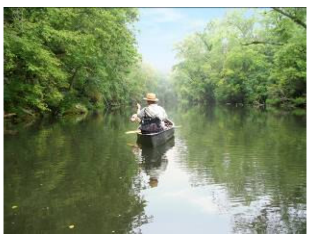
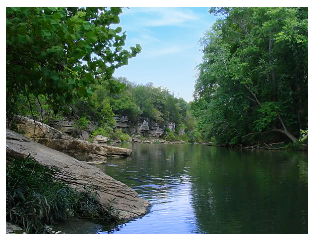
REPORT

Duck River Comprehensive Regional Water Supply Plan





Tennessee Duck River Development Agency

March 25, 2011

O'BRIEN & GERE

Duck River Comprehensive Regional Water Supply Plan

Shelbyville, Tennessee

Prepared for:

Tennessee Duck River Development Agency

Prepared by:

George Rest, PE and Thomas Dumm, PE
O'Brien & Gere Engineers, Inc.

Strategic Team:

Joseph Bishop, PE, CTI Engineers, Inc.
Brian McCrodden, PE, HydroLogics, Inc.
Richard Young, BDY Environmental, LLC
Justin Adams, Trauger & Tuke

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GLOSSARY OF TERMS

ARAP	Aquatic Resource Alteration Permit
BCUD	Bedford County Utility District
CIP	Capital Improvements Program
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	US 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
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
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 Resource Agency
TVA	Tennessee Valley Authority
ug/L	Micrograms per Liter
USACE	US Army Corps of Engineers
USDA	US Department of Agriculture
USEDA	US Economic Development Administration
USEPA	US Environmental Protection Agency
USFWS	US Fish & Wildlife Service
USGS	US Geological Survey

WTP	Water Treatment Plant
WWTP	Wastewater Treatment Plant
7Q10	Seven-day ten-year low flow

ACKNOWLEDGEMENTS

The DRA acknowledges the following for their participation in this effort:

Water Systems

Bedford County Utility District

Columbia Power and Water Systems

Duck River Utility Commission

HB&TS Utility District

Lewisburg Water and Wastewater

Manchester Water Department

Maury County Water System

Shelbyville Power, Water and Sewerage System

Spring Hill Water Department

Tullahoma Utility Board

Federal Agencies

Natural Resource Conservation Service

Tennessee Valley Authority

U S Department Agricultural

U S Fish and Wildlife Service

U S Geological Survey

State Agencies/Committees

Tennessee Advisory Commission on Intergovernmental Relations

Tennessee Department of Environment and Conservation

Tennessee Water Resource Technical Advisory Committee

Tennessee Wildlife Resource Agency

Legislators

Senator Bill Ketron

Senator Jim Tracy

Non – Government Organizations

Duck River Watershed Association

Friends of Short Springs

Tennessee Environmental Council

Tennessee Duck River Agency Board

Tennessee Farm Bureau Federation

The Nature Conservancy

World Wildlife Fund

Municipals

Columbia

Lewisburg

Manchester

Shelbyville

Spring Hill

Tullahoma

Wartrace

Strategic Team

George Rest, O'Brien & Gere

Thomas Dumm, O'Brien & Gere

Joe Bishop, CTI Engineers

Brian McCrodden, HydroLogics

Richard Young, BDY Environmental

Justin Adams, Trauger & Tuke

EXECUTIVE SUMMARY

INTRODUCTION

The Tennessee Duck River Development Agency (DRA) developed a Comprehensive Regional Water Supply Plan (Plan) for Bedford, Coffee, Marshall, Maury, and southern Williamson Counties to meet future water needs and address concerns with possible water shortages brought on by drought conditions. The Plan addresses water needs in this central Tennessee region through a 50-year planning period with a 100-year planning horizon and provides direction to the DRA for the management of available water resources, including the implementation of specific water supply infrastructure projects.

The Tennessee General Assembly created the DRA in 1965 as a comprehensive regional development agency. Its broad powers include the "control and development of the water resources" of those portions of the Duck River Watershed lying in Bedford, Coffee, Hickman, Marshall and Maury Counties. Any county or municipality in the Duck River Basin or any governmental entity from which flows any tributary stream of the river, or any county adjoining the river basin may become a sponsoring and participating entity. In 1998, the DRA Board of Directors adopted the following mission statement:

"To develop, protect, and sustain a clean and dependable water resource for all citizens of the Duck River region."

The DRA represents seven water utilities that serve approximately 250,000 people and industries that include car manufacturers, food processing plants, and other businesses utilizing water for production. In addition to these uses, 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.

The drought of 2007 highlighted the issue that in extended dry weather conditions, the citizens of the Duck River region primarily depend on the water stored in Normandy Reservoir (Figure 1) to meet all designated uses, including drinking water, wastewater assimilation, recreation, and natural resource protection. The dramatic decrease in rainfall, combined with the multiple uses of the reservoir and the river, caused record low water levels in Normandy Reservoir that resulted in temporary changes in dam operation to protect water uses. Weather patterns and growth projections, combined with the obligation to manage water resources responsibly for future generations, have created the need for a comprehensive regional water supply plan for the Duck River Region.

Figure 1 Normandy Reservoir

PLANNING PERIOD

This Comprehensive Regional Water Supply Plan project addresses a planning period that begins after 2010 and extends through 2060 – a 50-year plan with a 100-year vision. The level of detailed study for this planning period is adequate to make decisions regarding preferred alternatives. Near-term planning and additional studies will be required in order to develop a detailed implementation plan for the recommended alternatives (i.e., secure permits, refine cost estimates, purchase property, etc.).

SELECTING WATER SUPPLIES

As shown in Figure 2, the selection process for identifying the recommended water supply alternatives included the following steps:

- Determining the need for water supply
- Establishing evaluation criteria to be used for selection of alternatives
- Identifying comprehensive list of alternatives
- Identifying baseline alternatives
- Eliminating fatally-flawed alternatives
- Screening the remaining alternatives

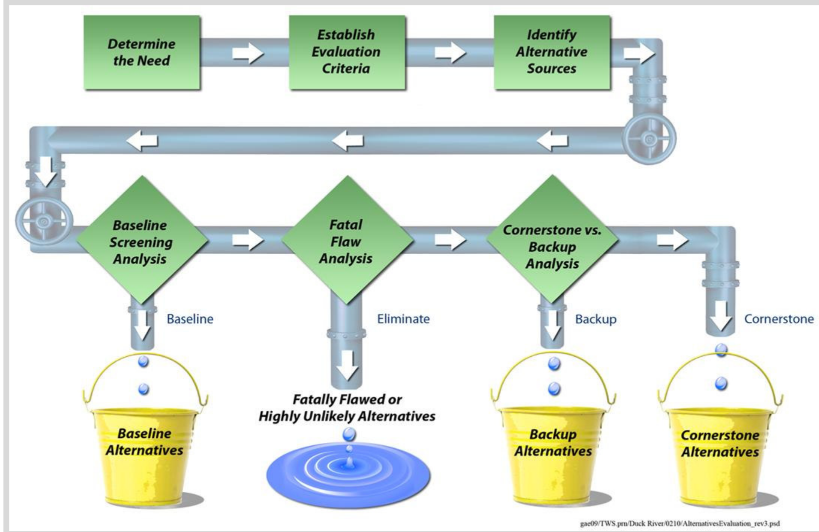

Figure 2 Alternatives selection process

WATER SUPPLY NEEDS

The first step in the Comprehensive Regional Water Supply Plan was the assessment of the need for additional water supply through the year 2060. This assessment included an evaluation of the available supply from Normandy Reservoir and the Duck River and a projection of water demands for domestic, commercial, and industrial purposes. The OASIS computer model was used to examine the operation of Normandy Reservoir and the hydrology of the Duck River to help gain a better understanding of how to satisfy the future need for not only public water supply but for all designated uses. Water users upstream from Normandy Dam (primarily Tullahoma and Manchester) are served from a water intake located in Normandy Reservoir while downstream uses are met by withdrawals from the Duck River. In periods of extended dry weather, the flow in the Duck River is primarily consists of water released from Normandy Reservoir. To estimate future water needs, the OASIS model used current and projected water demands as well as the following reservoir and river constraints defined by the Tennessee Department of Environment and Conservation (TDEC):

- Normandy Reservoir
  - » Release from Normandy Reservoir to maintain 25.8 mgd (40 cfs) minimum instantaneous flow just downstream of the dam.
- Shelbyville
  - » 77.5 mgd (120 cfs) minimum instantaneous flow at Shelbyville (December through May).
  - » 100.2 mgd (155 cfs) minimum instantaneous flow at Shelbyville (June through November).
  - » 6.5 mgd (10 cfs) allocation for Shelbyville's water supply intake.

- Columbia
  Columbia Power and Water System's Aquatic Resource Alteration Permit (ARAP) identifies the following permit conditions:
  - Columbia Power and Water System's maximum instantaneous withdrawal rate shall be limited to 19.4 mgd (30 cfs).
  - Columbia Power and 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 (Figure 3).

Figure 3 Columbia Dam

Demands for municipal, industrial, and other needs were calculated based on the amount of water that would be needed during a drought of record to assure that ample supplies would be available during a repeat of such a drought. Several sources of information were reviewed (i.e., US Geological Survey, Tennessee Valley Authority, and University of Tennessee) and ultimately water demands were projected using population projections from the University of Tennessee's Center for Business and Economic Research (CBER). Unrestricted water demands were projected to approximately double over the next 50 years (30 mgd in 2010 to 57 mgd in 2060). The OASIS modeling was performed over a period of hydrologic record extending from 1921 through 2008. The modeling results indicated that there is adequate supply for the users of Normandy Reservoir through 2060, but a potential deficit of up to 32 mgd for users of the Duck River between Shelbyville and Columbia. Currently, drought conditions such as those experienced in 2007 could result in a 4 mgd deficit, straining the river's ability to maintain water supply for all uses. The drought and population growth challenges faced by the region indicate that water supply plans must be reliable, flexible, and collaborative to meet both current and future demands.

