TRIANGLE REGIONAL WATER SUPPLY PLAN

Prepared For:

Jordan Lake Partnership

Prepared By:

Triangle J Council of Governments

FINAL
October 24, 2014

This page intentionally left blank.

Cover Photo: NMNC. Falls Lake along Mountains to Sea Trail. 2012. Downloaded from Panoramio.com. Used under Creative Commons noncommercial, nonderivative license. 14 Oct. 2012.

Acknowledgments

This document was produced through the collaborative effort of the members of the Jordan Lake Partnership along with staff from the Triangle J Council of Governments and FountainWorks, who demonstrated a remarkable commitment to working together to produce the best possible product. Never before has a water supply planning document of this kind been developed for the Triangle Region with this level of coordination, technical merit and peer-review.

Completion of this document would not have been possible without the commitment and support of the Partnership members, who engaged at multiple levels from technical staff and contractors to senior staff leaders. Partnership members each devoted time and resources throughout this iterative process.

Special thanks go to the Jordan Lake Partnership Technical Review Team, which included representatives of each Partnership member and provided essential guidance on every aspect of the planning process. The Technical Review Team members are listed below:

Tim Donnelly, Town of Apex
John Cratch, Town of Apex
Jessica Bolin, Town of Apex
David Hughes, Town of Apex
Leila Goodwin, Town of Cary
Sydney Miller, Town of Cary
Dan LaMontagne, Chatham County
Don Greeley, City of Durham
Vicki Westbrook, City of Durham
Ed Holland (Consultant for the City of Durham)
Kenny Keel, Town of Hillsborough
Stephanie Sudano, Town of Holly Springs
Kendra Parrish, Town of Holly Springs
David Mason & Kelly Boone, CDM Smith (Consultant for the Town of Holly Springs)
Richard Cappola, Town of Morrisville
Tom Davis, Orange County
Kevin Lindley, Orange County
Ruth Rouse, Orange Water and Sewer Authority
Fred Royal, Town of Pittsboro
Stuart Bass, Town of Pittsboro
Becky Smith, Hydrostructures, PA (Consultant for the Town of Pittsboro)
Kenneth Waldroup, City of Raleigh
Victor Czar, City of Sanford
Paul Weeks, City of Sanford
Eric Staehle, Wake County
Warren Miller, FountainWorks
Lars Hanson, Triangle J Council of Governments
Mike Schlegel, Triangle J Council of Governments

Additional thanks goes to the City of Durham, which serves as the Lead Agency and fiscal and contracting agent for the Jordan Lake Partnership. Funding for this project was provided by all of the members of the Jordan Lake Partnership.

This page intentionally left blank.

Executive Summary

What is the Triangle Regional Water Supply Plan?

The Triangle Regional Water Supply Plan (TRWSP) is a collaborative assessment of projected water demands and sources in the Triangle Region of North Carolina, developed by the Jordan Lake Partnership (JLP), that demonstrates the ability of existing and new or expanded sources of supply to meet demands through 2060.

What is the Jordan Lake Partnership?

The JLP is a consortium of 13 local governments and water systems (Partners) that was created in 2009 to collaboratively plan for the future of water supply in the Triangle Region, including the use of Jordan Lake. Figure 1 lists the thirteen Partners and shows their 2060 water service areas.

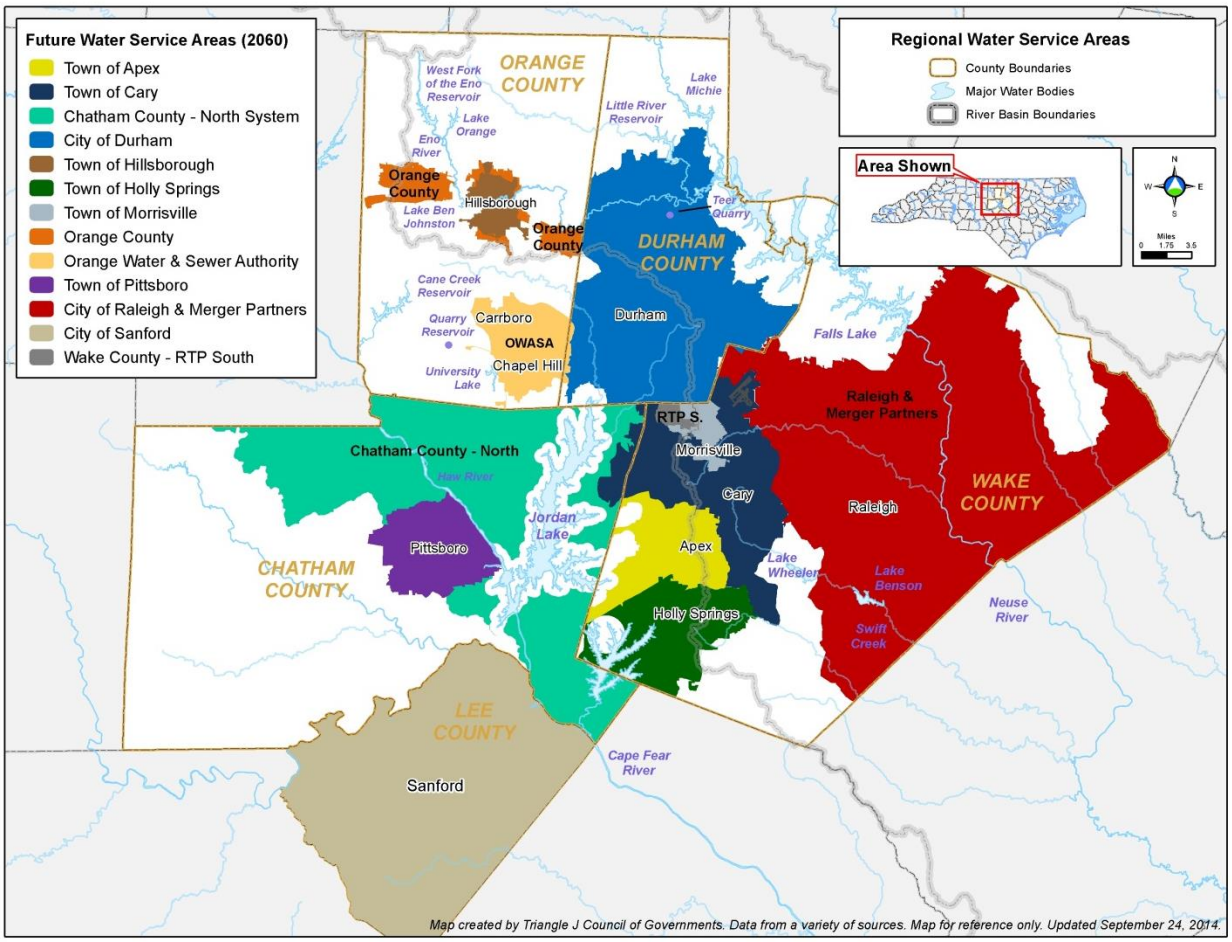


Figure ES-1. Future (2060) water service areas of the Jordan Lake Partners.

What are the Key Conclusions of the Plan?

- The Partners' current total water supply of 199 million gallons per day (MGD) is projected to meet their combined needs through approximately 2030.
- An additional 95 MGD of supply is needed to meet 2060 water supply needs (total 294 MGD).
- The 2060 demands can be met in an environmentally and economically sound manner through a combination of:
    - 36.4MGD: Allocation of most of the remaining Jordan Lake water supply storage (Apex, Cary, Chatham County, Durham, Orange County, Hillsborough, Pittsboro);
    - 20.6-22.6MGD: Expansion of existing reservoirs, off-stream quarry storage, and run-of-river withdrawals (Hillsborough, Orange County, OWASA, Pittsboro, Sanford); and
    - 41.1 MGD: Development of a combination – still to be determined – of new or expanded sources including reallocation from Falls Lake, a new intake in the Neuse River, off-stream quarry storage, and/or a new reservoir in eastern Wake County (Raleigh).
- Implementation of water use efficiency and conservation practices and expanded use of reclaimed water will continue to be essential strategies for meeting the region's future water needs.
- Hydrologic modeling has shown that the Triangle's water needs can be met without compromising the ability of downstream communities to meet their own water supply needs.
- The region's ability to meet projected water demands in 2060 may be compromised if any of the TRWSP's recommended future water supply sources are not implemented as planned.

Why was the Partnership Formed?

The Partners elected to be proactive in identifying potential water shortfalls and mutually acceptable and beneficial solutions for meeting future needs. The region experienced two historic droughts in 2002 and 2007-2008. Regional planning and collaboration – developing solutions on a geographic scale larger than individual water suppliers – will increase the resilience of our water supply under similar extreme conditions. In addition, the Partners wanted to use hydrologic modeling to confirm that other upstream and downstream water needs within the Cape Fear and Neuse River Basins would not be impacted by a proposed strategy that met the needs of the Triangle.

The challenges associated with utility management including increasing costs, greater regulatory requirements and increasing drought vulnerability can be more successfully met through inter-local collaboration in facility planning, design, construction, operation and management. The Partners, in various combinations, are engaged in joint projects including increasing the number and size of interconnections between water supply systems and consolidating utility systems through merger agreements. Some efforts include water supply planning over the entire hydrologic cycle where water, wastewater and stormwater service delivery are integrated to protect watersheds and improve response during drought or other water shortage conditions. The JLP was formed to complement these efforts, continuing to better prepare the Triangle Region to address water shortages on a regional basis.

What has the Partnership Accomplished?

The first step was for JLP members to develop demand projections through 2060, and a key part of this effort was engaging in a careful peer review of each other's demand projections. The Partners also shared information about conservation and water use efficiency efforts, identified existing interconnections and evaluated new interconnection opportunities. After determining future needs, the Partners developed a pool of potential water supply source options, and coordinated with the NCDENR Division of Water Resources (DWR) to use the combined Cape Fear-Neuse River Basin hydrologic model to define and evaluate alternatives. The result is the mutually-supported Triangle Regional Water Supply Plan for meeting the future water supply needs of the Triangle Region.

What are the Region's Water Supply Needs?

The region's existing and planned water supplies (Figure 2) are associated primarily with man-made reservoirs, along with a few run-of-river withdrawals and supplemental quarry storage. The region does not import water from outside the Neuse and Cape Fear River basins; though the Partners currently have a combined net transfer of surface water from the Neuse basin to the Cape Fear basin.

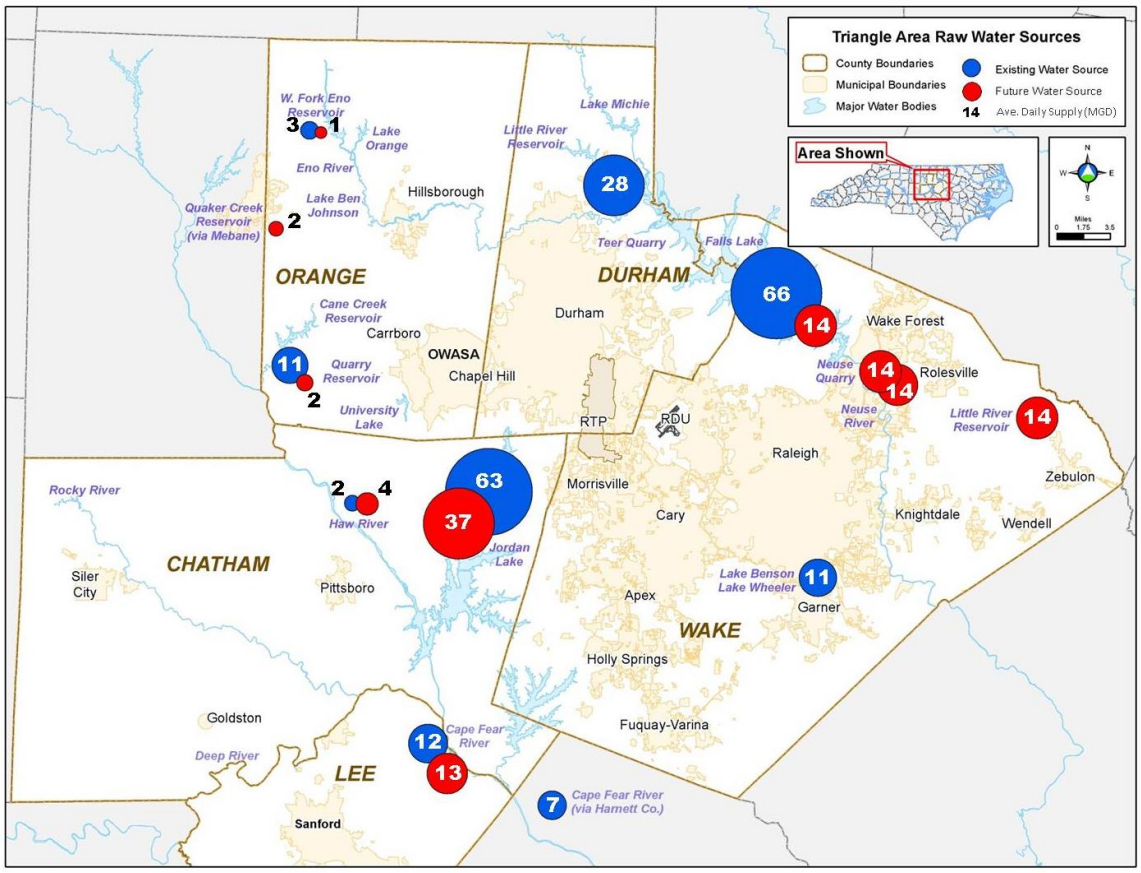


Figure ES-2. Existing and future water supply sources; JLP Recommended Alternative. Single dots sometimes represent multiple sources that are geographically close (e.g., OWASA's reservoirs) and/or more than one utility using the same source (e.g., Jordan Lake). The numbers by each source represent approximate yield in MGD, but have been rounded to whole numbers in this graphic. Details of each source are provided in the TRWSP.

The Triangle area is one of the fastest growing regions in the country, and as a result, the combined JLP water service area population is projected to increase from 1,066,000 in 2010 to 2,774,000 by 2060, a compounded rate of increase of about 1.9 percent. The corresponding water demands are projected to increase from 118 MGD in 2010 to 294 MGD by 2060, a compounded rate of increase of about 1.8 percent. The fact that water use is projected to grow slower than service area population illustrates the impact of the Partners' water efficiency and conservation programs, including increased use of reclaimed water.

While existing water supplies of 199 MGD are expected to meet the region's needs through approximately 2030, new water supplies of 95 MGD will be needed to meet 2060 estimated demands of 294 MGD. Figure 3 illustrates the growth in water demand for each partner. Raleigh makes up almost half of the JLP's combined demands – making the implementation of their future water supply projects essential to successfully meeting the needs of the Triangle Region.

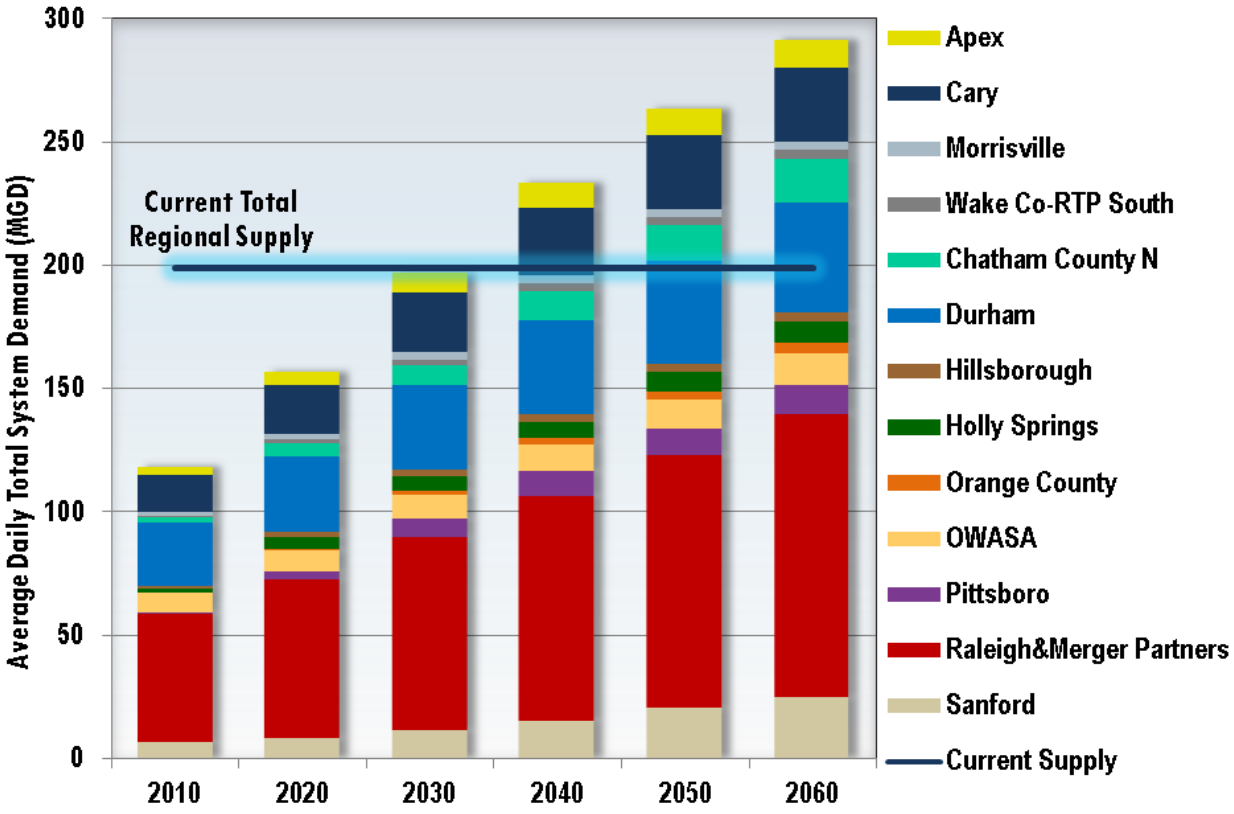


Figure ES-3: Regional demand projections and current supplies, including Jordan Lake allocations.

How will the Partners Meet 2060 Water Demands?

Many of the Partners have their own long-range master plans in which they have identified and evaluated a variety of water supply options. Using the information from these plans as a foundation, the JLP identified potentially feasible strategies for meeting the region's long-term water supply needs. These strategies were evaluated relative to each other according to their ability to meet regional water supply demands, costs, regulatory complexity and environmental impacts; and the strategy selected by the Partners is presented in detail in the TRWSP (JLP Recommended Alternative).

The JLP Recommended Alternative meets the region's cumulative 2060 water supply needs of 294 MGD with 36.4 MGD of new allocations from Jordan Lake, and development of about 63 MGD in water supply from increased and new withdrawals from river sources, increased and new supplemental quarry storage and a new reservoir on the Little River in eastern Wake County. Implementation of the JLP Recommended Alternative would decrease the existing net interbasin transfer from the Neuse River Basin to the Cape Fear River basin.

Currently, 63 percent of Jordan Lake's water supply pool has been allocated (a 1 percent storage allocation is estimated to yield approximately 1 MGD of average day supply). The JLP Recommended Alternative includes the same or increased allocations for all existing allocation holders (each is also a member of the JLP), as well as new allocations for several of the Partners. While the JLP is planning for 2060, the next round of Jordan Lake allocations (Round 4) will be based on 2045 needs. Table 1 presents current allocations and the total Jordan Lake allocation needs for 2045 (proposed Round 4 allocation requests) and 2060.

Table ES-1. JLP Recommended Alternative Jordan Lake Allocations (MGD).

Partner	Current Allocation	Total 2045 Need (Round 4 Allocation Basis)	Total 2060 Need
Apex	8.5	10.6	11.6
Cary	23.5	28.6	29.8
	32.0	46.2	48.5
Morrisville	3.5	3.5	3.6
Wake County (RTP South)	3.5	3.5	3.5
Chatham County - N	6	13	18.2
Durham	10	16.5	16.5
OWASA	5	5	5
Orange County	1	1.5	2
Holly Springs	2	2	2.2
Hillsborough	0	1	1
Pittsboro	0	6	6
Raleigh & Merger Partners	0	0	0
Sanford	0	0	0
TOTAL JLP	63	91.2	99.4

Table 2 summarizes additional water supply (62-64 MGD) from sources other than Jordan Lake in the JLP Recommended Alternative. While most of the sources are expansions of existing water supplies, about 41 MGD of the proposed water supply – nearly half of the 95 MGD in new supplies needed to meet regional 2060 demands – will come from a combination of new projects that are planned by the City of Raleigh.

Table ES-2. JLP Recommended Alternative Water Supplies (MGD).

Partner	Source Name	Basin	Type	Projected New Supply (MGD)
Hillsborough	W. Fork Eno Expansion	Neuse	Reservoir Expansion	1.2
Orange County	Purchase from Town of Mebane	Haw	Purchase	0.5 - 2.5
OWASA	Quarry Reservoir Expansion	Haw	Quarry Expansion	2.1
Pittsboro	Haw River - Increased Withdrawal	Haw	River Withdrawal	4.0
Raleigh	Exploring 4 options; must develop 3	Neuse	New Reservoir; Reallocation of Falls Lake Storage; Neuse River Withdrawal; Quarry	41.1
Sanford	Cape Fear River - Increased Withdrawal	Cape Fear	River Withdrawal	12.8
TOTAL	All New Sources			61.7-63.7

Can Downstream Communities Meet 2060 Needs under the TRWSP?

Yes. The JLP used DWR's combined hydrologic model of the Neuse and Cape Fear River Basins to simulate 2060 water demands, including the JLP Recommended Alternative, under the entire 80+ year range of hydrologic conditions and historic droughts. The results indicate that the long term water supply needs of the Partners, as well as those of downstream water users, can be met under the TRWSP. A preliminary modeling analysis by DWR, as they work toward development of a Cape Fear Basin Water Supply Plan, confirmed these results.

What Could Affect the Success of the TRWSP?

The TRWSP conclusion that the Triangle Region will have enough water to meet projected water demands through 2060 hinges on the accuracy of many assumptions, on Jordan Lake water supply allocations consistent with Table 1, and on each Partner implementing its water supply projects. The JLP Recommended Alternative will require implementation of many complex projects, with numerous regulatory and environmental challenges. Key uncertainties include:

- Rate of population growth;
- Adoption of water efficiency and conservation practices including reclaimed water use;
- Water quality policies, environmental permits, endangered species impacts, environmental justice concerns or evolving regulations, especially as they relate to the development of new water supply sources;
- Legislative and/or regulatory actions regarding competing water uses; and
- Declining source yields due to issues such as hydrologic variability (from climate and/or land use impacts), faster than assumed sedimentation of reservoirs or changes in required downstream releases.

What are the Partnership's Next Steps?

Consistent with the TRWSP and Table 1, those Partners who use or plan to use Jordan Lake submitted draft allocation requests to DWR on May 1, 2014; final applications will be submitted later in 2014 and the JLP will continue to coordinate with DWR on the allocation process and development of the Cape Fear Basin Water Supply Plan.

The Partners are developing a regional water distribution system computer model that will be used to evaluate system interconnection capacities and performance under different demand scenarios, with the goal of identifying joint projects to increase reliability for all customers and optimize water supplies during times of water shortage.

Several of the Partners have begun planning for the design and development of a new intake, water treatment plant and transmission facilities on the western side of Jordan Lake. Working together to build new infrastructure minimizes environmental impacts, and decreases both capital and operational costs due to economies of scale. A new intake and treatment plant at Jordan Lake, along with major interconnections between systems, would also provide redundancy in the event the existing Cary-Apex intake had to be taken offline for any reason.

The Partners will continue to work together toward successful implementation of the TRWSP, and to look for areas where they can improve the region's ability to address water supply needs and effectively prepare for and respond to water shortage conditions through cooperation and preparation.

This page intentionally left blank.

Table of Contents

SECTION I. Purpose 1
Background of the Jordan Lake Partnership 1
Jordan Lake as a Water Supply Source 2
Purpose 3
Principles for Collaborative Regional Water Supply Planning 3
Guide to the Report 4
SECTION II. Commitment to Sustainable Water Resources Management 6
Evolving toward a Collaborative, Area-wide Water Planning Paradigm 6
Water Efficiency Trends in the Nation, State, and Region 8
Efficiency, Conservation and Demand Management 9
Conservation and Efficiency in the Regional Demand Projections 14
SECTION III. Review of Volume I – Regional Needs Assessment 17
Summary of Regional Needs Assessment 17
Notable Changes from Volume I 21
SECTION IV. Regional Water Assets 26
Current Water Supplies in the region 26
Water Supply Infrastructure 27
Inter-utility Agreements and Planning 31
SECTION V. Framework for Analysis and Decision Process 32
Solicitation of Source Options 32
Frameworks 32
Collections of Sources 33
Water Supply Alternatives 34
Analysis and Decision Process 35
Hydrologic Modeling and Impact Analysis 36
Implementing the Plan 37
SECTION VI. Supply Source Options 38
Summary of Options Identified 38
Other Source Options 45
SECTION VII. Alternative Screening and Selection 46
Collections of Sources Considered 46

Initial Screening and Rating 51
SECTION VIII. Development of Preferred Alternative Scenarios 52
Descriptions of the Alternatives 53
Comparing the Alternatives 56
Comparing Impacts for the Alternatives 58
Summary of Alternative Development 62
SECTION IX. Impact Analysis and Modeling 63
Scenarios with the Cape Fear – Neuse River Basin OASIS Model 63
Preparation of JLP Data 64
Development of JLP Scenarios for Modeling 64
Caveats for Model Scenarios 66
Key Metrics for Analysis of Modeling Results 67
SECTION X. Other Considerations 77
Uncertainty in Growth Projections 77
Water Quality Issues and Regulations 78
Competing Uses 79
Declining Yields 80
Interbasin transfers 80
Permitting Issues 81
Hydrology and Climate Variability 81
Emergency Scenarios 82
SECTION XI. Important Findings 85
Peer-Review Improves Projections and Leads to Better Choices 85
Some Source Options are Obvious Choices 85
Meeting Raleigh's Need through its Preferred Sources Benefits the Region 86
SECTION XII. Recommended Water Supply Alternative 88
Description of Preferred Alternative 88
Detailed Composition, Evaluation, and Implementation of the Alternative 88
Impacts and Benefits 95
Summary of Alternative by Partner 97
SECTION XIII. References 113

List of Tables

Table 1. Projected Population Served in JLP water service areas. 18
Table 2. JLP Average Daily Raw Water Demand Projections (MGD), 2010 – 2060. 19
Table 3. Projected Water Needs (MGD) for the JLP water systems, 2010 – 2060. 20
Table 4. Revised Raleigh and Merger Partners demand projections, 2010-2060. 22
Table 5. Revised Town of Pittsboro Demand Projections (MGD), 2010 -2060 24
Table 6. Revised Durham Demand Projections (MGD) by sector. 24
Table 7. Average Day Available Supply (MGD) from Partners' existing water supply sources 27
Table 8. Regional Water Assets - Water Treatment Plants used by the Jordan Lake Partnership 28
Table 9. Reservoir Source Options Considered by JLP members. 41
Table 10. Run-of-River Source Options Considered by JLP members 42
Table 11. Quarry Source Options Considered by JLP members. 43
Table 12. Other Source Options Considered by JLP members. 44
Table 13. Collections of Sources Investigated Under Frameworks A-F. 47
Table 14. Primary source option descriptions (with color coding by source type) for reference with Table 15. 49
Table 15. Sources selected for collections of sources under initial consideration. Partner selections at top of table refer to activated sources in lower part 50
Table 16. Collections of Sources initial screening table. 51
Table 17. Differences in source selection and usage between alternatives A1, D3, and F5. 57
Table 18. Anticipated Jordan Lake Allocation by partner for each alternative A1, D3, and F5. 58
Table 19. Relative impact and complexities of the A1, D3, and F5 alternatives 58
Table 20. Minimum storage (% of usable storage) for key reservoirs and allocations, period of record (1930-2011). Color coding indicates year of minimum. 69
Table 21. Haw/Cape Fear locations of interest for flow changes. 75
Table 22. Neuse River locations of interest for flow changes. 75
Table 23. Supply source options with high likelihood of implementation. 86
Table 24. Preferred Alternative (A1) source selection detail by Partner. 89
Table 25. Current Jordan Lake allocations and projected allocation requests (1% ≈ 1 MGD). 92
Table 26. Town of Apex source selections under JLP preferred regional alternative. 98
Table 27. Town of Cary source selections under JLP preferred regional alternative. 99
Table 28. Town of Morrisville source selections under JLP preferred regional alternative. 100
Table 29. Wake County – RTP South source selections under JLP preferred regional alternative 101
Table 30. Chatham County N source selections under JLP preferred regional alternative. 102
Table 31. City of Durham source selections under JLP preferred regional alternative. 103
Table 32. Town of Hillsborough source selections under JLP preferred regional alternative. 104
Table 33. Town of Holly Springs source selections under JLP preferred regional alternative. 105
Table 34. Orange County source selections under JLP preferred regional alternative. 107
Table 35. OWASA source selections under JLP preferred regional alternative. 108
Table 36. Town of Pittsboro source selections under JLP preferred regional alternative 109
Table 37. Raleigh and Merger Partners source selections under JLP preferred regional alternative. 111

Table 38. City of Sanford source selections under JLP preferred regional alternative. 112

List of Figures

Figure 1. Water use per connection, NC's ten largest public water systems. (DWR, 2012) 8
Figure 2. Monthly residential water use at 217 NC water systems 1997-2010. (EFC, 2012) 8
Figure 3. JLP Regional Demand Projections with combined reductions from initial estimates shown. 15
Figure 4. Projected regional per capita demand decreases through the planning period. 16
Figure 5. Future (2060) water service areas for JLP members. 17
Figure 6. Projected Regional Demand relative to current supply, 2010 - 2060. 20
Figure 7. Projected surplus and deficit (MGD) for the JLP members 2010-2060. 21
Figure 8. Map of interconnection relationships between the Jordan Lake Partners. 29
Figure 9. Inter-utility water supply agreements. Red arrows on a yellow background indicate emergency connections, and white arrows on a blue background indicate a contract for regular supply. Arrow direction indicates flow from the provider to the recipient. 31
Figure 10. Each collection of sources (represented by a rectangle) under different frameworks ("A", "B", and "C") contains a slightly different combination of sources to meet the need. 34
Figure 11. Decision process used for identifying, analyzing, and selecting a preferred regional alternative. 36
Figure 12. Jordan Lake Water Supply Pool monthly minimum storage through the simulation period, by scenario. 70
Figure 13. Jordan Lake Water Quality Pool monthly minimum storage through the simulation period, by scenario. 70
Figure 14. Jordan Lake Water Supply (WS) Pool storage percent full versus portion of time below storage indicated. In the right plot, the horizontal axis is logarithmically transformed to show the lowest storage more clearly. 71
Figure 15. Jordan Lake Water Quality (WQ) Pool storage percent full versus portion of time below storage indicated. In the right plot, the horizontal axis is logarithmically transformed to show the lowest storage more clearly. 71
Figure 16. Jordan Lake elevation percentiles (monthly minimum): 50 percent (50pct) 10 percent (10pct), and overall minimum (min). 72
Figure 17. Falls Lake Water Supply Pool monthly minimum storage through the simulation period, by scenario. Note that the storage volume in 2045 and 2060 is increased to account for the potential future reallocation of Falls Lake. 73
Figure 18. Falls Lake Water Quality Pool monthly minimum storage through the simulation period, by scenario. 73
Figure 19. Falls Lake WS Pool storage percent full versus portion of time below storage indicated. In the right plot, the horizontal axis is logarithmically transformed to show lowest storage more clearly. 74
Figure 20. Falls Lake WQ Pool storage percent full versus portion of time below storage indicated. In the right plot, the horizontal axis is logarithmically transformed to show lowest storage more clearly. 74

Figure 21. Cumulative new supply implementation timeline. Individual sources are stacked, with some showing expansions. More transparent shading at the left of a source 'bar' indicates construction and preparation time to bring that source online. 90
Figure 22. Surplus by partner in five year increments for the recommended alternative. 91
Figure 23. Summary of projected Jordan Lake allocation requests by the JLP members. 92
Figure 24. Town of Apex - demands, current supply, and source implementation timeline. 98
Figure 25. Town of Cary - demands, current supply, and source implementation timeline. 99
Figure 26. Town of Morrisville - demands, current supply, and source implementation timeline. 100
Figure 27. Wake County- RTP South – demands and current supply. 101
Figure 28. Chatham County North - demands, current supply, and source implementation timeline. ... 102
Figure 29. City of Durham demands, current supply, and source implementation timeline. 103
Figure 30. Town of Hillsborough - demands, current supply, and source implementation timeline. 104
Figure 31. Town of Holly Springs - demands, current supply, and source implementation timeline. 106
Figure 32. Orange County - demands, current supply, and source implementation timeline. 107
Figure 33. OWASA demands, current supply, and source implementation timeline. 109
Figure 34. Town of Pittsboro - demands, current supply, and source implementation timeline. 110
Figure 35. Raleigh and Merger Partners - demands, current supply, and source implementation timeline. 111
Figure 36. City of Sanford - demands, current supply, and source implementation timeline. 112

APPENDICES

APPENDIX A – Demand Projections by Sector

APPENDIX B – Water Efficiency, Conservation and Demand Management Summaries by Partner

APPENDIX C –Source Information

APPENDIX D –Alternatives Summaries

APPENDIX E – OASIS Inputs

APPENDIX F – Cape Fear-Neuse OASIS Model Results

ABBREVIATIONS

CORPUD	City of Raleigh Public Utilities Department
DENR	Department of Environment and Natural Resources
DWR	Division of Water Resources
EMC	Environmental Management Commission
JLP	Jordan Lake Partnership
OWASA	Orange Water and Sewer Authority
RTP	Research Triangle Park
TJCOG	Triangle J Council of Governments
TRWSP	Triangle Regional Water Supply Plan
USACE	United States Army Corps of Engineers
cfs	cubic feet per second
EDD	economic development district
ETJ	extraterritorial jurisdiction
gpd	gallons per day
gpdc	gallons per day capita per capita
MGD	million gallons per capita
RCW	reclaimed water
USA	urban service area
WTP	water treatment plant
WWTP/WRF	wastewater treatment plant/ water reclamation facility

SECTION I. Purpose

Background of the Jordan Lake Partnership

The Jordan Lake Partnership (JLP) was created in 2009 by local jurisdictions and water systems in the Triangle Region to jointly plan for sustainable and secure water supplies for the Region.

A total of 13 local governments and public bodies have joined the Jordan Lake Partnership. Membership in the Partnership is voluntary, and the Partnership's activities are solely funded by the Partnership members through a cost-sharing agreement. The City of Durham is the Lead Agency and acts as the fiscal and contracting agent for the partnership. The Jordan Lake Partnership Members include:

- Town of Apex
- Town of Cary
- Chatham County (for the Chatham County North water service area)
- City of Durham
- Town of Hillsborough
- Town of Holly Springs
- Town of Morrisville
- Orange County
- Orange Water and Sewer Authority (OWASA)
- Town of Pittsboro
- City of Raleigh
- City of Sanford
- Wake County (for the RTP South service area)

The need to evaluate water supply planning and demand on a regional basis was accelerated by two historic droughts experienced in the Region and throughout the Southeast between 2001 and 2008. The Partnership is committed to working collaboratively to enhance the sustainability and security of the Region's water supply resources through optimization of existing resources, conservation and efficiency, interconnections, and coordinated planning and development. The Partnership demonstrates that local governments can work together in a cooperative fashion – within the Region, with constituent organizations, with upstream and downstream jurisdictions, and with regulators – to create environmentally sustainable, secure and mutually beneficial water supply strategies for the Triangle Region.

Members of the Partnership are committed to sustainable management of water resources and have implemented numerous water efficiency and water conservation measures within their service areas including tiered water pricing, year-round conservation measures and a regionally-consistent drought/water shortage response framework. Building on the already robust regional efforts to coordinate water efficiency/conservation measures and water resources planning, the Jordan Lake Partnership serves as a forum to share information. The Partnership coordinates information from members that is being used in regional planning for secure water supplies and compiles common information from local governments and water systems, such as water conservation and efficiency measures, expected growth in water utility service areas and anticipated future water supply demands.

The Partnership receives administrative and technical support from FountainWorks, LLC and Triangle J Council of Governments (TJCOG). FountainWorks, LLC is a market research and policy consulting firm and provides collaboration, communication, and administrative support for the Partnership by convening meetings of the Partnership members, facilitating discussions with the State of North Carolina, and coordinating communication with governmental contacts, regulators, organizations and stakeholders beyond the Partnership who are interested in regional water supply issues. Triangle J Council of Governments is a public organization serving municipal and county governments in the seven-county Region J area of North Carolina that includes Johnston, Wake, Durham, Orange, Chatham, Lee, and Moore Counties. TJCOG has been contracted by the Jordan Lake Partnership to provide technical support and coordination to develop the *Triangle Regional Water Supply Plan* (this report).

Jordan Lake as a Water Supply Source

As the name implies, the Jordan Lake Partnership has a strong interest in Jordan Lake for water supply planning. B. Everett Jordan Dam and Reservoir (known as Jordan Lake) was authorized for construction by Congress in 1963, and construction began in 1967 under the management of the U.S. Army Corps Engineers (USACE), Wilmington District. Construction was completed in 1981, and the lake reached its normal pool elevation of 216 feet in 1982. The lake covers nearly 14,000 acres at normal pool, and has 215,130 acre-feet of storage. Of that storage amount, 45,800 acre-feet (or about 21%) is allocated to the water supply pool. Given average inflows to the lake, this storage volume is conservatively estimated to have a yield of 100 million gallons per day (MGD).

"The State of North Carolina has authority to assign the entire available water supply storage volume in Jordan Lake. This storage is assigned to any local government that needs water supply." http://www.ncwater.org/Data_and_Modeling/Cape_Fear_River_Basin_Model/oldmodel/project1.htm Allocation decisions are made by the NC Environmental Management Commission (EMC) with the support of the NC Department of Environment and Natural Resources (NCDENR) Division of Water Resources (DWR). In the three previous rounds of Jordan Lake water supply allocations, a little less than two-thirds of the available water supply pool was allocated, and about half of the allocated portion is currently being used. Based on their future water supply needs as reported herein, some members of the Partnership will make individual requests to the State of North Carolina for an allocation of a portion of remaining water supply storage in Jordan Lake.

In November 2009, the Partnership requested that DWR and the EMC initiate the Jordan Lake water allocation process, and in January 2010, the EMC formally initiated the process for a fourth round of allocations. DWR issued application guidance and an allocation timeline that includes making draft allocation requests in May 2014.

The Partnership is not preparing water allocation applications for Partnership members or making policy recommendations, but serves as a forum to collaboratively develop information, communicate with interested parties, and inform members.

In addition to potential Jordan Lake allocation requests, some Partnership members may explore opportunities to jointly share in the costs and development of facilities to access the Jordan Lake water supply, such as an intake on the western side of the lake. Furthermore, the Partnership is conducting an interconnection study to determine the engineering capacity of water systems within the Region to move water among and between the individual systems. The ability to move water between interconnected systems greatly improves resiliency to drought or other emergency situations and

improves the security and reliability of the Region as a whole to meet the current and future water supply needs of its residents, businesses, and institutions. The Partnership may continue to serve as a forum for water resources planning and management coordination in the future.

Purpose

The purpose of the *Triangle Regional Water Supply Plan* is to support efforts to provide for long-term, sustainable and reliable water supplies for the communities in the Region.

The goals of this regional water supply planning effort are to:

1. identify the future service areas of the Region's water systems,
2. determine and verify the future water supply demand projections provided by the systems,
3. examine current water supply sources and estimated yields,
4. identify future water supply needs, and
5. present a collaborative strategy for meeting those future regional needs.

The Triangle Regional Water Supply Plan (TRWSP) is divided into two volumes. *Volume I: Regional Needs Assessment* addressed the first four goals above and presented the projected future water supply needs for each water system and for the Region as a whole. This document, *Volume II: Regional Water Supply Alternatives Analysis*, addresses the last goal and presents potential options for meeting the future water supply needs.

This two-volume TRWSP, the first document of its kind for the Triangle Region, is a long-range, 50-year cooperative water supply plan at a regional scale. This plan was prepared by TJCOG for the Jordan Lake Partnership and relies in large part on data provided by Partnership members. The focus of this document is on average daily demand and supply of raw, untreated source water. Where applicable, relevant treatment capacity, interconnection capacity, and other values are noted for informational purposes. This document is not intended to replace the Cape Fear Basin or Neuse River Basin Water Supply Plans developed by DWR, but rather to support those plans by providing a focused analysis of the systems in the Triangle Region.

Principles for Collaborative Regional Water Supply Planning

The Jordan Lake Partnership is committed to working together in a way that meets the water supply needs of individual partners and is in the best interests of the Region, both today and in the future, without compromising the abilities of downstream communities to meet their own water supply needs.

The JLP has a collaborative vision for the future of water supply in the region. Several key principles guide the process.

Mutual support: The JLP members are participating in this process to ensure a secure water supply for the Region, including each individual member. Therefore, by participating in this partnership, each partner agrees to support other partners' individual plans for water resources development. The selected regional alternatives should have support from all partners. If one component of any plan is not acceptable to all partners, the plan needs to be modified.

Transparency and Mutual Accountability: The JLP's process of peer-reviewing each other's projections and proposed water supply alternatives ensures a level of transparency. The presentation of projections, supporting information, and assumptions allows other partners to evaluate the quality of the information and flag potential issues. This leads to a two-way accountability; each partner is responsible for presenting information to other partners accurately and completely, and each partner must be willing to respond to concerns and suggestions raised by the other partners. Conversely, each partner is accountable to every other partner in the review process, during which each must ask questions and flag potential issues.

Collaboration and Openness to new ideas: The Partnership members have agreed to collaborate on this regional water supply plan and that includes each listening to ideas brought by other Partnership members. For the sake of expanding the range of potential regional water supply planning options, the members of the JLP must be open to ideas that are outside of their current individual planning boundaries.

Data-driven decision making: The Partnership members are committed to using the best available data and tools to evaluate potential water supply options. In many cases, this requires compiling data from disparate sources into a consistent (or at least relatable) form so that options can be compared on a level footing. In many cases, it is necessary to withhold judgment on an alternative until the metrics showing how it compares to other alternatives can be assembled. This insistence on high data standards and using the best tools available (such as an updated Cape Fear-Neuse OASIS hydrologic model) can at times slow the decision making process, but should ultimately lead to better decisions.

Sustained commitment: The JLP members realize that actually implementing these water supply plans will require sustained commitment. The Partnership members will continue to support one another as they implement individual components of the water supply plan.

Guide to the Report

This report, along with Volume I, presents a plan to meet the water supply needs of the Triangle Region over the next 50 years. Additionally, this report documents *how* the plan was developed and refined through a collaborative, peer-reviewing process. The sections of this report cover a range of important topics as described briefly below:

Section I: Purpose introduces the JLP, its background, purpose, and core principles.

Section II: Commitment to Sustainable Water Resources Management describes how each of the JLP water systems has committed to efficient water use and how this regional commitment is reflected in the regional water demand projections.

Section III: Review of Volume I – Regional Needs Assessment presents and updates the key findings from Volume I of the TRWSP; the regional water demand projections, existing supply, and future regional needs. This section also presents changes from the information presented in Volume I for individual Partnership systems.

Section IV: Regional Water Assets summarizes the current water supplies and infrastructure of the water systems that make up the Jordan Lake Partnership. This section summarizes the many components of water storage, treatment and distribution infrastructure that form the foundation for current and future water supply delivery, along with less tangible assets such as agreements and contracts between partners and neighboring systems.

Section V: Framework for Analysis and Decision Process outlines the methodology used to generate, analyze, and decide on regional water supply alternatives.

Section VI: Supply Source Options introduces the water supply sources that were identified by the Partnership members. A fuller listing of all of the supply sources advanced by the Partners can be found Appendix C.

Section VII: Alternative Selection and Screening summarizes the wide range of collections of sources that were considered for development into alternatives, and how they were screened to focus on a more limited set of alternatives.

Section VIII: Development of Preferred Alternative Scenarios describes the most viable potential alternatives in more detail and how they differ with respect to key features, implementation, and impacts.

Section IX: Impact Analysis and Modeling outlines how the OASIS hydrologic model of the Neuse-Cape Fear basins was used to investigate the potential benefits and impacts of the preferred alternative.

Section X: Other Considerations documents issues that affect the regional water supply planning process and decision making but for various reasons (lack of specificity of impact, uncertainty, too early to assess) could not be explicitly factored into the planning process.

Section XI: Important Findings presents several key observations realized by the JLP members as they worked to develop this TRWSP.

Section XII: Recommended Water Supply Alternative presents the preferred regional water supply alternative recommended by the JLP, including source selections, infrastructure needed, and a preliminary implementation timeline.

SECTION II. Commitment to Sustainable Water Resources Management

The JLP members are committed to sustainable, long term management of the Region's water resources through both collaborative regional planning and promotion of efficiency within each water system. This commitment means both careful management of the systems' existing water use and infrastructure, and planning for even better efficiency and management in the future. Improved management depends in part on an evolution towards more regionally focused planning that can look at water resources more holistically. Over the past 30 years, national trends in increasing water efficiency have been mirrored in the Region, but over the past 10 years especially, the members of the JLP have made significant advances in water conservation through careful management and policy initiatives promoting efficiency among water customers.

This section of the report details how the water supply planning process is changing, and the progress achieved (nationwide, statewide, and locally) in improving water efficiency. Each partner's specific actions to promote water conservation and efficiency are summarized. (Appendix B contains a more complete documentation of each water system's conservation and efficiency actions, programs, plans, and achievements.) Finally, this section presents the regional impact of commitment to efficient, sustainable water use as manifested in the water demand projections.

Evolving toward a Collaborative, Area-wide Water Planning Paradigm

In the traditional method of water supply planning, individual water systems plan for their own water supply needs using their own independent planning process. In general, this process consists of projecting future water demands, determining future water need, identifying alternative water supply sources available for meeting the need, and then analyzing the alternatives based on criteria including feasibility, cost, impacts, legal and regulatory constraints, and other criteria as appropriate. Then, once an alternative is selected, the individual system develops a plan to finance, build and operate the water supply alternative.

In many ways, the core elements of this planning process remain intact, yet it is increasingly uncommon for a water system to complete this process independently. Several trends in the Triangle Region have led to the need for greater cooperation, collaboration, and coordination between water systems in the area. A mix of practical constraints have pushed systems to plan for water supplies with greater coordination from nearby systems, and a number of benefits of collaborative planning have made it more attractive. The rapid growth in the region over the past 30 years has created a more interdependent *regional* water paradigm by expanding individual water system service areas in closer proximity to one another, creating more opportunities for physical interconnections, while increased demand adds more stress on the existing water sources. In addition to growth, water system consolidation, as evidenced by the City of Raleigh Public Utilities Department's (CORPUD's) addition of six merger partners and Cary's addition of Morrisville and Wake County RTP South customers, has led to larger water systems. These larger systems' water supplies are likely more reliable on average, but the consequences of water supply failure or even temporary disruption become more dire as the systems grow and more customers are affected in the event of shortage. As a result, these larger systems have to depend on each other for emergency supply, and as such systems have more need to consider impacts on their neighbors during the planning process.

Furthermore, the hydrography of the region and the limited availability of potential water sources increase the importance of collaborative planning. This region is characterized by a number of fairly large lakes in the upper portion of watersheds, as well as many situations in which downstream flow from one water system's source directly influences the yield of other system's sources. Notably, the Upper Neuse River Basin reservoirs supplying Durham and Hillsborough have an effect on inflow to Falls Lake, the water supply for Raleigh and its six Merger Partners. In the Cape Fear River Basin, Jordan Lake is influenced by upstream withdrawals, and more importantly, it is used as a supply by several partners. Both Falls Lake and Jordan Lake have many downstream users that depend on the releases from the lakes for their water supplies. And of course, as Jordan Lake is already shared by multiple users subject to the DWR Jordan Lake Allocation process, it is difficult to plan for its use without some coordination. Finally, most new water source options in the region will withdraw surface water from either the Cape Fear or Neuse River basins, and will affect downstream water users. As a result, it is very important for water systems to work and plan together for new water sources in this region because systems are already somewhat operationally interdependent and any new source options will likely have a hydrologic impact on other water systems' sources.

The move to more collaborative regional planning is not only a necessary result of these interdependencies, as there are significant benefits to participating in a cooperative planning process. Transparency and peer review have already had a salutary effect on demand projections. While the demand projections retain some degree of system specific details, the Jordan Lake Partnership's Water Needs Assessment process helped to standardize the definitions of certain water use sectors, and set reasonable expectations for the magnitude of certain uses like flushing and water treatment process use. Transparency of demand projections allowed systems to compare their projections with other systems, and more importantly peer sharing and review of methodology helped the systems strengthen underlying assumptions, and improve the projections. Multiple rounds of review and refinement ultimately resulted in a nearly 10% reduction in projected regional water demands, but even more importantly, established more reliable and defensible projections on which to base the water supply alternative analysis.

Another major benefit of collaborative planning is that it expands the range of potential solutions to the regional water supply needs by allowing inclusion of water supply alternatives too large or too impractical for a single system to plan, or much less build. Already, this sort of regional planning has resulted in benefits related to water resources management in our Region. Namely, the Western Wake Water Reclamation Facility was developed as a regional solution by a partnership (the Western Wake Partners) of independent utilities and dischargers. (http://www.water-technology.net/projects/western-wake/)

Even if each partner were to ultimately build its own future source option independently, it is beneficial to examine larger solutions that an individual partner could not examine on its own. In many cases, the work performed to examine how a large source option built collaboratively between several partners could actually distribute water to several utilities can have ancillary benefits such as demonstrating opportunities for expanding interconnections between systems. Developing options that compel the utilities to examine how to meet water needs from a different, regional perspective can create a different lens with which to view the relative benefits and shortcomings of their existing options.

Water Efficiency Trends in the Nation, State, and Region

The Triangle Region has already undergone significant changes in the way it uses water. In part, the Region's water use reflects a national trend toward more efficient use of water.

According to USGS Circular 1344, *Estimated Use of Water in the United States in 2005*, total US water withdrawals peaked in 1980, total per capita water use peaked in 1975, and total per capita usage of public supply water peaked in 1990. While US population has continued to increase, water usage efficiency on a national scale has improved considerably over the last 30+ years. (USGS, 2009).

These national trends have been echoed in North Carolina, as water use efficiency, as measured by multiple different metrics has increased, especially in the past two decades. For instance, the North Carolina Division of Water Resources in its 2012 report to the Environmental Resources Commission, showed that not only has total use per connection (all customer types) decreased, but residential use per connection has declined considerably, and continues to decline gradually. Figure 1 shows the water use per connection at NC's ten largest water systems.

The same trends are repeated on a utility-wide basis in a larger sample. The Environmental Finance Center at the UNC School of Government conducted a study of 316,000 residential customers of 217 water utilities statewide, and found a similar trend, albeit with considerably more information about the nature of efficiency gains. (EFC, 2012) Figure 2 shows the range in average monthly residential use of these customers spread across 217 NC water systems from 1997 to 2010.

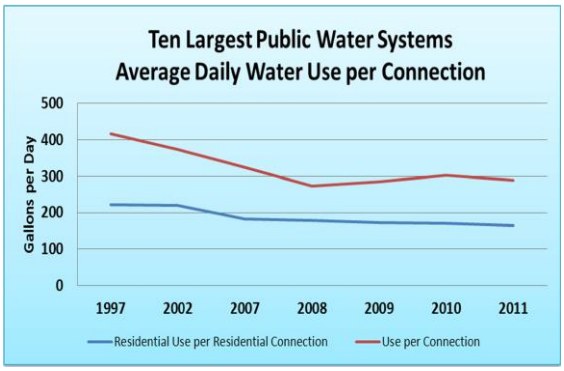


Figure 1. Water use per connection, NC's ten largest public water systems. (DWR, 2012)

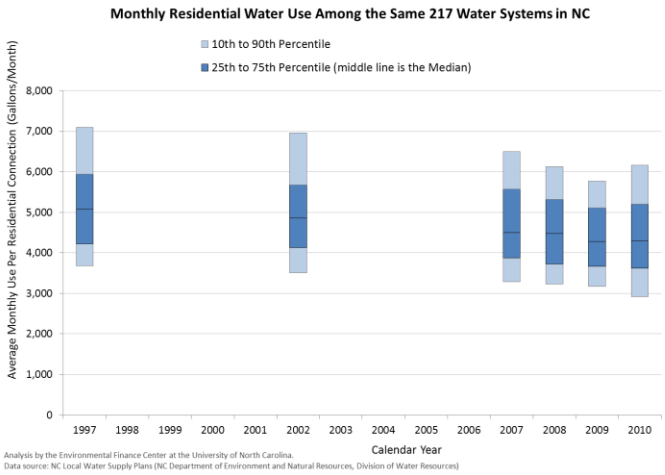


Figure 2. Monthly residential water use at 217 NC water systems 1997-2010. (EFC, 2012)

Notably, the gains in efficiency from 2007 – 2010 are not as linear as they may appear. About 66% of the households tracked reduced their water use from 2007-2010, but those reductions were not evenly distributed. Fully 21% of all water users reduced their usage by more than 20%. Between 10% and 15% of households actually cut their water use in half in the space of three years. National trends in water efficiency gains on the customer level can explain much of the shift in water efficiency, but are insufficient to account for the nature of the shifts in usage over the last several years.

While these national trends are mirrored in North Carolina for the period through the mid-2000s, recent trends have accelerated increases in water efficiency in North Carolina and the Triangle Region specifically. It is often assumed that the drought of 2007-2008, which affected much of the State,

bears primary responsibility for the shift in efficiency. Of course, hydrologic conditions alone cannot cause large changes in customer behavior. The utilities' response to the drought in the form of public communication and education, policy development, rate changes, and investments in infrastructure and programs drove changes in water use, and quite effectively. The increased efficiency realized during the drought did not 'evaporate' as the reservoirs refilled in large part because the water utilities continued, refined, and in most cases expanded their involvement in promoting water efficiency in their service areas.

Efficiency, Conservation and Demand Management

The water utilities in the Triangle Region have been active participants in driving the reductions in regional per capita water demands. Utilities have taken a range of approaches to managing their customer bases' water efficiency.

In most cases, a push for efficiency has started at the utilities themselves through investments in better tracking water within their systems, and programs and investments to enhance "in-house" efficiency (at the water plant, in the distribution system, and for municipal uses).

The drought of 2007-2008 was an effective driver of both short term and long term changes in water policy and rates, and correspondingly, water demand.

The policies and strategies enacted by water utilities in the Jordan Lake Partnership are widely varied, and are worth noting. Due to differences in the sizes of the water systems and by extension, resources available, the actions taken related to conservation and efficiency and future planned programs vary considerably. A brief summary of each utility's current and planned actions related to efficiency and conservation follow, along with expectations for how these actions affect future usage patterns in principle and the Partners' water demand projections specifically.

Town of Apex

The Town of Apex is committed to continuing its efforts to ensure efficient water use, limited non-revenue water, and rigorous water accounting. Most of the Town's residential homes (and corresponding water lines and meters) have been built since 2000 and include water efficient fixtures, helping to achieve low residential water use rates. The Town's water utility staff performs an annual water audit, tracking bulk water sales, non-metered construction water, metered non-billed water and in-house use for activities like street sweeping and water quality flushing. Through this process, Apex is able to account for 97% of its water use and just 3% is unaccounted for. Throughout its distribution system, finished water provided by the joint Cary-Apex Water Treatment Plan is used efficiently and non-revenue water is held to just 7.8% of its raw water demand, excluding water treatment plant process water. The Town of Apex was a core participant in developing regionally-consistent year-round water efficiency and water conservation measures following the 2007-2008 drought, and was one of the first towns to adopt those measures. The Town is committed to continuing to use water efficiently in the future and conducting annual water audits to track water use.

Towns of Cary, Morrisville, and the Wake County RTP-South Service Area

The Town of Cary water system, which includes the Town of Morrisville and Wake County – RTP South, has one of the oldest and most comprehensive water conservation programs in North Carolina. The program includes three primary elements – education and public information, financial incentives, and regulations. Additional components of the Town's strategy include a reclaimed water system,

annual water audits and advanced metering infrastructure. Within the past three years, the Town has replaced all 63,000+ water meters with advanced, fixed-based meters capable of transmitting water use data in 1-hour intervals. With its suite of water conservation, efficiency and demand management programs as a primary driver, Cary residential users have achieved a 24% decrease in per capita water use between 1996 and 2011, and a 20% decrease in total per capita water use over the same period. All water uses are tracked and audited annually and unmetered, nonrevenue water has ranged between 2% and 6% over the past five years (some of that water was used for flushing and some of that water was lost from the distribution system).

Cary's water conservation education program includes two key outreach campaigns (Fix a Leak Week and Beat the Peak) as well as a block leader program, residential and irrigation audits, a dedicated website and festival booths). Financial incentives include, or have included, a tiered rate structure, high efficiency toilet rebates, a turf buy-back program, at-cost rain barrels and free giveaways. Regulations include ordinances related to water waste, rain sensors, alternate-day watering and land development as well as requirements for irrigation system design and separate irrigation meters. The Town regularly evaluates its water conservation program effectiveness and perceptions and is committed to making continual improvements. Additionally, the Town is expanding its reclaimed water system to help reduce peak water use.

Chatham County – North water system

The Chatham County – North water system uses a proportionally high percentage of non-revenue water because of its geographically spread-out system and high treatment plant process water requirements. However, the County has decreased its water treatment process water and has the further potential to significantly reduce its non-revenue water in future years. The Chatham County – North water system is geographically large with a relatively sparse density of connections. As a result, a significant amount of water is required for water quality flushing to manage disinfection byproducts. As customer density increases in the future, the need for flushing will decrease. Also, the County is adding disinfection injection to more precisely manage disinfectant concentrations and further reduce the need for flushing. The County has recently implemented improvements to the treatment plant backwash system, which has resulted in significant water savings. Additionally, the percentage of water treatment plant process water is expected to decrease in the future as a new western intake and treatment plant is built with the latest efficiencies and as the fixed portion of treatment plant process water decreases proportionally as volume increases.

Chatham County also works to improve demand side efficiency through conservation policies and programs. In 2008, Chatham County passed one of the most aggressive water conservation ordinances in the region. In Chatham County, lawn irrigation is limited to only 2 days/week with a maximum total application rate of 1 inch per week. This is coupled with a steeply tiered water rate that is designed to encourage water conservation. The Chatham County – North water system is committed to further reducing its non-revenue water and continuing to improve water use efficiencies, loss detection and water tracking as well as water conservation outreach to its customers. The commitment to more efficient use of water is incorporated into the system's future water demand projections.

City of Durham

City of Durham water customers used 12% less water in 2012 than in 1999, despite a 20% increase in total customer accounts during that same period. This trend was encouraged and reinforced by a number of demand management and conservation programs by the City. Since 2008, the City has replaced conventional water meters with automated meter reading technology coupled with data

loggers to track usage through time, which has facilitated more rapid and accurate leak detection. In 2008, the City implemented a tiered water rate structure and has recorded a significant reduction in water use, with the highest tier consumption class dropping from 16.1% of single family residences in 2008 to just 2.7% in 2012. The City offers a high-efficiency toilet rebate program that provided incentives for replacing nearly 5,100 conventional toilets, resulting in approximately 22 million gallons per year of reduced water use. Durham has also developed an aggressive conservation communications campaign that integrated traditional media (TV, radio, print, and online), direct marketing, public relations, cross promotions, and social networking; and a water conservation ordinance that includes an alternate day watering schedule that has significantly reduced daily demand spikes during peak seasonal periods. To ensure compliance, staff is deployed daily during times of peak irrigation. A unique service that Durham provides to residential and small commercial customers is water use assessments to help determine the sources of any leaks, along with one-on-one advice regarding the array of opportunities to reduce water use and promote water efficient behaviors. Finally, the City provides bulk reclaimed water at one of its wastewater treatment plants and plans to expand this to its second treatment plant. Durham also plans to begin a reclaimed master planning process to develop a more robust reclaimed water system. The City of Durham is committed to maintaining and increasing the efficiency gains achieved over the past several years.

Town of Hillsborough

The Town of Hillsborough's conservation and demand management program focuses on reducing non-revenue water, maintaining low per capita use rate, encouraging conservation and efficiency, tracking water use, and detecting and fixing leaks. The Town performs an annual water audit, which has helped reduce unaccounted-for water from a high of 24% in 1998 to just 6.5% in 2012. Hillsborough had their entire water system examined by a consultant in the early 2000's with acoustical leak detection to identify leaks, and made repairs accordingly. This work, as well as periodic strategic acoustic leak detection by NC Rural Water Association has reduced their non-revenue water percentage tremendously. The Town does not have water conservation pricing, although their regular water rates are among the highest in the Triangle, which has kept their total water usage flat over the last 10 years, despite a growing customer base. The Town has a water conservation ordinance, which includes an alternate-day watering schedule. Additionally, Hillsborough offers small rebates for customers installing water-efficient fixtures and has no-cost water conservation kits available its customers that include a low flow shower hear, bath and kitchen sink aerators, and toilet water saver. Hillsborough is committed to continuing to use water efficiently in the future and maintaining the current average residential use of only 110 gallons per day (gpd) per residential connection. Through continued emphasis on finding leaks in their system and minimizing waste, Hillsborough projects to keep their unaccounted-for water levels below 10%.

Town of Holly Springs

The Town of Holly Springs is committed to using its water efficiently and reducing potable water use through a multi-pronged approach. The approach includes water loss reduction measures, a reuse water system, an increasing-block water rate structure, and a water conservation program. Following a 2006 study, the Town took aggressive measures to reduce unaccounted-for water by metering all known non-revenue water uses and enhancing its water loss detection program. In 2009, the Town of Holly Springs installed a reuse water system to reduce its potable water demand while at the same time reducing its wastewater discharge volume. Through the reuse system, the town offsets 12% of its average day potable water demands and provides process and cooling water for industrial use and outdoor irrigation water for commercial, residential and golf course use. The system serves nearly 300

customers with plans to expand in the future. In 2011, Holly Springs instituted a water conservation program that includes regulations and fines for wasting water and a voluntary alternate-day watering schedule. In times of water shortage, water restrictions become mandatory. Finally, the Town has an increasing block rate water billing structure designed to encourage water conservation. The Town also requires separate water irrigation meters and potable water for irrigation is billed at the highest rate. Reuse water for irrigation is dramatically less expensive, encouraging reuse water for outdoor use. In the future, Holly Springs intends to expand its reuse water system and continue to reduce its water loss.

Orange County

Orange County has had a long standing commitment to protecting area water supplies. Orange County was the first County in North Carolina to institute water supply watershed protection measures and has continued to refine and implement measures to protect and conserve water supplies. Furthermore, the County is highly committed to increasingly efficient water in the future. The County's water demand projections include decreasing per capita water through time, from 70 gallons per person in 2010 down to 58 gallons per person in 2065. While Orange County does not presently operate a water system, three targeted Economic Development Districts (EDD) will need water in the future and the County intends to work with the City of Mebane, the Town of Hillsborough and the City of Durham to provide water. The County benefit from the water efficiency, conservation and demand management measures of these cooperating systems. Additionally, the County will install new water distribution lines to serve these areas. In 2007, the County adopted a resolution to encourage all County citizens to conserve water and to support water conservation restrictions by those water systems operating in the county. In addition, County staff have conducted water conservation and watershed protection education programs for several years. Orange County has continually factored water-minded decisions into its land use planning process. This includes focusing growth into strategic areas near existing transportation infrastructure and consistently targeting potential development with low to moderate water needs. Recognizing that there is a limited supply of water since the County is situated in headwaters, the County is committed to balancing economic growth and efficient water use in the future.

Orange Water and Sewer Authority

OWASA, serving the Towns of Chapel Hill and Carrboro, is committed to efficient water use. While they do not have the jurisdiction to enact ordinances, OWASA worked with the Towns of Chapel Hill and Carrboro and Orange County as early as the 1970's to enact water conservation ordinances and has itself adopted water conservation standards that mimic the conditions of the ordinances and are a condition for receiving OWASA service. OWASA also has a water conservation rate structure, a public education program, a reclaimed water system, and internal utility management measures that together have resulted in a 28% reduction in water used between 2002 and 2012. In fact, average day water use in 2012 was at the same level as 1992, despite 60% more accounts over the same period.

In 2002 and 2007, OWASA enacted a water rate structure to incentivize conservation among commercial and residential customers. The commercial rate structure includes a seasonal block rate, whereby the price per 1,000 gallons in May-September (peak season) is nearly double the rate of water in the off-season, strongly incentivizing water conservation when inflows are lowest and daily demands are the highest. Residential rates follow an increasing block rate structure, whereby the price per 1,000 gallons increases as more water is used. The highest block is about 7.5 times more expensive than the lowest block.

In 2009, OWASA began operation of a reclaimed water system to provide non-potable water for use at the University of North Carolina – Chapel Hill. The system provides cooling water for power generation, irrigation for athletic fields and toilet flushing water in a few new buildings.

OWASA has also instituted several internal efficiencies to reduce raw water use. They recycle process water at the water treatment plant, maintain an aggressive leak detection program, and perform water audits using AWWA software. As noted earlier, OWASA has seen dramatic results from its water conservation, efficiency and demand management programs. In the future, OWASA plans to continue its current strategies and will look for opportunities to expand its reclaimed water system. Finally, OWASA has planned for further efficiency gains from its customer base; therefore, water demand projections assume 15% less water use per account from existing customers by 2060 compared to 2010.

Town of Pittsboro

The Town of Pittsboro is in the midst of planning for major system upgrades and modernization. Historically, Pittsboro has operated a small water system with a very limited budget for staff support for conservation and demand management programs. Partly as a result of the JLP's planning efforts, Pittsboro has upgraded its billing software, and has performed its first water audit. In 2010, the Town installed a reclaimed water system, which provides water to a single industrial customer. Within the first 7 months, the system provided over 157 million gallons of reclaimed water. The Town has an increasing block rate structure that encourages conservation, and in 2007, Pittsboro instituted a voluntary water conservation program encouraging alternate day irrigation, and water efficient fixtures. Pittsboro is currently planning for rapid growth in its ETJ, which will necessitate expanding its water treatment plant, and modernizing its water supply infrastructure, a process that offers an opportunity to aggressively target leakage and unbilled use. As part of the future growth, the plan calls for extensive use of reclaimed water, increased efficiencies and conservation policies.

City of Raleigh – Public Utilities Department

The City of Raleigh has a water conservation ordinance, an education program, a toilet rebate program, increasing block rate structure, aggressive leak detection, annual water audits and a reclaimed water system. These programs have contributed to a decreased per capita water use; average day water use in 2012 was about the same as 2006, despite an increased service area population of approximately 56,000 over the same time period. The City performs an annual water audit using the AWWA software, and also requires large water users (over 100,000 gpd) to perform water audits. The City's conservation ordinance includes residential year-round water conservation measures as well as commercial practices for food service and hospitality customers. The ordinance also specifies water use restriction during times of shortage, and in 2001, the City updated the triggers for water restrictions based on detailed OASIS modeling of the system's water supplies. The City's education program is coupled with a toilet rebate that provides $100 rebate for installing water sense-labeled toilets. In 2010, Raleigh instituted an increasing block rate structure and requirement for all new irrigation systems to have a separate meter, billed at the highest block rate. Raleigh also has a leak detection program, and makes their acoustic leak detection equipment and trained personnel available to other water systems. The City has a reclaimed water system serving 27 connections for irrigation and cooling water. The City is updating its Reuse Master Plan and has initiated conversations with NC State University to provide reclaimed water for non-potable needs. The City is also seeking approval to conduct a pilot test for indirect potable reuse, which could augment the City's future water supplies. Raleigh is committed to maintaining its existing water conservation programs,

exploring how it can expand its reclaimed water system, and installing a water recycling system at the D.E. Benton Water Treatment Plant to recycle process water. The City will also implement future pricing increases, building toward a full cost accounting model, and has factored additional residential efficiencies into its future water demand projections.

City of Sanford

The City of Sanford has a very large distribution system that requires significant distribution process water for flushing to maintain water quality. The primary area where Sanford is targeting water conservation and efficiency gains is in managing non-revenue water. The geographic extent of the City's distribution system will not change much in the future as it already spans most of Lee County, but many additional connections will be added as infill. Through careful management of the distribution system, and careful hydraulic design of additional pipes added to the system, Sanford intends to keep the flushing usage roughly constant, thereby decreasing the percentage of total distribution system process water over time. New water pipes will also be less prone to leaks. Furthermore, Sanford will have to expand its treatment plant, and it is expected that after the upgrades the WTP will be able to use less water (percentage-wise) for process usage.

Conservation and Efficiency in the Regional Demand Projections

The programs, strategies, and policies used by the JLP water systems to promote conservation and efficiency will continue to evolve. On the whole, the JLP water demand projections assume continued increases in efficiency and better system management. The JLP peer review process encouraged systems to reevaluate their own assumptions in light of assumptions used by other JLP members. The peer review process was documented in the Volume I: Regional Needs Assessment report.

Ultimately, *every system in the JLP revised its demand projections at least once*, and many systems did so more than once. The net result of the changes was to substantially lower the regional demand projections. Figure 3 shows the demand projections for the JLP, with the slice at the top of each column showing the net change in the regional projections from the first estimate of regional demand. The reductions compound over time, and on the whole, represent a roughly ten percent reduction in demand.

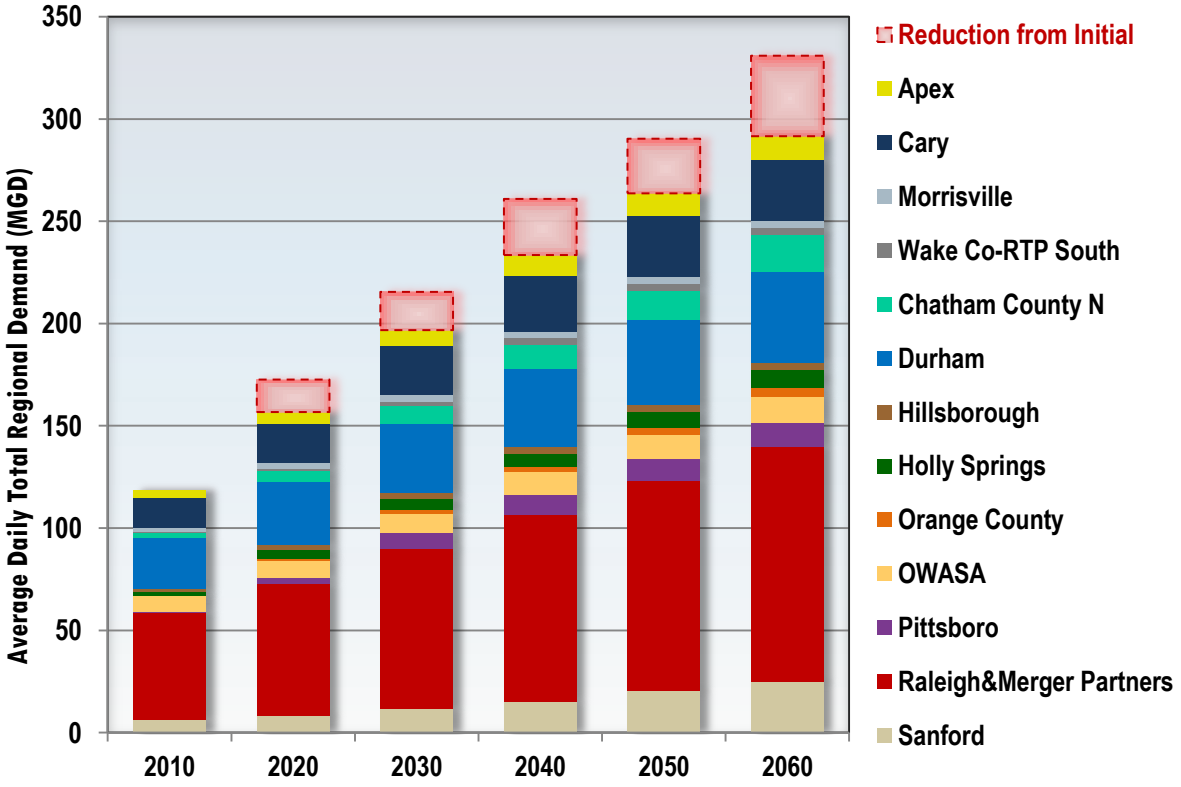


Figure 3. JLP Regional Demand Projections with combined reductions from initial estimates shown.

In 2060, the savings are nearly 40 MGD, which is larger than any individual JLP system's current demand except for the City of Raleigh. Given that the total projected 2060 need (after these savings are accounted for) is roughly 100 MGD more than currently available supplies, these reductions in projected demand result in a roughly 30% reduction in the new water supplies that would otherwise be brought online.

Many, if not most, systems projected a decrease in the percentage of non-revenue water (including process water), which represents commitments to good management of their water system infrastructure. A few systems were able to decrease their base year (usually 2010) demand based on actual use coming in lower than previous projections due to effectiveness of present day conservation programs and policies. This reduction propagated through the rest of the demand projections. Perhaps the most significant change was that many systems projected a continuing decrease in water usage rates. In most cases, the usage rate reductions came from systems with customers currently using water less efficiently than those systems with more mature water efficiency and conservation programs. The success of some systems in the region at reducing their per capita demand convinced other systems in the region that such an efficiency gain was achievable, and so their projections included it as a goal.

Figure 4 shows the aggregate projected per capita usage of the 13 JLP members through 2060. The Total Withdrawal line shown in black represents the per capita usage of total raw water withdrawals. The green line shows the total per capita usage for all service area consumption in the JLP. This excludes system process, non-revenue water, and sales. Finally, the blue line shows the overall per capita use by the residential sector. For the JLP as a whole, per capita residential usage is projected to decline from nearly 60 gallons per day per person to less than 54 gallons per day.

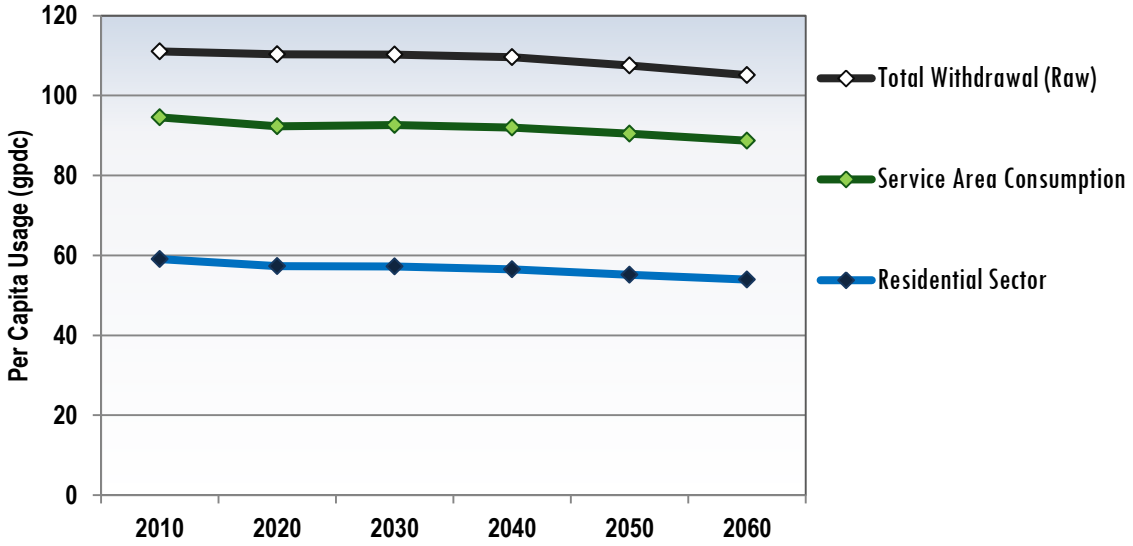


Figure 4. Projected regional per capita demand decreases through the planning period.

In summary, the members of the Jordan Lake Partnership are highly committed to continued efficient and sustainable use of water resources, and this commitment has been incorporated into nearly every aspect of this planning process.

SECTION III. Review of Volume I – Regional Needs Assessment

Summary of Regional Needs Assessment

Prior work by the JLP in Volume I of the Triangle Regional Water Supply Plan presented a *Regional Needs Assessment* that detailed population projections, water demand projections, available water supply, and projected water need for each partner individually and in summary for the region. The basic methodology used for the demand projections for each partner was described, and relevant assumptions were documented. Detailed demand breakdowns by sector were presented for each partner.

This section presents aggregate population, demand, and projected need for the JLP members. There have been some changes and updates since Volume I, and they are explained at the end of this section.

The future service areas of the JLP members encompass much of the Triangle Region's developable land, and as such, will have a major influx of future development. Figure 5 shows the expected future service areas for the JLP members in 2060.

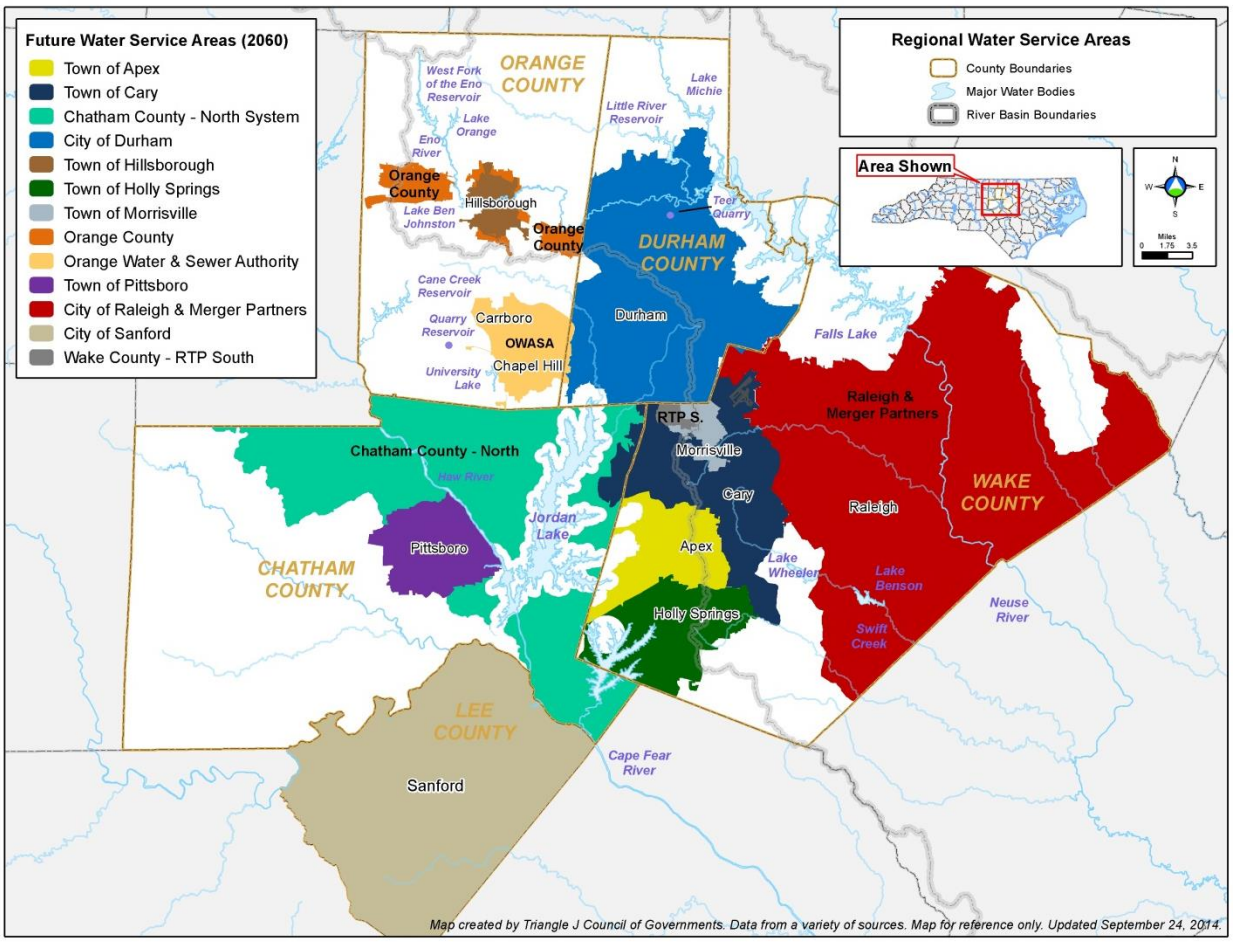


Figure 5. Future (2060) water service areas for JLP members.

Population Projections

Table 1 shows the total projected population that will be served within the JLP members' service areas. Overall, the population is projected to nearly triple, with the region adding over 1.7 million people in the next 50 years.

Table 1. Projected Population Served in JLP water service areas.

Service Area	Population					
	2010	2020	2030	2040	2050	2060
Apex	37,700	53,100	74,400	100,500	109,200	112,200
Cary/ Morrisville	145,000	176,400	208,100	230,700	247,900	248,400
Chatham County N	10,200	25,900	41,600	57,300	73,400	94,000
Durham	227,100	286,400	329,400	372,400	415,400	458,400
Hillsborough	14,000	16,800	20,100	24,200	29,000	33,800
Holly Springs	24,700	46,700	61,900	74,800	89,000	103,300
Orange County	100	4,000	9,300	14,500	19,800	25,100
OWASA	79,400	92,700	107,000	121,200	135,500	151,300
Pittsboro	3,700	24,000	58,600	79,900	87,100	96,800
Raleigh	483,300	638,500	799,100	963,200	1,134,200	1,316,200
Sanford	40,900	56,600	76,000	92,200	111,800	135,700
Wake Co-RTP South	-	-	-	-	-	-
TOTAL	***1,066,100***	***1,421,100***	***1,785,500***	***2,130,900***	***2,452,300***	***2,773,600***

These population figures have been updated since the Volume I: Regional Needs Assessment was published. Changes to the population and water demand projections from that report are explained later in this section.

Projected Water Demands by Partner

The *Volume I: Regional Needs Assessment* report documented the methodology that each system used to project the future water demand for its service area. The demand projections have been modified in a few cases, but for most water systems have remained the same. The net effect of the changes is negligible, as some of the changes increased demand and others reduced it. The changes, notably to Pittsboro and Durham demands, are explained at the end of this section.

Table 2 displays the average daily water demand projections for the JLP members from 2010-2060. The projections were originally completed in ten-year intervals for most JLP members, but the current round of the Jordan Lake allocation process requires 5-year projections, and Jordan Lake allocations are intended to meet 2045 need. As such, the JLP projections were converted to 5-year projections via interpolation unless more accurate five year projections were available.

Table 2. JLP Average Daily Raw Water Demand Projections (MGD), 2010 – 2060.

Jurisdiction	Demand (MGD)										
	2010	2015	2020	2025	2030	2035	2040	*2045*	2050	2055	*2060*
Apex	3.5	4.2	5.5	6.6	7.6	8.8	9.9	10.6	11.0	11.3	11.6
Cary	14.9	16.7	19.5	22.2	24.3	26.0	27.4	28.6	29.8	29.8	29.8
Morrisville	1.7	2.0	2.5	2.8	2.9	3.3	3.4	3.5	3.5	3.6	3.6
Wake County- RTP S.	0.6	0.9	1.4	1.9	2.2	2.7	3.2	3.2	3.2	3.3	3.3
Chatham County N	2.2	3.4	5.3	6.8	8.3	10.1	11.9	13.0	14.2	16.1	18.1
Durham	25.3	28.0	30.7	32.4	34.2	36.1	38.1	40.0	41.9	43.1	44.4
Hillsborough	1.2	1.7	2.3	2.5	2.7	2.9	3.0	3.2	3.4	3.5	3.7
Holly Springs	2.0	3.3	4.7	5.2	5.7	6.2	6.7	7.2	7.7	8.3	8.8
Orange County	0.0	0.4	0.7	1.1	1.6	2.0	2.4	2.8	3.2	3.6	3.9
OWASA	7.9	8.1	8.3	9.0	9.7	10.2	10.8	11.3	11.9	12.4	12.9
Pittsboro	0.6	2.0	3.3	5.6	7.8	8.9	10.1	10.4	10.8	11.3	11.8
Raleigh	52.0	58.2	64.4	71.3	78.2	84.8	91.3	97.0	102.7	108.9	115.0
Sanford	6.5	7.3	8.1	9.8	11.5	13.3	15.2	17.8	20.4	22.6	24.8
Total:	***118.3***	***136.2***	***156.8***	***177.2***	***196.6***	***215.4***	***233.6***	***248.8***	***263.6***	***277.6***	***291.6***

Projected Need by Partner

Projected Need is determined by subtracting the available supply from the projected demand. When the projected demand exceeds supply, there is a projected need (or put another way, a supply deficit). Current water supply sources are described in more detail in Section IV.

On a regional basis, the total current supply available is approximately 200 MGD (average day). Figure 6 shows how the regional demand projections exceed this amount in roughly 2030. Note that the graph does not indicate when any particular system's demand is projected to exceed its supply, which differs for each system.

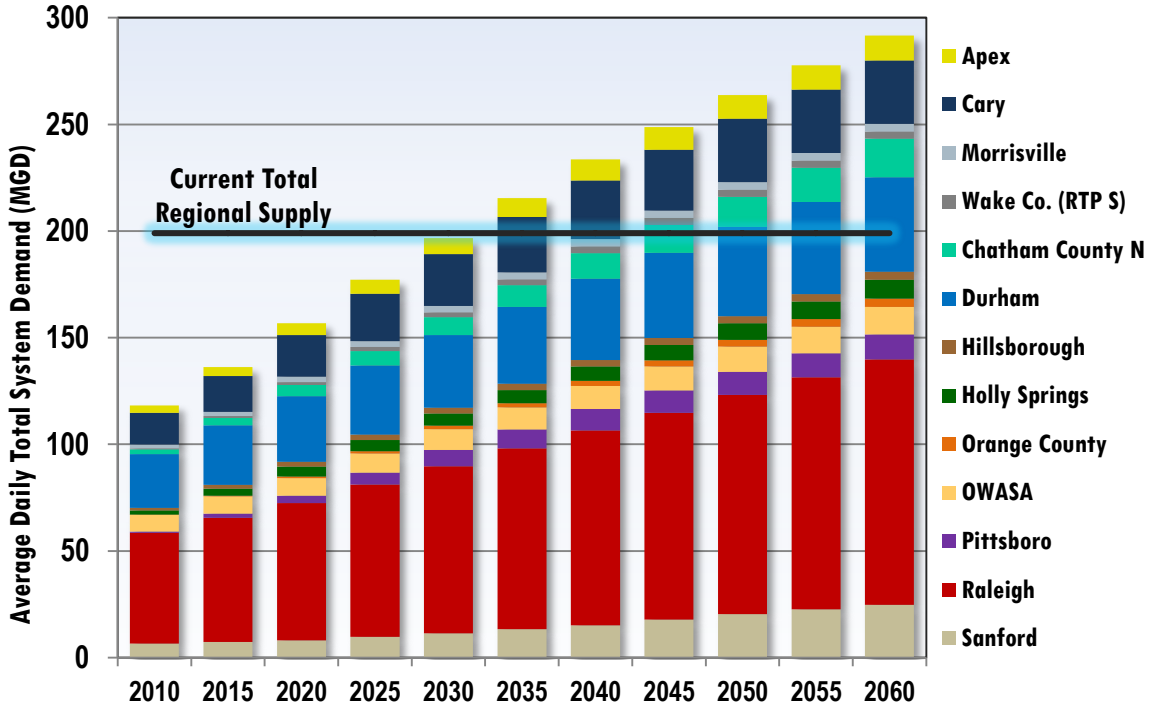


Figure 6. Projected Regional Demand relative to current supply, 2010 - 2060.

