FINAL REPORT

Maury County Regional Water Supply Intake and Pumping Station Siting Study





Tennessee Duck River Development Agency

August 31, 2017

O'BRIEN & GERE

CONTENTS

TABLES

FIGURES

GLOSSARY OF TERMS

ARAP	Aquatic Resource Alteration Permit
BCUD	Bedford County Utility District
CBER	Center for Business and Economic Research (at University of Tennessee)
CIP	Capital Improvements Program
CPWS	Columbia Power & Water Systems
CWA	Clean Water Act
D/DBP	Disinfectants/Disinfection Byproducts
DRA	Tennessee Duck River Development Agency
DRUC	Duck River Utility Commission
EA	Environmental Assessment
EIS	Environmental Impact Statement
EPA	U.S. Environmental Protection Agency
fps	Feet per Second
FY	Fiscal Year
gpm	Gallons per Minute
HAAs	Haloacetic Acids
IESWTR	Interim Enhanced Surface Water Treatment Rule

L	Liter
MC	Maury County
MCL	Maximum Contaminant Level
MG	Million Gallons
mgd	Million Gallons per Day
mg/L	Milligrams per Liter
NEPA	National Environmental Policy Act
psi	Pounds per Square Inch
RWSFS	Regional Water Supply Feasibility Study
RWSSP	Regional Water Supply Strategic Plan
SDWA	Safe Drinking Water Act
SRF	State Revolving Fund
SWTR	Surface Water Treatment Rule
TDEC	Tennessee Department of Environment and Conservation
THMs	Trihalomethanes
TNC	The Nature Conservancy
TWRA	Tennessee Wildlife Resources Agency
TVA	Tennessee Valley Authority
µg/L	Micrograms per Liter
USACE	U.S. Army Corps of Engineers
USDA	U.S. Department of Agriculture
USEDA	U.S. Economic Development Administration
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish & Wildlife Service
USGS	U.S. Geological Survey
WTP	Water Treatment Plant
WWTP	Wastewater Treatment Plant
7Q10	Seven-day Consecutive Low Flow with a Recurrence Interval of Ten Years

ACKNOWLEDGEMENTS

The Tennessee Duck River Development Agency (DRA) acknowledges the following for their participation in this effort:

Water Utilities

Columbia Power & Water Systems

City of Spring Hill

Maury County Water System

Strategic Team

O'Brien & Gere

Water Utility Representatives

Dempsey, Dilling & Associates, P.C.

inflo design group, llc

SECTION 1 – INTRODUCTION AND BACKGROUND

1.1. PURPOSE

In September 2015, O'Brien & Gere (OBG) and the Duck River Agency (DRA) initiated work on the *Maury County Regional Water Supply Intake and Pumping Station Siting Study* (Maury County Intake Siting Study) which was intended to achieve the following:

- Build on work performed in the *Maury County Regional Water Supply Feasibility Study* (April, 2014) and *Maury County Regional Water Supply Strategic Plan* (September, 2015) to further refine the general location and size of proposed water facilities (i.e., river intake, pumping station, and piping).
- Define the timing for implementation of proposed water facilities based on technical and financial considerations in order to provide a "roadmap" for planning, design, and construction of regional water facilities.
- Provide water utilities with the information needed to make sound decisions on the technical, environmental and economic benefits of future investments in regional water infrastructure in Maury County.
- Identify what work needs to be completed to bring the proposed water facilities on-line.

The *Maury County Intake Siting Study* addresses one of the five water supply components recommended in the DRA's *Comprehensive Regional Water Supply Plan* (March 2011).

1.2. PARTICIPANTS IN THE MAURY COUNTY INTAKE SITING STUDY

At the outset of the DRA's *Maury County Intake Siting Study*, the following key personnel were assembled to assist with development of the study (Table 1).

Table 1. Key participants in the Duck River Agency's Maury County Intake Siting Study

Participant	Entity
Doug Murphy	Duck River Agency
George Rest	O'Brien & Gere
Thomas Dumm	O'Brien & Gere
Caryl Giles	City of Spring Hill
Dan Allen	City of Spring Hill
Wes Kelley	Columbia Power & Water Systems (CPWS)
Jonathan Hardin	Columbia Power & Water Systems (CPWS)
Larry Chunn	Maury County Water System (MCWS)
Barney Fullington	inflo design group, llc and consultant for Columbia Power & Water Systems (CPWS)

1.3. BACKGROUND

In March 2011, the Duck River Agency completed the *Comprehensive Regional Water Supply Plan* which included a list of 40 potential water supply alternatives that was reduced to 26 unique alternatives considered worthy of further consideration. These alternatives were developed to meet a 2060 potential deficit of up to 32 mgd (1.4 BG) at Columbia. Alternatives included a wide array of non-structural and structural measures such as:

- Implementing additional water use efficiency measures
- Implementing a regional drought management plan
- Changing operation of Normandy Reservoir
- Modifying river constraints
- Raising Normandy Dam
- Constructing tributary reservoirs (Fountain Creek Reservoir)
- Building offstream storage reservoirs (pumped storage)
- Utilizing quarries
- Constructing pipelines from reservoirs, rivers or other water systems

A summary matrix was developed which described each of the alternatives and documented key aspects of the alternative related to seven criteria: reliable capacity, raw water quality, cost, implementability (permitting), flexibility (phasing), environmental benefits, and recreation. During public work sessions with stakeholders, the alternatives were discussed and sorted into four categories:

- Baseline (water use efficiency, drought management, etc.)
- Fatally Flawed or Highly Unlikely (unreliable, permitting obstacles, etc.)
- Backup (alternative which may be suitable for implementation with a cornerstone alternative)
- Cornerstone (alternatives capable of satisfying entire river deficit in 2060)

Using the evaluation criteria and working closely with the stakeholders, a reliable, diverse, and flexible portfolio of water supply alternatives was developed which included the following non-structural and structural components shown in Figure 1:

- **Non-Structural Components:**
  - **Drought Management Plan** – Develop and implement a regional drought management plan.
  - **Water Use Efficiency Program** – Develop and implement a water management program.
  - **Optimize Normandy Reservoir Releases** – Optimize releases from Normandy Reservoir to preserve water in storage in the reservoir for periods when it is most needed.
- **Structural Components**
  - **Normandy Reservoir Capacity Improvements** – Increase the elevation of Normandy Dam by five feet and increase the Winter/Spring pool elevation by approximately five feet (i.e., 864 feet to 869 feet) without increasing the Summer/Fall pool elevation (i.e., 875 feet). This component increases the volume of water in storage during droughts, enhances flood protection while minimizing environmental impacts relative to other alternatives, and enhances the reliable yield available for all Duck River uses.

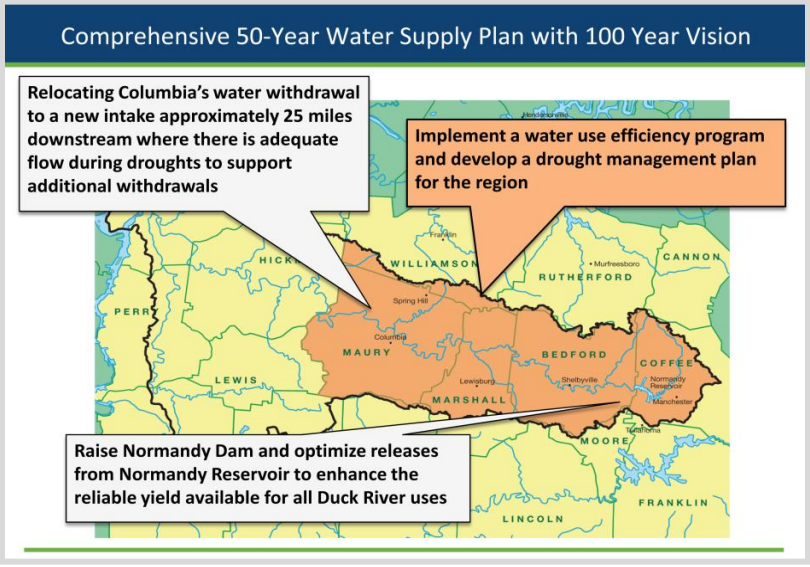

Figure 1. Recommended alternatives

  - **New intake on the Duck River for Columbia Power & Water Systems** – Relocate water withdrawals for a portion of Maury County customers to a new intake downstream of Columbia where there is adequate flow in the river during

droughts to satisfy Maury County's projected needs. This component addresses the potential deficit in Maury County and southern Williamson County with a local, highly reliable supply and will eliminate their sole reliance on Normandy Reservoir during a severe drought.

