,476,000	$ 1,476,000	Modified from UCM
4	Raw - Transmission Pump Station(s) & Storage Tank(s)	1	LS	$ 1,584,000	$ 1,584,000	Modified from UCM
5	Water Treatment Plant (2.5 MGD)	1	LS	$ 5,375,000	$ 5,375,000	Modified from UCM
				Construction Subtotal	$ 9,341,000	
	Engineering and Feasibility Studies, Legal Assistance, Financing, Bond Counsel, and Contingencies (40% for pipes & 40% for all other facilities)				$ 3,737,000	
	Land Acquisition and Surveying (15 acres)				$ 40,000	
	Interest During Construction (4% for 3 years with a 1% ROI)				$ 1,152,000	
				Project Total	**$ 14,270,000**	
Annual Costs						
	Debt Service (4 percent, 30 years)				$ 701,000	
	Operation and Maintenance					
	Intake, Pipeline, Pump Station (1% of Cost of Facilities)				$ 69,000	
	Water Treatment Plant (2.5% of Cost of Facilities)				$ 1,077,000	
	Pumping Energy Costs (1167985 kW-hr @ 0.09 $/kW-hr)				$ 105,000	
				Total Annual Cost Associated with New Facilities	**$ 1,952,000**	

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Section 8.0
POTENTIAL FUNDING SOURCES

A number of potential funding sources exist for designing and constructing water utilities located in rural areas of the state. Both state and federal agencies offer grant and loan programs to assist rural communities in meeting their infrastructure needs. Most are available to 'political subdivisions' such as counties, municipalities, school districts, special districts, and authorities of the state with some programs providing access to private individuals for agricultural assistance. Riverbend WRD serves as a conduit for financing for municipal, rural, industrial, and agricultural projects at all levels.

Grant funds are typically available to those entities that demonstrate financial need based on a median household income (MHI) value below 75 to 80 percent of the State's MHI value. The funds may be used for planning, design, and construction of water infrastructure projects. Some funds may be used to finance the consolidation or regionalization of neighboring water utilities. Three Texas agencies that offer financial assistance for water infrastructure are described below:

- **Texas Water Development Board (TWDB)** has several programs that offer loans at interest rates lower than the market offers to finance projects for public water systems that facilitate compliance with state and federal regulations. Additional subsidies may be available for disadvantaged communities. Low-interest rate loans with short- and long-term finance options at tax-exempt rates for water projects give an added benefit by making construction purchases qualify for a sales tax exemption. Generally, the program targets customers with eligible water projects for all political subdivisions of the state (at tax-exempt rates). These programs include the use of state and federal resources.
- **Texas Department of Agriculture (TDA, formerly TDRA and ORCA)** is a Texas state agency with a focus on rural Texas by making state and federal resources accessible to rural communities. Funds from the U.S. Department of Housing and Urban Development Community Development Block Grants (CDBG) are administered by TDA for small, rural communities with populations less than 50,000 that cannot directly receive federal grants. These communities are known as non-entitlement areas. One of the program objectives is to meet a need having a particular urgency, which represents an immediate threat to the health and safety of residents, principally for low- and moderate-income persons.
- **U.S. Department of Agriculture Rural Development (USDA Rural Development)** coordinates federal assistance to rural Texas to help rural Americans improve their quality of life. The Rural Utilities Service (RUS) programs provide funding for water systems. The application process, eligibility requirements, and funding structure vary for each of these programs. There are many conditions that must be considered by each agency to determine eligibility and ranking of projects. The principal factors that affect this choice are population, percent of the population under the State MHI, health concerns,

compliance with standards, Colonia status, and compatibility with regional and state plans.

In addition to state and federal water programs, funding sources may also originate from revenue bonds and developer participation towards the regional infrastructure of the system. Below is an overview of all of these financing mechanisms; all of the available water funding mechanisms should be matched, when appropriate and where possible, with local and state economic development funds,

8.1 FEDERAL AND STATE INFRASTRUCTURE PROGRAMS

There are a variety of funding programs available to entities through state and federal infrastructure programs. Depending on the type of entity that owns the proposed regional water facilities, funding is most likely to be obtained from programs administered by the TWDB, TDA and/or USDA Rural Development. Information required by these agencies for initial applications may include financial analyses, records demonstrating health concerns, failing infrastructure, and financial need.

8.1.1 TWDB Funding Options

The programs offered by the TWDB include the Drinking Water State Revolving Fund (DWSRF), State Loan Program (Development Fund II), State Participation Fund, State Water Infrastructure Fund for Texas (SWIFT) and Economically Distressed Areas Program (EDAP).

