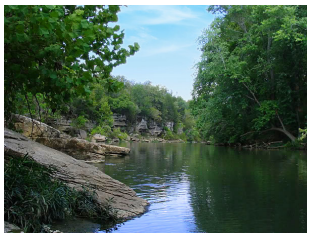
FINAL REPORT

Normandy Reservoir Capacity Improvements







Tennessee Duck River Development Agency

May 7, 2015

O'BRIEN & GERE

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GLOSSARY OF TERMS

ARAP	Aquatic Resource Alteration Permit
BCUD	Bedford County Utility District
CBER	Center for Business and Economic Research
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	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
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-DWR	Tennessee Department of Environment and Conservation – Division of Water Resources
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

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Thomas Dumm, O'Brien & Gere

Ed Drummond, O'Brien & Gere

Brian McCrodden, HydroLogics

Casey Caldwell, HydroLogics

SECTION 1 – INTRODUCTION AND BACKGROUND

1.1. PURPOSE

The purpose of the Tennessee Duck River Development Agency's (DRA) *Normandy Reservoir Capacity Improvements* report is to provide a document that summarizes the work performed to-date and identifies potential next steps associated with implementation of this water supply alternative. This study addresses one of the five recommended water supply alternatives in the DRA's *Comprehensive Regional Water Supply Plan* prepared in March 2011 for the study area shown in Figure 1.

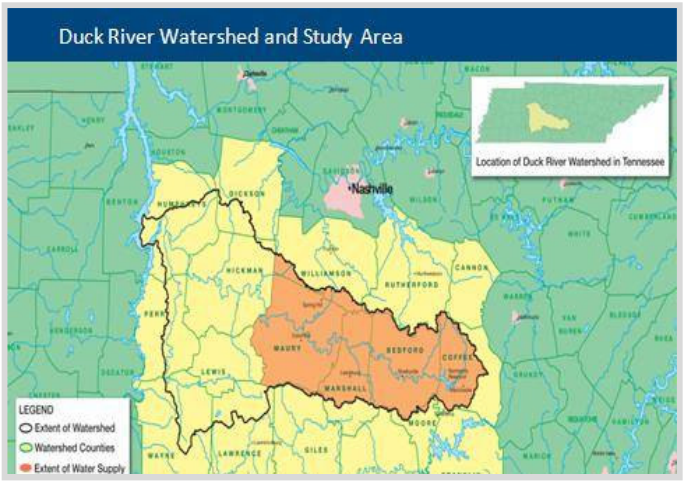

Figure 1. Duck River Watershed and Study Area

1.2. BACKGROUND FOR NORMANDY RESERVOIR CAPACITY IMPROVEMENTS

This study, *Normandy Reservoir Capacity Improvements*, is aimed at increasing the volume of water stored in Normandy Reservoir during droughts so that water is available for all Duck River uses when it is most needed (i.e., severe drought events). A chronological summary of the major studies and events related to Normandy Reservoir and leading up to the most recent investigations includes the following:

- **September 1968** – Tennessee Valley Authority (TVA) prepared a study titled "*The Duck River Project – Normandy & Columbia Reservoirs*". The study identified that construction of Normandy Reservoir would help to assure an adequate supply of water for the future needs in Coffee and Bedford Counties. The study also identified that Marshall and Maury Counties would be assured of an adequate water supply from the proposed Columbia Reservoir.

- **January 1976** - Normandy Reservoir (Figure 2) was completed in 1976 and is located on the Duck River in Bedford and Coffee Counties approximately 1.5 miles upstream of Normandy, Tennessee. The reservoir was constructed by TVA based on a request made by the Tennessee Duck River Development Agency (DRA). The TVA manages and operates Normandy Reservoir, including the dam and its downstream releases. Normandy Reservoir was designed to provide a variety of recreation, water supply, flood control and water quality benefits both upstream and downstream from the dam.



Figure 2. Normandy Reservoir

Downstream releases from Normandy Reservoir are the primary source of water for the Duck River between Normandy Dam and Columbia during severe droughts. The dam and reservoir have the following characteristics:

- Normandy Dam is located in the upper portion of the Duck River watershed between Shelbyville and Manchester (Duck River Mile 248.6) and is fed by the Duck River.
- Normandy Dam is 2,248 feet in length and is about 95 feet in height.
- Normandy Reservoir stores roughly 36 billion gallons of water at a Summer/Fall (June-November) pool level of 875 feet and 25 billion gallons at a Winter/Spring (December-May) pool level of 864 feet.
- Drainage area for the reservoir is roughly 195 square miles.