The projected water needs for each system have been evaluated and updated, and are shown below in Table 3.

Table 3. Projected Water Needs (MGD) for the JLP water systems, 2010 – 2060.

	Projected Need (MGD)										
Jurisdiction	2010	2015	2020	2025	2030	2035	2040	*2045*	2050	2055	*2060*
Apex	0.0	0.0	0.0	0.0	0.0	0.3	1.4	2.1	2.5	2.8	3.1
Cary	0.0	0.0	0.0	0.0	0.0	2.5	3.9	5.1	6.3	6.3	6.3
Morrisville	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1
Wake County- RTP S.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Chatham County N	0.0	0.0	0.0	0.8	2.3	4.1	5.9	7.0	8.2	10.1	12.1
Durham	0.0	0.0	0.0	0.0	0.0	0.0	0.2	2.1	4.0	5.2	6.5
Hillsborough	0.0	0.0	0.0	0.0	0.1	0.3	0.4	0.6	0.8	0.9	1.1
Holly Springs	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.6	1.1	1.6	2.1
Orange County	0.0	0.1	0.5	0.9	1.3	1.8	2.2	2.6	3.0	3.3	3.7
OWASA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pittsboro	0.0	0.0	1.3	3.6	5.8	6.9	8.1	8.4	8.8	9.3	9.8
Raleigh	0.0	0.0	0.0	0.0	0.9	7.5	14.0	19.7	25.4	31.6	37.7
Sanford	0.0	0.0	0.0	0.0	0.0	1.3	3.2	5.8	8.4	10.6	12.8
Total:	***0.0***	***0.1***	***1.8***	***5.3***	***11.2***	***24.7***	***39.4***	***54.0***	***68.4***	***81.8***	***95.2***

Need is only shown when demand exceeds available supply, and times with no need are shown as grayed out text. The difference between supply and demand can also be shown graphically as supply surplus or deficit. In this case, surplus is positive and represents supply in excess of demand, and deficit is negative. Figure 7 displays the stacked surplus and deficit values at 10-year intervals for the JLP systems. The supply quickly dwindles through 2030, when on the whole, the total amount of supply surplus approximately balances with the total deficit. This means that even if water could be freely moved across the region, the region would still have a net deficit a little after 2030, unless new sources could be brought online.

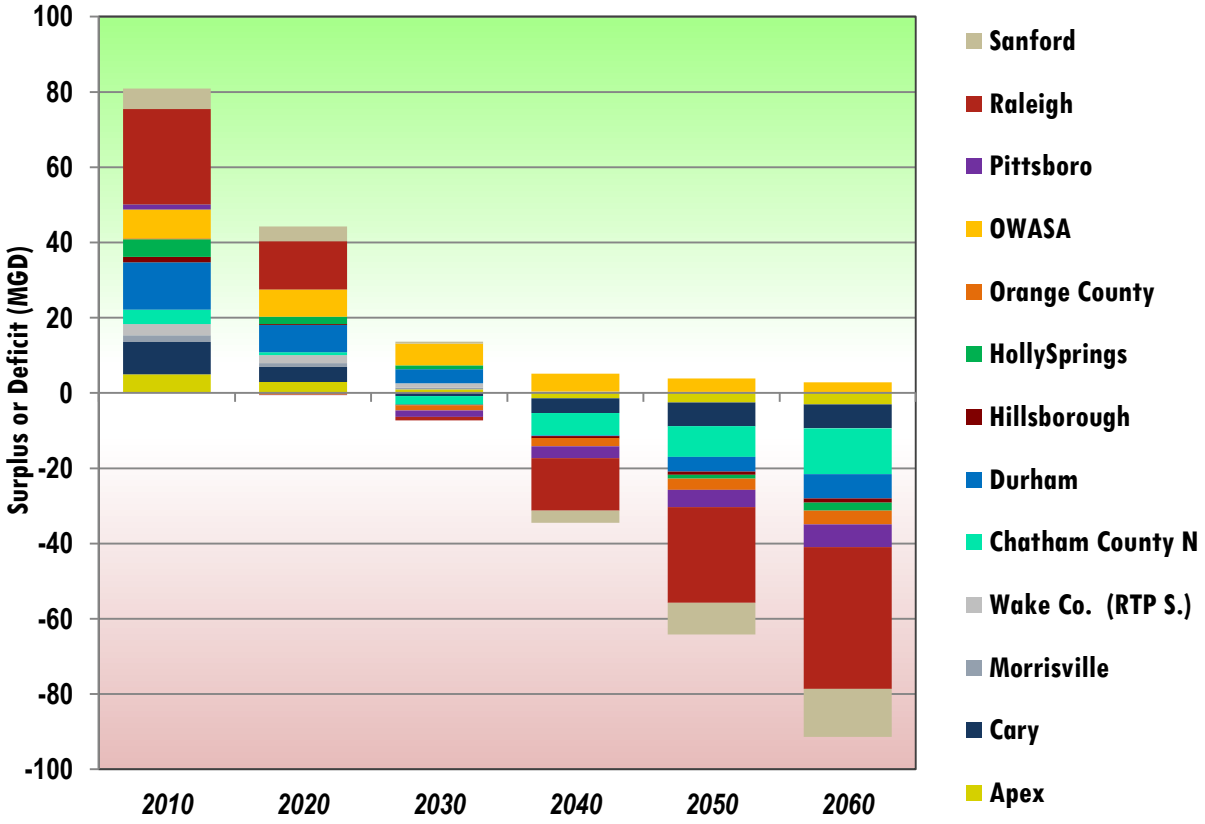


Figure 7. Projected surplus and deficit (MGD) for the JLP members 2010-2060.

Notable Changes from Volume I

The regional water supply planning process is a multi-year effort. Several developments and new analyses have led to changes in the planning from the original Volume I document for some of the Partners. These changes and their effects on the regional water supply planning are explained below.

Adjusted demand projection and decreased yield from Raleigh's existing sources

The City of Raleigh has continued to refine its projections of future needs through both a re-examination of its available water supply yield, and demand projections.

In the aftermath of the 2007-2008 drought, the City of Raleigh contracted a study to reexamine the yield of its water supply sources based on more recent hydrology. Specifically, the yield of Falls

Lake, and the Swift Creek system (including Lake Benson and Lake Wheeler) were re-examined, and found to have decreased based on modeling with the Neuse River Basin OASIS model. The yield of Falls Lake fell from 68.4 to 66.1 MGD.

The net effect of these changes is to reduce the combined yield of Raleigh's supply sources from 79.6 MGD to 77.3 MGD, a decrease of 2.3 MGD. As a result, the existing available yield of Raleigh's water supply sources was reduced. (This change reflected in Table 8 in Section IV.)

Raleigh has also revised its projection of service area demand for Raleigh and its Merger Partners. A full documentation of Raleigh's demand projection methodology can be found in the *2013 City of Raleigh Water Resources Assessment and Plan* (CORPUD, 2013). Raleigh's demand projections are based on its population projections combined with estimates of future overall per capita demand. With several more years of updated billing data, Raleigh has refined its estimates of overall per capita demand, and identified recent trends in the per capita usage. Additionally, Raleigh has more fully integrated the long range savings for its reclaimed water master planning. Using this updated data, Raleigh revised the overall per capita demand estimates for the 2020 – 2040 projection period.

Table 4 shows the revised demand projections with changes from Volume I shown in red.

Table 4. Revised Raleigh and Merger Partners demand projections, 2010-2060.

	Raleigh Demand Projections by Sector (MGD)					
Sector	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**
Residential	29.4	36.5	44.3	51.7	58.1	65.1
Commercial	11.4	14.2	17.2	20.1	22.6	25.3
Industrial	1.3	1.6	2.0	2.3	2.6	2.9
Institutional	3.4	4.2	5.1	5.9	6.7	7.5
WTP Process	0.1	0.2	0.2	0.2	0.3	0.3
Distribution Process	2.2	2.7	3.3	3.8	4.3	4.8
Other Non-revenue	4.2	5.2	6.3	7.3	8.2	9.2
Total	***52.0***	***64.4***	***78.2***	***91.3***	***102.7***	***115.0***
Overall per capita demand (gpdc)	***107***	***100.8***	***97.8***	***94.8***	***90.6***	***87.4***

These changes have some important effects on long term water supply planning. The demand projection changes primarily affect the intermediate years of the plan, while the reduction in yield affects the calculation of need throughout the entire planning period. The change in the source yield required a change in the assumed 2060 need for Raleigh from 35.4 to 37.7 MGD. The changes in the intervening years are shown in Table 3.

OWASA upgrades Jordan Lake Allocation to Level I

In the third round of Jordan Lake allocations, OWASA was granted a 5 % Level II allocation to Jordan Lake. OWASA plans to use Jordan Lake as an emergency supply or a secondary supply source before it can bring an expanded quarry source online and to provide reliability and resilience to address climate variability, operational emergencies, and water supply needs during extended droughts. OWASA demonstrated that it could access the allocation in the short term through interconnections

with Cary's system via the City of Durham system. A proposal was made to the NC Environmental Management Commission (EMC) to convert OWASA's 5 MGD Level II allocation to a Level I allocation. On March 14th, 2013, the EMC considered and approved OWASA's motion to convert the allocation. http://portal.ncdenr.org/web/emc/march-14-2013

This change in the status of OWASA's allocation has the effect of converting the allocation to an existing water supply source for the purposes of planning. Thus, OWASA's existing source yield increases by 5 MGD for the purpose of assessing need. OWASA will evaluate measures to access its allocation as it updates its Long-Range Water Supply Plan over the next several years.

The increased supply is reflected in Table 3 and Figure 7 earlier in this section, which technically show OWASA without need. For planning purposes, however, OWASA still has a need for adding supply sources to meet regular demand. OWASA's total 2060 need without the Jordan Lake allocation would be 2.4 MGD. The regional water supply plan analysis in the following sections reflects this reality.

Revisions to Pittsboro's demand projections

Since the *Volume I: Regional Needs Assessment* was published, the Town of Pittsboro's demand projections have changed considerably. A developer has proposed developing a 7,100 acre tract of land in Pittsboro's Extraterritorial Jurisdiction (ETJ) into a mixed use development named Chatham Park. The developer has been working with the Town to complete the planning for this development, which is being planned as a Private Development District (PDD). The Chatham Park developers envision there will be 60,000 residents and over 22,000 residences in addition to commercial and light industrial development by the time the development reaches build out (as early as 2040). While Pittsboro had this potential development on its radar during the development of the *Volume I: Regional Needs Assessment* and was planning for the growth, much more detail is known about the development plans now, which allowed the Town to refine its projections.

The net effects of this change in planning are to both increase the overall demand for the Town of Pittsboro, and accelerate the growth projections. The Town of Pittsboro took the opportunity to modify its growth projections to account for the higher rate of growth and density of development in Chatham Park, but also update some its assumptions to increase efficiency for the rest of the ETJ. Additionally, the Town has reduced the assumed percentages of water use for system process and other non-revenue water.

The current demand projections are shown in Table 5, which includes the full buildout of Chatham Park by 2040. The Town of Pittsboro is currently evaluating the assumptions embedded in the Chatham Park water demand projections provided, and may revise these projections again before the final Jordan Lake allocation applications are submitted. For regional planning purposes, these projections have been peer-reviewed by the JLP members, and are used in the remainder of this document and associated analyses. Further downward revisions will not materially affect the overall plan.

Table 5. Revised Town of Pittsboro Demand Projections (MGD), 2010 -2060

Sector	Pittsboro Demand Projections (MGD)					
	2010	2020	2030	2040	2050	2060
Residential	0.2	1.8	4.5	6.1	6.6	7.2
Commercial	0.1	0.6	1.3	1.8	2.0	2.2
Industrial	0.1	0.2	0.5	0.6	0.6	0.6
Bulk Sales	0.1	0.3	0.5	0.5	0.5	0.5
Other Non-Revenue	0.1	0.2	0.4	0.6	0.6	0.7
Distribution Process		0.1	0.1	0.2	0.2	0.2
WTP Process	0.1	0.2	0.4	0.3	0.3	0.3
Total	***0.6***	***3.3***	***7.8***	***10.1***	***10.8***	***11.8***

Demand projections were also converted to 5-year intervals (see Table 2) using interpolation.

Adjustment to Durham's demand projections and decrease in source yield

Durham's demand projections were revised in October 2013 based on updated information, including corrected records for the 2010 demand and a reduction in the assumed consumption rate by residential households. These changes affected the residential sector and non-revenue water demand projections. The net result is a reduction of approximately 3 MGD in the overall demand projections for 2060.

Durham' new water demand projections are shown in Table 6, which highlights the updated values in red and italics.

Table 6. Revised Durham Demand Projections (MGD) by sector.

Sector	Durham Demand Projections (MGD)					
	2010	2020	2030	2040	2050	2060
Residential	*13.2*	*15.5*	*17.5*	*19.4*	*21.2*	*22.9*
Commercial	*6.6*	7.2	8.4	9.5	10.5	11.5
Industrial	*1.3*	1.2	1.5	1.7	1.9	2.1
Institutional	*2.7*	2.2	2.4	2.6	2.8	3.1
WTP Process	*0.9*	*1.0*	*1.2*	*1.3*	*1.4*	*1.5*
Distribution Process	*(Included with Other Non-Revenue)*					
Other Non-Revenue	*0.5*	*3.5*	*3.2*	*3.6*	*4.0*	*3.3*
Total	***25.3***	***30.7***	***34.1***	***38.1***	***41.9***	***44.4***

The changes are reflected in Table 3 and Figure 7.

Durham has also re-evaluated the yield of its Upper Neuse basin sources using more recent hydrologic records including the 2007-2008 drought. Durham evaluated the yield of its sources including Lake Michie, the Little River Reservoir (Durham County), and emergency storage in one portion of Teer Quarry using updated hydrology. Durham's estimate of the total available yield of its Upper Neuse basin reservoirs fell from 38.9 MGD to 37.9 MGD. This decrease of 1 MGD is reflected in Table 8 in

Section IV. Additionally, this change increases the need for the City of Durham by 1 MGD over the entire projection period. The need in Table 3 earlier in this section reflects this change.

RTP Master Plan development changes

Research Triangle Park is split between Wake and Durham counties. The current development patterns are entirely nonresidential. The water demand for the RTP area is accounted for in the JLP demand projections with Durham's projections including the Durham County portion, and the Wake County RTP South projections (developed in tandem with Cary) for the remaining portion in Wake County. All of these projections were made prior to a major change in the proposed master planning for future development.

In November 2012, the Research Triangle Foundation published and presented the Research Triangle Park Master Plan. The new plan envisions new commercial development, as well as new higher density residential development around some walkable centers of development in the Durham County portion of RTP.

In summary, this new master plan has not advanced to the point where new water demand projections have been made, but this could change for the Durham County portion in the future. For the purposes of this RWSP, the RTP Master Plan is not included in the projections. It is anticipated that if the plan reaches a more advanced stage of planning, any additional demand could increase the regional demand projections, and additional water supply planning would be needed to determine whether new supply would be necessary.

http://rtp.org/about-rtp/planning-and-progress

http://rtp.org/research-triangle-parks-master-plan

http://rtp.org/sites/default/files/Concise%20PUBLIC%20Master%20Plan.pdf

Resolution of the planning area between Apex and Holly Springs

In November 2013, the Towns of Apex and Holly Springs reached an agreement on a new annexation and service area boundary for a previously unresolved planning area between the two towns. There had been some confusion as to which jurisdiction would plan for the future growth of an undeveloped portion of southwestern Wake County in the vicinity of Harris Lake. The agreement roughly follows US Highway 1, with each town planning for the future growth and service delivery on its side of the highway.

SECTION IV. Regional Water Assets

The JLP members are a diverse set of water systems with significant water supply infrastructure presently serving more than a million people. This section summarizes the current water supply sources and accompanying infrastructure that delivers water in the Region.

Current Water Supplies in the region

Geographically and hydrologically, the JLP members' water sources are a diverse mixture of types. While they are all surface water sources, they are geographically dispersed within the Region and are a mix of rivers and reservoirs. Additionally, off-stream storage (e.g., quarry) sources supplement the supplies. In general, the water sources for the Region are located in the upper portions of two river basins, the Neuse and the Cape Fear. Both the Upper Neuse and Upper Cape Fear River basins are essentially terminated by large reservoirs operated by USACE, Wilmington District. Falls Lake marks the downstream end of the Upper Neuse River basin. The Upper Cape Fear River basin is comprised of the Haw River and Deep River watersheds, and Jordan Lake is just upstream of the confluence of those two rivers. The Cape Fear River begins at the confluence of the Haw and Deep Rivers, , the start of the Middle Cape Fear River basin. With a few exceptions (Sanford's withdrawal on the Cape Fear River, Holly Springs' purchase from Harnett County which is also withdrawn from the Cape Fear River, and Raleigh's Lake Benson), all of the JLP member's source supplies are in the Upper Cape Fear and Upper Neuse River basin. Since Jordan Lake and Falls Lake are downstream of other water supply sources, there is some interdependency between the demand on upstream sources and the yield of the water supply pools of Jordan and Falls Lakes.

Table 7, below, shows the suite of existing water supply sources for the systems within the Partnership. It also shows the average day supply available from these sources.

Table 7. Average Day Available Supply (MGD) from Partners' existing water supply sources

Partner	Supply Source	Type	River Basin	Avg. day Supply (MGD)	Potential Supply
Apex	Jordan Lake Allocation - Level I	Jordan Lake	Cape Fear	8.5	
Chatham County N	Jordan Lake Allocation - Level I	Jordan Lake	Cape Fear	6.0	
Cary	Jordan Lake Allocation - Level I	Jordan Lake	Cape Fear	23.5	
Morrisville	Jordan Lake Allocation - Level I	Jordan Lake	Cape Fear	3.5	
Wake Co. (RTP S.)	Jordan Lake Allocation - Level I	Jordan Lake	Cape Fear	3.5	
Durham	Jordan Lake Allocation - Level I	Jordan Lake	Cape Fear	10.0	
	Lake Michie and Little River Reservoir	Multiple Lake System	Neuse	27.9	
Hillsborough	Lake Orange, Ben Johnson, & W. Fk. Eno Reservoir	Multiple Lake System	Neuse	2.6	
Holly Springs	*Jordan Lake Allocation - Level II*	Jordan Lake	Cape Fear		2.0
	Harnett County - Cape Fear River	Purchase	Cape Fear	6.7	
Orange County	*Jordan Lake Allocation - Level II*	Jordan Lake	Cape Fear		1.0
OWASA	Jordan Lake Allocation - Level I	Jordan Lake	Cape Fear	5.0	
	Cane Creek Reservoir, University Lake, and Quarry Reservoir	Multiple Lake System	Cape Fear	10.5	
Pittsboro	Haw River	River	Cape Fear	2.0	
Raleigh	Falls Lake	Falls Lake Allocation	Neuse	66.1	
	Lake Benson and Lake Wheeler	Multiple Lake System	Neuse	11.2	
Sanford	Cape Fear River	River	Cape Fear	12.0	
Jordan Lake Subtotal	*Level I and Level II*			*60.0*	*3*
Cape Fear Subtotal	(Includes Jordan Lake)			**91.2**	3
Neuse Subtotal				**107.8**	
Grand Total				**199.0**	**3.0**

Water Supply Infrastructure

In addition to the raw water sources themselves, the water systems in the Triangle have built an extensive network of water infrastructure to pump, treat, store, distribute, and/or transfer water. Foremost among these assets are the water treatment plants that treat the raw water to drinking water quality standards (i.e., finished water).

Water Treatment Plants

Water treatment plants (WTP) and the associated infrastructure to withdraw raw water and pump treated water to the distribution system are necessary components to using any water source. While raw water source availability (or yield) is specified on an average-day demand basis, WTP capacity is designed on a maximum-day basis.

Table 8. Regional Water Assets - Water Treatment Plants used by the Jordan Lake Partnership

Jurisdiction	Facility	Permit Capacity [MGD]	Planned Expansion	Expanded Capacity [MGD]
Cary, Apex (Morrisville, RTP South)	Cary-Apex WTP (CAWTF)	40.0	2016	56
Chatham County	Jordan Lake WTP	3.0		
Durham	Brown WTP	30.0	2016	42
	Williams WTP	22.0		
Hillsborough	Hillsborough WTP	3.0		
OWASA	Jones Ferry Road WTP	20.0		
Pittsboro	Pittsboro WTP	2.0	2015	4
Raleigh	E.M. Johnson WTP	86.0		
	D. E. Benton WTP	20.0		
Sanford	City of Sanford WTP	12.0		
Harnett County (sells to Holly Springs)*	Harnett County Regional WTP	*24.0* (10.0)	~2018	36-42
Mebane (sells to Orange County)**	Graham-Mebane WTP	*12.0* (0.25)		
REGIONAL TOTAL		***248.25***		**280+**

* Holly Springs has a 10 MGD (peak capacity) purchase contract from Harnett County. Only 10 MGD is counted in the regional total.

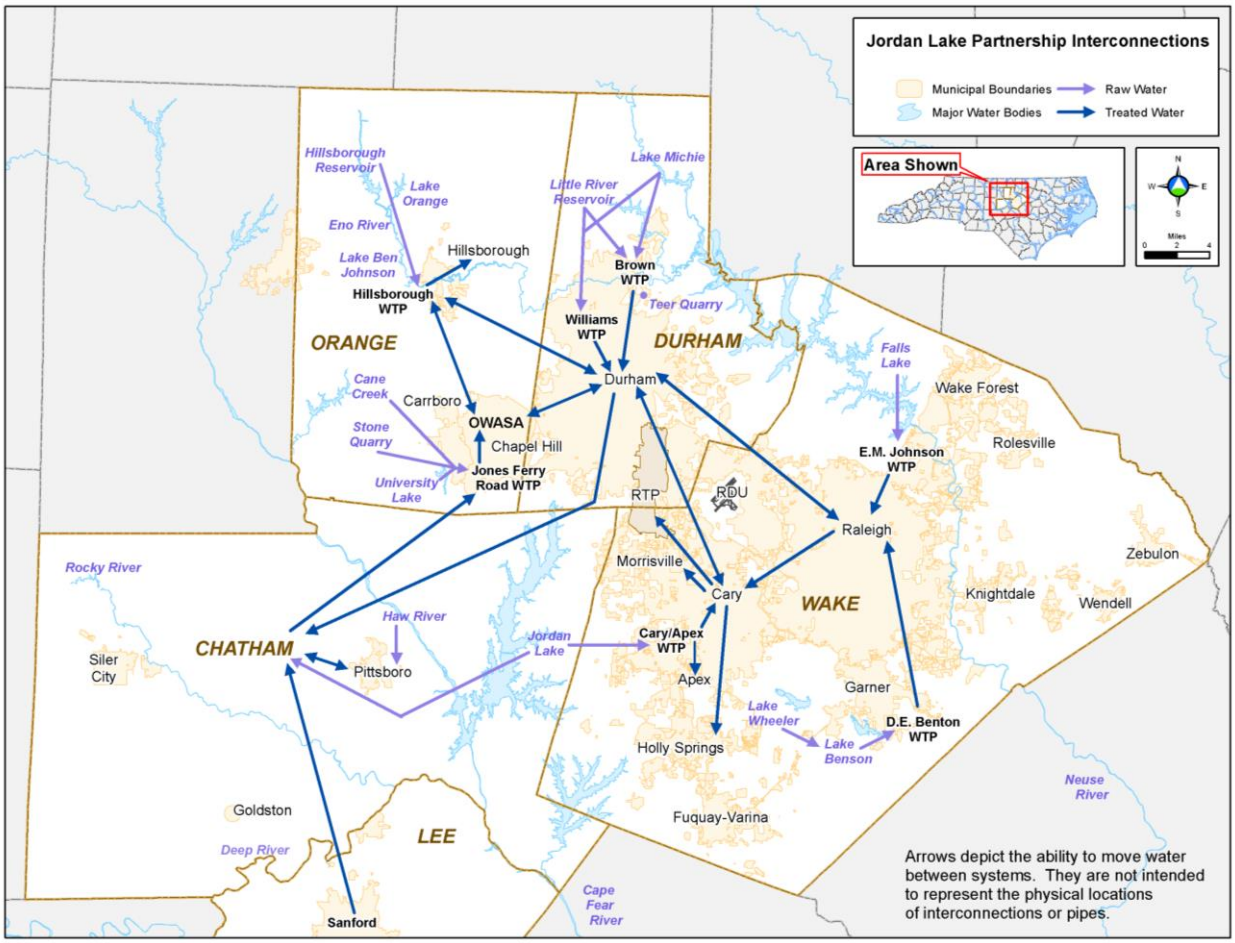
** The Town of Mebane sells water to Orange County customers from the Graham-Mebane WTP. The current contract is for 0.25 MGD, which is the amount counted in the regional total.

Distribution System, Storage, Transmission Capacity, and Pumping Infrastructure

The members of the Jordan Lake Partnership also own and maintain significant infrastructure for distributing finished water to their customers. Cumulatively, they operate roughly 6,500 miles of water distribution lines, and have roughly 120 MG in finished water storage capacity (DWR Local Water Supply Plan Data, 2012). It is through this distribution infrastructure that the Jordan Lake Partners are connected to their customers, to each other, and to other neighboring utilities. Figure 8, below depicts the connection relationships between water systems in the Partnership. The high level of interconnectedness is a great benefit to the Region, improving each system's reliability and resiliency to cope with localized water shortage, line breaks, or other emergency situations that could limit the ability to provide treated drinking water.

The JLP has begun investigating the use of connections between systems and limits of interconnection capacities. The interconnections allow water to be transferred from one system to a neighboring system, as well as for one system to pass water through a neighboring system to a third system. The calculation of capacity is a complex hydraulic problem that depends on pipe sizes, distance from one system to another, pumping capacity, pressure zones, and demand on the systems. The JLP has contracted an interconnection study to model the interconnections in detail and answer many of the operational and planning questions associated with moving water between and among systems. The first phase of the study resulted in an inventory of existing and potential interconnections (Hazen and Sawyer, 2012).

Figure 8. Map of interconnection relationships between the Jordan Lake Partners.



Water Reclamation Facilities and Water Reuse

The water systems that make up the Jordan Lake Partnership are also leaders in development of water reclamation and reuse projects. Since most of the JLP systems provide both water and wastewater service to customers, there is an opportunity to further treat wastewater effluent that would otherwise be discharged, and provide it to customers to meet non-potable water needs like outdoor irrigation, toilet flushing, and industrial process (e.g., cooling) water.

There are several water reclamation facilities currently in operation in the Region, and most of these systems can be expanded over time. These facilities have a dual benefit in that they reduce the wastewater discharge and loading to water bodies and also offset demands on the potable water system. The JLP's demand projections have already accounted for the present day water and wastewater impacts of these facilities, as well as plans for future expansion.

Cary – NCWRF, SCWRF, TWWTP – Reuse distribution system

The Town of Cary operates three reclaimed water distribution systems, serving customers near its North and South Water Reclamation Facilities (WRFs), and RTP South. The western Cary system is supplied with reclaimed water from the Triangle WWTP to serve RTP customers in Wake County and to Thomas Brooks Park in Cary. That system is being expanded to bring reclaimed water to the USA Baseball National Training Complex and will eventually be supplied by the North Cary WRF.

Combined, the systems are providing about 1 MGD to customers, through approximately 10 miles of distribution line, with roughly 10 MGD of pumping capacity. There is future potential for up to 20 MGD of peak flow. Cary also provides bulk fill reclaimed water at its WRFs.

OWASA – Mason Farm WWTP – Reuse water to University of North Carolina-Chapel Hill

OWASA's reclaimed system began operating in 2009, and has capacity to meet peak demand of 3 MGD, with potential expansion to 5 MGD. UNC Chapel Hill and UNC Hospitals now use RCW at all of their central campus chiller plant cooling towers instead of potable water. The RCW water system includes a storage tank and pumping station at Mason Farm Wastewater Treatment Plant. RCW is pumped to the University through about five miles of RCW pipes.

Pittsboro – Pittsboro WWTP – Reuse water to industrial facility

The Pittsboro Wastewater Reuse project was completed in 2012 and provides up to 0.25 MGD to the 3M Industrial Minerals Products Division facility south of Pittsboro. The project allows the 3M facility to use highly treated effluent instead of potable water for the manufacture of stone materials including crushed rock used in roofing, and it also reduces Pittsboro's wastewater discharge it into Robeson Creek. The project includes a new storage tank, pump station, and roughly 5 miles of RCW transmission line from the wastewater plant to the facility. The Town is currently in the planning stages of designing and constructing a bulk re-claimed water station to provide to the general public.

Holly Springs – Utley Creek WWTP – Onsite use, irrigation, industrial cooling

With the completion of the Utley Creek WRF, Holly Springs had a great source for reclaimed water, and began building a reclaimed water system in 2009. The reclaimed water system has a 0.5 MG tank, and delivers water to customers through 11 miles. The system serves a broad range of irrigation uses including single family residential, multifamily residential, commercial golf course customers, as well as well as landscaped roadway medians. The reclaimed water also serves industrial uses including cooling water at a Novartis facility, and process water at the WWTP. Bulk water users may also pick up water at the treated plant. The system started with approximately 0.2 MGD of use, but has grown since then.

Raleigh – Little Creek WWTP, NRWTTP – Onsite use, irrigation, industrial cooling, and investigating potable reuse

Currently, the City of Raleigh operates several types of reuse facilities. Bulk use is available at 3 WWTPs and one WTP as well. The reclaimed system includes the Little Creek WWTP in Zebulon that provides roughly 0.3 MGD through 4,500 feet of distribution line to customers for cooling tower use and irrigation for the Five County Stadium. Several additional industrial/manufacturing users and schools will be added. The Neuse River WWTP's existing reuse system serves onsite non-potable needs and irrigates nearby agricultural fields and a golf course. The system has a capacity of 2.5 MGD, and currently provides approximately 0.9 MGD. Raleigh had the potential to expand its system in the future. The City's Reuse System Master Plan has identified 128 potential customers with a total RCW demand of over 3 MGD that it could serve from the Neuse River WWTP with roughly 166 miles of distribution line. The system would be built over 30 years in 5 – 7 phases. The potential customers include NC State University, golf courses, industrial facilities, parks, and commercial and residential users, among others. The City is also pursuing a pilot study for indirect potable reuse.

Durham – NDWRF – Bulk reuse available for pick-up

The City of Durham provides bulk reclaimed water at its North Durham Water Reclamation Facility. Potential customers are required to complete a brief training class and may then obtain water with a truck at the facility's designated bulk refill terminal. The City plans to begin a reclaimed master planning process to develop a more robust reclaimed water system.

Inter-utility Agreements and Planning

A key component in making the best use of regional water assets is the ability to leverage those assets in the case of water supply shortage. The JLP members have a strong history of inter-utility cooperation, and there are numerous existing agreements between utilities for the provision of water service both for regular use and in emergencies. Figure 9 illustrates the current water supply agreements between the JLP members.

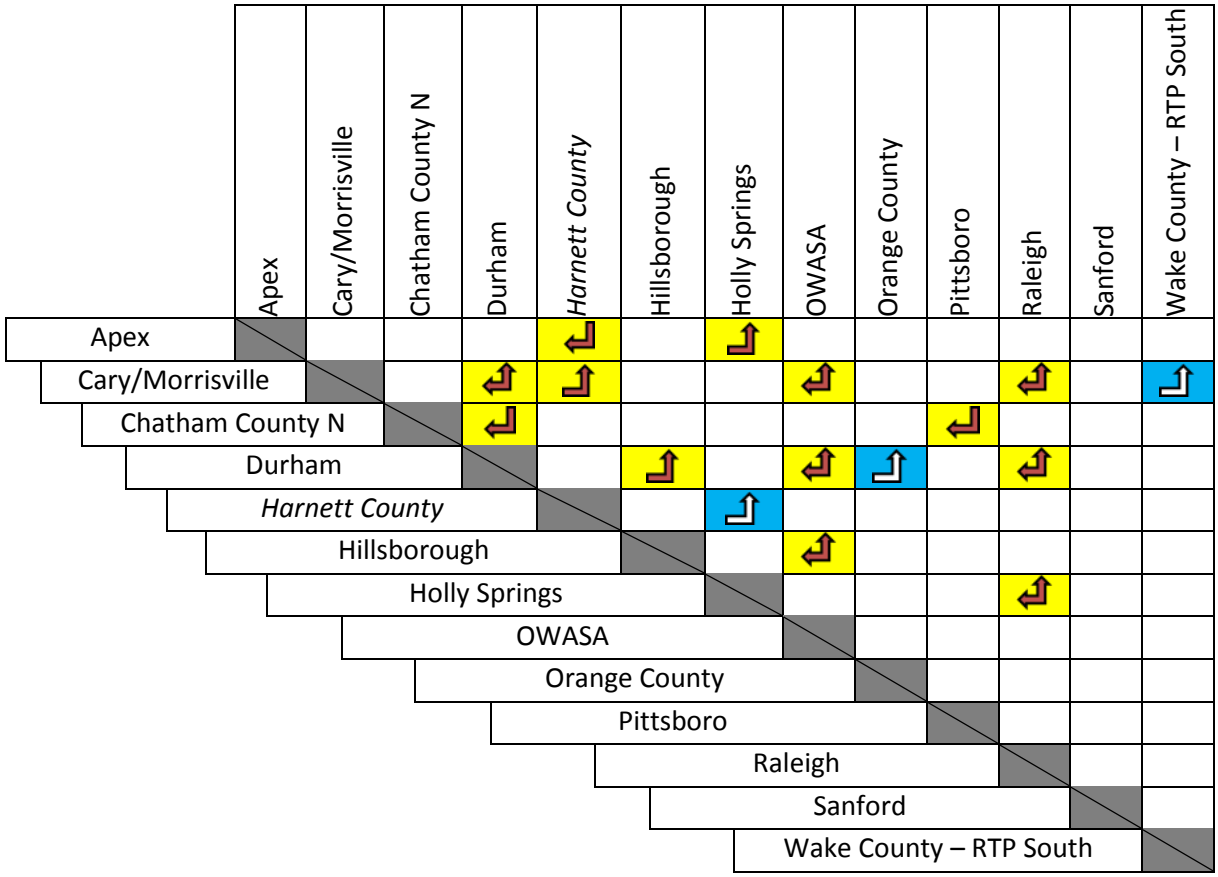


Figure 9. Inter-utility water supply agreements. Red arrows on a yellow background indicate emergency connections, and white arrows on a blue background indicate a contract for regular supply. Arrow direction indicates flow from the provider to the recipient.

The agreements in place enable the various water systems to transfer water quickly in case of emergency. There are additional physical connections between systems that could permit transfers in emergency situations, though connection capacities would have to be verified, a process that is being studied by the Partnership through an interconnection study. It is expected that additional agreements and existing agreements will be modified and renewed as necessary to support long-term development goals.

SECTION V. Framework for Analysis and Decision Process

This section describes the Partnership's decision making process to develop a suite of potential options for meeting the future water supply needs of the Region. The process included identifying the full breadth of potential individual sources, creating frameworks structured to meet specific high-level objectives, creating multiple combinations or collections of sources within each framework, determining water supply alternatives by establishing the timing of future sources, analyzing and screening alternatives, establishing preferences, choosing a preferred alternative, and modeling scenarios and evaluating impacts.

Solicitation of Source Options

The first step in creating the water supply alternatives was to identify the widest potential pool of individual source options that could supply water to one or more JLP water systems. All partners were asked to provide summary information on any potential options that were under consideration for future water supply. Additionally, the Partnership worked together to identify several large water supply source options that might be feasible with the support of several partners.

Frameworks

In developing a set of alternatives for such a diverse group of systems, some simplification was required to limit the set of alternatives. To achieve this simplification, the Jordan Lake Partners first developed a set of "frameworks" to set the general characteristics and high-level objective of an alternative. In this report, a *framework* refers to the set of conditions and goals that guide the selection of sources used to meet the future need. In general, the frameworks were designed with the 2060 need in mind, but no specific timeframe or time constraint was attached to them. Additionally, the frameworks were developed for raw water supply to meet average day demands, so infrastructure capacity concerns related to withdrawal, treatment, distribution, or transmission were ignored.

The set of frameworks was developed over several Partnership meetings. The main purpose of the frameworks was to ensure a suitable range of alternatives were considered, and that these alternatives would at least be considered, even if some seemed infeasible. Thus, the frameworks broadened the analysis, but in a bounded fashion.

Some of the frameworks were relatively obvious and straightforward, while others were developed after significant discussion.

The frameworks were:

A. Base Preference – This framework meets future needs according to the preferences of each individual system. Generally, this framework reflects current water supply planning and incorporates many of the most feasible and straightforward supply options.

B. Minimize New Supply Sources – Due to the complexity involved in building and permitting new impoundments, this framework limits the use of new storage impoundments. Variations of this framework may differ in the strict adherence to this principle. For instance, one variation may bar all new *or* expanded storage impoundments, while another variation may allow expanded sources, but still bar new impoundments.

C. Maximize New Sources – This framework investigates the impact of maximizing the use of new source options to help increase the overall yield and reliability of the system as a whole. This option has the effect of minimizing new Jordan Lake allocations.

D. Minimize Number and Size of New Sources – This framework minimizes the number of new sources by encouraging expansions of existing sources, building collaborative sources, and using storage allocations from the larger reservoirs.

E. Self-Supply Only – This framework restricts the systems to using only new sources developed by JLP members, and thus excludes options involving purchasing water from non-Partnership members or sources located outside of the region (e.g., Kerr Lake).

F. Large New Sources – This framework considers using a "mega-source" option that no utility could build alone, but that would have a major impact on meeting the needs of the Region. In general, these sources are larger than 25 MGD and may include options that are not within the Region. For example, maximizing storage in the Upper Neuse would require several partners. Other potential options would require cooperation to bring water to the Region from Kerr Lake, withdrawals from Cape Fear River downstream of Jordan Lake, or a pipeline to transfer water from the PCS Phosphate mine near the mouth of the Pamlico River.

G. Maximize Cooperation* – The concept of this framework was to use cooperation between JLP systems to help minimize the number of new sources developed and new water treatment plants required.

H. No Action – The traditional "No Action Alternative" is included for completeness as a way to assess the impact of relying only on current sources in their current configuration with respect to yield.

* It was determined that the "G. Maximize Cooperation" framework, though described differently, led to a nearly identical set of source options as other frameworks. Thus, it was dropped from the analysis.

Collections of Sources

While a framework is essentially a strategy for meeting future needs, the objective of the framework can be realized in a number of different ways with different collections of water supply sources and thus does not define an alternative by itself. To define an actual water supply alternative, a collection of sources must be selected that meets the broad outlines of the framework. Because the general frameworks are not overly restrictive, a "collection of sources" is any set of water supply options that meets future need under a given framework's goals and limitations.

Defining every possible collection of sources under a given framework would be a massive undertaking, and ultimately, unproductive. Instead, the JLP members focused their energy on selecting the most likely (or most preferred) collection of sources that would fit the framework. This divergent process started by outlining the constraints and goals of a specific framework, and asking the Partners which sources they would be most likely to build under that guidance. Several iterations were created with slightly different source options for certain utilities. In some cases, multiple collections of sources developed under one framework were considered feasible and brought forward to be analyzed as distinct alternatives. In other cases, clearly inferior collections of sources were rejected in favor of one preferred collection of sources under a given framework.

Figure 10 illustrates how each framework may have multiple collections of sources that meet its guidelines. Each collection of sources was a distinct alternative, though different collections of sources under the same framework might only differ by one or two sources.

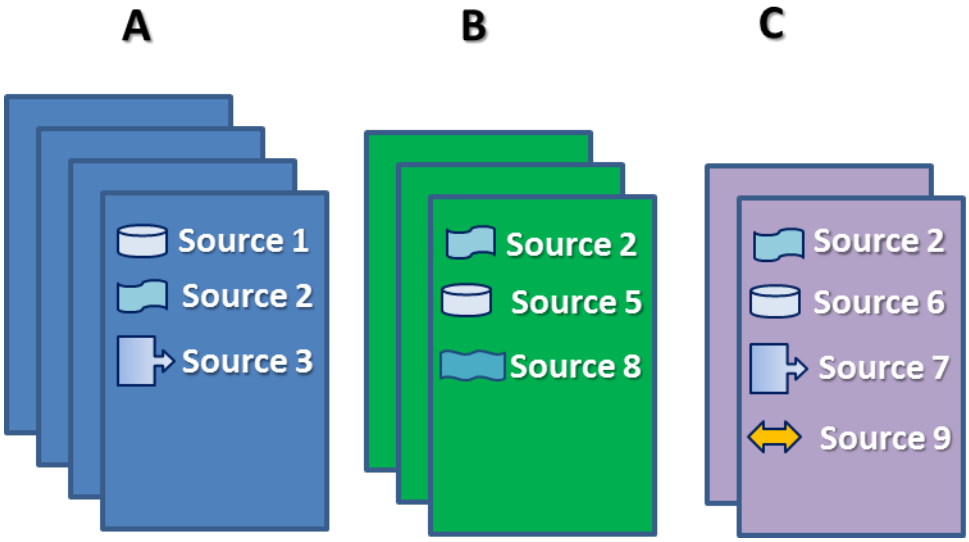


Figure 10. Each collection of sources (represented by a rectangle) under different frameworks ("A", "B", and "C") contains a slightly different combination of sources to meet the need.

The collections of sources are just the start of a plausible blueprint to meet long term demand. The details of implementation, timing, and operations still needed to be developed, but at a minimum, each collection of sources presented was a potentially viable way to meet 2060 needs.

Water Supply Alternatives

A "water supply alternative" under a given framework included the full collection of sources selected, as well as a basic timeline of implementation for the additional sources, such that the systems' individual needs were met at all projection intervals.

In some cases, basic implementation planning had to be worked out to make an alternative complete. There were some scenarios where the ultimate sources and supply was identical in 2060, but the infrastructure built to utilize the supply, and timing of sources was different.

For instance, consider one scenario in which several water systems partner on a new Jordan Lake withdrawal and large water treatment plant that is to be built in the near term, versus another scenario whereby those same systems rely on water transfers from existing WTPs drawing form Jordan Lake that may be expanded in several stages over the planning period. While both scenarios use Jordan Lake to meet future needs, they would have been considered separate, distinct alternatives.

Because developing a full water supply alternative for each collection of sources would have been time consuming and expensive, a decision process was used to narrow the collections of sources and focus time on only the most plausible and/or useful alternatives.

Analysis and Decision Process

The analysis and decision process was completed in a stepwise manner to first arrive at final collections of sources under various frameworks and then to develop the detailed alternatives for comparison.

1. Develop frameworks to explore the range of options and conceptual solutions to regional supply needs.
2. Develop trial collections of sources such that each utility states which sources would be most likely limit under the guidelines of a framework. At first, the collections of sources are developed with a goal to meet 2060 need.
3. Revise collections of sources based on preferences, and if necessary, develop additional collections of sources reflecting slight variations.
4. Perform preliminary screening and rating of collections of sources to eliminate those which are clearly not preferred.
5. Refine remaining collections of sources to analyze timing of implementation and ensure that need is met in all intermediate years. Developing the implementation timelines turns these collections into "alternatives" (assuming the timeline is feasible and need is met).
6. Select preferred scenarios for modeling and further analysis of alternatives.
7. Evaluate alternatives with respect to ability to meet need, institutional complexity, political complexity, technical complexity, financial cost impact, environmental impact, interbasin transfer effects, effects on downstream flow, and other factors.
8. Select a Preferred Alternative.

This stepwise process can be envisioned as a divergent→convergent decision-making process. Use of the frameworks and development of the collections of sources greatly expanded the decision space. The screening of collections of sources and development of alternatives narrowed the decision space and allowed the partners to converge on a preferred alternative.

Figure 11 illustrates the process.

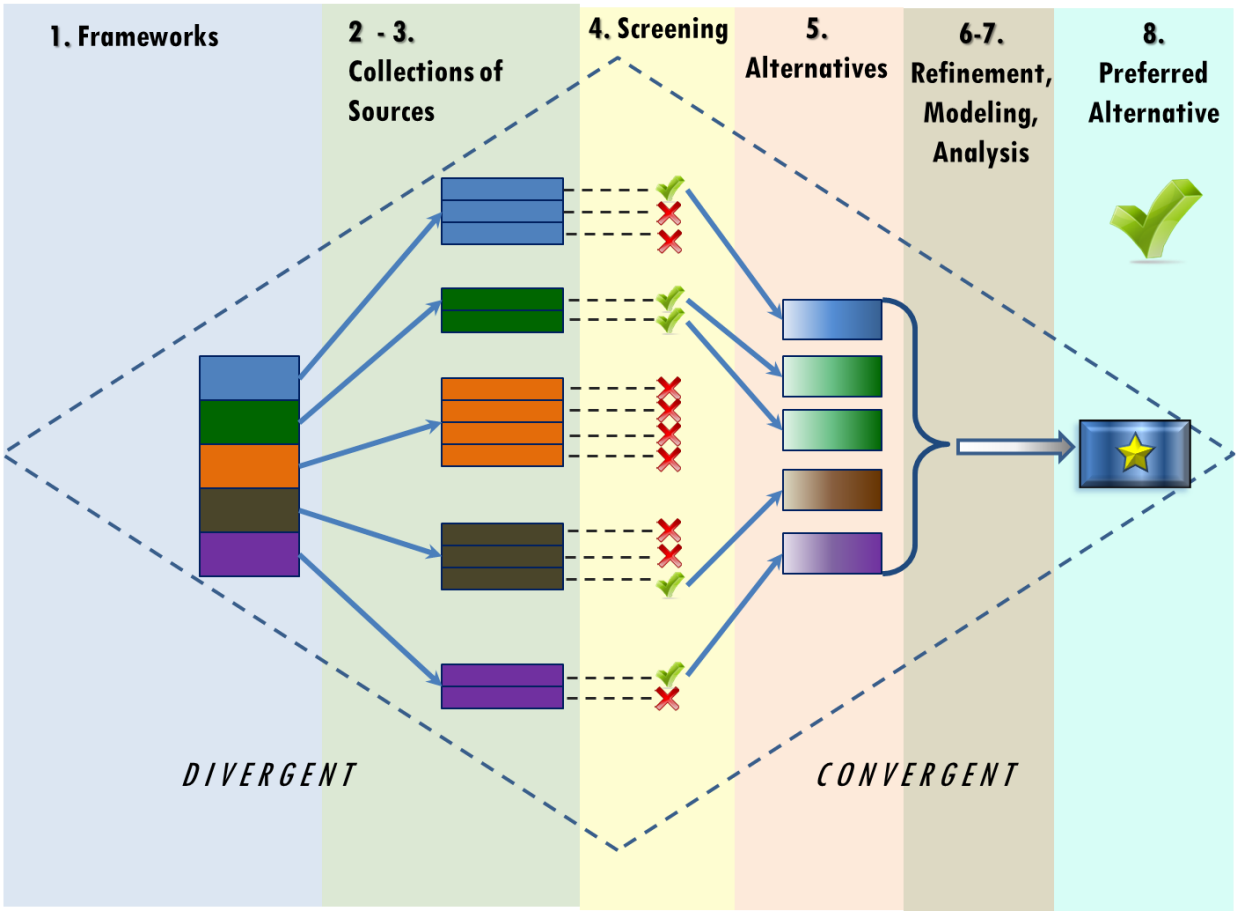


Figure 11. Decision process used for identifying, analyzing, and selecting a preferred regional alternative.

Hydrologic Modeling and Impact Analysis

One common difficulty in regional water resources planning is accounting for interdependencies between water systems from both a hydrologic and operational perspective. If every water system in the Region had independent water sources, each with its own undeveloped contributing watershed, it would be appropriate to determine the regional yield as a sum of individual source yields. By contrast, this region is very hydrologically interconnected – the inflow to some sources are dependent on the outflow from other sources – so it was important to consider how building new source options would affect the hydrologic regime and yield of existing sources.

Furthermore, the movement of water through the basin is affected not only by the operation of water supply infrastructure, but also projected return flows from wastewater discharges.

The most important verification was to determine whether the preferred alternative met the water supply needs of the JLP water systems, while at the same time was within acceptable levels of impact with respect to downstream users, environmental conditions, and regulations.

The JLP used the Cape Fear-Neuse river basin hydrologic model developed by HydroLogics and DENR in the OASIS modeling software. The previous Neuse Basin and Cape Fear Basin models were combined to make a new model including water systems in both basins and allowing transfers across basins to be more accurately accounted. DENR created baseline scenarios for the years 2010,

2020, 2030, 2040, 2045, 2050, and 2060 in which projected water demands for all water systems in the model were input based on Local Water Supply Plan estimates.

The JLP adapted the 2045 and 2060 scenario to analyze the top alternative(s) and assess impacts. The model was used to determine the selected alternative's ability to meet demand, and whether impacts on hydrology (e.g. lake levels, downstream flow) are acceptable.

Section VIII documents the building of the JLP scenarios in OASIS model, and presents summary results.

Implementing the Plan

The TRWSP documents the individual water supply plans of the Partnership's members and demonstrates that those plans are regionally harmonious and effective. Implementing the TRWSP will be a function of the Partnership's members and the particular water supply sources, but would likely include activities in the following general areas:

- Approval of the regional plan and individual water system components by local governments and authorities
- Applications for Jordan Lake Allocations
- Completing all necessary permits, studies, and analyses for chosen water supply options
- Engineering design and construction planning of chosen water supply options
- Permitting, engineering design, and construction planning of all infrastructure upgrades needed for water treatment, transmission, etc.
- Completing necessary inter-local agreements needed to build and operate new infrastructure, create or improve interconnections, transfer and sell water, or create or modify emergency aid agreements
- Individual partners working to modify their internal operations to fully incorporate the new infrastructure implemented as part of the regional water supply plan
- Periodic review of the plan to determine if demands, growth, or other local conditions changed, and if so, whether that would necessitate changes in planned infrastructure or implementation

SECTION VI. Supply Source Options

Summary of Options Identified

No single source under consideration was able to meet the full 94 MGD future regional water supply need across the thirteen Jordan Lake Partnership members. Thus, the regional alternatives were comprised of multiple sources, and the starting point was identifying all the distinct, individual source options being contemplated by the Partnership members. To this end, each system was asked to provide a list of all of the sources that could potentially be used to meet its own demands or could help meet demands regionally. A few Partnership members have already begun the detailed process of planning, designing, and permitting specific water supply sources. Nonetheless, the *Water Needs Assessment* did not include these as existing supplies (since they have not yet been constructed); and as such, they were listed as future source options, despite the fact that they will almost certainly be constructed.

The water supply source options are listed in summary form in the following tables. Sources were categorized into new reservoirs, reservoir modifications, allocations and reallocations, run-of-river withdrawals, quarry reservoirs and off-stream storage, and other. The key feature of a 'source option' is that it has the capability to increase water supply availability. Therefore, source options can either be new sources like new reservoirs, modifications to existing sources such as increasing the storage capacity of an existing reservoir, or even changes that only require increased infrastructure capacity or new permits such as expanding a treatment plant for a run-of-river withdrawal, receiving a larger storage allocation, or signing a long-term purchase agreement. More complete summaries of each source are included in Appendix C.

None of the supply source options considered by the JLP include groundwater as a source. Groundwater use for public water supply in the Triangle Region has long been recognized as problematic based on concerns about quality and quantity. While groundwater resources in the region are often sufficient to support small residential needs, there is little potential for utility scale usage of groundwater. The dominant hydrogeological character of the region is a rather shallow regolith composed of a saprolite aquifer and rock or clay transitional strata lying over fractured bedrock. The bedrock fractures allow occasionally significant, but highly unpredictable flows both laterally and connecting the fracture spaces with the surficial aquifer. The net effect is that the specific yield of wells is highly variable spatially, and not well correlated with dominant hydrologic and geologic characteristics of the area. (USGS, 2001: http://nc.water.usgs.gov/reports/wri004286/pdf/report.pdf) Accordingly, searching for a well site with enough yield to reliably supply a utility is a highly uncertain undertaking, likely requiring many expensive studies and tests before a suitable supply may be found, if one is found at all. Additionally, none of the partners had identified a suitable groundwater well site in their supply source options shared with the JLP. Thus, groundwater is not considered as a supply source for this water supply plan.

The source options for the Region are described in Tables 8 through 11 for reservoir, river, quarry and other sources, respectively. The tables show several metrics and rating criteria, described below.

- Primary Proponent – The water system most likely to build and operate this source or be the lead entity in a partnership

- Source Type – The type of water source or project that increases available supply; for example, stream withdrawal, new reservoir, reservoir modification, storage allocation, etc.
- Total Supply – The total additional supply made available by this project in MGD
- Range of Supply – In the case that the source option has a variable supply amount (e.g., a stream withdrawal where supply may be limited by treatment capacity), the approximate range in supply under the most likely configurations in MGD
- New Storage Volume – For sources that increase storage volume (e.g., reservoirs or quarries), the amount of new storage in millions of gallons (MG)
- Source Subbasin – The subbasin where the source is located according to the DENR IBT subbasin designations
- Source Water Quality Classification – The Water Quality Classification of the source water
- Technical Complexity – A comparative rating of the technical complexity of implementing the source on a scale of Not Complex, Complex, or Very Complex. The technical complexity refers to the technical design and operational challenges associated with building and operating the source
- Institutional Complexity - A comparative rating of the institutional complexity of implementing the source on a scale of Not Complex, Complex, or Very Complex. This primarily concerns the environmental review and other permitting necessary to build and operate the source
- Political Complexity – A comparative rating of the political complexity of implementing this source on a scale of Not Complex, Complex, or Very Complex. Factors influencing political complexity could include public support or opposition, effects from necessary zoning or land use controls, the effects of new regulations, perceived quality of the water source, or opposition from other water users
- Environmental Impact – A comparative rating of the environmental impact of implementing this source on a scale of Low, Moderate, or High
- Public Benefits – A rating of the level of public benefits expected by implementing the source (ancillary to the benefit of more water supply) on a scale of None, Few, or Many
- Cost Impact – A qualitative rating of the cost of the alternative on a scale of Low, Moderate, High. This rating is somewhat subjective or relative to other options
- Total Cost – Total Capital Cost in millions of dollars
- Unit Cost – Total Capital cost in million dollars/MGD of additional yield. (equivalent to dollars/gallon)

For additional context, the necessity of new infrastructure was considered. Because new treatment capacity and finished water distribution infrastructure will be required under any alternatives, only new infrastructure pertinent to the source itself and raw water transfer was considered for this

metric. If a completely new water treatment plant would be needed, that was also considered. These additional infrastructure components investigated include the following:

- New Treatment Plant – "Yes" if a new WTP would be required to activate the source. "No" if an existing plant will be used to treat the water from the source. "TBD" or "Possibly" if it has not been fully determined or there is not enough information to determine.
- New Impoundment – "Yes" if a new impounding structure would be required. This includes any major modification to an existing dam that would require review for dam safety. "No" if no additional impounding structure is built. Minor structures to finish/grout quarry reservoirs may or may not have been included depending on site conditions.
- New Withdrawal Infrastructure – "Yes" if a new intake would be developed or major modifications would be needed to existing intakes. "No" if there would not be additional withdrawal infrastructure needed.
- New Raw Water Transfer Infrastructure – "Yes" if new raw water transfer pipes and pumps would be needed to bring raw water to another source or treatment plant. "No" if not.

Finally, sources that were already in local plans as the preferred source for an individual system are indicated.

- Local Preferred Source – "Yes" if the source is the preferred local source by the primary proponent, especially for sources currently in permitting, design or engineering stages. Otherwise, "No". If the local entity has not settled on an approved, preferred local source option, "Possible" or "Top4" was indicated.

Table 9. Reservoir Source Options Considered by JLP members.

	Source Options - Reservoirs			
Source:	**1**	**2**	**3**	**4**
Source Name	West Fork Eno Reservoir Phase 2	Raise Lake Michie to 365'	Raise Lake Michie to 381'	Little River Reservoir
Primary Proponent	Hillsborough	Durham	Durham	Raleigh
Source Type	Modify Reservoir	Modify Reservoir	Modify Reservoir	New Reservoir
Total Addtl. Supply (MGD)	1.2	11	26	13.7
Range of Supply (MGD)	-	-	-	-
New Storage Volume (MG)	1043	5300	10500	3700
Source Subbasin	Neuse	Neuse	Neuse	Neuse
Source WQ Classification	WS-IV NSW ?	WS III NSW CA	WS III NSW CA	WS-II
Technical Complexity	Complex	Complex	Complex	Very Complex
Institutional Complexity	Complex	Complex	Complex	Very Complex
Political Complexity	Not Complex	Very Complex	Very Complex	Very Complex
Environmental Impacts	Low	Moderate	Moderate	High
Public Benefits	Few	Few	Few	Few
Cost Impact	High	High	High	Moderate
Total Capital Cost ($ Millions)	3	TBD	TBD	263
Unit Cost ($/gpd supply)	2.5	0	0	19.2
New Treatment Plant	No	No	No	Probably
New Impoundment	Yes	Yes	Yes	Yes
New Withdrawal Infra.	No	Yes	Yes	Yes
New Raw Water Transfer	No	Yes	Yes	Yes
Local Preferred Source	Yes	No	No	Top 4

Table 10. Run-of-River Source Options Considered by JLP members.

	Source Options – River Withdrawals				
Source:	**1**	**2**	**3**	**4**	**5**
Source Name	Expand Cape Fear Withdrawal	Cape Fear River @ Harnett Co.	Haw River Withdrawal Expansion	Haw River to Cane Creek Reservoir	Neuse River Intake upstream of NRWWTP
Primary Proponent	Sanford	Cary	Pittsboro	OWASA	Raleigh
Source Type	River Withdrawal (Expansion)	River Withdrawal (New)	River Withdrawal (Expansion)	Raw water transfer	River Withdrawal (New)
Total Supply (MGD)	12.8	16.5	4	7.7	13.7
Range of Supply (MGD)	0	0	0-8	0	0
New Storage Volume (MG)	N/A	N/A	0	N/A	N/A
Source Subbasin	Cape Fear	Cape Fear	Haw	Haw	Neuse
Source WQ Classification	WS II-NSW	WS IV CA	WS IV NSW	WS-V NSW	WS IV-NSW
Technical Complexity	Complex	Complex	Complex	Complex	Very Complex
Institutional Complexity	Not Complex	Complex	Complex	Very Complex	Very Complex
Political Complexity	Complex	Complex	Not Complex	Very Complex	Very Complex
Environmental Impacts	Low	Low	Low	Moderate	Moderate
Public Benefits	None	None	Many	None	None
Cost Impact	Moderate	Moderate	High	Moderate	High
Total Cost ($ Millions)	0	173.4	5 – 8	60	225.5
Unit Cost ($/gal)	0	10.50	1.25 – 2.00	7.80	16.46
New Treatment Plant	No	Probably	Yes	No	TBD
New Impoundment	No	No	No	No	No
New Withdrawal Infrastructure	Yes	Yes	Yes	Yes	Yes
New Raw Water Transfer Infra.	No	Yes	Yes	Yes*	Yes
Local Preferred Option	Yes	No	Yes	No	Top4

Table 11. Quarry Source Options Considered by JLP members.

	Source Options – Quarries				
Source:	**1**	**2**	**3**	**4**	**5**
Source Name	Expanded Quarry Reservoir (shallow)	Expanded Quarry Reservoir (deep)	Teer Quarry - Eno (low)	Crabtree Creek & Triangle Quarry	Raleigh Quarry Reservoir with Richland Creek Intake
Primary Proponent	OWASA	OWASA	Durham	Cary	Raleigh
Source Type	Quarry Reservoir	Quarry Reservoir	Quarry Reservoir	Quarry Reservoir	Quarry Reservoir
Total Supply (MGD)	2.1	3.4	5.2	10	13.7
Range of Supply (MGD)	0	0	5.2-10.5	0	8.9-15.4
New Storage Volume (MG)	1500	2200	2200	4600	4000 (2700-8000)
Source Subbasin	Haw	Haw	Neuse	Neuse	Neuse
Source WQ Classification	WS-II/HQW/NSW	WS-II/HQW/NSW	WS-IV NSW	C NSW	WS IV NSW CA
Technical Complexity	Not Complex	Not Complex	Not Complex	Complex	Very Complex
Institutional Complexity	Not Complex	Not Complex	Not Complex	Very Complex	Very Complex
Political Complexity	Not Complex	Not Complex	Not Complex	Very Complex	Very Complex
Environmental Impacts	Low	Low	Low	Moderate	Low
Public Benefits	Few	Few	None	Few	Few
Cost Impact	Low	Moderate	Moderate	Moderate	High
Total Cost ($ Millions)	1.4	64.6	0	62.7	265 to 900
Unit Cost ($/gal)	0.7	19	0	6.27	19.34 -65.69
New Treatment Plant	No	No	No	No	TBD
New Impoundment	No	No	No	No	No
New Withdrawal Infrastructure	Yes	Yes	Yes	Yes	Yes
New Raw Water Transfer Infra.	Yes	Yes	Yes	Yes	Yes
Local Preferred Option	Yes	Possible	No	No	Top4

Table 12. Other Source Options Considered by JLP members.

	Alternatives				
Source:	**1**	**2**	**3**	**4**	**5**
Source Name	Transfer from Kerr Lake	Falls Lake - WQ Pool Reallocation	Eagle Resources PCS Phosphate Mine	Reclaimed Water Initial Implementation	Aggressive reclaimed system (RCW)
Primary Proponent	Multiple	Raleigh	Raleigh	Durham	Durham
Source Type	River Withdrawal	Reservoir Reallocation	Other (Raw Water Transfer)	Other	Other
Total Supply (MGD)	55	14	50	2.8	9.6
Range of Supply (MGD)	0	0	0		
New Storage Volume (MG)	0	4100	N/A	N/A	N/A
Source Subbasin	Roanoke River (14-1)	Neuse	Neuse	Neuse	Neuse
Source WQ Classification	WS III B CA	WS IV-NSW	Unknown	N/A	N/A
Technical Complexity	Very Complex	Very Complex	Very Complex	Very Complex	Very Complex
Institutional Complexity	Very Complex	Very Complex	Very Complex	Complex	Complex
Political Complexity	Very Complex	Very Complex	Complex	Very Complex	Very Complex
Environmental Impacts	Moderate	High	High	Moderate	Moderate
Public Benefits	Few	Few	Few	Few	Few
Cost Impact	High	Unknown	High	Moderate	High
Total Cost ($ Millions)	Unknown	Unknown	$720 - $825	23.9	104.4
Unit Cost ($/gal)	Unknown	Unknown	$2.00 to $2.25	8.54	10.88
New Treatment Plant	TBD	No	Yes	Yes	Yes
New Impoundment	No	No	No	No	No
New Withdrawal Infrastructure	Yes	No	No	No	No
New Raw Water Transfer Infra.	Yes	No	Yes	No	No
Local Preferred Option	No	Top4	No	No	No

Other Source Options

There are a few other source options that are not listed in the tables above, but could be available for many of the JLP systems. These include:

- **Purchases from within the JLP –** The JLP water systems are already highly interconnected, so any individual JLP system would potentially have the ability to purchase water, if available, from another JLP system. This does not increase the overall regional supply, but would allow balancing surpluses and deficits among partners, or sustaining some of the partners until a planned source comes online.

- **Purchases outside of the JLP –** Many of the JLP water systems are connected to other water systems that are outside of the JLP. Currently, two partners have contracts for water supply with external water systems: Holly Springs with Harnett County and Orange County with the City of Mebane. Other physical interconnections do exist, or could be built, so there is some potential for relatively small purchases from neighboring water systems external to the JLP. These purchases could have the effect of increasing regional supply to the JLP.

- **Additional Quarry/Offstream Storage** – Several stone quarries in various stages of excavation have been identified as potential supply 'sources' since the pit left behind after quarrying could be used to store water. A quarry or other offstream storage is typically filled by pumping water from a nearby river during periods of high flow. Therefore, a quarry itself is not a water source, but along with a system to fill the quarry could serve as a water supply source. In this regional water supply planning process, quarries are treated as sources and implicitly include the mechanisms necessary to fill them. Several suitable quarries in the Region have been identified in this plan as source options; however, there are several other smaller active quarries or yet undeveloped quarry locations with potential for future excavation. Many of the JLP members could have access to quarry storage locations at some point in the future. In addition to quarries, other forms of smaller storage could be developed including ring levees, and small impoundments.

- **Additional Reclaimed Water (beyond currently planned)** – Several of the JLP systems have existing reclaimed water (RCW) systems to provide highly treated water for meeting non-potable demands. These same systems usually have a RCW master plan calling for future RCW capacity or service area expansion. JLP members with known, planned expansions of RCW systems have already included the impact of these systems as offsets to their potable water demand projections. Thus, these planned systems are not considered as potential future sources, but new RCW systems or expansions in addition to currently planned systems could be considered as potential sources. Conceptually, it seems that many of the Partnership systems could have some potential to use RCW supply (in addition to current planned systems) to offset a portion of their potable water demand.

These four types of sources are assumed to be available to any partner, but only to meet very small demands.

SECTION VII. Alternative Screening and Selection

The large number of frameworks under consideration led to an even larger number of collections of sources that could have become alternatives. While that expansive process was important to get all the potential options on the table and help to identify creative solutions that might not have otherwise been considered, some level of screening and prioritization was needed to help focus the efforts of the Partnership and limit the number of alternatives developed to those with the most merit.

Evaluation of the collections of sources was accomplished over the course of four meetings in which the JLP members developed, refined, and discussed the relative merits of each option. The key metrics and points of discussion included:

- Proposed Jordan Lake allocations and cumulative portion of water supply storage allocated;
- Cost and implementation feasibility;
- Compatibility with local plans and expected local political acceptability;
- Relative environmental impacts and difficulty of permitting;
- Consideration of interbasin transfer and hydrologic impacts on downstream water supplies (both within and outside of the Partnership); and,
- Anticipated reliability and robustness of the collection of sources.

Ultimately, each Partnership member rated every collection of sources from their individual water system's perspective on a 5-point scale as follows:

1. Full Approval – Full support for this collection of sources and willingness to work to implement the overall option;
2. Approval – Support for this collection of sources with minor reservations and/or have minor reservations about implementing this option;
3. Conditional Approval – Potential support for this collection of sources with some reservations, but will conditionally support this option if some concerns are addressed;
4. Limited Acceptance – Not preferred, either from a local or regional perspective, but potentially willing to more fully investigate impacts and work to improve certain elements if developed into an alternative; major reservations about this option, but will not work actively to prevent it; or,
5. Disapproval – This collection of sources does not meet local interests of needs, likely even with significant modifications; level of impact is not acceptable either from a local or regional perspective, and will work actively to oppose this option.

Collections of Sources Considered

The collections of sources developed under the various frameworks are shown below in Table 13. At the time of initial analysis, each of the collections of sources met the 2060 needs of each system. The

letters correspond to the general frameworks presented in Section V, and the numbering distinguishes the different collections of sources from other variations under the framework. The differences among the collections of sources are noted in the description section.

Table 13. Collections of Sources Investigated Under Frameworks A-F.

Collection of Sources	Description
A1 Preferred Options	The A1 Option reflects the individual preferences of the JLP members, with additional considerations for regional cooperation.
A2 Alternate Choice Option	The A2 option is an alternate option in which JLP members with more than one viable source option select their equally or slightly less preferred option.
B1 * No New Reservoirs	The B1 option highlights sources that would be selected if no new reservoirs could be constructed (though reservoir expansions would be permitted).
B2 Non-reservoir Sources	The B2 option envisions what JLP members would do if non-reservoir sources were highlighted and new reservoirs or reservoir expansions options were minimized.
B3 Minimize new storage	The B3 option maximizes use of sources that do not require large new storage volumes, which minimizes use of reservoirs, reservoir expansions, and quarries.
C1 Build New Sources	The C1 option prioritizes adding new sources to the regional source portfolio (instead of expanding existing sources).
C2 New Sources/Purchases	The C2 option investigates the potential for both adding new sources and purchases from other water systems to meet future needs.
C3 Max. New Sources	The C3 option investigates the possibility of using new sources to meet as much of the future need as possible for systems. This will have the effect of minimizing the use of Jordan Lake.
D1 Minimize New Sources	The D1 option attempts to minimize construction of new sources, and minimize the size of sources that are built. This will also maximize use of Jordan Lake among as many partners as possible.
D2 Min. New Neuse Sources	The D2 option attempts to minimize construction of new sources in the Neuse Basin. This will likely include using Jordan Lake by as many partners as possible.
D3 Min. Number of Sources	The D3 option minimizes construction of new sources, especially in the Neuse Basin, but also for as many partners as possible. For 2060, this option allows more than 100 MGD of total supply from Jordan Lake.
E1 Self-Supply	The E1 option envisions what would happen if all JLP members had to meet their own needs with their own supplies (or purchases if necessary) and could not build cooperative source options.
F1 – *Large New Sources* Pipeline from Phosphate Mine	The F1 option starts by including the proposed option by Eagle Resources to build a large pipeline to bring roughly 50 MGD of water from the PCS Phosphate mine's dewatering process near the mouth of the Neuse. The option starts by meeting Raleigh's need, and then other adjacent systems.
F2 – *Large New Sources* Kerr Lake Transfer	The F2 option includes a group of the JLP members applying for a storage allocation from Kerr Lake and transferring up to 60 MGD to the Upper Neuse Basin. This option would first meet needs in Durham and Raleigh and then subsequently other JLP members as available.
F3 – *Large New Sources* Quarries and Reclaimed	The F3 option includes maximizing use of alternative sources including quarries (and other offstream storage) and reclaimed water. These will be distributed across the JLP members as available.
F4 – *Large New Sources* Max. Upper Neuse 1	The F4 option maximizes storage in the Upper Neuse Basin by building a large expansion of Lake Michie that would meet Durham's needs, but also some of the needs of other JLP members.
F5 - *Large New Sources* Max. Upper Neuse 2	The F5 option is a variation of F4, but instead, a smaller expansion of Lake Michie is built, along with an expansion of Teer Quarry.
H *- No Action*	No Action. Existing sources only with no expansions.

* - The B1 collection of sources is listed because it was developed, but it was found the source selections were indistinguishable from several of the other frameworks. It was omitted from further consideration.

These collections of sources are perhaps best defined by the specific sources selected to meet the 2060 need. Table 15 displays the actual sources selected for each of the collections of sources shown in the table above. Table 15 is organized into an upper portion that identifies sources selected by JLP member and a lower portion that identifies which sources are active, and in some cases, which version of a source is built. The numbering of sources in the lower half of the table is used in the top portion of the table to identify the source selections by each system.

Some of the potential source options previously identified were never selected under any of the frameworks and are omitted from Table 15. Additionally, a few more general source options and options for purchases and transfers are included in the table.

Table 14 introduces the source options included in Table 15, and identifies the sources by type. Each type of source is color coded, with this color coding carrying through to Table 15 to help readability.

A few notes are particularly relevant to help clarify the source options. Source options numbered 1-3 all refer to additional Jordan Lake allocations (i.e. beyond current allocations), but are differentiated by how the allocation is accessed: (1) for allocations accessed from existing treatment plant, expanded as necessary; (2) for allocations accessed through a new WTP, operated either solely or in partnership; and, (3) for allocations accessed only by direct purchase agreements from other allocation holders.

The reclaimed water source option (17) refers only to reclaimed water projects that are beyond what is currently planned. Currently planned reclaimed water systems or expansions were already factored into the JLP member's demand projections.

Finally, Raleigh is in the midst of its own future water supply planning efforts, and there is some uncertainty regarding selection of preferred source options at the time of this writing. Raleigh has identified four primary source options that are of similar size and could be used in some combination to meet Raleigh's long term need. Given their current planning process, it is difficult to fully prioritize among these sources, except to the extent that these four source options are preferred over other potential options. These sources include:

- Building a new reservoir called Little River Reservoir in Wake County,
- Reallocating a portion of Falls Lake storage (from the water quality or sediment storage pools) to the water supply pool,
- Building a new run-of-river intake on the Neuse River upstream of the Neuse River Wastewater Treatment Plant (NRWTTP), and
- Using offstream quarry storage with pumping from the Neuse River near Richland creek.

There is currently no expressed preference for any of the four options over another, and all four are currently being investigated for potential implementation. Under current estimates of need, roughly three of these options (all with roughly 10-14 MGD of yield) would be needed by 2060. As a result, selecting among these sources is less a question of which sources are built, but how many are built and when. In Table 14, these sources are numbered 19a-d, and labeled as Raleigh Option 1-4. These option identifiers do not correspond to the same particular sources across a row for the collections of sources. That is, Option 19a could be Little River Reservoir in one case, and a reallocation of Falls Lake in another column. There is simply no way to specify more detail at present. In a few cases, the selected sources are color coded in Table 15 to indicate that certain types of sources were selected, or

were unable to be selected based on the instructions of that particular framework. Otherwise, they are simply colored dark red.

Table 14. Primary source option descriptions (with color coding by source type) for reference with Table 15.

#	Source	Type	Description
1	Jordan Lake - Expand Existing	Storage Allocation	JL allocation accessed by expanding WTP
2	Jordan Lake - New WTP	Storage Allocation	JL allocation accessed with new WTP
3	Jordan Lake - Transfer	Storage Allocation	JL allocation accessed through purchase/transfer
4	W. Fork Eno Reservoir Expansion	Reservoir Modification	Hillsborough's W. Fk. Eno Reservoir expansion
5	L. Michie Expansion (L or H)	Reservoir Modification	Durham expansion of Lake Michie, either in a low (L) or high (H) configuration
6	Teer Quarry (L or H)	Quarry Reservoir	Durham expansion of Teer Quarry, either in a low (L) or high (H) configuration
7	OWASA Quarry Reservoir (L or H)	Quarry Reservoir	OWASA expansion of Quarry Reservoir in either Shallow (L) or deep (H) configuration
8	Cape Fear Withdrawal Expansion	Stream Withdrawal	Expansion of Cape Fear R. withdrawal near Sanford
9	Cape Fear Withdrawal (New)	Stream Withdrawal	New withdrawal location on Cape Fear River
10	Haw River Withdrawal (L or H)	Stream Withdrawal	Expansion/New withdrawal on Haw R. near Pittsboro
11	Kerr Lake transfer	Raw transfer	Raw water transfer from Kerr Lake
12	Crabtree Creek Quarry Reservoir	Quarry Reservoir	Use of quarry for offstream storage
13	Eagle Resources PCS Phosphate	Raw transfer	Raw water transfer from PCS Phosphate mine
14	Purchase - Graham-Mebane	Purchase	Orange County purchase from Graham-Mebane
15	Purchase - Harnett County	Purchase	Holly Springs purchase from Harnett County
16	Purchase - Other	Purchase	Other purchase from non-JLP member
17	Reclaimed Water (addtl.)	Reclaimed Use	Reclaimed water in excess of current plans
18	Quarry/Pond Offstream (TBD)	Quarry Reservoir	Storage in Quarry/Pond at location TBD
19a	Raleigh Option 1	New Reservoir, Storage Allocation, Stream Withdraw., Quarry Res.	*4 options, in no particular order*: Little River Reservoir; Falls Lake Storage Reallocation; Neuse R. withdrawal upstream of NRWWTP; Quarry Reservoir option adjacent to Neuse River near Richland Creek;
19b	Raleigh Option 2		
19c	Raleigh Option 3		
19d	Raleigh Option 4		
20	Internal Transfer	Internal purchase	Purchase from other JLP member
P	Provider - Internal Transfer	Internal sale	Indicates JLP member is a provider to others

Table 15. Sources selected for collections of sources under initial consideration. Partner selections at top of table refer to activated sources in lower part.

	Partner	A1	A2	B2	B3	C1	C2	C3	D1	D2	D3	E1	F1	F2	F3	F4	F5
A	Apex	1	1	1	1	9	9	9	1	1	1	1	1	1	12	1	1
B	Cary (Morrisville, RTP South)	1	1	1	1	9	9	9,12,P	1	1	1	1	1	1	12	1	1
C	Chatham County	2	2	2	2	20	20	20	2	2	2	2	2	2	2	2	2
D	Durham	2	6, 3	2	3,2	5,6, P	5, P	5,6,17,P	2	17, 2	2	6,17	13, P	11, P	6, 17	5, P	5,6,P
E	Hillsborough	4, 3	4	3	3	4	4,20	4,20	4	4, 3	4	4	4, 20	4, 11	4, 3	4, 3	4
F	Holly Springs	1	1	15	15	15, 1	15	15	15	1	1	1,15	1	1	1, 17	1	1
G	Orange County	14, 3	14, 3	14, 3	14, 3	14	14, 20	14, 20	14, 3	14, 3	14, 3	14,3	14, 3, 20	14, 20	14, 3	14, 20	14, 20
H	OWASA	7,3	7, 3	7, 3	3,2	7, P	7, 17	7, P	7, 3	7, 3	7, 3	7	7, 20	7, 3	7, 17	7, 3	7
I	Pittsboro	10,2	10, 2	10,2	10,2	10, 20	10, 17	10, 20	2	2, 10	2	10, 17	10, 2	2, 10	10, 2	2, 10	2, 10
J	Sanford	8	8	8	8	8	8, P	8	8	8	8	8	8	8	8	8	8
K	Raleigh	19abc	19bcd	19bcd	19bc,17	19abc	19abc	19ab,20	19acd	19ab,3	3,19ab	19abc	13	11	19ab,17	19a,20,17	19ab,20
	Source																
1	Jordan Lake - Expand Existing	x	x	x	x				x	x	x	x	x	x	x	x	x
2	Jordan Lake - New WTP	x	x	x	x				x	x	x	x	x	x	x	x	x
3	Jordan Lake - Transfer	x	x	x	x				x	x	x	x	x	x	x	x	x
4	W. Fork Eno Reservoir Expansion	x	x			x	x	x	x	x	x	x	x	x	x	x	x
5	L. Michie Expansion (L or H)					L		L								H	L
6	Teer Quarry (L or H)		L	L		L		L				L			L		L
7	OWASA Quarry Reservoir (L or H)	L	L	L		L	L	H	H	H	L	H	L		L	L	H
8	Cape Fear Withdrawal Expansion	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
9	Cape Fear Withdrawal (New)					x	x	x									
10	Haw River Withdrawal (L or H)	L	L	H	H	H	H	H		L		H					
11	Kerr Lake transfer													x			
12	Crabtree Creek Quarry Reservoir							x							x		
13	Eagle Resources PCS Phosphate												x				
14	Purchase - Graham-Mebane	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
15	Purchase - Harnett County			x	x	x	x	x	x	x							
16	Purchase - Other																
17	Reclaimed Water (addtl.)				x	x	x	x		x		x			x		
18	Quarry/Pond/Offstream (TBD)														x		
19a	Raleigh Option 1	x				x	x	x	x	x	x	x				x	x
19b	Raleigh Option 2	x	x	x	x	x	x	x		x	x	x			x		x
19c	Raleigh Option 3	x	x	x	x	x	x		x			x			x		
19d	Raleigh Option 4		x	x					x						x		
20	Internal Transfer					x	x	x					x	x		x	x
P	Provider - Internal Transfer					x	x	x					x	x		x	x

Initial Screening and Rating

After the collection of sources were developed and analyzed in such a way that each Partnership member understood how they would meet their individual needs, the relative merits and drawbacks of each collection of sources were discussed during a JLP meeting. JLP members voiced their concerns about certain options and discussed the potential impacts and challenges with respect to financial, environmental, technical, organizational, political, or operational viability.

Once the Partnership members had a firm understanding of the collections of sources, and they rated each option on the five point scale presented at the beginning of this section, the scores were tabulated and averaged, with each Partnership system receiving one 'vote'.

The collections of sources were then stratified into three tiers based on the average rating. The JLP members agreed that any options receiving an average rating of 3 or worse should not be considered further. The remaining collections of sources were divided into a mid-range (scoring between 2 and 3) and a top-tier (scoring between 1 and 2). Table 16 indicates the tiers for each collection of sources. The order of presentation within each tier is not sorted by actual score, only grouped by tier and sorted alphabetically. Additionally, the final column indicates if any of the partners gave a particular collection of sources a '5', which is a warning that there were significant objections from at least one system about that particular collection of sources.

Table 16. Collections of Sources initial screening table.

Collection of Sources	Score Range	Any 5 scores?
A1 – Preferred Options	Top Tier (1-2)	No
D1 - Minimize New Sources	Top Tier (1-2)	No
A2 – Alternate Preferred	Mid-Range (2-3)	Yes
D3 – Min. Number of Sources	Mid-Range (2-3)	No
E1 – Self-Supply	Mid-Range (2-3)	No
F4 – Large Sources, Upper Neuse 1	Mid-Range (2-3)	Yes
F5 – Large Sources, Upper Neuse 2	Mid-Range (2-3)	No
B2 – Non-reservoir Options	Lowest Tier (3-5)	Yes
B3 - Minimize new storage	Lowest Tier (3-5)	Yes
C1 – Build New Sources	Lowest Tier (3-5)	Yes
C2 – New Sources/ Purchases	Lowest Tier (3-5)	Yes
C3 – Max. New Sources	Lowest Tier (3-5)	Yes
D2 – Min sources, Neuse	Lowest Tier (3-5)	Yes
F1 – Pipeline from Phosphate Mine	Lowest Tier (3-5)	Yes
F2 – Kerr Lake	Lowest Tier (3-5)	Yes
H - No Action	N/A – Does not meet need	N/A

Based on the results of the discussion and initial screening process, the collections of sources in the lowest tier were not carried forward for development into alternatives. Of the remaining collections of sources in the Top Tier or Mid-Range scoring categories, the JLP members agreed to consider how the collections of sources could potentially become viable alternatives.

SECTION VIII. Development of Preferred Alternative Scenarios

The JLP members worked to develop the more favorably rated collections of sources into more cohesive regional alternatives. The goals of investigating these alternatives were either to:

1) Identify a preferred regional alternative, or

2) Investigate an alternative that, while still viable and potentially implementable, was particularly useful for the purpose of investigating the impacts on the Partnership systems and downstream stakeholders.

Referring to Table 16 from the previous section, there were seven collections of sources with potential viability for further analysis. Of the top tier and mid-range collections of sources, three were developed into alternatives. By focusing on the two goals above, seven options were reduced to three.

Under the first goal, the most logical collection of sources to develop into an alternative was option A1 – Preferred Options, which represents the current individual preferences of each of the Partnership members. Option A2 – Alternate Options was also potentially viable, but as it was already known that this option would be less preferred than A1, it did not make sense to investigate this option unless major flaws or issues were discovered with A1. Additionally, at least one system rated the A2 collection of sources with a '5' score, indicating strong objections.

Looking to the other options, F4 – Large New Sources – Upper Neuse 1 was eliminated because Durham no longer considered the large Lake Michie expansion implementable, and at least one partner gave this option a score of '5'. Option D1 – Minimize New Sources was considered for analysis, but the source selections were actually very similar to Option A1, though less preferred overall. Option E1 – Self-Supply was considered useful as a thought exercise, but had major drawbacks and concerns about implementability (especially how several partners would access Jordan Lake allocations without cooperating with other partners).

Eliminating those options left two more options for consideration and both meet the second goal listed above. Option D3 – Minimize Number of Sources was particularly useful because it minimizes the number of sources needed and maximizes use of Cape Fear Basin sources. These features put a great deal of water stress on the Cape Fear sources, so if this alternative was evaluated with the hydrologic model and the impacts were found to be acceptable, it would provide useful insights into the reliability of the Cape Fear sources. For similar reasons, Option F5 – Large New Sources, Upper Neuse 2 was a useful alternative because it put a large amount of water stress on the Neuse Basin. Both of these options were less preferred than Option A1, but by investigating them, there were potentially valuable insights to be gained about the regional water supply systems that made it worth the effort.

These three collections of sources were developed into alternatives, meaning that further detail was added and analysis was conducted to indicate they were potentially viable for meeting demands not only in 2060, but also in all intervening years. The rest of this section describes these alternatives in more detail.

Descriptions of the Alternatives

A1 – Preferred Options

Option A1 represents the preferred options for each of the Jordan Lake Partnership systems (with slight adjustments made to ensure overall regional viability). In general, source options that were already in final planning stages or had necessary permits in place for construction were assumed to be built as planned. For water systems considering multiple future source options, the source option that was currently the locally preferred or leading candidate was generally selected for this alternative.

This alternative includes a combination of additional Jordan Lake allocations, expansions of several existing sources of different types, water purchases, and a few new supply sources. In this alternative, several systems –Apex, Cary, Morrisville, Wake County – RTP South, Chatham County, Holly Springs, and Durham – would rely exclusively on Jordan Lake allocations to meet future needs. Other systems – Orange County, Pittsboro, and Hillsborough – would use Jordan Lake to meet a portion of their future needs but would also expand existing sources (a purchase agreement with the City of Mebane, a run-of-river withdrawal from the Haw River, and the West Fork Eno Reservoir expansion, respectively). Sanford would expand its use of the Cape Fear River to meet future needs, and Raleigh would develop three of its leading four source options by 2060.

A key feature of this alternative is collaboration between several partners to build a new intake on the western side of Jordan Lake to provide a new way to access Jordan Lake water supply. This proposed intake and an associated WTP is being jointly evaluated by the City of Durham, Chatham County, the Town of Pittsboro, and OWASA. It would be capable of withdrawing Jordan Lake water (using these systems' current or future allocations if approved) and pumping finished water to each system. OWASA is participating to ensure access to its existing Jordan Lake allocation, which is primarily intended as an emergency water supply source. Pittsboro plans to use water treated at the new WTP primarily to meet demands in planned future development areas within its ETJ. Like OWASA, Hillsborough plans to request an allocation that would provide emergency supply, which it would access through purchase from Durham or possibly OWASA. In practice, the proposed Western Intake and WTP would probably treat the water for the Hillsborough allocation as well.