8.1.1.1 Drinking Water State Revolving Fund

The Drinking Water State Revolving Fund (DWSRF) provides loans at interest rates lower than the market to political subdivisions with the authority to own and operate a water system. The DWSRF also includes Disadvantaged Communities funds that provide even lower interest rates for those meeting the respective criteria.

The DWSRF offers fixed and variable rate loans at subsidized interest rates. The maximum repayment period for a DWSRF loan is 30 years from the completion of project construction. A cost-recovery loan origination charge of 2.25 percent is imposed to cover administrative costs of operating the DWSRF; however, there is no additional interest rate subsidy for those financing the origination charge.

TWDB accepts Project Information Forms (PIFs) from prospective loan applicants throughout the year; however, applicants submit their PIFs by early March (deadline posted each year) to be included on the DWSRF Intended Use Plan (IUP) for consideration of loan-forgiveness funding. The Project Information Form describes the applicant's existing water facilities, facility needs, the nature of the project being considered and project cost estimates. This information is used to rate each proposed project and place them in priority order on the IUP. Applicants eligible for funding through the DWSRF program are notified during the summer to attend a pre-application meeting and submit an application for financial assistance. TWDB will typically take 60 to 90 days to review a complete application and to present the funding request formally to the Board for approval. Once approved, the applicant could then proceed with closing on the funding.

8.1.1.2 State Loan Program: Texas Water Development Fund (DFund)

The Texas Water Development Fund (DFund) is a diverse lending program directly from state funding sources. As it does not receive federal subsidies, it is more streamlined. The loans can incorporate more than one project under the umbrella of one loan. Political subdivisions of the state are eligible for tax-exempt rates. Projects can include purchase of treatment plants, pump stations, storage tanks, distribution lines, and land acquisitions. The loan requires that the applicant pledge revenue or taxes. The maximum financing life is 50 years, and the average financing period is approximately 20 years. The lending rate scale varies according to several factors but is set by the TWDB based on cost of funds to the board, risk factors of managing the board loan portfolio, and market rate scales.

The application materials must include an engineering feasibility report, environmental information, rates and customer base, operating budgets, financial statements, and project information. The TWDB considers the needs of the area; benefits of the project; the relationship of the project to the overall state water needs and the State Water Plan; and the availability of all sources of revenue to the rural utility for the ultimate repayment of the loan. TWDB will typically take 60 to 90 days to review a complete application and to present the funding request formally to the Board for approval. Once approved, the applicant could then proceed with closing on the funding.

8.1.1.3 State Water Plan Funding: State Participation Fund

The State Participation Fund (SPF) encourages the optimum regional development of projects by funding excess infrastructure capacity for consideration of future needs. This program allows the TWDB to provide funding and assume temporary ownership interest in a regional water project when the local sponsors (i.e. political subdivision of the state, including a water supply corporation) are unable to assume debt for an optimally sized facility.

State Participation Funding can only be used to finance the portion of water infrastructure projects that is designated as ‘excess capacity’. For new water supply and state water plan projects, TWDB can fund as much as 80 percent of project costs, as long as the local sponsor finances at least 20 percent of the total project cost. The total capacity of the proposed project also must serve at least 20 percent of existing needs.

For other State Participation projects, the TWDB can fund as much as 50 percent of costs, provided that the local sponsor finances at least 50 percent of the total project cost. The total capacity of the proposed project also must serve at least 50 percent of existing needs.

8.1.1.4 State Water Implementation Fund for Texas (SWIFT)

In 2013, the Texas Legislature created the State Water Implementation Fund for Texas (SWIFT) to provide affordable, ongoing state financial assistance for projects listed in the State Water Plan. The constitutional amendment for SWIFT, known as Proposition 6, enables the one-time investment of two billion dollars from the state's Rainy-Day Fund to create a revolving loan program for water projects across Texas. This new program became effective on Nov. 6, 2014 and adopted concepts from other existing programs including the Water Infrastructure Fund (WIF), WIF Deferred, and the State Participation Fund.

As a result of active management of the fund(s), SWIFT is intended to provide approximately $27 billion in state financial assistance for over $50 billion in state water plan projects over the next 50 years. SWIFT financing includes the following three options: (1) Subsidized Loan Interest Rates (2) Deferral of Principal and Interest – interest does not accrue, and principal payments are deferred for up to eight years or until the end of construction, whichever comes first; and (3) Board Participation. Types of eligible projects include conservation and reuse, building new pipelines and water treatment plants, as well as numerous other water management strategies listed in the current State Water Plan.

8.1.1.5 Economically Distressed Areas Program (EDAP)

The EDAP Program was originally designed to assist populations along the U.S./Mexico border in areas that were economically distressed. In 2008, this program was extended to apply to the entire state as long as specific requirements are satisfied. This program provides financial assistance through the provision of grants and loans to communities where present facilities are inadequate to meet resident's minimal needs. Eligible communities are those that have median household incomes less than 75 percent of the state household income.