- **December 1987** - The "Rule Curve" for the Winter/Spring normal pool at Normandy Reservoir was set at 859 ft in 1976 and was raised to 864 ft to facilitate refilling the reservoir to Summer/Fall pool level of 875 ft.

- **August 1998** - TVA completed a water supply inventory and needs analysis (*Water Supply Needs Analysis for Bedford, Marshall, Maury, and Southern Williamson Counties, Tennessee*) which showed that an additional water source would be needed in the Duck River region after 2015.

- **December 2000** – TVA prepared a Programmatic Environmental Impact Statement (PEIS) titled "*Future Water Supply Needs in the Upper Duck River Basin*". TVA provided DRA with a study that identified a 22 cfs (14 mgd) deficit in 2050 for Bedford, Marshall, and Maury/southern Williamson counties at the Columbia Power & Water Systems withdrawal point (Duck River Mile 133.9). The PEIS investigated five water supply alternatives:
  - Alternative A – Use Present Sources (No action)
  - Alternative B – Fountain Creek Reservoir (build a reservoir in the downstream portion of the Fountain Creek watershed southeast of Columbia)
  - Alternative C – Downstream Water Intake (construct a water supply intake on the Duck River downstream from the mouth of Catheys Creek northwest of Columbia at Duck River Mile 108)
  - Alternative D – Raise Normandy Reservoir Pool Level (raise the Summer/Fall normal pool level by 5 feet from 875 ft to 880 ft, raise the Winter/Spring normal pool level by 5 feet from 864 ft to 869 ft, and raise the dam crest by 5 feet from 895 feet to 900 feet)
  - Alternative E – Tims Ford Pipeline (transfers water by pipeline to the Duck River from Tims Ford Reservoir)

  The PEIS prepared by TVA concluded that one or more action alternatives should be pursued to meet the future water needs in the Maury/southern Williamson County water service area. This conclusion that one or more action alternatives should be pursued was the TVA's "Preferred Alternative" in the PEIS.

- **2007/2008** – The Duck River region experienced the longest drought in the period of record extending back 117 years. The dramatic decrease in rainfall during the 2007/2008 drought, combined with the multiple uses of the reservoir and the river, caused record low water levels in Normandy Reservoir (42% full) that resulted in temporary changes in dam operation to protect designated water uses (Figure 3).

- **Spring 2007** – DRA met with TVA in Chattanooga to discuss the feasibility of increasing water storage capacity in Normandy Reservoir.

- **August 2007** - DRA sent letters to TVA asking TVA to begin considering the possibility of raising the water levels in Normandy Reservoir to increase water storage capacity and raising Normandy Dam to maintain flood protection. The additional volume of water stored in Normandy Reservoir would be used to meet future water supply needs identified in the TVA's PEIS.



Figure 3. Normandy Reservoir during 2007/2008 drought

- **April 2008** - TVA delivered a presentation to the DRA Board on the findings from the examination of raising Normandy Reservoir water levels to increase water storage capacity. The PEIS conducted in 2000 did not provide a recommendation based on the evaluation of the four identified alternatives, which included raising Normandy Reservoir water levels. TVA concluded that there may be issues to be addressed and possibly mitigated, but there was nothing known that renders the option of raising Normandy Reservoir infeasible. Cost to raise the dam, modify the spillway gates, modify several roads and bridges, acquire land, and prepare Final Environmental Impact Statement (FEIS) was approximately $21M. It was noted that TVA investigated only this alternative (i.e., Raising Normandy Reservoir water levels) at the directive of DRA. Consequently, TVA recommended that DRA conduct a comprehensive study to determine the best solution to meet future water supply needs in the Duck River Region. For the option involving raising Normandy Reservoir, TVA identified a possible approach going forward:
  - Phase 1: Detailed Feasibility Study
    - Determine increase in reservoir yield
    - Determine change in flood risk
    - Conduct dam stability analysis and develop cost estimate
    - Conduct gate and spillway analysis
  - Phase 2: Conduct National Environmental Policy Act (NEPA) study