Chatham County currently serves its North water system by treating water at its Jordan Lake WTP (which receives raw water from the Cary-Apex intake) and pumping water across the lake. This configuration constrains the amount of water that can be provided to the portion of the service area on the western side of the lake. In this alternative, Option A1, the current Jordan Lake WTP would be abandoned once the new proposed Western Intake and WTP goes online.

Currently, the Apex and Cary/Morrisville/RTP South systems rely exclusively on Jordan Lake as their sole water supply source, and under Option A1, would continue to do so in the future. The joint Cary-Apex WTF (CAWTF) would be expanded as necessary to provide access to these future allocations. Under Option A1, the CAWTF would no longer be used by Durham or OWASA as the primary means of accessing their Jordan Lake allocations in lieu of the new proposed intake and WTP on the western side of Jordan Lake.

Holly Springs would continue to receive treated water through its purchase agreement with Harnett County. However, given that the purchase agreement is for maximum flow and projected future summer demands would exceed this maximum, Holly Springs needs to seek an alternate source. Under Option A1, Holly Springs would convert (and slightly increase) its current Level II allocation to a Level I allocation. Holly Springs would then access this allocation by requesting the Corps release

this amount of water from Jordan Lake (to Harnett County's downstream intake) and purchasing finished water from Harnett County. Alternately, Holly Springs would purchase finished water from its interconnection with the Town of Apex, using Holly Springs' allocation as the raw water source.

Sanford will expand its withdrawal and WTP on the Cape Fear River, likely in two phases, to meet future needs.

Finally, Raleigh would implement three of its four preferred water supply options by 2060. These four alternatives include 1) building a new reservoir called Little River Reservoir in Wake County, 2) working with the Corps to reallocate a portion of the Falls Lake water quality pool or sedimentation pool to the water supply pool, 3) a new run-of-river withdrawal on the Neuse River upstream of the Neuse River Wastewater Treatment Plant, and 4) using a (currently active) quarry adjacent to the Neuse River near Richland Creek for water supply storage with pumping from the Neuse River during periods of high flow. Based on Raleigh's water demand projections and this regional planning effort, one of these sources would be needed by 2025, a second source would be needed by roughly 2035-2040, and the third after 2050.

D3 – Minimize Number of New Sources

This alternative is primarily aimed at minimizing the number of new source options that are brought online in order to take advantage of economies of scale in building new infrastructure. Fewer (larger) sources means fewer, larger WTPs would be needed to treat the water. In part, this alternative would encourage more cooperation between water systems. The most straightforward way to minimize the number of new sources is to allocate (i.e. share) water from larger storage reservoirs and expand existing sources. As a result, this alternative includes expanded allocations from Jordan Lake and Falls Lake and the most feasible expansions of other existing sources.

A key feature of this alternative is its heavy reliance on Jordan Lake allocations. In this alternative, Apex, Cary, Morrisville, RTP South, Durham, Holly Springs, and Pittsboro would rely exclusively on Jordan Lake to meet all future needs. Additionally, Orange County would seek a Jordan Lake allocation to meet roughly half of its future need, Hillsborough would seek a 1 MGD allocation as an emergency supply, and OWASA would continue to use its Jordan Lake allocation as an emergency supply. Finally, Raleigh (likely via interconnections with Durham or Cary) would use a Jordan Lake allocation to avoid building one of its sources. In order to accommodate these increased Jordan Lake allocations, it was assumed Jordan Lake could yield in excess of 100 MGD, the only alternative to do so. This alternative, therefore, represented the approximate maximum supply that could come from sources in the Cape Fear Basin. In this sense, this alternative is the opposite of the F5 alternative, which maximizes supply in the Neuse Basin.

Beyond the Jordan Lake allocations, the majority of the supply increase would come from expansions. Hillsborough would complete its planned West Fork Eno Reservoir expansion, OWASA would complete the planned Quarry Reservoir expansion, and Sanford would expand its Cape Fear River withdrawal. Orange County's western service area (Efland-Mebane Economic Development District) would continue to be served through purchase from the Town of Mebane.

Raleigh, by virtue of using a Jordan Lake allocation, would only need to use two of its four preferred sources. One of the preferred sources is an increase in the water supply pool of Falls Lake, which fits with the goal of this framework. Thus, the other new source required to meet Raleigh's remaining future water supply need would be one of its other three preferred sources (Little River Reservoir, a Neuse River withdrawal, or quarry storage near Richland Creek).

In infrastructure terms, the key to this alternative is moving water across the Region. As in the Option A1, a new intake and WTP on the western side of Jordan Lake would be built to provide access to Jordan Lake allocations for Chatham County, Durham, Pittsboro, OWASA, Orange County (via Durham), and possibly Hillsborough (emergency use, probably via Durham). Finished water pipelines with pump stations would be needed to move this water to these partners. A difference in this alternative is that Pittsboro would receive an allocation large enough to meet its whole future need, which would necessitate a larger WTP than Alternative A1.

Apex, Cary, Morrisville, and RTP South would continue to access their Jordan Lake supply from an expanded CAWTF. In this alternative, however, some of Raleigh's need would be met directly or indirectly from Jordan Lake. Thus, either the CAWTF or the proposed Western Intake and WTP would have to be significantly larger to meet this need. Additionally, interconnections between either Raleigh and Durham or Raleigh and Cary would have to be expanded.

This alternative has several major potential barriers that would need to be overcome. First, the expected yield of the Jordan Lake water supply pool would need to be increased (or the Corps would have to reallocate water from the water quality or sediment pool to the water supply pool). While recent OASIS modeling seems to indicate that the safe yield of the Jordan Lake water supply pool may be higher than 100 MGD, it does not seem prudent to plan for higher yields than the currently assumed yield of 100 MGD. Secondly, if Raleigh were to obtain and use a Jordan Lake allocation this alternative would require a major new interbasin transfer permit (>10 MGD) from the Haw Basin to the Neuse Basin. A potential alternative to the IBT would be for Durham to meet more of its need from a larger Jordan Lake allocation and sell water to Raleigh from Durham's existing Neuse Basin sources.

F5 – Large New Sources – Maximize Upper Neuse 2

This alternative was aimed at maximizing the usage of the Upper Neuse Basin sources under the "Large New Sources" framework. This alternative includes Durham expanding storage in Lake Michie by raising the dam to 361 feet in elevation. An even larger expansion to 380 feet was initially considered in the collection of sources, but Durham did not consider this larger expansion viable by the time the alternative was being developed. This alternative, Option F5, was based on the principle that Raleigh, Durham, and Hillsborough should meet as much of their future need as possible using sources in the Upper Neuse Basin. In order to further maximize the Upper Neuse sources, a Teer Quarry expansion would also be constructed by Durham.

By expanding Lake Michie, Durham would not only able to meet all of its need, but would also have a significant surplus that could be provided to other neighboring utilities. Raleigh would build two of its preferred sources, including the reallocation of Falls Lake as one of them, and then receive the remainder of its supply by from the Lake Michie and/or Teer Quarry expansion projects. Raleigh would essentially partner with Durham on the expansions and develop a long-term water purchase agreement. Additional surplus would also allow Durham to supply water to Hillsborough and Orange County. Hillsborough would still build its West Fork Eno Reservoir expansion, so the surplus supply from Durham would be for emergency use. For Orange County, Durham would provide water supply for the Eno EDD and Hillsborough EDD.

OWASA would still build the Quarry Reservoir expansion and use its existing Jordan Lake allocation for emergency and seasonal peak usage.

Cary, Apex, Morrisville and RTP South would meet their needs through increased Jordan Lake allocations, expanding the CAWTF as needed to treat the water.

Chatham County would also meet its needs through an increased Jordan Lake allocation and would still need a new treatment plant. The Town of Pittsboro would meet its needs through a combination of increasing the Haw River withdrawal and a Jordan Lake allocation. Pittsboro would likely access its allocation through interconnections with Chatham County or by participating in a new WTP with Chatham County.

Ultimately, this alternative was designed to provide insights into the upper limits of source water capacity of the Neuse River Basin by maximizing usage of the upper basin and investigating impacts on Falls Lake and the flow of the Neuse River downstream.

As a result of increasing the Neuse Basin sources, Jordan Lake allocation requests were somewhat lower in this alternative.

Comparing the Alternatives

The collections of sources and alternative developed by the Partnership demonstrated that there are a number of ways to meet the future water supply needs of the Region. In many cases, certain water supply sources are common across several alternatives, especially in the more favorably rated options. Therefore, in order to compare the alternatives, it is useful to focus on the differences between them.

The first important comparison is to distinguish the number and types of sources selected. For this TRWSP, part of that differentiation is determining how Jordan Lake will be used. Table 17 compares the source selections among the three alternatives in terms of both number and type of sources selected as well as the amount of supply in MGD. The 'Surplus' row shows that all of the alternatives had a positive supply surplus (ranging from 10-13 MGD), which indicates that all need is met for the Region as a whole in 2060. It is also true that need was met individually for each JLP system both in 2060 and for all intervening years as well. The next rows show the anticipated Jordan Lake allocation requests for Round 4 (target year 2045) and requests for future rounds through the end of the planning period (2060). These values indicate that the F5 alternative keeps Jordan Lake allocations lowest, the A1 alternative uses the majority of the current water supply pool by 2060, and the D3 alternative uses a much higher amount (greater than 100 MGD) of Jordan Lake supply in 2060, though not necessarily in 2045.

The next rows indicate the breakdown of *new* water supply (new and expanded sources) between Jordan Lake allocations, other Cape Fear Basin sources, and Neuse Basin sources. The A1 alternative has the most balance between the two basins. The D3 alternative is skewed to the Cape Fear Basin (taking Jordan Lake allocations into account), and the F5 alternative is skewed to the Neuse Basin.

The next three rows indicate the number of systems using Jordan Lake supply. The total partners with Jordan Lake allocations by 2060, the number of increased allocations, and the number of new allocations are shown.

The next five rows indicate the number of sources, purchases, or internal transfers included in each alternative. The total number of new source or source expansions is shown in total, and then broken down by basin. Then, the number of purchases from outside the JLP and number of internal transfers are indicated.

The last section of the table indicates the amount of new (non-Jordan Lake) supply by type of source, including purchases (from outside the JLP), reservoir expansions, quarry reservoirs, and run-of-river withdrawals. Since Raleigh's four preferred source options include a new reservoir, a storage allocation expansion (Falls Lake), a run-of-river withdrawal, and a quarry, Raleigh's new sources are show in a single row separate from the other sources. In the A1 alternative, three of these types will be activated, and in the other two alternatives, only two of these sources will be needed.

Table 17. Differences in source selection and usage between alternatives A1, D3, and F5.

	Category	A1	D3	F5
Surplus [MGD]	Total 2060 Supply Surplus	10.4	10.0	13.3
Allocation Amount	Jordan Lake Allocation Total - 50 year (2060)	99.4	114.0	90.1
	Jordan Lake Allocation Total - Round 4 (2045)	91.2	92.8	82.3
New Supply Amount [MGD]	Jordan Lake Allocations	39.4	54.0	30.1
	Cape Fear sources (non-Jordan Lake)	21.9.	16.7	20.7
	Neuse sources	41.1	28.6	53.9
	TOTAL New Supply	*102.4*	*99.3*	*104.7*
# of Allocations	Total Jordan Lake Allocations	11	12	9
	Increased Jordan Lake Allocations	7	7	4
	New Jordan Lake Allocations	2	3	2
# of sources, purchases, transfers	# of new/expanded supply sources	*7*	*5*	*8*
	… in the Neuse Basin	4	3	5
	… in the Cape Fear Basin	3	2	3
	# of new internal transfers	0	0 or 1	3
	# new/increased external purchases	1	1	3
Additional Supply by Source Type [MGD]	Additional Supply from…			
	Purchases	1.8	1.8	1.8
	Reservoir expansions	1.2	1.2	20.5
	Quarries	2.1	2.1	8.1
	Run-of-River Withdrawals	16.8	12.8	16.8
	TBD (Raleigh Sources)	41.1	27.4	27.4

Table 18 shows additional detail about anticipated Jordan Lake allocation requests for each system under these alternatives. The first column indicates the applicant, and includes all the Partnership members except Sanford, because Sanford does not anticipate requesting an allocation. Several of the systems' requests are the same across the alternatives, so they are grouped at the top of the table and highlighted in gray. The partners at the bottom half of the table have variation in requests across the alternatives. The second column indicates the current allocations held by each partner.

Table 18. Anticipated Jordan Lake Allocation by partner for each alternative A1, D3, and F5.

			Round 4 (2045)						Future (2060)					
Partner	**Current**		**A1**		**D3**		**F5**		**A1**		**D3**		**F5**	
Apex	8.5	32	10.6	46.2	10.6	46.2	10.6	46.2	11.6	48.5	11.6	48.5	11.6	48.5
Cary	23.5		28.6		28.6		28.6		29.8		29.8		29.8	
Morrisville	3.5		3.5		3.5		3.5		3.6		3.6		3.6	
RTP South	3.5		3.5		3.5		3.5		3.5		3.5		3.5	
Chatham County	6		13		13		13		18.2		18.2		18.2	
Holly Springs	2		2		2		2		2.2		2.2		2.2	
OWASA	5		5		5		5		5		5		5	
Orange County	1		1.5		1.5		0		2		2		0	
Hillsborough	0		1		1		0		1		1		0	
Durham	10		16.5		16.5		10		16.5		16.5		10	
Pittsboro	0		6		8		6		6		10		6	
Raleigh	0		0		0		0		0		11		0	
TOTAL	**63**		**91.2**		**93.2**		**82.2**		**99.4**		**114.4**		**89.9**	

Comparing Impacts for the Alternatives

The following discussion summarizes some of the differences in impacts in qualitative terms between the top three alternatives when compared with each other. These alternatives and their potential impacts were discussed over several Jordan Lake Partnership meetings, and only the key points and differences between the alternatives are presented here.

Table 19 shows a comparison of the expected impact levels and complexities of the three alternatives. In general, Option A1 is not without impact, but impacts would be generally lower and more easily mitigated than the other two alternatives. A narrative description of the differences in the ratings follows the table.

Table 19. Relative impact and complexities of the A1, D3, and F5 alternatives.

Category	A1	D3	F5
Environmental Impact	Moderate	Low to Moderate	High
Political Complexity	Complex	Very Complex	Very Complex
Institutional Complexity	Not Complex	Very Complex	Very Complex
Financial Impact	Moderate	Moderate	High
Technical Complexity	Complex	Complex	Very Complex

Environmental Impacts

The three alternatives presented have varying levels of environmental impacts. In general, the A1 and D3 alternatives are expected to have lower to moderate impacts, while the F5 alternative would have a very significant impact.

The F5 alternative likely has the highest degree of environmental impact as the Lake Michie expansion would impound considerable additional area. Increasing the size of (and withdrawals from) Lake Michie, Teer Quarry, and the West Fork Eno Reservoir would likely reduce inflows to Falls Lake from the Eno and Flat Rivers. Combined with potentially increased demand on Durham's Little River Reservoirs and Falls Lake itself, Falls Lake levels could be reduced moderately and for longer periods on average. On the other hand, Raleigh would only have to build two additional sources instead of three, all of which have some level of environmental impact. Additionally, smaller and fewer pipelines would need to laid to bring water from a new Western Intake and WTP to Durham.

The A1 alternative has a low to moderate level of environmental impact, albeit with some level of uncertainty. The largest impacts would be associated with Raleigh's implementation of three of its preferred sources. All of these sources have some level of environmental impact due to either water withdrawals or creation of a new impoundment. Overall, Raleigh's success in building these sources with appropriate mitigation strategies would result in lower total environmental impacts on the region. In the rest of the region, the supply expansions generally have low environmental impacts. The new WTP proposed for the western side of Jordan Lake would have an impact mainly caused by the construction of distribution lines to partners, which would cross several streams and wetland areas, and require mitigation. The total impact from this infrastructure to access Jordan Lake water is likely to be significantly lower than constructing more sources across the region, more reservoirs, and more pipelines and WTPs. Additionally, the A1 alternative would help reduce the net interbasin transfer of water from the Neuse to Haw subbasin through Durham. Durham's use of its Jordan Lake allocation would likely help preserve flows in the Upper Neuse basin and elevations of Lake Michie, Little River Reservoir and Falls Lake.

The D3 alternative may actually have lower impacts than A1, primarily because Raleigh would be able to avoid building a third source. The tradeoff is that a new net flow from the Haw River basin could be created. The additional flow from Jordan Lake to meet Raleigh's demand would likely be returned to surface water at Raleigh's NRWWTP, which is downstream of Falls Lake. The additional flow out of the Haw subbasin could also potentially reduce flows in the Cape Fear River. Some of the net transfer would be mitigated as Durham's total wastewater return flow to the Haw basin would still be larger than Durham's use of water from Jordan Lake. On the whole, however, the D3 alternatives requires building the fewest individual sources and least treatment infrastructure, which helps limit total land and water area that will be affected by the implementation of the sources.

Political Complexity

All three alternatives would involve some political complexity, but in general the A1 alternative would be least complex.

The primary political complexity associated with the A1 alternative is the collaboration required to build the proposed WTP on the western side of Jordan Lake (note that all three alternatives include this proposed WTP). This treatment plant and the associated finished water transmission pipelines would require a substantial level of agreement between Durham, Chatham County, OWASA, Pittsboro, Orange County, and Hillsborough. The other major political complexities would be primarily internal to Raleigh as it seeks approval of is preferred options, since the top four options can have effects on zoning, contracts with private entities (quarry owners), recreation at existing or planned water bodies, or impacts on private property related to construction of infrastructure.

The other alternatives could create significantly more political complexity. The D3 alternative involves Raleigh either directly or indirectly obtaining a Jordan Lake allocation, and total allocations

in excess of 100 MGD. It is highly likely that this plan would face significant opposition from downstream stakeholders in the Cape Fear River basin. Additionally, there is potential for political complexity among the Partnership members if it were determined (as it likely would be) that requested Jordan Lake allocations would not be granted in full.

The F5 alternative is likely the most complex from a political standpoint. This alternative would require a high level of cooperation between Durham and Raleigh on the expansion of Lake Michie, a project that Durham might not complete on its own. The political complexity arises because Raleigh and Durham would effectively be sharing a water supply, while both are accustomed to managing their own supplies. A management agreement for obtaining water from Lake Michie could be worked out, but the potential issues are much more significant due to hydrology in the Upper Neuse Basin. The expansion of Lake Michie, combined with the expansion of Teer Quarry and the West Fork Eno Reservoir means that there are several water supply projects under this alternative that would directly impact inflows to Falls Lake as well as, potentially, the Neuse River downstream. In practice, by cooperating on the Lake Michie project, it is highly likely that Raleigh and Durham would have to develop a combined water resources management plan for the entire Upper Neuse Basin because of the degree of hydrologic interconnectedness of the sources. Furthermore, day to day operations would have to become very much integrated. While this could be accomplished from a technical perspective, it might be a challenge to gain full support of the two governing authorities for such a plan. Finally, the high level total withdrawals from the Neuse Basin under this alternative could face political opposition from downstream users of the Neuse River or even other users within the Upper Neuse Basin.

Institutional Complexity

The institutional complexity associated with these alternatives is lower for the A1 alternative than for the other two. The A1 alternative requires some permitting, but should be manageable from an institutional perspective. The Jordan Lake allocation process is well understood, and the JLP members are working together to improve the process for the individual applicants and the State by making coordinated requests in the context of a regional plan. There are some institutional issues associated with constructing a new WTP on the western side of Jordan Lake, but care would be taken to obtain the appropriate permits, study impacts, and provide mitigation where needed. Of course, this process is no different than what would be required for any alternative that includes a new WTP. Finally, the largest source of institutional complexity pertains to Raleigh's completion of three of its preferred source options. Each of the top four source options for Raleigh would have moderate to high institutional complexity (presented for each source in more depth in Appendix C), but on the whole, the total level of complexity would likely be lower than the other alternatives.

The D3 alternative would have increased complexity due to interbasin transfers and withdrawals from Jordan Lake greater than its 100 mgd yield. If a reassessment of the yield of the water supply pool of Jordan Lake does not support an increase in yield sufficient to meet the requests, the JLP members would have to petition the US Army Corps of Engineers, NCDENR, and ultimately the US Congress to study whether a reallocation of more storage to the water supply pool could be completed. Furthermore, an interbasin transfer from the Haw River subbasin to the Neuse Basin could create significant complexity for Raleigh.

The F5 alternative would create significant institutional complexity. The construction of the Lake Michie expansion as well as the Teer Quarry expansion would necessitate a significant amount of permitting and environmental review to determine impacts on stream flows, streams and wetlands in the inundated areas, endangered and threatened species, and other impacts. Additionally, special study

may be needed to assess potential impacts on lake levels and water quality in Falls Lake. Part of the reason for this is that under this alternative, water from Lake Michie could be provided directly to Raleigh (as finished water through its interconnection with Durham), which means that flow would "skip over" Falls Lake and be returned directly to Raleigh's wastewater treatment plant downstream of Falls Lake. The proposed management of the ensemble of sources in the Upper Neuse Basin under this alternative could have a significant influence on whether or not impacts are deemed acceptable. This alternative would create significant interbasin transfer issues with net flow moving from the Neuse to the Cape Fear. The net interbasin transfer from Durham would be increased as the proportion of Durham wastewater flow returned to the Haw subbasin would be unchanged at roughly 55-60 % of wastewater flows, but an increasing portion of Durham's demand would be met from the Neuse basin.

Financial Impact

All of these alternatives would have a high overall cost from a regional perspective, though the costs are almost certainly lower than many of the other less favorable options presented as collections of sources that were not developed into full alternatives. It is important to consider relative costs when comparing alternatives. For instance, no matter what source of water is used, the water must be treated, so in general, costs for water treatment are relatively similar (with some exceptions) across alternatives.

The A1 alternative is generally among the lower cost alternatives, though it is still expensive. The cost of new sources is kept lower by relying on sources that have local acceptance (i.e., individual system preferences) and are partially complete with respect to design and permitting. Furthermore, by working through a long range plan, water supply sources can be anticipated well in advance and implementation can be planned over several years in a way that lowers costs both during design and construction.

The D3 alternative may be only slightly more expensive than the A1 alternative. Meeting part of Raleigh's need with a Jordan Lake allocation would require either a new finished water line from one of the two Jordan Lake treatment plants or reconfiguring Cary or Durham's distribution systems to allow a regular 11 MGD average transmission to Raleigh. This additional cost would potentially be offset in part by Raleigh building one fewer of its preferred source options. Additionally, Pittsboro's ability to avoid building a Haw River withdrawal expansion with a new WTP and rely more heavily on water treated at the proposed Western Intake and WTP would help control costs over the long run in this alternative.

The F5 alternative would almost certainly the most expensive of the three, as it would require building the most new sources and source expansions. The Lake Michie and Teer Quarry expansions would be very expensive. Even accounting for reductions in the cost of the Western Intake and WTP (Durham, Hillsborough, and Orange County wouldn't participate), and Raleigh building two rather than three sources, the overall cost for this alternative would still be higher.

Technical Complexity

The alternatives vary somewhat in technical complexity. The A1 and D3 alternatives are the least complex, in part because they use Jordan Lake for much of the future supply. Delivering finished water over long distances (from the proposed Western Intake and WTP) adds some complexity, but it is a normal part of water supply infrastructure engineering. Implementation of Raleigh's sources would likely add the most complexity, in part because of the challenges of operating multiple sources

simultaneously. Some of the source options, such as the Raleigh quarry option, would introduce some complexity in developing operating guidelines.

The F5 alternative is much more technically complex. As explained previously, the Lake Michie expansion project will have the effect of inextricably linking Raleigh and Durham's water supply operations and management decisions. The heavy development and expansion of the Upper Neuse sources combined with higher demands will require a large degree of coordination to operate multiple sources simultaneously while meeting water supply needs and other water management objectives in the basin.

Summary of Alternative Development

After developing these three alternatives, *it is clear that Alternative A1 is the best and most preferred alternative for the JLP*. Alternative A1 was simulated in the Cape Fear-Neuse hydrologic model to test the ability of the proposed source selections to meet demand, and analyze impacts.

Alternatives D3 and F5 would be excellent candidates for future modeling and analysis, as they would provide insights into the ability of the hydrologic system in our region to meet increased future demands.

SECTION IX. Impact Analysis and Modeling

Scenarios with the Cape Fear – Neuse River Basin OASIS Model

The JLP modeled water supply alternatives using the combined Cape Fear-Neuse River Basin hydrologic model, building upon scenarios created by DWR for the purpose of river basin planning. There are existing interbasin transfers between the two basins, so to accurately model regional water supplies it was advantageous to include both basins in the model. The Cape Fear-Neuse River Basin OASIS hydrologic model simulates the operations of all major withdrawals and discharges within the two basins and their interaction with 'natural hydrology'. The natural hydrology inputs in the model are constructed to simulate over 80 years of streamflow records throughout the whole basin, for which the effects of anthropogenic water management have been removed. All of the JLP modeling scenarios use the same 80+ year hydrologic record. The model operates by using a modeling scenario that includes a set of inputs that are constant from year to year through the simulation, and then tests what happens through the variations in the historic hydrologic record.

The main strength of the Cape Fear-Neuse model is its ability to model water system operations, as well as industrial/agricultural withdrawals and discharges. For a specific modeling scenario, the way in which the water systems, withdrawals, and discharges are parameterized (e.g., total demands, withdrawal patterns, operations, and discharges ratios) is what makes the scenario distinct. Thus, a 2010 scenario could be built such that the demands (and other withdrawals), discharges, and water supply operations would match the actual 2010 behavior.

DWR has created several modeling scenarios that the JLP modified to conduct its analysis. Using Local Water Supply Plan (LWSP) data from all public water supply systems in the two basins, DWR created scenarios reflecting projected future demands for the years 2020, 2030, 2040, 2045, 2050, and 2060, in addition to a base year 2010 scenario.

The JLP focused on the 2010, 2045, and 2060 scenarios for its analysis, listed below:

- **2010 no DR** – 2010 demands and water supply sources with no drought restrictions activated (i.e., no individual water system's water shortage response plan is activated).
- **2010 w/ DR** – 2010 demands and water supply sources with drought restrictions activated (i.e., all individual water systems with a water shortage response plan that can be modeled are activated).
- **2045 no DR** – 2045 JLP demands with Preferred Water Supply Alternative sources activated and no drought restrictions.
- **2045 w/ DR** – 2045 JLP demands with Preferred Water Supply Alternative sources activated and no drought restrictions.
- **2060 no DR** – 2060 JLP demands with Preferred Water Supply Alternative sources activated and no drought restrictions.
- **2060 w/ DR** – 2060 JLP demands with Preferred Water Supply Alternative sources activated and no drought restrictions.

Preparation of JLP Data

In order to update the DWR models for the 2010, 2045, and 2060 scenarios, the first step was to ensure that the JLP water systems were represented correctly in the model and that their projected demands, monthly demand patterns, and return flow patterns were accurate. The projected demands reflected the average daily demand in the projection year as developed for this TRWSP. The demand patterns establish the monthly variation as a ratio from the average to simulate a realistic seasonal change in water demand (i.e., higher than the annual average during summer months and lower than the annual average during the winter months). Finally, the return flow factors determine the proportion of the withdrawn water that gets returned as wastewater discharge.

As part of this TRWSP, each member of the JLP worked to update their monthly demand pattern for the OASIS modeling effort. In general, the monthly demand patterns reflect actual average monthly water use/production data for the years 2007 to 2012. The JLP members also worked to update or develop return flow patterns for their wastewater discharge(s). The return flow patterns specify the portion of the monthly water delivery that is sent to a given wastewater treatment plant. For systems with multiple wastewater treatment facilities, multiple patterns were required. In general, the wastewater return flow patterns were calculated based on water use/production and wastewater treatment plant discharge data from years 2007 to 2012. All of the demands, demand patterns, and wastewater return factors were subsequently submitted to DWR for incorporation into their updated model scenarios.

Development of JLP Scenarios for Modeling

The DWR 2010, 2045, and 2060 scenarios establish the basis for modeling the water supply alternatives, because they use the best available demands/demand projections for all of the water systems in the two basins, of which the JLP members are a subset. In the DWR's future modeling scenarios (2045 and 2060), the demands were updated, but the water supply configurations and operations were based on the current (2010) operations.

To create the JLP modeling scenarios, the water supply configurations and operations of the JLP water systems were modified to represent the regional water supply alternative being modeled. The modifications include adding nodes or arcs, changing factors and constants, and/or altering the system operations coding. The changes to the model included adding the new sources or expansions developed through the TRWSP and enabling the water systems to use these additional supplies such that the model scenario reflects the future water supply alternative. The JLP recommended water supply alternative (A1) was developed into modeling scenarios for 2010, 2045, and 2060.

Increased stream withdrawals – No changes in the model schematic (the modeled relationships between withdrawals, discharges, streams and reservoirs) were needed for increasing stream withdrawals if no other sources were present. More water is simply taken from the appropriate stream model node until the demand is met (assuming there is sufficient supply and does not conflict with other operating rules). For Pittsboro, which is planning to have a stream withdrawal and a Jordan Lake allocation, the system operations were updated to balance the demand between the two sources.

- Sanford's increased withdrawal from Cape Fear River required no changes to the model schematic.

- Holly Springs' purchase from Harnett County required no changes to the model schematic, since Harnett County is represented by a node withdrawing from the Cape Fear River. There is a constraint to limit purchases to 10 MGD, as stated in the water purchase contract.

- Pittsboro's increased withdrawal from Haw River required no changes to the model schematic; System operations were coded to equally balance demand between Haw River and Jordan Lake in 2045 and 2060.

Increased Jordan Lake allocations – For systems currently using Jordan Lake, the constants that set the water supply account size and initial storage were changed in the model. This included:

- Cary-Apex, Morrisville, Wake County RTP South use Jordan Lake as their only source, so the primary changes were to modify the water supply storage accounts. Led by the Town of Cary, these partners created some new operational code to more faithfully represent the operations of the CAWTF and the delivery to the demand nodes.

- Holly Springs' use of Jordan Lake was activated when needed to augment their supply from Harnett County. Jordan Lake was used when Holly Springs' monthly demand exceeded 10 MGD, to cover the portion not met by the Harnett County contract.

Western Intake and WTP added, accounts added and modified – A new node was added to represent the proposed Jordan Lake Western Intake and WTP which is currently being studied jointly by several JLP members, and new arcs were added to connect the node to Jordan Lake and to the demand nodes in the 2045 and 2060 model scenario. The system specific changes include:

- Durham was connected to the new WTP and its full recommended allocation of 16.5% of the storage pool (estimated to yield 16.5 MGD) was activated as a constant source. Lake Michie and Little River Reservoir provide the remaining supply, and operate according to the existing reservoir balancing rules in the baseline model. Minimum release requirements are added to both Lake Michie and Little River Reservoir in accordance with those proposed in the Brown WTP Environmental Assessment.

- Pittsboro was connected to the WTP with its demand split equally between Jordan Lake and the Haw River. A new Jordan Lake water supply account was added for Pittsboro.

- Chatham County was connected to the new WTP and the arcs representing connections to the existing Cary/Apex Jordan Lake intake were removed.

- OWASA was connected to the new WTP and the Jordan Lake supply was weighted with a low priority so it will only activate when OWASA's other supplies are restricted. The Jordan Lake allocation is used as an emergency source when Cane Creek Reservoir's usable storage falls below 40% full.

- Orange County was reconfigured in the model to have its own demand mode and an interconnection with Efland-Mebane. The demand was balanced between the sources to simulate the Graham-Mebane reservoir providing water for the Buckhorn EDD and Jordan Lake providing water for the Hillsborough and Eno EDDs from a new Western Intake and WTP. Return flows were also split for the three EDDs to the appropriate WWTPs via Graham-Mebane, Hillsborough, or Durham.

- Hillsborough was connected to the new WTP and the Jordan Lake supply was weighted with a low priority so it will only activate when Hillsborough reaches Stage III water shortage response. Hillsborough's water shortage response demand reductions were also added to the model.

Reservoir Expansions – For systems that plan to expand existing reservoirs, stage-storage relationships and system operations were updated in the model. These included:

- Hillsborough's planned expansion of the West Fork of the Eno Reservoir was updated in the model. The West Fork Eno Reservoir was raised by 10 ft, and the Stage II and Stage III drought trigger elevations were adjusted accordingly. These updated triggers result in equivalent percentages of storage remaining as under the old plan. All changes were made based on information provided by Hillsborough based on its state-approved plan for expanding the West Fork Eno Reservoir.

- OWASA's planned expansion of the Quarry Reservoir was updated in the model along with the reservoir system operations, but the balance between Cane Creek Reservoir, University Lake, and Quarry Reservoir remained largely the same.

- Raleigh's potential expanded use of water supply storage from Falls Lake was updated.

New Reservoirs/Off Stream Storage – New water sources were added or activated for Raleigh in the model along with rules for balancing the demand based on the proportion of total yield.

- Raleigh's potential Little River Reservoir in eastern Wake County was already in the model, but was activated for the JLP 2045 and 2060 scenarios.

- Raleigh's potential quarry storage near Richland Creek was added to the model for the 2060 scenario along with operational parameters for filling and using the quarry storage.

Caveats for Model Scenarios

Operating rules for new sources are very simplified – In general, the calibrated 2010 Cape Fear-Neuse hydrologic model is designed to simulate water supply operations in the year 2010. Bringing new sources online requires new operating rules to integrate operation of the new source with existing sources. The code to operate these sources was kept as simple as possible, and may not reflect actual operations should these sources be built and integrated into the water supply portfolio with existing sources.

Water Shortage Response Plan rules not updated for future conditions – The 2045 and 2060 scenarios with drought restrictions (i.e., water shortage response plans activated) should be used cautiously. The water shortage response plans (WSRP) used in these scenarios were not, in most cases, updated from the 2010 scenario. Thus, for systems with modified sources or new sources added to their water supply portfolio, the WSRP triggers may not be correlated with actual risk of shortage. Modifying WSRP plan triggers is an iterative exercise and requires many levels of review and approval. Additionally, the demand reduction goals associated with the drought stages may be different in the future than they are currently. These additional modifications were not within the scope of this study.

Incomplete modeling of non-Jordan Lake Partnership systems – For water systems not within the Jordan Lake Partnership, the future scenarios include updated demand values based on the Local Water Supply Plans submitted to DWR, but no other changes have been made to future water supply scenarios for these systems, such as new sources.

Industrial and agricultural water use and return flows held constant – Relative to the 2010 scenario, no changes were made to industrial or agricultural demand nodes or inflow nodes. The general assumptions are that agricultural water use has been declining and will not increase in the future, and future industrial use is included in each water system's demand projection.

No infrastructure capacity constraints – With few exceptions, the OASIS model as currently set-up does not consider the capacity of water treatment and transmission infrastructure. It is assumed that if water is available in a source, and the operation rules allow using it, then there is sufficient WTP capacity to treat it, and sufficient distribution capacity to get it to customers.

Key Metrics for Analysis of Modeling Results

The OASIS model runs on a daily time step, meaning that results for every day of the simulation can be provided for every arc, node, and user defined variable in the model. For the purposes of assessing the JLP modeling scenarios, several key metrics were examined as described below.

Water Shortage

The first metric was to examine whether any of the partners or downstream water users experienced water shortage during the simulation, meaning that the model simulation resulted in the inability of a water system to meet its demand. *The model results indicated that all of the water systems, both upstream and downstream, were able to meet their demands for all days without activating their individual water shortage response plans and no water shortages were experienced*. This was true for both scenarios without water shortage response plans activated in the model (i.e., no drought restrictions), and also with WSRPs activated (with drought restrictions). This means that the water supplies that comprise the JLP Recommended Alternative are able to meet the future water demands of the region under the full range of recorded hydrologic conditions, while at the same time allowing other water users to meet their own future water demands.

Water Shortage Response Plan Activation

All of the JLP scenarios included the Corps' drought response protocol for Jordan Lake, in which the downstream flow target at Lillington and Jordan Lake releases are reduced as storage in the low flow augmentation (water quality) pool decline. The OASIS model also has the ability to simulate the activation of individual water shortage response plans for systems whose plans are triggered by physical conditions that can be simulated in the model such as percent storage remaining or reservoir elevation levels.

The DWR update to the OASIS model incorporated many of the water shortage response plans for the systems in the basins. However, many of the water shortage response plans were developed for current, near-term conditions and may not be appropriately configured for future conditions. As such, the 2045 and 2060 JLP modeling scenarios were run with and without individual system water shortage response plans. It is important to note that without activating the individual water shortage response plans in the future modeling scenarios, the model still resulted in no water shortages. Therefore, in reality, when water shortage response plans would be activated under drought or

emergency conditions, water supplies would be expected to be more resilient than shown in the model. In this way, the JLP modeling scenarios without water shortage response plans represent a worst case scenario under the 80+ year hydrologic conditions in the model. Modeling results of future scenarios with individual water shortage response plans activated confirmed this, even though the water shortage response plans were not updated to reflect the future water supply conditions.

Storage in Important Reservoirs and Water Supply Accounts

Another metric examined in interpreting the results was the storage levels in several key reservoirs, including the reservoirs of the JLP members and the storage accounts for Jordan Lake. This can be assessed by the minimum available storage reached, and the frequency that storage falls below a threshold. One of the more important metrics is the amount of time or frequency that the reservoirs used by the JLP members go below certain thresholds. The modeling results were analyzed by the monthly minimum storage for the key reservoirs and water supply storage. Table 20 shows the overall simulation period minimum for each reservoir and water supply account, organized by partner. The color coding indicates the year in which the minimum value occurred. For completeness, the WQ pools for both Jordan Lake and Falls Lake are also shown.

Future modeling scenarios show reservoirs are drawn down more often and to lower levels than the 2010 scenario, as would be expected, but none of the reservoirs failed to meet demands. The results demonstrate that OWASA and Hillsborough would have experienced supply failure in the 2060 scenario were it not for their emergency Jordan Lake allocations.

Table 20. Minimum storage (% of usable storage) for key reservoirs and allocations, period of record (1930-2011). Color coding indicates year of minimum.

		Scenario					
Partner/Node	Source Name	2010 noDR	2010 wDR	2045 noDR	2045 wDR	2060 noDR	2060 wDR
Cary Apex							
470	Jordan Lake WS Allocation *	78.2	76.5	25.8	28.7	20.7	28.4
Chatham County N							
470	Jordan Lake WS Allocation *	86.8	85.5	37.5	43.8	34.1	44.2
Durham							
1140	Lake Michie	18	28.8	22.8	39.1	8.6	29.2
1200	Little River Res. (Durham)	39	47	42.5	54.6	31.9	46.9
470	Jordan Lake WS Allocation *	99.6	99.5	41.2	34.4	37.1	32.5
Hillsborough							
1050	W. Fork Eno Reservoir *	50.7	50.8	31.7	31.8	16	17
1060	Lake Orange	0	0	0	0	0	0
470	Jordan Lake WS Allocation **	NA	NA	32.3	52.8	0	0
Holly Springs							
470	Jordan Lake WS Allocation *	99.1	99.1	97.2	97.2	95.2	96.5
Morrisville							
470	Jordan Lake WS Allocation *	81.5	79.9	21.6	24.7	16.7	24.5
Orange County							
470	Jordan Lake WS Allocation *	NA	NA	43.9	36.9	35.3	32.7
OWASA							
430	University Lake	53.6	53.6	37.4	50.9	0	0
390	Cane Creek Reservoir	22.2	22.2	2.7	9.6	0	0
395	Quarry Reservoir *	98.7	98.7	0	0	0	0
470	Jordan Lake WS Allocation	99.6	99.5	65.8	68.8	3.3	37
Pittsboro							
470	Jordan Lake WS Allocation **	NA	NA	51.2	44.3	36.9	34.3
Raleigh							
1420	Lake Wheeler	29	29	0	0	0	0
1440	Lake Benson	51.8	51.8	29	29	2.2	2.2
1740	Little River Res. (Wake) **	NA	NA	33.9	34.1	34.7	34.7
1291	Raleigh Quarry Option **	NA	NA	NA	NA	87.5	87.5
1300	Falls Lake WS Pool *	31.4	32.5	8.7	13.6	17.4	20.7
Wake County - RTP South							
470	Jordan Lake WS Allocation	95.9	95.1	30.7	33.5	23.5	30.9
Jordan Lake Water Supply Pool - Total		91.5	90.7	44.1	45.6	29.9	38.6
Jordan Lake WQ Pool		22.6	21.0	33.5	30.4	31.7	30.2
Falls Lake WQ Pool		15.3	13.7	27.1	25.7	28.4	27.1

Notes: Color coding is by year with minimum storage.

1932 1953-1954 2002 2007-2008 Other (1934, 1962, 1982, 1985)

* Size of storage allocation changes between scenarios ** Source is not online for all scenarios.

The storage in Jordan Lake can also be viewed as a time series so that the relative magnitude of different droughts can be compared. Figure 12 and Figure 13 show the monthly minimum storage for 1930-2011 simulation period for the three scenarios, for the Water Supply (WS) and Water Quality pools, respectively. The results are shown for only the scenarios in which no drought restrictions for individual systems were modeled. Plotting the monthly minimum storage tends to exaggerate the drawdown in the storage pool, as the plotted values represent the single lowest storage day each month. (Similar plots for many more reservoirs are available in the appendices.)

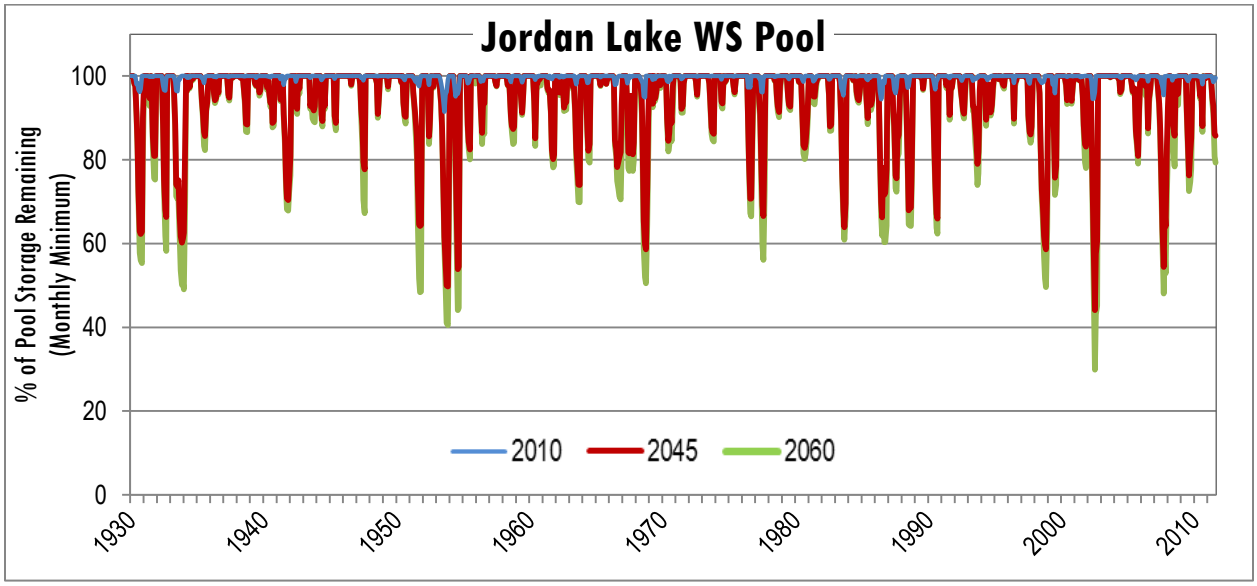


Figure 12. Jordan Lake Water Supply Pool monthly minimum storage through the simulation period, by scenario.

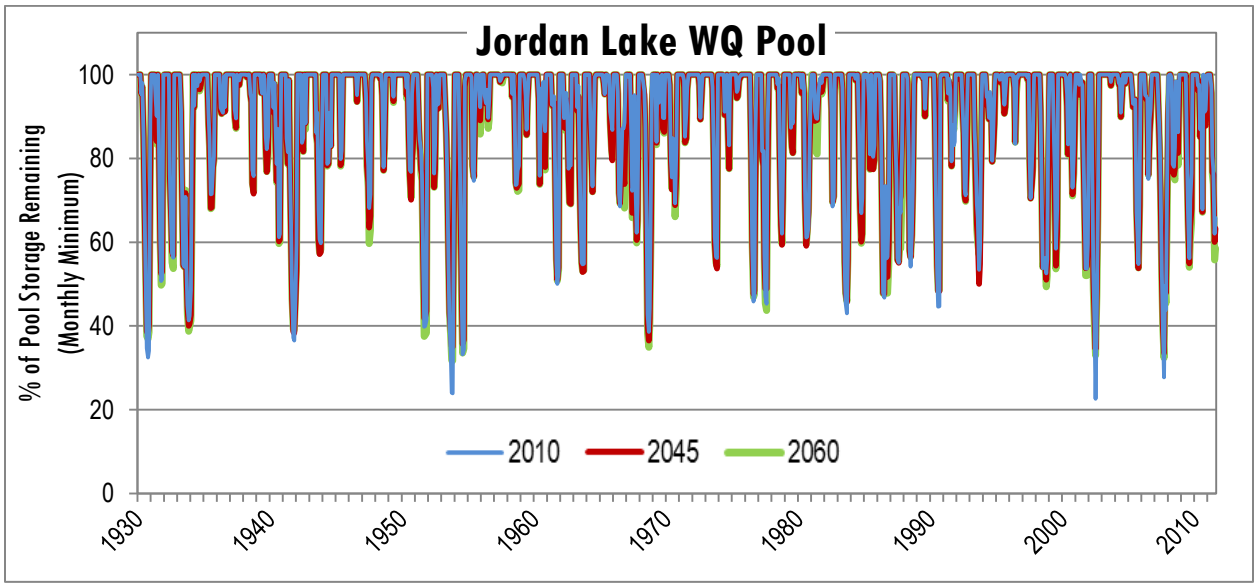


Figure 13. Jordan Lake Water Quality Pool monthly minimum storage through the simulation period, by scenario.

The storage in the Water Supply and Water Quality pools can also be viewed as a cumulative distribution or exceedance probability plot. On the vertical axis of Figure 14 and Figure 15 is the storage percentage, and the horizontal axis shows the corresponding probability of non-exceedance. The non-exceedance probability can be more conveniently thought of as the portion of time in the

simulation at or below the given storage. For example, if the storage is 38% at a horizontal axis value of 0.1, that indicates the storage was at 38% or below for 10% of the total simulation time. Each of the plots is shown in two ways. First, in standard format on the left, and then the same data is shown on the right with the horizontal axis logarithmically transformed in order to more clearly show the lower end of storages. The overall minimum storage for each scenario is indicated on the right-hand plots.

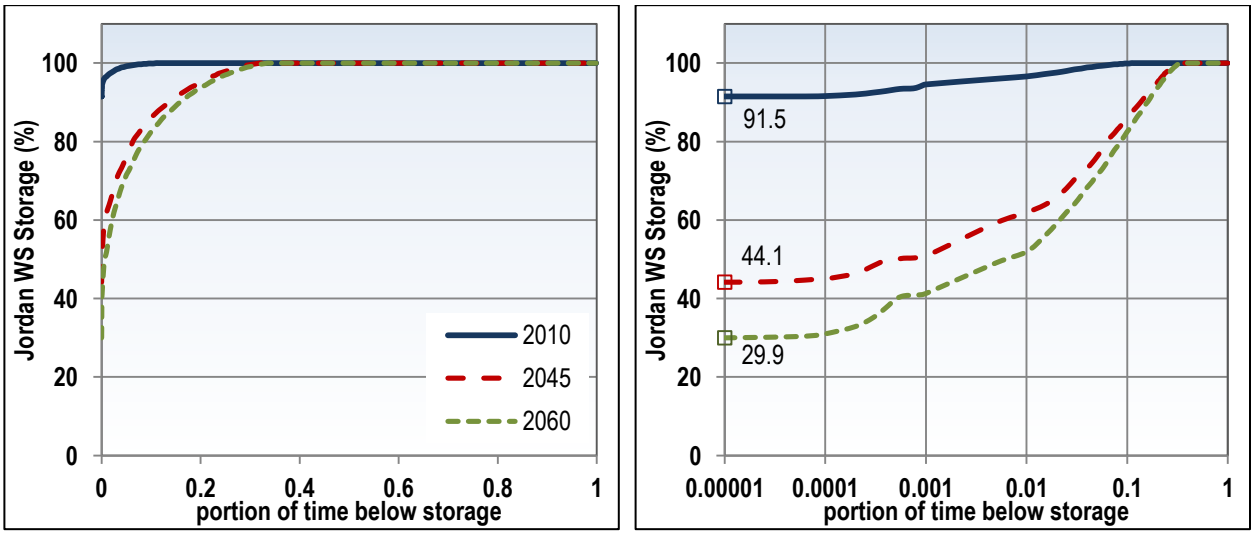


Figure 14. Jordan Lake Water Supply (WS) Pool storage percent full versus portion of time below storage indicated. In the right plot, the horizontal axis is logarithmically transformed to show the lowest storage more clearly.

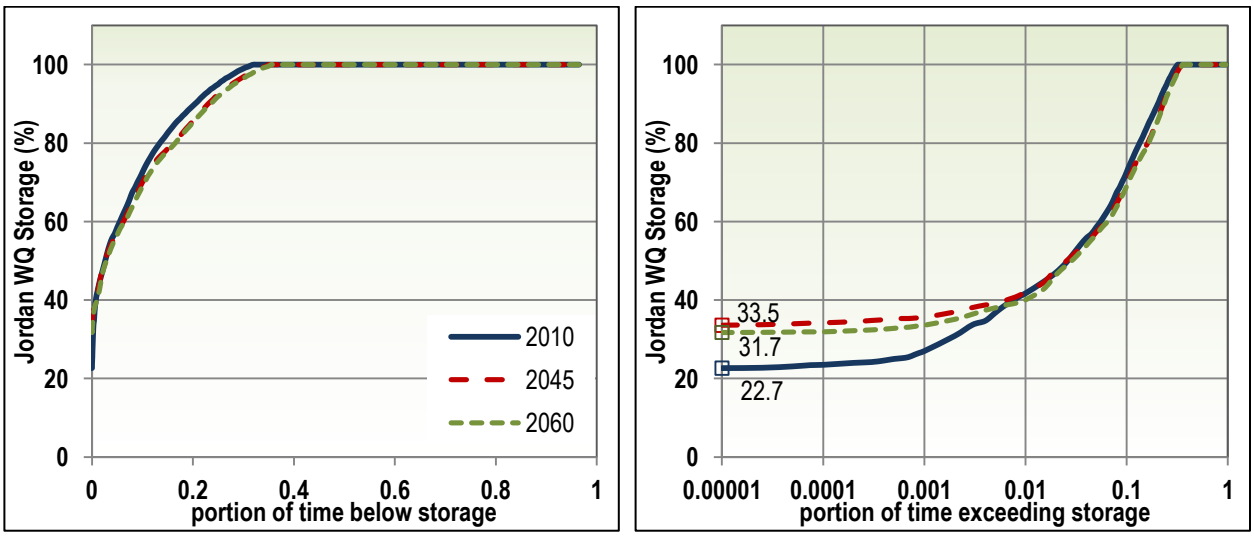


Figure 15. Jordan Lake Water Quality (WQ) Pool storage percent full versus portion of time below storage indicated. In the right plot, the horizontal axis is logarithmically transformed to show the lowest storage more clearly.

Elevation information on a seasonal basis is also a useful metric for resource planners. Figure 16 shows the yearly pattern of monthly minimum Jordan Lake elevations. The lowest set of lines shows the overall minimum for the relevant month in the simulation period. The middle set of lines shows the 10th percentile of minimum monthly elevations, and the upper set of lines shows the median monthly minimum elevation. With this information, the seasonal range of lake drawdown can be assessed. While the overall minimum reflects a significant drawdown, more than 90% of the time

there is a much less severe seasonal reduction in elevation. Additional modeling results are included in Appendix F.

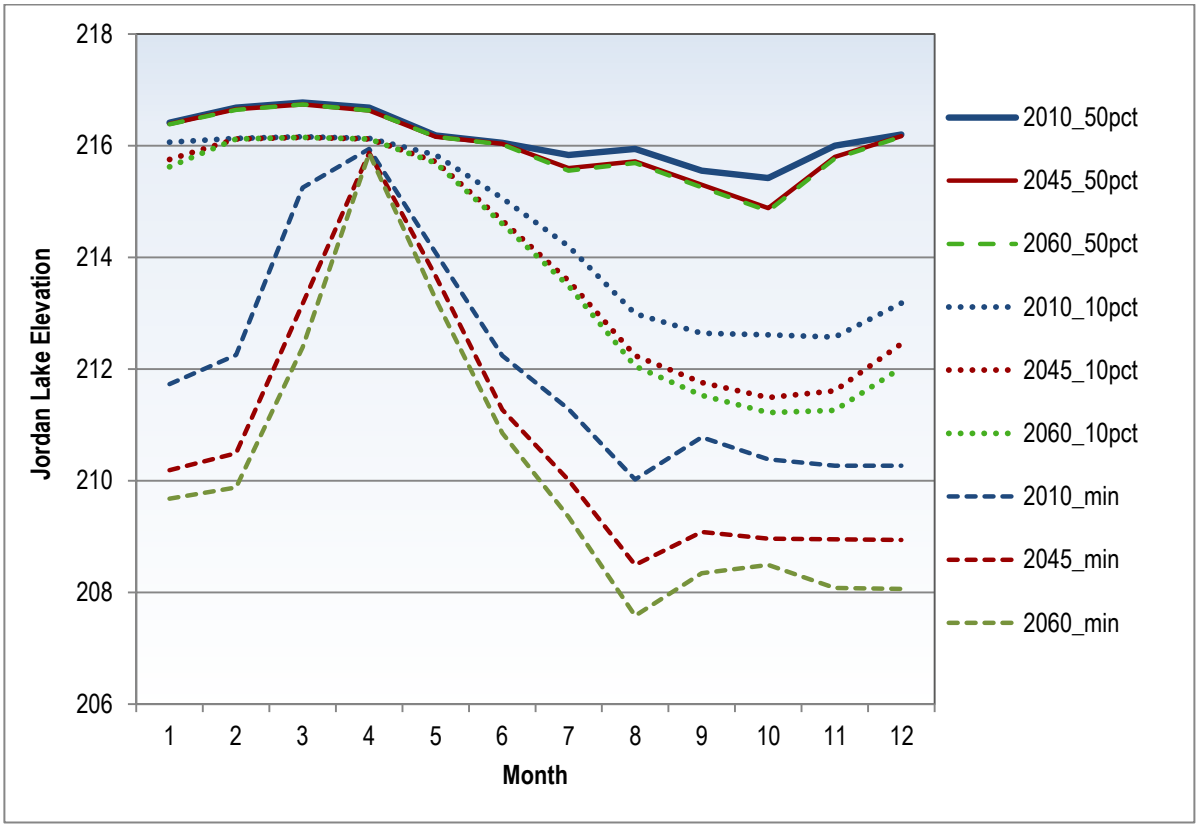


Figure 16. Jordan Lake elevation percentiles (monthly minimum): 50 percent (50pct) 10 percent (10pct), and overall minimum (min).

The same storage and exceedance plots can also be generated for Falls Lake. The storage in Falls Lake can also be viewed as a time series so that the relative magnitude of different droughts can be compared. Figure 12 Figure 17 and Figure 18 show the monthly minimum storage for 1930-2011 simulation period for the three scenarios, for the Water Supply (WS) and Water Quality pools, respectively. The results are shown for only the scenarios in which no drought restrictions were modeled. Exaggerate. Also note that the water supply storage volume in Falls Lake in 2045 and 2060 is increased to account for the proposed future reallocation of Falls Lake.

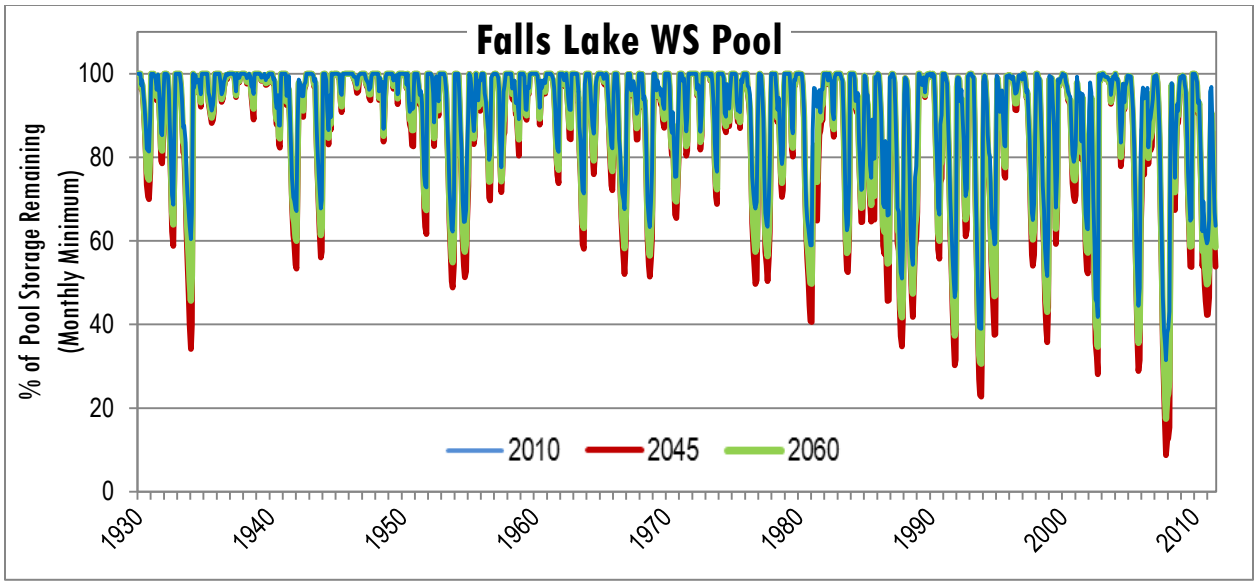


Figure 17. Falls Lake Water Supply Pool monthly minimum storage through the simulation period, by scenario. Note that the storage volume in 2045 and 2060 is increased to account for the potential future reallocation of Falls Lake.

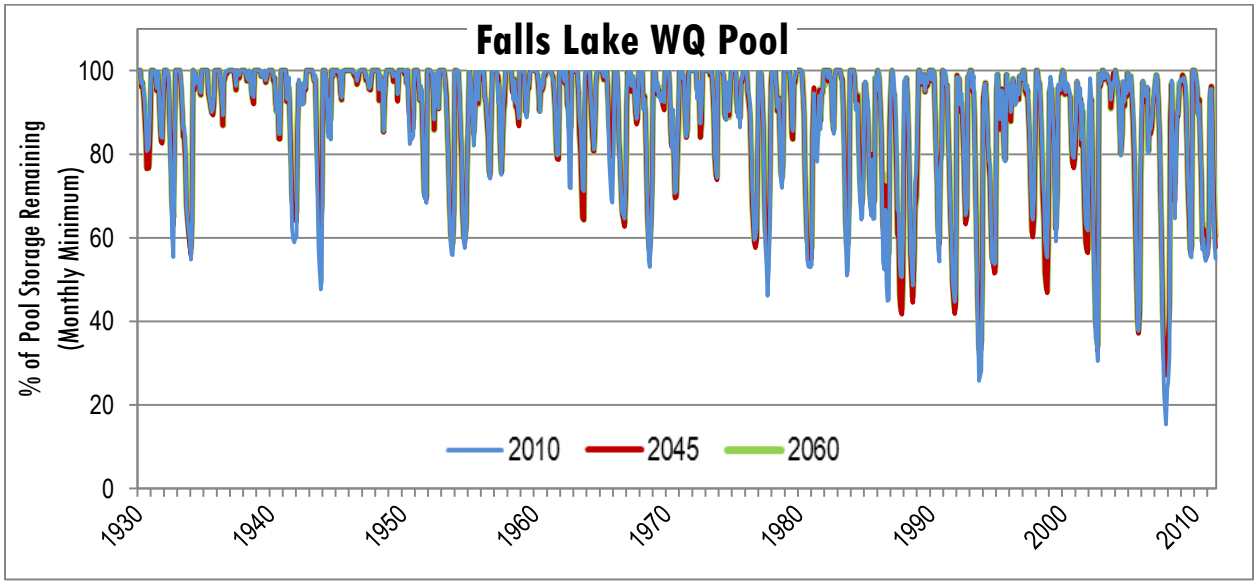


Figure 18. Falls Lake Water Quality Pool monthly minimum storage through the simulation period, by scenario.

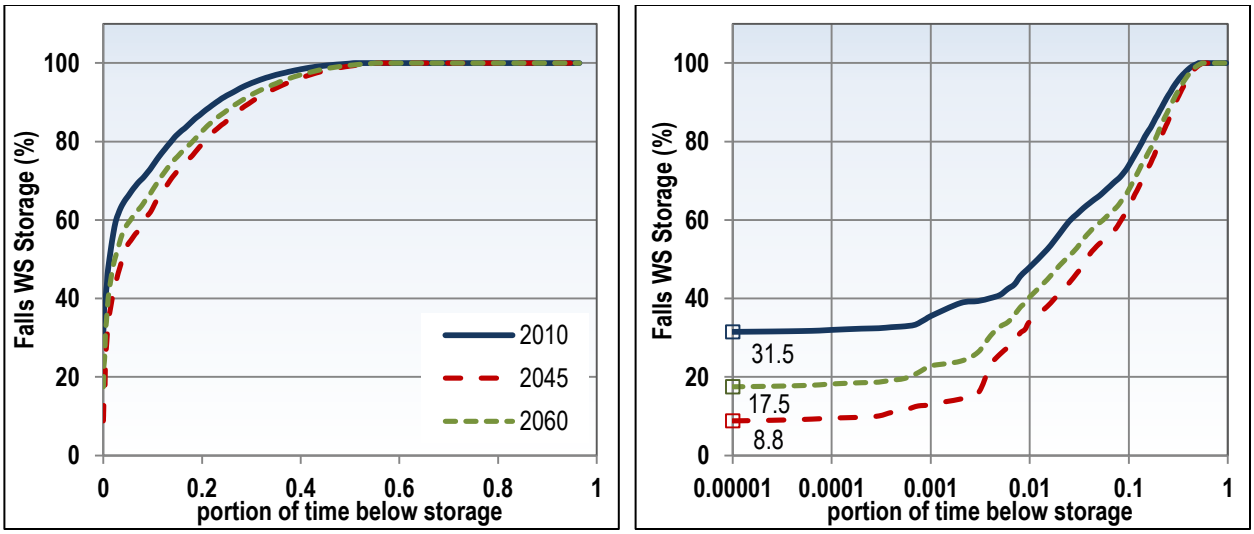


Figure 19. Falls Lake WS Pool storage percent full versus portion of time below storage indicated. In the right plot, the horizontal axis is logarithmically transformed to show lowest storage more clearly.

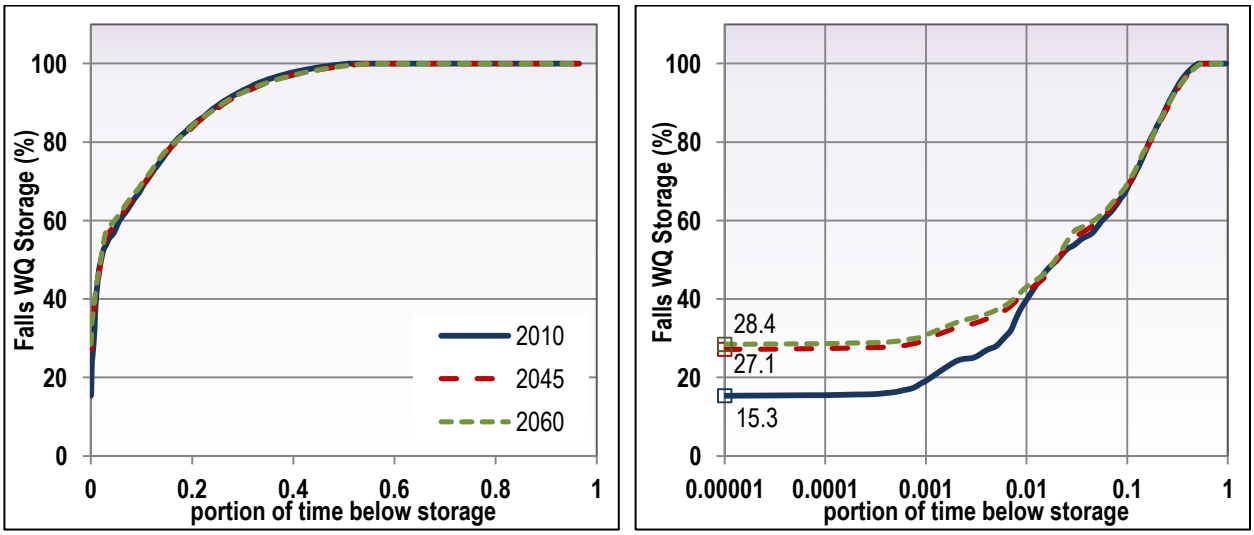


Figure 20. Falls Lake WQ Pool storage percent full versus portion of time below storage indicated. In the right plot, the horizontal axis is logarithmically transformed to show lowest storage more clearly.

Flow changes at water withdrawals and other key locations

A final key metric used to interpret the modeling results was the examination of the degree to which the flows at various points of interest change relative to the baseline scenarios. Several locations of interest were analyzed including the outflow from Jordan Lake and river withdrawal locations downstream of Jordan Lake (Haw/Cape Fear River, Table 21) and Falls Lake (Neuse River, Table 22). For the Cape Fear River, the JLP zone of influence stops below Lillington. That is, any changes to flow below Lillington are not affected by changes to water supply operations by the JLP members.

For the Neuse River, the first location of interest is the Clayton gage, which is strongly affected by both Raleigh's and Durham's operation of reservoirs on the Upper Neuse (including Raleigh's withdrawals from Falls Lake). The lower bound of the JLP zone of influence technically extends to the Neuse's Contentnea Creek confluence due to Raleigh's Little Creek WWTP discharging in that

subbasin, but the flow from the WWTP is quite small. For the most part, the JLP zone of influence stops at the Neuse and Little River confluence above Goldsboro.

Table 21. Haw/Cape Fear locations of interest for flow changes.

ID	Location	Description.
C1	Cape Fear R. upstream	Haw River at Haw River plus Big Alamance Creek (reflects all upstream users above JLP influence)
C2	Haw River at Bynum	Above Pittsboro intake
C3	Jordan Lake Inflow	Total Jordan inflow (excluding WTP process discharge)
C4	Jordan Lake Outflow	Release from the Jordan Dam
C5	Cape Fear R. below Sanford	Cape Fear below Sanford Intake
C6	Cape Fear R. at Lillington	Cape Fear at the Lillington gage (below Harnett County intake)

Table 22. Neuse River locations of interest for flow changes.

ID	Location	Description.
N1	Neuse R. at Clayton	Flow at the Clayton Gage (above Johnston intake 1)
N2	Neuse R. at Smithfield	Above Smithfield gage (above Smithfield intake)
N3	Neuse R. at Smith Creek confluence	Smith Creek confluence (above Johnston intake 2)
N4	Neuse R. at Little River confluence	Little River confluence (above Goldsboro intake)
N5	Neuse R. at Goldsboro gage	Flow at the Goldsboro gage (above NRWASA intake)
N6	Neuse R. at Kinston	Flow at the Kinston gage
N7	Neuse R. below Contentnea	Below Contentnea confluence (above Weyerhauser)

At all of these locations several flow metrics were analyzed to determine how flow changes between the 2010, 2045, and 2060 scenarios. The flow metrics examined in this report are shown in Appendix F and include the average flow, the median flow, the 20th percentile flow, and 80th percentile flow. The results of the 2045 and 2060 model runs with and without water shortage response plans activated is shown side-by-side as a change in flow and a percent change compared to the 2010 scenario. Locations are grouped along the x-axis from upstream (left) to downstream (right). A positive bar indicates an increase in compared to 2010 and a negative bar indicates a comparative decrease in flow.

The results indicate that the Neuse River sees a net increase in flow in the 2045 and 2060 scenarios at all locations for low (20%), median and average flows compared to the 2010 scenario. These flow changes start below the Clayton gage, which indicates that even with Raleigh's increased demand, the models shows that flow will be sufficient to meet the Neuse flow targets, and in fact, flow increases somewhat. Flows further downstream are much more influenced by changes to demand from downstream users. High flows (80%) downstream of the confluence with Little River are nearly unchanged (~0.01% change) in the 2045 and 2060 scenarios.

The flow change metric graphs in Appendix F for the Cape Fear River indicate that the lower (20%) flows in the Haw/Cape Fear River are either unchanged or slightly increased in the 2045 and 2060 scenarios compared to the 2010 scenario. Modeling shows that average, median and higher flows (80%) below Jordan Lake (C4 - C6) are approximately 5% to 10% lower in the 2045 and 2060 scenarios. Upstream of Jordan Lake (C1 – C3) median and average flows are shown to increase in 2045 and 2060 scenarios, and higher (80%) flows would be nearly the same as the 2010 scenario.

These results indicate that there is very little effect on flows at key locations in the Neuse and Cape Fear Rivers. During low flow periods, the rivers could have an insignificant effect or even a net increase in flow under the 2045 and 2060 conditions compared to the 2010 conditions.

SECTION X. Other Considerations

The TRWSP sets a broad framework for future development of water resources in the Triangle Region, and the JLP has explicitly considered many of the relative benefits and impacts of the various water supply alternatives. There are, however, other considerations and uncertainties that could impact future planning and implementation of this water supply plan, and in turn, the ability of each partner to meet its future water supply needs. The TRWSP conclusions hinge on the accuracy of many assumptions, on Jordan Lake water supply allocations consistent with Table 1, and on each Partner implementing its water supply projects. Implementing the regional water supply plan will require many complex projects, with numerous regulatory and environmental challenges. Key uncertainties include:

- Rate of population growth;
- Adoption of water efficiency and conservation practices including reclaimed water use;
- Water quality policies, environmental permits, endangered species impacts, environmental justice concerns or evolving regulations, especially as they relate to the development of new water supply sources;
- Legislative and/or regulatory actions regarding competing water uses; and
- Declining source yields due to issues such as hydrologic variability (from climate and/or land use impacts), faster than assumed sedimentation of reservoirs or changes in required downstream releases.

Uncertainty in Growth Projections

Making 50-year projections of growth is subject to considerable uncertainty, and even small deviations from projections, when compounded over time, can lead to significant deviations over 50 years. The sources of uncertainty are many and can influence the projections either up or down.

One significant source of uncertainty creating potential upward pressure on the projection is a change in the service area or land use planning for the area. Since the Holly Spring-Apex planning areas have been resolved, it is not anticipated that the 2060 service areas of the JLP member will change significantly. Zoning changes are more likely. Notably, a major change in the zoning of a large tract would change the basic assumptions for that land area in the projections. Two notable examples that have already surfaced include the new Master Plan for Research Triangle Park, and the Chatham Park development in Pittsboro's ETJ. The RTP Master Plan changes the type of development (as it includes more residential and commercial development), while the Chatham Park development would accelerate the timetable for growth in Pittsboro and increase the development intensity assumed for the Chatham Park land area. These kinds of changes in development assumptions are an inevitable source of uncertainty in projections. The net effect of these changes is likely toward higher water use, but the scope of the increase is somewhat controlled by the fact that parcel-based land use projections are bounded, because they place reasonable limits on the area that is developable. Furthermore, there are likely to be other areas in the service area that do not grow as quickly as projected.

Another source of uncertainty is the assumed water use rates. The water use by a specific sector in a system's projection depends on the assumed growth rate of the sector (as measured by a metric like

households, employees, building area, or number of connections) and by the expected water use rate. Just as growth projections have some inherent uncertainty, assumptions about the water use per unit could change over time as well. Notably, changes in the composition of a sector could lead to increases or decreases in water use rates. For instance, a town's industrial base shifting from primarily food and industrial materials processing to specialty technology manufacturing may see a decline in water use per industrial user. Whereas, a fast growing town whose older housing stock includes smaller, rural housing, may see an increase in per capita residential use if the new houses are 50% larger on average, and have large irrigated lawns. JLP members considered these potential shifts in sector composition over time and worked to factor this into their projections, but it should be noted that there is still some potential that the future composition and subsequent water use could differ from what was expected.

But mostly, the water use rates could also undergo a shift based on user behavior or a technology change that affects water use efficiency. Many of the Partnership members' projections include a reduction in per capita usage to partially account for these anticipated improvements in efficiency. Still, paradigm shifts in technology could cause unforeseen changes to the way water is used. For example, 'smart' infrastructure technology could become widely adopted in homes and businesses, and 'smart' irrigation controllers are already seeing adoption in the Triangle Region. Technology could also prompt some behavior changes. As one example, the Town of Cary has implemented advanced metering infrastructure that is capable of communicating to customers when their water use approaches a new block rate billing tier.

Water Quality Issues and Regulations

Water supply planning is only one of the water related issues that local governments must face. The local governments in the Jordan Lake Partnership are also required to address a range of water quality and regulatory issues, such as water quality impairments and interbasin transfers.

Jordan Lake itself is listed as impaired for chlorophyll-*a*, indicating it has eutrophication issues, caused in part by an excess loading of nutrients (nitrogen and phosphorus) to the lake. The Jordan Lake Rules, which received final approval from the legislature and EMC in 2009, establish a nutrient management strategy for the watershed area draining to Jordan Lake. The rules establish an adaptive management strategy, but primarily, define nutrient loading reductions to be achieved from several source types in the watershed. Notably, the rules affect local governments by requiring reductions from existing development, point sources including wastewater treatment plants, and establish nutrient thresholds for new development.

Portions of the Jordan Lake Rules' implementation have been put on hold by the legislature, though further study is continuing to quantify jurisdictional load allocations. The nutrient limitations will require the water suppliers with WWTPs in the Jordan Lake watershed to spend more money on wastewater treatment technology.

Similarly, Falls Lake is impaired for chlorophyll-*a*, and the most strict rules in the State's history have been enacted to improve water quality in the lake. The Falls Lake Rules are entering Phase I implementation, which includes monitoring and preliminary control measures. The second phase of implementation will begin enforcing strict limits on nutrient loading to Falls Lake, and require local governments, utilities, private developers, and agriculture to implement measures that reduce nutrient loads to the lake. Notably, the Falls Lake Rules' targeted nutrient reductions will necessitate substantial upgrades to WWTPs discharging in the Upper Neuse Basin in order to significantly reduce

effluent nitrogen and phosphorus concentrations. As population grows, so does total discharge volume, which lowers further the target concentrations.

The net effect of the Jordan and Falls Lake Rules on water quality in the lakes is not yet known, and the laws are likely to have an influence on future water supply uses of the lakes. The water quality benefits in the form of nutrient loading reductions (and also ancillary reductions in suspended solids, sediment, metals, and toxics due to nutrient reduction measures) will be beneficial from a water supply treatment perspective as the higher quality water is easier to treat. On the other hand, a significant portion of the cost of implementing these nutrient strategies falls on many of the same local governments that are involved in this TRWSP. The timing of water quality control infrastructure upgrades, especially at WWTPs, will have some influence on the capacity of local governments/water systems to design, permit, and build water supply infrastructure.

Another potential effect of the regulations is to alter future wastewater discharge volume and location. Meeting the nutrient reduction targets will be difficult for some WWTPs, especially as total wastewater flow increases. Especially for water systems that span multiple basins, redirecting wastewater to a WWTP that discharges in a basin with lower nutrient requirements may be a viable and economic option, depending on the cost of the WWTP upgrades needed to meet new regulatory requirements. Besides having potential IBT implications, changing the amount of or location of wastewater discharges could have impacts on downstream water availability. On the other hand, the economics of lowering wastewater discharge through water reuse could become more favorable compared to the cost of upgrading the WWTP treatment efficiency. In that case, discharges could be lower, but in theory, so would withdrawals from water supply sources as reuse water would displace some of the potable demand.

Competing Uses

The Region's reservoirs and rivers serve multiple purposes including water supply sources, but there are other uses, both natural and anthropogenic, with legitimate competing needs for water. Furthermore, this competition for use of the water plays out over both space (upstream vs. downstream) and time (seasonal variations in use and water availability).

Higher than expected water withdrawals from upstream systems can impact the flow assumptions that were used to calculate (or simulate in a modeling scenario) the available water supply of several sources. This includes upstream users outside of the Triangle Region such as the City of Greensboro as well as other more nearby towns in the Haw River basin. Water use upstream of Jordan Lake can directly impact inflows to Jordan Lake.

There are also competing water users in the Triangle Region. For instance, many of the reservoirs operated or used by JLP members are multi-purpose lakes also used for recreation (e.g. Jordan Lake, Falls Lake, University Lake, Cane Creek Reservoir, Lake Benson, and others). While generally secondary to water supply, sustained periods where lake levels are too low for recreation are undesirable. Another potential water use with potential for conflict with water supply is hydropower. The current owner of the Bynum Dam near Pittsboro is investigating installation of hydropower turbines in combination with dam upgrades. As Pittsboro's withdrawals increase, less water would be available for hydropower.

The State of North Carolina is also considering ecological flow requirements for streams and rivers. These requirements could limit the amount of water that can be taken from streams either as

withdrawals or high-flow skimming to fill off-stream storage such as quarries or for new water storage impoundments.

Finally, the State of North Carolina is considering allowing natural gas drilling via hydraulic fracturing. Some of the best potential gas reserves in North Carolina are in Chatham, Lee, and Durham counties, which are in the JLP water systems' service areas or contributing watersheds. The hydraulic fracturing process requires a substantial amount of water for mixing the fluid injected to fracture the gas bearing rock layers. The demand for mining water could potentially reduce supply by reducing streamflow upstream of JLP water sources. The amount, location and timing of water usage for mining will be very important in assessing impacts on water supply.

Declining Yields

Over time, the assumed yield of water supply sources may decline for several reasons. The first reason is that a severe drought worse than any in the existing hydrologic record can lower the assumed yield of an existing reservoir. But other changes to the reservoir and the watershed can have impacts on the reservoir's yield.

Changes to the amount or pattern of inflow caused by changes in the development pattern of the watershed or changes in upstream withdrawals can have an effect on yield. While modeling can forecast some of these changes, the greater the change in watershed characteristics from the last time the yield was calculated, the greater the chance is that the calculated yield may be inaccurate. Furthermore, increased development in a watershed can mobilize more sediment, which can reduce the reservoir's water supply storage volume. While most reservoirs built in the area include sediment storage allowances, major changes to development could potentially accelerate sediment accumulation beyond initial predictions, which could in time result in a declining yield.

Interbasin transfers

In order to preserve the prevailing hydrology within a river basin, for both anthropogenic and ecological uses, transfers of water between basins (i.e. Interbasin Transfers or IBT) must be monitored. DWR is responsible for monitoring transfers of surface water by water systems from one basin to another. Primarily, this occurs when a water system's service area is split between basins, or there is a WWTP that discharges treated effluent to a different basin than the source water.

The region studied within this TRWSP is split not only between two river basins, but for the purposes of IBT, there are also several subbasin boundaries that may have an impact on the applicability of IBT for certain alternatives.

This regional water supply planning effort considered the impact of alternatives on interbasin transfer in a general sense to determine whether new interbasin transfers would be created or if existing interbasin transfer amounts would be increased, decreased, or remain roughly unchanged. This document, however, does not attempt to calculate actual interbasin transfer amounts according to DWR guidelines, which recently changed to a metric of average daily interbasin transfer flow in a maximum month.

Those Partnership members with existing interbasin transfers may need to complete IBT certificate modifications as necessary to implement the preferred alternative. Partnership members with new potential interbasin transfers will need to work with DWR to acquire new IBT permits, or set up

monitoring as required. Partnership members with grandfathered IBTs will continue to monitor and report data.

Permitting Issues

The ability of the Partnership members to implement some of the recommended water supply source options will depend in many cases on the ability to get permits for construction of the water supply source, water withdrawal, or even an expanded treatment facility. Some of the major permitting issues that will have to be dealt with for the majority of water supply alternatives include:

- State Environmental Policy Act (SEPA) and National Environmental Policy Act (NEPA) requirements specify types of environmental review that are necessary when a state or federal agency is a sponsor of the proposed project. Additional review may also be necessary for projects built on state or federal lands.
- US Army Corps of Engineers issues Section 401 permits or Nationwide Permits (NWP), which are required for almost all projects that have an impact on 'navigable' waters of the United States. http://www.saw.usace.army.mil/Missions/RegulatoryPermitProgram/Permits/NationwidePermits.aspx
- 404 permits issued by NCDENR for projects that impact water under the State's jurisdiction
- IBT Certificates issued for the transfer of water from one basin to another.

Additionally, certain special permitting requirements may have an impact on the viability of some of the sources.

- Section 216 study – Under section 216 of the Flood Control Acts of 1970 (as amended) the US Army Corps of Engineers can determine if economic or physical conditions support a change in the physical structures or operation of a Corps project. This would include reallocating pool levels on Jordan or Falls Lake. The Study would have to investigate the impacts of the change on the ability of the project to meet all of its intended uses (flood control, water supply, recreation, fish and wildlife, downstream uses). While the Corps may cover costs of initial appraisals, local cost sharing would be required for a feasibility study to make recommendations for operational changes in a report to Congress. Cost sharing would also likely be required for implementation of the changes, if approved by Congress.

Hydrology and Climate Variability

The methodology used to determine the available supply of all of the sources, both existing and proposed, is highly dependent on the hydrology records of the past 80 years or so. This creates uncertainty in two primary ways. First, the process of developing historical flow records is inexact, and requires many assumptions and extrapolations. Secondly, the hydrologic record only covers a limited period of time, and does not examine the potential consequences climate variation.

The OASIS model used streamflow, lake level, precipitation, and temperature/evapotranspiration records to create approximations of 'natural' (i.e., unregulated) flow conditions at all major hydrologic points of interest in the Neuse and Cape Fear River Basins. The completeness of the hydrologic record varies both spatially and temporally across the basin based on when and where stream gages

were installed. Accordingly, a series of hydrologic statistical techniques (e.g., drainage area ratio adjustment) must be used to modify stream gage records to develop synthetic flow records for basin locations without gages or for time periods when gages were not active. These techniques are widely accepted, and the models are calibrated to closely match conditions in a few reference years, but the hydrology used in the OASIS model (or any other basin scale model) will always lack some of the complexity and variability of natural flow sequences. Fortunately, with over 80 years of hydrologic record included in the OASIS model, a wide range of climatic conditions are represented.

But the variability of the flow sequences in the model does not take into account potential changes to the hydrology due to more extreme climate conditions. Notably, more extreme droughts with higher temperatures and lower rainfall or simply longer durations could further lower current estimates of available supply.

Many Partnership members have built in conservative assumptions to their planning to allow a contingency for such conditions. For instance, OWASA and Durham assess their reservoirs' supply while allowing a 20% storage reserve for more extreme drought. Additionally, some partners are in the process of modifying their water shortage response plan triggers in order to ensure that conservation restrictions are implemented more readily at times of year with higher risk of creating shortages in the following weeks or months. (Conversely, many drought plans lower the likelihood of triggering events at times of year when refill is more likely.)

Emergency Scenarios

One significant uncertainty is the potential for catastrophic events to render a portion of the regional water supply unusable for a period of time. A wide range of potential scenarios could occur that would necessitate quick response and could put substantial stress on the Region's water systems. These could include, but are not limited to the following:

- Natural hazards such as flooding from tropical storms, tornados, or earthquakes could pose a direct risk to water supply infrastructure (e.g., dams, intakes, pumping stations), or other critical infrastructure (e.g., electrical lines) needed for water treatment and delivery.
- Water quality risks such as chemical spills or failure of upstream impoundments/holding ponds that process industrial/mining or other hazardous waste. Natural hazards could increase the likelihood of water quality risks.
- Physical, chemical, biological, or cyber-attacks on water supply infrastructure or water supplies.

Recent events including a chemical spill in Charleston, West Virginia and failure of a coal ash pond in Eden, NC demonstrate that these types of events can happen.

In these types of emergency scenarios, a water system may become unable to safely use one or more of its water supply sources for an unknown period of time. The impact on the water system's customers could range from a small inconvenience to a disruption of daily activities. In most cases, a water system would have from 24-72 hours of finished water storage at the WTP, in water tanks, or in the pipes themselves. If unable to treat or acquire additional water from auxiliary sources, the water system would almost certainly require users to severely curtail water usage (or stop altogether in certain cases of biological or chemical contamination).

Fortunately, the JLP's water systems have some level of resiliency in the event of emergency. The interconnectedness of the JLP water systems is a significant asset for being able to provide emergency water. Furthermore, the number of different sources and wide range of source types in the region is an important safeguard that minimizes risk from one source being out of commission and reduces the potential for multiple simultaneous source failures within the Region. Additionally, all of the water systems have a water shortage response plan to reduce demand and extend water supply viability in case of emergency.

The working relationships and joint planning being done by the JLP water systems are also significant intangible assets that improve the potential effectiveness of an emergency response. The interconnection study being completed by the JLP, and commitment to making sure emergency water supply and mutual aid agreements are up to date are important components of preparedness. Furthermore, the information resources developed by the both the JLP water systems (e.g., distribution system hydraulic models) and DWR (e.g., Cape Fear-Neuse river basin model) will allow water systems to much more quickly assess the severity of an emergency and identify potential solutions.

In the future, more planning will be needed to develop and maintain preparedness for water supply emergencies at both the individual water system and regional levels.

At this level of planning analysis, there are some general factors that would increase the capacity of the JLP water systems to deal with potential water supply emergencies.

- Understand finished water interconnection capacities, and develop and update inter-utility agreements for emergency aid with neighboring systems. Conduct joint planning studies of the regional distribution system to investigate how water may be moved between two systems, or through a third system if necessary.

- Increase overall storage capacity if feasible. Adding sources with additional storage capacity adds more reliability to the system. Back-up sources with storage such as quarry reservoirs can also add considerable flexibility in case of emergency.

- Keep water shortage response plans up to date. When new sources come online, model and study potential new metrics for drought triggers, and update the plan as needed.