The county where the project is located must adopt model rules for the regulation of subdivisions prior to application for financial assistance. If the applicant is a city, the city must also adopt Model Subdivision Rules of TWDB (31 TAC Chapter 364). The program funds design, construction, improvements, and acquisition, and includes measures to prevent future substandard development. The TWDB works with the applicant to find ways to leverage other state and federal financial resources. The loan requires that the applicant pledge revenue or taxes. The maximum financing life is 50 years, and the average financing period is approximately 20 years. The lending rate scale varies according to several factors, but it is set by the TWDB based on cost of funds to the board, risk factors of managing the board loan portfolio, and market rate scales. The TWDB seeks to make reasonable loans with minimal loss to the state. Most projects have a financial package with the majority of the project financed with grants; many recipients have received 100 percent grant funds. This program continues to evolve and adapt to changing local and state environments and fund availability.

8.1.2 TDA Funding Options

The Texas Department of Agriculture (TDA, previously TDRA and ORCA) seeks to strengthen rural communities and assist them with community and economic development and healthcare by providing a variety of rural programs, services, and activities. Of their many programs and funds, the most appropriate programs related to drinking water are the Community Development (CD) Fund and Texas Small Towns Environment Program (STEP). These programs offer attractive funding packages to help make improvements to water systems to mitigate potential health concerns.

8.1.2.1 Community Development Fund

The CD Fund is a competitive grant program for water and wastewater system improvements. Funds are distributed between 24 state planning regions where funds are allocated to address each region's utility priorities. Funds can be used for various types of public works projects, including water system improvements. Cities with a population of less than 50,000 that are not eligible for direct Community Development Block Grant (CDBG) funding from the U.S. Department of Housing and Urban Development are eligible. Funds are awarded on a competitive basis decided twice a year by regional review committees. Awards are no less than $75,000 and cannot exceed $800,000.

8.1.2.2 Texas Small Towns Environment Program

Under special occasions some communities are invited to participate in grant programs when self-help is a feasible method for completing a water project, the community is committed to self-help, and the community has the capacity to complete the project. The purpose is to significantly reduce the cost of the project by using the communities' own human, material, and financial capital. Projects typically are repair, rehabilitation, improvements, service connections, and yard services. Reasonable associated administration and engineering cost can be funded. A letter of interest is first submitted, and after CDBG staff determines eligibility, an application may be submitted. Awards are only given twice per year on a priority basis so long as the project can be fully funded ($350,000 maximum award). Ranking criteria are project impact, local effort, past performance, percent of savings, and benefit of low- to medium-income persons.

8.1.3 USDA Rural Development Funding Options

USDA Rural Development established a Revolving Fund Program (RFP) administered by the staff of the Water and Environment Program (WEP) to assist communities with water and wastewater systems. The purpose is to fund technical assistance and projects to help communities bring safe drinking water and sanitary, environmentally sound, waste disposal facilities to rural Americans in greatest need.

WEP provides loans, grants, and loan guarantees for drinking water, sanitary sewer, solid waste, and storm drainage facilities in rural areas and cities and towns with a population of 10,000 or less. Recipients must be public entities such as municipalities, counties, special purpose districts, Indian tribes, and corporations not operated for profit. Projects include all forms of infrastructure improvement, acquisition of land and water rights, and design fees. A request for a combination of grants and loans vary on a case by case basis, and some communities may have to wait though several funding cycles until funds become available.

Section 9.0
SUMMARY AND CONCLUSIONS

The recommended alternatives for Riverbend WRD are based on several key factors: availability of regional water infrastructure to meet the existing and future demands of the municipal, industrial/manufacturing, and agricultural sectors; the availability of firm water supply; the impact of the cost of water to participating customers; and, the need for meeting the TCEQ's regulatory requirements and minimum treatment capacity criteria of 0.6 gpm per connection. The recommended facility proposal is also based on an implementation plan that allows the recommendations to be permitted, constructed, and operational in a reasonable amount of time, as well as including adequate operations, maintenance, and management criteria.

As presented in Section 3.0, the population of Bowie County, where a majority of the Member Entities are located, is projected to reach over 100,000 by 2050 according to the Texas Demographic Center. The growth rates of the project participants shown in **Table 3-2** are quite conservative from a planning standpoint, yet provide for a steady increase in population and demand rates over the next several decades. These new growth rates and demand projections were adopted by the TWDB in April 2018 and are slightly higher than TWDB's original projections listed in the initial draft version of the next state water plan. As mentioned, each entity shows an increase in population data and average annual growth rate for their area, even though the project participants' Draft 2021 Region D municipal population projections are held constant from 2040 through 2070 with the exception of City of Atlanta (held constant starting in 2030) and City of Clarksville (held constant starting in 2020). The municipal water demand projections calculated for the participating entities, based on the conservative population projections, are 22.5 MGD by 2070 (reference **Table 3-3**).