- **June 2009** - DRA contracted with O'Brien & Gere Engineers to develop a regional water supply plan for the upper Duck River Region (upstream of Columbia). In the Duck River Agency's *Comprehensive Regional Water Supply Plan* (March 2011), 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. These alternatives were developed to meet a 2060 potential deficit of up to 32 mgd (which equates to 1.4 BG) at Columbia. A target of 3 BG was set as the deficit at Columbia if water is released upstream of Columbia and is available for the users of the Duck River between Shelbyville and 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 existing 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 - Measures that should be implemented together with (not instead of) the selected alternative. Baseline measures include water use efficiency and drought management.
- Fatally Flawed or Highly Unlikely - Alternatives that most likely cannot be implemented due to permitting obstacles, excessive cost, or other factors.
- Backup - Alternatives that will not satisfy the entire deficit, but which may be suitable for implementation with a cornerstone alternative.
- Cornerstone - Alternatives capable of satisfying the entire 2060 river deficit.

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 4:

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

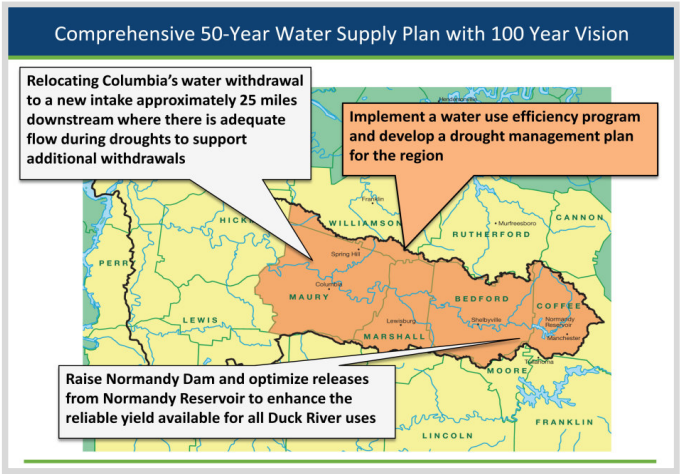

Figure 4. Recommended alternatives

- **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 water in storage during droughts and enhances the reliable yield available for all Duck River uses.
  - **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 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 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 – DESCRIPTION OF NORMANDY RESERVOIR CAPACITY IMPROVEMENTS ALTERNATIVE

The Normandy Reservoir Capacity Improvements alternative as it is currently defined has evolved over time from its inception in December 2000 in TVA's Programmatic Environmental Impact Statement (PEIS) titled "*Future Water Supply Needs in the Upper Duck River Basin*". In the PEIS, five unique water supply alternatives were evaluated by TVA including raising the pool level in Normandy Reservoir. This alternative had the following characteristics in the PEIS:

- Raise the Summer/Fall normal pool level by 5 feet from 875 ft to 880 ft
- Raise the Winter/Spring normal pool level by 5 feet from 864 ft to 869 ft
- Raise the dam crest by 5 feet from 895 ft to 900 ft

Under this configuration proposed in the PEIS, raising the Summer/Fall pool level by 5 feet would result in submergence of additional property adjacent to the reservoir between elevations 875 ft and 880 ft for several months during the Summer/Fall timeframe. Currently, the property surrounding the reservoir is submerged above an elevation of 875 ft only periodically during flood events. For the configuration proposed in the PEIS, raising the Winter/Spring and Summer/Fall pool levels and inundating areas above the current Summer/Fall pool level for several months each year raised concerns related to impacts and costs associated with the need to acquire additional property surrounding the reservoir (TVA owns the property to the top of the dam at elevation 895 ft), potential inundation of campgrounds, impacts to bridges and roads, submergence of natural areas and trails, etc.

For the PEIS, TVA concluded that the "preferred alternative" included one or more action alternatives and that one or more action alternatives should be pursued to meet the future water needs in the Maury/southern Williamson County water service area.

During the drought of 2007/2008, DRA requested that TVA conduct a more detailed evaluation of the feasibility of raising the Normandy Reservoir Winter/Spring and Summer/Fall pool levels and TVA identified that the cost to raise the dam, modify the spillway gates, modify several roads and bridges, acquire land, and prepare a Final Environmental Impact Statement (FEIS) was approximately $21M.