WATER SUPPLY ALTERANTIVES ANALYSIS

The water supply alternatives were evaluated using the following criteria which were developed and adopted by DRA early in the study process:

- **Reliable Capacity** – Reliable quantity of raw water to meet projected demands through the planning period. This criteria addresses interruptibility of sources of supply.
- **Raw Water Quality** – Raw water quality that meets existing water quality requirements, and can readily achieve future anticipated regulations. This criterion may also address water quality preferences such as superior raw water quality and finished water taste.
- **Cost** – The present worth cost for proposed raw and finished water improvements, including capital, operating and maintenance costs. This cost could include an allowance for wholesale water purchases.
- **Implementability** – The relative ease of implementing the proposed improvements in time to meet projected demands. This criterion considers the potential that regulatory permitting, public acceptance, property acquisition, or constructability issues could delay implementation.
- **Flexibility** – The ability to phase implementation and spread the cost over time, while still meeting projected demands.

- **Environmental** –This criterion includes environmental benefits associated with hydrologic regime, physical habitat, water quality and biota.
- **Recreation** – This criterion includes recreational benefits, either reservoir or riverine (e.g., boating, fishing, canoeing, sightseeing) and related economic benefit of the recreational features (e.g., tourism/eco tourism, enhanced property values).

A list of 40 potential water supply alternatives identified in previous studies was reduced to 26 unique alternatives which were considered worthy of further consideration. Alternatives included a wide array of non-structural and structural measures such as:

- Implementing a regional drought management plan
- Implementing a water use efficiency program
- Changing operation of Normandy Reservoir
- Modifying river constraints
- Raising Normandy Dam
- Constructing tributary reservoirs (i.e., 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. Using the evaluation criteria and working closely with the stakeholders, the Strategic Planning Team identified and recommended a reliable, diverse, and flexible portfolio of water supply alternatives which included the following non-structural and structural components:

- **Baseline** – an alternative that was selected at the outset of the alternatives evaluation to be a component of the recommended water supply plan such as a drought management plan or water use efficiency program.
- **Fatally Flawed or Highly Unlikely** – an alternative that was eliminated from further consideration due to lack of reliability, permitting obstacles, etc.
- **Backup** – an alternative that is less desirable when compared to the remaining alternatives, but will be considered as a potential component of the 50-year water supply plan.
- **Cornerstone** – an alternative in the "shortlist" that could satisfy the entire deficit through 2060, and is receiving further consideration as a key element of the 50-year water supply plan.

Using the evaluation criteria and working closely with the stakeholders, the Strategic Planning Team identified and recommended a reliable, diverse, and flexible portfolio of water supply alternatives which included the following non-structural and structural components shown in Figure 4:

- **Non-Structural Components:**
  - » **Drought Management Plan** – Develop and implement a regional drought management plan.
  - » **Water Use Efficiency Program** – Develop and implement a water use efficiency program.
  - » **Optimize Normandy Reservoir Releases** – Optimize releases from Normandy Reservoir to preserve storage in the reservoir for periods when it is most needed.

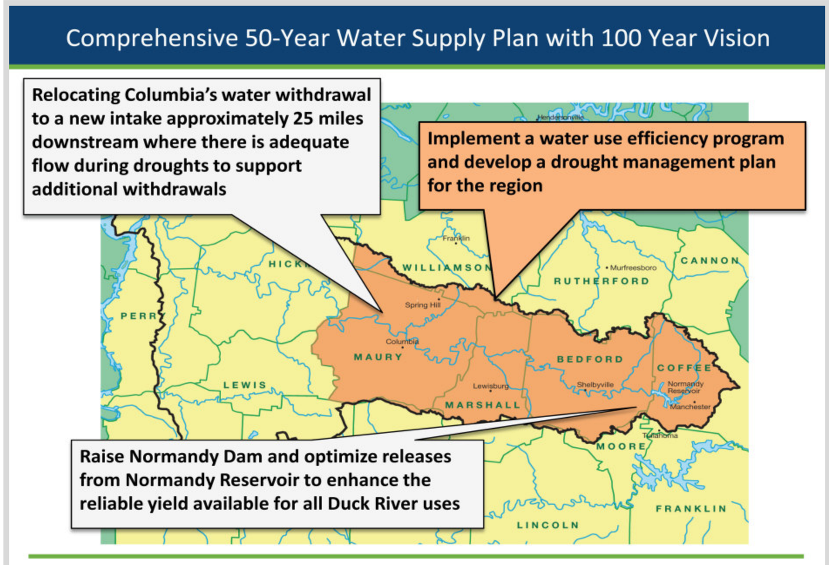

Figure 4 Recommended alternatives

- **Structural Components**
  - » **Normandy Dam Improvements** – Increase the elevation of Normandy Dam by five feet and increase the Winter/Spring pool elevation by approximately five feet without increasing the Summer/Fall pool elevation. This component increases water storage during droughts, enhances flood protection while minimizing environmental impacts, and enhances the reliable yield available for all Duck River uses.
  - » **Williamsport Intake** – Relocate Columbia's water withdrawals to a new intake approximately 25 miles downstream, near Williamsport, 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 eliminates their sole reliance on Normandy Reservoir.

This Comprehensive Regional Water Supply Plan increases reliability by utilizing multiple sources of supply. It is also a regional solution with benefits beyond water supply. It benefits the entire Duck River region by enhancing instream flows/reliability in the entire stretch of the Duck River, garnering regional financial support to lower the cost per customer, and providing flexibility to address uncertainties associated with potential changes in future water demands, regulations and hydrologic conditions.

COST

The estimated cost for the raw water facilities recommended in the Comprehensive Regional Water Supply Plan is roughly $62 million:

- Baseline alternatives – $4 million
- Raise Normandy Dam – $20 million
- Williamsport Intake and Raw Water Pipeline to Columbia (one 30-inch pipe for 20 mgd) – $38 million

Additional technical and environmental investigations are planned in the early stages of the implementation phase to refine the project cost.

EXTENSIVE PUBLIC INVOLVEMENT

The Comprehensive Regional Water Supply Plan was conducted using a uniquely open process, with extensive opportunities for input from the public, elected officials, and governmental and non-governmental agencies through the use of public workshops and informational meetings, routine updates via DRA's website, agency briefings and press coverage.

- **Public workshops and meetings** – A series of public workshops and "open house" style public meetings facilitated extensive public participation. Since June 2009, six public workshops were held at Henry Horton State Park. Several public meetings were held in September 2009 (Henry Horton State Park, Manchester City Hall, Maury County Courthouse), March 2010 (Henry Horton State Park), and September2010 (Henry Horton State Park). These public workshops and evening "open house" meetings provided a forum for citizen input and stakeholder input as well as an opportunity to ask questions of DRA's participating utilities and the consultant.
- **E-mail** – DRA used email to provide updates on the status of the study to the public and other stakeholders that attended the meetings.
- **Website** – DRA developed and maintained a website which included an overview of the project, project participants, project contacts, briefing materials, technical data and meeting information.
- **Agency briefings and technical meetings** – DRA held several technical meetings and provided updates on the status of the study to state and federal agencies including TDEC, TWRA, TVA, USFWS, and USGS.
- **Extensive press coverage** – Numerous articles were written in area newspapers documenting the work completed and the upcoming meetings.
- **Elected official, Council, and Board Updates** – DRA and DRATAC members have provided updates as appropriate to their elected officials and their Councils/Commissions/Boards throughout the study.

The DRA conducted six public workshops and several public meetings to obtain input from the public. Among the many stakeholders were the public water systems, represented by the Duck River Agency Technical Advisory Committee (DRATAC), and the DRA's Water Resources Council, which includes over 25 governmental and non-governmental organizations. The roles of the key decision-makers are shown on Figure 5.

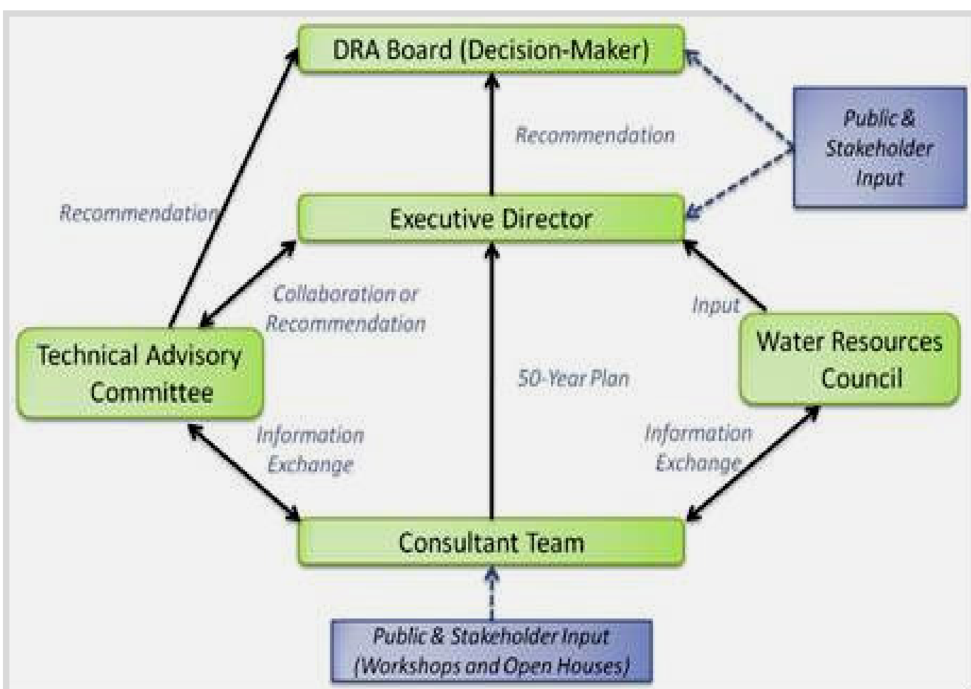

Figure 5 Roles in the decision-making process

HAVE THE OBJECTIVES OF THE STUDY BEEN MET?

The objectives of DRA's Comprehensive Regional Water Supply Plan have been met:

- DRA has identified a recommended solution that increases reliability, flexibility, and sustainability by utilizing multiple sources of supply ✓
- The recommended solution is also a regional solution with benefits beyond water supply such as reducing flood risk to communities downstream of Normandy Dam and extending recreation (reservoir and river) during droughts ✓
- A financial approach is being developed that is affordable and fairly apportions costs to the entire region ✓
- DRA has used a credible process with good science and worked effectively with stakeholders and the public by clearly communicating the study process and findings ✓

WHAT ARE THE NEXT STEPS?