The Duck River Agency is conducting investigations and developing implementation plans for the recommended alternatives.

SECTION 2 – WATER SUPPLY CHARACTERISTICS

2.1. OVERVIEW OF WATER SUPPLY CHARACTERISTICS

The Duck River Agency represents seven water utilities which serve approximately 250,000 people and industries. In addition to public water supply needs, the river provides a wide range of other values including recreation, an excellent fishery, and some of the most biologically-rich freshwater habitat in North America.

Portions of the Duck River have been impounded since the mid-1800's. Currently, there are four low head dams located on the Duck River which were constructed in the early 1900's:

- Cortner Mill near Normandy (drainage area = 214 square miles at approximately Duck River Mile 245.1)
- Shelbyville (drainage area = 425 square miles at Duck River Mile 221.4)
- Lillard Mill near Milltown (drainage area = 919 square miles at Duck River Mile 179.2)
- Columbia (drainage area = 1,206 square miles at Duck River Mile 133.5)

Normandy Reservoir (Figure 2) is located in Bedford and Coffee Counties about 1.5 miles upstream of Normandy, Tennessee and was constructed in 1976 by the Tennessee Valley Authority (TVA) based on a request made by DRA. Normandy Reservoir releases are the primary source of water for the Duck River upstream of Columbia during severe droughts.

Figure 2. Normandy Reservoir

Public water systems upstream from Normandy Dam (primarily Tullahoma and Manchester) are served from the Duck River Utility Commission's (DRUC) water intake located in Normandy Reservoir while downstream water systems meet their needs with direct withdrawals from the Duck River. Normandy Reservoir and the Duck River provide virtually all of the public water supply needs in the five county planning area. The following direct public water supply withdrawals occur along an 88-mile segment of the Duck River between Shelbyville and Columbia:

- Shelbyville Power, Water and Sewerage System - Duck River Mile 221.9
- Bedford County Utility District - Duck River Mile 202.4
- Lewisburg Water and Wastewater - Duck River Mile 181
- Spring Hill Water Department - Duck River Mile 166
- Columbia Power & Water Systems - Duck River Mile 133.9

Current and estimated future water use was loaded into the hydrologic model "OASIS" to predict the magnitude and timing for future water supply deficits. The hydrologic model was run using current and projected water demands under the following reservoir and river constraints:

- Normandy Reservoir
  - » Release from Normandy Reservoir to maintain 25.8 mgd (40 cfs) minimum instantaneous flow just downstream of the dam.

- Shelbyville
  - Release from Normandy Reservoir to maintain 77.5 mgd (120 cfs) minimum instantaneous flow at Shelbyville (December through May) at Duck River Mile 221.4.
  - Release from Normandy Reservoir to maintain 100.2 mgd (155 cfs) minimum instantaneous flow at Shelbyville (June through November) at Duck River Mile 221.4.
  - 6.5 mgd (10 cfs) allocation for Shelbyville's water supply intake at Duck River Mile 221.9.
- Columbia
  Columbia Power & Water System's Aquatic Resource Alteration Permit (ARAP) identifies the following permit conditions:
  - Columbia Power & Water System's maximum instantaneous withdrawal rate shall be limited to 19.4 mgd (30 cfs) at Duck River Mile 134.05.
  - Columbia Power & Water System's withdrawal shall not result in a reduction of flow in the Duck River of less than 64.6 mgd (100 cfs) as measured downstream of the intake at Duck River Mile 133.9 (Figure 3).

Figure 3. Columbia Dam

2.2. NEED FOR MAURY COUNTY WATER SUPPLY FACILITIES

The need for a water utility to construct major water supply facilities (i.e., water supply intakes, water treatment plants, pipelines) can be driven by a multitude of factors, such as drought, aging infrastructure, reduction in capabilities of existing supplies, growth or a combination of these and other considerations. As shown in Table 2, the hydrologic modeling conducted under the DRA's *Comprehensive Regional Water Supply Plan* identified that during severe droughts the current water supply deficit at Columbia is 4 mgd and the potential water supply deficit in 2060 is 32 mgd (which equates to approximately 1.4 BG).

Table 2. Current and projected water supply deficits at Columbia for the Duck River

Deficit	2010	2020	2030	2040	2050	2060
Potential water supply deficit at Columbia based on critical drought year of record and maintenance of 100 cfs at Duck River Mile 132.8 (MG)	300	500	700	900	1150	1400
Potential water supply deficit at Columbia based on critical drought year of record and maintenance of 100 cfs at Duck River Mile 132.8 (mgd)	4	10	15	21	27	32

In addition to the assessment of water supply availability from the Duck River during drought conditions, this *Maury County Intake Siting Study* builds on the work conducted in the *Maury County Regional Water Supply Feasibility Study (2014)* and in the *Maury County Regional Water Supply Strategic Plan (2015)* by further investigating the capabilities of existing production and delivery facilities under non-drought conditions. The water demand conditions of particular interest in this study include the following:

- Average day demands - represents the amount of potable water required in a year, divided by 365 days.

Population projections or other data are used to derive average day water demands.

- Maximum day demands - represents the amount of potable water required in a single 24-hour period for a historical day of maximum usage. Maximum day water demands are generated using a ratio of the historic maximum:average day water demands. Water demands for Spring Hill and CPWS which have direct withdrawals from the Duck River are based on maximum day demands because these water systems must withdraw water from the Duck River at a rate which essentially matches customer demands throughout the day. Maximum day demands are typically used to size raw water intakes on river supplies, water treatment plants, and major water transmission mains. As a result, maximum day demands are used extensively in this study.

Tables 3 through 5 summarize the water demands in Maury County for Spring Hill and Columbia Power & Water Systems. Note that Maury County Water System purchases water from CPWS for its entire customer base and these demands are therefore included in the water demands for CPWS.

Table 3 summarizes the water use for Spring Hill and CPWS in 2010 and the average day water demands developed from population projections for 2020 through 2060. Population projections were used in the DRA's Comprehensive Regional Water Supply Plan to estimate water demands and were based on information from University of Tennessee's Center for Business and Economic Research (CBER).

Table 3. Average and maximum day water demands for Maury/southern Williamson Counties

Water System	2010	2020	2030	2040	2050	2060
Average day demands (mgd)						
Spring Hill	2.6	3.1	3.7	4.2	4.7	5.3
Columbia (includes MCWS)	8.3	10.6	13.2	15.6	18.1	20.6
Total average day demand	**10.9**	**13.7**	**16.9**	**19.8**	**22.8**	**25.9**
Maximum day demands (mgd)						
Spring Hill	4.7	5.6	6.7	7.6	8.5	9.5
Columbia (includes MCWS)	12.5	16	19.8	23.5	27.2	30.8
Total maximum day demand	**17.2**	**21.6**	**26.5**	**31.1**	**35.7**	**40.3**

Table 4 compares the capacity of the Spring Hill intake and water treatment plant to the maximum day demands through the planning period. As shown in Table 4, Spring Hill has 6 mgd of capacity at the intake on the Duck River and the 18-inch pipeline from the intake to the water plant is sufficient to meet maximum day water demands through approximately 2025. For treatment, Spring Hill has a 4 mgd water treatment plant expandable to 6 mgd. TDEC has granted Spring Hill permission to operate the plant at peak rates up to 6 mgd, but improvements are needed for a continuous rating. Consequently, the Spring Hill WTP production capacity of 4 mgd is currently deficient and the 6 mgd capacity (with the required improvements) would be sufficient to meet maximum day demand through approximately 2025.

Table 4. Surplus/deficit for Spring Hill intake and water treatment plant

Spring Hill	2010	2020	2030	2040	2050	2060
River Intake						
Maximum day demands (mgd)	4.7	5.6	6.7	7.6	8.5	9.5
Intake capacity (mgd)	6	6	6	6	6	6
Intake surplus/deficit (mgd)	**1.3**	**0.4**	**-0.7**	**-1.6**	**-2.5**	**-3.5**
Water treatment plant						
Maximum day demands (mgd)	4.7	5.6	6.7	7.6	8.5	9.5
WTP capacity (mgd)	4	4	4	4	4	4
WTP surplus/deficit (mgd)	**-0.7**	**-1.6**	**-2.7**	**-3.6**	**-4.5**	**-5.5**

Table 5 compares the capacity of the CPWS intake and water treatment plant to the maximum day demands through the planning period. As shown in Table 5, CPWS has 20 mgd of capacity at the intake on the Duck River and at its water treatment plant is sufficient to meet maximum day water demands through approximately 2030.