- Seek regional diversity and redundancy in both sources and water treatment infrastructure. Too high a reliance on only a few large sources, intakes, or WTPs can create vulnerability in case of catastrophic failure. While expansions of sources or WTPs often make sense economically, they can lead to consolidation and overdependence on particular parts of the water system. Adding some diversity of new source types, and adding additional treatment plants will ensure that the rest of the Region's water systems can assist if one source goes offline temporarily in an emergency. Of course, the interconnections and distribution infrastructure must be sufficient to move water where it is needed.

- Understand regional water supply status, and cultivate good working relationships between utilities in the region. In the case of a water supply emergency, communication is important. Ideally, utility managers should be aware of the current status of water supplies at other utilities around region. Additionally, utilities should be prepared to communicate with each other quickly in case of emergency.

Fortunately, the water systems that are part of the JLP exhibit many of these factors already, and are committed to working together in the short- and long-term to ensure water supply for normal operations or emergency situations.

SECTION XI. Important Findings

In the course of the Jordan Lake Partnership's work on the Triangle Regional Water Supply Plan, there were several occasions at which the Partners collectively made some important observations about the future of the Region.

Peer-Review Improves Projections and Leads to Better Choices

In the *Triangle Regional Water Supply Plan: Volume I – Regional Needs Assessment*, the process used by the JLP members to project and refine estimates of future water need was laid out in detail. The benefits of that process, which included multistage peer review of projections, data, and assumptions, included better understanding, transparency, shared accountability, and a significant (greater than 10%) reduction in total projected water needs.

This success in improving demand projections should not be understated. The more rigorous demand projections gave the partners a firmer starting point for analyzing potential water supply alternatives, and the reduced total projected demand made finding viable alternatives easier. The accrued benefits of mutual accountability and transparency also carried over in the working relationship between partners for the regional alternatives analysis.

As a result of the trust developed from prior work of the JLP, communication about preferences, concerns, and objections to water supply options could be discussed more openly. Partners were up-front about why they supported some alternatives over others in their local planning. More importantly, partners could articulate which alternatives being considered by other partners caused them the most concern. For instance, Raleigh clearly articulated worries about sources that could reduce inflows to Falls Lake. Clear explanations of causes for concerns with well-reasoned justifications helped partners focus on the most viable sources, and not waste too much time analyzing options that could not win support from the whole Partnership. Similarly, strong preferences for particular sources by a few partners helped make decisions between otherwise comparable source options easier.

Some Source Options are Obvious Choices

In building collections of sources under various frameworks, some utility's selections of source options were practically invariant regardless of the conditions of the framework being considered. Such source options would be considered robust as there is little reason to choose another source option unless something in the framework constructions specifically disallows it.

These source options tend to have a few characteristics that make them obvious choices for a water utility.

- **Advanced stage of planning –** Source options that have already been selected as preferred source options through a local water supply planning process are also usually preferred in a regional process. Furthermore, the further a source is towards implementation, the more likely it is to be a consistent part of a water system's planning. If permitting, engineering design, land acquisitions, or agreements have already been completed to construct a source, it is unlikely another source would be preferred.

- **Available supply and geography** – In general, it makes sense to get water from as close as possible, so long as the supply is available. Several systems are located such that there is a significant amount of available supply that has not been fully utilized. This situation is especially common among systems with river withdrawals that are using far less than the available flow. But this also applies to systems with reservoirs or storage allocations. Those systems currently relying entirely on Jordan Lake are likely to prefer to continue to do so.

- **Cost and Use of Existing Infrastructure –** Building new infrastructure to withdraw, store, treat, and distribute water can be an expensive component of a water supply alternative. Source options that can utilize existing withdrawal infrastructure and existing treatment plants (even if an expansion may be necessary) are often preferred to options that require new intakes, treatment plants, or pipelines. Avoiding these costs (including permitting and land acquisition costs) can be a significant factor in some source being preferred over others.

Table 23. Supply source options with high likelihood of implementation.

Water System	Source Option	Yield (MGD)	Notes
Sanford	Cape Fear River Withdrawal	12.8 (or more)	Existing withdrawal location, with sufficient supply to meet future needs, and potential to expand WTP at current location.
Hillsborough	W. Fork Eno Reservoir Expansion	1.2	Design and permitting complete, construction contracts signed
OWASA	Quarry Reservoir Expansion	2.1	Preferred source from local water alternatives analysis. Public and political acceptance. Agreement in place with quarry company.
Orange County, Holly Springs	Upgrade Level II Jordan Allocation	1-2	Orange County and Holly Springs currently hold Jordan Lake allocations, but need to apply to convert them to Level I allocations.

Meeting Raleigh's Need through its Preferred Sources Benefits the Region

The City of Raleigh and its Merger Partners are served by the largest water system in the Region. While the projected growth within the service area of Raleigh and its Merger Partners is not exceptional in terms of percentage growth, the total increase in demand has a large impact on the regional water supply picture. Nearly 40% of the projected 2060 need is attributable to Raleigh and its Merger Partners.

Raleigh's ability to meet its entire need with its own projects has a direct effect on the rest of the Region's supply. To do so, Raleigh will likely need to build three of its four preferred projects, and almost certainly will need at least two. Even for alternatives in which Raleigh builds two sources, Raleigh would rely on water moved through Durham or Cary to meet roughly 11 MGD of Raleigh's demand. Under these alternatives, other JLP members (most often Durham) would have to build sources far in excess of their own needs in order to supply Raleigh.

While certainly not opposed to cooperation, the Partnership members agreed that alternatives that inextricably tied Raleigh's operations to that of other partners presented several difficulties. Notably, daily operational decisions and especially water management during drought would become much

more difficult as Raleigh and the other partners involved in building a joint source would necessarily have to create a cooperative management plan that also considers all existing sources and other new sources. Furthermore, this *de facto* joint operation of sources would also create issues with other partners interconnected with Raleigh and whichever partners participated in a joint source development with Raleigh. Specifically, the ability of Raleigh to meet mutual-aid requirements in water emergencies could be limited, potentially increasing the Region's vulnerability to severe droughts.

Furthermore, Raleigh's entire service area is in the Neuse Basin, as are its top four source options. Many of the other options to meet Raleigh's demand would require either significant interbasin transfers, or at a minimum, pumping of raw or finished water over a considerable distance.

Raleigh's top four source options are by no means simple, inexpensive, or easy to implement, but in some combination, they would allow Raleigh to meet its own needs. Compared to all of the other alternatives investigated by the Partnership, Raleigh meeting its needs through some combination of these four sources is the preferred outcome from the regional perspective.

Finally, by not seeking a Jordan Lake allocation, Raleigh helps significantly strengthen the regional supply picture. If Raleigh were to seek a Jordan Lake allocation, not only would there be significant infrastructure and permitting issues to consider, but the water supply allocation requests would likely exceed the available supply, putting Raleigh's request for water in direct conflict with the other Partnership members. The potential costs for Raleigh to access a Jordan Lake allocation would depend on the amount requested, and may not be much lower than its preferred alternatives. If other Partnership members needed to build new or expand existing sources in lieu of Jordan Lake allocation in order to accommodate a potential Jordan Lake allocation for Raleigh, the regional costs would almost certainly be higher than if Raleigh were able to meet its own needs.

Therefore, it benefits the Region's water systems as a whole from multiple perspectives (cost, cooperation, emergency response, operational efficiencies, political acceptance, water supply reliability) to support Raleigh's pursuit to implement its top source options. However, the recommended future water supply sources for the City of Raleigh are particularly complex, and there are numerous regulatory and environmental challenges. The recommended alternative for Raleigh is based upon several key assumptions, but represents the best available information at the present time. Given the challenges and current uncertainty as to the potential impacts of their preferred sources on water quality in Falls Lake, Raleigh may be compelled to pursue alternate, supplemental or interim sources until their Neuse River Basin sources can be developed as planned.

SECTION XII. Recommended Water Supply Alternative

The Jordan Lake Partnership recommends Alternative A1 as the preferred alternative for the Region.

Description of Preferred Alternative

This alternative is built upon a framework which assumes that Partnership members are able to use sources that are currently the preferred options for individual water systems. This includes sources that are already part of local water supply planning, expansions of current sources or allocations, and building new sources under consideration.

Several sources are part of local water supply planning efforts and are considered 'low-hanging fruit' source options. For example, Hillsborough would build an expansion of the West Fork Eno Reservoir, which has already been selected as the Town of Hillsborough's preferred option and has received permits for construction. OWASA already has an agreement with a quarrying company to use that emptied quarry for water storage once mining stops in 2030. Sanford has an intake on the Cape Fear River, which has sufficient supply to meet future needs.

Use of Jordan Lake is an important component of this alternative. Cary, Apex, Morrisville and Wake County – RTP South would continue to use Jordan Lake water treated at the CAWTF as their sole water supply. The importance of Jordan Lake as a water source would grow for several other partners, as well.

The largest infrastructure investment requiring significant cooperation between partners would be a new intake and water treatment plant on the western side of Jordan Lake to allow a group of partners to access Jordan Lake allocations. The water systems directly involved in the exploratory phase of the project include Chatham County, Durham, OWASA, and Pittsboro. Additionally, the plant would be designed to meet demands for the Orange County customers in the areas that would be served by Durham and Hillsborough. Chatham County (North service area) would be the only water system to receive its entire supply from this treatment plant. Pittsboro, Durham, and potentially the Orange County customers would use the treatment plant to meet roughly half their supply needs. OWASA and Hillsborough could use the plant to access their Jordan Lake allocations for emergency or seasonal usage.

Finally, meeting the needs of Raleigh and its Merger Partners will require a mixture of sources.

Detailed Composition, Evaluation, and Implementation of the Alternative

Source Options Selected by Partner and Implementation Timeline

Alternative A1 is most easily defined by the source options selected by each Partnership member and the planned years in which each of the sources would be brought online. Table 20 presents this information for each system. At this level of planning, specific years for implementation are uncertain beyond the next ten years. For instance, it is assumed that Jordan Lake allocations after Round 4 would be online in 2035. Note that this table shows only new or expanded sources to meet future needs (i.e., it does not include existing sources).

Table 24. Preferred Alternative (A1) source selection detail by Partner.

Partner	Source Option	Expected Supply [MGD]	Year Online
Cary/Apex	Jordan Lake - Addtl. Rd. 4	7.2	2015
	Jordan Lake - Addtl. Fut. Rd.	2.2	2035
Morrisville	Jordan Lake - Addtl. Fut. Rd.	0.1	2035
Chatham County N	Jordan Lake - Addtl. Rd. 4	7	2015 (2025 WTP)
	Jordan Lake - Addtl. Fut. Rd.	5.2	2035
Durham	Jordan Lake - Addtl. Rd. 4	6.5	2015 - 2020 (WTP)
Hillsborough	W. Fork Eno Reservoir Expansion	1.2	2015
	Jordan Lake - New, Fut. Rd.	1	2035
Holly Springs	Jordan Lake - Convert LII to LI	2	2015
	Jordan Lake - Addtl. Fut. Rd.	0.2	2035
Orange County	Mebane purchase	1.8	As needed
	Jordan Lake - Convert LII to LI	1	2015
	Jordan Lake - Addtl. Rd. 4	0.5	2015 (2025 WTP)
	Jordan Lake - Addtl. Fut. Rd.	0.5	2035
OWASA	Quarry Reservoir Expansion	2.1	2036
Pittsboro	Haw River withdrawal expansion	2	2015
	Haw River withdrawal expansion	2	2020
	Jordan Lake - New, Rd. 4	6	2025
Raleigh & Merger Partners	Source Option 1	41.1 total for Options 1-3	2025-2030
	Source Option 2		2040
	Source Option 3		2050
Sanford	Expand Cape Fear Withdrawal	6	2025
	Expand Cape Fear Withdrawal 2	6.8	2045
TOTAL		**102.4**	**by 2060**

Implementation of the source options that compose the preferred alternative is a very complex process. Building the sources or associated infrastructure will require varying levels of permitting, planning, and review, each subject to slightly different local conditions. As a result, the timeline is a very preliminary estimate that is primarily concerned with ensuring that sources are online in time to meet demands. The most important planning year is 2045, which is the expected target year for the current round of Jordan Lake allocation. As always with planning, projections of more distant future conditions are subject to the most uncertainty.

The JLP members are working individually on how to implement their components of the regional water supply plan. From a source supply perspective, the information in Table 24 is sufficient to create a basic timeline for how much supply is brought online in which years. Figure 21 displays how the sources in Table 24 are brought online, and how significant each source is as compared to the overall regional picture. Time is displayed on the x-axis, while the y-axis displays the amount of supply (or need). For simplicity, the Jordan Lake allocation expansions are combined according to

which treatment plant they are accessed from. The lowest two bars on the chart show the additional supply accessed from the CAWTF and the proposed Western Intake and WTP, respectively. The other sources that are part of the alternative are shown stacked on top of these sources. The left end of each source 'bar' indicates when it comes online, and the height corresponds to the amount of supply it adds. For added perspective, lines have been added to show cumulative regional supply relative to the projected need.

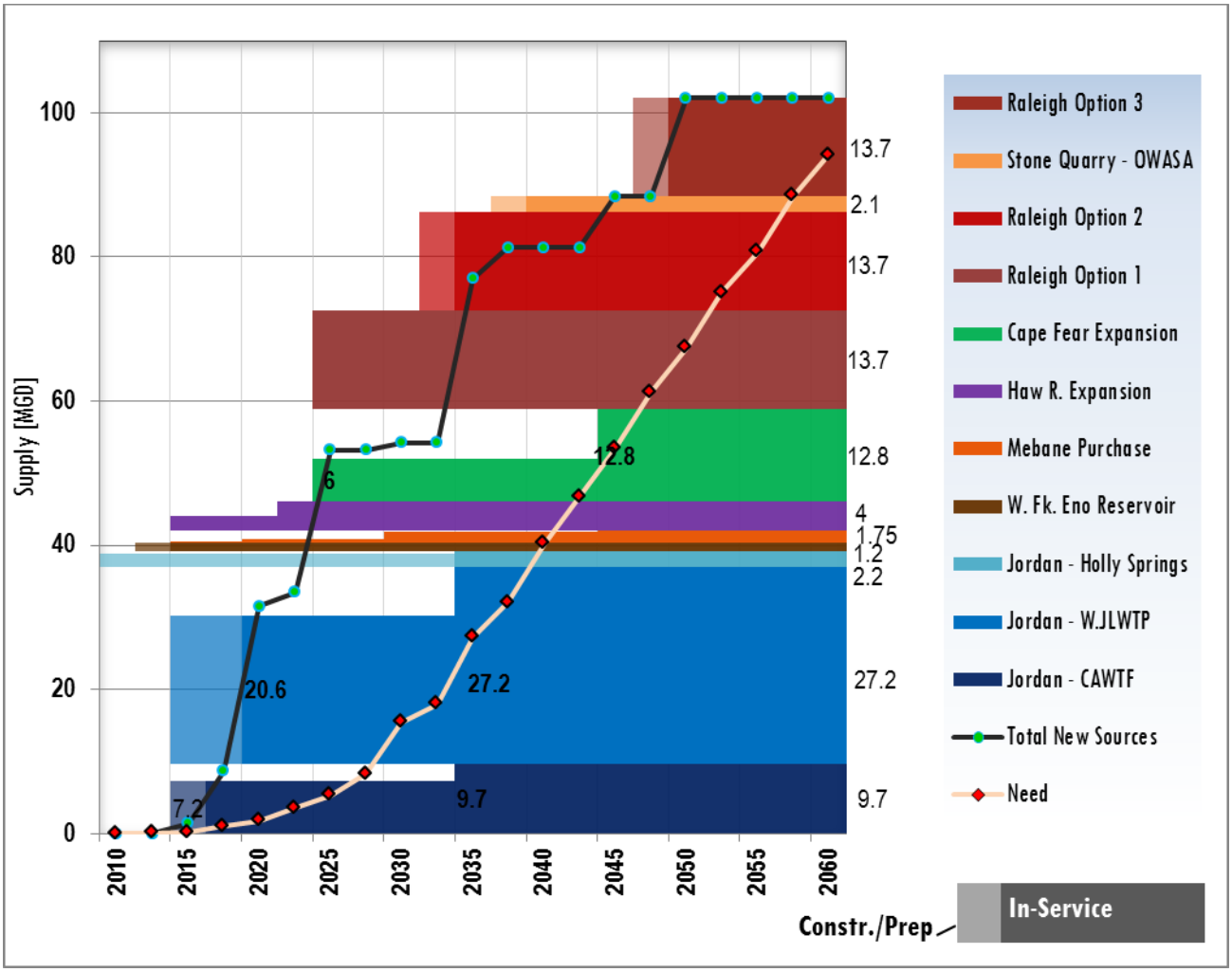


Figure 21. Cumulative new supply implementation timeline. Individual sources are stacked, with some showing expansions. More transparent shading at the left of a source 'bar' indicates construction and preparation time to bring that source online.

Another way to evaluate the alternative is to verify that the demand is met for all partners at each 5-year interval in the planning period. Figure 22 indicates the surplus at each five year interval for each partner as one slice of a stacked bar chart. The total height of each bar indicates the regional surplus. When compared to Figure 7 from earlier in this document, it is clear that the recommended alternative addresses water supply for each of the partners for the entire planning period.

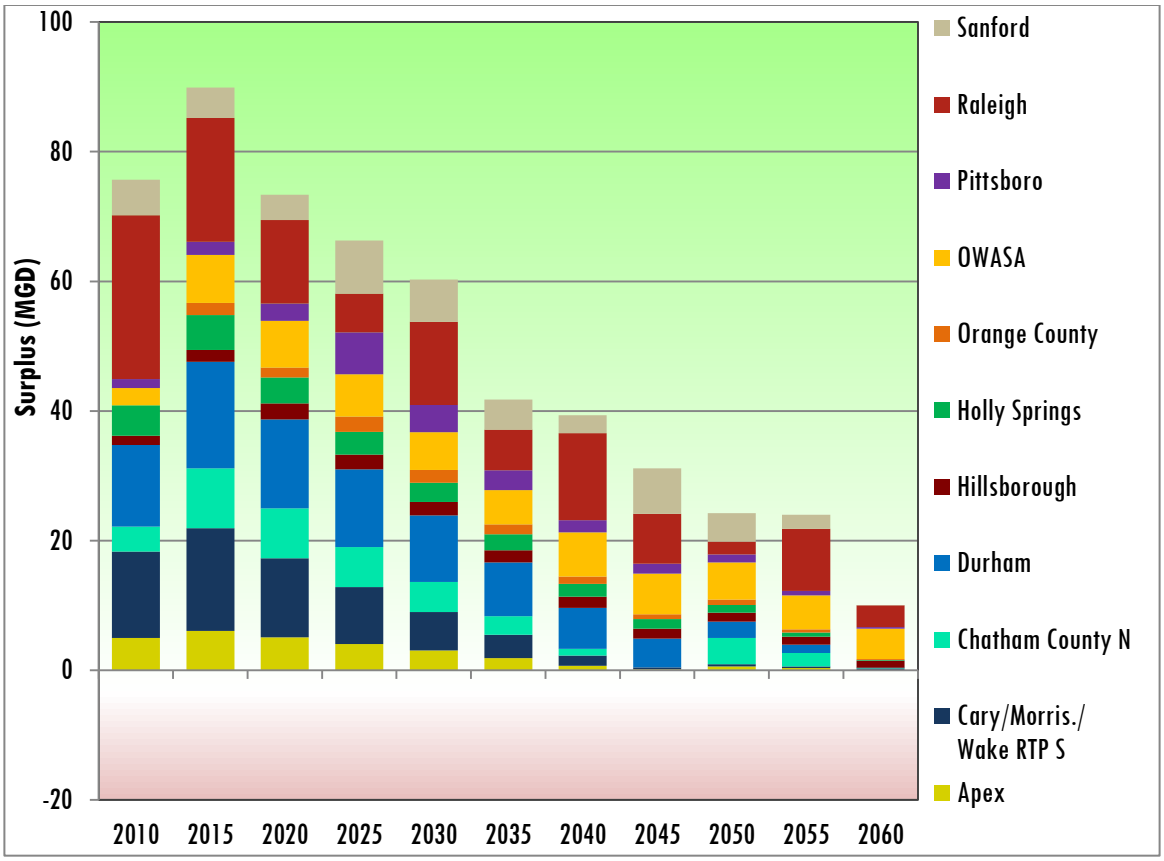


Figure 22. Surplus by partner in five year increments for the recommended alternative.

Jordan Lake Allocations

The viability of this alternative is contingent on the partners receiving Jordan Lake water supply allocations. The following table illustrates existing allocations, total projected round 4 allocation requests, and expected future (by 2060) Jordan Lake usage. The difference between Round 4 and the ultimate usage would be addressed in future rounds of allocations.

Table 25 and Figure 23 present the expected allocation requests from the Jordan Lake partners under the recommended alternative. The table includes all thirteen JLP members, even though Raleigh and Sanford are not expected to request Jordan Lake Allocations. As shown in Figure 23, the total allocation requests stay below the limit of 100 % of water supply storage. The Round 4 requests would leave more than eight percent of the storage unallocated, leaving some flexibility for future allocations. The table does not differentiate between Level I and Level II allocations, and JLP members with existing Level II allocations (Holly Springs and Orange County) may choose to request Level II allocations in Round 4. Subsequently, Level II allocations would be upgraded to Level I allocations before they are used for water supply.

Table 25. Current Jordan Lake allocations and projected allocation requests (1% ≈ 1 MGD).

	Jordan Lake Allocations/Allocation Requests					
Applicant	**Current**		**Round 4**		**Future (2060)**	
Apex	8.5	32	10.6	46.2	11.6	48.5
Cary	23.5		28.6		29.8	
Morrisville	3.5		3.5		3.6	
Wake Co. RTP South	3.5		3.5		3.5	
Chatham County	6		13		18.2	
Durham	10		16.5		16.5	
OWASA	5		5		5	
Holly Springs	2		2		2.2	
Orange County	1		1.5		2	
Hillsborough	0		1		1	
Pittsboro	0		6		6	
Raleigh	0		0		0	
Sanford	0		0		0	
TOTAL	63		91.2		99.4	

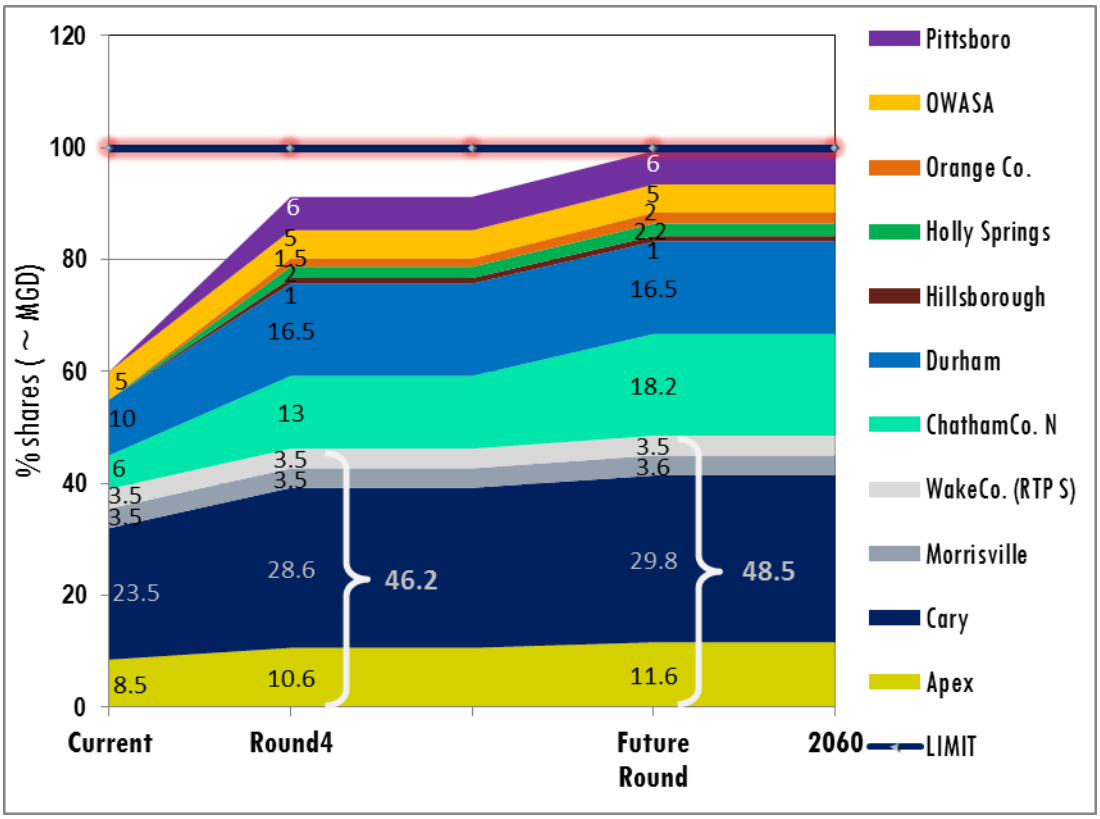


Figure 23. Summary of projected Jordan Lake allocation requests by the JLP members.

Necessary Infrastructure

The following infrastructure will be required to implement the source options in the Preferred Alternative.

- *Expansion of the Cary-Apex Water Treatment Facility*

  In order to treat the Jordan Lake allocations of Cary, Apex, Morrisville, and RTP South, the Cary-Apex WTF is being expanded to a capacity of 56 MGD. This should be sufficient capacity to treat all of the water for the Cary, Apex, Morrisville, and RTP South through 2030.

- *New Jordan Lake Western Intake and Water Treatment Plant along with Finished Water Pumping and Piping*

  Recognizing the need for additional water supply facilities to obtain Jordan Lake water, four members of the 13-member Jordan Lake Partnership (Chatham County, the City of Durham, OWASA, and the Town of Pittsboro) are jointly evaluating options for a new regional intake and treatment plant located on the western side the lake to supplement their existing supply sources and to provide more regional reliability and redundancy. The initial concept for this project includes a new intake structure, pumping facilities, and water treatment plant located south of U.S. Highway 64 near the western shore of Jordan Lake, as well as finished water transmission lines to serve the partners. Raw water intake and pumping facilities would be constructed within the lake and/or on land leased from the Army Corps of Engineers. The treatment plant would be constructed on property currently owned by OWASA adjacent to Corps land. Other concepts will be evaluated in the near future.

- *Expansion of West Fork of the Eno Reservoir*

  This expansion will be completed by Hillsborough in roughly 2015. There is not a direct intake into the reservoir for water supply. Instead, more precise outlet works will be added to allow water to be released downstream to the intake in Lake Ben Johnson. As part of planning and permitting the expansion, Hillsborough has worked to modify the West Fork Eno Reservoir release targets and trigger levels to take into account the expansion.

- *Expansion of the Brown WTP (City of Durham)*

  The City of Durham is currently working on design and permitting of an expansion to the Brown WTP, which treats water from Lake Michie and Little River Reservoir. The proposed expansion would increase the capacity from 30 to 42 MGD. As part of the permitting for the expansion, new in-stream flow requirements are under consideration for the Flat River below Lake Michie. Hydrologic modeling of the preferred alternative includes this projected flow-by requirement. This expansion, in conjunction with the proposed Western Jordan Lake Intake and WTP, is expected to provide Durham sufficient treatment capacity through the end of the planning period.

- *Haw River Capacity Increase and Upgraded existing Pittsboro WTP*

  The Town of Pittsboro plans to balance its source supply between the Haw River, where it currently has an intake, and Jordan Lake. Pittsboro will work to upgrade its Haw River source in 2 MGD phases. The Haw River source will provide a maximum of 6 MGD. As a parallel track to Haw River increases, Pittsboro will participate in investigating the development of an

intake, treatment and delivery system from Jordan Lake. Pittsboro's allocation application will request 6 MGD from Jordan Lake.

- *Intake Structure and Raw Water Pipeline from Quarry Reservoir (OWASA)*

  OWASA has an agreement with the stone company currently excavating Quarry Reservoir in Orange County to take over the quarry in the 2030s. OWASA will drain its existing quarry, and the mining company will construct an inter-pit passageway to connect the existing quarry with the newly mined portion. OWASA will fill the quarry by pumping water from Cane Creek Reservoir. The date the quarry is ready for use will depend, in part, on weather patterns when mining ceases as it will take time to fill it.

- *New Storage, Intakes, Pumping Infrastructure, and Expanded/ New Water Treatment Capacity for Raleigh's top sources*

  Under this alternative, Raleigh will construct three of four identified alternatives. The addition of each source has different infrastructure requirements.

  The reallocation of Falls Lake water supply storage has the least need for additional infrastructure because Raleigh's existing Falls Lake intake and EM Johnson WTP could be used to withdraw and treat the water.

  The Neuse River intake would require at minimum a new intake structure in the river, and a raw water pump station to move water from the river to a water treatment plant. It is likely the raw water line would be linked to one of Raleigh's existing treatment plants. Otherwise, a new water treatment plant would be required.

  The quarry option would require some preparation (grouting, etc.) of the emptied quarry storage to hold the water before filling. In order to fill the quarry, a new intake and (rather large) pump station would be required to move water from the Neuse River into the quarry. Then, a separate intake structure would be required in the quarry itself in order to access the water in the quarry when it is needed. This intake would then be connected to a raw water line that would either pump water to an existing treatment or a new treatment plant.

  The construction of the Wake County Little River Reservoir would require the most infrastructure. A new dam, spillway and outlet works would be constructed at the site, after appropriate preparation (e.g. clearing and grubbing) had been completed for the area to be impounded. Additionally, a new raw water intake and raw water pumping station would be required to withdraw from the lake. A new WTP would be possible for this option, though raw water could also conveyed to an existing WTP.

  Overall, Raleigh will likely need to increase treatment at least once, either by constructing a new treatment plant, or expanding an existing plant. Current treatment capacity is already 106 MGD, and 2060 demand is 115 MGD, so the need is not pressing.

- *Expansion of the Sanford WTP on the Cape Fear River*

  Sanford will maintain its current intake and WTP on the Cape Fear River. The WTP will be expanded to be able to treat roughly 18 MGD of average day flow in approximately 2025. Another expansion, with potential upgrades to the intake itself may be needed by roughly 2045, but will not be planned until the first expansion is complete.

- *Distribution system infrastructure in Orange County*

  Orange County's role in the Partnership has been to plan for the needs of Orange County customers that will be served by other water systems (since Orange County does not operate a water system). Since the planned development areas are currently undeveloped from a water supply perspective, a new water distribution and sewer system will have to be constructed for Mebane, Hillsborough, and Durham to serve these customers. The capital investments of these extensions are being planned jointly by Orange County and the water systems serving the areas. Customers will pay directly to the water utilities serving them, so some capital costs will be recouped in that way.

- *Possible Finished Water Distribution System Upgrades*

  The JLP is currently working on an interconnection study and accompanying hydraulic model to help identify potential upgrades to the distribution systems needed to transmit water across the Region to address emergencies. Some of the potential upgrades that could be completed include:

  - Durham – Hillsborough or OWASA – Hillsborough (to serve Orange County customers in the Hillsborough EDD and for emergency supply)
  - Cary – Holly Springs
  - OWASA – Chatham County N
  - Chatham County N – Pittsboro
  - Apex – Holly Springs
  - *Others as identified by the interconnection study.*

Impacts and Benefits

This Preferred Alternative has been analyzed according to several criteria, and its impacts and benefits have been found preferable to all of the other alternatives. The JLP members are committed to working to mitigate any potential negative impacts.

Use of Jordan Lake

The Preferred Alternative includes an increase in total allocation requests from Jordan Lake. The JLP members have worked diligently to ensure that the Partnership's allocation requests would not exceed Jordan Lake's water supply storage capacity. For the purpose of this TRWSP, the JLP assumed that the yield of the Water Supply pool is 100 MGD, which is consistent with DWR's assumptions. DWR is currently reinvestigating the yield of the water supply pool. The JLP members made sure to keep the projected 2060 allocations below 100 MGD and the 2045 requests even lower than that.

Cost and Implementability

The Preferred Alternative was viewed as the most favorable alternative from the perspective of cost and implementability. By building supplies that have already been planned and accepted by local decision makers and permitting authorities, costs are minimized up front. For example, the West Fork

Eno Reservoir expansion is on track for construction, and any deviations from the current plan would add costs. The OWASA Quarry Reservoir expansion option will not be finished until 2035, but it is locally accepted and has already been identified as a top choice by a local planning process. Repeating such analysis is costly unless new source options have emerged which appear highly preferable.

By cooperatively building a new Jordan Lake Western Intake and WTP, costs are reduced, potentially significantly. There are considerable avoided costs for infrastructure that would need to be developed to either bring other sources online or for each partner to access and treat Jordan Lake water separately. By sharing the cost of the single large treatment plant, the marginal cost per MGD of water delivered is significantly reduced. Additionally, by staging the construction with an initial phase and expansion, the partners can be ensured of having adequate treatment capacity up-front, but are afforded time to reevaluate when and how much water is needed for longer term demands.

The costs are also reduced by building comparatively few new sources. Not only are planning and permitting costs lower, but significantly, the cost of land acquisition is avoided by not creating completely new impoundments. Expanding existing WTP and distribution infrastructure is likewise cheaper than building new auxiliary treatment and distribution infrastructure to connect a new source to the existing water supply system.

Interbasin Transfer and Hydrologic Impacts

The most significant existing interbasin transfers involve the Apex and Cary/Morrisville/RTP South system which transfers water from the Haw subbasin to the Neuse Basin, and the Durham system which transfers water from the Neuse Basin to the Haw subbasin. One effect of the preferred regional alternative is that it would reduce Durham's existing and future transfers from the Neuse River Basin to the Haw (Cape Fear) compared to the other alternatives.

Apex and Cary/Morrisville/RTP South's water source is Jordan Lake in the Haw subbasin, but the majority of their combined service area is in the Neuse Basin. They currently operate three wastewater treatment plants in the Neuse basin (North Cary WRF, South Cary WRF and Apex WRF. This interbasin transfer is becoming significantly reduced now that the Western Wake WRF is becoming operational and some of the water currently discharged to the Neuse Basin is being sent instead to the Cape Fear basin.

The Durham IBT situation would be reduced by implementing this Preferred Alternative. Currently, the majority of Durham's water supply sources (roughly 29 of 39 MGD) are located in the Neuse basin, though Durham holds a 10 MGD Jordan Lake allocation accessed through Cary. Durham's service area is split between the Neuse and Haw subbasins. One of Durham's wastewater treatment plants (North Durham WRF) discharges to the Neuse Basin upstream of Falls Lake, but carries less than half of Durham's total wastewater discharge. The rest of the wastewater (slightly more than half of the total volume) is discharged to the Haw subbasin through two facilities, the South Durham WRF, and the Triangle WWTP (operated by Durham County). The only ways for Durham to reduce its interbasin transfer would be to either divert more wastewater to the Neuse basin, or to increase supply coming from the Haw River subbasin.

The preferred alternative meets Durham's need by increasing supply coming from the Haw River subbasin in the form of an increased Jordan Lake allocation. Water obtained and treated from Durham's Jordan Lake allocation would be used only within the Cape Fear (Haw) portion of Durham's service area. It is notable that Jordan Lake would support a significant reduction in

Durham's current and future transfers out of the Neuse Basin by decreasing its reliance on Lake Michie and the Little River Reservoir *[Durham has a grandfathered capacity to transfer up to 45.4 MGD from the Neuse to the Haw River subbasin.]*

The hydrologic impacts of this alternative on downstream supplies would be less than most other alternatives.

Acceptability to the Partners

This alternative is strongly supported by all members of the JLP. The source options included in this alternative are concordant with current local water supply planning, economically viable, technically feasible, and acceptable to local governments.

Through this peer-reviewed, cooperatively-developed Preferred Alternative, the Partnership members fully support the water supply plans of each other. The TRWSP demonstrates that the implementation of every Partnership member's new sources does not significantly reduce the ability of any member to meet its own needs. This Preferred Alternative (and the collaboration leading to its development) also helps to avoid potential water supply conflict between systems in the future.

Additionally, while the new WTP on the western side of Jordan Lake will be a substantial undertaking requiring a lot of cooperation, none of the individual components of the alternative are outside of the water systems' capacity to implement.

Summary of Alternative by Partner

The following sections include of summary of how each partner will implement its own portion of this recommended water supply alternative.

Apex

The Town of Apex's current supply source is an 8.5 MGD share of the joint Cary/Apex 32 MGD Jordan Lake Allocation. The water from this allocation is treated at the Cary-Apex Water Treatment Facility, co-owned with the Town of Cary.

The preferred alternative includes Apex meeting the remainder of its demand via additional Jordan Lake allocation. The 2045 need for Apex is just over 2 MGD, so the projected Round 4 allocation amount is 2.1 MGD. The 2060 need for Apex is just over 3 MGD, so the projected ultimate allocation is 3.1 MGD. Thus, Apex would apply for additional allocation in the amount of 1 MGD in a future round of Jordan Lake Allocations.

Infrastructure needed to supply Apex in the future includes an expansion of the CAWTF to a capacity capable of meeting the projected maximum day demand for Apex, Cary, Morrisville, and RTP South, collectively.

Table 26 shows how the Town of Apex would implement the preferred alternatives. The future round ("Fut. Rd.") Jordan Lake allocation is assumed active in 2035, though the actual year of activation will not be determined for many years. Figure 24 illustrates the information in the table. The sources are shown as stacked bars with solid fill for current sources and gradient fill for proposed sources under the recommended alternative. The blue line shows current supply, while the red line shows the demand projections. The total height of the bars always stays above the red line, indicating demand is met in all years.

Table 26. Town of Apex source selections under JLP preferred regional alternative.

Apex	2010	2015	2020	2025	2030	2035	2040	2045	2050	2055	2060
Demand Projection	3.5	4.2	5.5	6.6	7.6	8.8	9.9	10.6	11.0	11.3	11.6
Existing Sources											
Jordan Lake Allocation	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5
New Sources											
Jordan Lake Allocation - Rd 4		2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1
Jordan Lake Allocation - Fut. Rd.						1	1	1	1	1	1
TOTAL Surplus	**5.0**	**6.4**	**5.1**	**4.0**	**3.0**	**2.8**	**1.7**	**1.0**	**0.6**	**0.3**	**0.0**

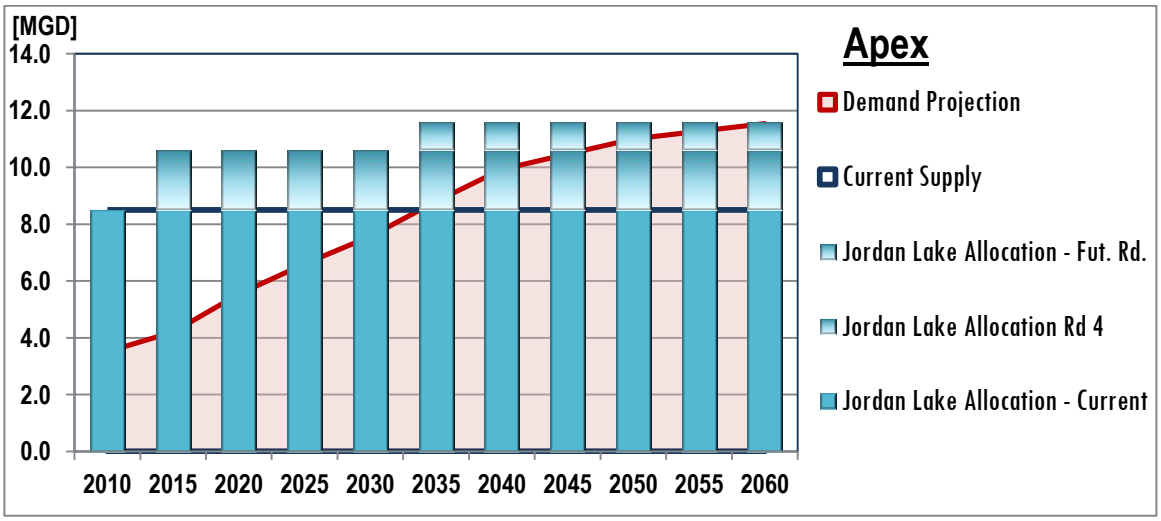


Figure 24. Town of Apex - demands, current supply, and source implementation timeline.

Cary

The Town of Cary's current supply source is a 23.5 MGD share of the joint Cary/Apex 32 MGD Jordan Lake Allocation. The water from this allocation is treated at the Cary-Apex Water Treatment Facility, co-owned with the Town of Apex. The Town of Cary also supplies water directly to customers in the Town of Morrisville and the Wake County – RTP South area, each of which possess a 3.5 MGD Jordan Lake Allocation.

The preferred alternative includes Cary meeting the remainder of its demand via additional Jordan Lake allocation. The 2045 need for Cary is 5.1 MGD, so the projected Round 4 allocation amount is 5.1 MGD. The 2060 need for Cary is 6.3 MGD, so the projected ultimate allocation is 6.3 MGD. Thus, Cary would apply for additional allocation in the amount of 1.2 MGD in a future round of Jordan Lake Allocations.

Infrastructure needed to supply Cary in the future includes an expansion of the CAWTF to a capacity capable of meeting the projected maximum day demand for Apex, Cary, Morrisville, and RTP South, collectively.

Table 27. Town of Cary source selections under JLP preferred regional alternative.

Cary	2010	2015	2020	2025	2030	2035	2040	2045	2050	2055	2060
Demand Projection	14.9	16.7	19.5	22.2	24.3	26.0	27.4	28.6	29.8	29.8	29.8
Existing Sources											
Jordan Lake Allocation	23.5	23.5	23.5	23.5	23.5	23.5	23.5	23.5	23.5	23.5	23.5
New Sources											
Jordan Lake Allocation - Rd 4		5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1
Jordan Lake Allocation - Fut. Rd.						1.2	1.2	1.2	1.2	1.2	1.2
TOTAL Surplus	**8.6**	**11.9**	**9.1**	**6.4**	**4.3**	**3.8**	**2.5**	**1.2**	**0.0**	**0.0**	**0.0**

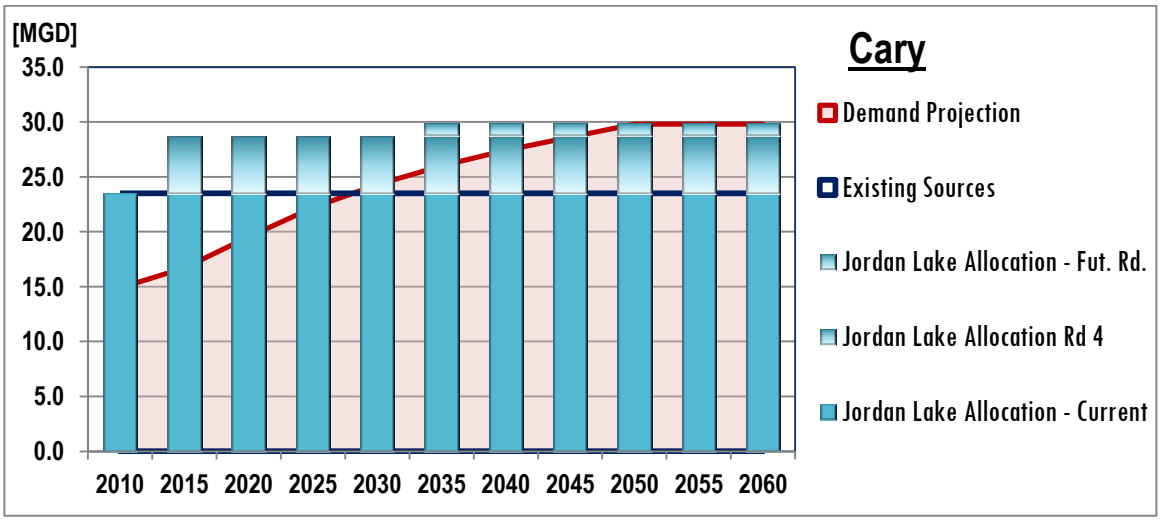


Figure 25. Town of Cary - demands, current supply, and source implementation timeline.

Morrisville

The Town of Morrisville's current supply source is a 3.5 MGD Jordan Lake Allocation. The Town of Morrisville merged its utility with the Town of Cary and Cary now includes Morrisville in its utility service area. The water from this allocation is withdrawn through an intake, treated at the Cary-Apex Water Treatment Facility, and delivered to Cary's customers in Morrisville.

The preferred alternative includes Morrisville meeting the remainder of its demand via additional Jordan Lake allocation. The 2045 need for Morrisville is equal to the current allocation amount. The 2060 need for Morrisville is 3.6 MGD, so the projected ultimate allocation is 3.6 MGD. Thus, Morrisville would need additional allocation in the amount of 0.1 MGD in a future round of Jordan Lake Allocations.

Infrastructure needs for Morrisville are managed by the Town of Cary, and have already been discussed.

Table 28 shows the Town of Morrisville's portion of the preferred alternative. Figure 26 shows the same information in chart form, indicating that the supplies exceed projected demands.

Table 28. Town of Morrisville source selections under JLP preferred regional alternative.

Morrisville	2010	2015	2020	2025	2030	2035	2040	2045	2050	2055	2060
Demand Projection	1.7	2.0	2.5	2.8	3.0	3.3	3.4	3.5	3.5	3.6	3.6
Existing Sources											
Jordan Lake Allocation	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
New Sources											
Jordan Lake Allocation Fut. Rd.						0.1	0.1	0.1	0.1	0.1	0.1
TOTAL Surplus	**1.8**	**1.5**	**1.0**	**0.7**	**0.5**	**0.3**	**0.2**	**0.1**	**0.1**	**0.0**	**0.0**

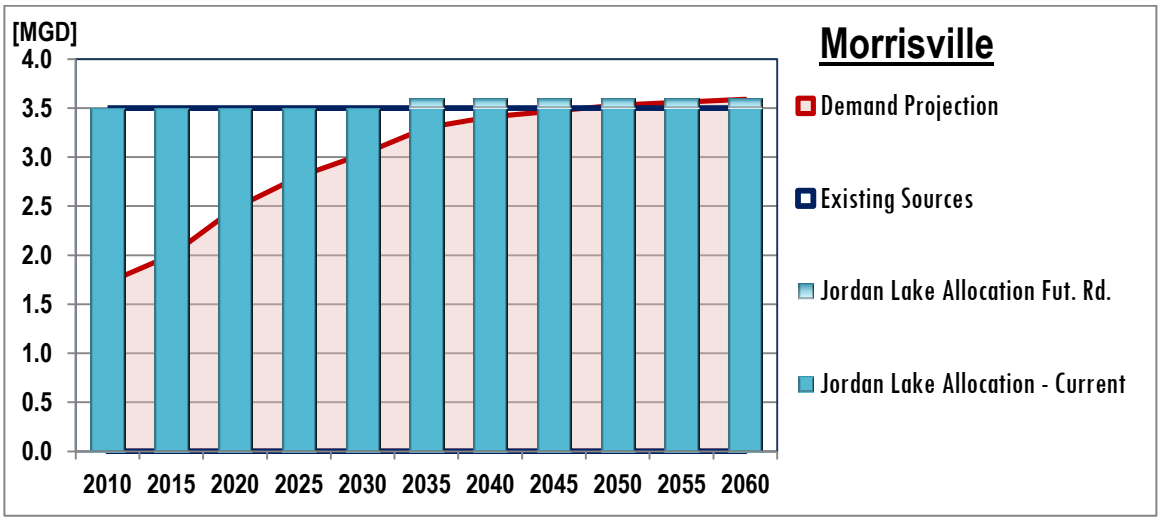


Figure 26. Town of Morrisville - demands, current supply, and source implementation timeline.

Wake County – RTP South

Wake County – RTP South's current supply source is a 3.5 MGD Jordan Lake Allocation. The water from this allocation is withdrawn through an intake, treated at the Cary-Apex Water Treatment Plant, and delivered to Cary's RTP South customers.

The preferred alternative includes RTP South maintaining its existing Jordan Lake Allocation. The 2060 demand does not exceed the current allocation, so no additional allocation is needed unless demand projections change.

Infrastructure needs for RTP South are managed by the Town of Cary, and have already been discussed.

Table 29 and Figure 27 show the Wake County – RTP South portion of the preferred alternative. In this case, demand does not exceed current supply, so no new sources are displayed in the table.

Table 29. Wake County – RTP South source selections under JLP preferred regional alternative.

Wake County - RTP South	2010	2015	2020	2025	2030	2035	2040	2045	2050	2055	2060
Demand Projection	0.6	0.9	1.4	1.9	2.3	2.7	3.2	3.2	3.3	3.3	3.3
Existing Sources											
Jordan Lake Allocation	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
TOTAL Surplus	**2.9**	**2.6**	**2.1**	**1.6**	**1.2**	**0.8**	**0.3**	**0.3**	**0.3**	**0.2**	**0.2**

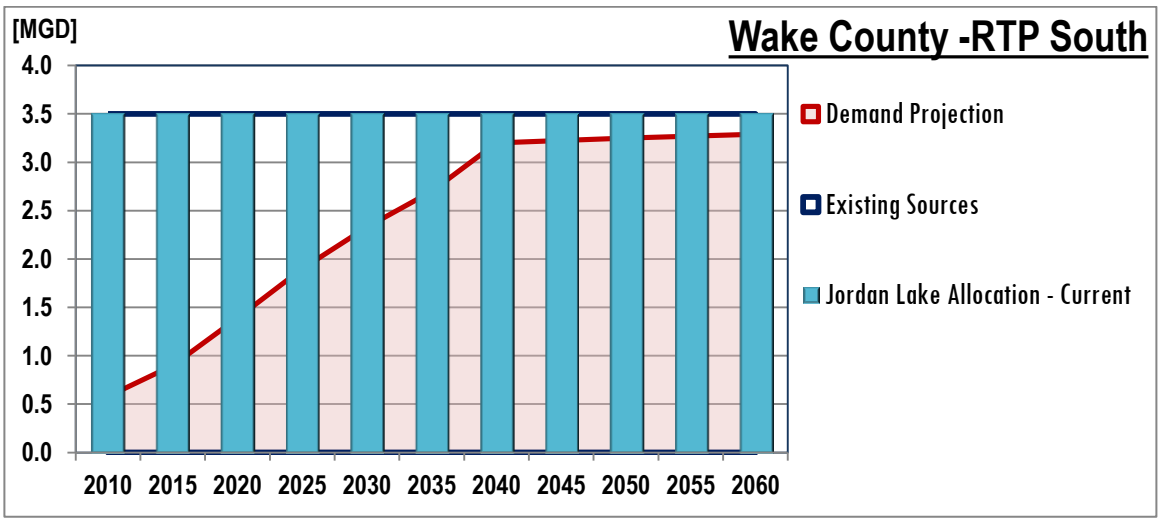


Figure 27. Wake County- RTP South – demands and current supply.

Chatham County N

The Chatham County North water system current has a 6 MGD Jordan Lake Allocation as its supply source. Water from Jordan Lake is withdrawn from the Cary/Apex WTP raw water intake, but the water is pumped to the Jordan Lake WTP operated by Chatham County N. Finished water is delivered to customers on the Western side of the lake through a finished water pipe. The Jordan Lake WTP has a current capacity of 3 MGD. In addition, Chatham County has an interlocal agreement with Durham to transfer Jordan Lake water treated at the CAWTP through the City of Durham water system and to Chatham County customers through an interconnection.

Under the preferred alternative, Chatham County plans to use additional Jordan Lake allocation as the sole source of supply to meet all future needs. There will be major changes to how Chatham County accesses its Jordan Lake allocation. In the near term (next 5-10 years), Chatham County will continue to treat water at the Jordan Lake WTP, and for meeting peak demands (over 3 MGD), Chatham County will access its Jordan Lake allocation by buying water from Durham, which in turn buys from the CAWTP.

For meeting long term needs, Chatham County will partner with Durham, Pittsboro, Orange County, and OWASA to evaluate the feasibility of a new regional intake and water treatment plant on the Western shore of Jordan Lake. The WTP may be located in Chatham County on a parcel of land currently owned by OWASA, and would be designed with a capacity sufficient to provide Jordan Lake allocation water to all of the partners who move forward with a regional plant. Chatham County's entire demand may be met by the water produced by a new plant. The new WTP would be planned

with an initial capacity to meet demand through 2040, and then could be expanded to meet demand through 2060.

Table 30 indicates the Chatham County N source preferences under the preferred regional alternative. In all cases, the supply source is Jordan Lake, but two additional allocations in addition to the current allocation are needed to meet 2060 demand. Figure 28 shows this information in chart form.

Table 30. Chatham County N source selections under JLP preferred regional alternative.

Chatham County N	2010	2015	2020	2025	2030	2035	2040	2045	2050	2055	2060
Demand Projection	2.2	3.4	5.3	6.8	8.3	10.1	11.9	13.0	14.2	16.1	18.1
Existing Sources											
Jordan Lake Allocation	6	6	6	6	6	6	6	6	6	6	6
New Sources											
Jordan Lake Allocation - Rd. 4		7	7	7	7	7	7	7	7	7	7
Jordan Lake Allocation - Fut. Rd.						5.2	5.2	5.2	5.2	5.2	5.2
TOTAL Surplus	**3.8**	**9.6**	**7.7**	**6.2**	**4.7**	**8.1**	**6.3**	**5.2**	**4.1**	**2.1**	**0.1**

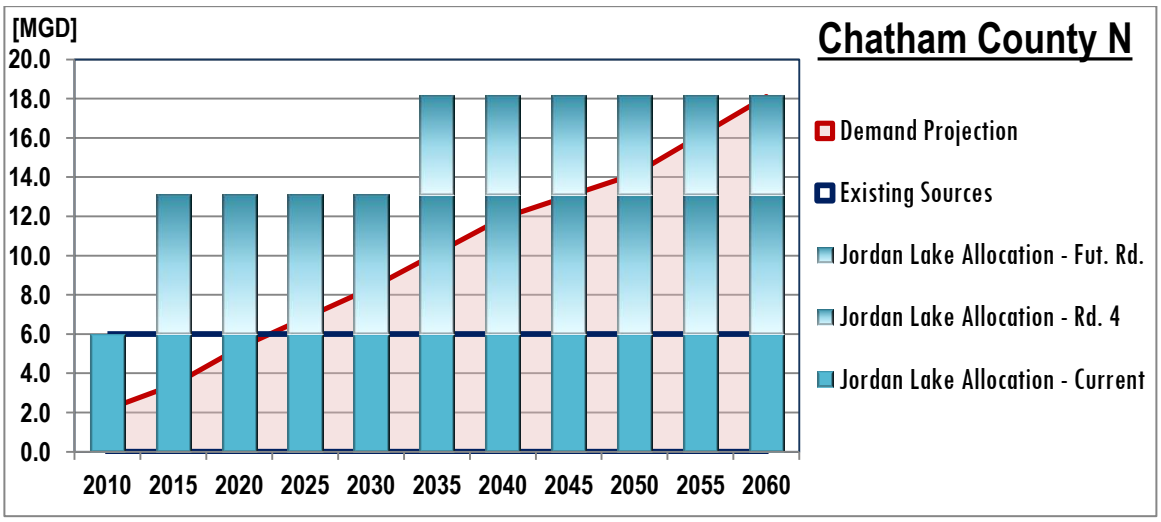


Figure 28. Chatham County North - demands, current supply, and source implementation timeline.

Durham

The City of Durham will continue to use its existing Lake Michie and Little River Reservoir system to meet daily needs under normal conditions. Durham's existing 10 MGD Jordan Lake allocation can be accessed through its finished water interconnections with the Town of Cary. These interconnections, plus a limited amount of storage in Durham's Teer Quarry reservoir, provide supplemental water during times of special need, such as severe drought or unforeseen operational situations.

Durham's preferred alternative is to obtain an additional 6.5 MGD of supply from Jordan Lake in the Round 4 allocation process. Durham is currently the lead agency in a regional planning project to determine the feasibility of constructing new intake and treatment facilities on the western side of Jordan Lake south of U.S. Highway 64. This proposed WTP would provide Jordan Lake water to several local entities, including Durham, OWASA, Chatham County, and the Town of Pittsboro.

Durham's intent would be to use its full 16.5 MGD share of the new facilities immediately upon their completion to base-load its normal daily demands from Jordan Lake. Additional demands would be met from Durham's Lake Michie/Little River Reservoir system in the Neuse River Basin upstream of Falls Reservoir, thus providing a more uniform balance among Durham's Neuse and Haw River sources. The proposed new Jordan Lake WTP, in conjunction with the planned expansion of Durham's Brown WTP, would provide sufficient treatment capacity to meet all projected needs through the planning period.

Table 31 and Figure 29 display Durham's demand projections, current supplies, and expansion of the Jordan Lake allocation as part of the recommended alternative.

Table 31. City of Durham source selections under JLP preferred regional alternative.

Durham	2010	2015	2020	2025	2030	2035	2040	2045	2050	2055	2060
Demand Projection	25.3	28.0	30.7	32.4	34.2	36.1	38.1	40.0	41.9	43.1	44.4
Existing Sources											
L. Michie, Little R. Res. system	27.9	27.9	27.9	27.9	27.9	27.9	27.9	27.9	27.9	27.9	27.9
Jordan Lake Allocation	10	10	10	10	10	10	10	10	10	10	10
New Sources											
Jordan Lake Allocation - Rd. 4		6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5
TOTAL Surplus	**13.6**	**16.4**	**13.7**	**12.0**	**10.2**	**8.3**	**6.3**	**4.4**	**2.5**	**1.3**	**0.0**

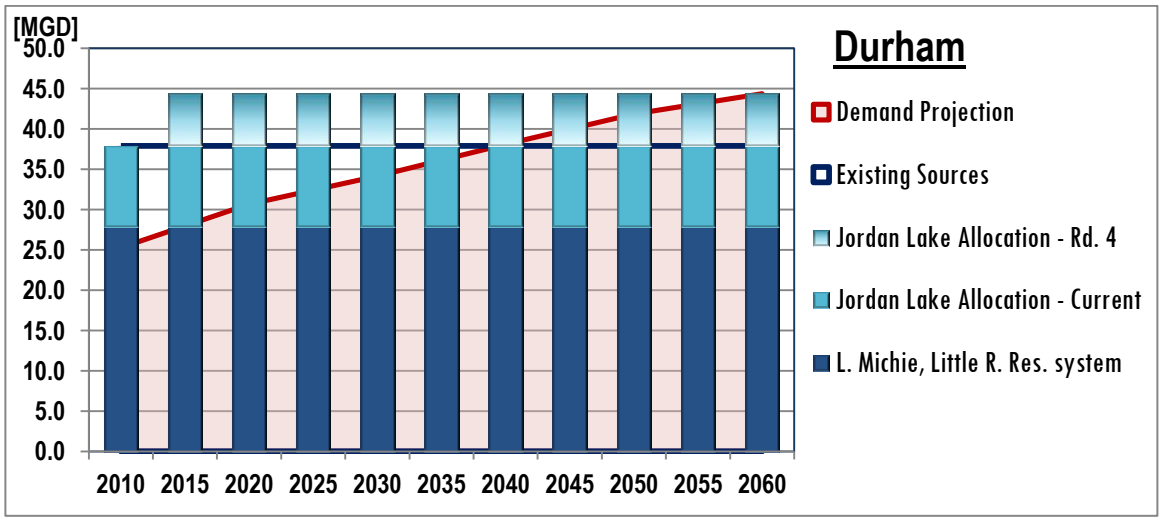


Figure 29. City of Durham demands, current supply, and source implementation timeline.

Hillsborough

The Town of Hillsborough's current water supply source is a system of reservoirs on the Eno River including the West Fork Eno Reservoir (WFER), Lake Orange, Corporation Lake, and Lake Ben Johnson, which are operated in cooperation with Orange-Alamance Water System and Orange County. Hillsborough withdraws water at Lake Ben Johnson, but the majority of the storage is held in Lake Orange and WFER, and then released downstream according to a series of agreements.

Under the preferred alternative (and almost every other alternative), Hillsborough expands its water supply by raising the dam on the WFER. Permitting and design are nearly complete, and construction will start within a year. The reservoir will still be used to manage releases downstream to the Hillsborough withdrawal point, so no new water withdrawal or raw water transfer infrastructure will be required.

The additional yield supplied by the WFER expansion just barely meets the projected need for Hillsborough in the 2050-2060 timeframe. As part of the preferred alternative, Hillsborough will also apply for a 1 MGD Jordan Lake allocation to use as a back-up supply during periods of peak use, or as an emergency supply. Hydrologic modeling of the preferred alternative does indicate that Hillsborough would use the Jordan Lake Allocation during several droughts in the historical record.

Hillsborough will access the Jordan Lake allocation either through connections with Durham or OWASA once the Western Jordan Lake intake and WTP is built.

The Town of Hillsborough's portion of the preferred alternative is shown in Table 32 and Figure 30.

Table 32. Town of Hillsborough source selections under JLP preferred regional alternative.

Hillsborough	2010	2015	2020	2025	2030	2035	2040	2045	2050	2055	2060
Demand Projection	1.2	1.7	2.3	2.5	2.7	2.9	3.0	3.2	3.4	3.5	3.7
Existing Sources											
Upper Eno Reservoir System	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6
New Sources											
West Fork Eno Reservoir Expansion		1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Jordan Lake Allocation - Fut. Rd.						1	1	1	1	1	1
TOTAL Surplus	**1.4**	**2.1**	**1.5**	**1.3**	**1.1**	**1.9**	**1.8**	**1.6**	**1.4**	**1.3**	**1.1**

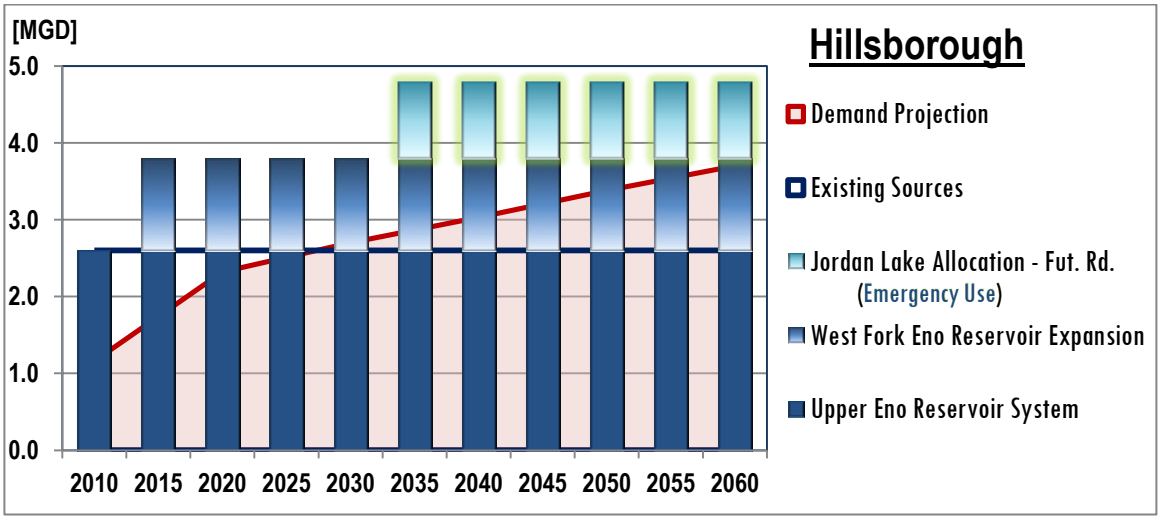


Figure 30. Town of Hillsborough - demands, current supply, and source implementation timeline.

Holly Springs

The Town of Holly Springs' current water supply source is a purchase agreement for regular water sales from Harnett County's WTP. Holly Springs manages its own distribution system and billing of

customers, but it receives all of its water as finished water from Harnett County. The current purchase agreement allows for peak use of up to 10 MGD of water transfer on a daily basis. For planning purposes, Holly Springs adjusts this peak supply to average day supply with a 1.5 peaking factor, meaning the 10 MGD contract can supply up to 6.7 MGD average day supply. Holly Springs also holds a Level II Jordan Lake allocation capable of supplying roughly 2 MGD.

Under the preferred alternative, Holly Springs converts its Level II allocation to Level I allocation to meet the majority of its demands. In the long term, approximately 0.2 MGD of additional allocation is required. Holly Springs can access allocation in one of two ways. The first way is to request the Corps release additional water downstream through Jordan Dam, and then work out a contract with Harnett County to treat the additional water in excess of 10 MGD and move it through the existing connection. The second way is to receive water treated at the CAWTP through interconnections with the Town of Apex.

From an infrastructure perspective, Holly Springs must ensure that its connection with Harnett County can meet peak demands based on 2060 average demand.

The Town of Holly Spring's portion of the preferred alternative is shown in Table 33 and in Figure 31. The 'Jordan Lake Allocation – Upgrade' represents the conversion of a current Level II allocation to a Level I allocation that is active for use. This allocation is currently held by Holly Springs, so it could potentially be counted as an existing source, but for planning purposes, it is not included as such in the following table and chart.

Table 33. Town of Holly Springs source selections under JLP preferred regional alternative.

Holly Springs	2010	2015	2020	2025	2030	2035	2040	2045	2050	2055	2060
Demand Projection	2.0	3.3	4.7	5.2	5.7	6.2	6.7	7.2	7.7	8.3	8.8
Existing Sources											
Harnett County - Purchase	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7
New Sources											
Jordan Lake Allocation - Upgrade		2	2	2	2	2	2	2	2	2	2
Jordan Lake Allocation - Fut. Rd.						0.2	0.2	0.2	0.2	0.2	0.2
TOTAL Surplus	**4.7**	**5.4**	**4.0**	**3.5**	**3.0**	**2.7**	**2.2**	**1.7**	**1.2**	**0.6**	**0.1**

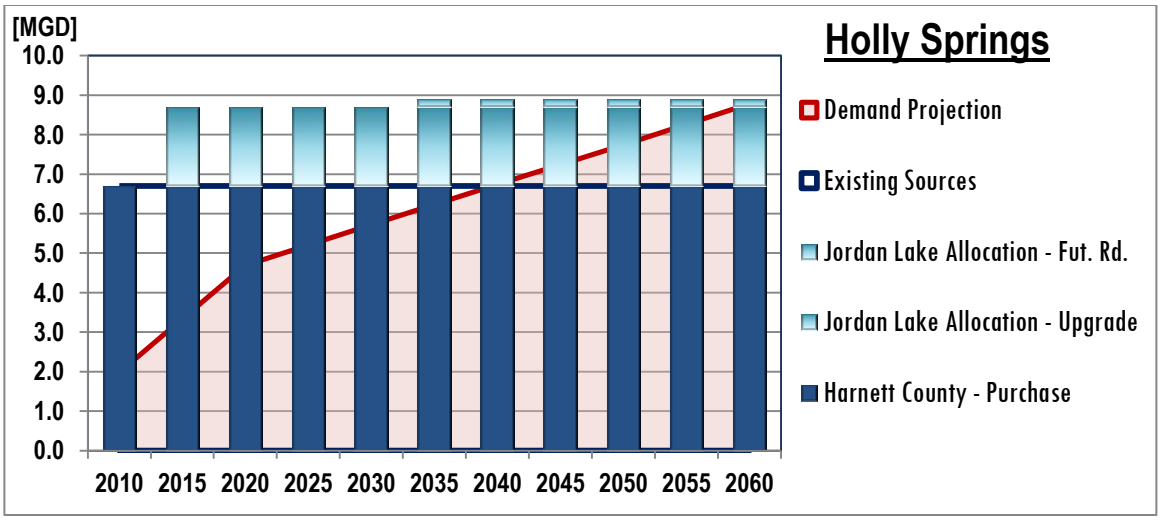


Figure 31. Town of Holly Springs - demands, current supply, and source implementation timeline.

Orange County

Orange County is unique among the partners in that it does not operate a water system, and does not intend to do so. Orange County's projected demands are separated into three primary development areas: Efland-Mebane Economic Development District (EDD), Hillsborough EDD, and Eno EDD. The Efland-Mebane area is the only area with current water service, and receives water from the Town of Mebane, while most of the wastewater is directed to the Hillsborough wastewater treatment plant while Orange-Alamance water system manages billing. The Hillsborough EDD is on the outskirts of the Town of Hillsborough's current service area. The Eno EDD is near the Orange County-Durham County border.

The current projections of growth indicate 49% of the Orange County demand will be in the Efland-Mebane EDD, 28% in the Hillsborough EDD, and 22% in the Eno EDD.

Under the preferred alternative, Orange County will contract with the Town of Mebane to provide water and sewer service directly to the Efland-Mebane EDD. Orange County currently has an agreement for Mebane to provide up to 250,000 gallons to Orange County customers. Mebane's water source is the Graham-Mebane reservoirs, which has sufficient supply to meet the long term water demand of just less than 2 MGD.

The Orange County customers in the Hillsborough EDD will be served by the Town of Hillsborough under the preferred alternative. Orange County will apply for a Jordan Lake allocation to meet these customers' demand, which it will transfer to Hillsborough. This is necessary since Hillsborough's projected supplies will barely meet its own demand. Hillsborough will access this allocation through either Durham or OWASA.

The Orange County customers in the Eno EDD will be served by the City of Durham water system. Orange County will apply for a Jordan Lake allocation to meet these customers' demand, which it will transfer to Durham.

Combined, the Eno and Hillsborough EDDs have a 2060 demand of 2 MGD. Orange County currently holds a 1 MGD (1%) Level II allocation that will be upgraded to a Level I allocation. In addition, Orange County will request an additional 0.5 MGD of Level I allocation to meet demands

through 2045. In a future round of allocations, Orange County will request the final 0.5 MGD, for a total of 2 MGD in 2060.

Orange County's portion of the preferred alternative is outlined in Table 34. Jordan Lake allocations transactions are shown in many separate components, but in general, Orange County will seek a total of 1.5 MGD in this round of allocations (including upgrading a current 1% Level II allocation), and an additional 0.5 MGD in a future round of allocations. The current agreement with Mebane to directly serve Orange County Efland-Mebane customers will be expanded as needed to serve future customers, so the 'Supplied by Mebane – Additional' row shows increasing supply over time.

Table 34. Orange County source selections under JLP preferred regional alternative.

Orange County	2010	2015	2020	2025	2030	2035	2040	2045	2050	2055	2060
Demand Projection	0.0	0.4	0.7	1.1	1.6	2.0	2.4	2.8	3.2	3.6	3.9
Existing Sources											
Supplied by Mebane	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
New Sources											
Jordan Lake Allocation - Upgrade		1	1	1	1	1	1	1	1	1	1
Jordan Lake Allocation - Rd. 4		0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Jordan Lake Allocation - Fut. Rd.						0.5	0.5	0.5	0.5	0.5	0.5
Supplied by Mebane - Additional			0.5	0.5	1.5	1.5	1.5	1.75	1.75	1.75	1.75
TOTAL Surplus	0.2	1.4	1.6	1.1	1.7	1.7	1.3	1.2	0.8	0.4	0.1

Figure 32 displays the same information in chart form. In the chart, an additional dashed line shows the projected demand for the Efland-Mebane EDD, which will be supplied directly by the Town of Mebane. The current agreement for provision of up to 0.25 MGD is shown as the only existing source. The additional supply from Mebane (added as needed) is shown in the chart directly above the current 'Supplied by Mebane' source to allow comparison with the Efland-Mebane demand line. The additional demand in the other service areas will be served by Durham or Hillsborough, but Orange County will seek Jordan Lake allocations to meet these demands. The current Level II allocation is shown, and it will be upgraded to a Level I.

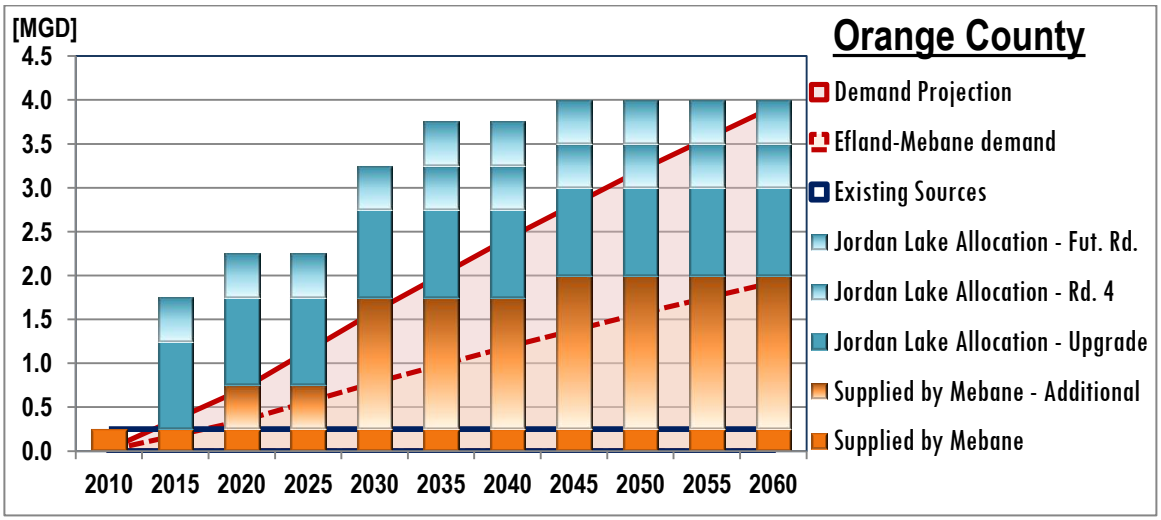


Figure 32. Orange County - demands, current supply, and source implementation timeline.

Orange Water and Sewer Authority

OWASA currently receives its source water supply from a system of reservoirs including University Lake and Cane Creek Reservoir with offstream storage in its Quarry Reservoir. OWASA also holds a 5% Level I Jordan Lake allocation, which it can access from the Town of Cary through connections with the City of Durham.

Under the preferred alternative, OWASA plans to expand the Quarry reservoir to augment its supply. There is an active quarry adjacent to the existing Quarry Reservoir which is permitted to operate through 2030. An inter-pit passageway will be constructed to create an expanded Quarry Reservoir. This additional storage will provide additional yield of up to 2.1 MGD.

OWASA is partnering with the City of Durham, Chatham County, and the Town of Pittsboro to evaluate the feasibility of a new WTP on the west side of Jordan Lake as a potential method to access its current allocation. The allocation will primarily be used for back-up or emergency supply. Hydrologic modeling of the preferred alternative indicates that for the 2060 scenario, OWASA does need to use the Jordan Lake allocation for several of the severe drought years in the model's hydrologic record.

OWASA's portion of the preferred alternative is outlined in Table 35 and Figure 33.

Table 35. OWASA source selections under JLP preferred regional alternative.

OWASA	2010	2015	2020	2025	2030	2035	2040	2045	2050	2055	2060
Demand Projection	7.9	8.1	8.3	9.0	9.7	10.2	10.8	11.3	11.9	12.4	12.9
Existing Sources											
University L., Cane Cr., Res. System	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5
Jordan Lake Allocation - Current	5	5	5	5	5	5	5	5	5	5	5
New Sources											
Quarry Reservoir Expansion							2.1	2.1	2.1	2.1	2.1
TOTAL Surplus	**7.6**	**7.4**	**7.2**	**6.5**	**5.8**	**5.3**	**6.8**	**6.3**	**5.7**	**5.2**	**4.7**

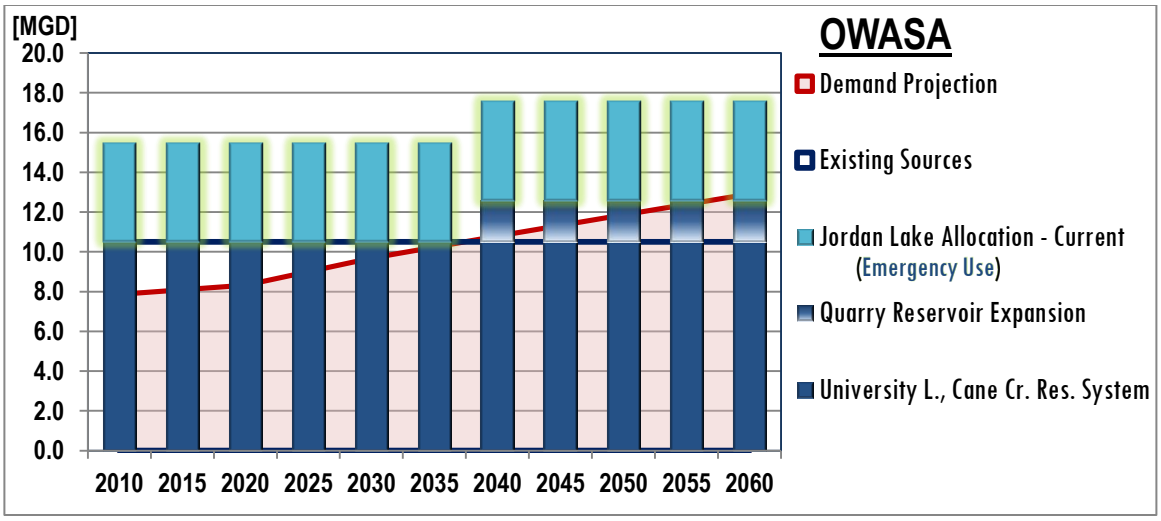


Figure 33. OWASA demands, current supply, and source implementation timeline.

Pittsboro

The Town of Pittsboro currently serves its population with source water withdrawn from the Haw River behind the Bynum Dam. The Pittsboro WTP is currently permitted for 2 MGD.

Under the preferred alternative, Pittsboro will work towards balancing its demand between the Haw River and Jordan Lake. Pittsboro's plan includes increasing capacity at the Haw River with a new or upgraded WTP, in two 2 MGD expansions planned for 2015 and 2020. The maximum capacity planned for the Haw River is 6 MGD. Pittsboro will also participate in the proposed Western Jordan Lake WTP project, and will pursue a new 6 MGD Jordan Lake allocation in Round 4. Once the new Haw River WTP and the shared Western Jordan Lake WTP are online, Pittsboro intends to balance supply between the two sources in equal proportions.

Pittsboro's source selections under the preferred alternative are outlined in Table 36. Unlike many of the other Partners with Jordan Lake allocations, Pittsboro does not currently have access to Jordan Lake, and so would need to wait until the proposed Western Intake and WTP are built to begin accessing supply from Jordan Lake. Therefore, Figure 34 and Table 36 show the Jordan Lake allocation being brought online in 2025, instead of 2015.

Table 36. Town of Pittsboro source selections under JLP preferred regional alternative.

Pittsboro	2010	2015	2020	2025	2030	2035	2040	2045	2050	2055	2060
Demand Projection	0.6	2.0	3.3	5.6	7.8	8.9	10.1	10.4	10.8	11.3	11.8
Existing Sources											
Haw River	2	2	2	2	2	2	2	2	2	2	2
New Sources											
Haw River Expansion		2	4	4	4	4	4	4	4	4	4
Jordan Lake Allocation - Rd. 4				6	6	6	6	6	6	6	6
TOTAL Surplus	**1.4**	**2.0**	**2.7**	**6.4**	**4.2**	**3.1**	**1.9**	**1.6**	**1.2**	**0.7**	**0.2**

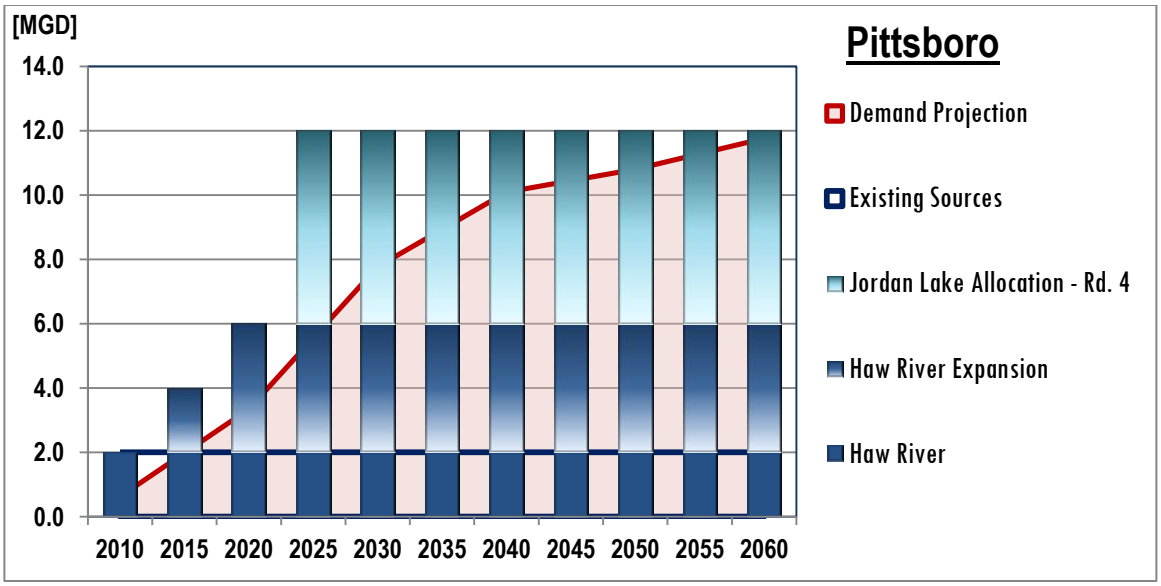


Figure 34. Town of Pittsboro - demands, current supply, and source implementation timeline.

Raleigh and Merger Partners

Raleigh and its Merger Partners, served by the City of Raleigh Public Utilities currently use water from Falls Lake treated at the E.M. Johnson WTP and the Swift Creek lakes (Lake Benson and Lake Wheeler) treated at the D.E. Benton WTP. Raleigh does not have a Jordan Lake allocation.

Due the current state of Raleigh's internal water supply planning, Raleigh's source selections for the preferred alternative must be considered more uncertain than most of the partners' plans. Raleigh's planning is primarily focused on projected need in 2040, though its long term 2060 needs are considered for this RWSP. There is no single preferred alternative for meeting Raleigh's needs through 2040, nor a set group of source options to meet 2045 or 2060 need.

For the preferred alternative, Raleigh has narrowed its group of top source options to four potentially viable sources. All four have similar yields for planning purposes, in the 10-14 MGD range. In general, at least one, and likely two sources will be needed by the 2040-2045 time period. By 2055, it is likely at least three of the four sources will be necessary. Raleigh's top four source options, presented in no particular order, include:

- **Little River Reservoir** – New Reservoir in Wake County
- **Falls Lake Re-allocation** – Allocate more storage to the water supply pool
- **Neuse River Withdrawal** – New withdrawal upstream of NRWWTP
- **Quarry near Richland Creek** – Use excavated quarry for storage, pump from Neuse River to fill

Table 37 and Figure 35 show the approximate timing with which Raleigh brings three of its four most viable source online. The supply provided by each of the sources is assumed to be 13.7 MGD for the purpose of this RWSP. In combination with the existing sources, implementing three new sources allows a small surplus for contingency. The table shows 'Source Option 4' for completeness, though it is not activated.

Table 37. Raleigh and Merger Partners source selections under JLP preferred regional alternative.

Raleigh & Merger Partners	2010	2015	2020	2025	2030	2035	2040	2045	2050	2055	2060
Demand Projection	52.0	61.0	64.4	71.3	78.2	84.8	91.3	97.0	102.7	108.9	115.0
Existing Sources											
Falls Lake	66.1	66.1	66.1	66.1	66.1	66.1	66.1	66.1	66.1	66.1	66.1
Lake Benson, Lake Wheeler	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2
New Sources											
Raleigh Source Option 1					13.7	13.7	13.7	13.7	13.7	13.7	13.7
Raleigh Source Option 2							13.7	13.7	13.7	13.7	13.7
Raleigh Source Option 3										13.7	13.7
Raleigh Source Option 4											
TOTAL Surplus	**25.3**	**19.1**	**12.9**	**6.0**	**12.8**	**6.3**	**13.4**	**7.7**	**2.0**	**9.6**	**3.4**

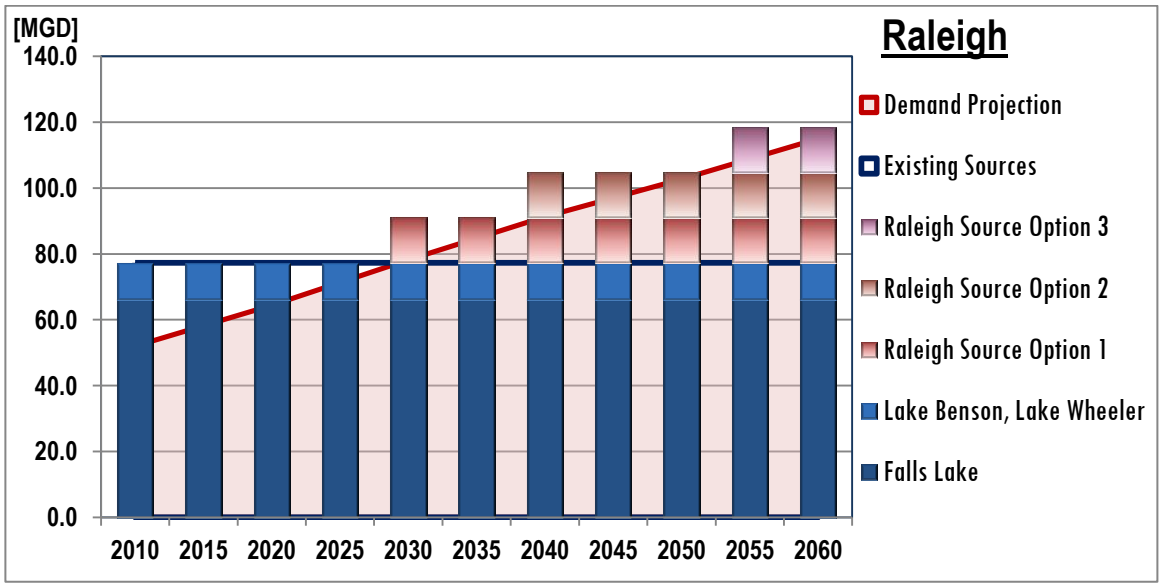


Figure 35. Raleigh and Merger Partners - demands, current supply, and source implementation timeline.

Sanford

The City of Sanford serves much of the population of Lee County from its Cape Fear River water supply source, with treatment occurring at the Sanford WTP. Sanford's intake on the Cape Fear is downstream of Jordan Lake.

Under the preferred alternative, Sanford will expand its intake and WTP on the Cape Fear River in order to meet its need. Sanford currently plans two expansions, with an initial expansion by 2025 increasing the current plant capacity to be able to meet 12 – 14 MGD of average day demand. The timing of the second expansion will depend on the rate demand growth, but for the purposes of this RWSP, it assumed the second expansion will occur in roughly 2045.