DRA has identified that the following items need to be addressed in the near term:

- Initiate work on a regional drought management plan.
- Initiate work on a water use efficiency program.
- Conduct planning and design of the proposed facilities as needed for permits and approvals.
- Develop appropriate financial and organizational structures to support implementation of the alternatives recommended in the Comprehensive Regional Water Supply Plan.

The DRA intends to move forward aggressively with these and other action items. By endorsing the recommendations of this study, DRA is "driving a stake in the ground", completing the first step in the long process to bring ample water supplies to the residents of central Tennessee.

INTRODUCTION

BACKGROUND

The Tennessee Duck River Development Agency (DRA) developed a Comprehensive Regional Water Supply Plan (Plan) for Bedford, Coffee, Marshall, Maury, and southern Williamson Counties (Figure 6) to meet future water needs and address concerns with possible water shortages brought on by drought conditions. The Plan addresses water needs in this central Tennessee region through a 50-year planning period with a 100-year planning horizon and provides direction to the DRA for the management of available water resources, including the implementation of specific water supply infrastructure projects.

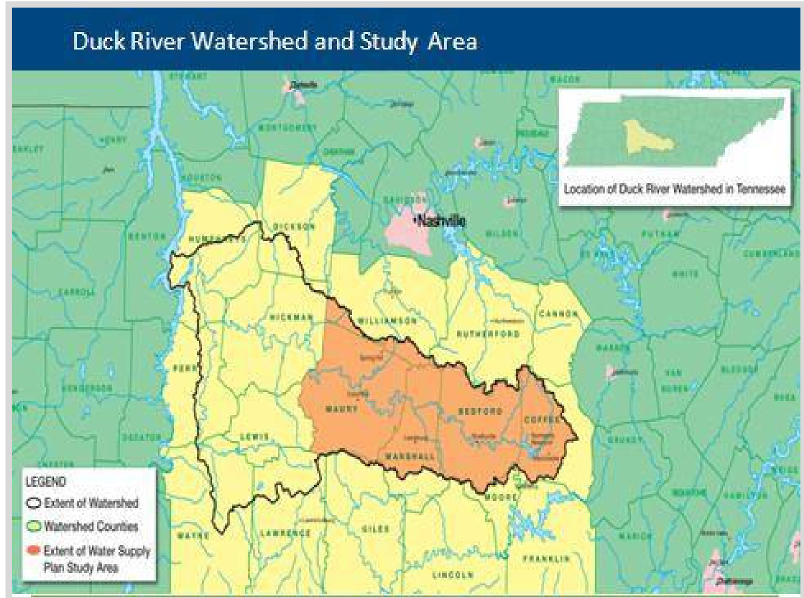

Figure 6 Duck River watershed and study area

The Tennessee General Assembly created the DRA in 1965 as a comprehensive regional development agency. Its broad powers include the “control and development of the water resources” of those portions of the Duck River Watershed lying in Bedford, Coffee, Hickman, Marshall and Maury Counties. Any county or municipality in the Duck River Basin or any governmental entity from which flows any tributary stream of the river, or any county adjoining the river basin may become a sponsoring and participating entity. In 1998, the DRA Board of Directors adopted the following mission statement:

“To develop, protect, and sustain a clean and dependable water resource for all citizens of the Duck River region.”

The DRA represents seven water utilities:

- Bedford County Utility District
- Columbia Power and Water Systems
- Lewisburg Water and Wastewater
- Manchester Water Department
- Shelbyville Power, Water and Sewerage System
- Spring Hill Water Department
- Tullahoma Utility Board

These utilities serve approximately 250,000 people and industries that include car manufacturers, food processing plants, and other businesses utilizing water for production. In addition to these uses, 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.

Figure 7 Normandy Reservoir during 2007 drought

The drought of 2007 highlighted the issue that in extended dry weather conditions, the citizens of the Duck River region primarily depend on the water stored in Normandy Reservoir to meet all designated uses, including drinking water, wastewater assimilation, recreation, agriculture, and natural resource protection. The dramatic decrease in rainfall, combined with the multiple uses of the reservoir and the river, caused record low water levels in Normandy Reservoir that resulted in temporary changes in dam operation to protect water uses (Figure 7). Weather patterns and growth projections, combined with the obligation to manage water resources responsibly for future generations, have created the need for a comprehensive regional water supply plan for the Duck River Region.

This study was financed by DRA from contributions from the water utilities. DRA served as manager for the study. A Strategic Team with expertise in engineering, environmental permitting, management and law, led by O'Brien & Gere Engineers, Inc. of Landover, Maryland was retained by DRA, in association with DRATAC, to complete this study:

- George Rest and Thomas Dumm, O'Brien & Gere - program management and primary authors of the Comprehensive Regional Water Supply Plan
- Joe Bishop, CTI Engineers – local engineering support
- Brian McCrodden, HydroLogics – hydrologic modeling
- Richard Young, BDY Environmental – environmental permitting
- Justin Adams, Trauger & Tuke – legal and organizational

This study represents an independent and comprehensive assessment that builds upon previous and ongoing efforts to meet the region's potable water supply needs.

STUDY GOAL AND OBJECTIVES

The source of future water supplies for the region has been the focus of numerous studies over the past 40 years. However, meaningful progress in dealing with this problem has been elusive. The DRA identified that the time had come to seek a regional solution and, through cooperative action, to implement that solution. The DRA's goal for the Comprehensive Regional Water Supply Plan is as follows:

"To develop a (comprehensive) Plan that will provide direction to the DRA regarding the management of available water resources, including the implementation of specific water supply infrastructure projects."

The key objectives for the DRA's study include:

- Identify sources of additional supply that provide reliability, flexibility and sustainability.
- Recommend solutions that provide benefits beyond water supply and address all designated uses.
- Develop a framework for financing the recommended solutions that is affordable and fairly apportions costs.
- Utilize a credible process with good science and work with stakeholders to effectively communicate the study process and findings.

The Strategic Team used a combination of independent reviews of prior studies, preparation of technical information, and extensive use of interactive workshops to facilitate decision-making to achieve each of the above objectives.

PROJECT APPROACH

The Comprehensive Regional Water Supply Plan was conducted using a uniquely open process, with extensive opportunities for input from stakeholders. At the foundation of this approach were six public workshops held at Henry Horton State Park at roughly 10 week intervals which focused simultaneously on four subject areas:

- Water Quality and Capacity
- Reliability and Permitting
- Financial
- Community Impacts and Public Policy

A graphic showing the Project Approach and Decision Making Process used in this study is included in Appendix A.

NEED FOR ADDITIONAL WATER SUPPLIES

WATER DEMANDS

Water demands for municipal, industrial, and other needs are typically calculated based on the amount of water that would be needed during a drought of record to assure that ample supplies would be available during a repeat of such a drought. Forecasts of future demands help managers and municipalities to plan for the future and to assess the adequacy of the present resources to meet future demands. Demand forecasting and resource assessments are critical to water resources planners and managers, because the time required to study, plan, and build new resources or implement demand management strategies is lengthy. Water demands are influenced by a number of factors: population, water use by commercial and industrial customers, housing, employment, income, weather, household size, water price, culture, lot size, season, water loss to theft, leakage, flushing, accidents and fire fighting. Other factors that introduce significant uncertainty into water demand projections include: vacation homes, schools, prisons, hospitals, and golf courses. It is important that the approach and sources of information used to project water demands are technically sound.

The first step in the water demand projection is to identify how water demands will be used to assess the capabilities of existing supplies and size waterworks facilities. Average day demands represent the amount of potable water required in a year, divided by 365 days. Maximum day demands represent the amount of potable water required in a single 24-hour period for a day of maximum usage. Both of these parameters are used to size or evaluate certain parts of a potable water system. Normandy Reservoir was evaluated based on meeting the annual average day demands for Manchester and Tullahoma as well as the downstream release to the Duck River. For the utilities with intakes on the Duck River, withdrawal rates must approximate customer demands which fluctuate throughout the day and from one day to the next. Consequently, the analysis for the utilities downstream of Normandy Dam were based on maximum (peak) day withdrawal rates. In addition, maximum day demands were used to size raw water intakes on river supplies, water treatment plants, and some of the major water transmission mains.

As shown in Figure 8, several sources of information were used to project average day water use for the water systems through 2060:

- **Historic water use** – Annual average day water use data was obtained from the DRA for each water system for the period from 1973 to 2008. This dataset provided a trend line which was useful in assessing the reasonableness of future projections.
- **Tennessee Valley Authority** – TVA Planning Report No. 65-100-01 projected the future potable water demands for Coffee, Bedford, Marshall, and Maury Counties for 2025 and 2075 (as presented in the *Report to OMB on Columbia Dam Alternatives* prepared by TVA in April 1979). This information was developed in 1965, but was used for comparison purposes because it projected water demands for the region through 2075.
- **US Geological Survey** – In 2008, the US Geological Survey published a report that estimated the use of water in the Upper Duck River watershed and included water demand projections from 2000 through 2030. Note that the USGS study included full or nearly full buildout of the industrial parks in the study area. This data provided a high “book end” for the projection because it assumed full or nearly full buildout of the industrial parks by 2030. Historic population data from the USGS was used in combination with the DRA’s historic water use data to define the gross per capita water use for Coffee, Bedford, Marshall and Maury Counties.

- **Center for Business and Economic Research (CBER)** – In June 2009, the University of Tennessee Center for Business and Economic Research and the Tennessee Advisory Commission on Intergovernmental Relations published population projections for the State of Tennessee for the period from 2010 through 2030. The University of Tennessee CBER is widely recognized as an independent source with authority on demographics in Tennessee. As a demographic prediction, CBER attempts to capture prevailing demographic trends, such as the economy, that influence population.