Table 5. Surplus/deficit for Columbia Power & Water Systems intake and water treatment plant

Columbia Power & Water Systems (including MCWS)	2010	2020	2030	2040	2050	2060
River Intake						
Maximum day demands (mgd)	12.5	16	19.8	23.5	27.2	30.8
Intake capacity (mgd)	20	20	20	20	20	20
Intake surplus/deficit (mgd)	**7.5**	**4**	**0.2**	**-3.5**	**-7.2**	**-10.8**
Water treatment plant						
Maximum day demands (mgd)	12.5	16	19.8	23.5	27.2	30.8
WTP capacity (mgd)	20	20	20	20	20	20
WTP surplus/deficit (mgd)	**7.5**	**4**	**0.2**	**-3.5**	**-7.2**	**-10.8**

A summary of the information presented in Tables 4 and 5 is shown in Figure 4. In addition, Figure 4 shows the combined maximum day water demands for Spring Hill and CPWS as well as the combined water treatment plant capacity. As shown in the figure, the combined capacity of the existing Spring Hill and CPWS water treatment plants is sufficient to meet the combined needs of Spring Hill and CPWS through approximately 2025.

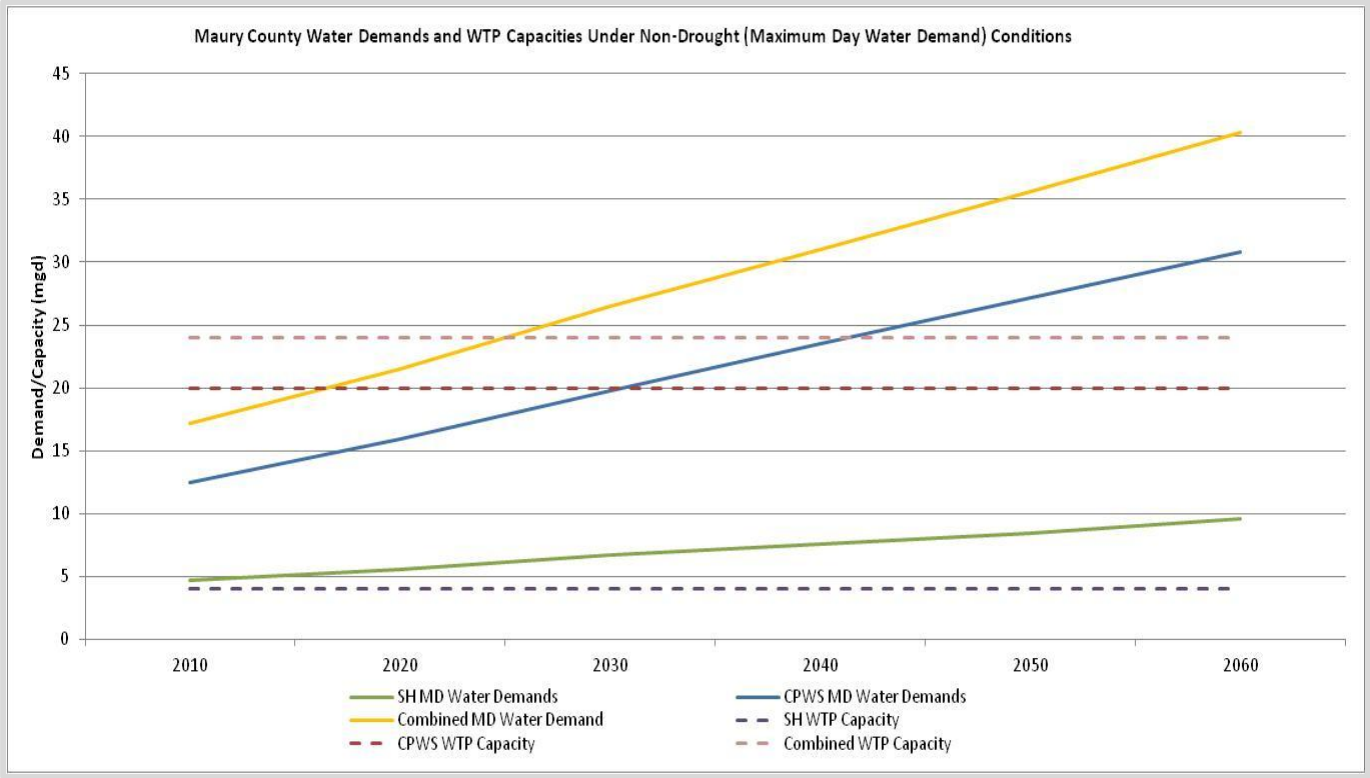

Figure 4. Maury County Water Demands and WTP Capacities under Non-Drought Conditions

SECTION 3 – RECOMMENDED ALTERNATIVES FROM PREVIOUS STUDIES

The alternatives investigated as part of the *Maury County Intake Siting Study* have been refined over time through the course of three separate studies. A brief summary of the recommendations that shaped the alternatives follows.

3.1. RECOMMENDED ALTERNATIVES FROM *COMPREHENSIVE REGIONAL WATER SUPPLY PLAN* (MARCH, 2011)

In the Duck River Agency's *Comprehensive Regional Water Supply Plan* (March 2011), one of the five recommended alternatives included relocating water withdrawals for a portion of Maury County customers to a new raw water intake downstream of Columbia (Figure 5). For comparison with other raw water supply options under consideration, this alternative includes a 30-inch water transmission main to deliver 20 mgd of raw water from an intake and pumping station near Williamsport to the CPWS WTP.

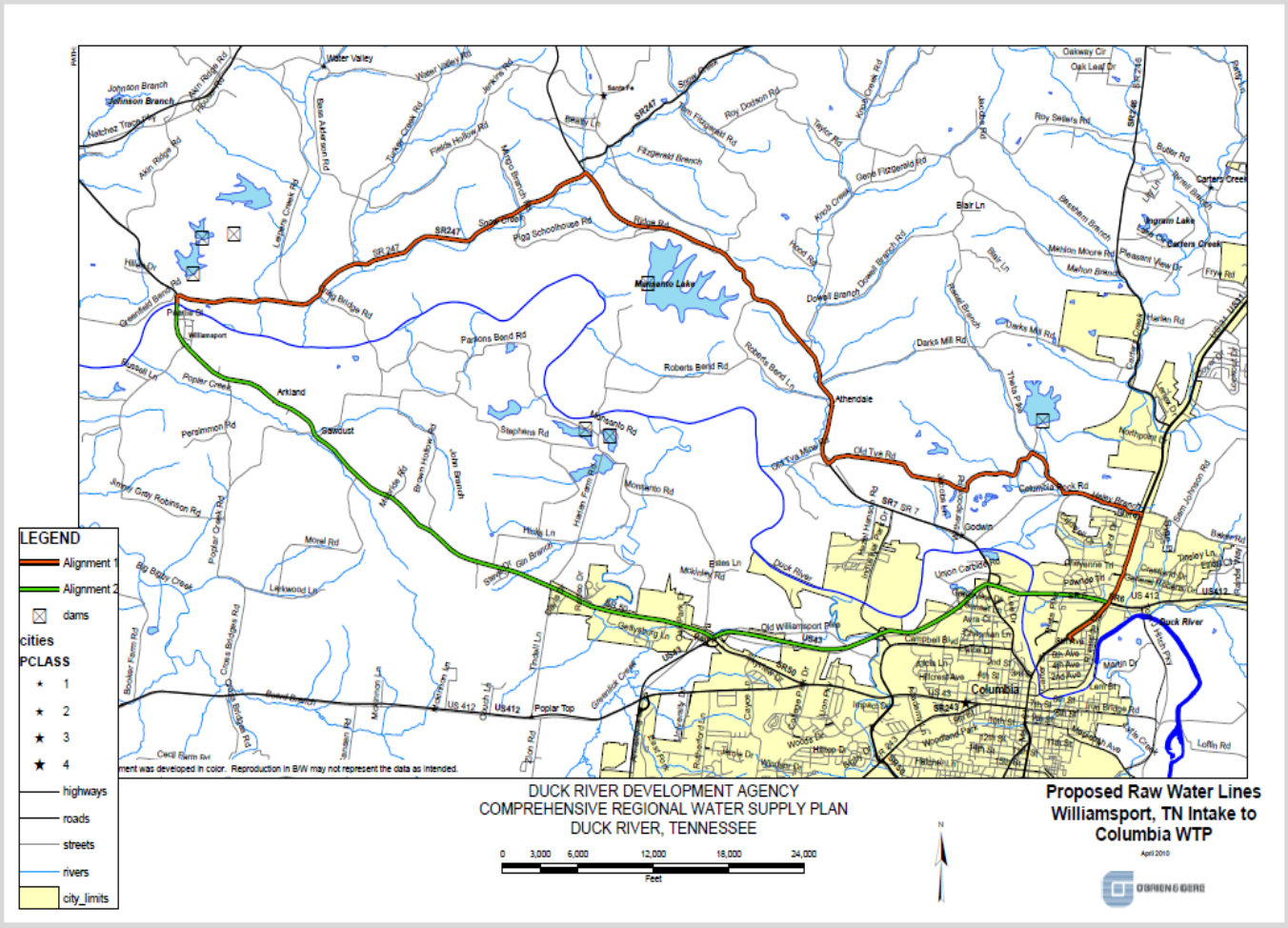

Figure 5. Proposed raw water pipelines from an intake downstream of Columbia to CPWS WTP