Table 38 and Figure 36 show Sanford's component of the proposed regional water supply plan. The chart combines the two separate expansions into a single series because the source remains the Cape Fear River.

Table 38. City of Sanford source selections under JLP preferred regional alternative.

Sanford	2010	2015	2020	2025	2030	2035	2040	2045	2050	2055	2060
Demand Projection	6.5	7.3	8.1	9.8	11.5	13.3	15.2	17.8	20.4	22.6	24.8
Existing Sources											
Cape Fear River	12	12	12	12	12	12	12	12	12	12	12
New Sources											
Cape Fear River Expansion				6	6	6	6	6	6	6	6
Cape Fear River Expansion 2								6.8	6.8	6.8	6.8
TOTAL Surplus	**5.5**	**4.7**	**3.9**	**8.2**	**6.5**	**4.7**	**2.8**	**7.0**	**4.4**	**2.2**	**0.0**

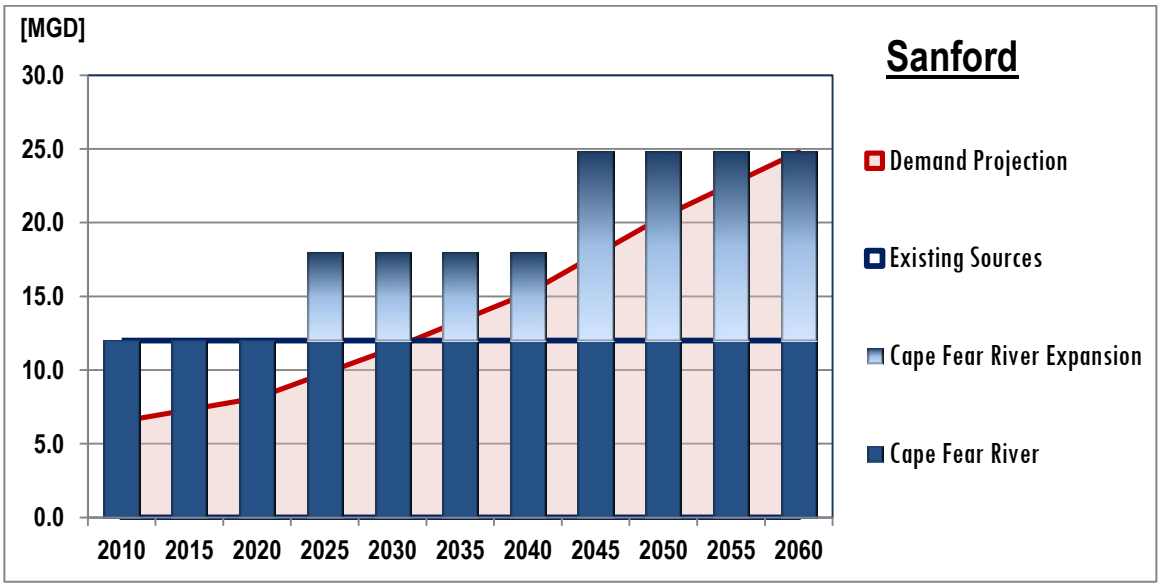


Figure 36. City of Sanford - demands, current supply, and source implementation timeline.

SECTION XIII. References

EFC, 2012. Eskaf, S. "Declining Residential Water Use: Part 1, North Carolina." Environmental Finance Center, University of North Carolina – Chapel Hill. Online. May 24 2012. <http://efc.web.unc.edu/2012/05/24/residential-water-use-is-declining-in-north-carolina/>

USGS, 2009. Kenny, J.F., Barber, N.L., Hutson, S.S., Linsey, K.S., Lovelace, J.K., and Maupin, M.A., *Estimated use of water in the United States in 2005: U.S. Geological Survey Circular 1344*. Online. <http://pubs.usgs.gov/circ/1344/>

Prepared For:

Jordan Lake Partnership

http://www.jordanlakepartnership.org/

Prepared By:

Triangle J Council of Governments

http://www.tjcog.org

For more information contact:
Mike Schlegel
mschlegel@tjcog.org
(919) 295-0017

Appendix A - Demand Projections by Sector

Volume I of the Triangle Regional Water Supply Plan included demand projections by sector for each partner at 10-year increments. For the Jordan Lake Allocation process, demands are needed at 5-year increments. Additionally, several JLP members have revised their demand projections since Volume I.

The revised projections at five year increments are below, with revisions in red.

Apex

Sector	2010	2015	2020	2025	2030	2035	2040	2045	2050	2055	2060
Residential	2.01	2.60	3.19	3.82	4.46	5.24	6.03	6.29	6.55	6.64	6.73
Commercial	0.57	0.73	0.90	0.98	1.07	1.16	1.26	1.37	1.48	1.59	1.70
Industrial	0.09	0.11	0.13	0.18	0.23	0.24	0.25	0.29	0.33	0.34	0.34
Institutional	0.07	0.09	0.10	0.12	0.14	0.16	0.19	0.20	0.21	0.21	0.21
System Process	0.50	0.65	0.80	0.94	1.09	1.26	1.42	1.50	1.58	1.62	1.66
Non-Revenue	0.27	0.35	0.43	0.51	0.59	0.68	0.77	0.82	0.86	0.88	0.90
Total	**3.51**	**4.53**	**5.54**	**6.56**	**7.57**	**8.75**	**9.93**	**10.46**	**11.00**	**11.27**	**11.54**

Cary

Sector	2010	2015	2020	2025	2030	2035	2040	2045	2050	2055	2060
Residential	8.30	9.55	10.80	11.95	13.10	13.95	14.80	15.50	16.20	16.20	16.20
Commercial	2.90	3.60	4.30	4.85	5.40	5.65	5.90	6.10	6.30	6.30	6.30
Industrial	0.10	0.15	0.20	0.35	0.50	0.65	0.80	0.85	0.90	0.90	0.90
Institutional	0.20	0.25	0.30	0.35	0.40	0.40	0.40	0.40	0.40	0.40	0.40
System Process	2.90	3.00	3.10	3.50	3.90	4.15	4.40	4.60	4.80	4.80	4.80
Non-Revenue	0.50	0.65	0.80	0.90	1.00	1.05	1.10	1.15	1.20	1.20	1.20
Total	**14.89**	**17.21**	**19.53**	**21.91**	**24.29**	**25.85**	**27.42**	**28.61**	**29.80**	**29.80**	**29.80**

Morrisville

Sector	2010	2015	2020	2025	2030	2035	2040	2045	2050	2055	2060
Residential	0.90	1.03	1.16	1.28	1.40	1.45	1.50	1.55	1.60	1.63	1.66
Commercial	0.40	0.59	0.78	0.84	0.90	1.00	1.10	1.10	1.10	1.09	1.08
Industrial	0.01	0.02	0.03	0.07	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Institutional	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.03
System Process	0.30	0.35	0.40	0.40	0.40	0.50	0.60	0.60	0.60	0.60	0.60
Non-Revenue	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Total	**1.72**	**2.10**	**2.48**	**2.75**	**3.03**	**3.22**	**3.41**	**3.47**	**3.53**	**3.57**	**3.60**

Wake County - RTP South

Sector	2010	2015	2020	2025	2030	2035	2040	2045	2050	2055	2060
Residential	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Commercial	0.30	0.65	1.00	1.35	1.70	2.05	2.40	2.40	2.40	2.45	2.50
Industrial	0.20	0.15	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Institutional	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
System Process	0.10	0.15	0.20	0.25	0.30	0.45	0.60	0.60	0.60	0.60	0.60
Non-Revenue	0.00	0.05	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Total	**0.60**	**1.00**	**1.40**	**1.80**	**2.20**	**2.70**	**3.20**	**3.20**	**3.20**	**3.25**	**3.30**

Chatham County N

Sector	2010	2015	2020	2025	2030	2035	2040	2045	2050	2055	2060
Residential	0.92	1.44	2.40	3.18	3.95	4.70	5.45	6.21	6.97	7.95	8.93
Commercial	0.25	0.39	0.72	1.05	1.38	1.78	2.18	2.48	2.79	3.18	3.57
Industrial	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Institutional	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
System Process	0.84	1.32	1.80	2.11	2.42	2.94	3.46	3.43	3.40	3.87	4.35
Non-Revenue	0.15	0.24	0.37	0.48	0.58	0.71	0.83	0.91	0.99	1.13	1.27
Total	**2.16**	**3.34**	**5.29**	**6.82**	**8.34**	**10.13**	**11.92**	**13.03**	**14.15**	**16.13**	**18.11**

Durham

Sector	2010	2015	2020	2025	2030	2035	2040	2045	2050	2055	2060
Residential	13.24	14.36	15.47	16.47	17.46	18.42	19.37	20.28	21.19	22.06	22.92
Commercial	6.62	6.91	7.19	7.80	8.40	8.95	9.50	10.02	10.53	11.01	11.49
Industrial	1.31	1.28	1.24	1.36	1.47	1.58	1.68	1.79	1.89	1.98	2.07
Institutional	2.73	2.46	2.19	2.30	2.41	2.52	2.63	2.74	2.84	2.95	3.05
WTP Process	0.86	0.95	1.04	1.10	1.16	1.23	1.30	1.36	1.42	1.47	1.51
Non-Revenue	0.51	2.02	3.53	3.39	3.24	3.43	3.62	3.80	3.98	3.66	3.33
Total	**25.27**	**27.97**	**30.67**	**32.41**	**34.15**	**36.13**	**38.11**	**39.99**	**41.86**	**43.12**	**44.38**

Hillsborough

Sector	2010	2015	2020	2025	2030	2035	2040	2045	2050	2055	2060
Residential	0.58	0.78	0.97	1.08	1.18	1.28	1.38	1.49	1.59	1.69	1.79
Commercial	0.19	0.35	0.51	0.53	0.54	0.55	0.56	0.57	0.59	0.61	0.62
Industrial	0.09	0.10	0.10	0.10	0.10	0.10	0.11	0.11	0.11	0.11	0.11
Institutional	0.09	0.20	0.31	0.34	0.38	0.39	0.41	0.42	0.44	0.45	0.45
System Process	0.06	0.17	0.28	0.30	0.33	0.35	0.38	0.40	0.43	0.45	0.48
Non-Revenue	0.15	0.15	0.15	0.16	0.17	0.19	0.20	0.22	0.23	0.24	0.25
Total	**1.16**	**1.74**	**2.32**	**2.51**	**2.70**	**2.86**	**3.03**	**3.21**	**3.38**	**3.54**	**3.70**

Holly Springs

Sector	2010	2015	2020	2025	2030	2035	2040	2045	2050	2055	2060
Residential	1.37	1.62	1.86	2.09	2.32	2.61	2.89	3.17	3.45	3.74	4.02
Commercial	0.15	0.30	0.44	0.59	0.73	0.82	0.91	1.00	1.09	1.18	1.27
Industrial	0.15	0.89	1.62	1.73	1.83	1.88	1.93	1.98	2.03	2.09	2.14
Institutional	0.00	0.08	0.16	0.24	0.32	0.36	0.40	0.44	0.47	0.51	0.55
System Process	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Non-Revenue	0.31	0.46	0.61	0.57	0.52	0.57	0.61	0.66	0.70	0.75	0.80
Total	**1.98**	**3.34**	**4.69**	**5.21**	**5.72**	**6.23**	**6.74**	**7.24**	**7.74**	**8.26**	**8.78**

Orange County

Sector	2010	2015	2020	2025	2030	2035	2040	2045	2050	2055	2060
Residential	0.01	0.14	0.26	0.43	0.59	0.75	0.90	1.05	1.19	1.32	1.46
Commercial	0.01	0.20	0.39	0.64	0.89	1.12	1.35	1.57	1.79	1.99	2.19
Industrial	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Institutional	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
System Process	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Non-Revenue	0.00	0.03	0.05	0.08	0.11	0.14	0.17	0.20	0.22	0.25	0.27
Total	**0.02**	**0.36**	**0.70**	**1.15**	**1.59**	**2.01**	**2.42**	**2.81**	**3.20**	**3.56**	**3.92**

OWASA

Sector	2010	2015	2020	2025	2030	2035	2040	2045	2050	2055	2060
Residential	4.00	4.12	4.23	4.58	4.93	5.21	5.49	5.76	6.03	6.30	6.57
Commercial	1.17	1.21	1.24	1.34	1.44	1.53	1.61	1.69	1.77	1.85	1.92
Industrial	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Institutional	1.90	1.96	2.01	2.18	2.34	2.48	2.61	2.74	2.87	3.00	3.12
System Process	0.09	0.10	0.10	0.11	0.11	0.12	0.12	0.13	0.14	0.15	0.15
Non-Revenue	0.70	0.72	0.74	0.80	0.86	0.91	0.96	1.01	1.05	1.10	1.15
Total	**7.86**	**8.09**	**8.32**	**9.00**	**9.68**	**10.24**	**10.79**	**11.33**	**11.86**	**12.39**	**12.91**

Pittsboro

Sector	2010	2015	2020	2025	2030	2035	2040	2045	2050	2055	2060
Residential	0.23	1.15	2.07	3.54	5.01	5.82	6.63	6.86	7.09	7.40	7.71
Commercial	0.13	0.35	0.57	0.95	1.32	1.56	1.79	1.88	1.97	2.09	2.21
Industrial	0.07	0.15	0.22	0.35	0.48	0.54	0.61	0.61	0.61	0.61	0.61
Institutional	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
System Process	0.10	0.16	0.22	0.37	0.52	0.50	0.48	0.50	0.52	0.54	0.56
Non-Revenue	0.09	0.17	0.25	0.34	0.43	0.51	0.58	0.60	0.62	0.64	0.67
Total	**0.62**	**1.98**	**3.34**	**5.55**	**7.77**	**8.93**	**10.09**	**10.45**	**10.80**	**11.28**	**11.76**

Raleigh

Sector	2010	2015	2020	2025	2030	2035	2040	2045	2050	2055	2060
Residential	29.43	34.49	39.56	43.09	46.63	49.43	52.23	55.17	58.12	61.60	65.08
Commercial	11.42	13.39	15.36	16.73	18.10	19.19	20.28	21.42	22.56	23.91	25.26
Industrial	1.30	1.53	1.75	1.91	2.06	2.19	2.31	2.44	2.57	2.73	2.88
Institutional	3.40	3.99	4.57	4.98	5.39	5.71	6.04	6.38	6.72	7.12	7.52
System Process	2.29	2.68	3.08	3.35	3.63	3.84	4.06	4.29	4.52	4.79	5.06
Non-Revenue	4.16	4.88	5.59	6.09	6.59	6.99	7.38	7.80	8.22	8.71	9.20
Total	**52.00**	**60.95**	**69.90**	**76.15**	**82.40**	**87.35**	**92.30**	**97.50**	**102.70**	**108.85**	**115.00**

Sanford

Sector	2010	2015	2020	2025	2030	2035	2040	2045	2050	2055	2060
Residential	2.68	3.20	3.71	4.43	5.14	5.69	6.23	6.90	7.56	8.37	9.17
Commercial	1.85	2.29	2.74	3.39	4.05	5.02	6.00	7.44	8.88	9.85	10.82
Industrial	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Institutional	0.20	0.24	0.28	0.35	0.41	0.49	0.58	0.70	0.82	0.91	1.00
System Process	1.03	0.82	0.61	0.69	0.77	0.87	0.96	1.09	1.22	1.33	1.44
Non-Revenue	0.76	0.77	0.77	0.93	1.09	1.27	1.45	1.69	1.94	2.15	2.35
Total	**6.52**	**7.32**	**8.11**	**9.78**	**11.46**	**13.33**	**15.21**	**17.82**	**20.42**	**22.61**	**24.79**

This page intentionally left blank.

Appendix B. Water Efficiency, Conservation, and Demand Management Summaries by Partner

This Appendix presents full summaries for each of the Jordan Lake Partners of the conservation, efficiency, and demand management activities that have been implemented or are under planning for future implementation. This section will support the partners' individual allocation applications, but also reinforces the commitment to sustainable and efficient use of water resources of the Partnership collectively.

While all of the partners are committed to sustainable use of water resources, there is considerable variation in the summaries presented here. Due to differences in system size, governance, and available resources both in financial and personnel terms, the systems have conservation, efficiency, and demand management programs of widely varying maturity, scope, and focus. All of the partners have been engaged in regional coordination (through this effort and others) to learn from other water system's programs, and provide feedback and advice to other partners on setting up, managing, or changing new or existing programs.

Town of Apex

The Apex water demand projections address water conservation indirectly in the sector's use rates. The rates reflect fairly efficient use by its residential and commercial sectors. Apex treats its water at the Cary/Apex WTP, which due to the quality of Jordan Lake source water, requires a considerable amount of process water. Once the water is treated, Apex is committed to keeping the other non-revenue sector usage under control. It is kept to 9% of finished water demand, or 7.8 % of raw water demand, which is a fairly low, though attainable percentage.

Apex has a water conservation ordinance in place to enforce the region-wide measures implemented since the 2007-2008 drought.

Bulk water sales, non-metered construction water, metered non-billed water, and in-house water use for activities such as street washing and water quality flushing are tracked and audited annually. Unaccounted water use averages less than 3%.

The majority of housing developments in Apex have been built since 2000 and already have efficient plumbing fixtures installed.

Towns of Cary and Morrisville and Wake County – RTP South

Conservation Program Overview

The Town of Cary has one of the longest-standing water conservation programs in the State of North Carolina (starting in 1995), one of the most comprehensive and proactive programs in the Southeast, and is well recognized across the country. The Town's water conservation program is led by a Conservation Program Supervisor who supervises a full-time Water Conservation Program Specialist and a half-time Conservation Specialist (communications). Two Water Conservation Technicians also implement the Water Conservation Program through field education and, when needed, enforcement, with priorities set by the Conservation Program Supervisor. The program is overseen by the Town's Water Resources Manager.

The Town has set forth goals for the conservation program within Town Policy Statement 111:

- Support the high quality of life in Cary by providing safe and reliable water service while reducing wasteful uses of water; reducing costs of infrastructure; and conserving a limited natural resource.
- Delay capital projects for the expansion of water supply facilities or the development of new sources.

The Town's water conservation program focuses on two primary areas to meet these goals: (1) reducing per capita water consumption and (2) managing peak day water demands. The program accomplishes its goals through a combination of three elements:

- Education
- Financial incentives
- Regulations

The combination of these three elements fosters the Town's culture of conservation, encouraging customers to reduce water use by installing efficient technologies and by practicing water wise behaviors. Table 1 summarizes the existing elements of Cary's Water Conservation Program, including target water use classes.

TABLE 1
Existing Cary Water Conservation Program Elements

Conservation Program Elements	Target Use Class
Education and Public Information	
Public Education/Beat the Peak Campaign	All
Fix a Leak Week Campaign	Residential
Block Leader Program	Residential
Residential Water and Irrigation Audits	Residential
Website	All
Festival Booths	All
Financial Incentives	

TABLE 1
Existing Cary Water Conservation Program Elements

Conservation Program Elements	Target Use Class
Tiered Rate Structure	All
Water Budgets (linked with tiered rates)	Commercial (some Residential)
High Efficiency Toilet (HET) Rebate	All
Turf Buy Back	Residential
Rain Barrel	Residential
Rain Barrels for Sale at Cost	
Build Your Own Rain Barrels for Sale at Cost	
Give-aways (showerheads, kitchen and bathroom aerators, shower timers, rain gauges)	Residential
Regulations and Policies	
Water Waste Ordinance	All
Rain Sensor Ordinance	All-Outdoor
Alternate Day Watering Ordinance	All-Outdoor
New Development	
Land Development Ordinance	Commercial-Outdoor
Irrigation Plan Review	All -Outdoor
Requirement for Separate Irrigation Meters	All-Outdoor

Reclaimed Water Program

In 2001, the Town of Cary became the first municipality in North Carolina to provide reclaimed water to homes and businesses for irrigation and cooling. The Town is permitted to divert up to 5 mgd of treated effluent to its reclaimed water system. In 2010, the Town provided approximately 0.3 mgd on an annual average day basis and in excess of 1 mgd on a seasonal peak day to over 600 customers.

The Town's Policy Statement No. 132 (PS 132), adopted in 2001 and most recently updated in March 2013 after completion of the Long Range Water Resources Plan (LRWRP), defines the reclaimed water services areas (Figure 1) and provides guidance on the effective utilization of reclaimed water. The goals of PS 132 and the Town's reclaimed water program are the reduction of non-essential use of potable water and to prevent peak potable water demands from accelerating the need for expansion of the CAWTP. Following are key points contained in PS 132:

- Residents and businesses are to utilize to the maximum extent possible reclaimed water for secondary plumbing usage; including irrigation, cooling towers and other potential uses ("secondary water use facilities") as determined by the Town Manager, within the Town's designated reclaimed water service area.

- Developers are responsible for the full cost of installation reclaimed water facilities within their own properties.

- If reclaimed water is not available to a property for use when the site is ready for development, all on-site reclaimed water infrastructure shall be constructed and designed for permanent conversion to use reclaimed water when reclaimed water supply becomes available.

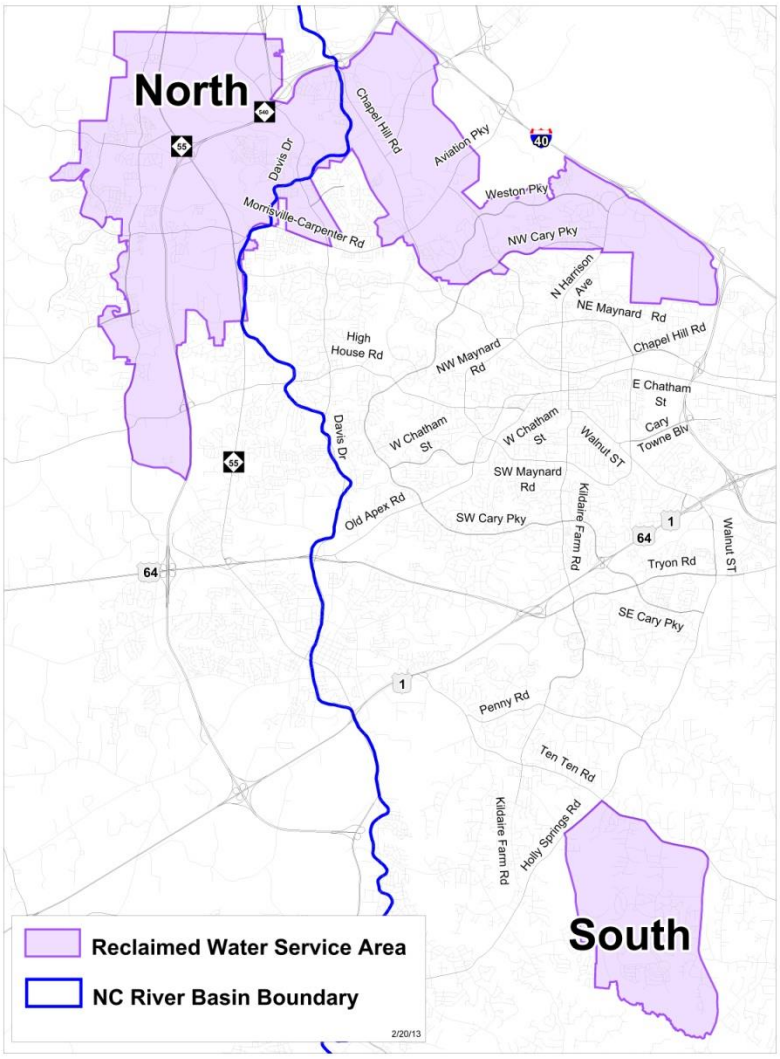
The Town's reclaimed water system currently consists of:

- **North Cary Reclaimed Water Service Area**: Reclaimed water from the North Cary Water Reclamation Facility (WRF) serves commercial facilities for irrigation and cooling needs, as well as lawn irrigation for single-family homes. Reclaimed water from Durham County's Triangle WWTP serves facilities in the Wake County portion of Research Triangle Park (RTP South) for irrigation and cooling needs, and by fall 2014 will serve additional residential and commercial facilities along Green Level Church Road extending from RTP to Thomas Brooks Park. Eventually the two systems will be connected, serving parts of Morrisville along the pipeline route, and supplied with reclaimed water from the North Cary WRF.

- **South Cary Reclaimed Water Service Area**: Reclaimed water from the South Cary WRF serves the irrigation needs for nearby schools and a recreational complex and is currently expanding its system to supply lawn irrigation for residential customers.

- **Bulk Reclaimed Wate**r: Both of the Town's WRFs allow approved contractors and Town employees to fill non-potable water tanks for use in irrigation, road construction, dust control, sewer flushing, and street cleaning. When completed in 2014, the Western Wake Regional WRF will also provide bulk reclaimed water.

Figure 1
Reclaimed Water Service Areas



Water Loss Reduction Program

The Town of Cary conducts annual water audits using the AWWA Water Loss Control Committee Water Audit Software v4.2. Unaccounted for water loss is consistently < 10%, ranging between 2% and 6% for the past five fiscal years.

All of the Town's potable and reclaimed water connections are metered. The Town requires contractor tank trucks to use a bulk water meter when withdrawing water from hydrants, and, for approved uses, encourages them to use bulk reclaimed water instead of potable water.

The Town recently replaced all of the 63,000+ manual read meters to electronic read meters with a new fixed base network system (advanced meter infrastructure or AMI) and refers to this as Aquastar. As a result of the Aquastar project, 98% of the meters in the Town's service area are less than three years old.

The large meters at the Cary Apex WTF (30” and 42”) are tested and calibrated every six months. Large electronic flow meters in the distribution system are calibrated quarterly. Large mechanical meters are typically not calibrated, but are tested during system-wide flow studies to determine their accuracy.

100% of the Town’s distribution system is mapped using GIS. All development projects that include installation of public water infrastructure are reviewed and permitted by the Town’s Engineering Department (EN) and inspected during construction by EN. EN receives as-built drawings for archiving, and updates the Town’s GIS data upon receipt of the as-builts.

The Town’s goal is to exercise all valves ≥ 30” two times per year and all valves < 30” once every two years. The Town is in the process of locating all valves by GPS.

Overall Customer Water Use Efficiency

The LRWRP assessed the overall water use efficiency of the Town’s customers and reviewed unit consumption data, by customer type, from 1995 through 2011. Since the inception of the Water Conservation Program in 1996, the Town has used and updated a database to track water consumption per unit for all residential and non-residential customer classes. In addition to actual consumption, the database also normalizes consumption to remove the influence of weather, estimating the annual unit consumption values had there been normal weather conditions, defined as the long-term average (20 and 30-year average). More detail on this methodology can be found in CH2M HILL, 2007b. Figure 2 presents the **residential** gpcd (combined single family and multi-family) from 1996, the first full year after the inception of the water conservation program, through 2011. Figure 3 presents the **overall** (combined residential and non-residential) gallons per day per account (gpd/account).

Reviewing total monthly water use by customer class (single family residential, multi-family residential, commercial, industrial, and institutional) from January 1996 through December 2011 reveals that the overall single family residential customer class’ daily consumption has decreased significantly over this 16-year period. The weather-adjusted data indicate that the single family residential customer class per capita consumption has decreased approximately 24 percent since 1996 (1996 was used as the baseline year for comparisons to be consistent with previous Town reports). This is compared to the weather-adjusted overall gpcd (combined residential and non-residential consumption) reduction of approximately 20 percent during the same period. It is important to note that this overall decrease in water use is by no means consistent on a yearly basis with some years showing increases in per capita consumption when compared with previous years. These fluctuations underscore the importance of the Town's commitment to long-term water resources management through its dynamic water conservation program.

It is challenging to explicitly link the influence of the Town’s water conservation program on these decreasing unit consumption trends (inclusive of adjustment for weather). Other factors that also influence water consumption include the economy, severe droughts in 2001-2002 and 2007-2008, changes in housing stock, changing regulations (outside of the Town’s control), and the influence of local as well as global perspectives on water resources and sustainability. However, Cary considers its Water Conservation Program to be one of the driving factors in the sustained decrease in unit water use since 1996. In addition, the conservation program has been in place as greater numbers of residential irrigation systems have been installed; the increased prevalence of these systems have the potential to drive peak season water demands above the historical peaks, but this situation has not been shown by the data.

Figure 2
Annual Average Combined Residential Water Use in Gallons per Capita per Day (GPCD), 1995 through 2011
Town of Cary Customers Only

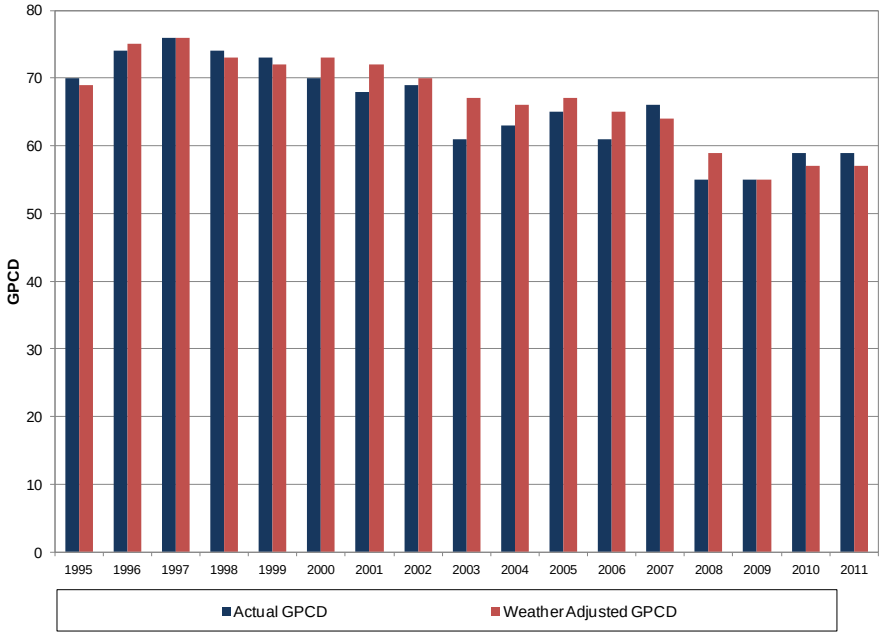
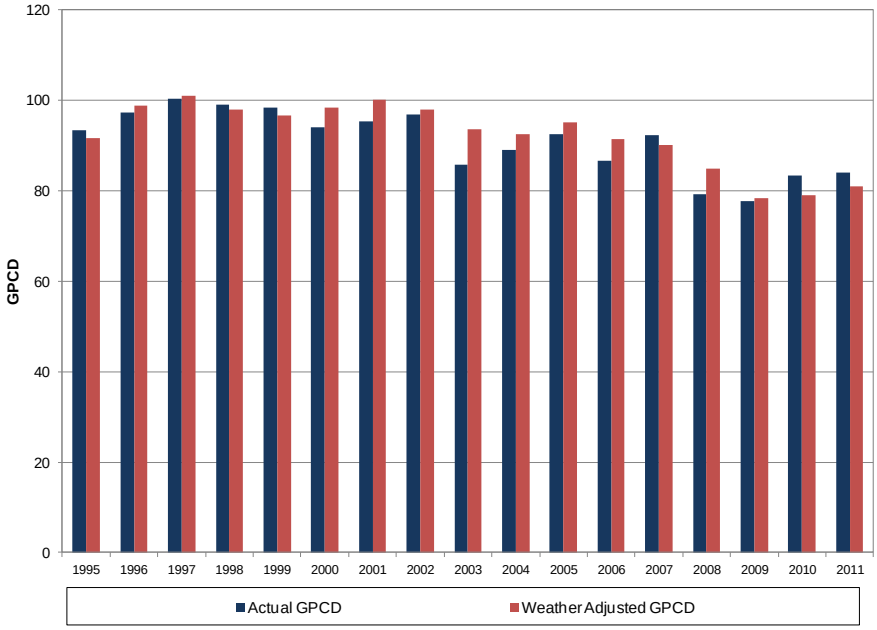


Figure 3
Annual Average Overall Water Use in Gallons per Capita per Day (GPCD), 1995 through 2011
Town of Cary Customers Only



Customer Water Consumption Trends

The Town has completed a significant amount of work to understand and track the consumption trends of its customers. Detailed analyses were completed by the Town during the development of the 2007

Integrated Water Resource Management Plan (IWRMP) (CH2M HILL, 2007a). These IWRMP analyses were updated in the 2010 Water Use Analysis report (CH2M HILL, 2010) and incorporated an additional 5 years of data. Both of these reports present a vast amount of consumption profile data which provides a strong foundation for evaluating conservation programs in the Town. The 2010 analyses include evaluations of water use by different customer classes to provide a more detailed understanding of how, when and where water is used and the trends in water use for the different customer classes.

Residential (single and multi-family) water use has continued to make up a majority of the Town's water use profile – approximately 65 percent of total consumption. Single family residential irrigation demands have been estimated to range from 10 to 28 percent of the annual average daily demand from 2001 through 2009 (CH2M HILL, 2010), and comprise up to 50 percent, or greater, of the total residential demand on the annual maximum day. Significant trends in single family residential consumption or factors that can and will impact consumption in the future, as identified in the Water Use Analysis report (CH2M HILL, 2010) include:

- Homes built after 2000 tend to be larger in size (with greater tax values), have more bathrooms, more water consuming fixtures, smaller lots and a higher prevalence of automatic inground irrigation systems than older homes.

- Newer homes tend to use approximately 20 percent more water on an average daily basis than older homes. Although newer homes have a greater number of bathrooms and water consuming fixtures, their indoor consumption volumes do not appear to be driving total consumption. Irrigation demands are likely driving the increased consumption level for new homes.

- Homes with inground irrigation systems use a significantly higher amount of water than those without. Total annual average daily demand for homes with an inground irrigation system, constructed after 2000, is approximately 30 percent irrigation. During the peak irrigation season, the daily water consumption of these homes can be comprised of more than 50 percent irrigation.

The trends identified above are not much different than those being identified in national studies being completed by AquaCraft (Mayer, 2011), Maddaus Water Management (Maddaus, 2011) and the AWWA Research Foundation (AWWARF, 2010a).

The Maddaus (2011) work presents some additional trends of interest for the future which are partly the result of the recent economic recession, and which could impact residential consumption profiles. Residential indoor profiles have historically been decreasing or flat due to improved fixture efficiency, reduced household sizes and conservation efforts. However, the recession-driven trends demonstrate an increased prevalence of teleworking, increased unemployment, household consolidation (increase in person per household), reduced vacations, and a shift in demographics for new homes (elderly vs. new families). A few of these trends are contrary to the declining trend in household size identified in a recent AWWARF (2010a) study which identified a decreasing trend in household water consumption, in part linked to decreasing household size. The water consumption dataset used for that AWWARF study included data through 2006-2007, which was the time period before the full impact of the economic recession, which started in 2007, was realized.

All of the identified trends, Town-specific and national, will influence the future consumption profile of the Town and shape its future water supply needs. Cary's water conservation program has been and

will continue to be an important part of managing the influence of these trends on the Town's water system.

Future Water Demands

Town of Cary staff worked with staff of Apex, Morrisville, and Wake County through a structured, two-phase process to develop a Long Range Water Resources Plan (LRWRP). The LRWRP takes a strategic long view – through 2060 – to prepare us to meet the Town's water resources challenges in a dynamic and holistic way, through development of a Water Resources Portfolio. The Portfolio provides a mix of practical strategies that we can apply to meet our water resources responsibilities by implementing the right actions at the right time.

In addition to infrastructure and regulatory solutions, the Water Resources Portfolio contains best management practices addressing supply side management, demand side management and reclaimed water use. Supply side management includes continuation of existing operational programs like optimizing the distribution system operation, performing annual system water audits, and leak detection. The specific recommendations are already part of or planned for utility operations, and increase the flexibility and resiliency of our water system management.

Demand side management and reclaimed water have the potential for a significant impact on water use which could vary greatly depending on Town policies and customer choices. Because of the uncertainty associated with these practices, we cannot depend on them to reduce potable water demand, but the LRWRP quantifies how they could – in combination – increase the reliability and/or extend the life of our water supply (Figure 5) and treatment plant (Figure 6). For example, Figure 5 shows that by continuing implementation of reclaimed water and demand-side management, we can decrease the probability that our raw water demand will exceed our current 39-mgd allocation in 2032 from 50 percent to only 25 percent – thereby increasing the reliability of our water supply. Similarly, Figure 6 illustrates that these strategies could decrease the probability that our treated water demand will exceed the expanded CAWTF 56-mgd capacity in 2032 from 50 percent to only 25 percent – possibly delaying the need for the next expansion.

Figures 5 and 6 are based on reclaimed water Scenario 4 (discussed below), and on overall potential demand side management water use reductions from current conservation programs, future federal efficiency requirements, and enhancements to the Towns' conservation programs.

Figure 5. Annual Average Daily Raw Water Demand, Towns of Apex, Cary, and Morrisville, RDU Airport, and RTP South, 2002 through 2060 – With the Incorporation of Enhanced Demand Management Programs and Reclaimed Water Program

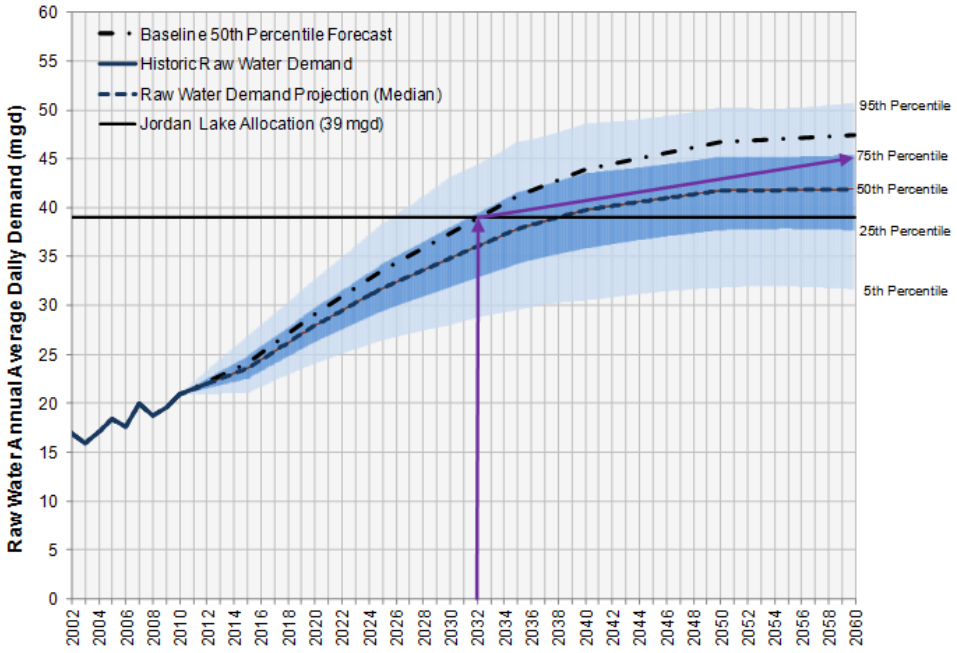
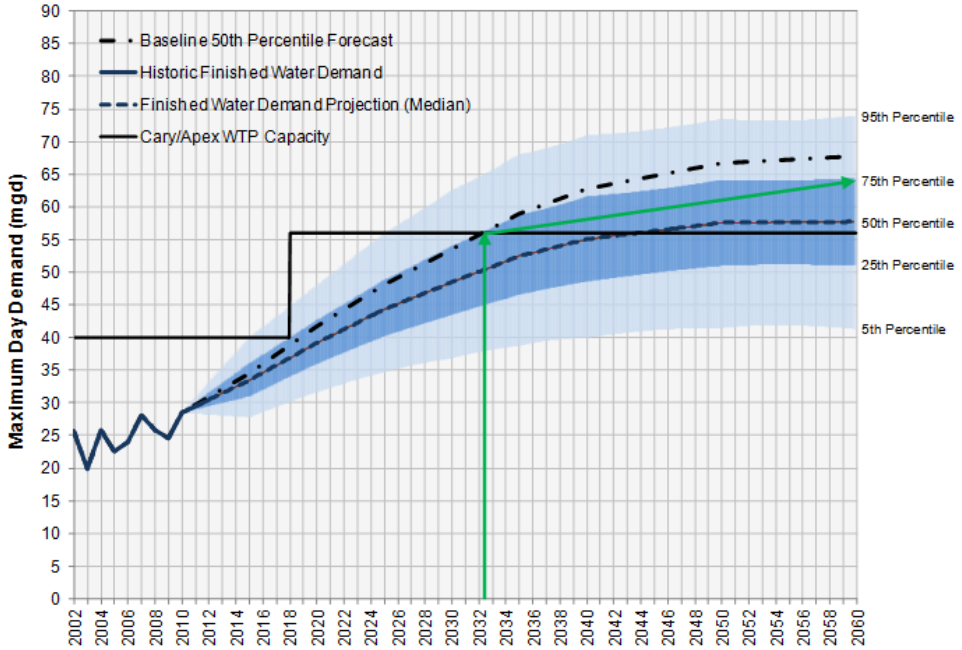


Figure 6. Maximum Day Finished Water Demand, Towns of Apex, Cary, and Morrisville, RDU Airport, and RTP South, 2002 through 2060 – With the Incorporation of Enhanced Demand Management Programs and Reclaimed Water Program



Demand Side Management

Demand side management includes both price-based (rate structure) and alternative (non-price-based) demand side management. The LRWRP includes an evaluation of Cary's current water conservation program (Appendix M, Town of Cary Water Conservation Program Evaluation and Future Considerations), incorporating a statistically valid survey of single family residential customers in Cary and Morrisville to assess water use awareness and values. On average, customers indicated that they were satisfied with the Town's conservation program. There was a general consensus that efficient water use is crucial to the Town's future water supply and the strongest motivation for conserving water is because it's "the right thing to do." Other key drivers to conserve water included compliance with water use ordinances and saving money.

Regulations as a strategy for conservation were viewed favorably and tiered water rates to encourage conservation are acceptable. Nearly 85% of respondents have a role (all or part) in maintaining their landscape indicating a potential opportunity for encouraging conservation. The preferred means of receiving information was limited to 4-5 methods including the BUD newsletter, postcards from the utility, Cary's e-mail list service and Cary's website.

Our nationally-recognized conservation program has always consisted of three main strategies: education and public information, financial incentives, and regulations. Over the years, the initiatives within these strategies have changed based upon program analysis from each of the long range plans, new technology, and community needs. The three-pronged approach provides a variety of opportunities for customers to understand their role in helping us manage our water resources for the long-term benefit of our community.

Currently, the primary initiatives of the education and public information component include the annual "Beat the Peak" and "Fix a Leak Week" campaigns, the Block Leader Program, and Residential Water and Irrigation Audits. Staff supports educators with teaching materials, but no longer teaches lessons in the schools. With information on our Web pages and regular Bud articles, as well as personal contact with citizens at Lazy Daze and Earth Day festivals, staff provides individuals, neighborhoods and the community at large with information to help them use water wisely. With the recent completion of its advanced water meter infrastructure, known in Cary as Aquastar, many of Cary's educational initiatives will focus on the benefits of this tool for all customer types.

Financial incentives currently include the Tiered Rate Structure, High Efficiency Toilet (HET) Rebate Program, Turf Buy Back Program, Rain Barrel Sales, and water efficient tool giveaways. As with the public information initiatives, financial incentives have changed over time based upon participation and quantifiable results. For example, previous program evaluations resulted in elimination of the Toilet Flapper Rebate program and reduction of the HET rebate from $150 to $100.

The water conservation regulations – Water Waste Ordinance, Rain Sensor Ordinance, Alternate Day Watering Ordinance, Land Development Ordinance, Irrigation System Design Requirements, and the Separate Irrigation Meter Requirement – provide clear expectations, and have changed as irrigation technology has improved watering efficiency.

The Town's well-established Water Conservation Program has been and will continue to be an integral part of Cary's water resources management. The LRWRP includes many suggestions for further evaluations and considerations for advancing the water conservation program that focus on efficient irrigation/peak day management and a broader framework for water resources communications strategies.

Reclaimed Water System

The Strategic Reclaimed Water System Plan (SRWSP) developed for the LRWRP (Appendices L1 and L2) was closely coordinated with the Reclaimed Water Master Plan update still in progress. Four reclaimed water scenarios were evaluated representing different future service areas and total reclaimed water demand, ranging from serving only the areas adjacent to the current built or funded reclaimed water infrastructure, to serving the entire town.

Scenario 4 was selected for future planning because it balances the extent of the reclaimed water service area and reclaimed water demand with the reclaimed water supply available. This changed the reclaimed water service area adopted in 2010 to include an area of the Town of Morrisville. The policy continues to prohibit use of potable water for new irrigation systems when reclaimed water is available. In the long term, depending on the rate of development and customer choices regarding water use, this scenario could include use of toilet flushing in new non-residential buildings and/or retrofit of existing residential irrigation systems to use reclaimed water. The selected scenario allows for the most cost-effective use of reclaimed water in the short term, with flexibility for continued system and policy development in the long term.

References

CH2M HILL and Brown and Caldwell. 2013. Long Range Water Resources Plan. Prepared for Towns of Cary, Apex and Morrisville, and Wake County.

CH2M HILL. 2012a. Town of Cary Water Conservation Program Evaluation and Future Considerations. Prepared for the Town of Cary.

CH2M HILL. 2012b. Strategic Reclaimed Water System Plan. Prepared for the Town of Cary.

CH2M HILL. 2012c. Town of Cary, Morrisville and RTP South Baseline Water Demand and Wastewater Flow Projections Technical Memorandum. Prepared for the Town of Cary.

CH2M HILL. 2011. Informal Survey of Other Utilities. Prepared for the Town of Cary.

CH2M HILL. 2010. Water Use Analysis. Prepared for the Town of Cary.

CH2M HILL. 2007a. Integrated Water Resources Management Plan (IWRMP). Prepared for the Town of Cary.

CH2M HILL. 2007b. Town of Cary IWRMP Voyage™ Model Manual. Prepared for the Town of Cary.

Chatham County - North

Chatham County's primary avenue for water efficiency gains is in reducing its non-revenue water as a percentage of total production. Although Chatham County uses a fairly high percentage of water during the treatment process and to maintain water quality in a geographically far-reaching distribution system, active steps are being taken to bring this percentage down markedly. Chatham County – North relies on Jordan Lake water for its raw water supply, which is difficult to treat to the Safe Drinking Water Act requirements, and requires a significant amount of water treatment process water. As Chatham's water demand increases, this WTP process water should decline as a percentage of total water use because a certain amount of the WTP use is relatively fixed regardless of the amount of production. Chatham County has also implemented some proactive improvements to the treatment plant backwash system which has already resulted in significant water savings. Over the longer term, a new treatment plant will likely be constructed, which will take advantage of the latest treatment technology, thereby increasing efficiency.

Chatham County – North also uses a significant amount of finished water for flushing because of the layout of its distribution system and the need to manage disinfection by-products. The current high distribution process water usage should decline as Chatham County's user base expands and evens out consumption. The water system is also in the process of adding disinfection injection in the distribution system to boost disinfection concentrations, thereby reducing some of the line flushing currently being done. These actions, combined with careful management of the treatment process, distribution system, and system improvements, Chatham County should be able to reduce its non-revenue water use in the future. These reductions in process usage are reflected in Chatham County's water demand projections.

Chatham County also works to improve demand side efficiency through conservation policies and programs. Additionally, in 2008 Chatham County passed one of the most aggressive water conservation ordinances in the region. In Chatham County, lawn irrigation is limited to only 2 days/week with a maximum of 1 inch total per week. The Chatham County North water system has also implemented a steeply tiered water rate that is designed to encourage water conservation. Many of the other measures included in the ordinance mirror what the majority of the other systems in region have implemented, such as, rain/moisture sensors requirements, automated meter reading program, water conservation marketing and advertising materials distribution, water shortage response plan development, and improved water loss tracking and reporting.

These measures have made a significant difference in water use in the county and this trend will continue as Chatham County North implements these steps along with plans for improved distribution system design as the system is expanded in the future.

City of Durham

Durham residents, businesses, and institutions used 12% less water in 2012 than in 1999, despite a 20% increase in total customer accounts during that same period. This significant increase in water efficiency is consistent with trends observed nationwide and reflects the conservation ethic that was fostered among customers in Durham and other Triangle area communities – many of whom implemented permanent changes to reduce water use – during the record droughts of 2001-2002 and 2007-2008.

The City of Durham has reinforced this trend through a combination of educational outreach and regulatory initiatives summarized below (parentheses indicate the month and year when first implemented):

Water Use Assessments (March 1995) – This ongoing service provided by Water Conservation/Efficiency staff continues to be one of the most valuable tools available to customers. Initially, Water Use Assessments (WUAs) were only available to residential customers; however in recent years the services has been expanded to small commercial customers as well. Customers who take advantage of WUAs have a small charged added to their account, but receive a huge benefit in determining the source of any leaks on their property and receiving one-on-one advice regarding the vast array of opportunities to reduce water use and promote water efficient behavior. The value of WUAs has been significantly increased with the implementation of dataloggers (electronic meters).

Tiered Water Rates (July 2008) – Higher volume single family residential (SFR) customers pay more per cubic foot than lower volume users through a five-tiered rate system. The first tier – up to 200 cubic feet (approximately 1,500 gallons) per month – is charged a rate of $1.75 per 100 cubic feet, or about $2.34 per thousand gallons. The fifth (highest) tier is $5.63 per 100 cubic feet, or about $7.54 per thousand gallons, for all use above 1500 cubic feet, or 11,200 gallons per month. Commercial/institutional/industrial customers are billed at the third tier while irrigation only customers are billed at Tier 5. Since implementation of tiered rates for SFR customers, average monthly use in cubic feet for this category of customer has decreased almost 18%. In 2008, 62.3% of SFR consumption was in Tiers 1 and 2; for 2012 75% of SFT consumption was in Tiers 1 and 2. Also, for the same time frame, Tier 5 consumption has decreased from 16.1% to 2.7%. Overall consumption for irrigation (Tier 5) has decreased as well.

Water and Sewer Rates and Charges (ongoing) – Consistent increases in customer rates and charges that reflect "the true cost of water" (supply, treatment, and delivery; wastewater collection and treatment; water and sewer line repair and replacement; maintenance and construction of major facilities, etc.) provide an additional economic incentive to reduce water waste and increase efficiency. Since adoption of tiered rates in 2008, Durham's governing board has supported small incremental increases each year for volumetric as well as service/availability charges.

Toilet Rebate/Credit Program (September 2008) – Durham offers a $100 rebate for the replacement of conventional toilets with approved high efficiency toilets (HETs). Residential customers receive rebates, which are credited to subsequent water/sewer bills, for replacing up to three toilets per household. The rebate program was expanded to non-residential customers in 2011. As of January 2014, nearly 5,100 conventional toilets have been replaced with high efficiency models, resulting in approximately 22 million gallons per year of reduced water use. Interest and participation in the program is expected to continue growing in the future. Conservation/Water Efficiency Program staff are members of the EPA WaterSense program and continue to evaluate additional opportunities to

incentivize customer participation in adopting water efficient practices. The governing board supports this program by consistently approving the funding source in each year's program budget.

Year-Round Irrigation Limits (June 2009) – Per Durham's Water Efficiency Ordinance adopted in 2009, spray irrigation is limited to three days per week under normal weather and rainfall conditions; one day per week during Stage 1 Water Shortage conditions; and prohibited during Stage 2 or more severe water shortages. The alternate day irrigation schedule has significantly reduced daily demand spikes during peak seasonal periods. To ensure compliance, staff is deployed daily during peak "watering" season.

Rain/Moisture Sensors (June 2009) – Also per ordinance, sensors are required on all new irrigation systems to prevent automatic activation when irrigation is unnecessary due to ambient soil moisture.

Reclaimed Water (June 2007) – Highly treated wastewater is available (for non-potable use only) to bulk customers at the North Durham Wastewater Reclamation Facility (WRF). The bulk reuse program will be expanded to the South Durham (WRF) in the next few years. A Reclaimed Water Master Planning effort will be under way in 2015 to expand the bulk reuse system and explore the development of a robust reclaimed water distribution system..

Multimedia Education, Marketing, and Advertising (June 2008) – After the drought of 2007-2008, Durham developed an aggressive conservation communications campaign that integrated traditional media (TV, radio, print, and online), direct marketing, public relations, cross promotions, and social networking. A central element of the campaign was the creation of the *DurhamSavesWater.org* website to provide ready access to water conservation information and tips, links to additional information, current and recent Durham demand trends, and other water-related information. DurhamSavesWater.org remains the central point of reference for water supply and conservation/efficiency information. Social media is now being incorporated into all messaging for these programs.

Automated Meter Reading (Final phase completed June 2014) – Durham embarked on a multi-phased meter replacement program in early 2010. In addition to using automated meter reading (AMR) technology to provide more efficient and accurate billing and leak detection, residential/small commercial customers are being converted from bi-monthly to monthly billing. As an efficiency measure, electronic meters capture usage information in great detail and also provide indicators of leaks (intermittent and persistent) as well as backflow. By downloading this information via dataloggers, permanent records of usage are maintained and attached to customer accounts. Detecting and tracking leaks and anomalies earlier in the billing cycle (from bi-monthly to monthly) provide opportunities for customers to voluntarily their water usage and decrease their water bills (for example moving into a lower tier) and well as preventing water waste and associated costs by fixing issues earlier.

Town of Hillsborough

The Town of Hillsborough has a Water Shortage Response Plan which has been adopted into their Town Code, and is available online on the Town website www.ci.hillsborough.nc.us. Hillsborough does not have water conservation pricing, although their regular water rates are among the highest in the Triangle, which has kept their overall water usage consistent over the last 10 years, despite a growing customer base.

Hillsborough had their entire water system examined by a consultant in the early 2000's with acoustical leak detection to identify leaks, and made repairs accordingly. This work, as well as periodic strategic acoustic leak detection by NC Rural Water Association has reduced their non-revenue water percentage by double digits.

Hillsborough performs an annual water audit, utilizing the AWWA WLCC Water Audit Software, as well as a traditional % unaccounted-for water calculation. Their unaccounted-for water loss has reduced from a high of 24% in 1998, to a low of 6.5% in 2012. Hillsborough's Infrastructure Leakage Index (AWWA) has been within the Target ILI range since they began using this method in 2006.

Hillsborough provides periodic reports on their website outlining water usage and water supply reservoir levels. Frequency increases to weekly during water restriction periods. They also, at least annually, provide a booth at the monthly Last Fridays downtown street fair which provides information on the water and sewer system, including conservation information.

Hillsborough offers rebates for customers installing efficient fixtures. Town Code Section 14-9 (b) states "Beginning July 1, 1999, the town will give a $10.00 rebate for new or replacement installation of low-flow faucets, showerheads and toilets. The rebate will be given one time per water and/or sewer customer. Proof of installation will be required in the form of a receipt or billing invoice showing the actual work done. The rebate will be included in the customers' next billing statement following approval of the town." Hillsborough also has water conservation kits available at no cost to our customers, containing a 1.5 gpm shower head, 1 gpm bath sink aerator, 1.5 gpm kitchen sink aerator, and a toilet water saver (fill cycle diverter).

Hillsborough has specific irrigation requirements, as follows:

> Town Code Section 14-19, Irrigation System Requirements: "(a) Spray irrigation shall not occur more than three days per week. Even-numbered properties may be irrigated with spray systems only on Sundays, Wednesdays, and/or Fridays. Odd-numbered properties may be irrigated with spray systems only on Tuesdays, Thursdays, and/or Saturdays. All spray irrigation shall occur only between the hours of 8:00 p.m. and 9:00 a.m. These restrictions shall not apply to properties using underground, drip irrigation, micro spray, low precipitation bubblers, hand watering, or where watering of containerized plants and commercial plant stock in trade is maintained for resale. (b) Regardless of irrigation methods used, no more than one inch of water may be applied to plant material in any given week. (c) All irrigation systems shall be equipped with automatic controllers that activate the system according to a desired frequency and duration, and shall also be equipped with rain or soil moisture sensors that will prevent irrigation during periods of rainfall or when there is sufficient moisture in the ground for plant health and survival. (d) Miscellaneous: (1) All hoses used for hand watering, car washing, or other allowable outdoor uses shall be equipped with shutoff nozzles. (2) Supplemental irrigation permits may be purchased from the utility by customers who

need to be released from the above regulations in order to protect new planting. The permits will be priced at $100.00 plus $20.00 per system zone. The duration of the permit is 90 days from the purchase date. To be eligible to purchase the permit, a property must have an active building permit, or had a permit within the previous 90 days. Permits shall be unavailable during water restriction Stage 2 or higher.

Hillsborough does not currently have any additional plans to encourage conservation and efficiency by their customers, due to their current level of usage (1.1 MGD average vs. 3 MGD available), and current low residential usage (110 gpd/customer). Since water rates are already high, which curtails usage, increased revenues are needed. Raising rates for additional revenue causes less consumption, and does not have the desired effect to increase revenues. As usage expands and excess supply decreases, Hillsborough will consider additional measures to encourage conservation and efficiency. Hillsborough plans to spend $20,000 on acoustical leak detection equipment within the next 5 years.

Water usage of only 110 gpd per residential connection (3,300 gallons/month) is used in Hillsborough's future projections, which is reflective of current actual customer usage. Through continued emphasis on finding leaks in their system and minimizing waste, Hillsborough projects to keep their unaccounted-for water levels below 10%.

Hillsborough has one rainwater harvesting system in its system at Durham Technical Community College, which uses rainwater for toilet flushing. Hillsborough's system has one gray water system at Orange County offices on N&K Street & West Margaret Lane that uses water from sink drains for toilet flushing.

Town of Holly Springs

Program Overview

Holly Springs uses approximately 1.8 million gallons of potable water daily through a contractual arrangement with the Harnett County Department of Public Utilities (HCDPU), which draws water from the Cape Fear River. The contract allows the Town to draw a maximum of 10 million gallons per day (MGD). [1]

Recognizing the value of its water, the Town has implemented multiple strategies to offset potable demands, including a reclaimed water program, a water loss reduction program, a conservation water rate structure, and a water shortage response plan. The following sections summarize these strategies.

Reclaimed Water Program

A few years ago, the Town recognized an opportunity to recycle water from the Utley Creek Water Reclamation Facility (wastewater treatment plant) to reduce total demand on the potable water system. The system, which is one of only four in the State of North Carolina, significantly reduces the Town's impact on drinking water supplies as well as its discharge of treated wastewater into nearby waterways. Construction of a Reclaimed Water System for Holly Springs began in 2009 and was completed in the fall of 2010. The $2M project was funded by development fees and a federal grant and included the following:[3]

- A reclaimed water pumping station;
- An overhead 500,000-gallon storage tank at the corner of Irving Parkway and New Hill Road; and
- Distribution piping from the treatment plant to the storage tank, which feeds irrigation lines in the public medians of Green Oaks Parkway, to several sites in the Holly Springs Business Park, to the Holly Springs Town Center Commercial Development, and to the golf course plus all single family homes in the Twelve Oaks Golf Course Community.

Currently, the system provides approximately 200,000 gallons of clean, treated wastewater per day to 150 customers, which is equivalent to approximately 11 percent of the average daily potable demand in the Town. A network of purple underground pipes delivers the water for residential, multifamily and commercial (golf courses) irrigation uses as well as some industrial uses including cooling water at a Novartis facility and process water at the wastewater treatment plant.

Reclaimed water is currently only available west of G.B. Alford Highway. IN 2014, lines will be extended eastward under the highway to a park and commercial area. Eventually, per a Reclaimed Master Plan, reclaimed water will be available to all parts of Holly Springs.[3] The current permit capacity for the system is 1.5 MGD. The Town's water demand forecasts consider the offset in demand projected to be provided by the reuse system.

Water Loss Reduction Program

In 2006, the Town completed a water demand forecasting study. Within this study, the Town was estimated to have approximately 19 percent unaccounted-for-water.[2] In response to this report and other local drivers, the Town enhanced their existing leak detection programs and implemented new programs to reduce the amount of "unaccounted-for-water". For example, the Town aggressively identified all known sources of non-revenue water throughout the Town and installed meters to measure the amount of non-revenue water. Based on these strategies, the Town has been able to reduce its "unaccounted-for-water" to approximately 5 percent, as reported in the most recent State Local Water Supply Plan Update. The Town continues to implement these strategies to manage overall potable water demand. The demand forecasts provided in the Town's Local Water Supply Plan includes consideration of this reduction in "unaccounted-for-water."

Conservation Rate Structure

The Town has implemented multiple measures within its water rate structure to incentivize conservation in its customer base. First, the Town has implemented an inclining block rate structure to discourage overuse of potable water. As water usage increases through a series of tiers or blocks, the rate charged per gallon of water increases. Table 1 summarizes the Town's current water rates.

Table 1: Water and Sewer Rates[4]

Location	Monthly Access Fee	0-2,000	2,001-5,000	5,001-9,000	9,001-14,000	14,001 & Over
In-Town	$11.50	$3.65	$4.70	$5.75	$6.80	$7.50
Out of Town	$23.00	$7.30	$9.40	$11.50	$13.60	$15.00

Secondly, the Town requires installation of irrigation meters so that irrigation water is metered and priced separately from potable water. Irrigation water is priced higher than potable water to discourage overwatering of lawns and landscaping. The Town currently has approximately 1,400 customers with irrigation meters. Table 2 provides a summary of the water irrigation rates.

Table 2: Water Irrigation Rates[4]

Apply To	Cost Per 1,000 Gallons	Monthly Access Fee
All Users	$7.50	$11.50

Lastly, the Town has a separate set of rates for reuse water. As noted previously, approximately 150 customers in the Town use reuse water for residential irrigation, golf course irrigation and industrial uses. Reuse water for irrigation and other uses is priced lower than potable water to provide a financial incentive for its use. Table 3 summarizes the current reuse water rates.

Table 3: Reuse Irrigation Rates[4]

Apply To	Cost Per 1,000 Gallons	Monthly Access Fee
Residential / Commercial	$3.75	$5.75
Bulk / Industrial	$2.50	$5.75

Water Shortage Response Planning and Demand Side Management

In 2011, the Town developed and approved a water shortage response plan that included year-round voluntary water conservation measures as well as specific demand reduction measures in case of water shortage.[5]

Year Round Permanent and Seasonal Water Conservation

Through the passage of this plan, the Town made it unlawful for persons to intentionally or unintentionally waste water, particularly by overwatering grass and landscaping such that runoff is generated and flows onto the street. Customers violating this provision are subject to a fine or termination of their water service.

In addition, the Town established a water conservation season annually from May 1 through September 30 when every Town customer is encouraged (through public outreach/education) to comply on a voluntary basis with an alternate day watering schedule for irrigation systems.

Water Shortage Alert, Warning, Emergency Crisis Stages

In the event that Harnett County, the Town's primary water supplier, begins to experience a water shortage, the Town has established a series of progressive stages for response to the severity of water shortage.

- At the ***Alert Stage (Stage 1),*** mandatory alternate day irrigation restrictions are enacted (covering 6 days per week) and restrictions are placed on the filling of new pools and ponds.
- At the ***Warning Stage (Stage 2),*** alternate day watering is restricted to only 4 days per week. In addition, outdoor water use such as vehicle, driveway and house washing is prohibited unless performed as part of a commercial business. Lastly, industrial, commercial, and manufacturing enterprises are requested to reduce consumption by any degree feasible with a goal of 20 percent reduction.
- At the ***Emergency Stage (Stage 3),*** irrigation using potable water, re-filling of swimming pools, and other outdoor uses of potable water are strictly prohibited. In addition, restaurants are required to use single-serve utensils and should only provide water upon request. Lastly, industrial, commercial, and manufacturing enterprises are requested to reduce consumption by any degree feasible with a goal of 40 percent reduction.
- At the ***Crisis Stage (Stage 4),*** nearly all non-essential uses of potable water are prohibited. Also, industrial, manufacturing, and commercial enterprises must reduce consumption to any degree feasible with goal of 50 percent reduction.

References

1. *2012 Annual Drinking Water Quality Report.* (2012) Retrieved from Town of Holly Springs website: https://nc-hollysprings.civicplus.com/DocumentCenter/View/6088
2. CDM (2006). *Town of Holly Springs Water Demand Forecasting.*
3. *Holly Springs, North Carolina – Official Website – Reclaimed Water.* http://www.hollyspringsnc.us/index.aspx?nid=222
4. *Holly Springs, North Carolina – Official Website – Rates*. (2013) Retrieved from http://www.hollyspringsnc.us/index.aspx?NID=184
5. Sudano, S.L (2011). *Water Shortage Response Plan (*P-38). Town of Holly Springs, N.C.

Orange County

Orange County's projections include significant reductions in per capita water demand as a result of improvements in water efficiency. As noted earlier, demand projections completed by Orange County forecast average water use rates for all users to decrease by 2.85% every decade through 2065. This means residential customers are projected to reduce their average usage from 70 gallons per person per day to 58 gallons per person per day by 2065.

Orange County has a long-standing commitment to water conservation as well as to the protection of water quality. This is demonstrated by the County's buffer rules for new development, County-defined Water Supply Watershed Critical Areas that exceed those established by the State, zoning rules that limit the impact of growth in selected areas of the county, and limitations placed on the expansion of water and sewer service areas in the county that also limit population growth, and as a result, water demand.

Current water conservation actions

Despite the fact that Orange County does not operate a water system, the Orange County Board of Commissioners adopted a resolution in October 2007 encouraging all County citizens to conserve water and supporting water conservation restrictions by those water systems operating in the county. This action was a result of the extreme drought of 2007-2008, and was intended to support all water providers in the county,

For several years County staff have conducted programs designed to educate citizens of the importance of water conservation as well as water quality protection. These ongoing efforts include providing handouts and presentations geared toward children and adults to encourage the reasonable use of potable water, whether it comes from public or private sources.

Planned future water conservation measures

The County intends to partner with existing neighboring jurisdictions to provide water service to limited, defined areas of economic development. The use of partner utilities means that the existing and future conservation and demand management strategies and regulations of these systems will extend into those areas of the county connected with each water system. The County is planning to utilize the City of Mebane to provide water and sewer service to the Buckhorn Economic Development District, the Town of Hillsborough to provide water and sewer service to the Hillsborough Economic Development District, and the City of Durham to provide water and sewer service to the Eno Economic Development District. Highlights of the water conservation and demand management strategies and policies for each of these systems are included below.

Mebane – The City of Mebane approved a Water Shortage Response Plan in 2010 that describes measures the City would take once its water supply reaches an available limit of 150 days. Mebane has a leak detection program that works to reduce the loss of finished and raw water. The City of Mebane also has a water conservation education program aimed to educate the customers to reduce their demand for water. Finally, as a result of the 2007-2008 drought, Mebane revised its billing structure from a decreasing block rate to a uniform rate to encourage water conservation.

Hillsborough – The Town of Hillsborough has taken extensive measures to reduce water loss by completing a system-wide leak detection program, which has been followed by periodic leak detection efforts by the NC Rural Water Association. These efforts have resulted in a dramatic reduction in the quantity of water lost through leaks in the Hillsborough system. The Town also conducts an annual water audit that, in combination with the leak detection work discussed above, has reduced the system's unaccounted-for water from 24% in 1998 to 6.5% in 2012. Hillsborough has also implemented a rebate program to encourage customers to install more efficient appliances, adopted requirements that restrict the use of potable water for irrigation, and provides water conservation kits to customers at no cost. Finally, it is likely that the high cost of Hillsborough water also serves as a deterrent to customers to consume excess water.

Durham – The City of Durham has conducted a water conservation education program since 1993. The severe drought of 2001-2002 served to institute a stronger conservation ethic amongst water customers in Durham, leading to permanent changes in appliances and water-use practices. These efforts were reinforced by public education and expanded rebate programs designed to replace appliances with more efficient models. As a result, total water usage for the City of Durham decreased by 12% between 1999 and 2010. This time interval included a second major drought, from 2007 into 2008. This most recent drought resulted in many additional steps being undertaken to further reduce water usage in Durham, including the following:

- Bulk Reclaimed Water Program
- DurhamSavesWater.org marketing/advertising/education campaign
- Tiered water rates
- Toilet Rebate/Credit Program for residential customers
- Year-round Irrigation Schedule
- Rain/Moisture Sensor requirement for all new irrigation systems
- Water Waste Ordinance
- Water Shortage Response Plan
- Consistent moderate increases in water and sewer rates and charges each year as a part of the annual budget/CIP process
- Automated Meter Reading Program
- Expanded Toilet Rebate/Credit Program to Non-Residential Customers
- Expanded Leak Detection/Water Loss Program

Impact of Water Conservation Plans on Demand Projections

Orange County does not have control over the efficiency of the water plant (or plants) that will treat the water used by Orange County customers. The County will design and install a water distribution system that will, in-turn, be incorporated into another water system. One consequence of this process will be that the water lines installed in the Orange County service areas will all be recently installed.

No older or outdated water lines will be present in the Orange County service areas. This will help to reduce water leakage from the system, and as a result, the County projects distribution system processed water and other non-revenue usage will be equivalent to 7.5% of revenue water.

Additional Water Conservation Information

In general, Orange County has had a strong, long-standing commitment to water conservation and watershed protection. In 1981, Orange County became the first county in North Carolina to adopt watershed protection zoning. Since then, watershed protection measures have been refined and increased repeatedly, incorporating technical watershed studies and new State minimum standards as they were developed. As a result, Orange County watershed protection standards meet, and in most cases exceed, the State minimum measures.

In 1987 Orange County was also the first county in North Carolina to adopt a Sedimentation and Erosion Control Ordinance (now known as the Erosion Control and Stormwater Ordinances). This ordinance helps protect water quality by regulating erosion control and stormwater practices on construction sites.

The County has conducted technical studies of nearly all of the ten water supply watersheds within the county. The ultimate result of these technical studies, in combination with the state watershed rules, is that much of the county's land area is comprised of small- to medium-sized water supply watersheds, which by their nature require special protection measures. The limited potential for future water supply sources makes increased protection of the existing sources all the more critical.

The County's overall approach to watershed protection is through the use of non-structural measures. This involves protection of water quality at the source, by using land use controls to limit impervious surface, the number of housing units (and hence wastewater systems), the infiltration of stormwater on-site, and the protection of stream buffers to further filter water as it moves from the watershed to stream corridors.

Minimum lot size and impervious surface limits are used widely to help reduce sheet flow runoff into streams and encourage infiltration into the soil.

Orange County's stream buffer provisions are another key component of the County's watershed protection approach. Implemented through the Unified Development Ordinance, the overall size and width of protected stream buffers are based on a calculation that takes into consideration the slope of the land and the existing vegetative cover along an identified water body. At a minimum, stream buffers are required to be fifty (50) feet in width along both sides of a stream, with an additional fifteen (15) or thirty (30) feet of protected buffer required based on severity of slope. Protected stream buffers are measured from the edge of the stream's 100-year flood plain, if identified, or from the edge of the stream's bank. Connected and isolated wetlands in Orange County are also buffered for fifty (50) feet from the defined edge of the wetland.

Orange County policies are designed to deliberately focus urban-level development in areas where it makes the most sense, i.e. along major transportation corridors which link population centers. The three Economic Development Districts mentioned earlier demonstrate this principle clearly. Even though the demand in our future service areas as described in this report is similar to other developed areas of similar size, the demand for public water in Orange County will be less county-wide than what would be needed in a county of comparable size. In addition, the services provided should be more efficient due to their concentration.

When recruiting potential development to the designated growth areas, the County has consistently focused on low to medium level water users. Because Orange County is situated at the headwaters of several streams, water supply is a concern. Recognizing that there is a limited supply of water, the County has been looking to recruit development that provides a healthy balance of economic benefit when compared to the development's water demand.

Following many years of discussion among the local governments located in Orange County and the Orange Water and Sewer Authority (OWASA), a county-wide Water and Sewer Management, Planning and Boundary Agreement (WSMPBA) was developed and signed in 2001. The agreement provides a comprehensive, county-wide system of utility service areas upon which the signatory entities rely when making decisions related to issues such as planning, land use, annexation, zoning, and growth management.

WSMPBA was originally in effect for 10 years and now renews automatically unless a signatory party provides a notice of intent to withdraw by following a process outlined in the agreement. All parties must approve any changes to the service boundaries shown on the WSMPBA map.

Map 15 is the WSMPBA map approved by the signatory parties. Primary Service Areas shown on the map are those areas where water and/or sewer service is now provided, or might reasonably be provided in the future. Long-Term Interest Areas are those areas within which public water and/or sewer service is not anticipated to be provided, but if such services were to be provided for "emergency" purposes due to private system failures, the designated party would be the service provider. One of the two Economic Development Districts (EDDs) within which the County plans to utilize Jordan Lake water to boost appropriate future development is located in an area designated in WSMPBA as an Orange County Primary Service Area. The other is in the Hillsborough Primary Service Area, but the Town has not included any land area from the County's Hillsborough EDD in their Jordan Lake allocation application. In order to insure the availability of water for this area's future development, Orange County is including a request for water to serve this area in the future.

The long-standing conservation ethic and watershed protection policies in the county, along with the conservation practices of the three utilities with whom the County is planning to partner within the EDDs, ensures that reasonable growth and effective water conservation will continue into the near future in Orange County.

Orange Water and Sewer Authority

OWASA Current Conservation and Demand Management Efforts

The OWASA Board of Directors approved a Long-Term Water Conservation and Demand Management Program in April 2005. In addition, OWASA's Water Shortage Response Plan and other programs include strategies that reduce water demand throughout the year including:

- Water Conservation Standards
- Water Conservation rates (Increasing Block Rate Pricing and Seasonal Rates)
- Public Education
- Reclaimed Water
- Utility Management Measures (process water recycling at WTP; water system auditing; meter testing and replacement program)

Each of these items is described below.

Water Conservation Standards

In the 1970s, OWASA worked with the Towns of Chapel Hill and Carrboro and Orange County to develop and implement local water conservation ordinances that are implemented and enforced by the Towns and County. OWASA does not have legislative authority to adopt a water conservation ordinance; however, in 2003, OWASA adopted Water Conservation Standards which are a condition of receiving OWASA service. The Standards parallel the requirements in the water conservation ordinances enacted by the Towns and County. OWASA's Water Conservation Standards and the local conservation ordinances were most recently revised in June 2009 to reflect the experience of the 2007-08 drought. The Standards and ordinances include year-round water use restrictions and four tiers of increasingly strict requirements depending on the severity of the water shortage conditions. These tiers are summarized in Table 1. OWASA's current water conservation standards are found here.

In addition to the water use restrictions, in 2007 OWASA approved a system of water rate surcharges that are to be imposed during declared water shortage conditions. The surcharges are intended to substantially increase the conservation pricing signal during declared droughts, and to help offset some of the revenue reduction effects that typically accompany imposition of mandatory water use restrictions.

TABLE 1

Summary of Key Conservation Standards for OWASA Drinking Water – Effective June 2009

Water Use	Year-Round	Stage 1	Stage 2	Stage 3	Emergency
Spray Irrigation of **Turf / Grass** (on designated days of the week as noted)	3 days per week, up to 1 inch per week, 6 pm - 10 am only ** Odd Addresses: Tu/Th/Sat Even Addresses: Sun/W/F	1 day per week, up to 1/2 inch per week, 6 pm - 10 am only ** Odd Addresses: Tues. Even Addresses: Thurs.	X**	X**	X
Spray Irrigation of **Non-Turf Plant Materials** (on designated days of the week as noted)	3 days per week, up to 1 inch per week, 6 pm - 10 am only ** Odd Addresses: Tu/Th/Sat Even Addresses: Sun/W/F	3 days per week, up to 1 inch per week, 6 pm - 10 am only ** Odd Addresses: Tu/Th/Sat Even Addresses: Sun/W/F	1 day per week, up to 1/2 inch per week, 6 pm - 10 am only ** Odd Addresses: Tues. Even Addresses: Thurs.	X***	X
Drip irrigation, underground drip emitters, soaker hose, hand-watering, and other non-spray methods allowed *at any time* or frequency	✓	✓	✓	✓	X
Washing of Building Exteriors **Before Painting**	✓	✓	✓	X	X
General Cleaning of Building Exteriors, Paved Areas, Etc.	✓	✓	X	X	X
Filling, Refilling, or Topping Off of Ornamental Ponds, Fountains,	✓	✓	X	X	X
Vehicle Washing	✓	✓	Only at commercial or institutional facilities where at least 50% of the water is being recycled, or is from a non-potable source	X	X
Filling, Refilling, or Topping Off of Swimming Pools and Backyard-Scale Facilities to Support Wildlife	✓	✓	✓	✓	X
Flushing or Pressure Testing New Water Lines	✓	✓	✓	✓	Only if captured and returned to system

Year-Round Requirements, Regardless of Water Shortage Condition

- Automatic controllers and rainfall or soil moisture sensors required on all irrigation systems
- "Wasteful" water use* prohibited at all times
- Water leaks must be repaIred within 10 days of discovery and/or notification by OWASA
- Water may be served in restaurants and other dining facilities only at customer's request
- Hotel/motel linens may only be changed upon customer changeover, every 5 days, or upon customer request

Symbols and Notes

*	*Please refer to actual text of OWASA's Conservation Standards for details.*
✓	*Water use is allowed.*
X	*Water use is not allowed.*
**	*Restrictions may not apply to public purpose athletic fields, recreational fields, or public purpose botanical sites operated in compliance with OWASA-approved Water Conservation Plans.*
***	*Restrictions may not apply to public purpose botanical sites operated in compliance with OWASA-approved Water Conservation Plans.*

Water Conservation Rates

Seasonal Rates for Commercial and Institutional Customers (Other than Irrigation Meters)

In May 2002, OWASA implemented a seasonal block water rate structure, and that structure remains in effect for all commercial and institutional customers. The seasonal rates are: $7.91 per 1,000 gallons for all water use during the peak season demand period (May – September), and $4.16 per 1,000 gallons for all water use during the off-peak season (October – April). Seasonal rates provide a substantial incentive for conservation during the time of the year when reservoir inflows are typically the lowest and daily demands are the highest.

Block Rate Pricing for Residential Customers

In 2007, OWASA decided to further strengthen its conservation pricing strategy by implementing increasing block rates applicable to all individually-metered residential customer accounts. The current rates for Block 1 (1,000 – 2,000 gallons per month) are $2.63 per 1,000 gallons as contrasted to the rates for Block 5 (16,000 gallons per month or greater), which are $19.79 per 1,000 gallons. This increasing rate structure encourages conservation.

Public Education

OWASA's website includes a page for conservation (http://www.owasa.org/conservationandeducation/default.aspx) which includes information on its conservation requirements as well as tips to effectively conserve water indoors and outdoors. In addition, the quarterly newsletter sent to OWASA customers often includes information on water conservation. Other efforts include occasional bill stuffers on conservation; public outreach at street fairs and festivals; conservation presentations to civic groups, professional groups, and in the classroom; and targeted technical assistance to customers.

Reclaimed Water

Following the record drought of 2001-02, OWASA and UNC-Chapel Hill collaborated to evaluate the technical, economic, and environmental feasibility of using reclaimed water to meet certain non-potable water needs on the main campus. The study concluded that such a strategy was feasible, and that OWASA, the University, and the community would realize substantial benefits if a reclaimed water system was implemented. OWASA and UNC subsequently partnered to design, finance and construct the system, and it was placed into service in April 2009. UNC now uses reclaimed water for cooling tower make-up water needs; irrigation of several major athletic fields, and for toilet flushing in some new buildings. The reclaimed water system became operational in April 2009 and currently meets approximately 0.7 mgd of demand on an annual average basis. The peak-day demand for reclaimed water has exceeded 1.7 mgd. The system is designed to meet a peak day demand of 3 mgd and could be modified cost-effectively to meet a peak day demand of 5 mgd.

Utility Management Measures

OWASA has implemented measures to reduce water use internally. OWASA treats and recycles its water treatment process water back to the head of the water plant. This measure has reduced raw water withdrawals, and the associated energy use for raw water pumping, by approximately 7 percent.

OWASA follows an aggressive leak detection program, and OWASA's Long-Term Water Conservation and Demand Management Program assigns high priority to distribution system leak

detection and repair. OWASA uses AWWA's software, and our system has an Infrastructure Leakage Index (ILI) of 0.61, which indicates that the system is well managed and maintained. This is well below the threshold of an ILI of 1.2 where North Carolina requires a leak detection and repair program to be eligible for State drinking water program revolving loan and grant funds.

Conservation and Demand Management Effectiveness

OWASA's demand management efforts have resulted in a 28 percent reduction in water use between Fiscal Year 2002 and 2012 despite a 19 percent increase in the number of customer accounts over that same period. In 2002, customers used 8.9 mgd of finished water on an average basis while in 2012, that number dropped to 6.3 mgd. In fact, average-day water sales in FY 2012 were at the same level they were in 1992, even though OWASA now has about 60% more customer accounts than it did in 1992.

OWASA Planned Conservation and Demand Management Efforts

OWASA water conservation and demand management strategy has proven to be very effective in reducing the community's water demands, and it has been very cost-effective as OWASA has not needed to make major expenditures for program staffing, rebates or fixture give-away programs. Therefore, no major changes are planned.

However, OWASA will continue to enhance its conservation and demand management efforts through strategies such as: improving its conservation education and outreach efforts; helping target available resources for customers in financial need to reduce their water and sewer bills through cost-effective water use reduction strategies; and seeking cost-effective opportunities to expand the use of reclaimed water in the OWASA service area.

OWASA Demand Projections and Water Conservation and Demand Management

OWASA's water demand projections assume that the demand reductions achieved since 2002 will be sustained in the future and that further decreases will be achieved through additional passive conservation and currently planned expansion of the reclaimed water system to serve UNC's Cogeneration Plant cooling towers. Passive conservation includes replacing conventional plumbing fixtures and appliances with more efficient devices as older homes and businesses are renovated and new development responding to more aggressive local water use efficiency requirements and the increasing cost of OWASA water. In addition to demand reductions already in place, the following additional efficiencies have been assumed and are reflected in OWASA's 2010-2060 demand projections:

- Unit demand (gallons per account) for existing (pre-2010) development will be 15 percent lower in 2060 than it is today.
- Unit demand (gallons per account) for all new development will be 10% lower in 2060 than today.
- Future efficiencies and reductions for UNC's Central Campus and Carolina North expansion are reflected in the estimates provided to OWASA by the University.

Other Conservation/Efficiency Information

OWASA's Board adopted a Drought Response Operating Protocol (DROP) in January 2013. The DROP reflects the graphs and management strategies described in OWASA's Water Shortage Response Plan (WSRP); however, it also provides for the declaration of a Water Shortage Advisory by OWASA no later than when water remaining storage in our reservoirs drops to within 10 percent of the mandatory Stage 1 drought trigger. At that time, OWASA will initiate communications with the Towns of Carrboro and Chapel Hill and UNC-Chapel Hill and its customers indicating the likelihood that Stage 1 restrictions will go into effect if the drought continues. The DROP clarifies that the OWASA Board may declare Drought stages with our without the corresponding drought surcharge earlier than noted on the WSRP graphs.

Town of Pittsboro

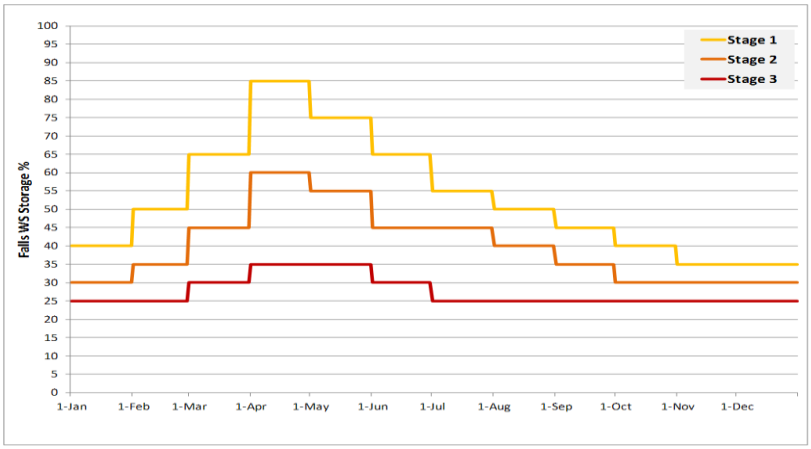
Pittsboro's development pattern in the future will likely differ significantly from current development around Pittsboro's historic center. The new development plans indicate that significant growth to the east that is planned to occur that will include residential, commercial, industrial, recreational and institutional development. The Chatham Park Investors, LLC have developed a Planned Development District Master Plan (PDD), which has been approved by the Town. As planned, the development will utilize a significant amount of reuse water from planned wastewater treatment and recovery plants. This development also proposes to utilize Town of Pittsboro potable water, which will cause a need to increase our water treatment capacity by approximately 2 mgd. This development generally proposes to incorporate energy and water reuse and efficiencies in the PDD.

The Town does have in place an increasing block rate structure or tiered rate structure that strongly encourages conservation by customers. In August 2007, the Town Board of Commissioners approved a voluntary water conservation guidance policy for its citizens. It includes measures common for conservation, such as irrigation limits, mulching and hand watering, using water efficient interior plumbing fixtures, fix leaky toilets and fixtures and other methods. In June of each year, this document (latest version) will be provided to the general public via the Town website and through other public outlets.

In June 2010, the Town completed installation of a Reclaimed Water System. The RCW system has a capacity to pump up to 0.43 MGD, but the facility currently operates for 8-10 hours per day and provides a capacity of 0.14-0.18 MGD. In just 7 months the Town delivered over 157 million gallons to an industrial customer, and in the last 3 months of 2011 have averaged 100,000 gpd in usage by a single industrial customer. (Potable water to this customer was originally supplied by Chatham County and therefore the demand reduction is at the Chatham County WTP). Plans are to expand the infrastructure of this system as the Town finds new customers, though the reclaimed water supply is limited by the volume of water treated at the WWTP, which averaged 0.375 MGD in 2011.