As part of DRA's Comprehensive Regional Water Supply Plan (2009-2011), a portfolio of five alternatives was recommended for implementation. Included in the five alternatives was the recommendation to raise the Winter/Spring pool level in Normandy Reservoir from 864 ft to 869 ft (i.e., Summer/Fall pool level remains at 875 ft) which was characterized as a project in the upper portion of the Duck River which benefits residents throughout the Duck River watershed. Extensive studies were conducted to conclude that raising the Winter/Spring pool level in Normandy Reservoir while maintaining the current Summer/Fall pool level should be part of the overall water supply solution. To assess the benefits of raising the Winter/Spring pool level, hydrologic modeling of the Duck River upstream of Columbia was performed using HydroLogics' OASIS software to define the drawdown of Normandy Reservoir during major droughts in the period of record (i.e., 1921 through 2009). Figure 5 shows the water levels in Normandy Reservoir for major droughts in the period of record if water was released from Normandy Reservoir to the Duck River to meet the flow targets in the Duck River under 2060 water demand conditions and using the existing "Rule Curve" (TVA operating guide or target water levels).

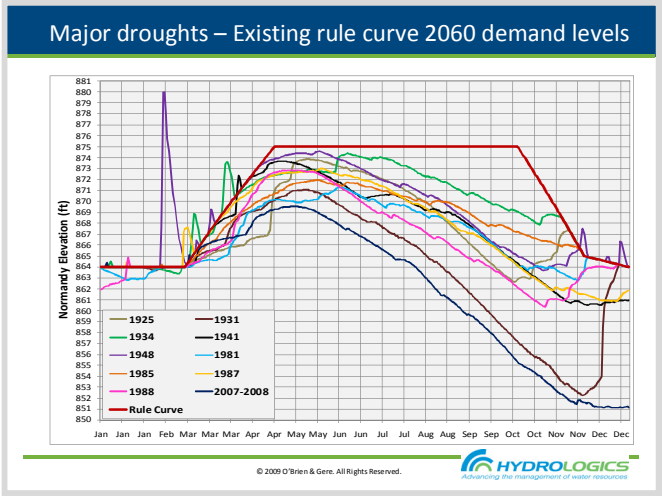

Figure 5. Existing Rule Curve

As shown in Figure 5 for the 2007 drought and 2060 water demand conditions, the model predicted that the water level in Normandy Reservoir would have reached its highest elevation of approximately 869.5 ft (roughly 5.5 ft below the "Rule Curve" for Summer/Fall pool level of 875 ft) in May and its lowest point of 851 ft in December (roughly 13 ft below the "Rule Curve" for Winter/Spring pool level of 864 ft).

Figure 6 shows that for the 2007 drought conditions and 2060 water demands raising the Winter/Spring normal pool level from the current "Rule Curve" elevation of 864 ft to 869 ft (5 ft) enabled the water level in the reservoir to reach a maximum elevation of roughly 873.5 ft and its lowest level dropped to 857 ft. Consequently, the modeling results show that changing the Winter/Spring normal pool level from 864 ft to 869 ft increases the water levels by 4 to 6 ft (roughly 5 billion gallons) under 2007 drought and meets the flow targets in the Duck River under 2060 water demand conditions.

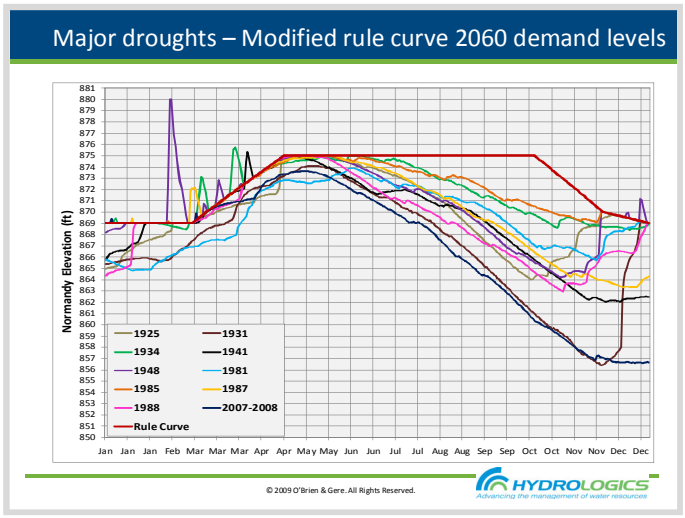

Figure 6. Proposed Rule Curve

Based on the results of the hydrologic modeling and discussions with TVA regarding the proposal to raise the Winter/Spring normal pool for Normandy Reservoir, TVA identified that their primary concern was that raising the "Rule Curve" for the Winter/Spring pool at Normandy Reservoir from 864 ft to 869 ft would increase the frequency of flooding downstream during the Winter/Spring timeframe. One option to address this concern is to raise the top of the floodgates at Normandy Reservoir (currently at 880 ft). Consequently, the configuration of the alternative was modified to include the following (Figures 7 and 8):