3.2. RECOMMENDED ALTERNATIVES FROM MAURY COUNTY REGIONAL WATER SUPPLY FEASIBILITY STUDY (APRIL, 2014)

In April 2014, DRA and OBG completed the *Maury County Regional Water Supply Feasibility Study* (Maury County RWSFS) which further evaluated the feasibility of constructing the water facilities described in the new raw water intake alternative recommended in the *Comprehensive Regional Water Supply Plan*. In the

Maury County RWSFS, the recommended alternative for each water system was briefly described as follows:

- **Spring Hill** – This alternative involved Spring Hill retaining its existing supply (4 mgd) from the Duck River, and purchasing additional water from CPWS in the near-term. This approach avoided the need for Spring Hill to invest in expanding the permanent capacity of its WTP to 6 mgd in the near-term. With Spring Hill's demand reaching 10 mgd in the planning period (2060), Spring Hill could purchase up to 6 mgd over the longer term depending on availability of water from CPWS. It was determined that compared to expansion of the Spring Hill WTP from 4 mgd to 6 mgd, purchasing finished water from CPWS could be significantly less expensive through 2025-2030.

- **Maury County Water System** – Due to the interconnectivity between the MCWS and CPWS systems, MCWS should continue to purchase treated water from CPWS, which currently has adequate spare capacity.

- **Mount Pleasant** – This alternative recommended that Mt. Pleasant retain its existing water supply sources, and construct a new 2 mgd membrane WTP as planned. Mt. Pleasant should continue to investigate development of 0.5 mgd of additional groundwater, and to add to 2 mgd of additional WTP capacity.

- **Columbia Power & Water Systems** - CPWS has available water treatment plant capacity and infrastructure to sell water to meet the near-term growth needs of Spring Hill, Maury County Water System and/or Mount Pleasant. In the long-term, CPWS could construct a new intake downstream of Columbia and expand its treatment capacity to meet the future needs for Maury County. Beyond the 2025-2030 timeframe, additional WTP capacity will be required to keep pace with growth in maximum day water demands in Maury County. It is noted that the increase in maximum day capacity would partially address the drought deficit estimated in DRA's *Comprehensive Regional Water Supply Plan* (March, 2011). It was recommended that CPWS and Spring Hill work together to determine how best to develop the initial increment of supply and treatment (say 5 mgd) and subsequent expansions to meet the maximum day demands beyond 2030. A possible configuration of water facilities with the new water treatment plant located downstream of Columbia is shown in Figure 6.

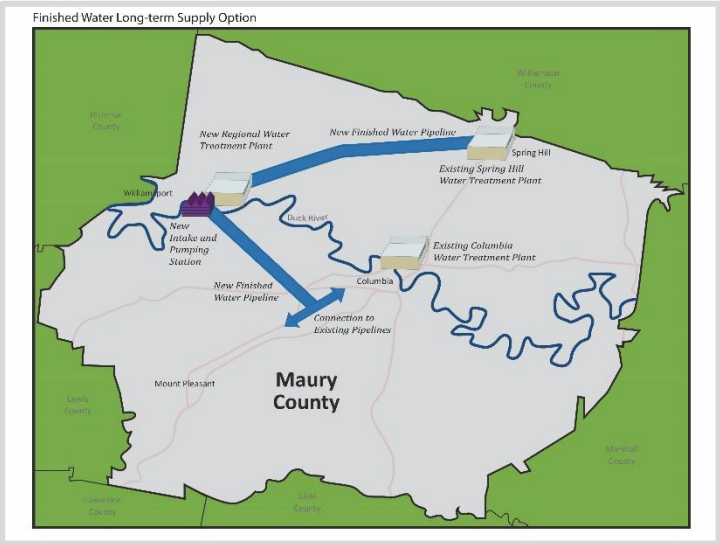

Figure 6. Long-term water supply option with new water treatment plant downstream of Columbia

3.3. RECOMMENDED ALTERNATIVES FROM MAURY COUNTY REGIONAL WATER SUPPLY STRATEGIC PLAN (MAY, 2015)

In May 2015, DRA and OBG completed the *Maury County Regional Water Supply Strategic Plan (*Maury County RWSSP) which included an evaluation of eight water supply alternatives configured to supply 30 mgd (2040), 40 mgd (2060), and 50 mgd (2080). The water system facilities proposed in the recommended alternative are shown in Figures 7 and 8 and include the following:

- **30 mgd water system (2040)**
  - Expand the Spring Hill raw water intake from 6 mgd to 10 mgd
  - Construct a new 24-inch raw water transmission main from the Spring Hill raw water intake to the Spring Hill WTP (note that existing 18-inch raw water pipeline to be used for Spring Hill wastewater discharge to the Duck River)
  - Expand the Spring Hill WTP from 4 mgd to 10 mgd
  - Construct a new 18 mgd raw water intake and pumping station on Duck River near Parsons Bend

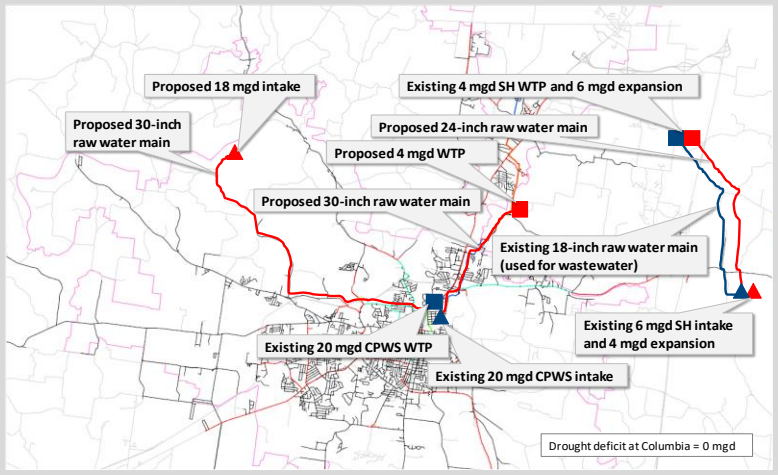

Figure 7. Recommended alternative for 30 mgd water system (2040)

  - Construct a new 30-inch raw water transmission main from the raw water intake at Parsons Bend to the existing CPWS WTP and continuing to the new 4 mgd WTP in the Spring Hill/Columbia corridor
  - Construct a new 4 mgd WTP in the Spring Hill/Columbia corridor
- **40 mgd water system (2060)**
  - Expand raw water intake and pumping station on Duck River near Parsons Bend from 18 mgd to 26 mgd
  - Expand WTP in the Spring Hill/Columbia corridor from 4 mgd to 11 mgd

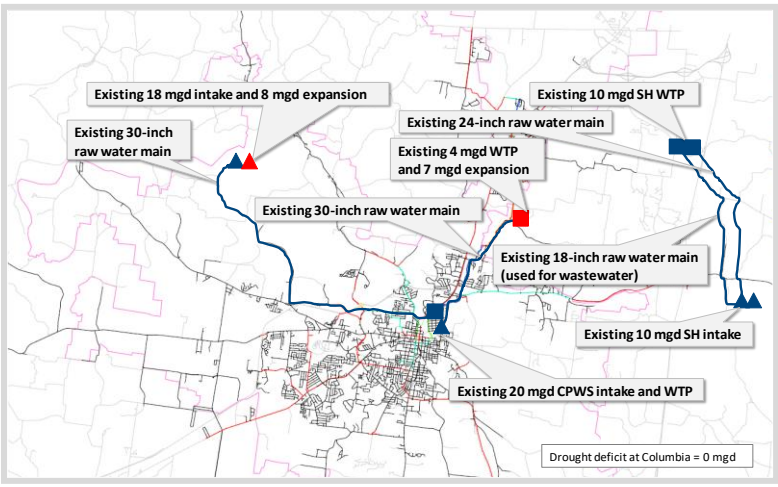

Figure 8. Recommended alternative for 40 mgd water system (2060)

The near-term and long-term benefits of the recommended alternative are as follows.