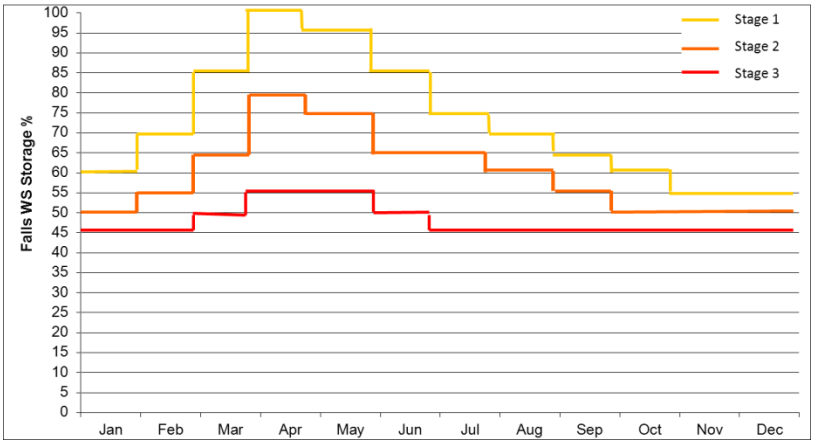
City of Raleigh

The City of Raleigh Public Utilities Department (CORPUD) has a water conservation ordinance in Section 8, Article E of the City Code of Ordinances. This article describes required water conservation actions such as restaurants only serving water upon request and local hotels/motels replacing towels and linens upon request, large water users (i.e. >100,000 gallons per day) conducting an AWWA audit, and water use restriction implementation triggers. In addition to this ordinance language, CORPUD also has a NC Division of Water Resources approved Water Shortage Response Plan which provides information on specific water use restrictions, water conservation and water efficiency concepts, and available water supply resources. It should also be noted that CORPUD adopted a new seasonal water use restriction trigger system based on the OASIS hydrologic model in May of 2011. Previously, the water use restriction triggers were based on the volume remaining the water supply pool at Falls Lake, regardless of time of year. However, using the OASIS model to evaluate this system, it became apparent water use restrictions would likely be implemented as often as once every 3 years, and in many cases would be unnecessary. Conversely, there was also significant risk that water use restrictions would not be adopted in sufficient time if drought conditions occurred in the late spring. Thus, the new seasonal trigger system takes the traditional drawdown and refill cycles of Falls Lake into account, which in turn will significantly improve the management of the City's water resources. The following graphs illustrate the seasonal trigger system action points:



IMPLEMENTATION

TRIGGERS



RESCISSION

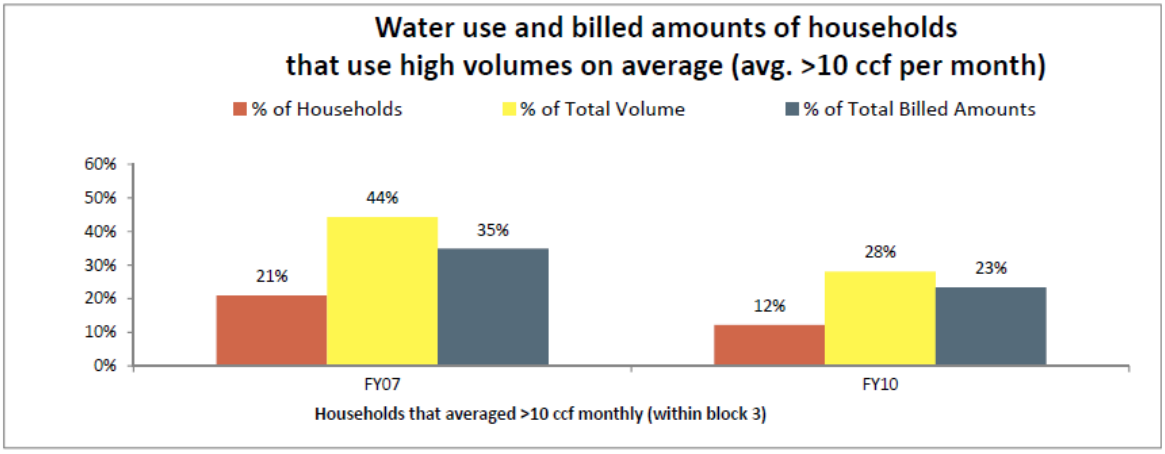
TRIGGERS

In regards to conservation pricing, CORPUD continues to maintain the residential tiered rate structure which was approved and adopted in November of 2010. The current rates are listed below:

2. Residential Consumption Charges

Consumption (CCF/Month)	Unit Rate Per CCF Inside City Limits	
Consumption 0 to 4 CCF	$	2.28
Consumption 5 to 10 CCF		3.80
Consumption 11 CCF and greater		5.07

It should also be noted that all new irrigation systems are required to have a separate meter and are billed at the highest tier. Since the implementation of the irrigation rate and the residential tiered system, the result has been a significant decline in high volume water users as described in this graph:



This is based on a study conducted by Mary Tiger the UNC-School of Government (attached – "Raleigh Final Profile") and this trend has continued since 2010.

Leak detection and repair efforts continue to be addressed through the use of permaloggers and specialized acoustic equipment, which record audio data that is subsequently reviewed to determine if leaks are present in a given part of the distribution system. Noted leaks are then accurately located with ground microphones and correlating system, which allows for efficient and timely repairs. Water Distribution staff are assigned and trained for this program, and CORPUD makes their expertise and equipment available to other systems without such resources.

Per the direction of the City Counci appointed Water Utility Tranistion Advisory Taskforce, CORPUD conducted an AWWA water system audit (attached – "Copy of COR Water Audit 2011"), which resulted in an overall score of 92 out of 100, and an Infrastructure Leakage Index of 1.18, both of which reflect an exceptionally low volume of water loss. In addition, the Utility Billing Division provides monthly updates (attached – "Daily billed vs pumped") which, among many metrics,

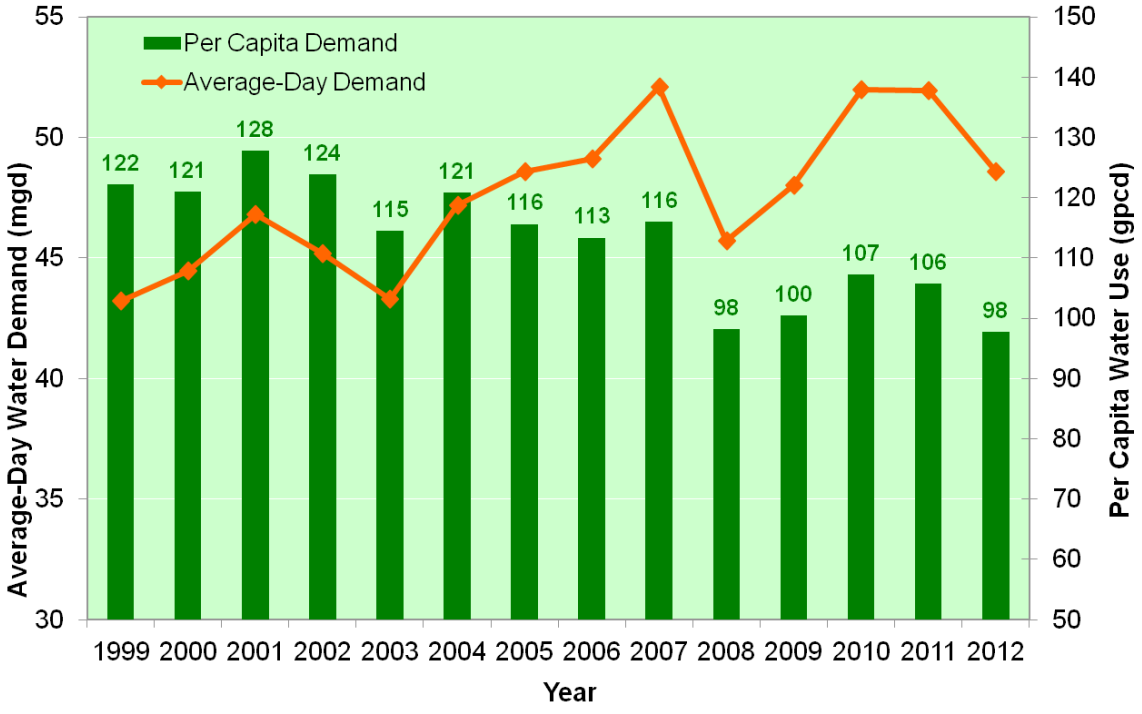
compares pumped potable water volume to bill potable water, and this consistently indicates only a 10% differential, which further validates the high water audit score.

CORPUD's pubilc eduction efforts are comprised of manning a booth at public events (e.g. Earth Day, Viva Raleigh, Artsplosure, etc…), visiting all Citizen Advisory Council locations to discuss Department initiatives, the creation and updating of a water conservation webpage (http://www.raleighnc.gov/environment/content/PubUtilAdmin/Articles/WaterConservationAndEfficiency.html) , and making water resource presentations to area schools and civic groups.

At this time, CORPUD continues to fund a toilet rebate program in which $100.00 is provided for each older model toilet replaced with a new Water Sense labeled model. Since 2009, the program has helped replace over 11,000 toilets in the CORPUD service area, and now averages 3,800 toilets replaced per year. In addition to the popular toilet rebate program, CORPUD also offers a free showerhead exchange program and distribution of free high efficiency faucet aerators upon request.

The Reuse Water masterplan was originally developed in 2007, and is currently in the process of being updated by CDM and CORPUD staff per direction of City Council (estimated completion date of November, 2013). Currently, the average Reuse water demand is 0.400 MGD with 27 connections, ranging from three golf courses, a hospital physical plant, and the City of Raleigh softball complex. Negotiations have been initiated with NC State University's facilities management group in hopes of providing Reuse water to their physical plant facilities. However, CORPUD staff have also proposed modification of existing North Carolina statute which would permit the pilot testing of an indirect and direct potable Reuse system. It is anticipated that this process will move forward sometime in 2014.

It is assumed all of the above mentioned water conservation programs and efforts have contributed to the steady decrease of the average gallons per capita day (gpcd) value, which is currently 98 gpcd. This trend is illustrated in the graph below:



It should be noted the current 98 gpcd value is identical to the 2008 value, which was a response to the severe water use restrictions implemented during the drought of record in 2007-2008. This trend is also reflected in the static to slightly decreasing average day pumpage, where 48.6 MGD was the average for 2012 and 2006, despite an estimated increase in service area population of approximately 56,000 (2012 population ~ 489,000, 2006 population ~ 433,000) during the same time period. While the gpcd calculation isn't necessarily the ideal metric to measure overall system water efficiency, our 98 gpcd value compares favorably with any similarly sized utility system in the country, and this value will likely slowly decrease in the future. Furthermore, recent studies have indicated this is most likely a national trend, and that utility system across the country have experienced similar decreases or flattening of demand (attached – "UMC Presentation").

However, when looking at the national trends and fully understanding the minor impacts of water fixture rebate programs, it becomes clear the decrease in overall water demand is mainly attributable to external factors such as the recent historic economic downturn, steadily increasing water and sewer rates, the lasting impact of three historic droughts from 2002 to 2008, and the gradual replacement and improvement of domestic water fixture efficiencies.

Planned water conservation and efficiency actions.

At this time, CORPUD continues to provide funding for the toilet rebate program ($500,000 for FY 2014) and offer free water conservation kits, high efficiency aerators, and high efficiency showerheads to all water customers. In order to further promote the efficiency program and improve customer access to the free fixtures, it is also planned to distribute the high efficiency showerheads and aerators to community centers within the service. The current leak detection program will also continue to be supported with staff resources and use of existing leak detecting equipment and techniques as described above.

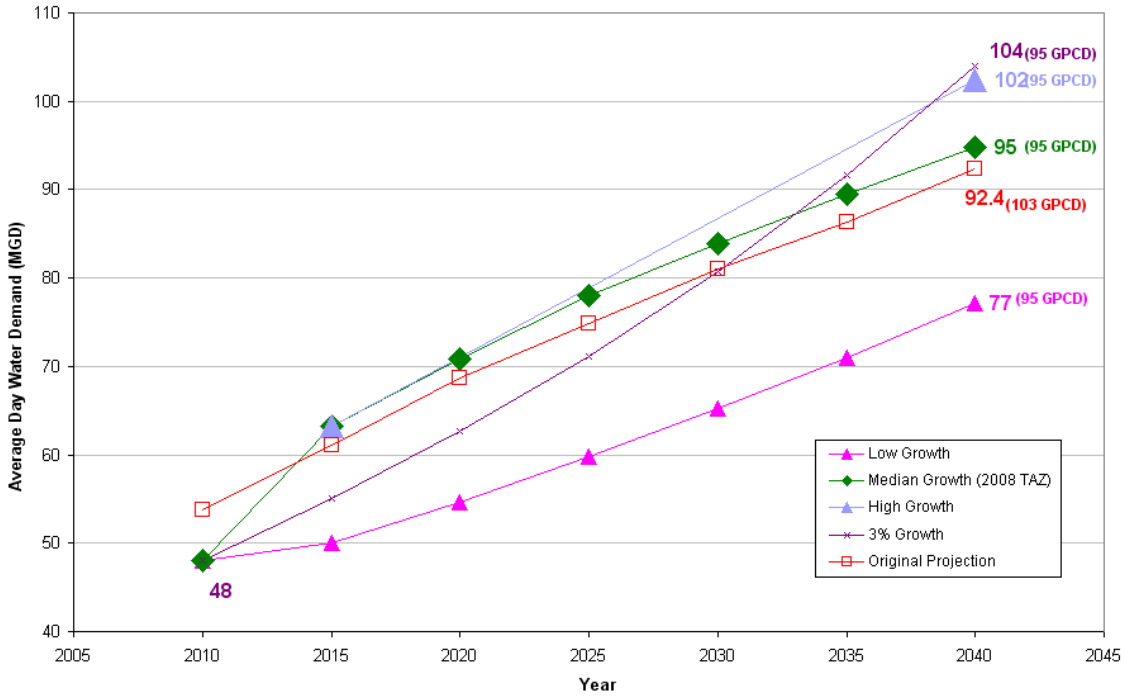
Another critical factor in maintaining and gradually decreasing per capita consumption rates is the willingness of the system's elected leadership to adopt rate increases as prescribed by utility financial managers and recent demand patterns. To this end, the City of Raleigh City Council has continued to implement the recommended rate increases (14% on volumetric sewer rates for FY14) and is expected to support future rate increases as needed. CORPUD and the City Council have also committed to the ultimate goal of developing a "full cost of service" rate/fee structure in the future, and this goal is widely understood to not only represent responsible fiscal management, but an additional incentive to decrease water consumption as rates increase.

Finally, it should also be noted that AWWA water system audits for FY 2012 and FY 2013 are being compiled, which will provide additional insights into quantifying and identifying non-revenue water.

Regarding more generalized future conservation and efficiency efforts, it is expected the updated Reuse Water master plan will have a significant impact on projected reuse water demand. As mentioned in the previous section, potential new legislation would have a profound impact on how reuse water is used, which could in turn reduce and/or defer future drinking water needs for the City. It is also anticipated that future process water recycle projects at the D.E. Benton plant will also improve overall system efficiency, and save an additional 100,000 gallons per day.

Long-term per capita reductions originally cited in the initial JLP summary (i.e. 5.8 gpcd for domestic water fixture replacement and 4.8 gpcd for irrigation demand) are presumed to still be valid, and will

clearly play a roll in evaluating the City's long term water resource needs as described in the graph below (also see "Raleigh Water Conservation Efficiency"):



City of Sanford

In its projections, Sanford does not directly take into account water use rates, so it is difficult to demonstrate conservation directly. Sanford's total residential sector water use grows at the same percentage rates as population, so it can be inferred that the residential per capita usage rate does not increase over time.

Sanford's projection methodology uses a decrease in the sectors' rates of growth over time. The residential sector and wholesale water sector growth rate decreases in 2030, and commercial/industrial and institutional sectors lower their growth rates after 2050. These shifts, especially in the non-residential sector, can represent either a slowing in the pace of development or greater efficiency.

The primary area where Sanford's projections demonstrate conservation and efficient management of water is in managing non-revenue water. Sanford currently has a very large distribution system which requires roughly 0.2 MGD of water for distribution system process usage including flushing. The geographic extent of the distribution system will not change much in the future as it already spans most of Lee County, but many additional connections will be added as infill. Through careful management of the distribution system, and careful hydraulic design of additional pipes added to the system, Sanford intends to keep the flushing usage roughly constant. By keeping the usage constant, the percentage of total usage will fall over time. Furthermore, Sanford will have to expand its treatment plant, and it is expected that after the upgrades the WTP will be able to use less water (percentage-wise) for process usage. Finally, the City of Sanford will work to keep other non-revenue water (leakage, etc.) to 10% of finished water pumpage.

Appendix C – Source Information

The Jordan Lake Partners, collectively, considered a wide range of source options of many different types in order to best evaluate how to meet future demand for the region.

The following page contains a draft list of all source options considered at some point in the process of building collections of sources and alternatives. The values in this list do not represent the final values used for evaluation.

The remainder of the appendix contains individual source summaries with a greater amount of detail documenting how each source was rated with respect to various impacts and complexities. Only sources under serious consideration have individual source summaries.

>> Num-ber	Partner	Source Option	Yield	Type	Source Basin	WQ Classi-fication	Online	Dvlp. Time (Yrs)	Fin. Cost	Environ. Imp.	Reg./Politic.
1	OWASA	Jordan Lake Level II (OWASA)	5.0	1	Haw	WS IV B NSW CA	2015	5	L	L	L
2	Holly Springs	Jordan Lake Level II (HS)	2.0	1	Haw	WS IV B NSW CA	2015	5	L	L	L
3	OrangeCo	Jordan Lake Level II (OC)	1.0	1	Haw	WS IV B NSW CA	2015	5	L	L	L
4	Apex	Jordan Lake Allocation	3.0	1	Haw	WS IV B NSW CA	2015	5	L	L	M
5	Cary	Jordan Lake Allocation	6.5	1	Haw	WS IV B NSW CA	2015	5	L	L	M
6	Morrisville	Jordan Lake Allocation	0.5	1	Haw	WS IV B NSW CA	2015	5	L	L	M
7	RTPSouth	Jordan Lake Allocation	1.5	1	Haw	WS IV B NSW CA	2015	5	L	L	M
8	ChathamCo	Jordan Lake Allocation	2.5	1	Haw	WS IV B NSW CA	2015	5	L	L	M
9	Durham	Jordan Lake Allocation	3.0	1	Haw	WS IV B NSW CA	2015	5	L	L	M
10	Hillsborough	Jordan Lake Allocation	1.5	1	Haw	WS IV B NSW CA	2015	5	L	L	M
11	Holly Springs	Jordan Lake Allocation	0.5	1	Haw	WS IV B NSW CA	2015	5	M	L	M
12	OrangeCo	Jordan Lake Allocation	3.0	1	Haw	WS IV B NSW CA	2015	5	M	L	M
13	OWASA	Jordan Lake Allocation	3.0	1	Haw	WS IV B NSW CA	2015	5	M	L	M
14	Pittsboro	Jordan Lake Allocation	8.1	1	Haw	WS IV B NSW CA	2015	5	M	L	M
15	Raleigh	Jordan Lake Allocation	13.7	1	Haw	WS IV B NSW CA	2015	5	M	M	H
16	Hillsborough	WF Eno Reservoir Expansion	1.2	2	Neuse	*WS-IV NSW ?*	2025	8	H	L	M
17	OWASA	*Expanded Quarry Reservoir (shallow)*	2.1	5	Haw	WS-II/HQW/NSW	2036	7	L	L	L
18	OWASA	*Expanded Quarry Reservoir (deep)*	3.4	5	Haw	WS-II/HQW/NSW	2036	7	M	L	L
19	Durham	*Teer Quarry - Eno (low)*	6.0	5	Neuse	WS-IV NSW	2017	6	M	L	M
20	Durham	*Teer Quarry-E,LR,LM online high*	10.5	5	Neuse	WS-IV NSW	2020	9	H	L	M
21	Sanford	Expand Cape Fear Withdrawal	12.8	4	Cape Fear	WS II-NSW	2015	5	M	L	L
22	Raleigh	Little River Reservoir	13.7	3	Neuse		2025	15	M	H	H
23	Cary	Cape Fear River @ Harnett Co.	16.5	4	Cape Fear	WS IV CA	2015	5	M	L	M
24	Cary	Kerr Lake	60.0	6	Roanoke	WS III B CA	2015	22	H	M	H
25	Cary	Crabtree Creek & Triangle Quarry	10.0	5	Neuse	C NSW	2015	15	M	M	H
26	Cary	Increased Jordan Lake Water Supply Pool	11.5	2	Cape Fear	WS IV B NSW CA	2016	30	L	L	H
27	Durham	*Raise Lake Michie to 365'*	18.0	2	Neuse	WS III NSW CA	2025	12	H	M	M
28	Durham	*Raise Lake Michie to 381'*	28.9	2	Neuse	WS III NSW CA	2025	12	H	M	M
29	Durham	Dam on Eno River	5.0	3	Neuse		2020	9	H	H	H
30	Holly Springs	Purchase from Harnett	4.0	6	Cape Fear	WS IV CA	2015	5			
31	OrangeCo	Orange County Reservoir	5.0	3	Unknown	Unknown	2036	25	H	H	H
32	*NonSpecific*	New Reservoir (for Orange County)	5.0	3	Unknown	Unknown	2036	25	H	H	H
33	OWASA	Haw River to Cane Creek Reservoir	7.7	5	Haw	WS-V/NSW	2030	10	M	M	H
34	OWASA	Cane Creek Reservoir - Expansion	5.0	2	Haw	WS-II/HQW/NSW	2030	15	H	H	H
35	OWASA	University Lake - Expansion	4.7	2	Haw	WS-II/HQW/NSW	2030	15	H	H	H
36	OWASA	University Lake - Dredge Sediment	0.2	2	Haw	WS-II/HQW/NSW	2030	3	H	H	H
39	OWASA	Other Conservation (OWASA)	0.5	7		N/A	2030	10	M	L	L
40	Pittsboro	Haw River Existing Intake (Keep)	2.0	4	Haw	WS IV NSW	2011	0	M	L	L
41	Pittsboro	Haw River Withdrawal Expansion	6.0	4	Haw	WS IV NSW	2025	10	M	M	M
42	Raleigh	*Falls Lake - WQ Pool Reallocation*	14.0	2	Neuse	WS IV-NSW	2025	15	H	H	H
43	Raleigh	*Falls Lake - Seasonal Norm Pool raise*	8.7	2	Neuse	WS IV-NSW	2025	15	H	H	H
44	Raleigh	*Falls Lake - Sed. Pool Reallocation*	13.7	2	Neuse	WS IV-NSW	2025	15	H	H	H
45	Raleigh	Neuse River Intake above NRWWTP	13.7	4	Neuse	WS IV-NSW	2025	15	H	M	H
46	Raleigh	*Raleigh Quarry 4 BG storage (quarry only)*	8.9	5	Neuse	Unknown	2025	15	H	L	H
47	Raleigh	*Raleigh Quarry 8 BG storage (quarry only)*	13.2	5	Neuse	Unknown	2025	15	H	L	H
48	Raleigh	*Quarry 4 BG w/ Neuse R @ Richland backup*	13.5	5	Neuse	Unknown	2025	15	H	L	H
49	Raleigh	*Quarry 8 BG w/ Neuse R @ Richland backup*	15.4	5	Neuse	WS IV-NSW	2025	15	H	H	H
50	Raleigh	Neuse River Intake Richlands Creek	13.7	4	Neuse	Unknown	2025	15	H	M	H
51	Raleigh	Eagle Resources PCS Phosphate Mine	50.0	6	Neuse	Unknown	2025	15	H	H	H
52	Raleigh	Swift Creek Lakes - Expansion	13.7	2	Neuse	WS IV-NSW	2025	15	H	H	H
53	Raleigh	Buffalo Creek Reservoir (5.4 - 7.2)	5.4	3	Neuse	WS III-NSW	2025	15	H	H	H
54	Raleigh	Quarry Options (other, small)	4.0	5	Neuse	Unknown	2025	15	H	L	H
55	Raleigh	Reclaimed Water (RCW) - Raleigh	3.0	7	Neuse	N/A	2025	15	H	L	H
56	Durham	Moderate reclaimed system (RCW)	2.0	7	Neuse	N/A	2020	5	M	L	M
57	Durham	Aggressive reclaimed system (RCW)	16.0	7	Neuse	N/A	2030	15	H	L	M
58	OWASA	Reclaimed Water Expansion (RCW)	0.3	7	Haw	N/A	2030	10	M	M	L
59	*NonSpecific*	Reclaimed Water (RCW)	5.0	7	TBD	N/A	2030		M	L	M
60	*NonSpecific*	Jordan Lake - Reallocation of _ Pool	5.0	1	Haw		2025	15	H	L	M
61	*NonSpecific*	Purchase from Outside Partnership	5.0	6	TBD	N/A			H	L	M
62	*NonSpecific*	Quarry Options (non-specific)	5.0	7	TBD	Unknown			M	M	M
63	*NonSpecific*	Conservation (non-specific)	5.0	7	TBD	N/A			M	L	L
64	*NonSpecific*	Indirect Reuse (ASR)	5.0	7	TBD	N/A			H	H	M
65	*NonSpecific*	Stormwater Recycling	5.0	7	TBD	Unknown			H	M	H
66	*NonSpecific*	Groundwater	5.0	7	TBD	N/A			H	M	M
67	*NonSpecific*	New Option	10.0	6	TBD						

Individual Source Summaries

SOURCE SUMMARY

Source Name:	
Expand Cape Fear Withdrawal	
Utility:	
Sanford	
Source Type:	***River Withdrawal***
Location - Latitude:	35.548982
Longitude:	-79.024762
Available Supply/Estimated Yield [MGD]:	***12.8***
Additional Storage Volume [MG]:	N/A
Subbasin:	***Cape Fear***
Water Quality Classification:	***WS II-NSW***
Estimated in-service Year:	***2015***
Design and Construction Time [yrs]:	***5***
Timeliness Rating	***Good***
Narrative Description:	
The City of Sanford withdraws water from the Cape Fear. Under this alternative, the water treatment plant is expanded and if necessary, the intake as well.	
Financial Cost Impact:	***Moderate***
Estimated Total Cost (if applicable):	
Estimated Unit Cost	
This expansion of the treatment will have a signifcant cost, but is manageable for the utility.	
Environmental Impact:	***Low***
This alternative has low environmental impact. The main impact is to remove more flow from the Cape Fear River. The projected increase in demand will still be well below 7Q10 flow.	
Projected Interbasin Transfer	***None***
From Basin:	
To Basin:	
N/A	
Institutional Complexity	***Not Complex***
Permits required for treatment plant expansion.	

Political Complexity	***Complex***
This alternative has some political complexity because it would remove flow from the river upstream of other user's stream withdrawals. This concern is likely to be mitigated somewhat because the 7Q10 at this location is high compared to the withdrawal amount.	

Public Benefits	***None***
No substantial public benefits are gained from this alternative, but it is relatively inexpensive.	

Technical Complexity	***Complex***
This alternative is well within the technical capabilities of standard engineering practice. Additionally, no major changes are needed to the distribution system as the WTP will remain in the same location.	

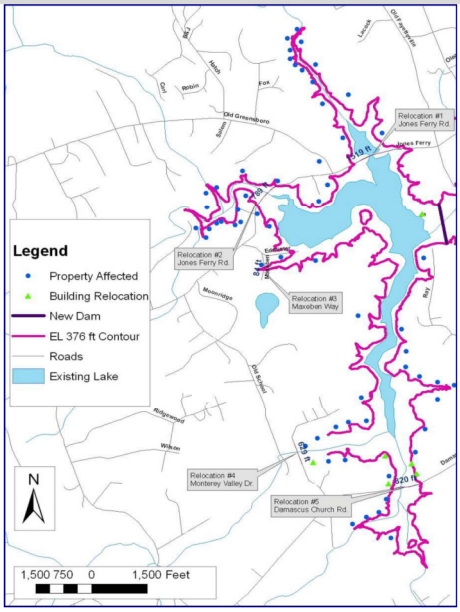
References/ Technical Reports/ Links:

Source Name:	
University Lake - Expansion	
Utility:	
OWASA	
Source Type:	***Modify Reservoir***
Location - Latitude:	
Longitude:	
Available Supply/Estimated Yield [MGD]:	***4.7***
Additional Storage Volume [MG]:	2550
Subbasin:	***Haw***
Water Quality Classification:	***WS-II/HQW/NSW***
Estimated in-service Year:	***2030***
Design and Construction Time [yrs]:	***15***
Timeliness Rating	***Unacceptable***

Narrative Description:

University Lake, located in Orange County, is OWASA's primary water source. This alternative involves constructing a new dam approximately 400 feet downstream of the existing dam to increase the lake level in University Lake by approximately 22 feet. This raising would add approximately 2.55 Billion gallons of storage, and would increase the yield of the Chapel Hill water supply system by 4.7 MGD.

This alternative would also require a new intake and pumping facilities since the existing facilities would be inundated.



Financial Cost Impact:	***High***
Estimated Total Cost (if applicable):	**$107 (capital only)**
Estimated Unit Cost	**22800**

This is high cost compared to other available alternatives. Currently, only capital costs are included. There would be other costs associated with engineering and design, land acquisition, permitting, construction, and other costs.

Environmental Impact:	***High***

This alternative would result in extensive impacts to streams, wetlands and potentially other environmentally sensitive lands that would require mitigation. In addition, approximately 260 acres of land would be inundated and impact 60 private lots, 5 residential buildings, 5 roads, and the UNC Francis Owen animal research facility. This alternative has greater environmental impacts than a Jordan Lake allocation.

Projected Interbasin Transfer	***None***
From Basin:	Haw (2-1)
To Basin:	N/A

There is no interbasin transfer impact.

Institutional Complexity	***Very Complex***

This alternative would require the development of an environmental impact statement under the National Environmental Policy Act. 404 and 401 permits would be required. In addition, the lake is owned by UNC and its expansion would require permission by UNC and the NC Council of State. This alternative would likely face vigorous public opposition.

Political Complexity	***Very Complex***

This alternative would likely be strongly opposed by the public and UNC. Other alternatives exist which would have lower environmental, social, and economic impacts. The dozens of property owners that would be affected by the inundation zone of raised lake would oppose the project. Additionally, there may be other opposition on environmental grounds.

Public Benefits	***None***

University Lake is currently used for recreation, including boating. This alternative would have no public benefits that are not already available at University Lake. While the existing amenities would be replaced in a similar condition if possible, there would be a period of time during construction and filling the lake where recreation would not be permitted.

Technical/Timing/Other Considerations:	***Very Complex***

The permitting process for this alternative would make the process to plan, design, permit, and build this alternative long. Constructing new dams requires a wide-variety of permits, and is especially difficult in areas with substantial life and property risk, and in environmentally sensitive areas, or watersheds.

References/ Technical Reports/ Links:

http://www.owasa.org/client_resources/whatwedo/appendix%20xiv.pdf

Source Name:	
Cane Creek Reservoir - Expansion	
Utility:	
OWASA	
Source Type:	***Modify Reservoir***
Location - Latitude:	
Longitude:	
Available Supply/Estimated Yield [MGD]:	***5***
Additional Storage Volume [MG]:	3000
Subbasin:	***Haw***
Water Quality Classification:	***WS-II/HQW/NSW***
Estimated in-service Year:	***2030***
Design and Construction Time [yrs]:	***15***
Timeliness Rating	***Unacceptable***

Narrative Description:

Under this alternative, the normal pool elevation of Cane Creek Reservoir would be raised 20 feet. Per work completed for the Long-Range Water Supply Plan, this would likely require a new dam downstream of the existing structure. This alternative would also require increasing the pumping capacity from Cane Creek Reservoir to 25 mgd and constructing new water mains from Cane Creek Reservoir to the Jones Ferry Road WTP. The yield assumptions listed above assume maintaining the existing minimum release.

Financial Cost Impact:	***High***
Estimated Total Cost (if applicable):	**127**
Estimated Unit Cost	**25400**

This is high cost compared to other available alternatives.

Environmental Impact:	***High***

Discussion of Environmental Impact This alternative would inundate 225 acres of private land and at least one secondary road. In addition, raising the level of Cane Creek Reservoir would impact wetlands and other environmentally sensitive resources that would require mitigation and likely additional land purchase. This alternative would have greater impacts than a Jordan Lake allocation.

Projected Interbasin Transfer	***None***
From Basin:	Haw (2-1)
To Basin:	N/A

There is no interbasin transfer impact.

Institutional Complexity	***Very Complex***
This alternative would require the development of an environmental impact statement under the National Environmental Policy Act. 404 and 401 permits would be required. This alternative would likely face vigorous public opposition as occurred with the original Cane Creek Reservoir project.	
Political Complexity	***Very Complex***
Public acceptance, community support or opposition, elected leader support or opposition, interest group support/opposition. This alternative would likely be strongly opposed by the public. Other alternatives exist which would have lower environmental, social, and economic impacts.	
Public Benefits	***None***
Discuss Public Benefits (recreation, etc.) No public benefits would occur that are not already available at Cane Creek Reservoir.	
Technical/Timing/Other Considerations:	***Very Complex***
Comment on any particular technical issues that are unique, innovative, or distinctive. Note if particular issues will prevent option from being completed within a certain time window. The permitting process for this alternative would make the process to plan, design, permit, and build this alternative long.	
References/ Technical Reports/ Links:	
http://www.owasa.org/client_resources/whatwedo/appendix%20xiii.pdf	

Source Name:	
Haw River to Cane Creek Reservoir	
Utility:	
OWASA	
Source Type:	***Raw water transfer***
Location - Latitude:	
Longitude:	
Available Supply/Estimated Yield [MGD]:	***7.7***
Additional Storage Volume [MG]:	N/A
Subbasin:	***Haw***
Water Quality Classification:	***WS-V/NSW***
Estimated in-service Year:	***2030***
Design and Construction Time [yrs]:	***10***
Timeliness Rating	***Problematic***

Narrative Description:

This option involves constructing a permanent intake on the Haw River in the vicinity of Old Greensboro Road in Orange County, installing approximately 5 miles of pipeline from the Haw River to Cane Creek Reservoir, improving the Cane Creek pumping station, and constructing approximately 11 miles of new pipeline parallel to the existing raw water transmission main from Cane Creek Reservoir to the Jones Ferry Road WTP. The location of the intake and 5 mile pipeline are based on studies completed by OWASA during the 2007-08 drought. OWASA's Long-Range Water Supply Plan does not recommend this alternative; instead it indicates that it could be used on temporary basis in the event of an emergency. With Jordan Lake, the need for this or any other emergency supply alternative would be less critical.

Financial Cost Impact:	***Moderate***
Estimated Total Cost (if applicable):	**60 (capital only)**
Estimated Unit Cost	**7800**

Environmental Impact:	***Moderate***

Discussion of Environmental Impact The pipeline construction from Haw River to Cane Creek Reservoir and from Cane Creek Reservoir to the WTP would have some environmental impacts. There are stream crossings associated with both pipeline sections, but water quality impacts could be minimized through directional drilling. The water would need to be pumped from Haw River to Cane Creek Reservoir, and there would be carbon emissions associated with the pumps. Environmental impacts would be more than a Jordan Lake alternative which used existing infrastructure; if a new intake facility were constructed, the environmental impacts of Haw River would be similar to those associated with a new intake on Jordan Lake.

Projected Interbasin Transfer	***None***
From Basin:	Haw (2-1)
To Basin:	N/A

There is no interbasin transfer impact.

Institutional Complexity	***Very Complex***

This alternative would require 404/401 permitting to build a new water supply intake on the Haw River. In addition, the Haw River would need to be reclassified as WS-IV. The NC Environmental Management Commission would require resolutions of support from the Orange and Alamance County Boards of Commissioners as they exercise planning and zoning jurisdiction in the proposed WS-IV protected area. These local governments would be required to adopt land use regulations to comply with DWQ's water supply protection regulations.

Political Complexity	***Very Complex***

Orange and Alamance Counties would need to develop land use regulations to protect a WS-IV classification within the Haw River. It may be difficult to gain the public support needed to support these new ordinances.

Public Benefits	***None***

No public benefits are associated with this alternative.

Technical Complexity	***Complex***

Given the time to reclassify the water supply and obtain support to develop land use ordinances to protect the WS-IV classification, this water supply option may not be available in time to meet OWASA's needs.

References/ Technical Reports/ Links:

http://www.owasa.org/client_resources/whatwedo/appendix%20viii.pdf

SOURCE SUMMARY

Source Name:	
West Fork Eno Reservoir Phase 2	West Fork Eno Reservoir Phase 2
Utility:	
Hillsborough	
Source Type:	***Modify Reservoir***
Location - Latitude:	36.148611
Longitude:	-79.171389
Available Supply/Estimated Yield [MGD]:	***1.2***
Additional Storage Volume [MG]:	1043
Subbasin:	***Neuse***
Water Quality Classification:	***WS-IV NSW ?***
Estimated in-service Year: 2018	***2018***
Design and Construction Time [yrs]: 4	***4***
Timeliness Rating	

Narrative Description:

Phase 2 of the West Fork Eno Reservoir was planned during the original design of the reservoir in the late 1990's. Phase 1 was constructed from 1998 to 2000, with a US Army Corps of Engineers 404 Permit that had a 20 year effective period (expires on December 31, 2018). This permit span was specifically made to allow the Phase 2 expansion to occur under the same permit. An additional 10 vertical feet will be added to the WFER, more than doubling its supply, and increasing its safe yield from 1.8 mgd to 3.0 mgd. An additional 10 vertical feet will be added to the concrete broad crested weir to form an ogee spillway. All necessary property was purchased during initial construction to accomodate Phase 2. Additional clearing of trees and the raising of two NCDOT roadways will be necessary during the Phase 2 construction. The Town of Hillsborough Capital Improvement Plan currently funds construction of Phase 2 beginning in FY16.

Financial Cost Impact:	***High***
Estimated Total Cost (if applicable):	**3**
Estimated Unit Cost	**2500**

Discussion of Financial Impact

Environmental Impact:	***Low***

The Environmental Impact Statement for the original WFER construction included Phase 2. Phase 2 impacts have already been addressed with the original construction.

Projected Interbasin Transfer	***None***
From Basin:	
To Basin:	

Discussion of Interbasin Transfer Impact.

Institutional Complexity	***Complex***

The 404 permit is already in effect, and the EIS was previously approved. Further permitting requirements will be determined as we begin preliminary engineering work in FY14. Actual institutional complexity may be "Not Complex", since much of the permitting requirements were addressed in the initial Phase 1 project.

Political Complexity	***Not Complex***

All property needed for Phase 2 is already owned by the Town of Hillsborough. The Hillsborough Board of Commissioners has previously approved our current Capital Improvement Plan which includes this project. We have not received any public opposition at this time.

Public Benefits	***Few***

The primary benefit is increased quantity of water supply. To a lesser extent, it is possible that the expansion will increase protection from flood and siltation downstream. In addition, if future recreation is allowed at the WFER, the additional water from Phase 2 should only bring improvement.

Technical/Timing/Other Considerations:	***Complex***

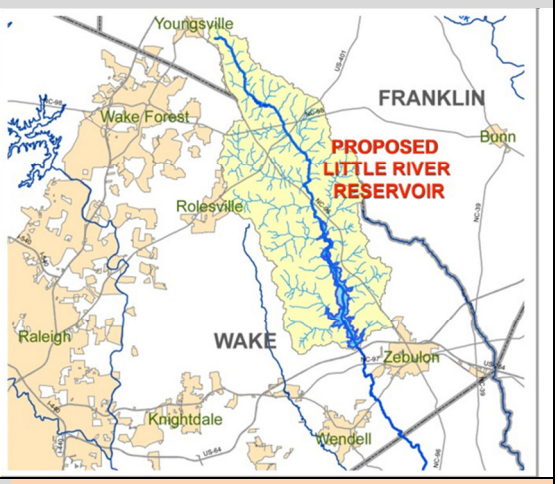
The primary obstacle to this project would be a delay that would prevent completion by December 31, 2018 (404 permit expiration). If this were to occur, significant additional costs for environmental remediation could make the construction cost prohibitive.

References/ Technical Reports/ Links:

Source Name:	
Little River Reservoir	
Utility:	
Raleigh	
Source Type:	***New Reservoir***
Location - Latitude:	35.833576
Longitude:	-78.357418
Available Supply/Estimated Yield [MGD]:	***13.7***
Additional Storage Volume [MG]:	3700
Subbasin:	***Neuse***
Water Quality Classification:	***WS-II***
Estimated in-service Year:	***2025***
Design and Construction Time [yrs]:	***15***
Timeliness Rating	***Acceptable***

Narrative Description:

This alternative involves the construction of new reservoir on Little River, just north of Rt. 64 in eastern Wake County. The City of Raleigh has entered into a Processing Agreement with USACE to prepare an Environmental Impact Statement (EIS) for the project. The project would build a new 39 foot tall dam, creating an 1150 acre reservoir with 3.7 BG of storage, with a yield 13.7 MGD. A new water treatment with 20 MGD capacity would be built adjacent to the reservoir.



Financial Cost Impact:	***Moderate***
Estimated Total Cost (if applicable):	**263**
Estimated Unit Cost	**19.20**

The estimated cost of $263 Million or $19.20/gallon includes $100 Million for a new water treatment facility. Of the remaining cost, a significant component is the estimated cost of mitigation for wetlands and streams that would be inundated by the reservoir. Two of the primary difficulties associated with new reservoir development is finding /reserving property and ensuring watershed protection. Both have already occurred with the proposed project.

Environmental Impact:	***High***

The reservoir will have its primary impacts on the land and water features that it covers, and in the changes to downstream flow. The lake will cover 1150 acres at normal pool, and will impact 38007 linear feet of stream and 572 acres of wetlands. The Little River is habitat to the endangered dwarf wedgemussel and Tar River spiny mussel, so Section 7 of the Endangered Species Act will apply environmental permitting. After the reservoir, average flows below the proposed dam location will be lower due evaporation losses and water withdrawals.

Projected Interbasin Transfer	***None***
From Basin:	Neuse
To Basin:	N/A

This alternative as proposed does not involve an interbasin transfer impact.

Institutional Complexity	***Very Complex***

The Little River Reservoir approval and permitting process, as with any new reservoir is very complex. The reservoir will require an environmental impact assessment, which will require a full alternatives analysis, and will likely require several additional permits (401, 404, possibly others). The reservoir's impact on existing streams, wetlands, and endangered species will have be studied. The impacts on endangered species are likely to be a significant factor in increasing complexity of the EIS process. A new reservoir would also require an Instream Flow Study to evaluate the impact on downstream flows. The dam construction would also require approval by Dam Safety officials in the Division of Land Resources, and development of an Emergency Action Plan, and other hazard mitigation planning as needed. It is also worth noting that the watershed has already been classified as WS-II water supply watershed by the EMC, and so no new classification would be necessary.

Political Complexity	***Very Complex***

There is potentially a large amount of political complexity in building this reservoir, as is the case for most new reservoir construction that goes through an EIS process. The presence of endangered species, and impacts to the existing stream and wetland areas are likely to be significant points of contention. The City of Raleigh already owns the land that would be inundated, so some of the property rights issues typically faced in reservoir construction may be less complex. Additionally, the proposed downstream releases mitigate some of the concerns for downstream users and habitat preservation, but there may be political conflict over setting the release amount and schedule. Finally, a significant source of political complexity would be justifying the need for a new reservoir, and selecting this alternative over other alternatives which do not require a new impoundment. A Project Review Team, composed of local government staff, private citizens, state and federal regulatory agency staff, and emergency responders was assembled durign the scoping phase of the EIS process.

Public Benefits	***Few***

This alternative creates a new reservoir that is primarily intended for water supply, but the lake could provide opportunities for recreation either on the lake or land adjacent to the lake. Additionally, having more water storage in the form of another reservoir could allow CORPUD to better regulate water supply levels at Falls Lake and the Swift Creek Lakes, resulting in fewer days of recreation lost to low water level restrictions.

Technical/Timing/Other Considerations:	***Very Complex***
The complexity of permitting new reservoirs in the United States has resulted in very few new projects. The proposed project must satisfy Nation Environmental Policy Act, State Environmental Policy Act, the Clean Water Act, the Safe Drinking Water Act, Endangered Species Act, EPA Region 4 Guidelines "Water Efficiency Measures for Water Supply Projects in the Southeast" and the results of the recent NC Supreme Court case titled L&S Water Power v. PTRWA. The complexity may rise as the City identifies needed reasonable and prudent measures to preserve and protect the two federally listed species. Other technical challenges include construction of a new water treatment plant and water transmission facilities.	
References/ Technical Reports/ Links:	
Summary of Water Supply Alternatives to the Little River Reservoir. Hazen & Sawyer. May 31, 2013. ¶ *2012 City of Raleigh Water Resources Assessment and Plan.* City of Raleigh, Sep 20 2012.	

SOURCE SUMMARY

Source Name:	
Transfer from Kerr Lake	
Utility:	
Multiple	
Source Type:	***River Withdrawal***
Location - **Latitude:** **Longitude:**	
Available Supply/Estimated Yield [MGD]:	***55***
Additional Storage Volume [MG]:	
Subbasin:	***Roanoke River (14-1)***
Water Quality Classification:	***WS III B CA***
Estimated in-service Year:	***2040***
Design and Construction Time [yrs]:	***22***
Timeliness Rating	***Problematic***

Narrative Description:

Kerr Lake, located approximately 40 miles from Durham on the North Carolina-Virginia border is a large multipurpose reservoir that impounds a section of the mainstem of the Roanoke River. The lake is managed by the Army Corps of Engineers. Under the Water Supply Act of 1958, the Corps is permitted to designate up to 50,000 acre-feet (yielding 97.2 MGD at the drought of record) to water supply. A little over 28,600 ac-ft remain unallocated, which yields 55.6 MGD at the drought of record.

Financial Cost Impact:	***High***
Estimated Total Cost (if applicable):	
Estimated Unit Cost	

The financial cost impact of this alternative is unknown, but would likely be very high. The cost for an allocation that would yield 55.6 MGD would start with paying USACE for the allocations in the form of a one time $11.6 M (2010$) payment for capital costs, and roughly $43,000 in annual O&M costs. But these costs would likely be low relative to the costs of bringing the water to the Triangle. Roughly 40 miles of pipeline with a capacity of in excess of 60 MGD would likely be needed to bring raw water close enough that it could be treated.

Environmental Impact:	***Moderate***

This alternative will likely have a moderate to potentially high environmental impact. The largest effect would be the transfer of 50+ MGD of water from one river basin to another.

Projected Interbasin Transfer	***up to 60***
From Basin:	Roanoke River (14-1)
To Basin:	Neuse (10-1), Haw (2-1), maybe others

Kerr Lake sits in the Roanoke River basin at the Virginia border. Any transfer to the Triangle Region would likely require a significant interbasin transfer. If water were brought primarily into the Neuse basin through a pipeline, the pipeline would also cross the Tar River basin.

Institutional Complexity	***Very Complex***

Discussion of Regulatory or Institutional issues and barriers. Be specific about types of permits, studies that may be required. (401, 404, 216, etc.)

Political Complexity	***Very Complex***

This options would certainly have significant political issues to overcome. Primarily, the Roanoke River water users downstream of Kerr Lake would likely have significant concerns about that quantity of water being diverted, especially in the summer months. Not only does the greater Virginia beach area rely on the Roanoke for its water, but significant portions of Northeast NC and Southeast VA get some power from the hydroelectric stations on the river.

Public Benefits	***Few***

Depending on the configuration of this alternative, there might be a few public benefits. The availability of the water from Kerr Lake may allow water systems in the Triangle Area to better manage their reservoir levels to allow more stable water levels for recreation.

Technical Complexity	**Very Complex**

This source option is very complex in terms of infrastructure needed to bring the water across several river basins. A dual pipeline would likely be needed in case maintenance would be required. Additionally, signficant pumping capacity and pressure regulation may be needed as the pipeline route would cross over the ridges of several basin boundaries. Some initial pretreatment would also be needed at the intake to prevent

References/ Technical Reports/ Links:

http://www.ncwater.org/Permits_and_Registration/Interbasin_Transfer/Status/Kerr/KLWRS_IBT_Scoping.pdf
http://www.deq.state.va.us/Portals/0/DEQ/Water/WaterResources/RRBBC/RRBBC-AllocationCommittee-03-10-StatusReport-Revised-03-30-10.pdf
http://www.deq.virginia.gov/Portals/0/DEQ/Water/WaterResources/RRBBC/RRBBC-KerrLakeWaterSupplyAllocationStatus-COE-Young-03-27-09.pdf

Source Name:	
Cape Fear River @ Harnett Co.	
Utility:	
Cary	
Source Type:	***River Withdrawal***
Location - Latitude:	TBD
Longitude:	TBD
Available Supply/Estimated Yield [MGD]:	***16.5***
Additional Storage Volume [MG]:	N/A
Subbasin:	***Cape Fear***
Water Quality Classification:	***WS IV CA***
Estimated in-service Year:	***2031***
Design and Construction Time [yrs]:	***15***
Timeliness Rating	***Acceptable***

Narrative Description:

Raw water would be pumped from the Cape Fear River in the reach between Jordan Lake Dam and the Town of Lillington. Water would be withdrawn using either a reservoir intake within the Buckhorn Dam impoundment or a run-of-river intake. Based on an initial evaluation of this reach, a range of approximately 11 mgd to 31 mgd of average day water supply should be available in the summer peak demand months. Water would be treated either at a new WTP, between the intake location and the connection to the Towns' current distribution systems, or at the existing Cary/Apex WTP. To transmit water from the Cape Fear River to the Towns' current distribution facilities would require approximately 21 miles of pipeline, depending on the point of interconnection. Alternatively, Cary could partner with other entities in lieu of building a new intake. The City of Sanford and Harnett County have existing raw water facilities on this reach of the Cape Fear River and present partnership opportunities for facility expansions. In that case, new finished water transmission capacity would be needed. Progress Energy has expressed its intent to construct a new intake and raw water pipeline from the Cape Fear River at Buckhorn Dam to Harris Lake; the water would be used to supplement cooling water supply for a new nuclear reactor unit. This would present a partnership opportunity for building an intake, raw water pipeline, and perhaps a treatment plant.

Financial Cost Impact:	***Moderate***
Estimated Total Cost (if applicable) [$Millions]:	**173.4**
Estimated Unit Cost [$/1000 gallons]:	**10509.09091**

The construction cost would decrease if a new WTP and raw water intake did not need to be built, however finished water would still need to be pumpded over a great distance.

Environmental Impact:	***Low***

It is important to note that if the cumulative withdrawals along this reach of the Cape Fear River exceed 20 percent of 7Q10 flows (7-day, consecutive low flow with a 10-year recurrence interval), an instream flow study may be required by the NC DWR. An environmental document meeting SEPA requirements would be necessary for the new water supply and infrastructure development. One of the key issues associated with receiving the appropriate approvals will be how to address potential direct impacts of the water withdrawal, including maintaining minimum instream flows to meet habitat and water quality requirements.

Projected Interbasin Transfer	***TBD***
From Basin:	Cape Fear
To Basin:	Haw and Neuse

This option would require a new Interbasin Transfer certificate, because the new transfer would be from the Cape Fear River Basin, rather than the Haw River Basin. The impacts would need to be studied at projected future demands.

Institutional Complexity	***Complex***

Developing a new raw water intake could be done alone, or in partnership with others. One possibility is partnering with Progress Energy to construct a new intake and raw water pipeline from the Cape Fear River at Buckhorn Dam to Harris Lake (Progress Energy, 2007). But several institutional issues may make it difficult to partner with Progress Energy. Nuclear Regulatory Commission (NRC) licensing guidelines may prevent or limit the ability of Progress Energy to partner with the Towns for the shared development of a raw water intake and/or transmission pipelines. Additional levels of federal review may be triggered as well. If Cary instead partnered with Sanford or Harnett County to expand a treatment plant, contracts and cost-sharing agreements would be need for the construction, and for the provision of finished water to Cary system customers. In any situation, some permits and studies would be required to actually construct the withdrawal and other infrastructure. As discussed in the Environmental Impacts section, an environmental document meeting SEPA requirements would need to be developed for the new infrastructure, and impacts on the in-stream flow would likely need to be studied to receive the necessary permits.

Political Complexity	***Complex***

Concerns about the cumulative withdrawal from this reach of the Cape Fear could lead to opposition from downstream water users on the Cape Fear. This alternative would require new, interlocal agreements with multiple local governments. Approvals would be needed from other local/county governments to acquire land and easements for new infrastructure.

Public Benefits	***None***
Discuss Public Benefits (recreation, etc.)	

Technical Complexity	***Complex***
Moving the water from the Cape Fear River to the existing Cary-Apex WTP or building a new treatment plant would add to the the technical complexity. If the water were treated at the existing Sanford or Harnett County plants, a method for transferring sufficient finished water would be needed.	

References/ Technical Reports/ Links:

CH2M HILL and Brown and Caldwell. 2013. Long Range Water Resources Plan. Prepared for Towns of Cary, Apex and Morrisville, and Wake County. (Final Report available at http://www.townofcary.org/Departments/Public_Works_and_Utilities/Water/longrangeplan.htm)

Progress Energy. 2007. Presentation "Harris Nuclear Plant Expansion" at Cape Fear River Water Supply Plan Meeting, October 1, 2007.

Source Name:	
Haw River Withdrawal Expansion	
Utility:	
Pittsboro	
Source Type:	***River Withdrawal***
Location - Latitude:	
Longitude:	
Available Supply/Estimated Yield [MGD]:	***8***
Additional Storage Volume [MG]:	
Subbasin:	***Haw***
Water Quality Classification:	***WS IV NSW***
Estimated in-service Year:	***2025***
Design and Construction Time [yrs]:	***6***
Timeliness Rating	***Acceptable***

Narrative Description:

Existing intake/withdrawl currently has a DENR permit for 3 MGD. Current treatment plant has 2 MGD design capacity. Required up-grades include study of existing in-take structure and possible new design, new treatment plant and retrofit of existing plant to increase treatment capacity, additional/new distribution system and storage tanks to service new development and improvements to portions of the existing distribution system.

Financial Cost Impact:	***High***
Estimated Total Cost (if applicable):	**$5 - $8 M**
Estimated Unit Cost	**$5.00 - $8.00**

See discussion above of key components. Actual cost will depend on many factors that are to be determined.

Environmental Impact:	***Low***

Minimal environmental impacts given the in-take infrastructure is in place at the river and the existing plant property is proposed to locate the new treatment plant. In-take re-design may require more extensive environmental impact assessment activities.

Projected Interbasin Transfer	***None***
From Basin:	
To Basin:	

There is no interbasin transfer impact for this source.

Institutional Complexity	***Complex***
Impacts are considered to be complex only due to the private dam issue. All other complexities are thought not to be complex.	

Political Complexity	***Not Complex***
Public support will depend upon the recommended final design of the intake and impacts to the Haw River. Increasing withdrawals will certainly cause some comment from the Haw River Assembly and other groups or individuals. However, by limiting the maximium withdrawal to below 20 percent of the most recent 7Q10 data, the Haw River ecosystem will not be impacted.	

Public Benefits	***Many***
By increasing the public water supply, the public will benefit with safe and reliable drinking water and with a pressurized and adequate distribution system for fire supression and other emergency purposes.	

Technical Complexity	***Complex***
The treatment plan up-grade will require a new plant to be designed and constructed adjacent to the exitsing treatment plant without taking the existing plant off-line until the new plant is completed and ready for testing. Upon full operation of the new plant, the existing plant will either be retrofitted to meet new standards or it will be dismantled and a new plant expansion will be constructed.	

References/ Technical Reports/ Links:
NC Rural Water Association Report: Water/Wastewater Rate Study, March 2009 and Town of Pittsboro Water Treatment Plant Evaluation to construct a 7.6 MGD Up-grade

Source Name:	
Haw River to Cane Creek Reservoir	
Utility:	
OWASA	
Source Type:	***Raw water transfer***
Location - Latitude:	
Longitude:	
Available Supply/Estimated Yield [MGD]:	***7.7***
Additional Storage Volume [MG]:	N/A
Subbasin:	***Haw***
Water Quality Classification:	***WS-V/NSW***
Estimated in-service Year:	***2030***
Design and Construction Time [yrs]:	***10***
Timeliness Rating	***Problematic***

Narrative Description:

(key design features, reason for selection, level of analysis) This option involves constructing a permanent intake on the Haw River in the vicinity of Old Greensboro Road in Orange County, installing approximately 5 miles of pipeline from the Haw River to Cane Creek Reservoir, improving the Cane Creek pumping station, and constructing approximately 11 miles of new pipeline parallel to the existing raw water transmission main from Cane Creek Reservoir to the Jones Ferry Road WTP. The location of the intake and 5 mile pipeline are based on studies completed by OWASA during the 2007-08 drought. OWASA's Long-Range Water Supply Plan does not recommend this alternative; instead it indicates that it could be used on temporary basis in the event of an emergency. With Jordan Lake, the need for this or any other emergency supply alternative would be less critical.

Financial Cost Impact:	***Moderate***
Estimated Total Cost (if applicable):	**60 (capital only)**
Estimated Unit Cost	**7800**

Discussion of Financial Impact

Environmental Impact:	***Moderate***

Discussion of Environmental Impact The pipeline construction from Haw River to Cane Creek Reservoir and from Cane Creek Reservoir to the WTP would have some environmental impacts. There are stream crossings associated with both pipeline sections, but water quality impacts could be minimized through directional drilling. The water would need to be pumped from Haw River to Cane Creek Reservoir, and there would be carbon emissions associated with the pumps. Environmental impacts would be more than a Jordan Lake alternative which used existing infrastructure; if a new intake facility were constructed, the environmental impacts of Haw River would be similar to those associated with a new intake on Jordan Lake.

Projected Interbasin Transfer	***None***
From Basin:	Haw (2-1)
To Basin:	N/A

Discussion of Interbasin Transfer Impact. There is no interbasin transfer impact.

Institutional Complexity	***Very Complex***

Discussion of Regulatory or Institutional issues and barriers. Be specific about types of permits, studies that may be required. (401, 404, 216, etc.) This alternative would require 404/401 permitting to build a new water supply intake on the Haw River. In addition, the Haw River would need to be reclassified as WS-IV. The NC Environmental Management Commission would require resolutions of support from the Orange and Alamance County Boards of Commissioners as they exercise planning and zoning jurisdiction in the proposed WS-IV protected area. These local governments would be required to adopt land use regulations to comply with DWQ's water supply protection regulations.

Political Complexity

Discussion of Political Complexity of implementing the source. Public acceptance, community support or opposition, elected leader support or opposition, interest group support/opposition. Orange and Alamance Counties would need to develop land use regulations to protect a WS-IV classification within the Haw River. It may be difficult to gain the public support needed to support these new ordinances.

Public Benefits

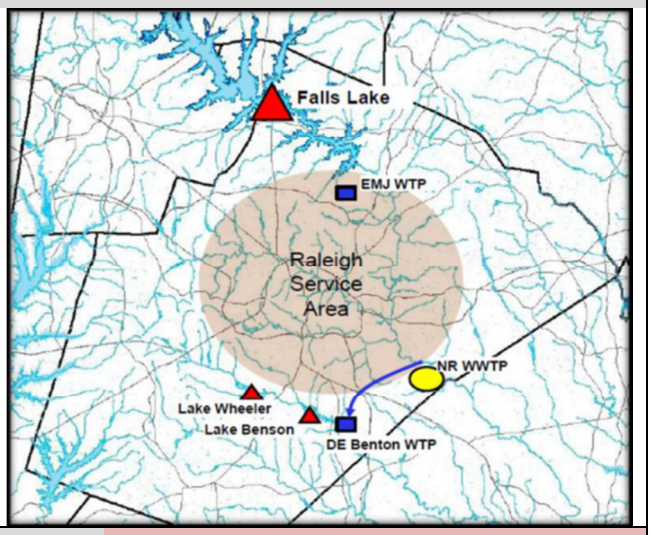
Discuss Public Benefits (recreation, etc.) No public benefits are associated with this alternative.

Technical/Timing/Other Considerations:
Comment on any particular technical issues that are unique, innovative, or distinctive. Note if particular issues will prevent option from being completed within a certain time window.
References/ Technical Reports/ Links:
http://www.owasa.org/client_resources/whatwedo/appendix%20viii.pdf

Source Name:	
Neuse River Intake upstream of NRWWTP	
Utility:	
Raleigh	
Source Type:	***River Withdrawal***
Location - Latitude:	35.724392
Longitude:	-78.501828
Available Supply/Estimated Yield [MGD]:	***13.7***
Additional Storage Volume [MG]:	N/A
Subbasin:	***Neuse***
Water Quality Classification:	***WS IV-NSW***
Estimated in-service Year:	***2030***
Design and Construction Time [yrs]:	***15***
Timeliness Rating	***Acceptable***

Narrative Description:

This source option would build a new intake on the Neuse River below Falls Lake and just upstream of the NRWWTP. This option requires the construction of a new raw water intake and pumping station. A raw water transmission main would be required from the proposed intake to DE Benton. Operation of the new intake would involve pumping when the Falls Lake level is below 251.0. During these conditions, raw water would be pumped at a continuous fixed rate of approximately 16 MGD. At higher lake levels, the new intake could be used to send water to DE Benton WTP, or more water could be withdrawn from Falls Lake to be treated at EM Johnson WTP, or more water could be treated from Lake Benson at DE Benton.



Financial Cost Impact:	***High***
Estimated Total Cost (if applicable):	**$225.5**
Estimated Unit Cost	

Cost estimates include construction of 40,000 linear feet of 30-inch raw water main and upsizing of the DE Benton WTP from its current 20 MGD (peak) treatment capacity to 40 MGD (peak). Cost estimate does not include pretreatment facilities to reduce the impact of turbidity on treatment processes designed for base load operations.

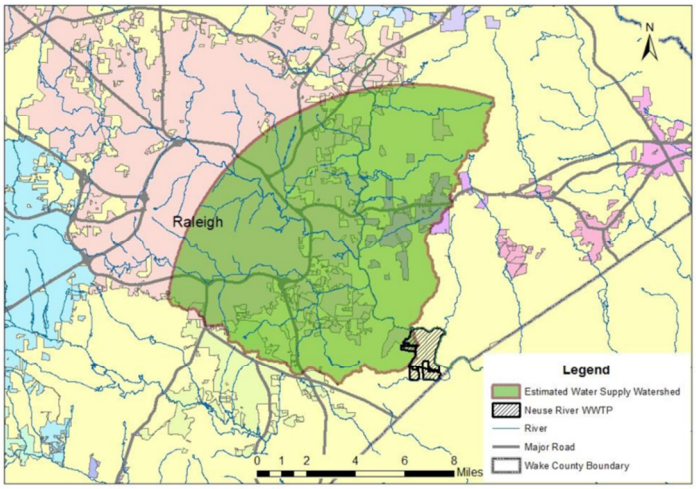
Environmental Impact: ***Moderate***

The recent listing of the Atlantic sturgeon as a federally protected species, known to inhabit the Neuse River, and the possible removal of the Milburnie Dam will add important new challenges to securing a Neuse River intake.

Projected Interbasin Transfer	***None***
From Basin:	Neuse
To Basin:	N/A

This source option does not involve an interbasin transfer.

Institutional Complexity	***Very Complex***



This option could be very complex from an institutional perspective. A 401 permit would likely be required for building the intake structure within the Neuse. The hydrologic impacts of removing water from the river during high flow would have to be studied, but more importantly, since it might be necessary to release more water from Falls Lake to meet downstream flow requirements, there would be impacts on Falls Lake operations and perhaps its water quality and nutrient rules. The impact on the downstream flow could complicate permitting expansion of the NRWWTP due to changes in low-flow characteristics in the river at the discharge point, which is just downstream of this options water withdrawal. The need to meet low-flow requirments may require some additional releases from the Falls Lake conservation pool, which could impact lake levels and existing water quality in Falls Lake. Furthermore, the Atlantic sturgeon or other species could trigger some action under the Endangered Species Act. A water supply intake at this location would require the implementation of a new water supply watershed overlay zoning district up to to 10 miles upstream of the intake. The new zoning district would cover a major portion of downtown Raleigh, and could limit development in the area.

Political Complexity	***Very Complex***

This option is politically complex, notably because of the water supply watershed overlay over much of downtown Raleigh. The development limitations that the new overlay would create would create political challenges. There are also potential issues with downstream water users, or even recreational users of the river in the vicinity of the withdrawal. Some of the flow impacts are mitigated by the withdrawal being in close proximity to the NRWWTP discharge point.

Public Benefits	***None***

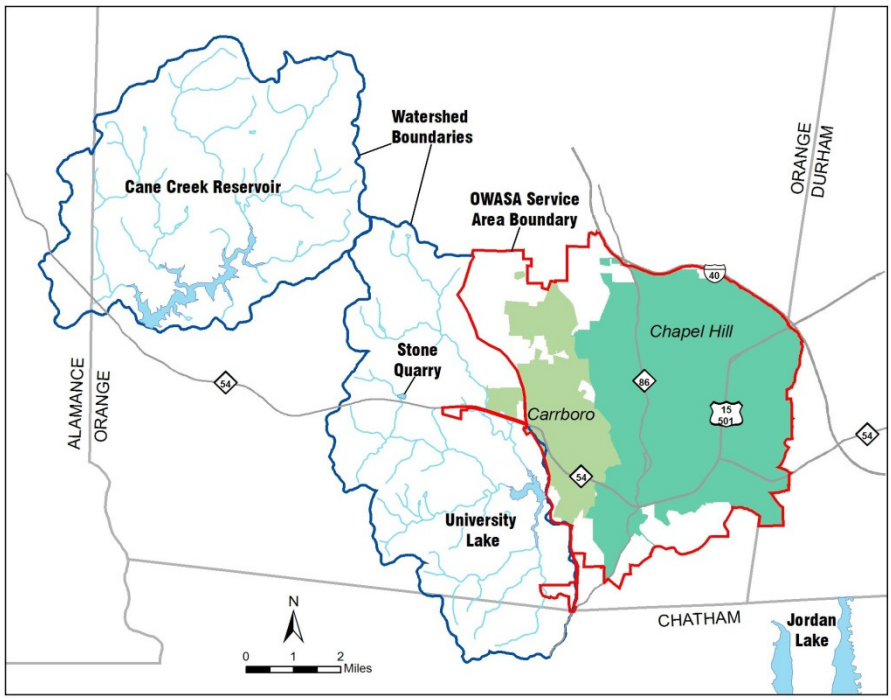
It is unlikely there will be signficant public benefits from this option.

Technical Complexity	***Very Complex***
The construction of a raw water intake that is size to remove 16 million gallons per day without fish impingement will be extremely challenging on the Neuse River. Furthermore, raw water transmission facilities to transport the water to the D.E. Benton WTP and facility upgrades to the plant to treat the water will be required. The corridor between the Neuse and the D.E. Benton facility is congested with other utilities, including a large wastewater force main that transmits wastewater from the Garner service area to the NRWWTP.	
References/ Technical Reports/ Links:	
Summary of Water Supply Alternatives to the Little River Reservoir. Hazen & Sawyer. May 31, 2013. ¶ 2012 City of Raleigh Water Resources Assessment and Plan. City of Raleigh, Sep 20 2012.	

Source Name:	
Expanded Quarry Reservoir (shallow)	
Utility:	
OWASA	
Source Type:	***Quarry Reservoir***
Location - Latitude:	
Longitude:	
Available Supply/Estimated Yield [MGD]:	***2.1***
Additional Storage Volume [MG]:	1500
Subbasin:	***Haw***
Water Quality Classification:	***WS-II/HQW/NSW***
Estimated in-service Year:	***2036***
Design and Construction Time [yrs]:	***7***
Timeliness Rating	***Problematic***

Narrative Description:

Under this alternative, OWASA would expand its existing Stone Quarry Reservoir by accessing storage currently being mined by American Stone Company using its existing pumping facilities. Work completed as part of OWASA's Long-Range Water Supply Plan indicates that this source offers the greatest water supply benefit for the lowest economic and environmental costs, and represents the least challenging regulatory/political hurdle. The quarry options do not add redundancy to OWASA's overall system.



Financial Cost Impact:	***Low***
Estimated Total Cost (if applicable):	**$1.4 (capital costs only)**
Estimated Unit Cost	**700**

Discussion of Financial Impact - This is a relatively low cost option that can supplement OWASA's other water supply sources.

Environmental Impact:	***Low***

Discussion of Environmental Impact - This is an expansion of an existing water source so few environmental impacts would occur. No new infrastructure is needed for this alternative. Impacts are relatively the same to the Jordan Lake alternative if OWASA accessed its allocation through the Town of Cary and City of Durham. If a new intake and transmission lines are constructed for Jordan Lake, this alternative would have fewer environmental impacts than a Jordan Lake allocation.

Projected Interbasin Transfer	***None***
From Basin:	Haw (2-1)
To Basin:	N/A

Discussion of Interbasin Transfer Impact. There is not interbasin transfer impact.

Institutional Complexity	***Not Complex***

Discussion of Regulatory or Institutional issues and barriers. Be specific about types of permits, studies that may be required. (401, 404, 216, etc.) - No stream reclassification or major permitting is required for this alternative. The OWASA Board and customers support this alternative.

Political Complexity	***Not Complex***
Discussion of Political Complexity of implementing the source. Public acceptance, community support or opposition, elected leader support or opposition, interest group support/opposition. OWASA is already using the quarry for additional storage, and community leaders and our customers have supported this alternative. Carrboro, Chapel Hill, and Orange County have all adopted resolutions necessary to accommodate the expanded Quarry Reservoir project in their local and joint land use plans.	
Public Benefits	***Few***
Discuss Public Benefits (recreation, etc.) - There will be permanent public greenspace surrounding the expanded quarry when it is ultimately completed.	
Technical Complexity:	
Comment on any particular technical issues that are unique, innovative, or distinctive. Note if particular issues will prevent option from being completed within a certain time window. The existing quarry will be removed from service in approximately 2030 to develop this option. During this time, OWASA will need an alternative water supply. This alternative alone does not meet OWASA's long-range water supply needs (2060).	
References/ Technical Reports/ Links:	
http://www.owasa.org/client_resources/whatwedo/appendix%20v-a.pdf	

Source Name:	
Expanded Quarry Reservoir (deep)	
Utility:	
OWASA	
Source Type:	***Quarry Reservoir***
Location - Latitude:	
Longitude:	
Available Supply/Estimated Yield [MGD]:	***3.4***
Additional Storage Volume [MG]:	2200
Subbasin:	***Haw***
Water Quality Classification:	***WS-II/HQW/NSW***
Estimated in-service Year:	***2036***
Design and Construction Time [yrs]:	***7***
Timeliness Rating	***Problematic***

Narrative Description:

Under this alternative, OWASA would expand its existing Stone Quarry Reservoir by accessing storage currently being mined by American Stone Company adn constructing a 250 foot vertical shaft and multi-level pumps to access deep storage. Work completed as part of OWASA's Long-Range Water Supply Plan indicates that the shallow option is more cost-effective, but OWASA will continue to evaluate this alternative through approximately 2025. This alternative has the same environmental, regulatory, and political impacts as the shallow quarry alternative. The quarry alternatives do not add redundancy to OWASA's overall system.

Financial Cost Impact:	***Moderate***
Estimated Total Cost (if applicable):	**$64.6 (capital only)**
Estimated Unit Cost	**19000**

Due to cost, OWASA's preferred alternative is the shallow option. However, OWASA will continue to evaluate this alternative through approximately 2025 to determine if the cost-effectiveness changes.

Environmental Impact:	***Low***

This is an expansion of an existing water source so few environmental impacts would occur. No new infrastructure is needed for this alternative. Impacts are relatively the same to the Jordan Lake alternative if OWASA accessed its allocation through the Town of Cary and City of Durham. If a new intake and transmission lines are constructed for Jordan Lake, this alternative would have fewer environmental impacts than a Jordan Lake allocation.

Projected Interbasin Transfer	***None***
From Basin:	Haw (2-1)
To Basin:	N/A

There is no interbasin transfer impact.

Institutional Complexity	***Not Complex***

No stream reclassification or major permitting is required for this alternative. The OWASA Board and customers support this alternative.

Political Complexity

Public acceptance, community support or opposition, elected leader support or opposition, interest group support/opposition. OWASA is already using the quarry for additional storage, and community leaders and our customers have supported this alternative. Carrboro, Chapel Hill, and Orange County have all adopted resolutions necessary to accommodate the expanded Quarry Reservoir project in their local and joint land use plans.

Public Benefits

There will be permanent public greenspace surrounding the expanded quarry when it is ultimately completed.

Technical/Timing/Other Considerations:

Comment on any particular technical issues that are unique, innovative, or distinctive. Note if particular issues will prevent option from being completed within a certain time window. The existing quarry will be removed from service in approximately 2030 to develop this option. During this time, OWASA will need an alternative water supply.

References/ Technical Reports/ Links:

http://www.owasa.org/client_resources/whatwedo/appendix%20v-a.pdf

SOURCE SUMMARY

Source Name:	
Teer Quarry - Eno (low)	
Utility:	
Durham	
Source Type:	***Quarry Reservoir***
Location - Latitude:	***36.07***
Longitude:	***-78.89***
Available Supply/Estimated Yield [MGD]:	***5.2***
Additional Storage Volume [MG]:	***1,315***
Subbasin:	***Upper Neuse***
Water Quality Classification:	***WS-IV NSW***
Estimated in-service Year:	***2020***
Design and Construction Time [yrs]:	***6***
Timeliness Rating	***Acceptable***

Narrative Description:

The City owns a decommissioned quarry (Teer Quarry) in northern Durham adjacent to the Eno River. The quarry has a water storage capacity of 1.3 billion gallons and would provide an additional 50-year safe yield of 5.2 mgd to Durham's existing Lake Michie/Little River Reservoir supply system. Teer Quarry supplied supplemental water during the record drought of 2007-2008 through the use of portable diesel-powered pumps and an emergency connection to Durham's nearby 42-inch raw water main. A Finding of No Significant Impact (FONSI) issued by the NC Department of Natural and Envrionmental Resources (DENR) allows the City to construct a raw water pumping station and to refill Teer Quarry from the Eno River. The use of the quarry as a permanent supplement to Durham's existing Lake Michie/Little River Reservoir system will require the construction of new intake, pumping, and transmission facilities.

Financial Cost Impact:	***Moderate***
Estimated Total Capital Cost ($ in millions):	**$22.6**
Estimated Unit Cost: ($M per mgd):	**$4.35**

The City would likely fund this project through the issuance of revenue bonds.

Environmental Impact:	***Low***

The direct impact of facility construction would be temporary and limited in extent. Impacts on Eno River stream flow would be minimized through compliance with the Eno River Water Management Operations Plan, to which Durham is a party, and which permits the City to withdraw up to 15 mgd from the Eno River during periods of higher flows. As discussed below, this option would increase the total volume of water transferred out of the Neuse River Basin. This option would not be required if Durham's future water supply needs are met through an increased Jordan Lake allocation.

Projected Interbasin Transfer First Year Online	***0.2***
Projected Interbasin Transfer in 2045	***3.5***
From Basin:	***Upper Neuse (10-1)***
To Basin:	***Haw (2-1)***

Durham has a grandfathered IBT capacity of to 45.4 mgd from the Neuse River Basin (10-1) to the Haw River Basin (2-1). Actual amounts transferred (maximum month) during the three most recent calendar years (2011-2013) have averaged 14.5 mgd, which is well within the grandfathered capacity. The Teer Quarry option would continue Durham's existing IBT configuration and increase existing transfers by approximately 0.2 mgd if implemented in 2020 and by 3.5 mgd in 2045, for a total IBT of 18.0 mgd during months of maximum transfer. Because these volumes are substantially less than Durham's 45.4 mgd grandfathered capacity, this option would require no further IBT certification.

Institutional Complexity	***Complex***

This project would likely require the following Federal and State regulatory permits: Letter of Map Revision (LOMR) or No-Impact (No-Rise) Certification from the Federal Emergency Management Agency (FEMA); Army Corps of Engineers Nationwide (or Individual) Section 404 Permit; North Carolina Section 401 Water Quality Certification; submittal of a Water System Management Plan to NC DENR's Public Water Supply Section; and re-classification of Teer Quarry to WS-IV/CA/NSW.

Political Complexity	***Not Complex***

The Teer Quarry option is not poltically complex. Durham's elected leaders are familiar with the quarry's value during drought shortages, and the project's compliance with the Eno River Capacity Use Agreement ensures that it will not degrade the desired flow regime of the Eno River.

Public Benefits	***None***

This project would not provide any public benefits other than its value as a water supply source.

Technical Complexity	***Not Complex***

This alternative is well within the practical range of existing utility engineering practices and procedures.

References/ Technical Reports/ Links:

Draft Teer Quarry Raw Water Storage and Pumping Facility (Supplemental Preliminary Engeering Report), Kimley-Horn and Associates, Inc., July 27, 2012; *Use of the Teer Quarry Supplemental Raw Water Storage Project*, Hazen and Sawyer Environmental Engineers & Scientists, November 2012; *Letter dated February 6, 2014* from Mr. Linwood Peele, Supervisor, Water Supply Planning Branch, NCDENR to Mr. Donald F. Greeley, Director, City of Durham Department of Water Management.

Source Name:	
Crabtree Creek & Triangle Quarry	
Utility:	
Cary	
Source Type:	***River Withdrawal with Quarry Storage***
Location - Latitude:	TBD
Longitude:	TBD
Available Supply/Estimated Yield [MGD]:	***10***
Additional Storage Volume [MG]:	4600
Subbasin:	***Neuse***
Water Quality Classification:	***C NSW***
Estimated in-service Year:	***2029***
Design and Construction Time [yrs]:	***13***
Timeliness Rating	***Acceptable***

Narrative Description:

Raw water would be pumped from Crabtree Creek, stored in Wake Stone Corporation Triangle Quarry (Figure 2), treated at a new WTP located nearby, and distributed through the existing water system. The quarry has the potential to provide up to 4.6 billion gallons of raw water storage at the projected final excavated volume. For this strategy, raw water would be withdrawn under operational guidelines based on thresholds for different withdrawal scenarios that could occur based on available flows in Crabtree Creek. • Water would be withdrawn only when flows in the creek are above approximately 17 mgd

• 30 mgd would be the maximum withdrawal capacity

• The difference between the daily water withdrawn and the daily demand would refill the quarry

• When the quarry reaches 100 percent storage capacity, the withdrawals from the creek would return to the amount of the average day demand

Based on these preliminary guidelines, an annual average safe yield of 10 mgd from Crabtree Creek is projected. During the summer peak demand months, up to 12 mgd could be provided from the quarry storage.

Financial Cost Impact:	***Moderate***
Estimated Total Cost (if applicable):	**62.7**
Estimated Unit Cost	**6270**

The primary costs for this alternative would include purchasing the quarry, building a new water treatment plant, and building a raw water intake and water line to the treatment plant. If the quarry mining operations are not complete when this strategy needs to be initiated, the total storage volume would be reduced and the Towns could have to purchase the remaining un-mined rock. This would add significant costs to this strategy effectively making this strategy more expensive with less water supply yield.

Environmental Impact:	***Moderate***

This alternative will have some environmental impact, especially on the flow in Crabtree Creek. A study of the flow impacts would be required, as a significantamount of flow might be diverted (up to 10 MGD), though only at times when flow is already high. See the Instutional Complexity section for an explanation of the environmental permit requirements.

Projected Interbasin Transfer	***None****
From Basin:	
To Basin:	

A study of the flow impacts of this source integrated with the wastewater discharge projections, and intended areas served would be needed to determine interbasin transfer impacts. If used by the Town of Cary, it is possible this source could ameliorate current interbasin transfer issues, as Cary does not currenlty have source in the Neuse basin, but has wastewater discharges there.

Institutional Complexity	***Very Complex***

An environmental document meeting the State Environmental Policy Act (SEPA) requirements would be necessary for this strategy. There are several key issues which could affect the feasibility of this alternative including:

• Potential direct impacts of the water withdrawal, including maintaining minimum instream flows to meet habitat and water quality requirements.

• Reclassification of the highly urbanized Crabtree Creek watershed to a water supply watershed that would involve not only Cary but potentially also portions of the Town of Morrisville, City of Raleigh, City of Durham, Wake County and Durham County jurisdictions. The reclassification would be contingent on the water quality of Crabtree Creek meeting water supply watershed water quality criteria.

• The Crabtree Creek watershed has a Superfund site in the headwater area.

Political Complexity	***Very Complex***

The reclassification of the watershed to a water supply watershed would affect development ability in several nearby jurisdictions, which could cause some political issues. In addition, the State of North Carolina has the first right of refusal for the quarry parcel when the mining is complete, so the state would have to agree to relinquish that right to the property.

Public Benefits	***Few***

The primary public benefit is the availability of water supply without having to impound a new reservoir. If the land around the reservoir is purchased, it could be put to other beneficial use.

Technical Complexity	***Complex***

This water supply storage option is currently an active quarry. The rate at which the stone is depleted will affect when the option can come online, how much storage would be available, and how expensive purchasing the quarry would be. A new treatment plant would also be required, and new raw water transfer piping and pumps would be needed both to fill the reservoir, and to send to the treatment plant. Additionally, the operating rules for filling the quarry will require some technical analysis.

References/ Technical Reports/ Links:

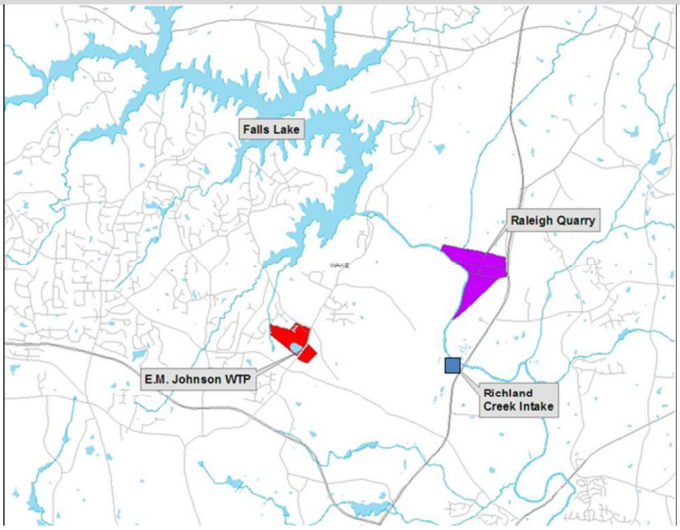
CH2M HILL and Brown and Caldwell. 2013. Long Range Water Resources Plan. Prepared for Towns of Cary, Apex and Morrisville, and Wake County. (Final Report available at http://www.townofcary.org/Departments/Public_Works_and_Utilities/Water/longrangeplan.htm)

CH2M HILL. 2007a. Integrated Water Resources Management Plan (IWRMP). Prepared for the Town of Cary.

SOURCE SUMMARY

Source Name:		
Raleigh Quarry Reservoir with Richland Creek Intake		
Utility:		
Raleigh		
Source Type:		***Quarry Reservoir***
Location -	**Latitude:**	35.928224
	Longitude:	-78.552425
Available Supply/Estimated Yield [MGD]:		***13.5 (8.9-15.4)***
Additional Storage Volume [MG]:		4000 (2700-8000)
Subbasin:		***Neuse***
Water Quality Classification:		***WS IV NSW CA***
Estimated in-service Year:		***2030***
Design and Construction Time [yrs]:		***15***
Timeliness Rating		Problematic

Narrative Description:



This source option would build a new intake on the Neuse River below Falls Lake at Richland Creek, which is upstream of the NRWWTP. A pump station would pump water from this location to the existing Raleigh Quarry, which currently has roughly 2.7BG of storage available. To make the option work as planned, the quarry should have been excavated to over 4BG by 2030. Then, a pump station at the quarry, and a new raw water line would bring water from the quarry reservoir to the EM Johnson WTP. In general, raw water would be conveyed from the quarry to the EM Johnson WTP at roughly 18.7 MGD, but only when the Falls Lake elevation fell below 251.5 MGD. The quarry would be filled when flow in the river exceeded targets at the intake location, which may require a transmission capacity of 50 MGD from the intake to the quarry.

Financial Cost Impact:	***High***
Estimated Total Cost (if applicable):	
Estimated Unit Cost	

This option is potentially very costly. The quarry would have to be condemned for it to be used as a reservoir, and the quarry owner would have to be paid for the land and remaining mineral rights. Furthermore, the benefit cost ratio is likely to be lowest the sooner the quarry is converted to a water storage facility. The longer the quarry is in service, the more storage will be available, and the less the mineral rights will be worth. There is an additional risk of legal challenges to condemning a quarry, especially in the near term. The pumping capacity needed both at the intake and the quarry and the raw water transfer lines are not insignificant costs.

Environmental Impact:	***Low***

The primary impact of this alternative is the removal of flow from the reach of the Neuse River between Richlands creek and the NRWWTP. Additionally, the recent listing of the Atlantic sturgeon as a federally protected species, known to inhabit the Neuse River, and the possible removal of the Milburnie Dam will add important new challenges to securing a Neuse River intake.

Projected Interbasin Transfer	***None***
From Basin:	Neuse
To Basin:	N/A

This source option does not involve an interbasin transfer.

Institutional Complexity	***Very Complex***

This option could be very complex from an institutional perspective. A 401 permit would likely be required for building the intake structure within the Neuse. The hydrologic impacts of removing up to 50 MGD from the river during high flow would have to be studied, as well as any potential impacts caused by filling the quarry with water. The impact on the downstream flow could complicate permitting expansion of the NRWWTP. The need to fill the quarry may require some additional releases from the Falls Lake conservation pool, which could impact lake levels and existing water quality in Falls Lake. Furthermore, the Atlantic sturgeon or other species could trigger some action under the Endangered Species Act.

Political Complexity	***Very Complex***

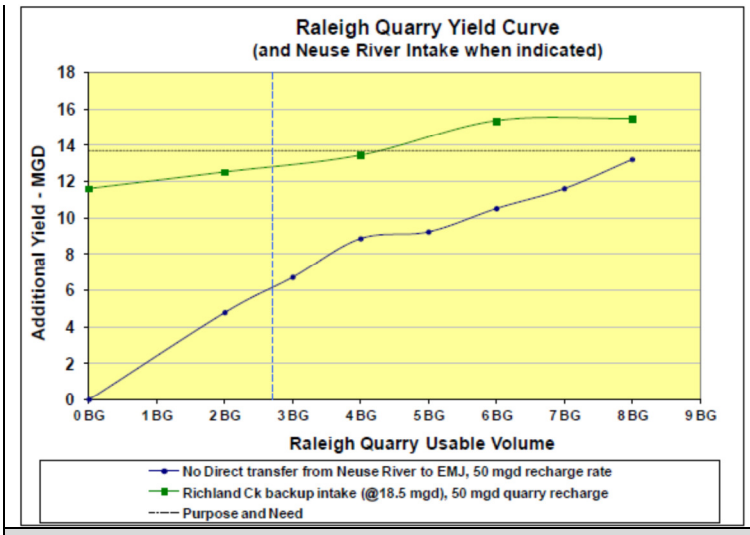
This option is politically complex, especially in terms of acquiring the quarry. The quarry is privately owned and many years away from exhausting its mineral resources. The owner has shown no interest in a voluntary sale, and damages from condemnation could include compensation for lost mining revenues (mineral rights). Acquiring the quarry may be possible many years from now through agreement, which would have the benefit of more storage being available. Acquiring the quarry sooner would be contentious, and potentially politically charged.