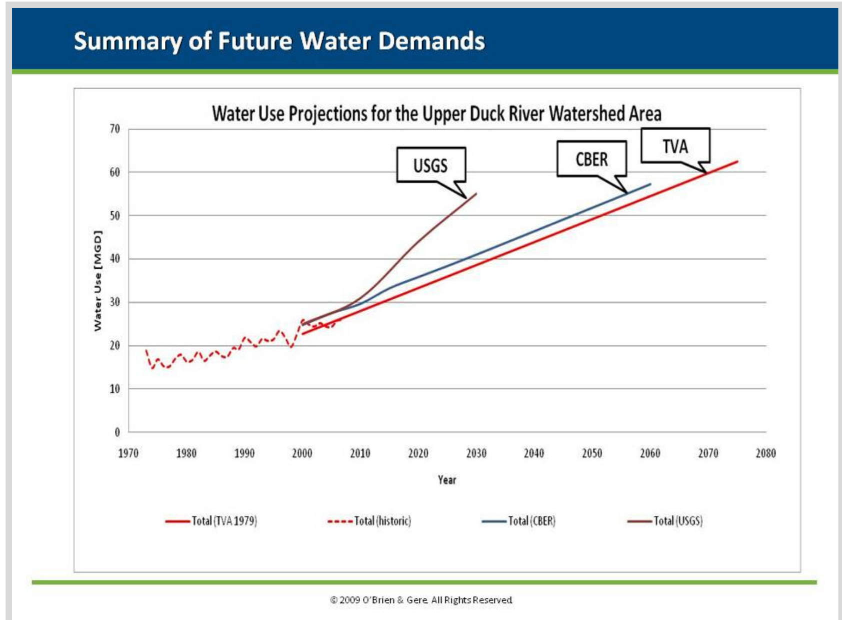

Figure 8 Summary of future water demands

Based on the availability of data, it was determined that a "gross" per capita approach should be used in the Comprehensive Regional Water Supply Plan to project water demands. Utilizing historic population data from the US Geological Survey and water use data from the DRA, a "gross" per capita water use factor was developed which represents the overall water use per unit of population for the current mix of residential, non-residential and public use/loss (i.e., total water use divided by population). The O'Brien & Gere projections are based on the assumption that the current mix of uses/customer behaviors, etc. will result in the same per capita usage in the future as is current. This assumption is founded on an analysis which shows that the gross per capita usage in the study area has been relatively constant for the period 1981-2000. A sensitivity analysis was performed on the water needs to assess the impact of potential reductions in per capita usage. Water demands were projected by multiplying the CBER-based population projections for 2010 through 2030 by the "gross" per capita usage calculated for each of the four service areas (Coffee, Bedford, Marshall and Maury). Water demands for 2030 through 2060 were derived based on a straight-line projection of the "gross" per capita usage derived from the CBER-based population for 2010 through 2030. Each of the four sources of data shown in Figure 8 was used in the projection of water demands, but the primary source was the University of Tennessee CBER because it is widely recognized as an independent source with authority on demographics in Tennessee.

The results of the water demand projections through 2060 are summarized in Table 1.

Table 1. Average day water demands

Water System	2010	2020	2030	2040	2050	2060
Coffee County						
Tullahoma	2.9	3.3	3.5	3.8	4.1	4.4
Manchester	2.6	3.0	3.2	3.4	3.7	4.0
Bedford County						
Shelbyville	4.7	6.1	7.2	8.2	9.3	10.4
BCUD	2.0	2.6	3.1	3.5	4.0	4.4
Marshall County						
Lewisburg	3.0	3.6	4.1	4.5	4.9	5.3
Maury/Southern Williamson						
Spring Hill	2.5	3.1	3.5	4.1	4.6	5.1
Columbia	11.5	14.1	16.3	18.8	21.2	23.6
Total	**29.2**	**35.8**	**41.0**	**46.4**	**51.8**	**57.2**

Population projections from CBER and current water usage patterns were used to project future water usage, which will roughly double by 2060.

EXISTING WATER SUPPLY SOURCES

Normandy Reservoir and the Duck River supply virtually all of the public water supply needs in the five county planning area. The Duck River has been impounded since the mid-1800s. Currently, there are three low head dams located on the Duck River which were constructed in the early 1900s for water supply:

- Shelbyville (drainage area = 481 square miles)
- Lillards Mill near Milltown (drainage area = 916 square miles)
- Columbia (drainage area = 1,208 square miles)

Normandy Reservoir was constructed in 1976 and is the primary source of water supply for the Duck River during dry weather conditions. Normandy Reservoir has the following characteristics:

- Located in the upper portion of the Duck River watershed between Shelbyville and Manchester (Duck River Mile 248.6).
- Normandy Dam is 2,248 feet in length and is about 95 feet in height.
- Storage volume is roughly 38 billion gallons at a Summer/Fall pool level of 875 feet.
- Drainage area is roughly 208 square miles.

Normandy Reservoir was designed to provide a variety of benefits upstream and/or downstream from the dam, including recreation, flood protection, water supply, and water quality benefits. Water users upstream from Normandy Dam (primarily Tullahoma and Manchester) are served from DRUC's water intake located in Normandy Reservoir. The mainstem of the Duck River is the primary water supply source for water systems downstream of Normandy Reservoir. TVA operates Normandy Reservoir using the following priorities to decide how to release water under normal rainfall conditions:

- Minimize downstream flooding (especially in winter and early spring).
- 40 cfs minimum instantaneous flow just downstream from the dam (sustains aquatic habitat in the reach immediately downstream of the dam).
- 120 cfs minimum instantaneous flow at Shelbyville (December - May) at the USGS gage located at Duck River Mile 221.4.
- 155 cfs minimum instantaneous flow at Shelbyville (June - November) at the USGS gage located at Duck River Mile 221.4.
- Up to 10 cfs additional instantaneous flow at Shelbyville for water supply.

Note, the Duck River flow target near Shelbyville is located at Duck River Mile 221.4 which is approximately 27 river miles downstream of Normandy Reservoir (18 hours travel time).

In 1996, the TDEC Division of Water Pollution Control evaluated the minimum instream flow required to maintain recreation and fish and aquatic life uses in the Duck River at Columbia in response to questions about the ability of the Duck River to meet additional water supply needs. The analysis resulted in a requirement that the streamflow should not fall below 100 cfs at Duck River Mile 132.8, immediately downstream from the Columbia water supply intake. This minimum flow requirement is included in Columbia's water permit (ARAP) and establishes a state-identified limit below which no additional water can be withdrawn from the Duck River by Columbia (Appendix B). This 100 cfs requirement at Duck River Mile 132.8 (Figure 9) is recognized as a key constraint in the Comprehensive Regional Water Supply Plan.

Figure 9 Columbia Dam

PROJECTED SHORTFALL IN WATER SUPPLY

The OASIS computer model developed by HydroLogics, Inc. was used to evaluate the adequacy of Normandy Reservoir and the Duck River to meet current and future demands using a period of hydrologic record extending from 1921 through 2008 (87 years). Due to the inherent differences in the characteristics of the Normandy Reservoir and the Duck River water supplies, the model was used to separately evaluate the adequacy of the following:

1. Normandy Reservoir for its users (i.e., Manchester and Tullahoma)
2. Duck River for Shelbyville and the downstream users to Columbia

The OASIS model performs a daily water budget using numerous components such as reservoir inflow data, reservoir releases, streamflow data, water demands, minimum flows in Duck River, flood releases, and water withdrawal return flows. Note that because of streamflow data limitations (i.e., changes in the operation / flow through the Shelbyville, Lillards Mill and Columbia dams on the Duck River during the 87-

year period of record in the model), the OASIS model cannot accurately calculate daily gains and losses in the river which are needed to compute an average daily river flow and deficit at Columbia. Consequently, a weekly average flow of 125 cfs was used in the model as a surrogate flow constraint at Columbia (Duck River Mile 132.8) to represent a 100 cfs instantaneous flow constraint.

The hydrologic modeling over the 87 year period of record indicated that based on a low water level of 850 feet in Normandy Reservoir, the supply available from Normandy Reservoir is adequate to meet the needs (i.e., water withdrawals plus downstream releases to Shelbyville) of the reservoir users through 2060.
For the Duck River users downstream of Normandy Reservoir, the OASIS model was used to identify a volume and rate of deficit under current and future water demand conditions. For the 100 cfs Duck River constraint at Columbia, the hydrologic modeling indicates that during extreme or prolonged drought conditions there is a potential maximum deficit of 32 mgd in the year 2060. In drought conditions like those in 2007, there is presently (2010) a potential maximum deficit of 4 mgd, which would strain the Duck River's ability to supply water for all designated uses. The results of the OASIS modeling are shown in Table 2. The annual and daily volumes of the potential deficits are illustrated in Figures 10 and 11, respectively, and a summary of each figure follows:

- Figure 10 illustrates the annual volume of the potential deficit for maintenance of the 125 cfs average weekly flow target in the Duck River at Columbia for years 2010, 2020, 2040 and 2060 demand conditions based on the hydrology that occurred in each year of the 87-year period of record. The volumes of potential deficit shown in Table 2 are taken from the maximum values on Figure 10 which occur in year 1999.
- Figure 11 shows the daily volume of the potential deficit for maintenance of the 100 cfs target for flow in the Duck River at Columbia for 2010 through 2060 based on the 1-year in 87-year period of record (worst drought for the 87-year period of record) and for a 1-in-10-year drought event. The potential average daily deficits shown in Table 2 are based on the critical drought event for the period of record which shows the potential deficit increasing from 4 mgd in 2010 to approximately 32 mgd in 2060.

Table 2. Current and projected deficits at Columbia for Duck River users

Deficit	2010	2020	2030	2040	2050	2060
Potential 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 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

A more detailed discussion of the needs assessment is included in Appendix C.