Near-term Benefits (prior to 2025)

The combined capacity of the existing Spring Hill and CPWS water treatment plants is sufficient to meet the

combined needs of Spring Hill and CPWS through approximately 2025. There are a number of reasons why the water systems in Maury County would elect to construct elements of the recommended alternative prior to 2025 (i.e., drought resiliency, emergency reliability, water quality, uncertainty in water demands, etc.). Because CPWS currently has available treatment capacity and Spring Hill has an immediate need, the critical component of the near-term program is the Spring Hill/CPWS Water Sales Agreement which has the following benefits:

- Allows Spring Hill to meet their rapidly increasing water demands, and addresses Spring Hill's urgent need for additional capacity
- Allows CPWS to use the revenues from water sales to Spring Hill to help finance water facilities in the recommended alternative which improves regional drought resiliency
- Increases Spring Hill's ability to draw water from CPWS in an emergency after piping improvements are completed
- Facilitates the extension of the existing water withdrawal permits (ARAP permits) for both Spring Hill and CPWS and would likely be viewed favorably by TDEC
- Allows Spring Hill to expand its revenue base prior to assuming debt for a long-term construction program. A wholesale water purchase agreement with CPWS would substantially reduce Spring Hill's need for additional revenues, and therefore substantially lessen the size of near-term rate increases. Assuming a 10-year term agreement that utilizes the available treatment capacity from CPWS, Spring Hill could potentially save an average of $2 million annually by purchasing treated water. Expanding Spring Hill's water system to 10 mgd would require water rates to roughly double. The wholesale agreement between Spring Hill/CPWS would allow for a much smaller and more gradual increase in water rates.
- Allows Spring Hill to sell water to CPWS after Spring Hill's water supply and treatment facilities are expanded

Long-term Benefits

- Retains operation of the existing Spring Hill intake, piping and WTP, which is expected to receive support and approvals from Spring Hill representatives
- Uses existing Spring Hill raw water main for Spring Hill wastewater discharge to Duck River which could result in a substantial cost savings for Spring Hill
- Provides new raw water main (10 mgd capacity) from existing Spring Hill raw water intake on the Duck River to the existing Spring Hill WTP
- Offsets additional Spring Hill withdrawals from Duck River upstream of Columbia and supplements flow in Designated Critical Segment of the Duck River by returning flow from Spring Hill's wastewater treatment plant to the Duck River
- Allows Spring Hill to independently implement water supply projects based on its schedule and needs
- Facilitates approvals of landowners and utilities by avoiding construction of a long cross-county pipe
- Addresses regional drought deficit with new Parsons Bend raw water intake and raw water pipeline
- Meets drought deficit at Columbia through 2060
- Allows CPWS to fully utilize capacity at existing WTP during drought by obtaining water from Duck River downstream of Columbia
- Allows CPWS to independently implement projects as growth develops and provides a number of potential WTP locations in the CPWS service area

- Provides opportunity to extend piping to a future intake on Duck River further downstream for additional supply if needed
- Provides opportunity for bi-directional buy-sell agreement between Spring Hill and CPWS

4. EVALUATION OF ALTERNATIVES FOR MAURY COUNTY INTAKE SITING STUDY

Building on the alternatives identified in the *Maury County Regional Water Supply Strategic Plan,* the purpose of the *Maury County Intake Siting Study* was to identify suitable locations along the Duck River for construction of a raw water intake and pumping station between the Columbia Wastewater Treatment Plant (WWTP) and the Hickman County border. A number of key investigations were conducted to identify locations and a summary of these investigations follows.

4.1. PRELIMINARY INTAKE CONCEPT PLAN AND BATHYMETRIC SURVEY

The purpose of the preliminary intake concept plan and bathymetric survey was to identify sites in the Duck River between the Columbia WWTP and the Hickman County border that would have adequate water depth for construction of a raw water intake. In March 2016, OBG and DRA completed a cursory bathymetric survey for a section of the Duck River between the Columbia Wastewater Treatment Plant (near Duck River Mile 127) and the Route 50 Bridge near Williamsport (near Duck River Mile 114).

Prior to conducting the bathymetric survey, OBG developed a preliminary conceptual plan for the raw water intake screen to generally define the size and configuration. This information was used to determine whether the water depths measured in the Duck River would be sufficient for installation of the river intake. The screen drum sizing and configuration for the passive screen was based on a capacity of 30 mgd (roughly 21,000 gpm) which approximates the near-term future capacity at the CPWS WTP (20 mgd) and the Spring Hill WTP (10 mgd). Using four 30-inch diameter screens, it was determined that pools in the Duck River which were over 5 ft in depth and at least 40 ft in length would be suitable (Figure 9).

Figure 9. Possible intake screen configuration (*photo courtesy of Johnson Screens*)

As a result of the bathymetric survey, eight (8) sites on the Duck River between the Columbia Wastewater Treatment Plant and the Route 50 Bridge near Williamsport were considered to have sufficient depth to be included in the evaluation of possible intake locations. Additionally, a subsequent meeting held with CPWS in late September 2016 resulted in an additional intake site (Intake Site No. 9) which was also evaluated. The following nine locations were identified as candidates for construction of a new raw water intake and pumping station:

- Intake Site No. 1: Site No. 1 is located approximately 0.75 mile west of the Columbia Wastewater Treatment Plant (WWTP).
- Intake Site No. 2: Site No. 2 is located at Sellers Bluff, approximately 1.6 miles east of the Roberts Bend Road Bridge.
- Intake Site No. 3: Site No. 3 is located at Roberts Bend Road Bridge.
- Intake Site No. 4: Site No. 4 is located at Roberts Bend, approximately 0.9 mile northwest of Roberts Bend Road Bridge.
- Intake Site No. 5: Site No. 5 is located at Parson's Bend.
- Intake Site No. 6: Site No. 6 is located at Cave Bluff, approximately 1.5 miles northeast of Craig Bridge Road Bridge.

- Intake Site No. 7: Site No. 7 is located at the bridge on Craig Bridge Road.
- Intake Site No. 8: Site No. 8 is located at the State Route 50 Bridge near Williamsport.
- Intake Site No. 9: Site No. 9 is located along the Duck River at Church's Bluff (near Duck River Mile 100). The site is located approximately 3 miles west of Intake Site No. 8.

Figure 10 shows the general location of each of the raw water intake and pumping station sites.