Public Benefits	***Few***

It is unlikely there will be signficant public benefits from this option. The quarry is close to the Upper Neuse River Greenway, so some educational signage could be created to explain the quarry reservoir system. It is unlikely the quarry reservoir could be used for recreation.

Technical/Timing/Other Considerations:	-

The largest technical and timing issue relates to the amount of quarry storage over time. The longer the quarry can operate, the more storage will be available in the quarry reservoir, and the lower the costs will be to acquire the quarry. As such, this option has some flexibility in the amount of storage available, and correspondingly, the amount of yield it can provide. The yield also depends on the pumping capacity and rules for pumping from the Neuse to the quarry. It is even possible to use the quarry reservoir without pumping from the Neuse, though the yield would be lower. The default assumption is that the quarry would have roughly 4 BG of storage, with up to 50 MGD of pumping at high flow, which would yield 13.5 MGD. As the size of the quarry (up to a max of 8 BG) and assumed pumping capacity varies, this source option's yield could vary between 8.9 and 15.4 MGD.



References/ Technical Reports/ Links:

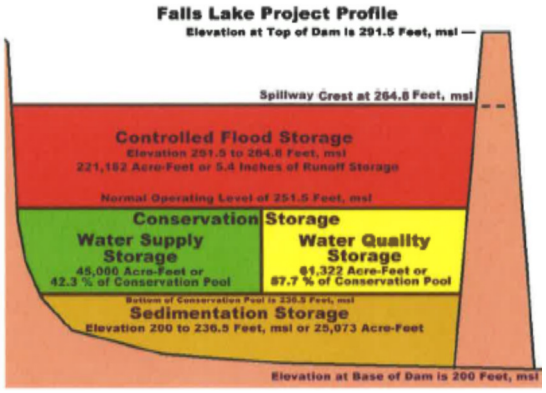
Summary of Water Supply Alternatives to the Little River Reservoir. Hazen & Sawyer. May 31, 2013. ¶
2012 City of Raleigh Water Resources Assessment and Plan. City of Raleigh, Sep 20 2012.

SOURCE SUMMARY

Source Name:	
Falls Lake - WQ Pool Reallocation	
Utility:	
Raleigh	
Source Type:	***Reservoir Reallocation***
Location - Latitude:	35.940968
Longitude:	-78.583522
Available Supply/Estimated Yield [MGD]:	***14***
Additional Storage Volume [MG]:	4100
Subbasin:	***Neuse***
Water Quality Classification:	***WS IV-NSW***
Estimated in-service Year:	***2025***
Design and Construction Time [yrs]:	***15***
Timeliness Rating	***Acceptable***

Narrative Description:

This option involves reallocating water storage from the Water Quality Pool to the Water Supply Pool in Falls Lake. The Water Quality Pool, unlike the sediment or flood storage pool, can be reallocated on a permanent basis. Using the OASIS Neuse River Basin model, it has been determined that 4.1 Billion gallons of storage could be transferred from the WQ to the WS pool without affecting the ability to meet the seasonal flow targets at the Neuse River at Clayton. This alternative would require very little in the way of infrastructure changes, as the withdrawal facilities are already present on Falls Lake.



Financial Cost Impact:	***Unknown***
Estimated Total Cost (if applicable):	**Unknown**
Estimated Unit Cost	**Unknown**

Costs for this option are unknown at this time. The City has petitioned the United States Army Corps of Engineers to undertake a study to establish costs. The City as agreed to full fund the costs of the study (estimated to be $500K). It does seem likely that new transmission and pumping facilities will be required to transport the reallocated water to the E.M. Johnson WTP, where facilities will have to be expanded to treat the new allocation.

Environmental Impact:	***High***

By moving water from the Water Quality Pool to Water Supply Pool, this alternative withdrawals more water from the lake, and reduces the amount that is available to augment downstream flow via dam releases. This alternative would likely reduce flow on the Neuse River's reach between the Falls Lake Dam and the NRWWTP discharge point. Below the discharge point, 90+% of the water withdrawn for water supply would be returned as wastewater discharge. The increased withdrawal from Falls Lake could, at some times of the year, reduce storage volume in Falls Lake and affect water quality and temperature.

Projected Interbasin Transfer	***None***
From Basin:	Neuse
To Basin:	

There is no Interbasin Transfer impact expected for this alternative.

Institutional Complexity	***Very Complex***

This alternative would certainly require a 216 study to be conducted by USACE to examine the reallocation of storage. The study would take 18 months, but would not require Congressional authorization. This alternative could have an impact on water quality in Falls Lake (due to changes in storage), and could impact compliance with the Falls Lake Nutrient Management Strategy. This alternative would decrease flows between the Falls Dam and NRWWTP, and could make permitting additional discharge at the NRWWTP difficult as the NRWTTP discharge becomes a larger component of Neuse River flow at 7Q10.

Political Complexity	***Very Complex***

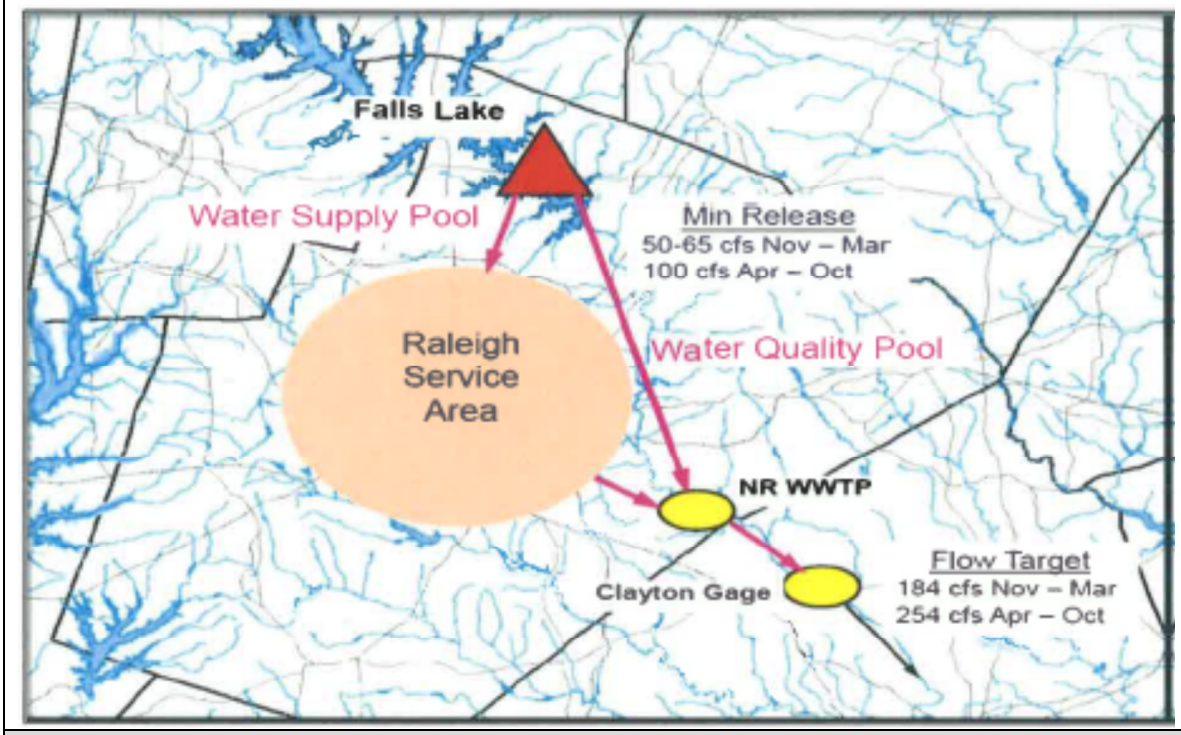
This is a complex alternative from a political perspective. The first issue would be successful coordination between CORPUD, the State (DWR), and USACE regarding reallocating storage from the Water Quality to Water Supply pool. Further, by changing the operation of the lake's conservation pool and removing more water from Falls Lake for water supply, there may be effects on the Falls Lake Nutrient strategy, which could negatively impact other local governments subject to the Falls Lake rules. Finally, there may be some concerns from downstream users of the Neuse River regarding lower releases from Falls Lake Dam and increased discharges from the NRWWTP.

Public Benefits	***Few***

It is unlikely there will be significant alternative public benefits from this option beyond the provision of a new water source for growing Wake County communities.

Technical Complexity	*Very Complex*

This alternative has an interesting technical consideration in that it removes water from Falls Lake in lieu of releasing it from the dam. However, the NRWWTP, several miles downstream of the dam, returns roughly 90% of the water that is removed from Falls Lake to the Neuse River.



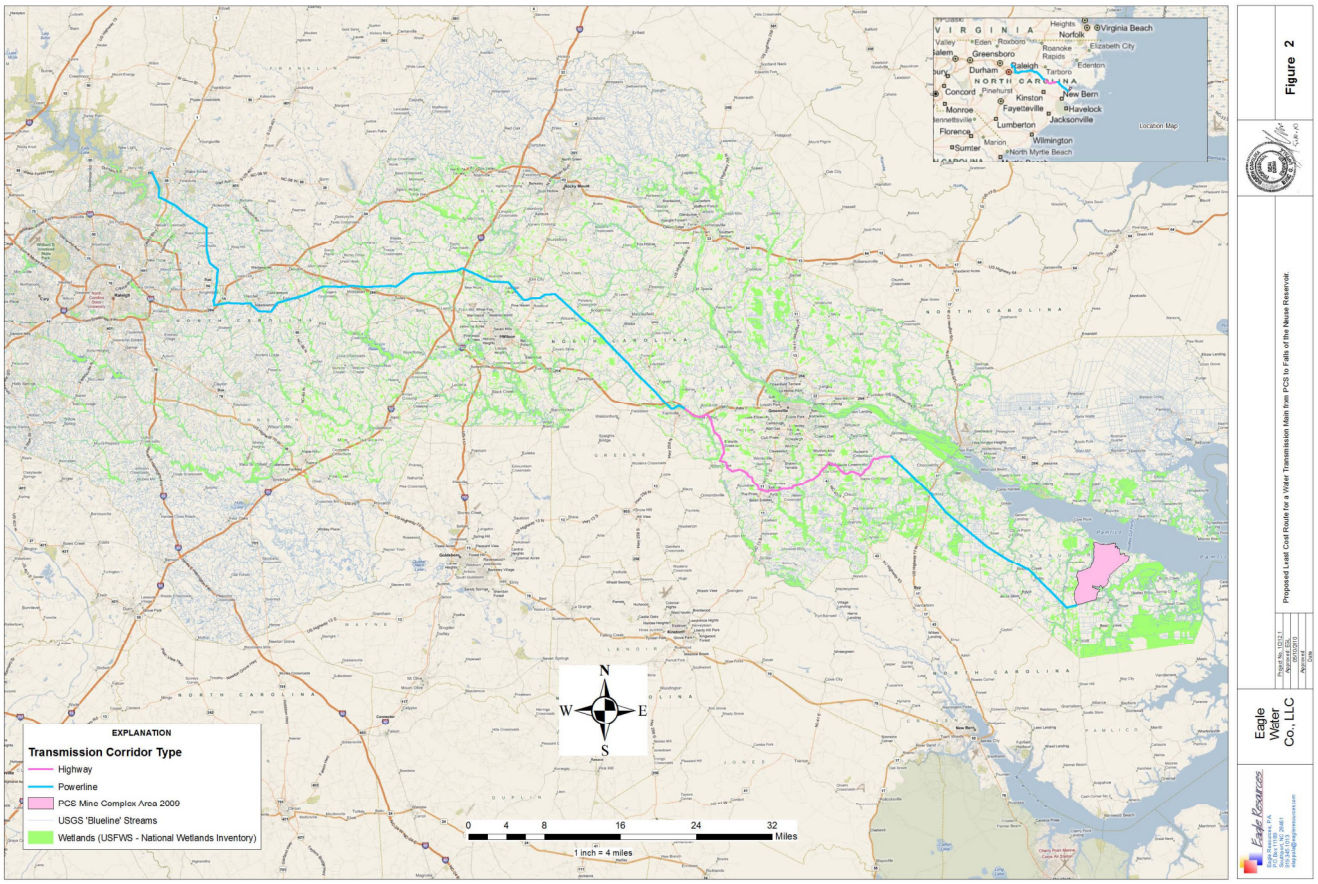
References/ Technical Reports/ Links:

Summary of Water Supply Alternatives to the Little River Reservoir. Hazen & Sawyer. May 31, 2013. ¶ 2012 City of Raleigh Water Resources Assessment and Plan. City of Raleigh, Sep 20 2012.

Source Name:	
Eagle Resources PCS Phosphate Mine	
Utility:	
Raleigh	
Source Type:	***Other (Raw Water Transfer)***
Location - Latitude:	35.336554
Longitude:	-76.808882
Available Supply/Estimated Yield [MGD]:	***50***
Additional Storage Volume [MG]:	N/A
Subbasin:	***Neuse***
Water Quality Classification:	***Unknown***
Estimated in-service Year:	***2025***
Design and Construction Time [yrs]:	***15***
Timeliness Rating	***Acceptable***

Narrative Description:

PCS Phosphate mine (PCS) pumps groundwater from the Castle Hayne aquifer to depressurize their mine floor for phosphate mining operations and the water is subsequently discharged into the brackish Pamlico River. Eagle Water has a 20-year, perpetually renewable contract with PCS phosphate to provide up to 58 million gallons per day (MGD) of the water produced from their Castle Hayne wells to public and/or private entities. The water would be pumped to Falls Lake through 132 miles of pipeline, 102 of which would be along existing power line rights-of-way. The transmission line would be either a single 48-inch HDPE pipeline or parallel 30-inch HDPE lines. Three pumping stations would be required along the recommended route to overcome the 240-foot elevation difference between the source at PCS and Falls Lake in Wake County as well as the frictional resistance of the transmission line(s). These stations would require a total of 40,000 horsepower for the two 30-inch lines and a total of 24,000 horsepower for the single 48-inch line.



Financial Cost Impact:	***High***
Estimated Total Cost (if applicable):	**$720 - $825**
Estimated Unit Cost	**$2.00 to $2.25**

The overall cost for this alternative could be in the range of $720 to $825 Million, depending on several factors, including whether or not the water is filtered before discharge to Falls Lake. The range of costs calculated using current interest rates and a 30-year recovery period to construct a pipeline system to deliver raw water to the Falls Lake range from $2.00 to $2.25 per 1000 gallons for a single 48-inch pipeline and dual 30-inch pipelines, respectively.

Environmental Impact:	***High***

This option would discharge up to 58 MGD of raw water into Falls Lake. In general, the water quality is good, but the impacts of moving that volume of water, and potential for chemical changes are yet to be determined. Based upon water sampling and analysis by PCS and Eagle, groundwater withdrawn from the Castle Hayne by the depressurization system meets primary drinking water standards. However because of the limestone and dolomite that comprise the rock matrix of the aquifer, hardness as CaCO3 ranges from approximately 100 mg/l to 325 mg/l. There is no health-based drinking water standard for hardness. There is potential for environmental benefit to Falls Lake and the Neuse River, as the water may enable higher downstream flows. The construction of the distribution line has its own environmental issues, as the 132 mile line would traverse 119 wetland areas, and 120 streams. The proposed plan envisions crossing all of these features by drilling underground tunnels for the pipeline.

Projected Interbasin Transfer	***None (Exempt)***
From Basin:	Tar-Pamlico
To Basin:	Neuse

There is no Interbasin Transfer impact expected for this alternative. Eagle's water source is located in the Tar-Pamlico surface water basin and the delivery point at Falls Lake is in the Neuse surface water basin. The water that Eagle Water is proposing to transport after withdrawal is excluded or exempted from the definition of "surface waters" contained in N.C. Gen. Stat. § 143-215.22G(2), since the water is "derived by pumping from groundwater." The regulation and certification requirements of N.C. Gen. Stat. § 143-215.22I apply only to "surface waters."

Institutional Complexity ***Very Complex***

There is some institutional complexity for this option. The transfer of this amount of water into Falls Lake would necessarily change the operation of Falls Lake, and at the least would require close coordination between Raleigh, USACE, and the State. The water quality impact of the discharge, and potential downstream impacts would likely need to be examined. Depending on how the pipeline is constructed, several types of review or permits could be necessary. An EIS may or may not be required, but some amount of review would be required especially where the pipeline would cross wetlands and streams. Furthermore, just by virtue of passing through so many towns and counties, there are potential local land issues to work out for the pipeline. Given the pipeline's path, additional coordination may be needed between the power company, Eagle Resources, and Raleigh.

Political Complexity ***Complex***

There is some political complexity to this source option. Notably, any project proposing a 130-mile pipeline will face some controversy over pipeline routes. This proposed source option seeks to mitigate many of those concerns by running the pipeline through the existing rights-of-way of power transmission lines, but there could still be issues with the route. Additionally, this option would move water upstream past a number of towns who may also have a need for water. There are potential issues that could arise between Eagle Resources, Raleigh, and other towns about the delivery of water to other towns along the way.

Public Benefits ***Few***

Because this option discharges into Falls Lake, it is possible that the additional water could be used to regulate levels on Falls Lake to maintain guide curve elevation more closely than in other alternatives. Fewer days with substantial lake drawdown would offer more opportunities for recreation on the lake, and potentially mitigate navigation risks associated with lower water levels.

Technical/Timing/Other Considerations:

Although Eagle's source water (with a relatively high-hardness) will not require softening if it is piped directly into Falls Lake, the estimated costs for a nano-filtration treatment plant located at the source have been included as a separate line item in the cost estimate tables.

References/ Technical Reports/ Links:

Eagle Water Company, 2010. *Summary Preliminary Engineering Report, Water Supply Source and Transmission System, Eagle Water Alternative for the City of Raleigh.* Prepared by Eagle Water Company, LLC. May 10 2010.
Eagle Water Company, 2013. "Eagle Water Company Introduction and Background." Letter to Warren Miller, Jordan Lake Partnership. Apr 9 2013.

SOURCE SUMMARY

Source Name:		
Reclaimed Water Initial Implementation		
Utility:		
Durham		
Source Type:		***Other***
Location -	**Latitude:**	***36.00***
	Longitude:	***-78.90***
Available Supply/Estimated Yield [MGD]:		***3.1***
Additional Storage Volume [MG]:		***0***
Subbasin:		***Upper Neuse***
Water Quality Classification:		***N/A***
Estimated in-service Year:		***2020***
Design and Construction Time [yrs]:		***5***
Timeliness Rating		***Acceptable***

Narrative Description:

Wastewater treated to non-potable reuse standards would be provided to four water reuse service areas to support an average day non-potable demand of 2.8 mgd (equivalent to 3.1 mgd of raw water) for commercial, industrial, and irrigation uses that would otherwise be met through potable drinking water. The project would require improvements at both of Durham's water reclamation facilities and construction of approximately 40 miles of new distribution pipelines ranging in size from 4 to 16 inches.

Financial Cost Impact:	***Moderate***
Estimated Total Capital Cost ($ in millions):	**$23.9**
Estimated Unit Cost: ($M per mgd):	**$7.80**

The City would likely fund this project through the issuance of revenue bonds.

Environmental Impact:	***Moderate***

The chief impacts of this project would be from the construction and installation of approximately 40 miles of new distribution pipeline within a highly developed urban environment. It is not known at this time how much, if any, disturbance would occur within environmentally sensitive areas, such as wetlands.

Projected Interbasin Transfer	***1.5***
From Basin:	***Upper Neuse (10-1)***
To Basin:	***Haw (2-1)***

Durham has a grandfathered IBT capacity of to 45.4 mgd from the Neuse River Basin (10-1) to the Haw River Basin (2-1). Actual amounts transferred (maximum month) during the three most recent calendar years (2011-2013) have averaged 14.5 mgd, which is well within the grandfathered capacity. Implementing the Initial Reclaimed Water option would continue Durham's existing IBT configuration and increase existing transfers by approximately 0.2 mgd if implemented in 2020 and by 2.1 mgd in 2045, for a total IBT of 16.6 mgd during months of maximum transfer. Because these volumes are substantially less than Durham's 45.4 mgd grandfathered capacity, this option would require no further IBT certification.

Institutional Complexity	***Complex***

This project would likely require the following State and Federal regulatory permits: NCDENR non-discharge permit; NCDENR reclaimed water permit for the South Durham Water Reclamation Facility (WRF); modifications to the existing permit at the North Durham WRF; U.S. Army Corps of Engineers Nationwide (or Individual) Section 404 Permit and North Carolina Section 401 Water Quality Certification for stream or wetland pipeline crossings; NCDOT permits or encroachment agreements for pipelines installed in DOT rights-of-way; NC Railroad Corporation permit for one or more pipeline crossings of the railroad right-of-way.

Political Complexity	***Very Complex***

Approximately 40 miles of pipeline would be installed, primarily within or adjacent to existing public rights of way, in a highly developed and urbanized environment over a period of about five years. This would likely disrupt vehicular traffic and impose substantial inconvenience on thousands of residents for the duration of the project. Widespread citizen complaints and opposition would be anticipated.

Public Benefits	***None***

This project would provide few, if any, additional public benefits other than an alternative water supply source to help meet future needs.

Technical Complexity:	***Very Complex***

This project is well within the range of standard engineering practices, but its complexity is compounded by the geographic scope of expected community disturbance.

References/ Technical Reports/ Links:

City of Durham Water Reuse Feasibility Study, McKim & Creed, Inc., October 2011; *Draft Technical Memorandum, City of Durham Water Resuse Alternative,* Secure Resources, PLLC, January 2014; *Letter dated February 6, 2014* from Mr. Linwood Peele, Supervisor, Water Supply Planning Branch, NCDENR to Mr. Donald F. Greeley, Director, City of Durham Department of Water Management.

SOURCE SUMMARY

Source Name:		
Aggressive reclaimed system (RCW)		
Utility:		
Durham		
Source Type:		***Other***
Location -	**Latitude:**	***36.00***
	Longitude:	***-78.90***
Available Supply/Estimated Yield [MGD]:		***10.5***
Additional Storage Volume [MG]:		***0***
Subbasin:		***Upper Neuse***
Water Quality Classification:		***N/A***
Estimated in-service Year:		***2030***
Design and Construction Time [yrs]:		***15***
Timeliness Rating		***Acceptable***

Narrative Description:

Wastewater treated to non-potable reuse standards would be provided to four reclaimed water pressure zones to support an average day non-potable (future) demand of 9.6 mgd (equivalent to 10.5 mgd of raw water demand) for commercial, industrial, and irrigation uses that would otherwise be met through potable drinking water. The project would require improvements at both of Durham's water reclamation facilities, construction of five elevated storage tanks, and approximately 80 miles of new distribution pipelines ranging in size from 4 to 16 inches.

Financial Cost Impact:	***High***
Estimated Total Capital Cost ($ in millions):	**$104.4**
Estimated Unit Cost: ($M per mgd):	**$9.93**

The City would likely fund this project through the issuance of revenue bonds.

Environmental Impact:	***Moderate***

The chief impacts of this project would be from the construction and installation of approximately 80 miles of new distribution pipeline within a highly developed urban environment. It is not known at this time how much, if any, disturbance would occur within environmentally sensitive areas, such as wetlands.

Projected Interbasin Transfer	***5.3***
From Basin:	
To Basin:	Haw

Durham has a grandfathered IBT capacity of to 45.4 mgd from the Neuse River Basin (10-1) to the Haw River Basin (2-1). Actual amounts transferred (maximum month) during the three most recent calendar years (2011-2013) have averaged 14.5 mgd, which is well within the grandfathered capacity. Implementing the Initial + Assertive Reclaimed Water options would continue Durham's existing IBT configuration and increase existing transfers by approximately 3.3 mgd if implemented in 2030 and by 7.0 mgd in 2045, for a total IBT of 21.5 mgd during months of maximum transfer. Because these volumes are substantially less than Durham's 45.4 mgd grandfathered capacity, this option would require no further IBT certification.

Institutional Complexity	***Complex***

This project would likely require the following State and Federal regulatory permits: NCDENR non-discharge permit; NCDENR reclaimed water permit for the South Durham Water Reclamation Facility (WRF); modifications to the existing permit at the North Durham WRF; Army Corps of Engineers Nationwide (or Individual) Section 404 Permit and North Carolina Section 401 Water Quality Certification for stream or wetland pipeline crossings; NCDOT permits or encroachment agreements for pipelines installed in DOT rights-of-way; NC Railroad Corporation permit for one or more pipeline crossings of the railroad right-of-way; FAA permit for one or more elevated storage tanks in southeast Durham in the vicinity of RDU International Airport.

Political Complexity	***Very Complex***

Approximately 80 miles of pipeline would be installed, primarily within or adjacent to existing public rights of way, in a highly developed and urbanized environment over a period of about 15 years. This would likely disrupt vehicular traffic and impose substantial inconvenience on thousands of residents for the duration of the project. Widespread citizen complaints and opposition would be anticipated.

Public Benefits	***None***

This project would provide few, if any, additional public benefits other than an alternative water supply source to help meet future needs.

Technical Complexity:	***Very Complex***

This project is well within the range of standard engineering practices, but its complexity is compounded by the geographic scope of expected community disturbance.

References/ Technical Reports/ Links:

City of Durham Water Reuse Feasibility Study, McKim & Creed, Inc., October 2011; *Draft Technical Memorandum, City of Durham Water Resuse Alternative*, Secure Resources, PLLC, January 2014: *Letter dated February 6, 2014* from Mr. Linwood Peele, Supervisor, Water Supply Planning Branch, NCDENR to Mr. Donald F. Greeley, Director, City of Durham Department of Water Management.

This page intentionally left blank.

Appendix D. Alternatives Summaries

This Appendix presents summaries for each of the potential regional water supply options the Jordan Lake Partners developed for meeting the future water supply needs of the Region. The decision making process is described in detail in Sections V-VIII of the Triangle Regional Water Supply Plan (TRWSP). The process included identifying the full breadth of potential individual sources, creating frameworks structured to meet specific high-level objectives, creating multiple combinations or collections of sources within each framework, determining water supply alternatives by establishing the timing of future sources, analyzing and screening alternatives, establishing preferences, choosing a preferred alternative, and modeling scenarios and evaluating impacts.

The summaries in this Appendix are the twelve collections of sources developed to meet 2060 needs as a Region. Each summary includes a table that shows the need and supply by Partner and a list showing the specific water supply sources by Partner that are included in that alternative. There is also a graphic representation of the sources. Finally, there is a brief write up for each alternative of the general characteristics, Partner specific notes, and concerns and issues to be worked out.

The name and numbering for several of these collections of sources have changed slightly between the time they were developed and the final version of the TRWSP. Table D1 below shows how the collections of sources in this appendix correspond to Table 13 in the TRWSP.

Table D1. Alternative summaries in Appendix D and the corresponding collection of sources from Table 13 in the TRWSP.

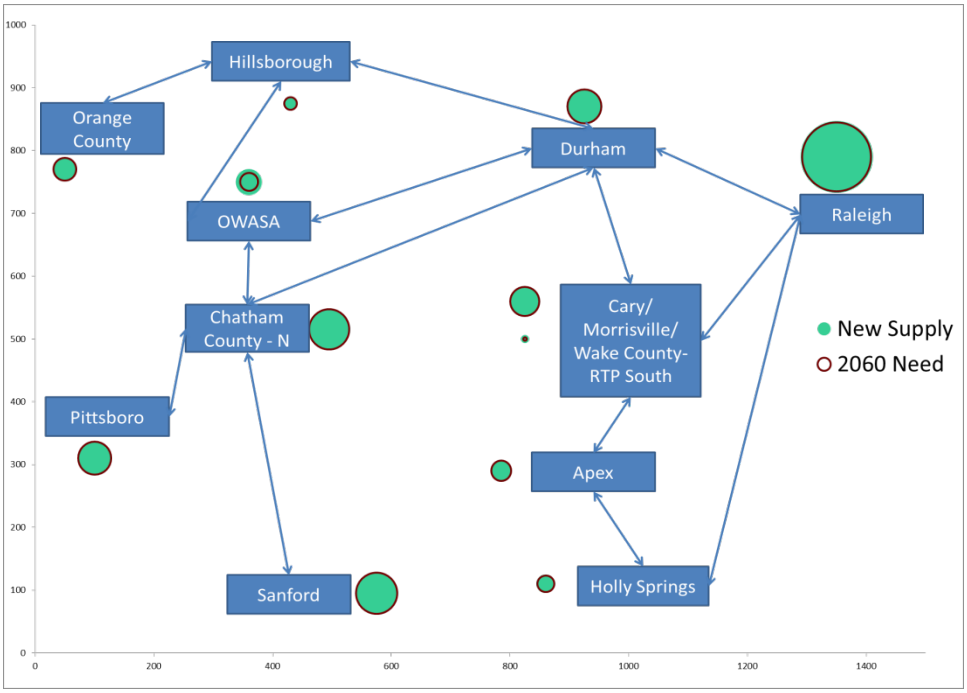
Collection of Sources from Table 13 in TRWSP	Corresponding Alternative Summary in Appendix D
A1 – Preferred Options	**A1** – Option A1
A2 – Alternate Choice Option	
B1 – No New Reservoirs	**B1** – No Little River Reservoir
B2 – Non-reservoir Sources	
B3 – Minimize new storage	**B3** – No New Reservoirs
C1 – Build New Sources	**C1** – Limit Jordan Lake
C2 – New Sources/Purchases	**C1b** – Limit Jordan Lake
C3 – Max. New Sources	**C2** – Limit Jordan Lake
D1 – Minimize New Sources	**A3** – Maximize Jordan Lake Usage
D2 – Min. New Neuse Sources	
D3 – Min. Number of Sources	
E1 – Self-Supply	**E1** – Every Partner for themselves
F1 – *Large New Sources* Pipeline from Phosphate Mine	**F1** – Mega-source option: PCS Phosphate pipeline
F2 – *Large New Sources* Kerr Lake Transfer	**F2** – Mega-source option: Kerr Lake
F3 – *Large New Sources* Quarries and Reclaimed	
F4 – *Large New Sources* Max. Upper Neuse 1	**F4 & F4b** – Mega-source option: Lake Michie expansion
F5 - *Large New Sources* Max. Upper Neuse 2	
H *- No Action*	

A.1	Option A1
Descrip-tion	Low-hanging fruit and Partners' most preferred options.

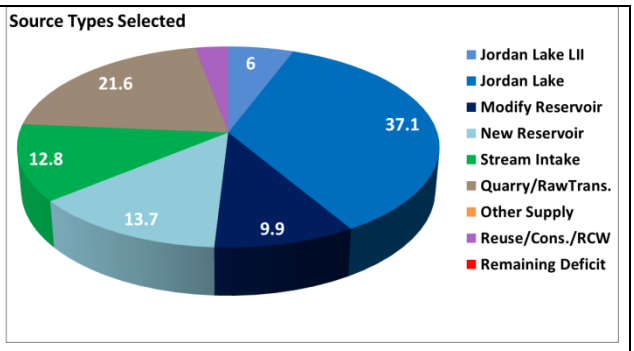
Partner	2060 Deficit	2060 New Source	Net	JL-New Lev. I	JL-2060 Tot
Apex	3.0	3	0.0	3	11
Cary	6.3	6.5	0.2	6.5	30
Morrisville	0.1	0.5	0.4	0.5	4
RTPSouth	-0.2	0	0.2	0	3.5
ChathamCoN	12.1	12.5	0.4	12.5	18.5
Durham	8.6	9	0.4	3	13
Hillsborough	1.1	1.2	0.1	0	0
Holly Springs	2.1	2.5	0.4	2.5	2.5
OrangeCo	3.9	4	0.1	3	4
OWASA	2.4	5.1	2.7	3	3
Pittsboro	8.0	8.1	0.1	8.1	8.1
Raleigh	35.4	38.9	3.5	0	0
Sanford	12.8	12.8	0.0	0	0
NonSpecific		0	0.0	0	
TOTAL	**95.7**	**104.1**	**8.4**	**42.1**	**98.1**

Sources Selected:

Apex	**3**
Jordan Lake Allocation	3
Cary	**6.5**
Jordan Lake Allocation	6.5
ChathamCo	**12.5**
Jordan Lake Allocation	12.5
Durham	**9**
Jordan Lake Allocation	3
Teer Quarry - Eno (low)	6
Hillsborough	**1.2**
WF Eno Reservoir Expansion	1.2
Holly Springs	**2.5**
Jordan Lake Allocation	0.5
Jordan Lake Level II (HS)	2
Morrisville	**0.5**
Jordan Lake Allocation	0.5
OrangeCo	**4**
Jordan Lake Allocation	3
Jordan Lake Level II (OC)	1
OWASA	**5.1**
Jordan Lake Level II (OWASA)	3
Expanded Quarry Reservoir (shallow)	2.1
Pittsboro	**8.1**
Jordan Lake Allocation	8.1
Raleigh	**38.9**
Little River Reservoir	13.7
Reclaimed Water (RCW) - Raleigh	3
Quarry 4 BG w/ Neuse R @ Richland	13.5
Falls Lake - Seasonal Norm Pool	8.7
Sanford	**12.8**
Expand Cape Fear Withdrawal	12.8



General Characteristics:



This alternative is focused generally on each system's most preferred mix of sources for meeting their future need. In general, this includes many of the low-hanging fruit sources, including already approved projects, and projects currently in some stage of planning.
Option A.2 is essentially identical to this option from a perspective of sources selected, but may be done with a different implementation. For example, a Western Intake may be built for Pittsboro and Chatham County only, while Orange County and Durham receive their JL allocation from the CAWTP.

Specific Partner Notes:

- Raleigh has a significant future need, and this alternative addresses this by building
  - Raleigh's construction of Little River Reservoir, but also
  - A large quarry option along with flow skimming from the Neuse to fill the quarry
  - Use of some Reclaimed Water, and
  - A reallocation of Falls Lake to raise the Normal Pool seasonally to allow more water in the conservation pool.
- Chatham County – N, Cary, Apex, Morrisville, RTP South all continue to rely entirely on Jordan Lake.
- Pittsboro abandons its current source and meets entire demand with Jordan Lake.
- Orange County activates its Level II allocation (converting to level I), and adds 3 MGD more from Jordan Lake. Will receive water through interlocal agreements.
- OWASA activates its Quarry option, and meets the small amount of remaining need through its Jordan Lake allocation. Its Level II allocation is converted to Level I, but reduced from 5 to 2.5 MGD. However, there is nearly enough remaining unallocated to reach 5 MGD if desired.
- Durham pursues its Teer Quarry option, and also increases its Jordan Lake allocation by 3 to 13 total.
- Hillsborough builds its W. Fork Eno River Reservoir Expansion currently being planned.
- Holly Springs converts its Level II JL allocation to Level I, plus a little bit more to meet its need. Holly Springs will most likely access its allocation through Apex.
- Sanford expands its Cape Fear withdrawal and treatment plant to meet its need.

Concerns and Issues to be worked out:

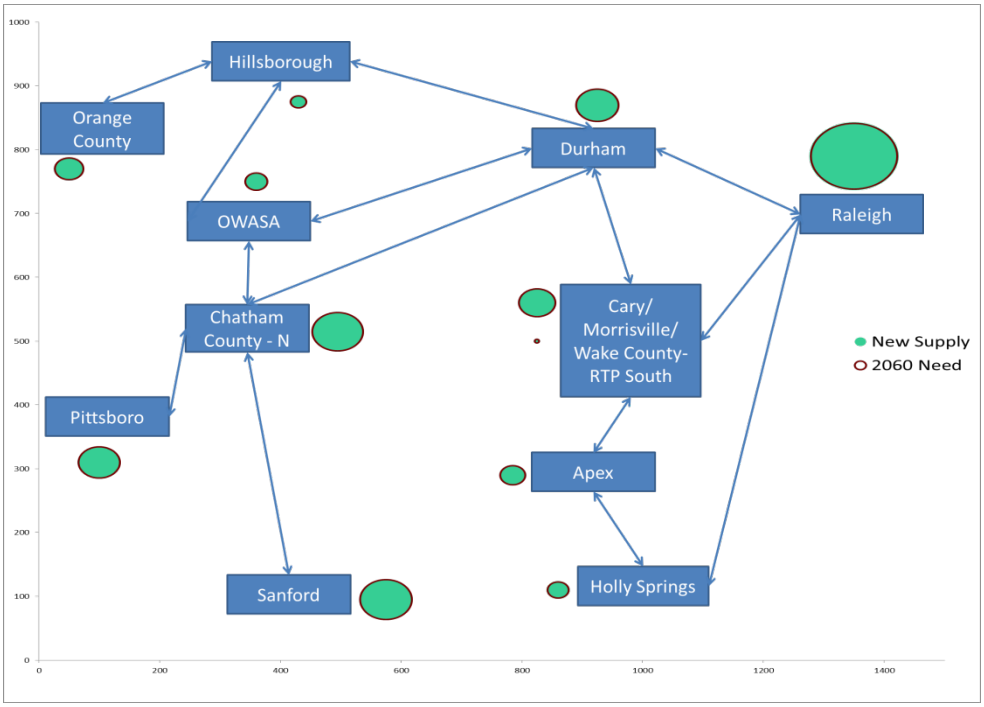
- Implementation of Jordan Lake Allocation delivery. This alternative relies significantly on Jordan Lake Allocations to meet future needs in many areas that are not currently served by Jordan Lake. Notably, Orange County, Pittsboro and Holly Springs all plan to use Jordan Lake water and do not do so currently. Transfers may be possible to get Jordan Lake water from the CAWTP to Holly Springs and to Orange County. Pittsboro presents a greater problem, which is compounded by the expanded need in Chatham County- North. Delivery of this Jordan Lake water will have to be considered. One possibility may be a Western Jordan Intake and new treatment plant to be jointly operated by Chatham County, Pittsboro, and/or OWASA, Orange County, Durham.
- Meeting Raleigh's demand will be difficult under any scenario.

A.3	Maximize Jordan Lake Usage
Descrip-tion	Meet as many partners' demands as possible with Jordan Lake and "easier" sources.

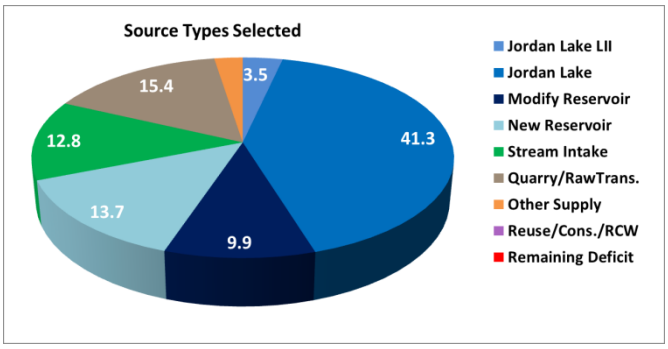
Partner	2060 Deficit	2060 New Source	Net	JL-New Lev. I	JL-2060 Tot
Apex	3.0	3	0.0	3	11
Cary	6.3	6.3	0.0	6.3	29.8
Morrisville	0.1	0.1	0.0	0.1	3.6
RTPSouth	-0.2	0	0.2	0	3.5
ChathamCoN	12.1	12.2	0.1	12.2	18.2
Durham	8.6	8.6	0.0	8.6	18.6
Hillsborough	1.1	1.2	0.1	0	0
Holly Springs	2.1	2.5	0.4	0	0
OrangeCo	3.9	4	0.1	3	4
OWASA	2.4	2.5	0.1	2.5	2.5
Pittsboro	8.0	8.1	0.1	8.1	8.1
Raleigh	35.4	37.8	2.4	0	0
Sanford	12.8	12.8	0.0	0	0
NonSpecific		0	0.0	0	
TOTAL	**95.7**	**99.1**	**3.4**	**43.8**	**99.8**

Sources Selected:

Apex	**3**
Jordan Lake Allocation	3
Cary	**6.3**
Jordan Lake Allocation	6.3
ChathamCo	**12.2**
Jordan Lake Allocation	12.2
Durham	**8.6**
Jordan Lake Allocation	8.6
Hillsborough	**1.2**
WF Eno Reservoir Expansion	1.2
Holly Springs	**2.5**
Purchase from Harnett	2.5
Morrisville	**0.1**
Jordan Lake Allocation	0.1
OrangeCo	**4**
Jordan Lake Allocation	3
Jordan Lake Level II (OC)	1
OWASA	**2.5**
Jordan Lake Level II (OWASA)	2.5
Pittsboro	**8.1**
Jordan Lake Allocation	8.1
Raleigh	**37.8**
Little River Reservoir	13.7
Quarry 8 BG w/ Neuse R @	15.4
Falls Lake - Seasonal Norm Pool	8.7
Sanford	**12.8**
Expand Cape Fear Withdrawal	12.8



General Characteristics:



This alternative seeks to optimize usage of Jordan Lake to meet the need for as many partners as possible and build fewer new sources. In general, this still includes many of the low-hanging fruit sources, including already approved projects, and projects currently in some stage of planning.
This option matches JL allocations fairly closely with actual needs to allow as much allocation as possible to meet other partners' needs.

Specific Partner Notes:

- Raleigh has a significant future need, and this alternative addresses this by building
  - Raleigh's construction of Little River Reservoir, but also
  - A large quarry option along with flow skimming from the Neuse to fill the quarry
  - Use of some Reclaimed Water, and
  - A reallocation of Falls Lake to raise the Normal Pool seasonally to allow more water in the conservation pool.
- Chatham County – N, Cary, Apex, Morrisville, RTP South all continue to rely entirely on Jordan Lake.
- Pittsboro abandons its current source and meets entire demand with Jordan Lake.
- Orange County activates its Level II allocation (converting to level I), and adds 3 MGD more from Jordan Lake. Will receive water through interlocal agreements.
- OWASA converts its allocation to Level I, but only at 2.5 MGD, sufficient to meet its need, but without additional back-up. The OWASA quarry is not built.
- Durham meets its full future need by an increased JL allocation of 8.6 MGD
- Hillsborough builds its W. Fork Eno River Reservoir Expansion currently being planned.
- Holly Springs abandons its JL allocation and expands its purchase contract with Harnett County.
- Sanford expands its Cape Fear withdrawal and treatment plant to meet its need.

Concerns and Issues to be worked out:

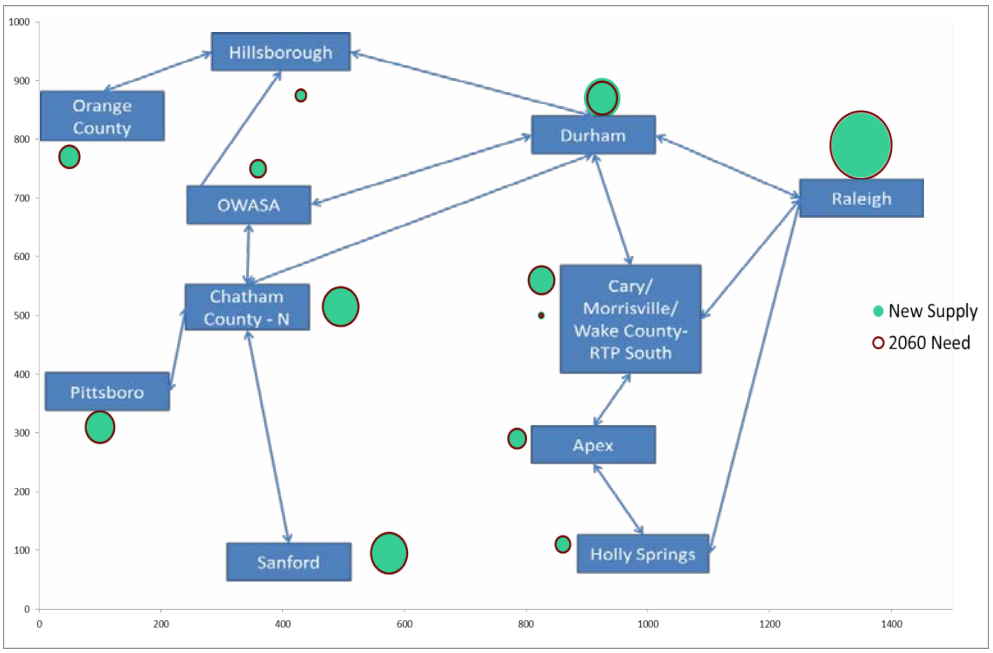
- Implementation of Jordan Lake Allocation delivery. This alternative relies significantly on Jordan Lake Allocations to meet future needs in many areas that are not currently served by Jordan Lake. Notably, Orange County, Pittsboro and Holly Springs all plan to use Jordan Lake water and do not do so currently. Transfers may be possible to get Jordan Lake water from the CAWTP to Holly Springs and to Orange County. Pittsboro presents a greater problem, which is compounded by the expanded need in Chatham County- North. Delivery of this Jordan Lake water will have to be considered. One possibility may be a Western Jordan Intake and new treatment plant to be jointly operated by Chatham County, Pittsboro, and/or OWASA, Orange County, Durham.
- OWASA may not be willing to abandon a portion of its JL allocation, and not have back-up.
- Holly Springs may not be willing to abandon its allocation.
- IBT issues may become more important.
- Downstream flow from Jordan Lake.
- Meeting Raleigh's demand will be difficult under any scenario.

B.1	No Little River Reservoir
Descrip-tion	Raleigh is unable to build Little River Reservoir. What sources can make up for the difference?

Partner	2060 Deficit	2060 New Source	Net	JL-New Lev. I	JL-2060 Tot
Apex	3.0	3	0.0	3	11
Cary	6.3	6.5	0.2	6.5	30
Morrisville	0.1	0.5	0.4	0.5	4
RTPSouth	-0.2	0	0.2	0	3.5
ChathamCoN	12.1	12.5	0.4	12.5	18.5
Durham	8.6	13	4.4	5	15
Hillsborough	1.1	1.2	0.1	0	0
Holly Springs	2.1	2.25	0.1	2.25	2.25
OrangeCo	3.9	4	0.1	3	4
OWASA	2.4	3	0.6	3	3
Pittsboro	8.0	8.1	0.1	8.1	8.1
Raleigh	35.4	32.1	-3.3	0	0
Sanford	12.8	12.8	0.0	0	0
NonSpecific		0	0.0	0	
TOTAL	**95.7**	**98.95**	**3.3**	**43.85**	**99.9**

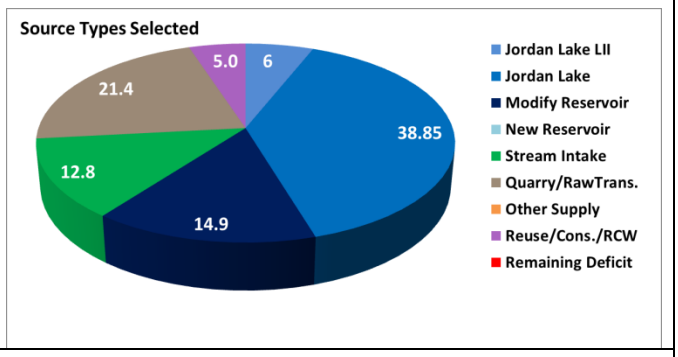
Sources Selected:

Apex	
Jordan Lake Allocation	3
Cary	
Jordan Lake Allocation	6.5
ChathamCo	
Jordan Lake Allocation	12.5
Durham	
Jordan Lake Allocation	5
Teer Quarry - Eno (low)	6
Moderate reclaimed system (RCW)	2
Hillsborough	
WF Eno Reservoir Expansion	1.2
Holly Springs	
Jordan Lake Level II (HS)	2
Jordan Lake Allocation	0.25
Morrisville	
Jordan Lake Allocation	0.5
OrangeCo	
Jordan Lake Level II (OC)	1
Jordan Lake Allocation	3
OWASA	
Jordan Lake Level II (OWASA)	3
Pittsboro	
Jordan Lake Allocation	8.1
Raleigh	
Reclaimed Water (RCW) - Raleigh	3
Quarry 8 BG w/ Neuse R @ Richland	15.4
Falls Lake - Sed. Pool Reallocation	13.7
Sanford	
Expand Cape Fear Withdrawal	12.8



General Characteristics:

This alternative assumes the Little River Reservoir can not be built. As a result, Raleigh must seek additional sources to meet its need. Since LRR only meets a portion of Raleigh's total need, Raleigh still builds several other sources, but comes up a bit short of its need, so it buys roughly 3.3 MGD from Durham.



Specific Partner Notes:

- Raleigh has a significant future need, and this alternative addresses this by building
  - A large quarry option along with flow skimming from the Neuse to fill the quarry
  - Use of some Reclaimed Water (3 MGD), and
  - A reallocation of Falls Lake to raise the Normal Pool seasonally to allow more water in the conservation pool.
  - AND buying 3.3 MGD from Durham.
- Durham meets 3.3 MGD of Raleigh's demand. To meet demand, Durham builds a mix of sources, including the smaller Teer Quarry option, increasing JL allocation by 5 MGD, and moderate RCW system.
- Chatham County – N, Cary, Apex, Morrisville, RTP South all continue to rely entirely on Jordan Lake.
- Pittsboro abandons its current source and meets entire demand with Jordan Lake.
- Orange County activates its Level II allocation (converting to level I), and adds 3 MGD more from Jordan Lake. Will receive water through interlocal agreements.
- OWASA activates its Level II allocation is converted to Level I for 3 MGD to meet need with a little bit of buffer. Alternatively, building the quarry is still an option.
- Hillsborough builds its W. Fork Eno River Reservoir Expansion currently being planned.
- Holly Springs converts its Level II JL allocation to Level I, plus a little bit more to meet its need. Holly Springs will most likely access its allocation through Apex.
- Sanford expands its Cape Fear withdrawal and treatment plant to meet its need.

Concerns and Issues to be worked out:

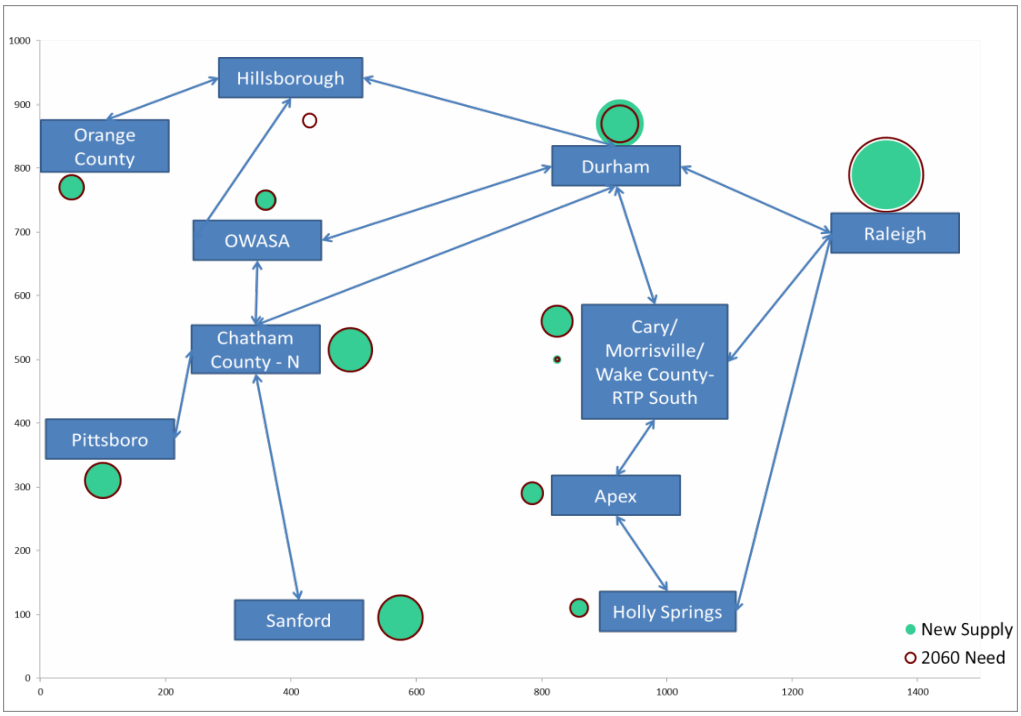
- Is Raleigh comfortable buying water from Durham, even if only a few MGD?
- Can the Falls Lake Sediment pool reallocation provide 13.7 MGD?
- Could RCW be a larger portion of the regional strategy, especially in Raleigh? Is a 6.3 MGD system that would provide independence feasible? Preferable to purchasing from Durham?
- Implementation of JL options needs to be determined. (Western Intake, etc.)
- Is Jordan Lake too close to maximum allocation?

B.3	No New Reservoirs
Description	Meet need without building major new reservoirs or storage.

Partner	2060 Deficit	2060 New Source	Net	JL-New Lev. I	JL-2060 Tot
Apex	3.0	3	0.0	3	11
Cary	6.3	6.5	0.2	6.5	30
Morrisville	0.1	0.5	0.4	0.5	4
RTPSouth	-0.2	0	0.2	0	3.5
ChathamCoN	12.1	12.5	0.4	12.5	18.5
Durham	8.6	15	6.4	5	15
Hillsborough	1.1	0	-1.1	0	0
Holly Springs	2.1	2.25	0.1	2.25	2.25
OrangeCo	3.9	4	0.1	3	4
OWASA	2.4	3	0.6	3	3
Pittsboro	8.0	8.1	0.1	8.1	8.1
Raleigh	35.4	30.4	-5.0	0	0
Sanford	12.8	12.8	0.0	0	0
NonSpecific		0	0.0	0	
TOTAL	**95.7**	**98.05**	2.4	**43.85**	**99.9**

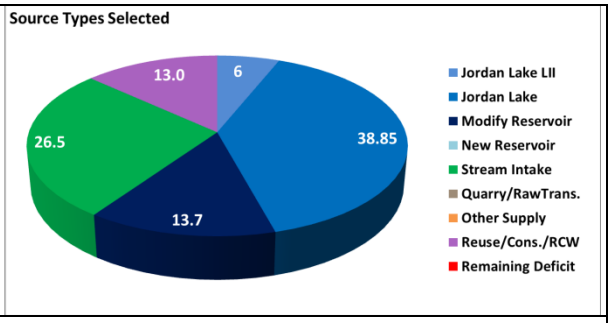
Sources Selected:

Apex	**3**
Jordan Lake Allocation	3
Cary	**6.5**
Jordan Lake Allocation	6.5
ChathamCo	**12.5**
Jordan Lake Allocation	12.5
Durham	**15**
Jordan Lake Allocation	5
Aggressive reclaimed system (RCW)	10
Holly Springs	**2.25**
Jordan Lake Level II (HS)	2
Jordan Lake Allocation	0.25
Morrisville	**0.5**
Jordan Lake Allocation	0.5
OrangeCo	**4**
Jordan Lake Level II (OC)	1
Jordan Lake Allocation	3
OWASA	**3**
Jordan Lake Level II (OWASA)	3
Pittsboro	**8.1**
Jordan Lake Allocation	8.1
Raleigh	**30.4**
Reclaimed Water (RCW) - Raleigh	3
Falls Lake - Sed. Pool Reallocation	13.7
Neuse River Intake above NRWWTP	13.7
Sanford	**12.8**
Expand Cape Fear Withdrawal	12.8



General Characteristics:

This alternative assumes that essentially no new major storage can be built. As a result, the region relies heavily on Jordan Lake and reclaimed water. Durham builds an aggressive RCW system and supplies Hillsborough's need, as well as part of Raleigh's need.



Specific Partner Notes:

- Durham does not expand its lakes or build any quarry options. Durham increases its Jordan Lake allocation by 5 MGD and builds an aggressive RCW for 10 MGD, giving Durham a surplus of over 6 MGD. This surplus is used to supply needs in Hillsborough (~ 1 MGD), and Raleigh (~ 5 MGD).
- Hillsborough does not build its reservoir expansion, and instead buys water from Durham to meet its future need. Hillsborough could also build an RCW system that would reduce the size of system built in Durham.
- Raleigh does not build its LRR or quarry options. Instead, Raleigh builds the options below, which do not meet the entire need, so ~ 5 MGD are purchased from Durham.
    - A reallocation of the Falls Lake sediment pool sufficient to get 13. 7 MGD
    - Use of some Reclaimed Water (3 MGD), and
    - A new Neuse River intake above the NRWWTP
    - AND buying 5 MGD from Durham.
- Chatham County – N, Cary, Apex, Morrisville, RTP South all continue to rely entirely on Jordan Lake.
- Pittsboro abandons its current source and meets entire demand with Jordan Lake.
- Orange County activates its Level II allocation (converting to level I), and adds 3 MGD more from Jordan Lake. Will receive water through interlocal agreements.
- OWASA activates its Level II allocation is converted to Level I for 3 MGD to meet need with a little bit of buffer. OWASA does not build the quarry option.
- Holly Springs converts its Level II JL allocation to Level I, plus a little bit more to meet its need. Holly Springs will most likely access its allocation through Apex.
- Sanford expands its Cape Fear withdrawal and treatment plant to meet its need.

Concerns and Issues to be worked out:

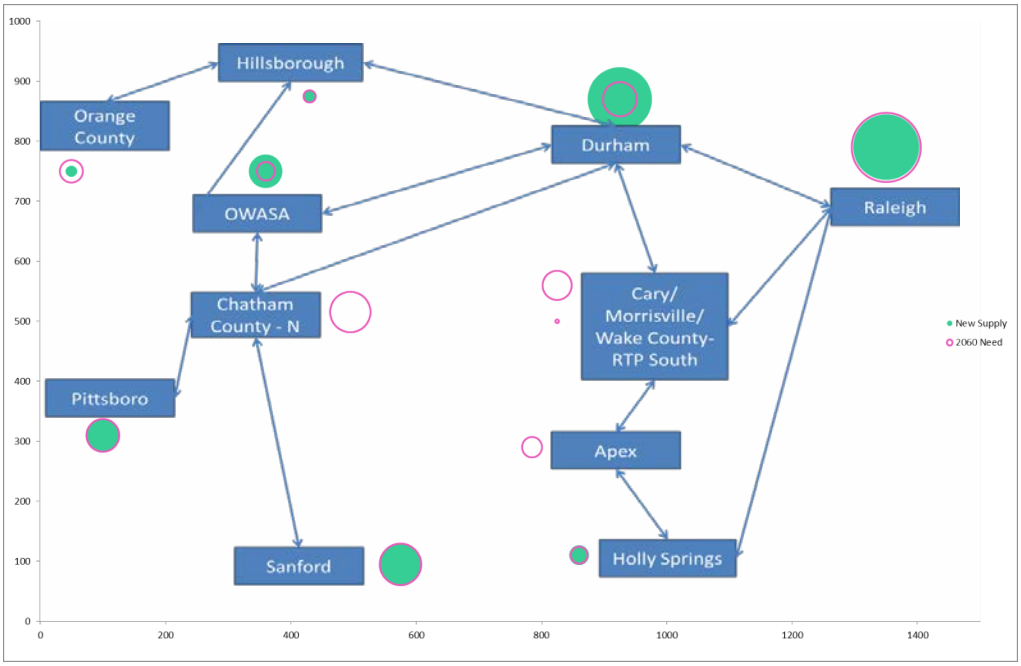
- Is Raleigh comfortable buying water from Durham, even if only a few MGD?
- The Falls Lake sediment pool reallocation will require a 216 study and major impact assessment
- Can the Falls Lake Sediment pool reallocation provide 13.7 MGD?
- Could RCW be more balanced around the region? Is a 10 MGD system in Durham feasible? Would it be more or less feasible for Raleigh/Hillsborough/others to build RCW systems (or enlarge them) such that Durham's system could be smaller? Or, by economies of scale, is it better for Durham to make a larger RCW system?
- Implementation of JL options needs to be determined. (Western Intake, etc.)
- Is Jordan Lake too close to maximum allocation?

C.1	Limit Jordan Lake
Description	Meet need without increasing Jordan Lake Allocations. (Level II may be converted to Level I).

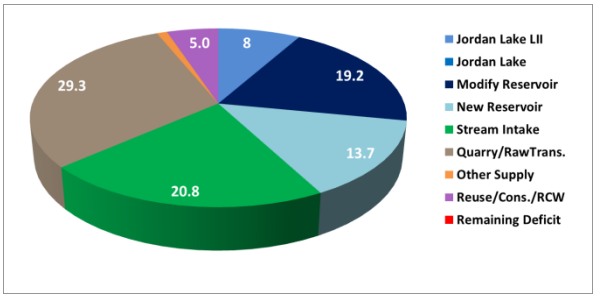
Partner	2060 Deficit	2060 New Source	Net	JL-New Lev. I	JL-2060 Tot
Apex	3.0	0	-3.0	0	8
Cary	6.3	0	-6.3	0	23.5
Morrisville	0.1	0	-0.1	0	3.5
RTPSouth	-0.2	0	0.2	0	3.5
ChathamCoN	12.1	0	-12.1	0	6
Durham	8.6	30.5	21.9	0	10
Hillsborough	1.1	1.2	0.1	0	0
Holly Springs	2.1	3	0.9	2	2
OrangeCo	3.9	1	-2.9	1	1
OWASA	2.4	8.4	6.0	5	5
Pittsboro	8.0	8	0.0	0	0
Raleigh	35.4	32.1	-3.3	0	0
Sanford	12.8	12.8	0.0	0	0
NonSpecific		0	0.0	0	
TOTAL	**95.7**	**97**	**1.3**	**8**	**63**

Sources Selected:

Durham	**30.5**
Teer Quarry-E,LR,LM online high	10.5
Raise Lake Michie to 365'	18
Moderate reclaimed system (RCW)	2
Hillsborough	**1.2**
WF Eno Reservoir Expansion	1.2
Holly Springs	**3**
Jordan Lake Level II (HS)	2
Purchase from Harnett	1
OrangeCo	**1**
Jordan Lake Level II (OC)	1
OWASA	**8.4**
Expanded Quarry Reservoir (deep)	3.4
Jordan Lake Level II (OWASA)	5
Pittsboro	**8**
Haw River Existing Intake (Keep)	2
Haw River Withdrawal Expansion	6
Raleigh	**32.1**
Little River Reservoir	13.7
Quarry 8 BG w/ Neuse R @ Richland	15.4
Reclaimed Water (RCW) - Raleigh	3
Sanford	**12.8**
Expand Cape Fear Withdrawal	12.8
Apex	
Cary	
Morrisville	
RTP South	



General Characteristics:



This alternative assumes a limitation on the future usage of Jordan Lake to see what other options would have to be pursued. Level II allocation may be upgraded to Level I, but no new Level I allocations are used.

In general, OWASA and Durham build sources and become suppliers for many partners that would rely on Jordan Lake (Cary et al., Apex, Chatham, Orange County). Pittsboro would have to be self reliant, as it would be impractical for OWASA/Durham to meet their needs in addition to the needs of the closer partners.

Specific Partner Notes:

- Durham builds its large Teer Quarry option, and builds the smaller Lake Michie expansion, as well as building a moderate RCW system. This allows Durham to have a 21.9 MGD surplus. Of this surplus,
    - 9.4 (6.3+0.1+3) goes to Cary/Morrisville and Apex.
    - 3.3 goes to Raleigh.
    - ~ 9 MGD goes to Chatham County and Orange County in some combination.
- OWASA becomes the other supply center in the region by virtue of its JL allocation that is upgraded to Level I. In addition, OWASA builds its deep quarry option. In total OWASA has a surplus of 6.0. OWASA uses this surplus to supply ~ 6 MGD to Orange County and Chatham County in some combination. It is unclear how the allocation is accessed. A new western intake may still make sense.
- Raleigh has a significant future need, and this alternative addresses this by building
    - A large quarry option along with flow skimming from the Neuse to fill the quarry
    - Use of some Reclaimed Water (3 MGD), and
    - The Little River Reservoir option
    - AND buying 3.3 MGD from Durham.
- Cary, Apex, Morrisville, RTP South keep current treatment plant, but rely on Durham for supply of future need. They may be effectively purchasing Durham's existing allocation, and treating JL water at the CAWTP instead of importing water from Durham.
- Pittsboro must continue to use the Haw River as a source. This requires major dam repairs at the existing source, in addition to work necessary to expand the source, plus a new treatment plant.
- Orange County activates its Level II allocation (converting to level I). In addition, 3 MGD are supplied in some combination by OWASA and Durham.
- Chatham County is forced to rely on OWASA and Durham to meet its significant 12 MGD need. It is unclear how the need will be broken down, but most likely, ~ 2/3 of need (8-9 MGD) will be provided by Durham, and the rest by OWASA.
- Hillsborough builds its W. Fork Eno River Reservoir Expansion currently being planned.
- Holly Springs converts its Level II JL allocation to Level I, plus must increase its purchase from Harnett slightly. It is assumed the allocation will be accessed through Apex.
- Sanford expands its Cape Fear withdrawal and treatment plant to meet its need.

Concerns and Issues to be worked out:

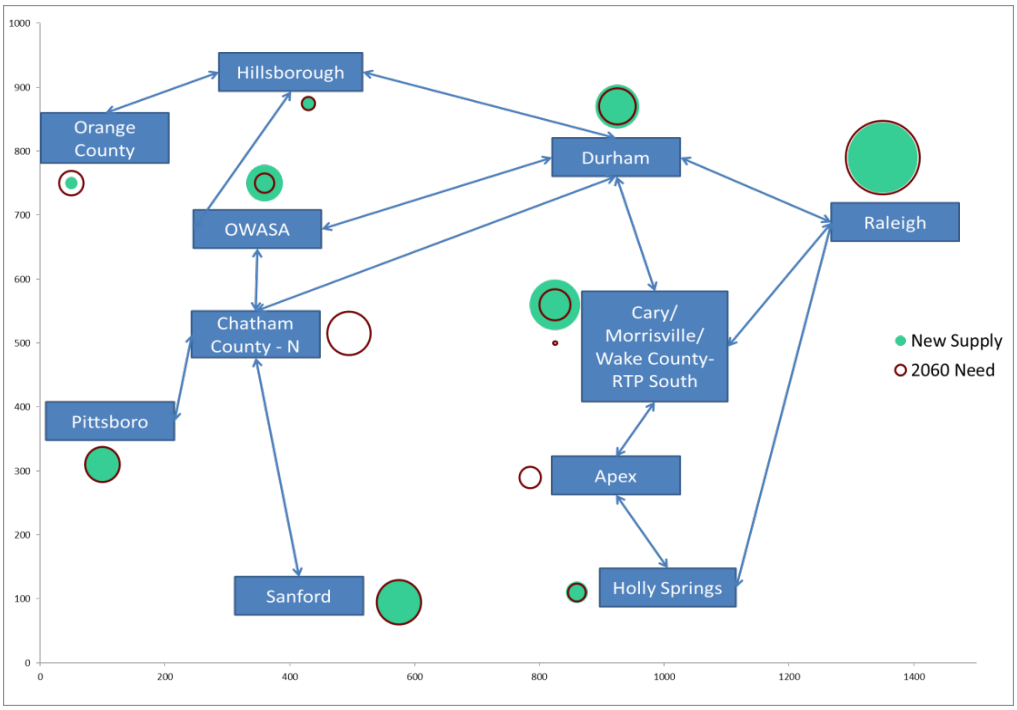
- The limitation of Jordan Lake leads to some bizarre scenarios in which utilities most able to access the lake are purchasing water from utilities whose own Jordan Lake allocations are accessed by purchasing water from the utilities they would now be selling to.
- The implementations of the scenario could be complex. It is unclear how OWASA, Orange County, and Holly Springs (as well as Durham) would access their allocation. A new western intake may still be an option, and could include the ability to treat the existing Level I allocations of Chatham (6 MGD) and Durham (up to 10 MGD), and also the upgraded OWASA (5 MGD)and Orange County (1 MGD) allocations. Alternatively, the CAWTP plant gets expanded, and many of tranfers of JL allocation become paper exercises.
- Does the construction of Durham's alternatives reduce the yield of Falls Lake? Furthermore, do Raleigh's needs reduce downstream flow too much?
-

C.1b	Limit Jordan Lake
Description	Meet need without increasing Jordan Lake Allocations. (Level II may be converted to Level I). Less sharing than C1.

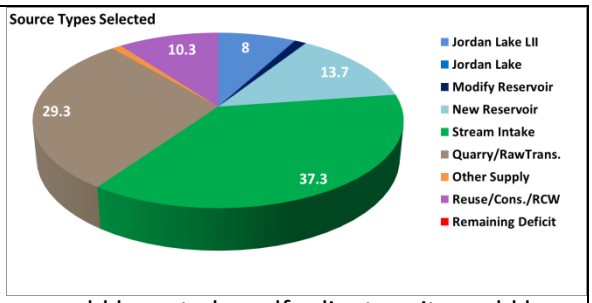
Partner	2060 Deficit	2060 New Source	Net	JL-New Lev. I	JL-2060 Tot
Apex	3.0	0	-3.0	0	8
Cary	6.3	16.5	10.2	0	23.5
Morrisville	0.1	0	-0.1	0	3.5
RTPSouth	-0.2	0	0.2	0	3.5
ChathamCoN	12.1	0	-12.1	0	6
Durham	8.6	12.5	3.9	0	10
Hillsborough	1.1	1.2	0.1	0	0
Holly Springs	2.1	3	0.9	2	2
OrangeCo	3.9	1	-2.9	1	1
OWASA	2.4	8.7	6.3	5	5
Pittsboro	8.0	8	0.0	0	0
Raleigh	35.4	32.1	-3.3	0	0
Sanford	12.8	12.8	0.0	0	0
NonSpecific		5	5.0	0	
TOTAL	**95.7**	**100.8**	5.1	8	**63**

Sources Selected:

Cary	
Cape Fear River @ Harnett Co.	16.5
Durham	
Teer Quarry-E,LR,LM online high	10.5
Moderate reclaimed system (RCW)	2
Hillsborough	
WF Eno Reservoir Expansion	1.2
Holly Springs	
Jordan Lake Level II (HS)	2
Purchase from Harnett	1
OrangeCo	
Jordan Lake Level II (OC)	1
OWASA	
Expanded Quarry Reservoir (deep)	3.4
Jordan Lake Level II (OWASA)	5
Reclaimed Water Expansion (RCW)	0.3
Pittsboro	
Haw River Existing Intake (Keep)	2
Haw River Withdrawal Expansion	6
Raleigh	
Little River Reservoir	13.7
Quarry 8 BG w/ Neuse R @ Richland	15.4
Reclaimed Water (RCW) - Raleigh	3
Sanford	
Expand Cape Fear Withdrawal	12.8
NonSpecific	
Reclaimed Water (RCW)	5



General Characteristics:



This alternative assumes a limitation on the future usage of Jordan Lake to see what other options would have to be pursued. Level II allocation may be upgraded to Level I, but no new Level I allocations are used.

In general, OWASA, Durham, and Cary build sources and become suppliers for some nearby partners. Pittsboro would have to be self reliant, as it would be impractical for OWASA/Durham/Cary to meet their needs in addition to the needs of the closer partners. Cary/Morrisville/Apex seek out other sources, and build a new run-of-river source on the Cape Fear.

Specific Partner Notes:

- Durham builds its large Teer Quarry option, and a moderate RCW system.(No L. Michie expansion) This allows Durham to have a 3.9 MGD surplus. Depending on implementation, this water could go to Orange County, Raleigh, or Chatham County, or a combination.
- OWASA upgrades its 5 MGD Level II allocation to Level I. In addition, OWASA builds its deep quarry option, and expands its RCW. In total OWASA has a surplus of 6.3. OWASA uses this surplus to supply ~ 6 MGD to Orange County and Chatham County in some combination. It is unclear how the allocation is accessed. A new western intake may still make sense.
- Cary (in partnership with Apex) builds a run-of-river source on the Cape Fear River, likely in Harnett county. This source meets need for Cary/Morrisville and Apex, and has 10 MGD left over. Some of this supply will likely have to be used to meet Chatham County demand, and could be used to supply some of Raleigh's need if Durham doesn't.
- Raleigh has a significant future need, and this alternative addresses this by building
    - A large quarry option along with flow skimming from the Neuse to fill the quarry
    - Use of some Reclaimed Water (3 MGD), and
    - The Little River Reservoir option
    - AND buying 3.3 MGD from Durham OR Cary.
- Pittsboro must continue to use the Haw River as a source. This requires major dam repairs at the existing source, in addition to work necessary to expand the source, plus a new treatment plant.
- Orange County activates its Level II allocation (converting to level I). In addition, 3 MGD are supplied in some combination by OWASA and Durham.
- Chatham County is forced to rely on OWASA, Cary, and/or Durham to meet its significant 12 MGD need. It is unclear how the need will be broken down, but most likely much of the need will be provided by Cary, with the rest provided by OWASA and Durham in some combination.
- Hillsborough builds its W. Fork Eno River Reservoir Expansion currently being planned.
- Holly Springs converts its Level II JL allocation to Level I, plus must increase its purchase from Harnett slightly. It is assumed the allocation will be accessed through Apex.
- Sanford expands its Cape Fear withdrawal and treatment plant to meet its need.
- 5 MGD non-specific RCW supply added to give regional flexibility for implementations, but it could be removed.

Concerns and Issues to be worked out:

- The limitation of Jordan Lake leads to some bizarre scenarios in which utilities most able to

access the lake are purchasing water from utilities whose own Jordan Lake allocations are accessed by purchasing water from the utilities they would now be selling to.

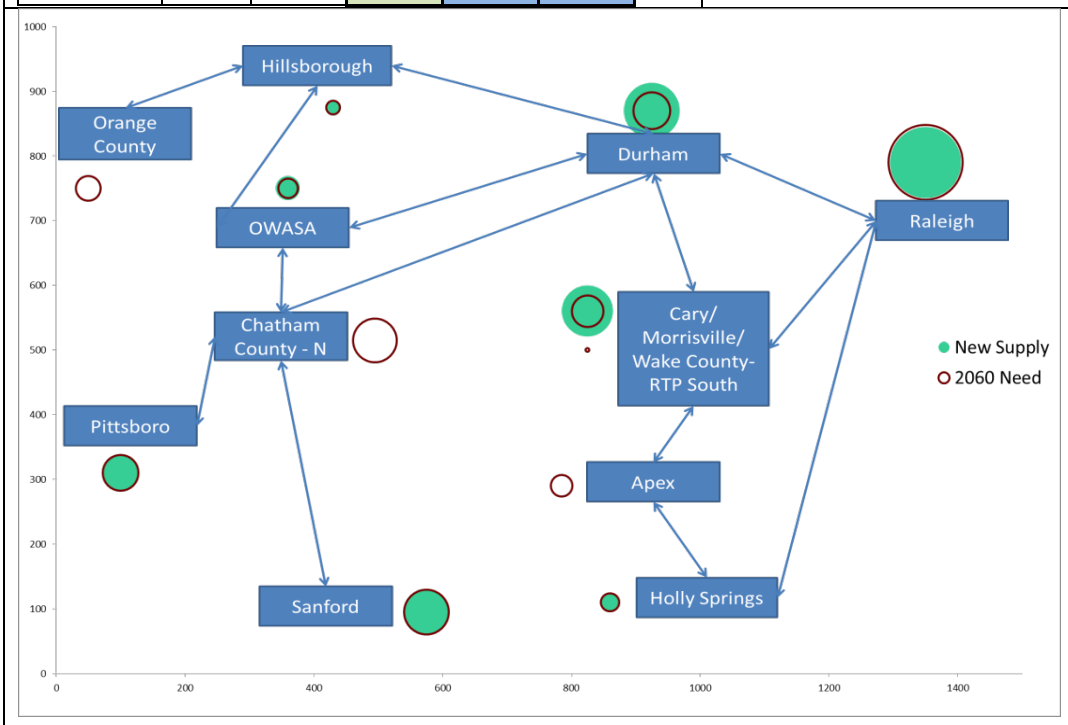
- The implementations of the scenario could be complex. It is unclear how OWASA, Orange County, and Holly Springs (as well as Durham) would access their allocation. A new western intake may still be an option, and could include the ability to treat the existing Level I allocations of Chatham (6 MGD) and Durham (up to 10 MGD), and also the upgraded OWASA (5 MGD)and Orange County (1 MGD) allocations.
- More implementation issues: Cary/Apex now supplying water to Chatham County and Holly Springs (via allocation). Paper transfers may make more sense for some of the allocations. The new Cary source on the Cape Fear may in effect supply much of Apex and Holly Springs (which would basically receive JL water on paper only). Cary/Morrisville could be supplied by CAWTP, along with some part of Chatham County, and/or Raleigh.
-

C.2	Limit Jordan Lake
Description	Meet need without increasing Jordan Lake Allocations at all.

Partner	2060 Deficit	2060 New Source	Net	JL-New Lev. I	JL-2060 Tot
Apex	3.0	0	-3.0	0	8
Cary	6.3	16.5	10.2	0	23.5
Morrisville	0.1	0	-0.1	0	3.5
RTPSouth	-0.2	0	0.2	0	3.5
ChathamCoN	12.1	0	-12.1	0	6
Durham	8.6	20	11.4	0	10
Hillsborough	1.1	1.2	0.1	0	0
Holly Springs	2.1	2.1	0.0	0	0
OrangeCo	3.9	0	-3.9	0	0
OWASA	2.4	3.7	1.3	0	0
Pittsboro	8.0	8.1	0.1	0	0
Raleigh	35.4	32.1	-3.3	0	0
Sanford	12.8	12.8	0.0	0	0
NonSpecific		0	0.0	0	
TOTAL	**95.7**	**96.5**	**0.8**	**0**	**55**

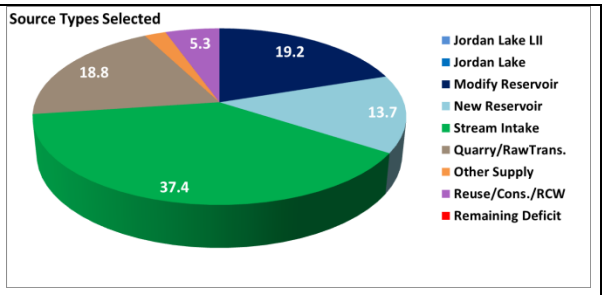
Sources Selected:

Cary	
Cape Fear River @ Harnett Co.	16.5
Durham	
Raise Lake Michie to 365'	18
Moderate reclaimed system (RCW)	2
Hillsborough	
WF Eno Reservoir Expansion	1.2
Holly Springs	
Purchase from Harnett	2.1
OWASA	
Expanded Quarry Reservoir (deep)	3.4
Reclaimed Water Expansion (RCW)	0.3
Pittsboro	
Haw River Existing Intake (Keep)	2
Haw River Withdrawal Expansion	6.1
Raleigh	
Little River Reservoir	13.7
Reclaimed Water (RCW) - Raleigh	3
Quarry 8 BG w/ Neuse R @ Richland	15.4
Sanford	
Expand Cape Fear Withdrawal	12.8
Apex	
Morrisville	
OrangeCo	



General Characteristics:

This alternative assumes a limitation on the future usage of Jordan Lake to see what other options would have to be pursued. No new allocations or upgrades. In this scenario, Durham and Cary have significant surplus to meet the needs of neighbors. Pittsboro must continue to rely on its own Haw River source.



Specific Partner Notes:

- Durham builds its smaller Lake Michie expansion, and moderate RCW system. Durham's surplus is 11.4 MGD. Durham will supply portions of Orange County, Chatham County, and potentially, Raleigh.
- Cary builds a run-of-river source and pipelines to get water from the Cape Fear River. Cary's surplus of 10.2 MGD will first go to meet need in Apex and Cary. After that the remaining surplus will be sent to Chatham County and Raleigh.
- Raleigh builds several sources and buys some water
    - A large quarry option along with flow skimming from the Neuse to fill the quarry
    - Use of some Reclaimed Water (3 MGD), and
    - The Little River Reservoir
    - AND buying 3.3 MGD from Durham or Cary.
- OWASA builds a deep quarry option and expands its RCW for 1.3 MGD surplus. This surplus goes to meet need in Orange County or Chatham County.
- Chatham County – N will have to rely on multiple other partners for meeting its need. Durham, Cary, and to a lesser extent, OWASA, will provide water.
- Pittsboro must preserve and expand its current Haw River source (or find a more suitable nearby location). Significant dam repair costs and treatment plant expansions will be incurred.
- Orange County will buy all of its water from neighboring utilities. Durham and OWASA will be the most likely suppliers.
- Hillsborough builds its W. Fork Eno River Reservoir Expansion currently being planned.
- Holly Springs will not use its allocation, so will purchase more water from Harnett County. There is not sufficient surplus water from the Cary Cape Fear River alternative to meet Holly Springs, otherwise that would be an option.
- Sanford expands its Cape Fear withdrawal and treatment plant to meet its need.

Concerns and Issues to be worked out:

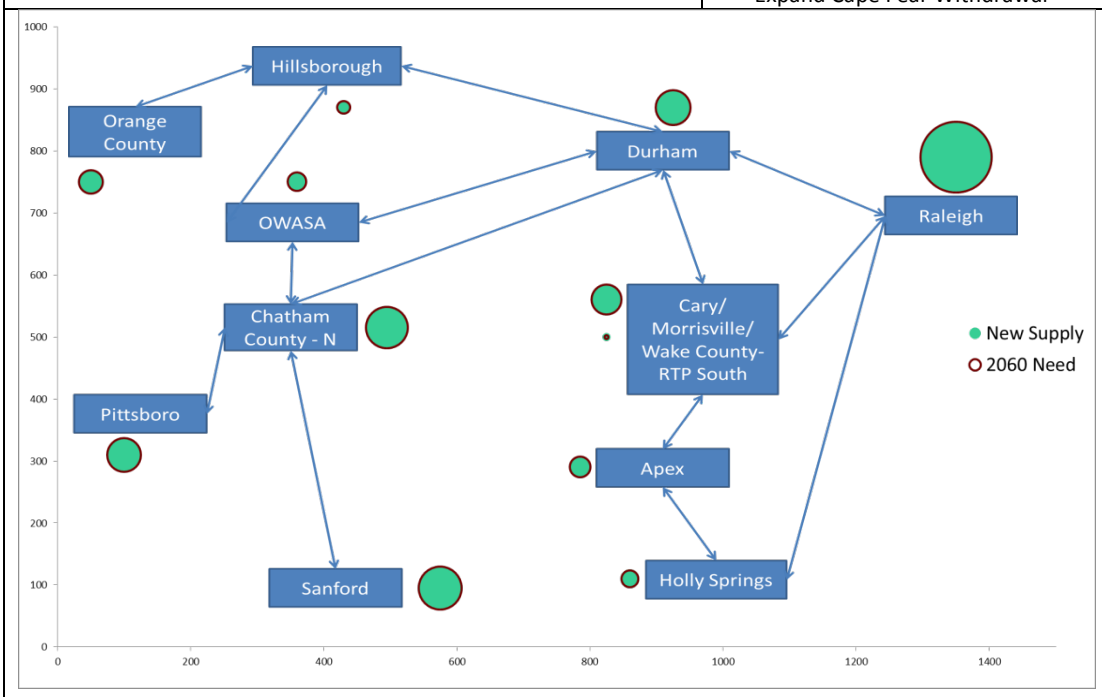
- The limitation of Jordan Lake leads to some bizarre scenarios in which utilities most able to access the lake are purchasing water from utilities whose own Jordan Lake allocations are accessed by purchasing water from the utilities they would now be selling to.
- The implementations of the scenario could be complex. No new western intake is likely unless Durham works with Chatham County on a new way to access their existing allocations.
- More implementation issues: Cary (after supplying Apex and Morrisville) has a surplus of ~ 7, Durham has 11.4 and OWASA has 1.3 for a total of 19.7. Orange County (3.9), Chatham (12.1), and Raleigh (3.3) have needs of 19.3 MGD. Chatham by necessity has to rely on several different suppliers.

E.1	Every Partner for themself
Description	Each partner must have either own sources, or own Jordan Lake Allocation (accessible) to meet need.

Partner	2060 Deficit	2060 New Source	Net	JL-New Lev. I	JL-2060 Tot
Apex	3.0	3	0.0	3	11
Cary	6.3	6.5	0.2	6.5	30
Morrisville	0.1	0.5	0.4	0.5	4
RTPSouth	-0.2	0	0.2	0	3.5
ChathamCoN	12.1	12.5	0.4	12.5	18.5
Durham	8.6	9	0.4	3	13
Hillsborough	1.1	1.2	0.1	0	0
Holly Springs	2.1	2.5	0.4	2.5	2.5
OrangeCo	3.9	4	0.1	4	4
OWASA	2.4	2.4	0.0	0	0
Pittsboro	8.0	8.1	0.1	8.1	8.1
Raleigh	35.4	35.9	0.5	0	0
Sanford	12.8	12.8	0.0	0	0
NonSpecific		0	0.0	0	
TOTAL	**95.7**	**98.4**	**2.7**	**40.1**	**95.1**

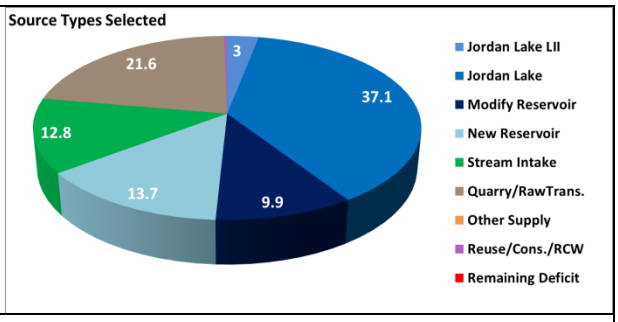
Sources Selected:

Apex	**3**
Jordan Lake Allocation	3
Cary	**6.5**
Jordan Lake Allocation	6.5
ChathamCo	**12.5**
Jordan Lake Allocation	12.5
Durham	**9**
Jordan Lake Allocation	3
Teer Quarry - Eno (low)	6
Hillsborough	**1.2**
WF Eno Reservoir Expansion	1.2
Holly Springs	**2.5**
Jordan Lake Allocation	0.5
Jordan Lake Level II (HS)	2
Morrisville	**0.5**
Jordan Lake Allocation	0.5
OrangeCo	**4**
Jordan Lake Allocation	3
Jordan Lake Level II (OC)	1
OWASA	**2.4**
Expanded Quarry Reservoir (shallow)	2.1
Reclaimed Water Expansion (RCW)	0.3
Pittsboro	**8.1**
Jordan Lake Allocation	8.1
Raleigh	**37.8**
Little River Reservoir	13.7
Falls Lake - Seasonal Norm Pool raise	8.7
Quarry 8 BG w/ Neuse R @ Richland	15.4
Sanford	**12.8**
Expand Cape Fear Withdrawal	12.8



General Characteristics:

This alternative assumes each utility meets its own demand through either its own sources or Jordan Lake allocations.