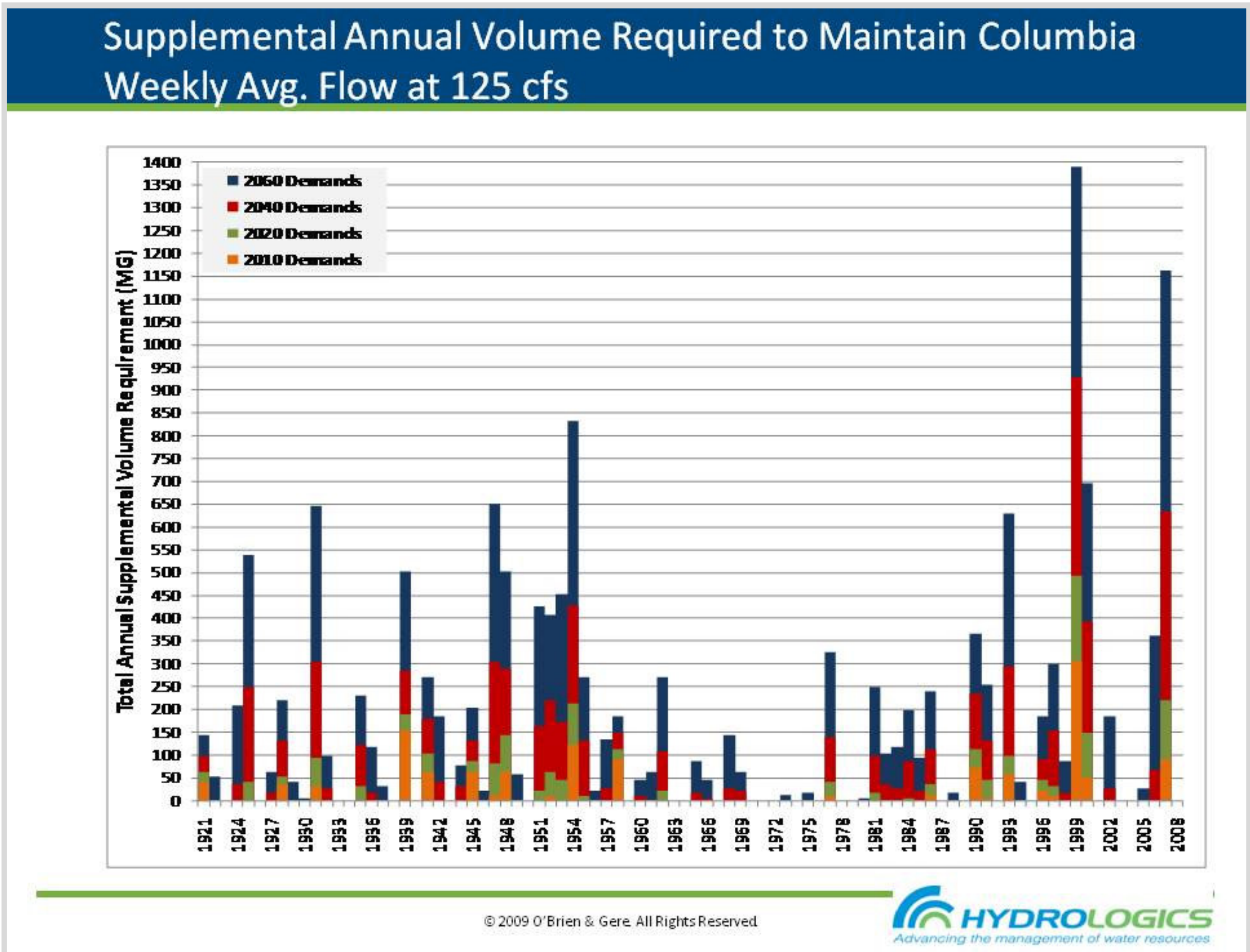

Figure 10 Supplemental annual volume required to maintain Columbia flow at 125 cfs

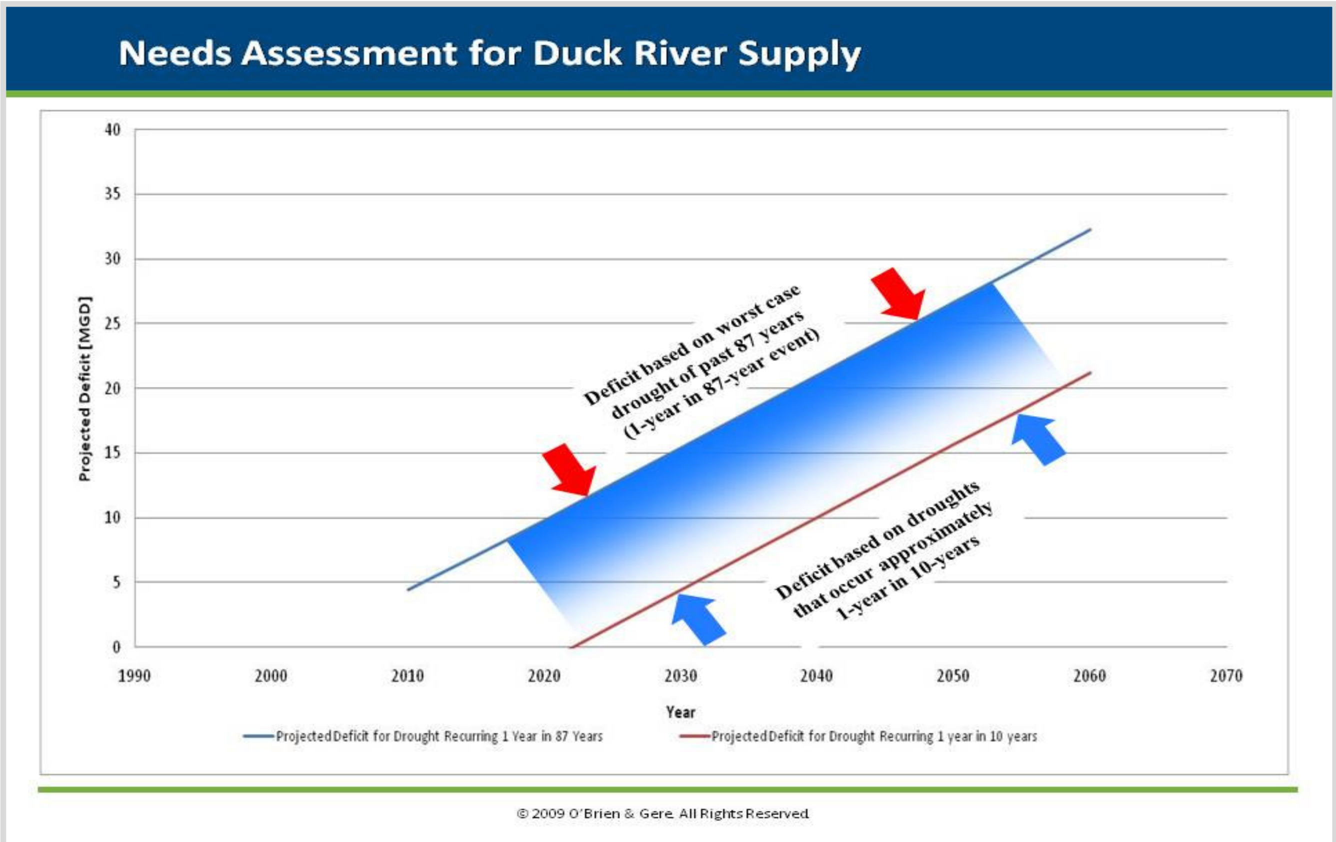

Figure 11 Needs assessment for Duck River supply

SOURCES OF UNCERTAINTY IN PROJECTED DEFICITS

Throughout the Comprehensive Regional Water Supply Plan, stakeholders discussed the sources of uncertainty that influence the ability of the water supply sources to adequately meet future needs which may include the following:

- **Alteration of instream flows (USFWS flow and habitat study).** The US Fish & Wildlife Service is initiating a study of the Duck River to identify instream flow needs for critical habitat and the outcome of this study will likely not be known for several years. Changes in the instream flow requirements could impact Normandy Reservoir storage and operations as well as river constraints used for assessing water supply needs.
- **Changes in demand projections**. Water demands will change through the 50-year planning period and the recommended structural and non-structural components can be phased to reflect changes in demand over time. The timing for construction of the water facilities associated with the withdrawals from a new river intake near Williamsport will be driven by water demands in Maury County, permitting, and water facility replacement needs.
- **Variability of drought events** – A drought more severe than the critical drought that occurred in the previous 87 years of record will occur in the future.
- **Climate change** – Shifts within the hydrologic cycle due to climate change are expected in the future, but the site specific impacts in the Duck River region are not well defined at this time.

- **Manual operation of Normandy Reservoir and travel times** – TVA operates Normandy Reservoir manually along with many other reservoirs under their supervision. Recognizing that these systems are constantly changing and require significant supervision, TVA strives to meet the instantaneous downstream constraints in the Duck River given limitations to data quality and staffing. The OASIS hydrologic model used in the Comprehensive Regional Water Supply Plan assumes that TVA can achieve nearly "perfect" releases (includes additional 5 cfs in release for buffer) from Normandy Reservoir to meet the Shelbyville constraint which is 27 river miles downstream of the dam (roughly 18 hours of travel time). The Columbia constraint is 116 river miles downstream (roughly 80 hours of travel time). In addition, the travel times between Normandy Reservoir and Columbia can vary depending on the volume of flow in the river. Consequently, TVA releases water in "excess" of the "perfect" release from Normandy Reservoir in order to meet the instantaneous flow constraints downstream at Shelbyville and the "excess" release would be much greater if TVA needed to meet the constraint significantly further downstream at Columbia.
- **Irrigation withdrawals** – By using historic streamflow data, the OASIS model accounts for historic irrigation withdrawals. For modeling purposes, it is assumed that the irrigation withdrawals will remain unchanged in the future, but the amount and timing of irrigation withdrawals is highly variable.
- **Losses underground from Duck River system downstream of Shelbyville** – Prior studies by USGS have indicated that there may be a significant "loss" of flow from the river to underground (up to 30% reduction) in the segment of the Duck River downstream of Shelbyville. The magnitude of this loss under changing river flow conditions as well as the location of its return to the Duck River is not well understood.
- **Inflows from tributary streams** – Localized thunderstorms on the ungaged tributary streams to the Duck River below Normandy Reservoir can create the impression of "excess" releases from Normandy Reservoir because they can produce flows above the target levels at Shelbyville. Flow from these ungaged streams is another factor which makes it difficult for TVA to accurately match release requirements from Normandy Reservoir to the streamflow target at Shelbyville.
- **Changes in return flows** – The difference between the amount of water withdrawn and water returned to a source (i.e., discharged back to the river by the wastewater treatment plant) is usually taken to represent "consumptive use". The model assumes that the current percentage of return flows from the wastewater plants will remain unchanged in the future. Wastewater technology and the quality of wastewater effluent will continue to improve and the demand for wastewater effluent for irrigation, industrial processes, and other consumptive uses may also increase thereby reducing the amount of water returned to the Duck River.
- **Accuracy of USGS stream gage data** – The USGS calibrates the streamflow gages on the Duck River on a monthly basis while the flows in the river at Shelbyville and Columbia must be met on an instantaneous basis.