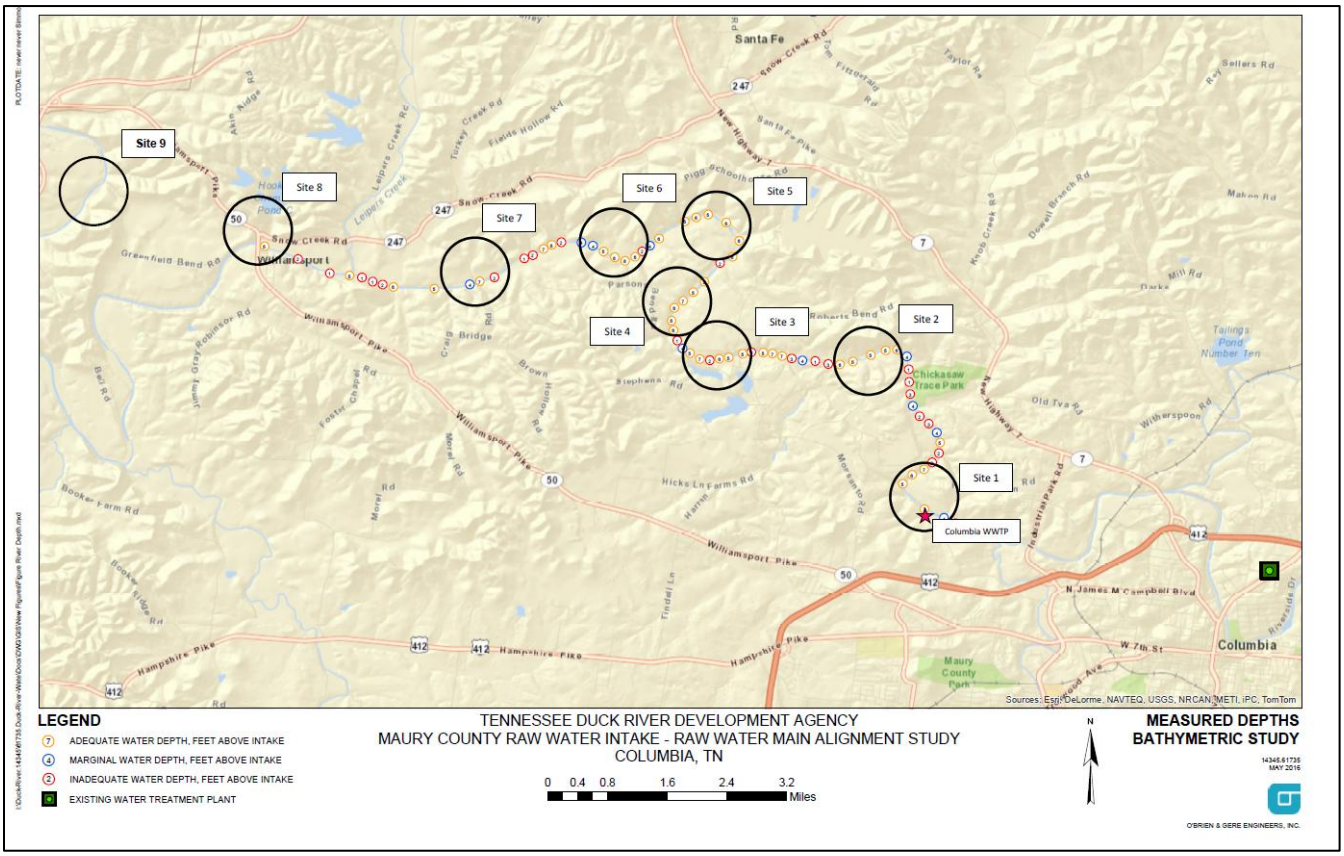

Figure 10. Possible raw water intake and pumping station sites

A more detailed discussion of the preliminary intake concept plan and bathymetric survey is presented in Appendix A.

4.2. WATER QUALITY

BDY Environmental, LLC (BDY) developed a letter report documenting surface water sampling completed along various Duck River pool reaches under the following conditions:

- May 12, 2016 (Low Flow Event) - Duck River USGS Gage 03599500 at Columbia, TN, recorded a discharge of 181 cubic feet per second (ft^3/s) at 12:00 CDT on 5/12/2016.
- September 20, 2016 (High Flow Event) - The Duck River USGS Gage 03599500 at Columbia, TN, recorded a discharge of 513 (ft^3/s) at 12:00 CDT on 9/20/2016.

The sampling was conducted to determine water quality conditions of the Duck River near proposed Maury County Water Intake locations. Overview maps and sampling locations are provided in Appendix B.

None of the surface water samples for both low and high sampling events reported metals, pesticides, VOC, SVOC, or PCBs above laboratory reported detection limits, with the exception of low-level barium concentrations below EPA MCLs. Low level barium concentrations are considered normal and commonly encountered in surface water in the region.

A more detailed discussion of the water quality sampling and results is presented in Appendix B.

4.3. ENVIRONMENTAL

BDY Environmental LLC (BDY) prepared a natural resources regulatory constraints analysis (RCA) of the nine sites proposed for potential intake stations on the Duck River. BDY conducted a desktop review of the sites and assessed sites from the road where possible. The analysis included identification of potential aquatic resources such as wetlands and streams using criteria prescribed by the U.S. Army Corps of Engineers (USACE) and the Tennessee Department of Environment & Conservation (TDEC). BDY assessed TDEC databases to determine if impaired or high quality waters are included at each site. BDY also evaluated the potential for rare, threatened, or endangered (RTE) plant or animal habitats to be present on the subject property. BDY contacted TDEC's Division of Archaeology regarding presence or absence of documented archaeological sites in the State records. BDY conducted site reconnaissance on October 25, 2016. A summary of the findings from the natural resources analysis is presented in Figure 11.

Intake Site	TDEC Antidegredation Status	Bat Habitat	Other RTE Observations	Wetlands	Hydric Soils	Historical Resources	Cultural Resources within 1 mi
Site 1	●	◑	◐	--	--	--	--
Site 2	●	◑	◐	--	--	●	●
Site 3	●	◑	◐	●	○	--	--
Site 4	●	◐	◐	--	○	--	--
Site 5	●	◑	--	●	○	--	●
Site 6	●	◑	--	●	○	--	--
Site 7	◐	◐	◐	--	○	●	●
Site 8	◐	◐	◐	●	○	●	--
Site 9	○	◑	--	●	○	●	●
Legend	● Impaired: Phosphorus and DO ◐ Impaired: Phosphorus ○ Fully Supporting	◑ Likely Present ◐ Potentially Present	◐ Potentially Present -- None Recorded	● Wetlands Nearby -- None Recorded	○ ≤ 4 Hydric Rating -- None Recorded	● Historical Nearby -- None Recorded	● Cultural Nearby -- None Recorded

Figure 11. Summary of regulatory constraints analysis

A more detailed discussion of the regulatory constraints analysis for the nine alternative intake sites is presented in Appendix C.

4.4. PROPERTY OWNERS ADJACENT TO INTAKE SITE ALTERNATIVES

Identifying and providing information on property owners adjacent to and across the Duck River for each intake site alternative will be part of the public notification process. Figures showing the properties in the vicinity of the nine intake site alternatives and a table providing the names and addresses of the property owners is presented in Appendix D.

4.5. POTENTIAL FLOWS IN THE DUCK RIVER

The purpose of the analysis of potential flows in the Duck River is to compare the possible effects of anticipated water withdrawals and wastewater discharges on the flows in the Duck River under severe

drought conditions and 2060 water demands. Gaining a better understanding of the approximate quantity of flow at the existing Columbia intake and at the nine proposed intake locations during drought conditions can be used as a factor in identifying the adequacy of supply at the proposed raw water intake locations in the segment of the Duck River between the Columbia Wastewater Treatment Plant (WWTP) and the Hickman County border. Figure 12 shows a plot that was developed using information from Figure 3 of the *Upper Duck River Water Supply Analysis and Final Programmatic EIS* (TVA, 2000) as well as information from DRA's water supply planning studies for Maury County and the region. Figure 12 represents a hypothetical drought condition that is used to illustrate how the existing and proposed intake and outfall locations impact flows in the Duck River. Note that downstream of the existing CPWS intake the "blue" line and the "green" line represent the "bookends" of the flow conditions in the Duck River with the entire CPWS 2060 maximum day water withdrawal at either the existing CPWS intake (blue line) and proposed downstream intake (green line), respectively. If CPWS withdraws water from both the existing intake and the proposed intake simultaneously to meet the water demand, the flow condition downstream of the CPWS intake would plot between the "blue" line and the "green" line in Figure 12.