Additionally, the TexAmericas Center (TAC) has received numerous requests over the past five years from potential industrial and commercial customers for potable and raw water supply. Water supplies were not available to meet these requests. This list of potential prospects identified an additional 30 MGD of water demand beginning immediately and continuing through the next several years. Ultimately, TAC's water demand is projected to double to 60 MGD by 2050. After a thorough analysis of potential prospects ideal for the region and in exchange for acquiring the water and wastewater utilities from TAC in May 2016, Riverbend WRD has committed to providing the necessary infrastructure in order to supply TAC with a total of 90.0 MGD of raw water for potential industrial and commercial customers by 2070.

Although the primary municipal supply comes from the intake on Wright Patman Lake that provides raw water supply to the New Boston Road WTP, the distribution system is comingled with the surface water supply from Millwood Lake, where raw water from Millwood Lake is treated at the Millwood WTP and connected to the TWU distribution system. The New Boston Road WTP is over 60 years old and has a rated capacity of 18.0 MGD. The Millwood WTP is over 30 years old and has a rated capacity of 15.12 MGD. Based on their current conditions, it is not recommended that either plant undergo major expansions to add processes or expand capacity significantly. As a result, the Roth Team recommends implementing Alternatives 3A and 4B to serve both the projected municipal and industrial water demands in the study area using a complete regional approach, as follows:

- **Alternative 3A:** Construction of a new raw water intake at Wright Patman Lake, raw water conveyance system, terminal equalization tank, new Advanced Treatment WTP (15 MGD constructed in Phase 1; 10 MGD constructed in Phase 2) located on Bowie County Parkway at the TexAmericas Center, and regional transmission mains from the new WTP to Riverbend WRD Member Entities' distribution systems in Bowie and Red River Counties. Phase 1 consists of a 42-in. diameter raw water pipeline designed to carry a maximum of 50 MGD; Phase 2 includes a second parallel 54-in. diameter pipeline to bring the total pipeline capacity to 115 MGD. This alternative involves construction in a two-phase approach and provides advanced treatment capabilities for the participants' in a cost-effective manner.
- **Alternative 4B:** Construction of a new 2.5 MGD Conventional WTP, located in Cass County, to serve the municipal needs of the Cities of Atlanta, Domino and possibly Queen City.

Alternative 3A (New Water Treatment Plant/Raw Water Intake & Conveyance System/Regional Transmission Lines Project) provides the most flexibility for all project participants, as well as the opportunity for a phased construction approach to allow for 'growth to pay for growth.' This project would also address the regulatory issues regarding the current alternative capacity requirement and water production limitations, which in turn has impacted the Member Entities' ability to serve their growing population and expand their water CCN service areas.

The new raw water intake and conveyance system to deliver raw water to TAC would be constructed initially, and municipal demands of the Member Entities presently met by the existing New Boston Road WTP would be transferred to the new regional WTP. The City of Texarkana's (TX) municipal demands from the new WTP would be phased-in during the decommissioning process of the New Boston Road WTP.

The infrastructure proposed in Phase 1 of Alternative 3A, which includes utilizing existing distribution lines where feasible (i.e. existing pipeline along U.S. Highway 82), has a total project cost of approximately $178.5 million and annual debt service payments of approximately $9.4 million based on an interest rate of 4.0 percent and a 30-year financing term. The project participants' 2070 maximum day demands were used as the basis for sizing the capacity of the intake structure, raw water conveyance system, water treatment plant and transmission lines; this infrastructure would be constructed in two separate phases.

The infrastructure proposed in Phase 4B involves constructing a new 2.5 MGD conventional/surface water treatment plant in Cass County to serve the Cities of Atlanta, Domino, and Queen City. Recently, the International Paper (IP) Texarkana Mill was acquired by Graphic Packaging International (GPI). The conventional package treatment plant would be sized for 2.5 MGD and would utilize the existing GPI intake; however, a new raw water pipeline would tie into the existing GPI raw water pipeline immediately upstream of the GPI pre-chlorination system to avoid the TTHM and HAA5 issues due to the high concentration of chlorine injected at that point in the system. Raw water and treated water lines would be constructed to ultimately tie into the existing distribution line that currently serves the City of Atlanta. This alternative has a total project cost of approximately $14.3 million and annual debt service payments of approximately $700,000 based on an interest rate of 4.0 percent and a 30-year financing term.