In summary, the possible sources of uncertainty that affect the assessment of the adequacy of supply in the Duck River are many-fold and include not only demographics and water use, but uncertainty regarding weather, hydrology, accuracy of stream gaging, and many other factors. While the uncertainty of some of these factors can be mitigated, many cannot and therefore must be addressed in some other fashion. If water was stored upstream of Columbia and conveyed down the Duck River to meet the deficits at Columbia, it was concluded that a target of approximately 3 BG of additional storage should be used (rather than the 1.4 BG) to meet the projected 2060 deficit and offset potential losses in the Duck River. An approach used in this study and being employed by many water utilities in recent years to address uncertainty is the implementation of a portfolio of non-structural and structural measures that are reliable, diverse and flexible. To assess the sensitivity of the uncertainty in water use projections and many other factors on the overall water needs, the OASIS hydrologic model was used to estimate the projected deficit in supply by considering varying levels of reduction in unrestricted water use by the utilities (i.e., 5%, 10%, 20%, and 30%) which could result from a combination of factors (i.e., water efficiency measures, climate change, economic conditions, etc.). A 30% reduction in future unrestricted water demands was used as a "book end" to test an extreme level of reduction. The unrestricted water demand of 57 mgd in 2060 would be reduced to approximately 40 mgd under the "30% reduction" scenario. Modeling results indicated that the volume of water needed to meet the permit constraint at Columbia in 2060 would be reduced by approximately one-half (1.4 billion gallons to 0.7 billion gallons) if a 30% reduction in water demands occurred. The study's initial findings are that reductions due to water efficiency measures are likely to be in the range of 5% to 10%. A summary of the modeling results is presented in Table 3.

Table 3. Water use reduction versus water needs for 2060

Water Use Reduction	Water Demand (mgd)	Volume of Water Needed to Meet Permit Constraint at Columbia (MG)
0%	57	1,400
5%	54	1,250
10%	52	1,150
20%	46	900
30%	40	700

WATER SUPPLY ALTERNATIVES

SELECTION PROCESS FOR WATER SUPPLY ALTERNATIVES

The selection process for identifying the recommended water supply solution included the following steps:

- Determining the need for water supply
- Establishing evaluation criteria
- Identifying alternative sources of water supply
- Identifying baseline alternatives
- Eliminating fatally-flawed alternatives
- Screening and evaluating backup and cornerstone alternatives
- Selecting alternatives

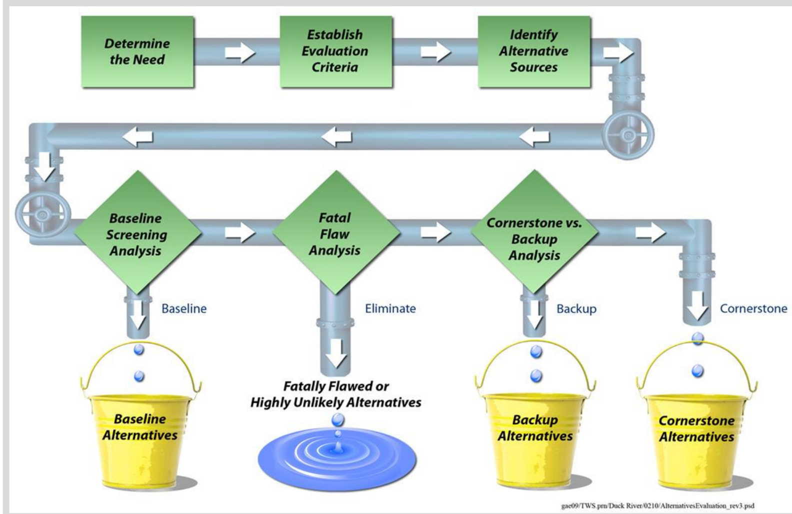

Figure 12 Alternatives selection process

EVALUATION CRITERIA

The evaluation criteria were developed and refined with the stakeholders in several meetings and workshops prior to Workshop No. 3 as follows:

- **Reliable Capacity** – Reliable quantity of raw water to meet projected demands through the planning period. This criteria addresses interruptibility of sources of supply.
- **Raw Water Quality** – Raw water quality that meets existing water quality requirements, and can readily achieve future anticipated regulations. This criterion may also address water quality preferences such as superior raw water quality and finished water taste.
- **Cost** – The present worth cost for proposed raw and finished water improvements, including capital, operating and maintenance costs. This cost could include allowance for wholesale water purchases.
- **Implementability** – The relative ease of implementing the proposed improvements in time to meet projected demands. This criterion considers the potential that regulatory permitting, public acceptance, property acquisition, or constructability issues could delay implementation.
- **Flexibility** – The ability to phase implementation and spread the cost over time, while still meeting projected demands.
- **Environmental** – This criterion includes environmental benefits associated with hydrologic regime, physical habitat, water quality and biota.
- **Recreation** – This criterion includes recreational benefits, either reservoir or riverine (e.g., boating, fishing, canoeing, sightseeing), and related economic benefit of the recreational features (e.g., tourism/eco tourism, enhanced property values).

The stakeholders requested that the evaluation criteria be used solely to document key aspects of the various alternatives, and not weighted and used for assigning scores to the alternatives.

WATER SUPPLY ALTERNATIVES EVALUATED IN THIS STUDY

A list of 40 potential water supply alternatives identified in previous studies was reduced to 26 unique alternatives which were considered worthy of further consideration. Alternatives included a wide array of non-structural and structural measures such as:

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

A detailed step-by-step process was utilized for screening and evaluating the alternatives in the Comprehensive Regional Water Supply Plan. A summary matrix was developed which described each of the alternatives and documented key aspects of the alternative related to each of the evaluation criteria (Appendix D). Using the evaluation criteria and working closely with the stakeholders through a series of workshop and meetings, the Strategic Team evaluated and assigned the alternatives to the following groups:

- **Baseline** – an alternative that was selected to be a component of the recommended water supply plan:
  - » **Alt. #1** – Develop Water Use Efficiency Program – Baseline
  - » **Alt. #3** – Develop Regional Drought Management Plan – Baseline
  - » **Alt. #4** – Optimize Releases from Normandy Reservoir – Baseline
- **Fatally Flawed or Highly Unlikely** - an alternative that was eliminated from further consideration:
  - » **Alt. #7** – Reduce Irrigation Withdrawals – Fatally Flawed (no added reliable capacity)
  - » **Alt. #12** – Construct Fountain Creek Reservoir and Pipe Raw Water to Columbia WTP – Highly Unlikely (i.e., major issues include water quality and quantity, aquatic ecology, endangered and threatened species and their critical habitats, wetlands, archeological and historic resources)
  - » **Alt. #13** – Construct Fountain Creek Reservoir with Downstream Release – Highly Unlikely (i.e., major issues include water quality and quantity, aquatic ecology, endangered and threatened species and their critical habitats, wetlands, archeological and historic resources)
  - » **Alt. #14** – Upgrade Existing Columbia City Dam to Allow Releases – Fatally Flawed (no added reliable capacity)
  - » **Alt. #17** – Construct Pipeline from Tennessee River to Columbia WTP – Highly Unlikely (high cost and energy requirements associated with long pipeline)
  - » **Alt. #18** – Construct Pipeline from Tims Ford Reservoir – Highly Unlikely (i.e., major issues include interbasin transfers and potential impact on environmental flows in the Elk River downstream of Tims Ford Reservoir)

  - **Alt. #20** – Purchase Water from Nearby Systems – Highly Unlikely (potential high cost due to infrequent use and lack of control)
  - **Alt. #21** – Utilize Groundwater Sources – Fatally Flawed (no added reliable capacity)
  - **Alt. #22** – Pump Treated Wastewater from Columbia WWTP to Below Columbia Dam – Highly Unlikely (i.e., major issues include potential transfer of species during pumping from downstream location to upstream location, change in permit conditions and flows for WWTP)
  - **Alt. #23** – Construct New Intake for Maury County at River Mile 163 – Fatally Flawed (no added reliable capacity)
  - **Alt. #25** – Construct New Intake for Maury County at River Mile 108 and Pump Back to Columbia Dam Pool – Highly Unlikely (Alt. #24 is similar and is a better option)
  - **Alt. #26** – Construct Infrastructure to Return Treated Wastewater from Tullahoma WWTP to Normandy Reservoir – Highly Unlikely (i.e., major issue includes significant reduction or elimination of flow in existing stream if Tullahoma WWTP flow is diverted to Normandy Reservoir during dry weather conditions)

- **Backup** – an alternative that is less desirable compared to the remaining alternatives, but will be considered as a potential component of the 50-year water supply plan:
  - **Alt. #2** – Increase Normandy Reservoir Release to Meet Columbia Constraint Without Raising Dam or Pool Levels – Backup (does not provide "new" water). Combine with Alt. #10 (Improve DRUC Intake) or Alt. #11 (Construct Second DRUC Intake) to address lower Normandy Reservoir levels during drought
  - **Alt. #8** – Modify River Constraints to Preserve Storage in Normandy Reservoir – Backup (no indication that agencies will change river flow constraints)
  - **Alt. #16** – Utilize Quarries – Backup (relatively small storage volume)
  - **Alt. #19** – Convey Arnold Cooling Water to Normandy Reservoir – Backup (potential lack of control makes this poor fit for cornerstone)

- **Cornerstone** - an alternative in the "shortlist" that could satisfy the entire deficit, and is receiving further consideration as a key element of the 50-year water supply plan:
  - **Alt. #5** – Raise Normandy Reservoir Winter/Spring Pool Level Without Raising Dam – Cornerstone (difficult to obtain property or acquire easements in timely manner and may be similar in cost to Alt. #9). Combine with Alt. #6: Modify Normandy Flood Rule Curve (Early Refill).
  - **Alt. #9** – Raise Normandy Dam – Cornerstone (Recommended)
  - **Alt. #15** – Pond #15 (Existing Offstream Storage Reservoir) – Cornerstone (less reliable and more expensive compared to Alt. #24)
  - **Alt. #24** – Construct Water Intake near Williamsport and Pump Back to Columbia WTP – Cornerstone (Recommended)