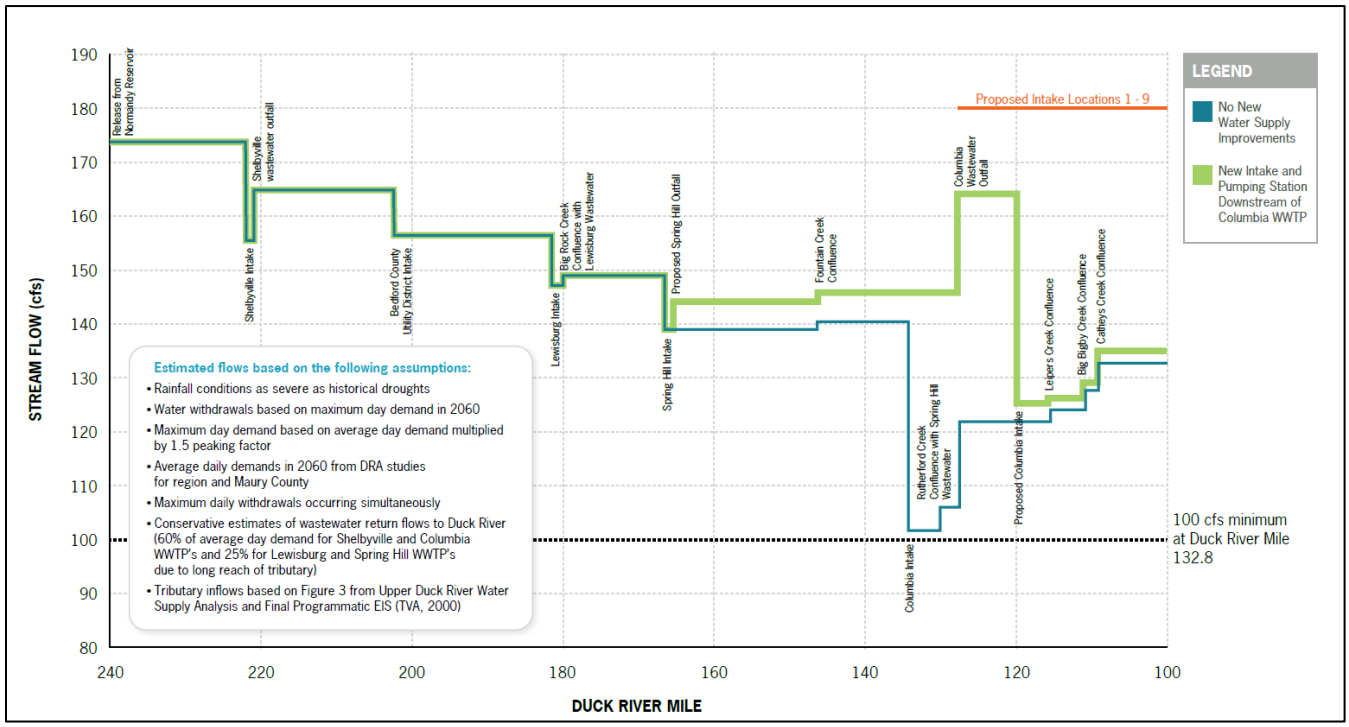

Figure 12. Potential effects of water withdrawals and wastewater discharges on the flows in the Duck River under drought conditions in 2060

The plot considers the following key components:

- Locations of USGS streamflow gages and river flow constraints
- Releases from Normandy Reservoir
- Approximate location and quantity of direct public water supply withdrawals from the Duck River from Normandy Reservoir to the Hickman County border
- Approximate location and quantity of wastewater discharge returning to the Duck River
- Expected tributary inflows during severe droughts

A summary of the findings based on the information presented in Figure 12 follows:

- Using the existing Spring Hill raw water main for a direct discharge of Spring Hill wastewater to the Duck River just downstream of the Spring Hill intake would more than offset the additional future Spring Hill water withdrawals from Duck River upstream of Columbia (i.e., Spring Hill withdrawals proposed to increase by 4 mgd from 6 mgd to 10 mgd). Consequently, Spring Hill's increased future withdrawals would have no adverse impact on the 100 cfs flow constraint at Columbia under the proposed Spring Hill withdrawal and discharge configuration.
- Direct discharge of Spring Hill wastewater to Duck River just downstream of the Spring Hill intake would supplement flow in Designated Critical Segment of the Duck River upstream of the Columbia WWTP discharge.
- CPWS's ARAP identifies that the withdrawal at the Columbia intake shall not result in a reduction of flow in the Duck River of less than 100 cfs (64.6 mgd) as measured downstream of the intake at Duck River Mile 133.9. For the drought shown in Figure 12, the withdrawal at the existing CPWS intake would be limited to approximately 40 cfs (26 mgd) due to the 100 cfs flow constraint downstream at Columbia.
- The 100 cfs flow constraint at Columbia in the CPWS ARAP is due in large part to the need for wasteload assimilation at the Columbia WWTP downstream. The 100 cfs flow constraint would not be applicable at the nine proposed raw water intake and pumping station sites identified in this study because these sites

are located downstream of the Columbia WWTP (Figure 12). In Figure 12, the flow in the Duck River is between roughly 165 cfs (106 mgd) and 175 cfs (113 mgd) depending on which of the nine proposed intake sites is being considered.

- Withdrawals from the new intake on the Duck River would be located downstream of the Columbia and Spring Hill WWTP's and as shown in Figure 12 it is assumed that approximately 60 percent of the withdrawal would be returned to the Duck River upstream of Intake Sites 1 through 9. To illustrate this relationship between the water withdrawals and wastewater discharges, consider the examples shown in Table 6. These examples are based on holding constant the flow conditions upstream of the existing Columbia intake at 144 cfs and varying the CPWS withdrawal. As shown in Table 6, CPWS could meet an average day water demand of 50 mgd (maximum day demand of 75 mgd) and maintain 98 cfs (63 mgd) in the Duck River downstream of the proposed intake (*Note that the CPWS average day water withdrawal for 2016 was approximately 9.4 mgd*).

Table 6. Examples illustrating relationship between Columbia WWTP discharge, CPWS withdrawal and Duck River flows

Duck River Flow Downstream of Existing CPWS Intake (cfs)	CPWS Average Day Water Demand (mgd)	CPWS Average Day Water Demand (cfs)	Columbia WWTP Average Wastewater Discharge at 60% of Average Day Water Demand (cfs)	CPWS Maximum Day Water Demand at 1.5 Times Average Day Water Demand (cfs)	CPWS Maximum Day Water Demand with 20% Reduction for Water Use Restrictions (cfs)	Duck River Flow Downstream of Proposed CPWS Intake at Sites 1 through 9 (cfs)
144	20.4	32	19	47	38	126
144	30	46	28	70	56	117
144	40	62	37	93	74	108
144	50	77	46	116	93	98

- During severe drought conditions, Figure 12 shows that the tributary contributions between the Columbia WWTP and the Hickman County border are limited to roughly 10 cfs (7 mgd) or about 6 percent of the Duck River flow.

In conclusion, based on the relationship between water withdrawals and wastewater return flows to the Duck River in Maury County, any of the nine proposed intake sites meet the projected water demands in Maury County through 2060 and beyond.

A more detailed discussion of potential river flows is presented in Appendix E.

4.6. PIPE ALIGNMENTS

Preliminary alignments for the raw water transmission main were identified for each of the proposed intake and pumping station sites and a cursory evaluation of the characteristics of each alignment was provided as well as the estimated cost. In total, almost 70 alignment alternatives were identified for the nine intake sites, each extending from the respective raw water intake location to the existing CPWS WTP. A summary of the findings from the investigation of the alternative alignments follows:

- With the exception of Intake Site Nos. 4 and 5 on Parsons Bend, the pipeline alignments following the Southern Routes were comparable in capital cost or less expensive for each intake site compared to the Northern Routes. In addition, for Intake Site Nos. 7, 8, and 9, the costs for the 30-inch water main along

the Southern Routes in the Williamsport Pike corridor were typically 10% to 35% less expensive compared to the northern alignments. In addition, the topography along the Williamsport Pike corridor is flatter than the Northern Routes as well as the segment of pipeline in proximity to Site Nos. 4 and 5 on Parsons Bend which would result in a cost savings associated with reduced pumping energy.

- Intake Site No. 7 is comparable in capital cost to Intake Site No. 4 and less expensive compared to Intake Site Nos. 5 and 6 on Parsons Bend.

Consequently, from a pipeline alignment perspective it is recommended that future investigations associated with siting of the raw water intake and pumping station be directed toward Intake Site Nos. 1 through 3 and 7 through 9 with a 30-inch water transmission main along a Southern Route in the Williamsport Pike corridor.

A more detailed discussion of the pipeline alternatives is presented in Appendix F.

4.7. PLANNING LEVEL CONSTRUCTION COSTS

Planning level construction costs were developed for the proposed raw water transmission main, intake and pumping station for each of the nine proposed sites. Planning level construction cost estimates were developed for each of the water main alignments based on 2016 dollars. Given the preliminary nature of this study, costs were developed by roughly quantifying the following components for each alignment:

- Transmission main installed "cross-country" or through existing overhead powerline right-of-ways ($200/LF)
- Transmission main installed within "primary" roads or state highways ($300/LF)
- Transmission main installed within rural or county roads ($250/LF)
- Duck River crossings ($750,000 each)

The minimum planning level construction cost for each raw water transmission main route is listed in Table 7. Planning level construction costs for the raw water transmission mains that were considered to be less expensive than the corresponding alternative route (i.e., Lowest Northern vs. Lowest Southern, Highest Northern vs. Highest Southern) are highlighted.