- Retain the Summer/Fall normal pool level at 875 ft
- Raise the Winter/Spring normal pool level by 5 feet from 864 ft to 869 ft
- Raise the dam crest by 5 feet from 895 ft to 900 ft
- Increase the elevation of the top of floodgates from 880 ft to 885 ft
- Increase the elevation of the top of the spillway used by the floodgates from 840 ft to 845 ft (to retain existing floodgates if possible)

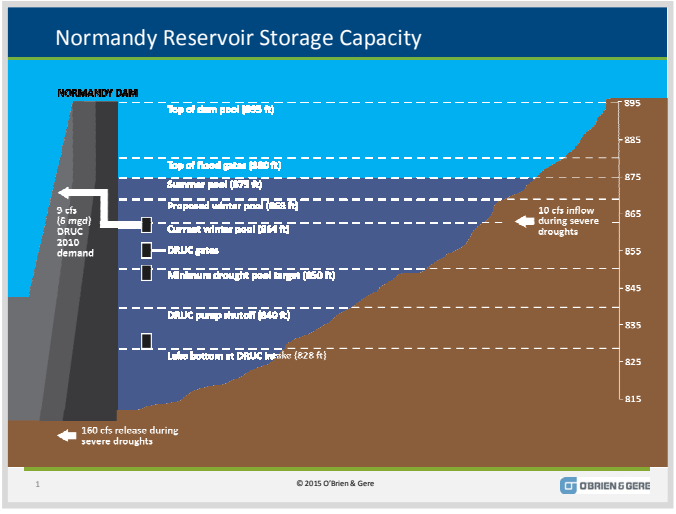

Figure 7. Normandy Reservoir alternative characteristics

In addition, this alternative has the following characteristics:

- The volume of water stored in Normandy Reservoir during the Winter/Spring timeframe is increased and the current volume of water storage during the Summer/Fall months remains unchanged.
- The required downstream releases from Normandy Reservoir to meet the flow target in the Duck River at Shelbyville during Winter/Spring and Summer/Fall conditions remain unchanged compared to current conditions.
- The configuration of the alternative raises the height of the spillway crest and floodgates which maintains the current volume of flood storage available in Normandy Reservoir and thereby minimizes the risk of increased downstream flooding.

- The 5 ft increase in Winter/Spring pool level was considered for planning purposes and an alternate water level may be more attractive based on more detailed investigations of the dam stability and environmental impacts.

- The difference between the current Summer/Fall pool level (875 ft) and the Winter/Spring pool level (864 ft) is currently 11 ft, and would be reduced to 6 ft of fluctuation if the Winter/Spring pool was increased to 869 ft. Reducing the fluctuation between the Winter/Spring pool level and the Summer/Fall pool level by almost 50% should significantly reduce the extent of Winter "mudflats" for waterfront property owners adjacent to Normandy Reservoir.



Figure 8. Normandy Dam and floodgates

As an alternative to raising the spillway crest and floodgates to maintain the current volume of flood storage in Normandy Reservoir and minimize the impact of increased downstream flooding, DRA could purchase property or acquire easements in the Duck River floodplain downstream of Normandy Reservoir. A cursory review of potentially impacted properties was performed as part of the DRA's Comprehensive Regional Water Supply Plan. The review of existing mapping indicated that between Normandy Reservoir and Shelbyville the area within the 100-year and 500-year floodplains is roughly 4,500 acres and 5,000 acres, respectively. Additional studies would be needed to define the extent of the property that would be impacted by downstream flooding and the cost for purchasing property or acquiring easements. The results of the work currently being conducted by TVA on the Normandy Dam will better define improvements that may be needed to meet TVA's current design criteria and whether further studies involving purchasing property or acquiring easements downstream of the dam is warranted.