RECOMMENDED ALTERNATIVES

Using the evaluation criteria and working closely with the stakeholders, the Strategic Planning Team identified and recommended a reliable, diverse, and flexible portfolio of water supply alternatives which included the following non-structural and structural components:

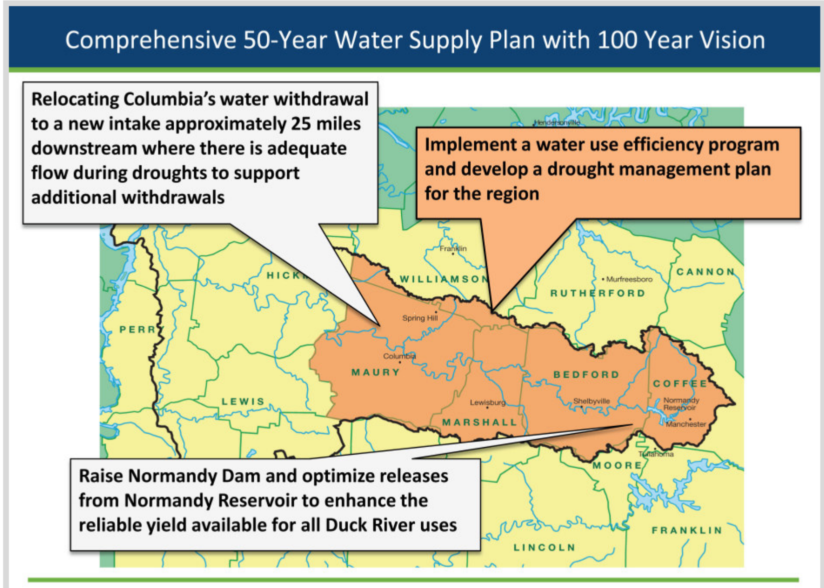

Figure 13 Recommended alternatives

- **Non-Structural Components** (Baseline Alternatives):
  - **Drought Management Plan (Alt. #3)** – Develop and implement a regional drought management plan.
  - **Water Use Efficiency Program (Alt. #2)** – Develop and implement a water use efficiency program.
  - **Optimize Normandy Reservoir Releases (Alt. #4)** – Optimize releases from Normandy Reservoir to preserve storage in the reservoir for periods when it is most needed.
- **Structural Components** (Recommended Cornerstone Alternatives):
  - **Normandy Dam Improvements (Alt. #9)** – Increase the elevation of Normandy Dam by five feet and increase the Winter/Spring pool elevation by approximately five feet without increasing the summer pool elevation. This component provides the following benefits:
    - **Water Supply Reliability** – increases water storage which enhances the reliable yield for all Duck River uses
    - **In-lake Recreation** – improves in-lake recreation by providing a higher pool level for longer use during drought
    - **Instream Flow** – provides environmental protection by allowing a longer duration of releases from Normandy Reservoir to Duck River during drought periods
    - **Flooding** – reduces flood risk to communities/property downstream of Normandy Dam due to increase in flood storage
    - **Shoreline** – reduces exposed shoreline and erosion along Normandy Reservoir because of higher Winter/Spring water levels
    - **Environment** – avoids impacts to upstream wetlands and streams compared to other alternatives
  - **Williamsport Intake (Alt. #24)** – Relocate Maury County water withdrawals to a new intake approximately 25 miles downstream, near Williamsport, where there is adequate flow in the river during droughts to satisfy Maury County projected needs. This component provides the following benefits:

- **Water Supply Reliability** – provides a highly reliable source of supply , which eliminates reliance on Normandy Reservoir as the sole source of water supply during drought
- **River Constraint** – increases instream flow at Columbia gage to maintain minimum flow of 100 cfs for all designated uses
- **Columbia Intake** – Avoids Columbia withdrawal from Columbia Pool, at least during low flows (existing Columbia intake could be used as a backup)

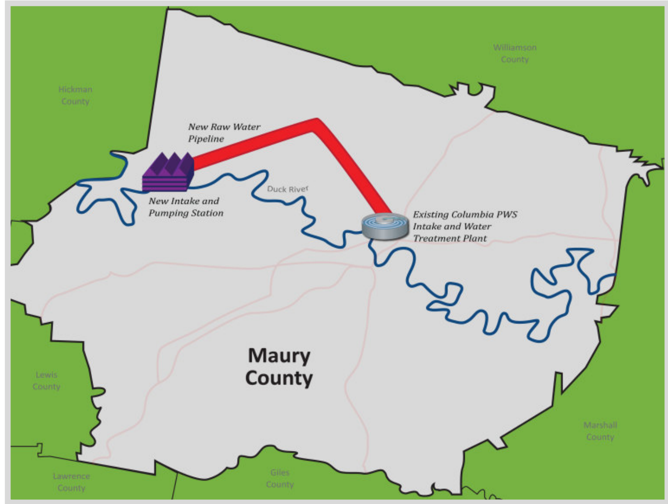

Figure 14 Williamsport intake

- **Regional Water System** – provides the potential to create a regional water system in Maury County and would also allow Spring Hill to reduce or avoid withdrawal from Duck River upstream of the Columbia Pool, thereby increasing instream flow in designated critical habitat (existing Spring Hill intake could be used as a backup)

The estimated project cost for implementation of the Comprehensive Regional Water Supply Plan is $62 million:

- Baseline alternatives – $4 million
- Raise Normandy Dam – $20 million
- Williamsport Intake and Raw Water Pipeline to Columbia (one 30-inch pipe for 20 mgd) – $38 million

The project cost represents the cost for planning, design, and construction of the reservoirs, river and reservoir intakes, pumping stations, and transmission mains needed to deliver raw water to the water systems (Appendix E). Planning-level construction costs were estimated using available information from previous reports, construction cost curves from similar projects, and manufacturers' cost data. The estimates are based on July 2010 prices and include an allowance for construction contingencies (20%); regulatory permitting (project specific); and engineering, legal, administrative (20%). In addition, an allowance in the form of an "upfront" cost was added, as necessary, for land acquisition. Additional technical and environmental investigations are planned in future phases to refine the project costs.

POTENTIAL FINANCING APPROACH AND IMPLMENTATION PLAN

At the stakeholder's request, a potential philosophy and approach for financing the recommendations was developed. A "cost-sharing" philosophy was derived based on two fundamental tenants:

1. "Growth Pays for Growth" which is based on a system development charge (SDC) for new water services and larger water services for customers served by utilities drawing water from the Duck River.
2. Common charge for all water withdrawals from Normandy Reservoir or the Duck River.

Three examples of the initial estimated increase in cost per household were developed based on a typical household usage of 5,000 gallons per month:

1. Using solely water withdrawal fees – the estimated increase in cost per household would be approximately $3.00 per month.

2. Using water withdrawal fees (all customers) and system development charges (SDC) for new services and larger services – the estimated increase in cost per household would be approximately $1.50 per month.
3. Using water withdrawal fees (all customers), system development charges (SDC) for new services and larger services, plus phasing the construction and using DRA's current reserve funds – the estimated increase in cost per household would be approximately $0.60 per month.

A more detailed financing plan for implementation of the recommendations is slated for the next phase of the study.

A potential schedule for implementation of the recommended alternatives was developed and is shown in Figure 15. Several key aspects of the proposed schedule include:

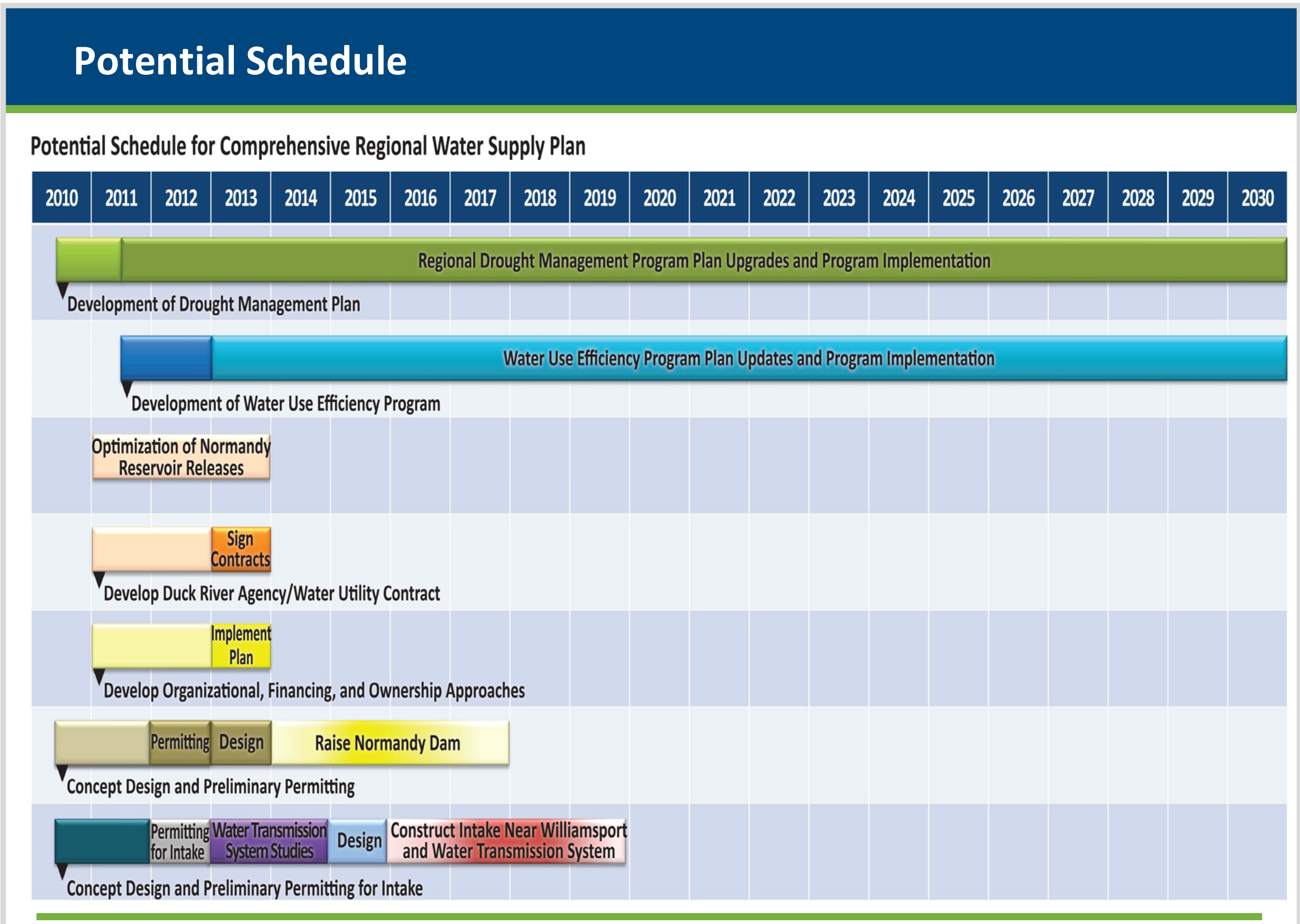

Figure 15 Potential implementation schedule

- The Drought Management Plan and Water Use Efficiency Plan will be developed over the next two years and will be implemented and updated throughout the planning period.
- A program for optimization of releases from Normandy Reservoir will be developed in concert with TVA and others over the next three years.
- The DRA/DRATAC contracts as well as the organizational, financial and ownership issues should be initiated in 2011 and need to be resolved prior to initiating bidding and construction on any of the structural recommendations.
- Permitting for the Normandy Reservoir and Williamsport intake recommendations should proceed concurrently and both should be implemented as soon as possible based on the outcome of the financial studies.

PUBLIC PARTICIPATION

OVERVIEW

The Comprehensive Regional Water Supply Plan was conducted using a uniquely open process, with extensive opportunities for input from the public, elected officials, and governmental and non-governmental agencies through the use of public workshops and informational meetings, routine updates via the DRA website, agency briefings and press coverage (Figure 16).

Figure 16 Communication with stakeholders

PUBLIC WORKSHOPS AND MEETINGS

The DRA conducted six public workshops and several public meetings to obtain input from the public. Among the many stakeholders were the public water systems, represented by the Duck River Agency Technical Advisory Committee (DRATAC), and the DRA's Water Resources Council, which includes over 25 governmental and non-governmental organizations. The roles of the key decision-makers are shown on Figure 17.

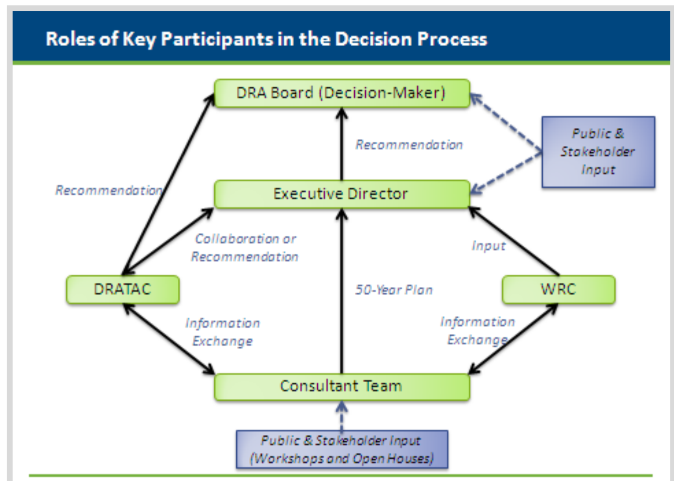

Figure 17 Roles in the decision-making process

The public workshops and "open house" style public meetings facilitated extensive public participation. Since June 2009, six public workshops were held at Henry Horton State Park (Table 4). Five public meetings were held throughout the study (Table 5). These public workshops and "open house" style public meetings provided a forum for citizen and stakeholder input as well as an opportunity to ask questions of DRA's participating utilities and the consultant. Materials from the six workshops and the "open house' meetings are included in Appendix F and Appendix G, respectively.

Table 4. Public workshops

Workshop No.	Workshop Title	Location	Date
1	Kickoff	Henry Horton State Park	June 24, 2009
2	Preliminary Feasibility	Henry Horton State Park	August 26, 2009
3	Developing Alternatives	Henry Horton State Park	December 9, 2009
4	Evaluating Alternatives	Henry Horton State Park	February 24, 2010
5	Implementation Planning	Henry Horton State Park	May 5, 2010
6	Conclusions	Henry Horton State Park	August 11, 2010

Table 5. "Open House" public meetings

Meeting No.	Meeting Title	Location	Date
1	Preliminary Feasibility	Henry Horton State Park	September 22, 2009
2	Preliminary Feasibility	Manchester City Hall	September 23, 2009
3	Preliminary Feasibility	Maury County Courthouse	September 24, 2009
4	Evaluating Alternatives	Henry Horton State Park	March 24, 2010
5	Implementation Planning	Henry Horton State Park	September 9, 2010

E-MAIL

DRA used to emails to provided updates on the status of the study to the public and other stakeholders that attended the meetings.

WEBSITE

DRA developed and maintained a website (www.duckriveragency.org) which included an overview of the project, project participants, project contacts, briefing materials, technical data, and meeting information.

AGENCY BRIEFINGS AND TECHNICAL MEETINGS

DRA held several technical meetings and provided updates on the status of the study to stakeholder agencies and organizations. A number of the meetings are shown in Table 6.

Table 6. Agency briefings and technical meetings

Meeting Participant	Meeting Date
DRATAC	July 8, 2009 September 22, 2009 October 22, 2009 January 13, 2010 April 7, 2010 July 7, 2010
Steering Committee Meetings	June 23, 2009
Water Resources Council	July 9, 2009 October 8, 2010 January 14, 2010 April 8, 2010 July 8, 2010 October 14, 2010
USGS	July 13, 2009
TDEC	August 25, 2009 September 23, 2009 January 29, 2010 July 22, 2010
TVA	September 23, 2009 October 21, 2010 April 8, 2010 July 27, 2010
TNC/USFWS/TWRA	September 24, 2009
DRA Board	January 28, 2010 April 22, 2010 July 22, 2010 October 28, 2010

EXTENSIVE PRESS COVERAGE

Numerous articles were written in area newspapers documenting the work completed and the upcoming meetings. A number of newspaper articles are included in Appendix H.

ELECTED OFFICIAL, COUNCIL, AND BOARD UPDATES

DRA and DRATAC members have provided updates as appropriate to their elected officials and their Councils/Commissions/Boards throughout the study. In addition, DRA has provided briefings to elected officials and the Boards of the Water Systems. A copy of the presentation to the DRA Board on October 28, 2010 is included in Appendix I.

RECOMMENDATIONS

The Tennessee Duck River Development Agency developed a Comprehensive Regional Water Supply Plan for Bedford, Coffee, Marshall, Maury, and southern Williamson Counties to meet future water needs and address possible water shortages brought on by drought conditions. The Comprehensive Regional Water Supply Plan addresses water needs through a 50-year planning period with a 100-year planning horizon, and provides direction to the DRA for the management of available water resources, including the implementation of specific water supply infrastructure projects.

The first step in the planning process was the assessment of demands on the Duck River for additional water supply through the year 2060, which included a projection of water demands for domestic, commercial, industrial, and other purposes. The OASIS computer model was used to examine the operation of Normandy Reservoir and the hydrology of the Duck River to better understand future needs not only for public water supply but for all designated uses. O'Brien & Gere developed water demands using population projections from the University of Tennessee's Center for Business and Economic Research ("CBER"). O'Brien & Gere's needs analysis indicates that during extreme or prolonged drought conditions there is a potential maximum deficit of 32 mgd in the year 2060. In drought conditions like those in 2007, there is presently (2010) a potential maximum deficit of 4 mgd, which would strain the Duck River's ability to supply water for all designated uses. The drought and population growth challenges faced by the region indicate that water supply plans must be reliable, flexible, and collaborative to meet both current and future demands.

O'Brien & Gere then considered 40 potential water supply alternatives and ultimately reduced that number to 26 unique alternatives for further evaluation. These alternatives included a wide array of non-structural (e.g., water efficiency) and structural measures (e.g., reservoirs). O'Brien & Gere evaluated each alternative on the basis of seven criteria: reliable capacity, raw water quality, cost, implementability (permitting), flexibility (phasing), environmental benefits, and recreation. Using the evaluation criteria and working closely with regional stakeholders, O'Brien & Gere identified a combination of non-structural and structural components that increase reliability by using multiple sources of supply.

O'Brien & Gere developed the Comprehensive Regional Water Supply Plan using an open process that incorporated extensive input from the public, elected officials, and governmental and non-governmental agencies. The resulting Comprehensive Regional Water Supply Plan provides a regional solution with benefits beyond water supply.

Based on the findings of the Duck River Comprehensive Regional Water Supply Study, O'Brien & Gere recommends that the DRA adopt and implement the Comprehensive Regional Water Supply Plan, which includes the following non-structural and structural components:

- Non-Structural Components:
  - **Drought Management Plan** – Develop and implement a regional drought management plan.
  - **Water Use Efficiency Program** – Develop and implement a water use efficiency program.
  - **Optimize Normandy Reservoir Releases** – Optimize releases from Normandy Reservoir to preserve storage in the reservoir for periods when it is most needed.

- Structural Components:
  - **Normandy Dam Improvements** – Increase the elevation of Normandy Dam by five feet and increase the Winter/Spring pool elevation by approximately five feet without increasing the Summer/Fall pool elevation. This component increases water storage during droughts, enhances flood protection while minimizing environmental impacts, and enhances the reliable yield available for all Duck River uses.
  - **Williamsport Intake** – Relocate Columbia's water withdrawal to a new intake approximately 25 miles downstream, near Williamsport, where there is adequate flow in the Duck 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 eliminates their sole reliance on Normandy Reservoir.

The estimated project cost for implementation of the Comprehensive Regional Water Supply Plan is $62 million:

- Baseline alternatives – $4 million
- Raise Normandy Dam – $20 million
- Williamsport Intake and Raw Water Pipeline to Columbia (one 30-inch pipe for 20 mgd) – $38 million

Additional technical and environmental investigations are planned in future phases to refine the project cost.

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