Table 7: Maury County raw water transmission main cost estimates

Intake Site No.	Northern Alignments		Southern Alignments	
	Lowest Cost Raw Water Main Alternative ($, Millions)	Lowest Cost Raw Water Main, Intake and Pumping Station Alternative ($, Millions)	Lowest Cost Raw Water Main ($, Millions)	Raw Water Main, Intake and Pumping Station ($, Millions)
1	$13.3	$22.3	$11.2	$20.2
2	$15.4	$24.4	$15.9	$24.9
3	$19.7	$28.7	$18.9	$27.9
4	$20.6	$29.6	$21.6	$30.6
5	$20.0	$29.0	$23.4	$32.4
6	$35.1	$44.1	$23.8	$32.8
7	$34.4	$43.4	$21.9	$30.9
8	$36.0	$45.0	$27.3	$36.3
9	$41.3	$50.3	$33.7	$42.7

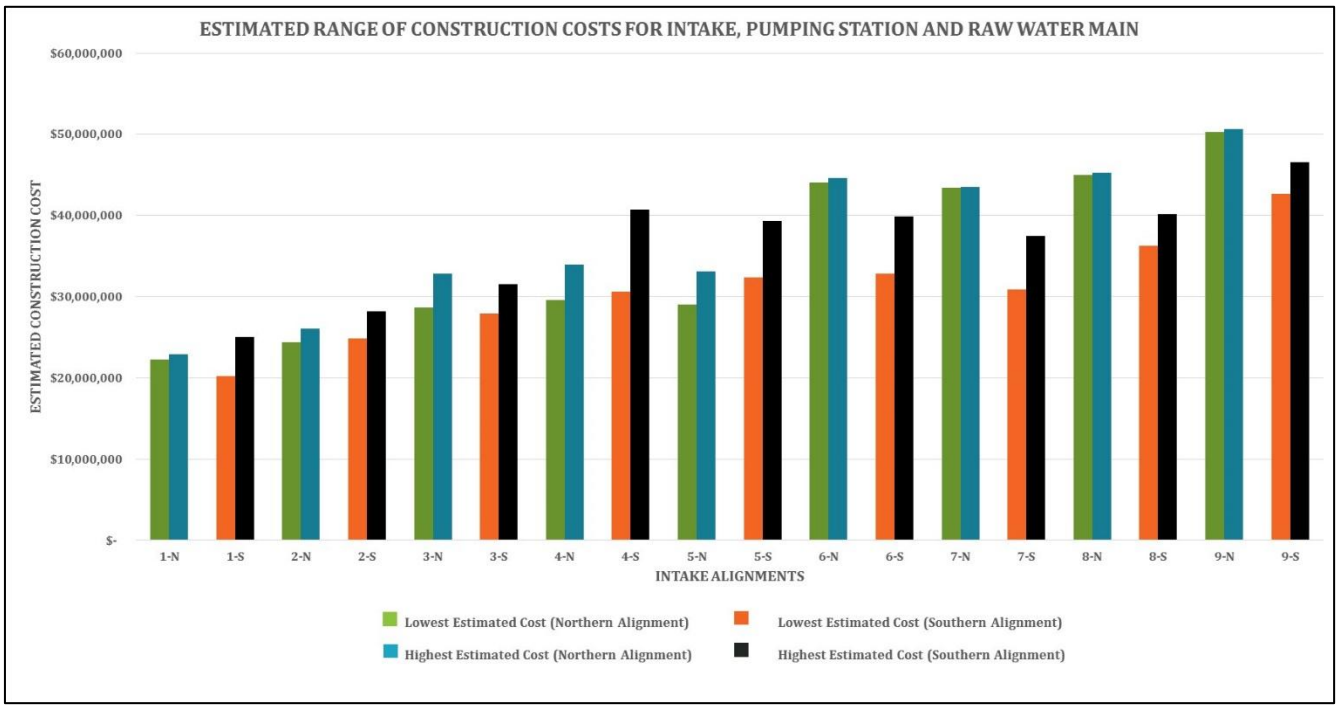

Figure 13. Estimated range of construction cost for intake, pumping station and raw water main

Table 1 and Figure 13 indicate the following:

- With the exception of Intake Site No. 5 on Parsons Bend, the pipeline alignments following the Southern Routes were comparable in capital cost or less expensive for each intake site compared to the Northern Routes (as highlighted in Table 1). In addition, for Intake Site Nos. 7, 8, and 9, the costs for the 30-inch water main along the Southern Routes in the Williamsport Pike corridor were typically 10% to 35% less expensive compared to the northern alignments. In addition, the topography along the Williamsport Pike corridor is flatter than the Northern Routes and it is flatter than the segment of pipeline in proximity to Site Nos. 4 and 5 on Parsons Bend which would result in a cost savings associated with reduced pumping energy.
- Intake Site No. 7 is comparable in construction cost to Intake Site No. 4 and less expensive compared to Intake Site Nos. 5 and 6 on Parsons Bend.

Consequently, from a cost perspective it is recommended that future investigations associated with siting of the raw water intake and pumping station be directed toward Intake Site Nos. 1 through 3 and 7 through 9 with a 30-inch water transmission main along a Southern Route in the Williamsport Pike corridor. The lowest planning level construction costs for the intake, pumping station and 30-inch transmission main at Intake Site Nos. 1 through 3 range from $11 million to $19 million and for Intake Site Nos. 7 through 9 the costs range from $22 million to $34 million.

A more detailed discussion of costs is presented in Appendix G.

5. CONCLUSIONS AND RECOMMENDATIONS

A summary of the findings and conclusions from the key investigations conducted in this study follows:

- Preliminary intake concept plan and bathymetric survey - As a result of the bathymetric survey, eight (8) sites on the Duck River between the Columbia Wastewater Treatment Plant and the Route 50 Bridge near Williamsport were considered to have sufficient depth (greater than 5 ft) to be included in the evaluation of possible intake locations. Subsequent to the survey, an additional site at Church's Bluff downstream of Williamsport was included in the list of alternative sites.
- Water quality – None of the surface water samples for both low and high sampling events reported metals, pesticides, VOC, SVOC, or PCBs above laboratory reported detection limits, with the exception of low-level barium concentrations below EPA MCLs. Low level barium concentrations are considered normal and commonly encountered in surface water in the region.
- Environmental – Based on the regulatory constraints analysis conducted in this study, it does not appear that any of the nine sites should be eliminated and none of the nine sites appear to have a significant advantage over the others from a regulatory constraints perspective.
- Potential flows in the Duck River
  - Using the existing Spring Hill raw water main for a direct discharge of Spring Hill wastewater to the Duck River just downstream of the Spring Hill intake would more than offset the additional future Spring Hill water withdrawals from Duck River upstream of Columbia.
  - The 100 cfs flow constraint for the Duck River at Columbia would not be applicable at the nine proposed raw water intake and pumping station sites identified in this study because these sites are located downstream of the Columbia WWTP.
  - During severe drought conditions, tributary contributions between the Columbia WWTP and the Hickman County border are limited to roughly 10 cfs (7 mgd) or about 6 percent of the Duck River flow.
  - Based on the relationship between water withdrawals and wastewater return flows to the Duck River in Maury County, any of the nine proposed intake sites will meet the projected water demands in Maury County through 2060 and beyond.
- Pipeline alignments and planning level cost estimates
  - In general, the pipeline alignments following the Southern Routes were comparable in capital cost or less expensive for each intake site compared to the Northern Routes.
  - For Intake Site Nos. 7, 8, and 9, the costs for the 30-inch water main along the Southern Routes in the Williamsport Pike corridor were typically 10% to 35% less expensive compared to the northern alignments.
  - The topography along the Williamsport Pike corridor is flatter than the Northern Routes and it is flatter than the segment of pipeline in proximity to Site Nos. 4 and 5 on Parsons Bend which would result in a cost savings associated with reduced pumping energy.

Consequently, it is recommended that future investigations associated with siting of the raw water intake and pumping station on the Duck River downstream of Columbia be directed toward Intake Site Nos. 1 through 3 and 7 through 9 with a 30-inch water transmission main along a Southern Route in the Williamsport Pike corridor. The lowest planning level construction costs for the intake, pumping station and 30-inch transmission main at Intake Site Nos. 1 through 3 range from $11 million to $19 million and for Intake Site Nos. 7 through 9 the costs range from $22 million to $34 million.

Prior to selection of the raw water intake and pumping station site, a number of investigations may be warranted including the following:

- Further definition of the timing for implementation based on water supply capabilities, water demand projections and adequacy of funding
- Project phasing based on water supply requirements and availability of funding
- Finalize hydraulic and environmental criteria in order to define screen type, sizing and configuration as well as redundancy considerations
- Detailed bathymetric surveys of the Duck River at shortlisted sites
- Potential for sediment transport and deposition in the vicinity of the proposed intake
- Detailed investigations to predict flood levels for various flood frequency events
- Probable cost of construction and proposed operation
- Siting of a new water treatment plant
- Transmission system hydraulics (i.e., topography, pipe characteristics, etc.)
- Transmission system construction corridor and ability to secure easements
- Provisions for future capacity
- Permitting for water withdrawal
- Property acquisition/easement considerations
- Access to electrical power
- Environmental studies for permitting and to protect aquatic species from entrainment and impingement
- Recreational use of the river and safety considerations