In summary, the configuration of the Normandy Reservoir Capacity Improvements alternative involves modifications to Normandy Dam which was designed to impound water for a variety of designated uses including recreation, water supply, flood control and water quality benefits for the region. Releases from Normandy Reservoir are the primary source of water for the Duck River upstream of Columbia during severe droughts. Increasing the Winter/Spring pool level for Normandy Reservoir provides insurance in the form of additional water storage that can serve the entire region and meet the designated uses in the future. The most critical reservoir condition for water suppliers (i.e., highest risk) is the impact that occurs at the lowest reservoir water levels (i.e., severe droughts). The alternative has been configured such that raising the Winter/Spring pool level directly increases the volume of water stored in the reservoir by raising the low water levels that occur during the most severe droughts. In addition, the alternative addresses the risk of increased flooding downstream by either modifying the floodgates at Normandy Dam or purchasing property or acquiring easements downstream of Normandy Reservoir.

SECTION 3 - RECENT INVESTIGATIONS FOR NORMANDY RESERVOIR CAPACITY IMPROVEMENTS

Subsequent to development of the Comprehensive Regional Water Supply Program (2009-2011), a number of studies and investigations were conducted to assess the viability of raising the water levels in Normandy Reservoir and the crest for Normandy Dam. A chronological summary of the studies follows.

- **May 2010** – O'Brien & Gere and DRA initiated discussions with TVA regarding the stability analysis for Normandy Dam for the current and raised dam crest conditions. O'Brien & Gere prepared a scope of work for the investigation of water storage capacity improvements for Normandy Reservoir and initiated work on the stability analysis for Normandy Dam.

- **September 2010** – O'Brien & Gere provided DRA with a technical memorandum on the *Initial Review of Existing Dam Features and Stability Analysis Records related to Feasibility of Increasing Impoundment Storage.* The memorandum included a preliminary review of the dam features, general construction, and stability analysis records of the existing facility. The memorandum was developed for the purposes of identifying inherent characteristics and/or original design methodology that could potentially have significant adverse impacts on the feasibility of increasing the water storage capacity in the reservoir by raising the Winter/Spring normal pool elevation. The memorandum identified analyses that need to be updated as well as additional information that would be needed to investigate the feasibility of raising the Winter/Spring normal pool level.

- **October 2010** – O'Brien & Gere submitted to TVA the revised criteria and parameters proposed for use in the pre-preliminary stability analysis for Normandy Dam.

- **March 2011** – O'Brien & Gere submitted the *Pre-Preliminary Stability Analysis* document to TVA for review.

- **July 2011** – O'Brien & Gere coordinated with TVA and DRA to develop a scope of work for refining the dam stability analysis for Normandy Reservoir.

- **January 2012** – O'Brien & Gere and DRA attended and participated in a meeting with TVA in Chattanooga, TN to discuss the *Comprehensive Regional Water Supply Plan*, status of the Normandy Dam stability investigations, and potential economic development in the Duck River region. TVA indicated that there were no roadblocks to DRA's request to the TVA Governance Council and Board to raise the Winter/Spring pool for Normandy Reservoir. TVA also identified that it would take about two years for TVA to evaluate all their dams against the new storm and design criteria. TVA would expect DRA to pay the additional costs that were required above and beyond what TVA would be required to complete to satisfy the new regulations. TVA identified that they would be developing a list of priorities for their facilities over the next couple years and it was unclear where Normandy Reservoir would fall in the priority list.

- **March 2012** - O'Brien & Gere prepared a draft memorandum and responded to TVA's comments on the pre-preliminary dam stability analysis.

- **August 2012** – O'Brien & Gere transmitted to TVA the draft version of O'Brien & Gere*'s Technical Review Report Rock Characterization and Strength Parameters Pertinent to the Evaluation of Normandy Dam Foundation*.

- **August 2012** – O'Brien & Gere submitted to TVA the *Interim Summary of Embankment Stability Analysis* for review. The document served as an interim deliverable for the *Preliminary Stability Analysis* and identified the factors of safety for various loading conditions on Normandy Dam.

- **September 2012** - Conducted conference call with TVA, O'Brien & Gere and DRA to discuss dam stability calculations, results and next steps.

- **November 2012** - Transmitted to TVA the final version of O'Brien & Gere*'s Technical Review Report Rock Characterization and Strength Parameters Pertinent to the Evaluation of Normandy Dam Foundation*. Incorporated TVA's suggestions as reviewed in TVA conference call. The report identified that while the available geologic data from the Normandy Dam site was extensive and useful, additional site specific geologic/rock mechanics data was needed to support the selection of rock foundation shear strength parameters for the proposed dam raising project. O'Brien & Gere recommended a geotechnical/geologic investigation be completed that would include rock coring and laboratory testing of the foundation rock, as well as the concrete rock contact.

- **July 2013** – O'Brien & Gere was retained by DRA to investigate the stability of Normandy Dam if the Winter/Spring pool was raised as recommended in DRA's Comprehensive Regional Water Supply Plan. O'Brien & Gere prepared a *Draft Preliminary Stability Analysis Report* which was submitted to TVA and showed that the stability of the dam was sensitive to changes in the flood levels and that reductions in design flood levels would significantly improve dam stability. TVA indicated that they would be applying a risk-based analysis for the evaluation of the safety of their dams. This approach would allow TVA to prioritize their dam related investments by initially addressing those with high risk/high impact. Potential changes in precipitation events and related flood levels would be considered in the risk analysis. Therefore, it can be stated that the results of TVA's hydrology and hydraulic analyses, the flood levels established from those studies, and the future risk-based analysis will have a significant impact on the extent of any dam modifications that may be needed and the timing of those improvements.

- **September 2013** - O'Brien & Gere and DRA attended and participated in a meeting with TVA in Shelbyville, TN to discuss the results of the dam stability analyses. TVA identified that reasonable cost estimates could be generated based on the stability analysis work completed to-date and that the next steps in the analysis of the dam are much more detailed (including items such as geotechnical field investigation and laboratory testing, geotechnical and structural analysis, finite element analysis, etc.) and should be included in the next phase of study. TVA stated that there is no reason to proceed to next phase of the dam stability analysis unless the decision is made to raise the dam. Meeting participants agreed that OBG and DRA should set up a meeting with TVA's National Environmental Policy Act (NEPA) folks in Chattanooga, TN.

- **October 2013** – O'Brien & Gere provided DRA with a memorandum summarizing the conceptual evaluation of potential dam modifications considering dam safety and the operation of the dam spillway gates to mitigate flood impacts. Conceptual cost estimates developed for raising the dam, stabilizing the dam, and modifying the gates and spillway were on the order of $16 million. Consequently, the overall project cost will likely be on the order of $25 million to $30 million, including non-dam costs (land acquisition, road and park impacts) plus engineering, geotechnical investigations and miscellaneous costs. Consequently, the unit cost is estimated to be on the order of roughly $5 to $6 per 1,000 gallons ($25M to $30M for 5 BG).

- **October 2013** – O'Brien & Gere and DRA met with TVA in Chattanooga, TN to discuss the NEPA permitting requirements associated with the water storage capacity improvements for Normandy Reservoir. Discussed project background, water supply needs, water quality, costs, alternatives analysis, and NEPA process.

- **May 20, 2014** – O'Brien & Gere and DRA met with TVA in Chattanooga, TN to request TVA's support for three areas of DRA's Comprehensive Regional Water Supply Plan: Raising Normandy Dam and Winter/Spring pool, flow optimization and Regional Drought Management Plan. Regarding raising

Normandy Dam and Winter/Spring pool levels, TVA identified that they were currently examining the precipitation estimates for the watershed above Normandy Reservoir. TVA indicated that upon completion of the study, the results may require a change in the calculated inflow design flood for Normandy Dam. TVA identified that they were conducting evaluations at all of their dams to determine where structural modifications may be necessary. TVA proposed that DRA wait until these studies are complete before pursuing any option that would require a structural modification to Normandy Dam. TVA stated that even if they pursue a project in the future to raise Normandy Dam to address changes in the design inflows, there is no guarantee that TVA would subsequently raise the Winter/Spring pool in the reservoir as proposed by DRA.

SECTION 4 - NEXT STEPS

DRA has identified the following key items that need to be addressed in the near-term in conjunction with the Normandy Reservoir Capacity Improvements alternative:

- Continue to work with TVA on the NEPA permitting requirements associated with the water storage capacity improvements for Normandy Reservoir.
- Continue to work with TDEC to solicit decision on anti-degradation determination for the recommended alternatives in the DRA's Comprehensive Regional Water Supply Plan.
- Maintain communication with TVA on the findings from the hydrologic and stability analyses being performed on the Normandy Reservoir and Normandy Dam and the impacts on the recommended alternative proposed in this study.
- Define the increase in water level in Normandy Reservoir that is "best fit" based on findings from ongoing studies.
- Determine whether conducting investigations associated with purchasing properties or acquiring easements in the floodplain downstream of Normandy Reservoir is warranted.
- Provide briefings for DRATAC, DRA Board, regulators and stakeholders.