Specific Partner Notes:

- Raleigh has a significant future need, and this alternative addresses this by building
  - A large quarry option along with flow skimming from the Neuse to fill the quarry
  - The Little River Reservoir
  - A reallocation of Falls Lake to raise the Normal Pool seasonally to allow more water in the conservation pool.
- Durham builds the smaller quarry option and increases its Jordan Lake allocation by 3 MGD.
- Chatham County – N, Cary, Apex, Morrisville, RTP South all continue to rely entirely on Jordan Lake.
- Pittsboro abandons its current source and meets entire demand with Jordan Lake.
- Orange County activates its Level II allocation (converting to level I), and adds 3 MGD more from Jordan Lake. Will receive water through interlocal agreements.
- OWASA builds its quarry option and expands its RCW system. Level II allocations are not presented here, but enough water is left unallocated that OWASA could potentially keep a 5 MGD Level II allocation as an insurance policy.
- Hillsborough builds its W. Fork Eno River Reservoir Expansion currently being planned.
- Holly Springs converts its Level II JL allocation to Level I, plus a little bit more to meet its need. Holly Springs will most likely access its allocation through Apex.
- Sanford expands its Cape Fear withdrawal and treatment plant to meet its need.

Concerns and Issues to be worked out:

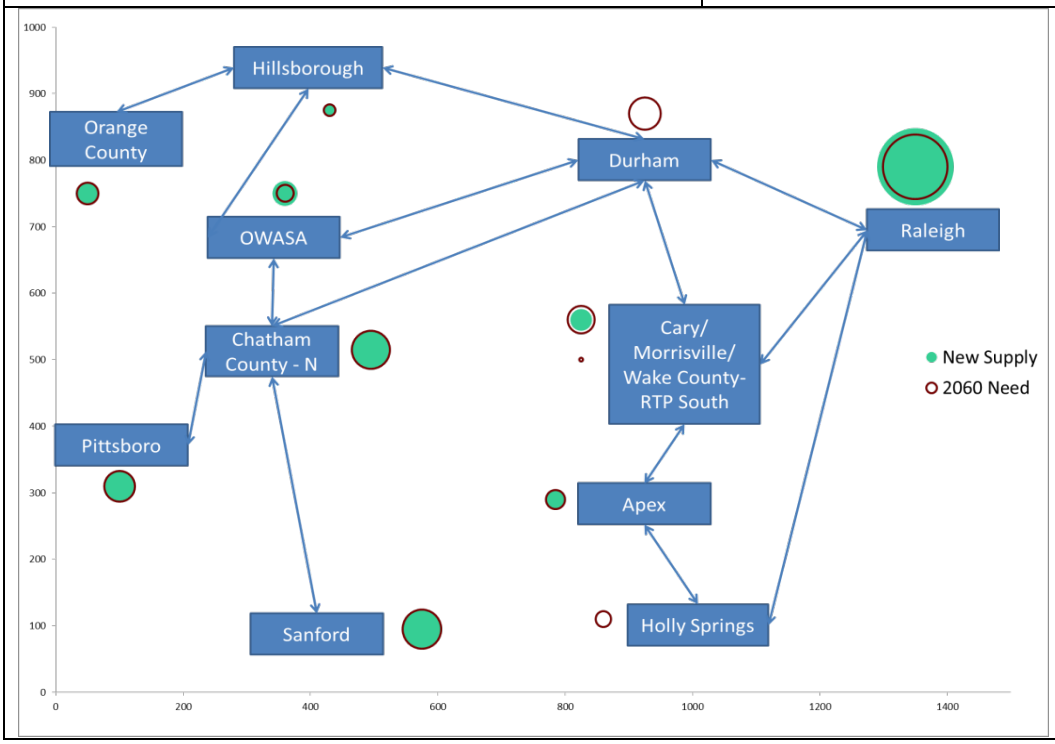
- Can Raleigh build all of its alternatives?
- How is treatment of Jordan Lake allocations handled. A joint Western Intake could supply Pittsboro, Chatham County, Orange County, and maybe Durham. But does this cooperative project violate the spirit of this alternative framework? (Other options like building even more treatment plants and intakes seem less likely, as does relying only on CAWTP to provide all the water, so maybe a Western Intake is ok.)
- Could RCW be a larger portion of the regional strategy?
-

F.1	Mega-source option: PCS Phosphate pipeline
Description	Raleigh (et al.) builds 50 MGD pipeline from PCS Phosphate in lower Neuse.

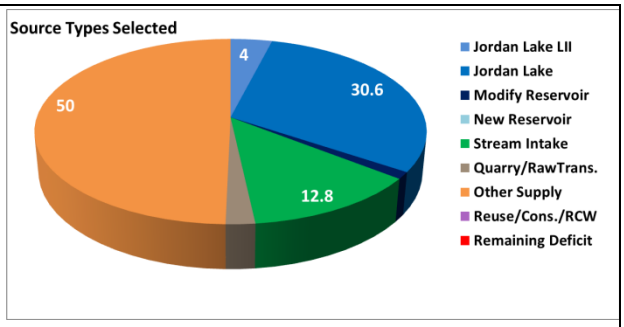
Partner	2060 Deficit	2060 New Source	Net	JL-New Lev. I	JL-2060 Tot
Apex	3.0	3	0.0	3	11
Cary	6.3	4	-2.3	4	27.5
Morrisville	0.1	0	-0.1	0	3.5
RTPSouth	-0.2	0	0.2	0	3.5
ChathamCoN	12.1	12.5	0.4	12.5	18.5
Durham	8.6	0	-8.6	0	10
Hillsborough	1.1	1.2	0.1	0	0
Holly Springs	2.1	0	-2.1	0	0
OrangeCo	3.9	4	0.1	4	4
OWASA	2.4	5.1	2.7	3	3
Pittsboro	8.0	8.1	0.1	8.1	8.1
Raleigh	35.4	50	14.6	0	0
Sanford	12.8	12.8	0.0	0	0
NonSpecific		0	0.0	0	
TOTAL	**95.7**	**100.7**	**5.0**	**34.6**	**89.6**

Sources Selected:

Apex	**3**
Jordan Lake Allocation	3
Cary	**4**
Jordan Lake Allocation	4
ChathamCo	**12.5**
Jordan Lake Allocation	12.5
Hillsborough	**1.2**
WF Eno Reservoir Expansion	1.2
OrangeCo	**4**
Jordan Lake Allocation	3
Jordan Lake Level II (OC)	1
OWASA	**5.1**
Jordan Lake Level II (OWASA)	3
Expanded Quarry Reservoir (shallow)	2.1
Pittsboro	**8.1**
Jordan Lake Allocation	8.1
Raleigh	**50**
Eagle Resources PCS Phosphate Mine	50
Sanford	**12.8**
Expand Cape Fear Withdrawal	12.8
Durham	**0**
Morrisville	**0**
Holly Springs	**0**



General Characteristics:



Raleigh is considering as a source the ground-water pumped out from the PCS Phosphate facility in the lower Neuse, which is currently discharged to the sea. A pipeline could collect this ~ 50 MGD and bring it to the Triangle (Falls Lake?). Raleigh's demand would be met, plus several other partners as well. This alternative investigates how this large source would change thinking for the rest of the region. One bonus is to reduce Jordan Lake demand.

Specific Partner Notes:

- Raleigh's need would be met by the pipeline, and would not need any other sources. Raleigh would end up with a surplus that could meet other demands in the region, which would help with cost sharing.
- Durham could meet its need as well from the pipeline, and may participate in the project, or purchase water from Raleigh.
- Holly Springs could also have its need met by Raleigh, and is currently connected, so it is the next most logical choice to receive water from the pipeline.
- Cary may purchase some water (~2.3 MGD) from Raleigh (via the pipeline) in order to help the project water and help deal with its IBT issues.
- Chatham County – N, Apex, Morrisville, RTP South all continue to rely entirely on Jordan Lake.
- Pittsboro abandons its current source and meets entire demand with Jordan Lake.
- Orange County activates its Level II allocation (converting to level I), and adds 3 MGD more from Jordan Lake. Will receive water through interlocal agreements.
- OWASA builds its quarry option. OWASA also activates its Level II allocation is converted to Level I for 3 MGD to meet need with a little bit of buffer.
- Hillsborough builds its W. Fork Eno River Reservoir Expansion currently being planned.
- Sanford expands its Cape Fear withdrawal and treatment plant to meet its need.

Concerns and Issues to be worked out:

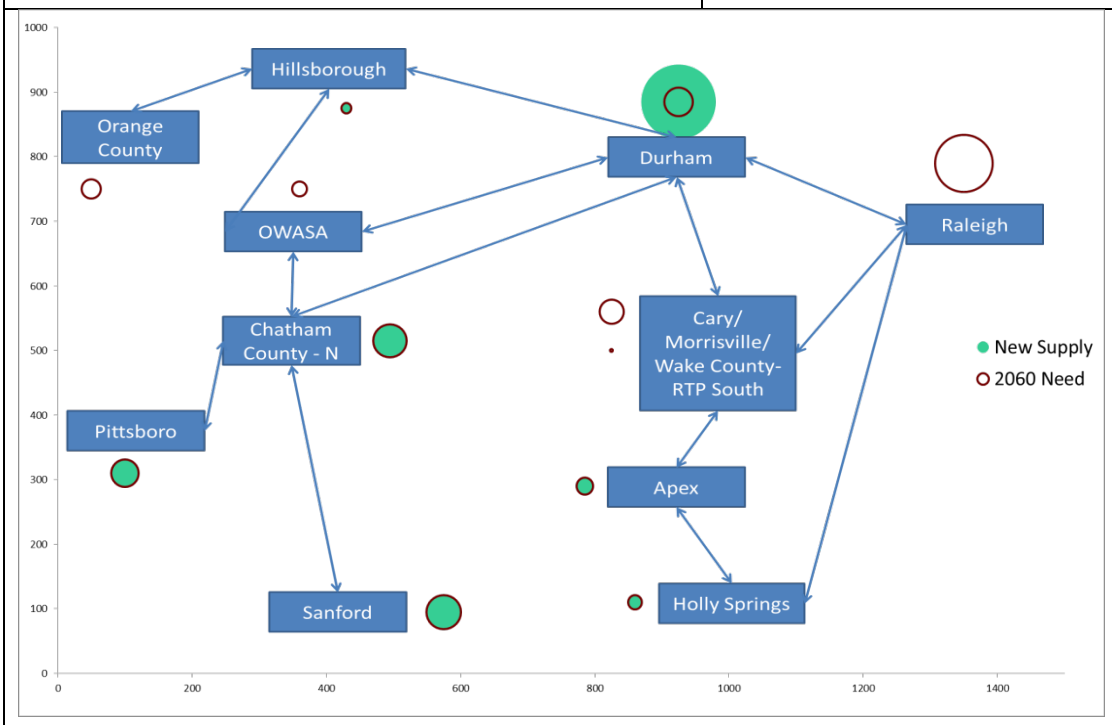
- How would the pipeline water be delivered to the region? Treated directly from the pipeline, or released into the watershed (Falls Lake)? Would Raleigh and Durham operate a joint treatment plant.
- Are there water quality issues with high phosphate in the water? (Falls Lake Rules)
- Can the full 50 MGD be brought to Raleigh, or would downstream neighbors want to put a 'straw' in to access the water as it passes them?
- Would Cary participate in the pipeline to help make it happen for the region? Pipeline water is not subject to IBT. Ample Jordan Lake water is available, however.
- Implementation of JL options needs to be determined. (Western Intake, etc.)
-

F.2	Mega-source option: Kerr Lake
Description	A pipeline is built to transfer water from Kerr Lake. Water enters region through Durham.

Partner	2060 Deficit	2060 New Source	Net	JL-New Lev. I	JL-2060 Tot
Apex	3.0	3	0.0	3	11
Cary	6.3	0	-6.3	0	23.5
Morrisville	0.1	0	-0.1	0	3.5
RTPSouth	-0.2	0	0.2	0	3.5
ChathamCoN	12.1	12.5	0.4	12.5	18.5
Durham	8.6	60	51.4	0	10
Hillsborough	1.1	1.2	0.1	0	0
Holly Springs	2.1	2	-0.1	2	2
OrangeCo	3.9	0	-3.9	0	0
OWASA	2.4	0	-2.4	0	0
Pittsboro	8.0	8.1	0.1	8.1	8.1
Raleigh	35.4	0	-35.4	0	0
Sanford	12.8	12.8	0.0	0	0
NonSpecific		0	0.0	0	
TOTAL	**95.7**	**99.6**	**3.9**	**25.6**	**80.6**

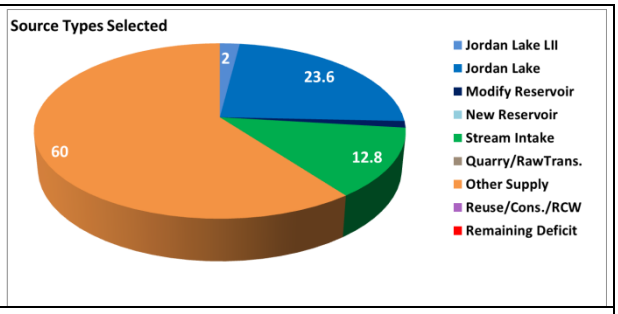
Sources Selected:

Apex	**3**
Jordan Lake Allocation	3
ChathamCo	**12.5**
Jordan Lake Allocation	12.5
Durham	**60**
Kerr Lake	60
Hillsborough	**1.2**
WF Eno Reservoir Expansion	1.2
Holly Springs	**2**
Jordan Lake Level II (HS)	2
Pittsboro	**8.1**
Jordan Lake Allocation	8.1
Sanford	**12.8**
Expand Cape Fear Withdrawal	12.8
Cary	**0**
Morrisville	**0**
Holly Springs	**0**
Raleigh	**0**
OrangeCo	**0**
OWASA	**0**



General Characteristics:

This alternative assumes the region secures a significant allocation from Kerr Lake and transfers that water to the region, likely through Durham. With this source, several partners can have their needs met.



Specific Partner Notes:

- Durham receives the 60 MGD source (somehow), and has a 51.4 MGD surplus to meet needs for multiple other partners. Notably, it appears the source could meet needs for Raleigh, Orange County, OWASA, and Cary/Morrisville.
- Raleigh's need is met by the Kerr Lake source.
- OWASA and Orange County also receive water from the Kerr Lake source.
- Cary and Morrisville have their future need met by the Kerr Lake source.
- Pittsboro abandons its current source and meets entire demand with Jordan Lake.
- Chatham County relies on Jordan Lake.
- Hillsborough builds its W. Fork Eno River Reservoir Expansion currently being planned, though it could use the Kerr Lake water.
- Apex expands its Jordan Lake allocation, and transfer Jordan Lake water to Holly Springs.
- Holly Springs converts its Level II JL allocation to Level I, plus a little bit more to meet its need. Holly Springs will most likely access its allocation through Apex.
- Sanford expands its Cape Fear withdrawal and treatment plant to meet its need.

Concerns and Issues to be worked out:

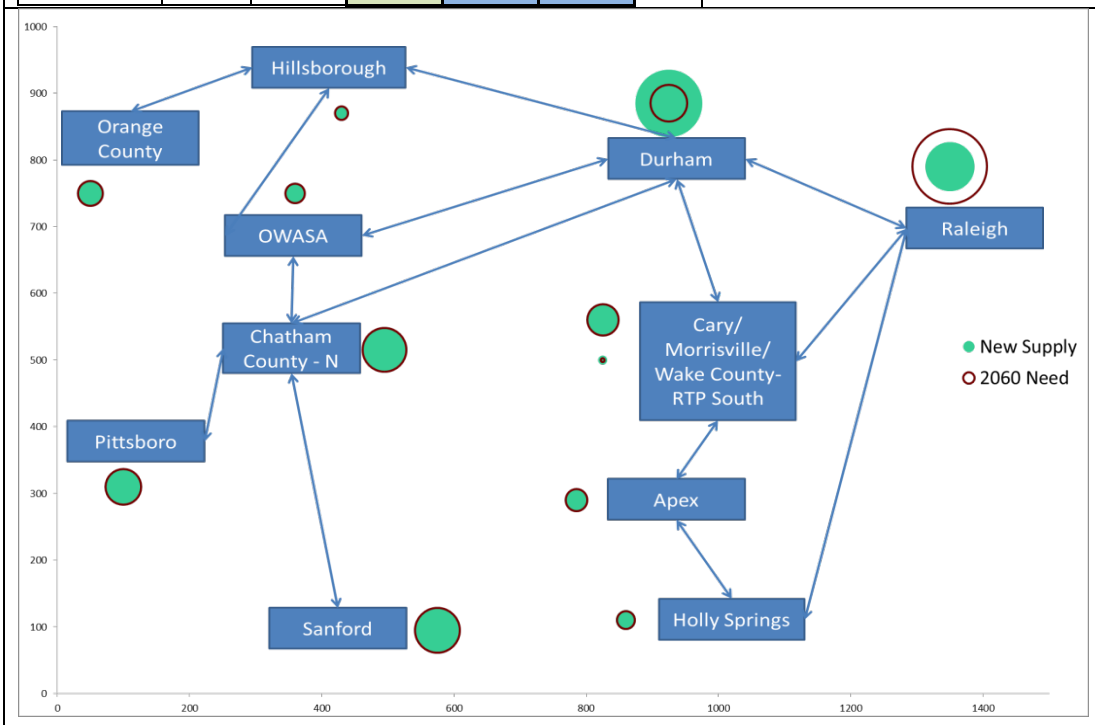
- How is the water actually delivered to the region? Shortest path would be to release to the watershed upstream of Lake Michie, and let Durham pull the water out of there. Could put the water in Falls Lake, too. Or, could simply treat the water out of the pipeline, and move finished water. Since Raleigh's need will be met, would the pipeline branch to Raleigh?
- There are major IBT issues to be worked out. From Kerr Lake to the Neuse is a major IBT move. Is moving water again from the Neuse to OWASA, Orange County, and parts of Durham, Cary, Morrisville another IBT issue to be dealt with?
- Implementation of JL options needs to be determined. (Western Intake, etc.)
-

F.4	Mega-source option: Lake Michie expansion
Description	Lake Michie is expanded to its maximum feasible size.

Partner	2060 Deficit	2060 New Source	Net	JL-New Lev. I	JL-2060 Tot
Apex	3.0	3	0.0	3	11
Cary	6.3	6.5	0.2	6.5	30
Morrisville	0.1	0.5	0.4	0.5	4
RTPSouth	-0.2	0	0.2	0	3.5
ChathamCoN	12.1	12.5	0.4	12.5	18.5
Durham	8.6	28.9	20.3	0	10
Hillsborough	1.1	1.2	0.1	0	0
Holly Springs	2.1	2.5	0.4	2.5	2.5
OrangeCo	3.9	4	0.1	4	4
OWASA	2.4	2.4	0.0	0	0
Pittsboro	8.0	8.1	0.1	8.1	8.1
Raleigh	35.4	15.4	-20.0	0	0
Sanford	12.8	12.8	0.0	0	0
NonSpecific		0	0.0	0	
TOTAL	**95.7**	**97.8**	**2.1**	**37.1**	**92.1**

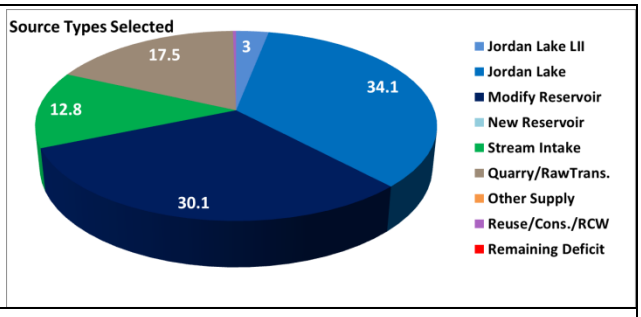
Sources Selected:

Apex	**3**
Jordan Lake Allocation	3
Cary	**6.5**
Jordan Lake Allocation	6.5
ChathamCo	**12.5**
Jordan Lake Allocation	12.5
Durham	**28.9**
Raise Lake Michie to 381'	28.9
Hillsborough	**1.2**
WF Eno Reservoir Expansion	1.2
Holly Springs	**2.5**
Jordan Lake Allocation	0.5
Jordan Lake Level II (HS)	2
Morrisville	**0.5**
Jordan Lake Allocation	0.5
OrangeCo	**4**
Jordan Lake Allocation	3
Jordan Lake Level II (OC)	1
OWASA	**2.4**
Expanded Quarry Reservoir (shallow)	2.1
Reclaimed Water Expansion (RCW)	0.3
Pittsboro	**8.1**
Jordan Lake Allocation	8.1
Raleigh	**15.4**
Quarry 8 BG w/ Neuse R @ Richland	15.4
Sanford	**12.8**
Expand Cape Fear Withdrawal	12.8



General Characteristics:

This alternative examines the effect of Durham building the largest possible Lake Michie expansion. Raleigh builds its largest quarry option, but not LRR, and buys water from Durham. Other partners largely rely on their own sources or Jordan Lake.



Specific Partner Notes:

- Durham builds the largest expansion of Lake Michie (to elevation 381). This meets Durham's demand, and allows a ~ 20 MGD surplus, which is used by Raleigh.
- Raleigh has a significant future need, and this alternative addresses this by building
  - A large quarry option along with flow skimming from the Neuse to fill the quarry
  - Purchase from Durham/cooperation on Lake Michie project for 20 MGD.
- Chatham County – N, Cary, Apex, Morrisville, RTP South all continue to rely entirely on Jordan Lake.
- Pittsboro abandons its current source and meets entire demand with Jordan Lake.
- Orange County activates its Level II allocation (converting to level I), and adds 3 MGD more from Jordan Lake. Will receive water through interlocal agreements.
- OWASA builds its quarry option, and expands its RCW system.
- Hillsborough builds its W. Fork Eno River Reservoir Expansion currently being planned.
- Holly Springs converts its Level II JL allocation to Level I, plus a little bit more to meet its need. Holly Springs will most likely access its allocation through Apex.
- Sanford expands its Cape Fear withdrawal and treatment plant to meet its need.

Concerns and Issues to be worked out:

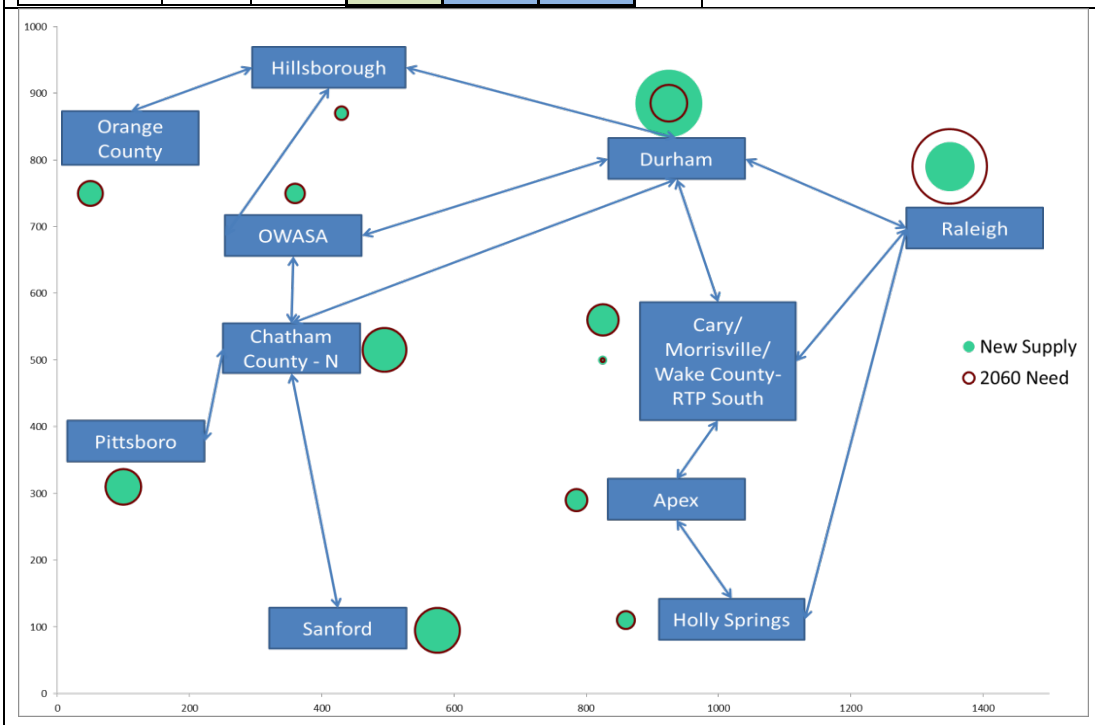
- How would the Lake Michie project be built? As a Durham-Raleigh partnership?
- How would the project be used in conjunction with Durham's LRR, Fall Lake?
- Could RCW be a larger portion of the regional strategy?
- Implementation of JL options needs to be determined. (Western Intake, etc.)
-

F.4b	Mega-source option: Lake Michie expansion
Description	Lake Michie is expanded to its maximum feasible size.

Partner	2060 Deficit	2060 New Source	Net	JL-New Lev. I	JL-2060 Tot
Apex	3.0	3	0.0	3	11
Cary	6.3	6.5	0.2	6.5	30
Morrisville	0.1	0.5	0.4	0.5	4
RTPSouth	-0.2	0	0.2	0	3.5
ChathamCoN	12.1	12.5	0.4	12.5	18.5
Durham	8.6	28.9	20.3	0	10
Hillsborough	1.1	1.2	0.1	0	0
Holly Springs	2.1	2.5	0.4	2.5	2.5
OrangeCo	3.9	4	0.1	4	4
OWASA	2.4	2.4	0.0	0	0
Pittsboro	8.0	8.1	0.1	8.1	8.1
Raleigh	35.4	16.7	-18.7	0	0
Sanford	12.8	12.8	0.0	0	0
NonSpecific		0	0.0	0	
TOTAL	**95.7**	**99.1**	**3.4**	**37.1**	**92.1**

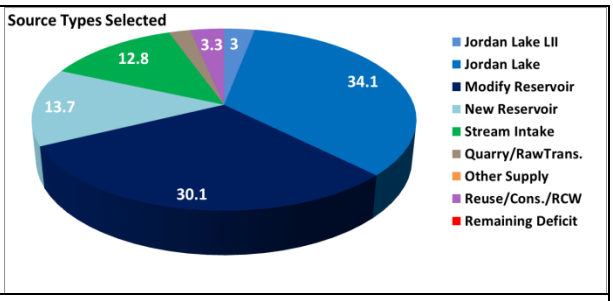
Sources Selected:

Apex	**3**
Jordan Lake Allocation	3
Cary	**6.5**
Jordan Lake Allocation	6.5
ChathamCo	**12.5**
Jordan Lake Allocation	12.5
Durham	**28.9**
Raise Lake Michie to 381'	28.9
Hillsborough	**1.2**
WF Eno Reservoir Expansion	1.2
Holly Springs	**2.5**
Jordan Lake Allocation	0.5
Jordan Lake Level II (HS)	2
Morrisville	**0.5**
Jordan Lake Allocation	0.5
OrangeCo	**4**
Jordan Lake Allocation	3
Jordan Lake Level II (OC)	1
OWASA	**2.4**
Expanded Quarry Reservoir (shallow)	2.1
Reclaimed Water Expansion (RCW)	0.3
Pittsboro	**8.1**
Jordan Lake Allocation	8.1
Raleigh	**15.4**
Little River Reservoir	13.7
Reclaimed Water (RCW) - Raleigh	3
Sanford	**12.8**
Expand Cape Fear Withdrawal	12.8



General Characteristics:

This alternative examines the effect of Durham building the largest possible Lake Michie expansion. Raleigh builds its LRR option, and buys water from Durham. Other partners largely rely on their own sources or Jordan Lake.



Specific Partner Notes:

- Durham builds the largest expansion of Lake Michie (to elevation 381). This meets Durham's demand, and allows a ~ 20 MGD surplus, which is used by Raleigh.
- Raleigh has a significant future need, and this alternative addresses this by building
  - The Little River Reservoir
  - A 3 MGD RCW system
  - Purchase from Durham/cooperation on Lake Michie project for ~19 MGD.
- Chatham County – N, Cary, Apex, Morrisville, RTP South all continue to rely entirely on Jordan Lake.
- Pittsboro abandons its current source and meets entire demand with Jordan Lake.
- Orange County activates its Level II allocation (converting to level I), and adds 3 MGD more from Jordan Lake. Will receive water through interlocal agreements.
- OWASA builds its quarry option, and expands its RCW system. (There is enough of JL unallocated to keep Level II allocation if desired.)
- Hillsborough builds its W. Fork Eno River Reservoir Expansion currently being planned.
- Holly Springs converts its Level II JL allocation to Level I, plus a little bit more to meet its need. Holly Springs will most likely access its allocation through Apex.
- Sanford expands its Cape Fear withdrawal and treatment plant to meet its need.

Concerns and Issues to be worked out:

- How would the Lake Michie project be built? As a Durham-Raleigh partnership?
- Can both the Lake Michie and LRR projects be completed (and financed)?
- How would the project be used in conjunction with Durham's LRR, Fall Lake?
- Implementation of JL options needs to be determined. (Western Intake, etc.)
-

This page intentionally left blank.

Appendix E - OASIS Inputs

E.1 Demand Pattern

Demand Pattern by Node		Demand in year			Pattern												
Jurisdiction	**Node**	**2010**	**2045**	**2060**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	
Pittsboro	401	0.62	10.45	11.76	0.898	0.949	0.907	0.958	1.022	1.086	1.076	1.150	1.112	0.984	0.937	0.889	
OWASA	431	7.86	11.33	12.91	0.893	0.891	0.898	0.974	1.003	1.080	1.105	1.131	1.142	1.073	0.955	0.819	
Cary Apex	471	18.4	39.1	41.3													*
Wake Co. - RTP South	474	0.6	3.2	3.3													*
Morrisville	477	1.7	3.5	3.6													*
Chatham County N	473	2.16	13.04	18.11	0.655	0.674	0.743	0.929	1.174	1.366	1.361	1.280	1.239	1.061	0.790	0.706	
Sanford	491	6.52	17.82	24.79	0.896	0.891	0.899	0.950	1.022	1.108	1.129	1.143	1.092	1.036	0.945	0.890	
Orange County	921	0.02	2.81	3.92	0.961	0.942	0.941	0.951	1.009	1.046	1.067	1.077	1.056	0.997	0.959	0.958	
Holly Springs	923	1.98	7.24	8.78	0.779	0.735	0.795	0.940	1.081	1.221	1.218	1.196	1.133	1.098	0.919	0.840	
Hillsborough	1106	1.16	3.21	3.70	0.973	0.940	0.964	0.949	1.003	1.022	1.049	1.068	1.051	1.001	0.972	0.971	
Durham	1162	25.27	39.98	44.37	0.950	0.850	0.920	0.940	1.000	1.070	1.130	1.120	1.080	1.040	0.950	0.940	
Raleigh	1301	52	97.50	115.00	0.857	0.872	0.879	0.943	1.036	1.151	1.181	1.159	1.113	1.009	0.896	0.867	

* Defined in OCL code provided by the Town of Cary.

E.2 - Return Flow Patterns

Return Flow Patterns by Arc

System	Lookup Name	Arc	Constraint Name	YearlyAvg.	1	2	3	4	5	6	7	8	9	10	11	12	Notes	
Pittsboro	PittsboroWW	0401.0410	PittsboroWW	*0.583*	0.693	0.680	0.813	0.685	0.514	0.463	0.434	0.429	0.457	0.472	0.633	0.726		2010
	"	0401.0410	PittsboroWW		0.900	0.868	0.981	0.819	0.633	0.571	0.526	0.510	0.557	0.614	0.814	0.932		2045
	"	0401.0410	PittsboroWW		0.903	0.871	0.984	0.821	0.635	0.573	0.528	0.511	0.559	0.616	0.817	0.935		2060
OWASA	OWASA_WW	0431.0440	OWASA_WW	*0.954*	1.063	1.092	1.089	0.991	0.895	0.849	0.820	0.845	0.869	0.871	0.971	1.103		
Chatham County N	ChathamN_JLWTP_Disch	0473.470 (New)	NorthChathamWTP	*0.140*	0.180	0.163	0.185	0.122	0.137	0.103	0.122	0.123	0.119	0.127	0.134	0.164		
Cary-Apex	CaryApexReturn	0471.0472 (new)	CaryApexReturn		1.056	1.056	0.923	0.862	0.692	0.566	0.597	0.631	0.732	0.785	0.973	1.051	*	
Morrisville (Cary-Apex)	CA_MorrisReturn	0477.0472 (new)	MorrisReturn		1.131	1.269	0.985	0.982	0.731	0.562	0.596	0.626	0.759	0.825	0.986	1.113	*	
Wake Co. RTP South	CA_RTPS_Return	0474.0472 (new)	RTP_S_Return		0.731	0.715	0.601	0.628	0.458	0.354	0.368	0.356	0.436	0.497	0.588	0.696	*	
Sanford	Sanford_WWTP	0491.0610	Sanford_WWTP	*0.621*	0.711	0.754	0.795	0.666	0.556	0.521	0.515	0.521	0.544	0.535	0.646	0.694		
Sanford	SanfordWTP_Discharge	0491.0490	SanfordWTP_Disch	*0.103*	0.160	0.160	0.160	0.120	0.090	0.080	0.070	0.080	0.080	0.070	0.080	0.090		
Holly Springs	HollySpringsWW	0923.0520	HollySpringsWW	0.786	0.938	1.017	1.037	0.829	0.693	0.621	0.585	0.655	0.666	0.666	0.810	0.926		
Orange County	OrangeReturn	0921.{0323,0463,1109,1163} (New)		0.800	0.895	0.895	0.919	0.860	0.737	0.721	0.693	0.692	0.722	0.727	0.853	0.893	**	
Hillsborough	HillsReturn	1106.1109 (New)	Hillsborough	*0.641*	0.686	0.741	0.766	0.709	0.584	0.610	0.528	0.546	0.578	0.559	0.681	0.728		
Durham	DurhamNDWRF	1162.1163 (new DS)	Durham_NDWRF	*0.327*	0.411	0.400	0.399	0.351	0.298	0.258	0.238	0.229	0.279	0.285	0.385	0.400		
Durham	DurhamSDWRF	1162.0463 (new DS)	Durham_SDWRF	*0.374*	0.453	0.467	0.447	0.397	0.350	0.301	0.290	0.281	0.322	0.338	0.412	0.441		
Durham	DurhamTWWTP_WW	1162.0453 (new DS)	DurhamtoTWWTP	*0.130*	0.157	0.161	0.155	0.137	0.121	0.104	0.100	0.097	0.111	0.117	0.143	0.152		
Raleigh	RalNeuseR_Return	1362.1620	Raleigh_NeuseWWTP	0.853	0.973	0.972	0.996	0.908	0.807	0.717	0.682	0.726	0.781	0.813	0.911	0.946		
Raleigh	RalLitCrReturn	1362.1500	Zebulon_LittleCreek	*0.013*	0.016	0.016	0.018	0.016	0.012	0.010	0.009	0.010	0.011	0.010	0.012	0.015		
Raleigh	RalWakeFReturn	1362.1300	WakeForest_SmithCreek	*0.488*	0.575	0.559	0.554	0.495	0.440	0.388	0.378	0.409	0.434	0.471	0.560	0.591	***	

* - Specific handling of wastewater handled by OCL coding specified by Town of Cary. These values only reflect recent averages.

** - OCL code distributes wastewater from Orange County to the watewater plants of the three Orange county suppliers in the proportion they supply demand.

*** - Multiplied by 0.05 before being applied to Raleigh demand.

Jordan Lake Allocations			Supply in year		
Partner	**Node/Arc**	**Description**	**2045**	**2060**	**Notes**
	(new)	W. JL WTP	42.6	48.2	New WTP on West side of Jordan Lake. Supplies JL allocations to Chatham Co N, Durham, OWASA, Pittsboro, Orange County, Hillsborough. Add a node (478?) Will be online ~ 2020 - 2025.
Chatham	*(new)>473*	*JLA - Chatham Co*	*13.1*	***18.2***	*Total allocation amounts (MGD) for Chatham Co.*
OWASA	*(new)>431*	*JLA - OWASA*	*5*	*5*	*Total allocation amounts (MGD) for OWASA. Replace 0479>0431.*
Durham	*(new)>1151*	*JLA - Durham*	***16***	*16*	*Total allocation amounts (MGD) for Durham. Replace 0479>1151.*
Pittsboro	*(new)>401*	*JLA - Pittsboro*	*6*	*6*	*Total allocation amounts (MGD) for Pittsboro.*
Hillsborough	*(new)>1106*	*JLA - Hillsborough*	*1*	*1*	*Total allocation amount (MGD) for Hillsborough. May require new arc. Is an emergency source.*
Orange County	*(new)>921*	*JLA - Orange*	*1.5*	***2***	*Total allocation amount (MGD) for Orange County.*
Holly Springs	*0470>0923*	*JLA- Holly Springs*	*2*	*2.2*	*Total allocation amount (MGD) for Holly Springs.*
CAMR	*479>471*	*CAWTP expansion*	*46.3*	*48.7*	*Total allocation for Cary, Apex, Morrisv., RTPS.*
Cary	*0479>Cary*	*JLA Cary*	*28.7*	*29.9*	*Total allocation for Cary.*
Morrisville	*0479>Morrisville*	*JLA- Morrisville*	*3.5*	*3.7*	*Total allocation for Morrisville.*
Wake Co RTP S	*0479> RTP S*	*JLA - Wake Co RTP S*	*3.5*	*3.5*	*Total allocation for Wake Co RTP S*
Apex	*0479>Apex*	*JLA - Apex*	*10.6*	*11.6*	*Total allocation for Apex.*

Expanded Sources			Supply in year		
Partner	**Node/Arc**	**Description**	**2045**	**2060**	**Notes**
Pittsboro	400>401	Haw River WTP	6	6	New treatment plant on Haw River. Expands by 4 from current 2. Total capacity 6 MGD in both 2045, 2060.
Sanford	490>481	Sanford WTP expansion	24.8	24.8	Total Capacity Sanford WTP. Two expansions, but both before 2045. Probably don't need to change anything in the model.
OWASA	395	OWASA Stone Quarry expa	2.1	2.1	Expands such that initial estimates say it provides 2.1 *additional* MGD. Provided stage storage info in pdf document.
Hillsborough	1050	W. Fk. Eno Expansion	1.2	1.2	Expand W. Fork Eno Reservoir. New stage-storage provided. New operation rules (changed trigger elevations) were sent to you. Compute yield using model.
Raleigh	1300	Raleigh Option 1	14	14	Reallocate from Falls WQ pool to WS pool
Raleigh	1740	Raleigh Option 2	13.7	13.7	Little River Reservoir
Raleigh	On Neuse River	Raleigh Option 3	0	**13.7**	New Neuse River Withdrawal. Need to look up node/create new junction node at withdra
Raleigh		Raleigh Option 4	0	0	New quarry option with pumping from Neuse. Probably the most difficult to model.

Notes:
JL Only systems - Cary, Apex, Morrisville, RTP South, Chatham County
For Pittsboro, aim to balance water demand between haw river and Jordan Lake allocation from the new Western JL
For Hillsborough, add the W. Fk. Eno Reservoir expansion, and meet most demand in that manner. Use JL as an emergency source (lower priority).
For Sanford, all demand met by expanding treatment plant at current location. No model changes needed.
For OWASA, add the Stone Quarry expansion.
OWASA also has a JL allocation. In general, this should be used as an emergency source, when usable of storage of other sources is low.
For Durham, generally try to use the full JL allocation on a daily basis (don't vary seasonally). Existing sources to meet rest of demand.
For Orange County, there are three service areas. One gets water by purchase from Graham Mebane (and will send WW there). The other two will get water through JL allocation, and will return WW to Hillsborough, and Durham (need to check which WWTP).
For Holly Springs, constraint of 10 MGD connection from Harnett County. Rest (if needed) from JL allocation.
For Raleigh, follow guidance from H&S.

This page intentionally left blank.

Appendix F - Cape Fear-Neuse OASIS Model Results

This appendix contains model results from the Neuse-Cape Fear hydrologic model developed in the OASIS software.

This model was calibrated by NCDENR to represent 2010 water management conditions throughout both the Neuse and Cape Fear river basins, and included the capability to activate water shortage response plans.

From this calibrated base model, the Jordan Lake partnership worked to model the JLP Recommended Alternative for two future scenarios, representing conditions in 2045 and 2060. The model set-up and parameterization was described in Appendix E.

The model results are relevant for the way they indicate differences between scenarios. The results should not be used as a prediction for what hydrologic conditions will be. The differences can show how the different system configurations may stress the system in different ways based on the range of conditions experienced over the past 80 years.

This appendix focuses on 3 main model outputs:

F.1 - Jordan Lake and Falls Lake Storage levels

F.2 - Storage percentage in Jordan Lake Partnership reservoirs and storage allocations

F.3 - Streamflow changes at key flow locations

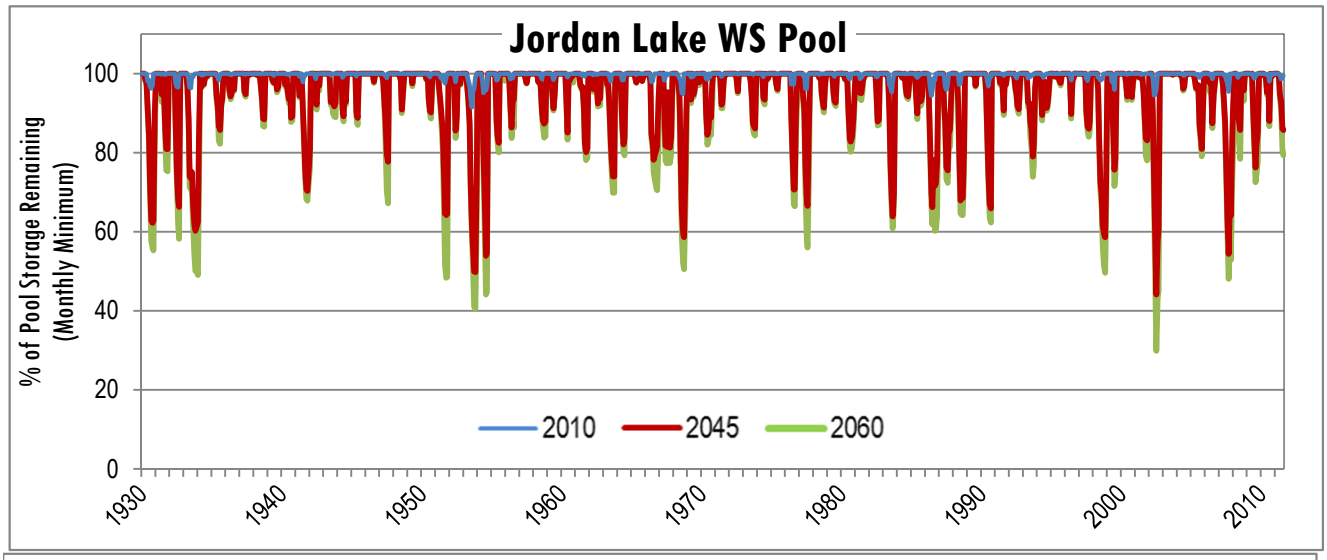
For all of the results, the time axis refers to the hydrologic conditions over the period of record included in the model. The inputs do not change year to year for plots with a time axis.

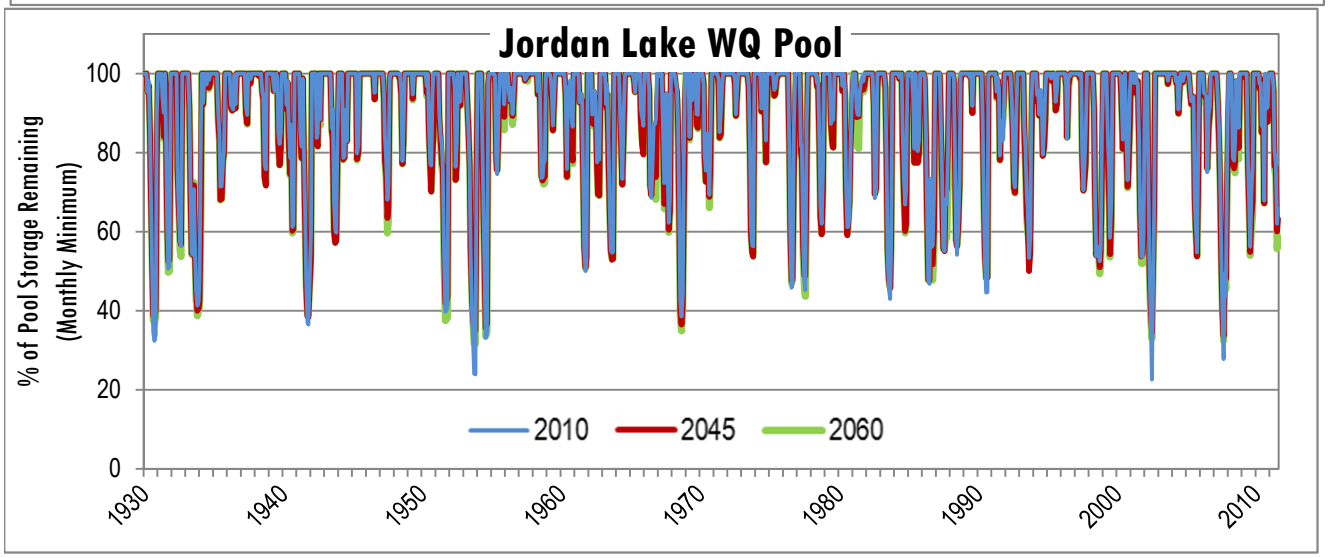
The model was run for the future scenarios both with and without water shortage response plans activated. In cases where WSRP status is not indicated in results, the scenario without WSRPs activated is shown.

Appendix F.1 - Jordan and Falls Lake

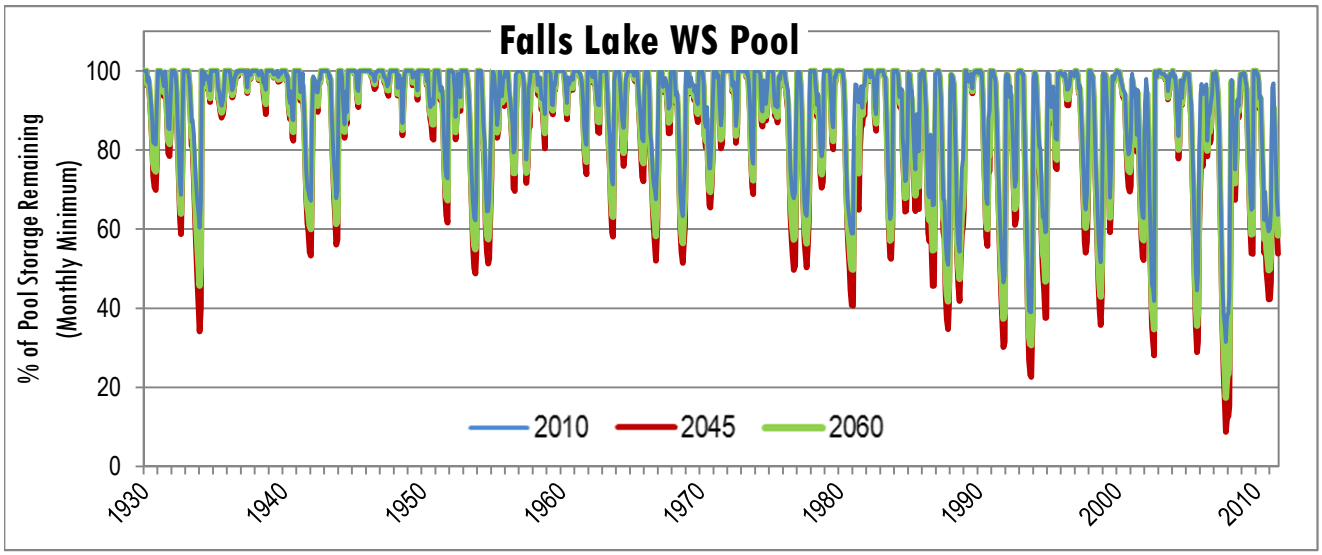
Monthly Minimum Storage Plots - Jordan Lake and Falls Lake.

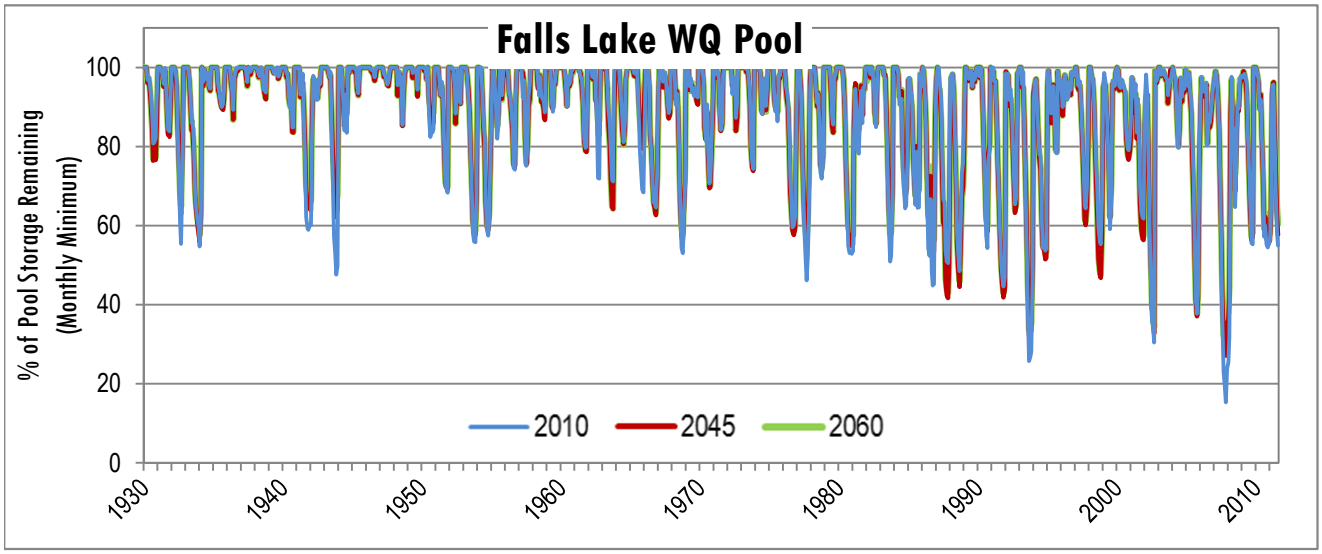
Node 470 - Jordan Lake





Node 1300 - Falls Lake

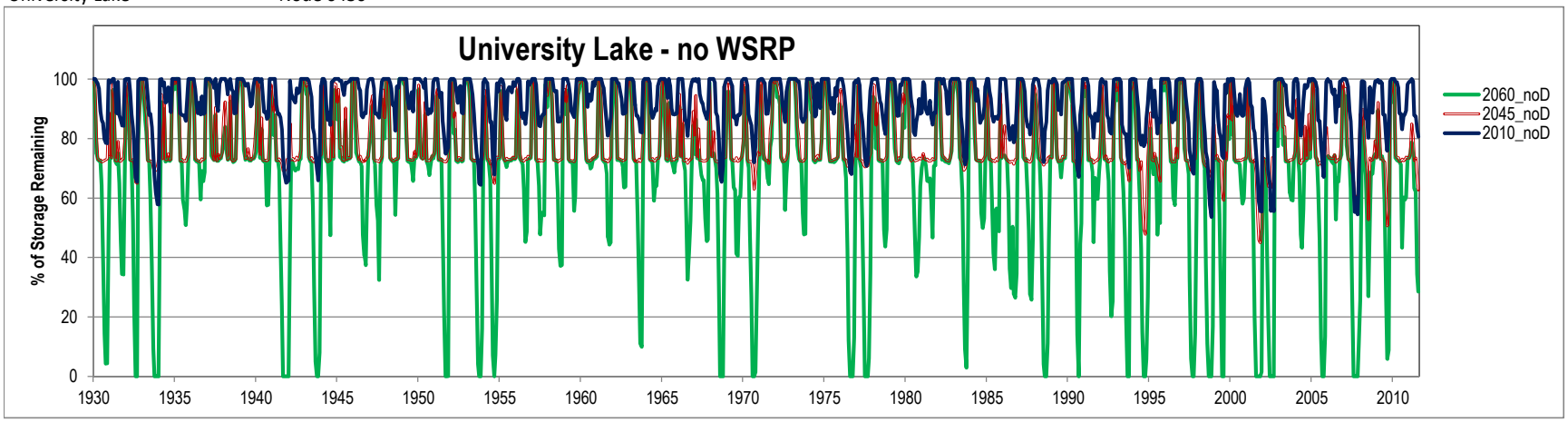


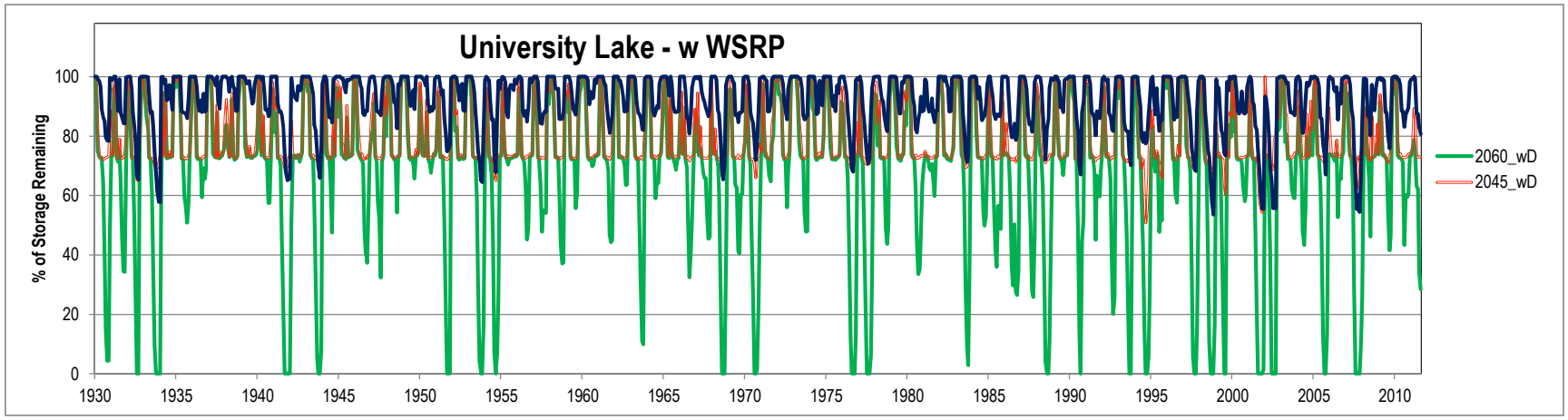


Appendix F.2 - Reservoir and Storage Allocation Plots, Minimum Monthly Usable Storage Percentage.

Partner: OWASA

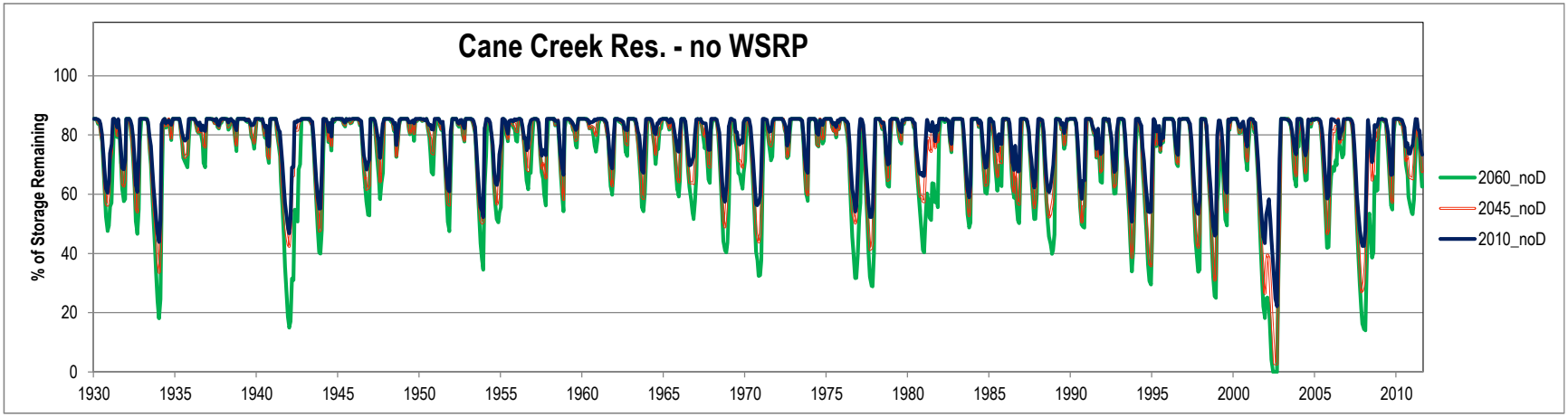
University Lake Node 0430

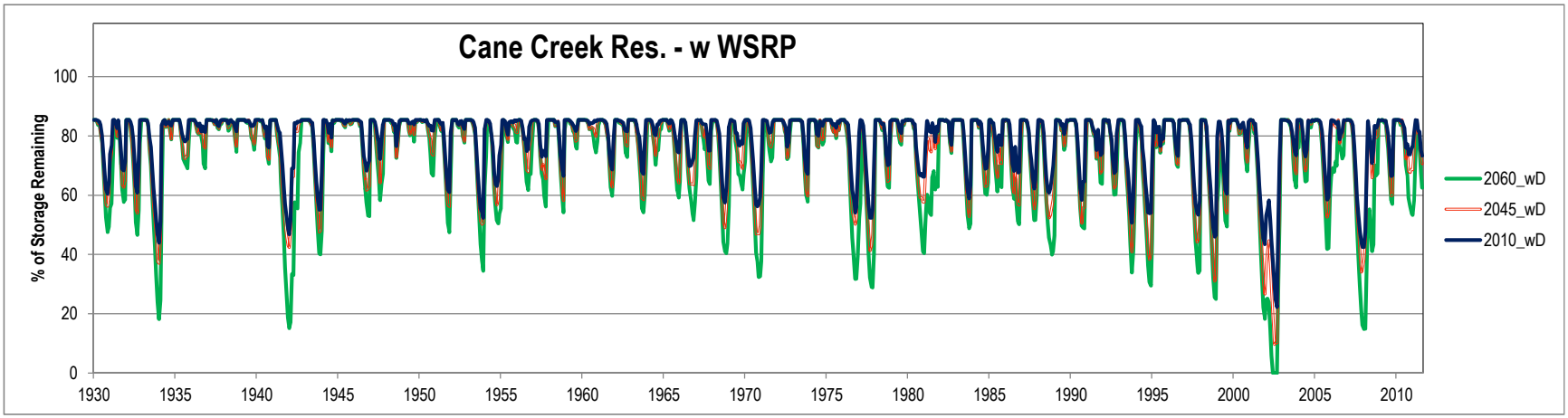




Partner: OWASA

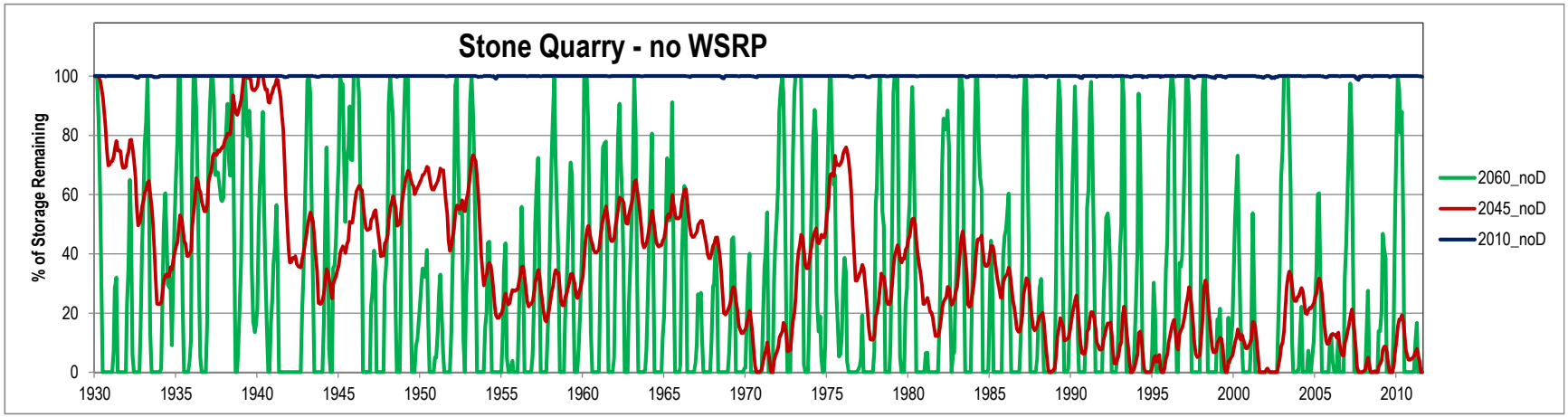
Cane Creek Reservoir Node 0390

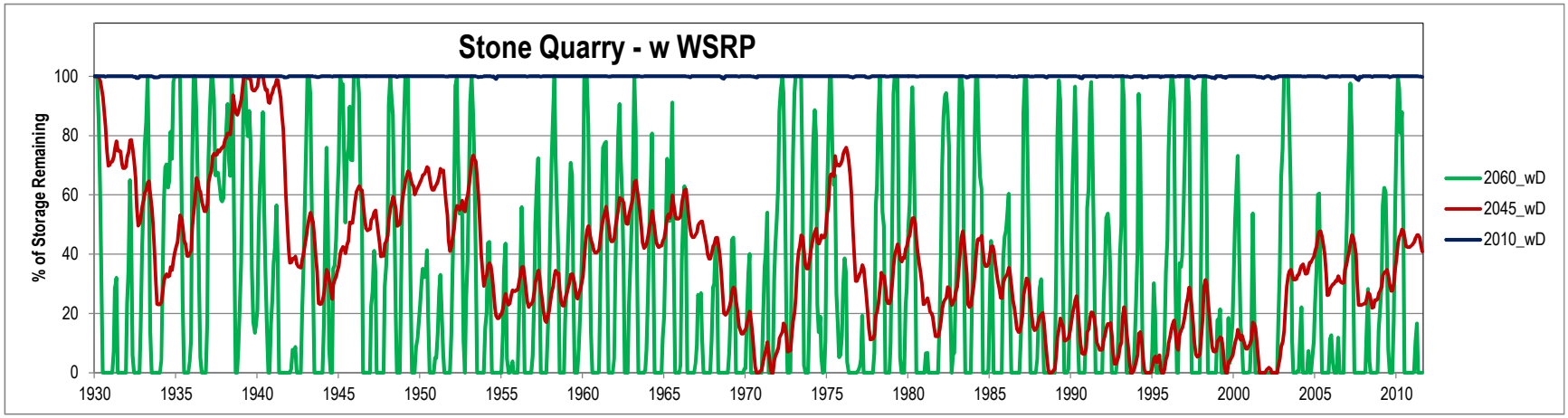




Partner: OWASA

OWASA Stone Quarry Node 0395 Note: Expanded in 2045, 2060

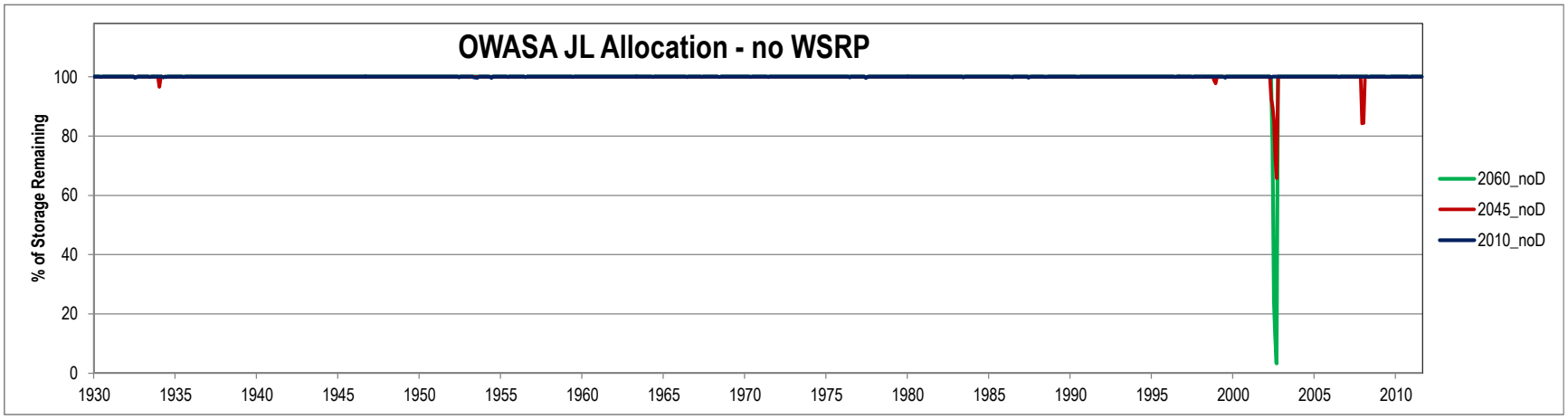


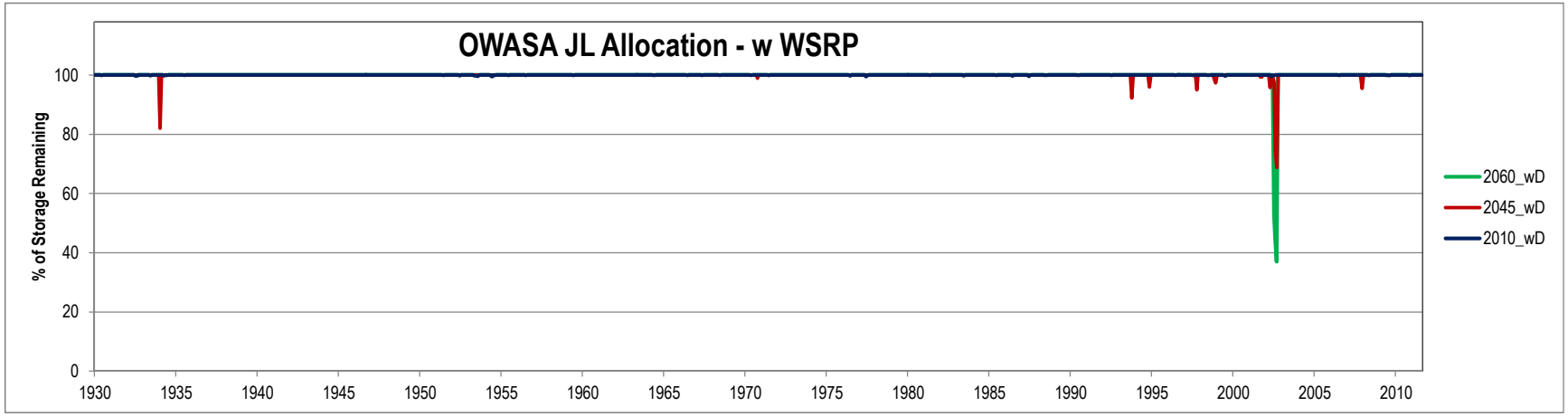


OWASA Jordan Lake Allocation

5% allocation

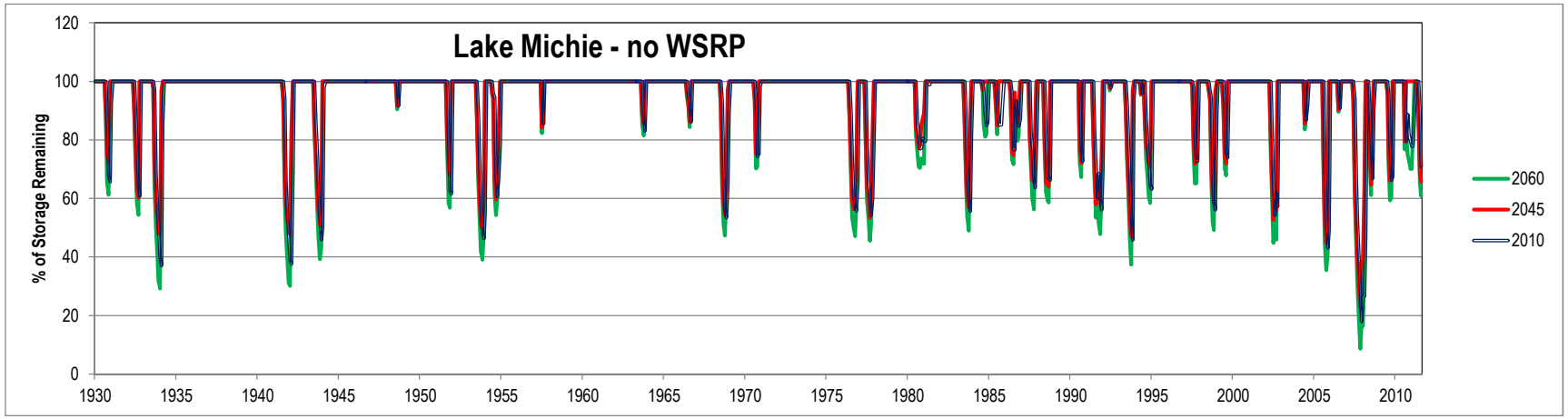
Notes: Emergency use only.

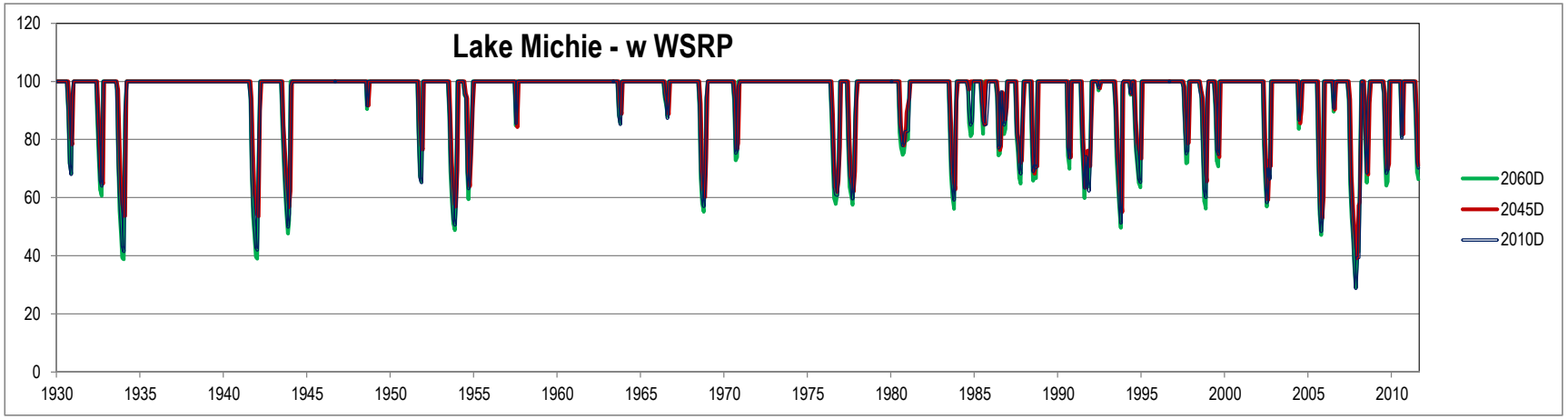




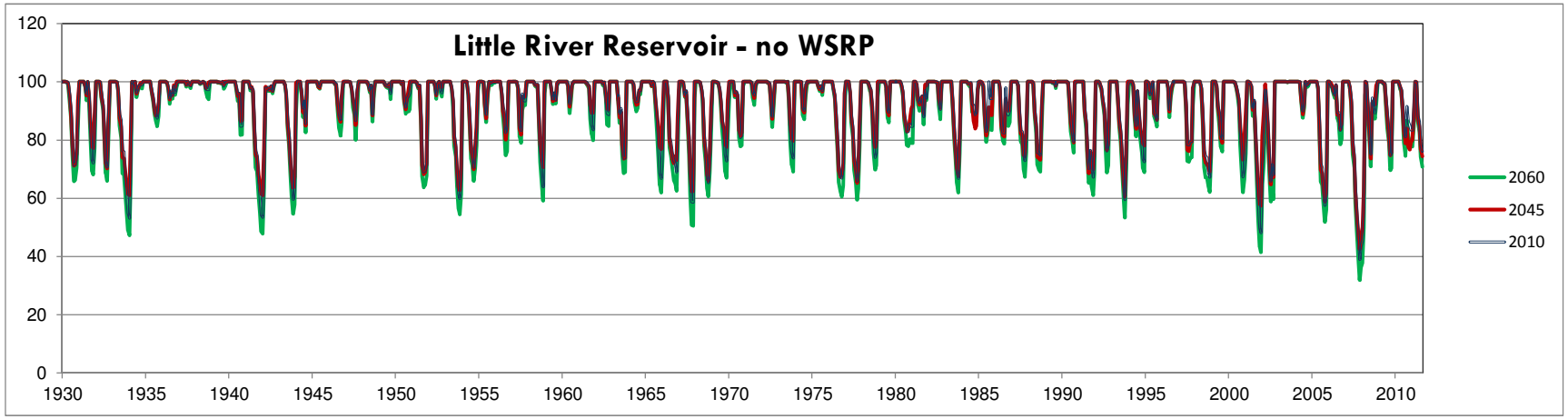
Partner: Durham

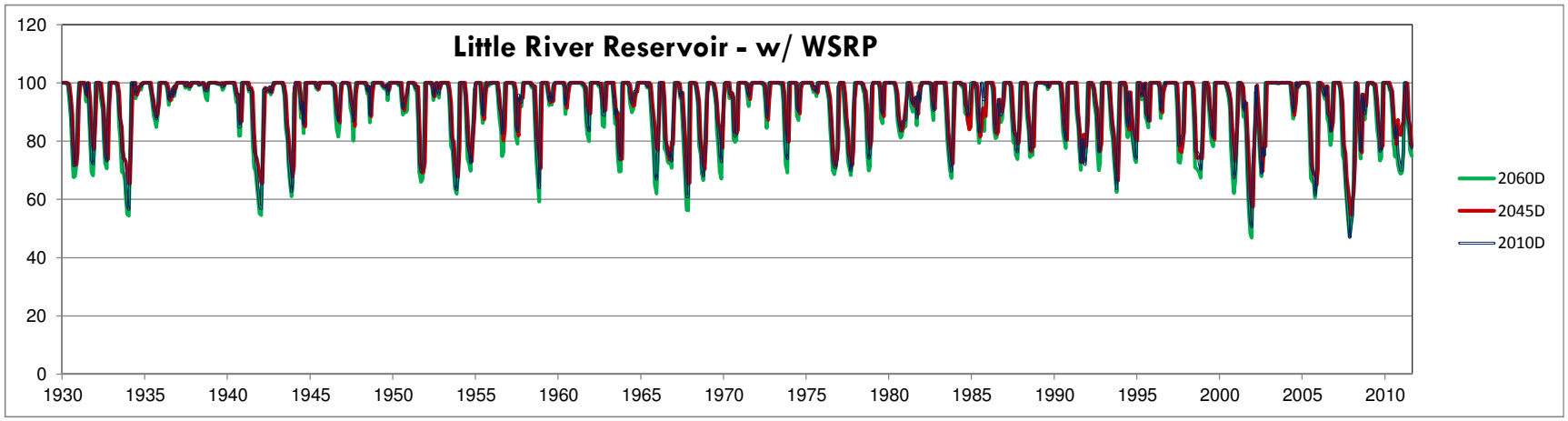
Lake Michie Node 1140



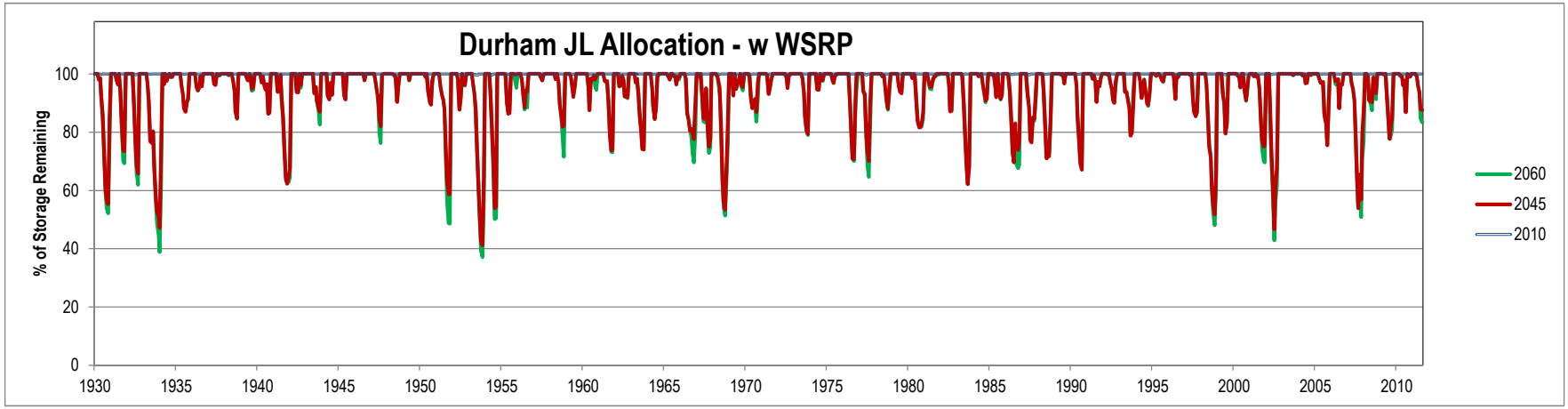


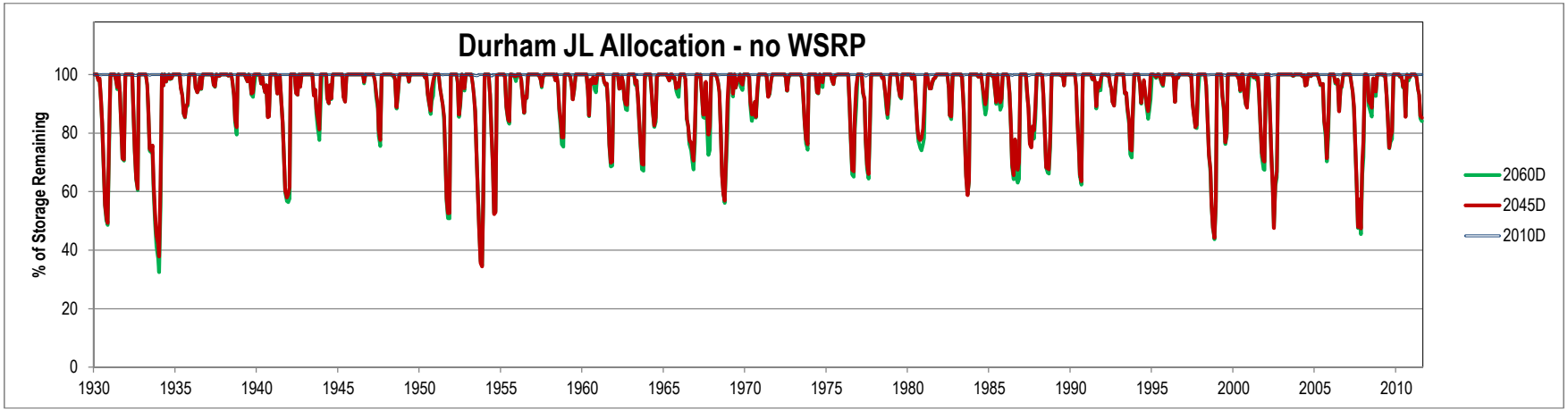
Partner: Durham
Little River Reservoir Node 1140





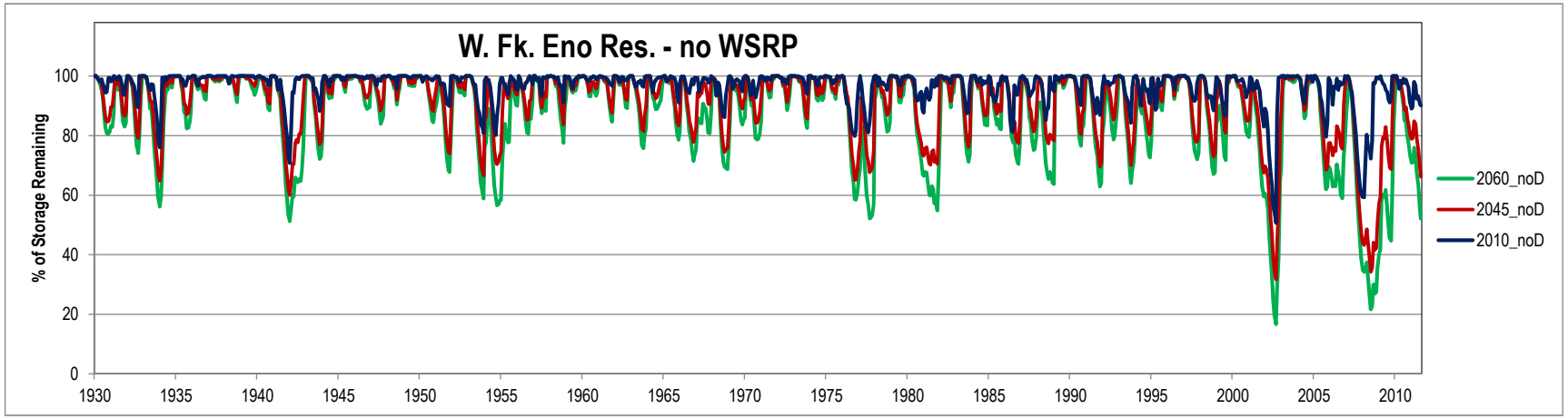
Durham Jordan Lake Allocation
10% allocation 2010, 16.5% allocation in 2045 & 2060

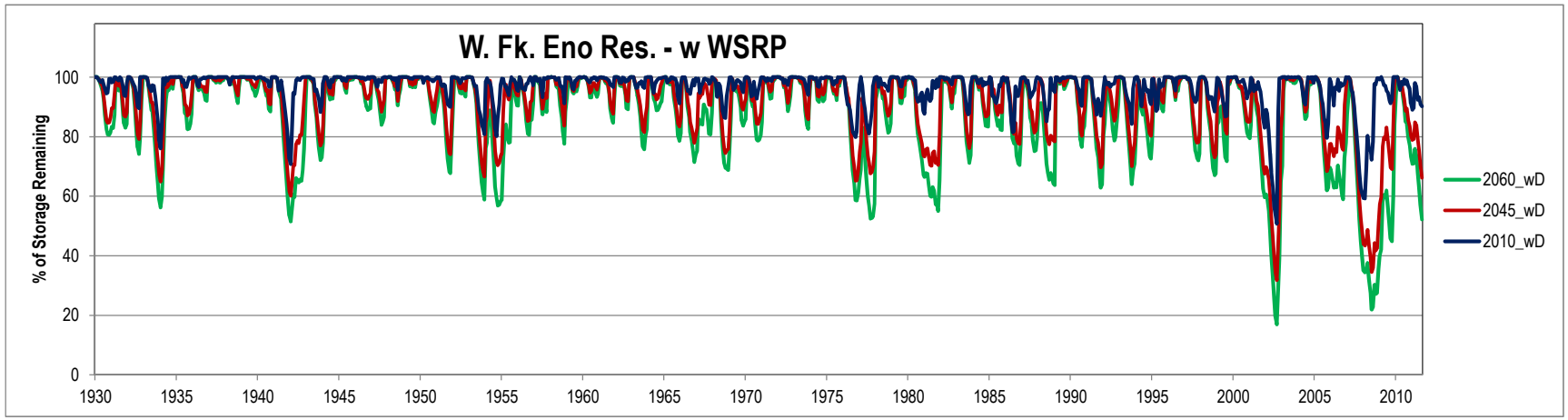




Partner: Hillsborough

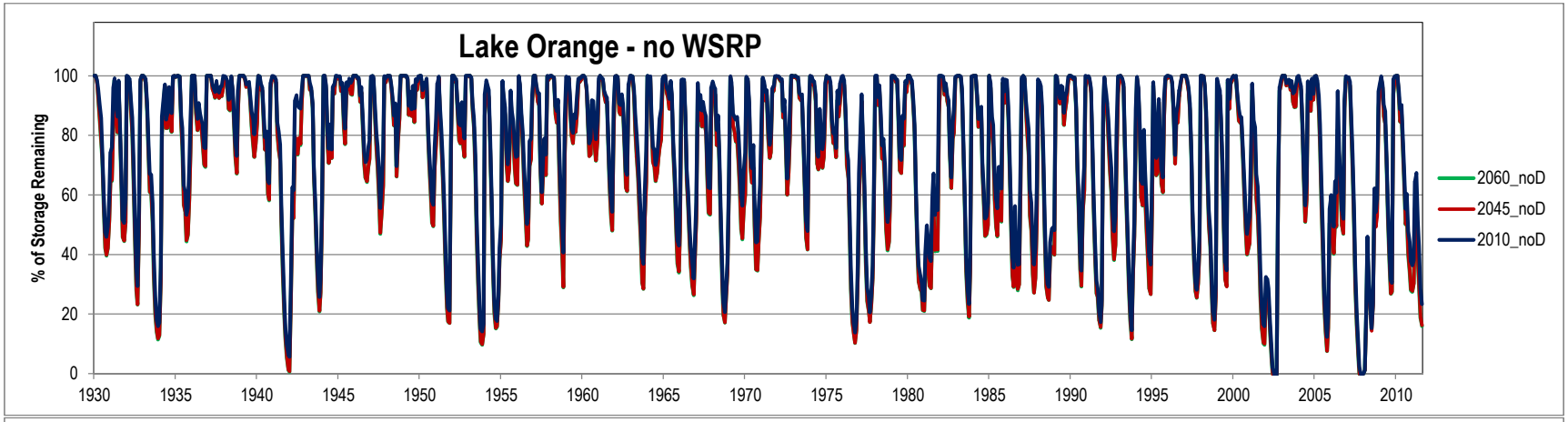
West Fork Eno Reservoir Node 1050 Notes: Expansion in ~2015 active for 2045, 2060 scenarios

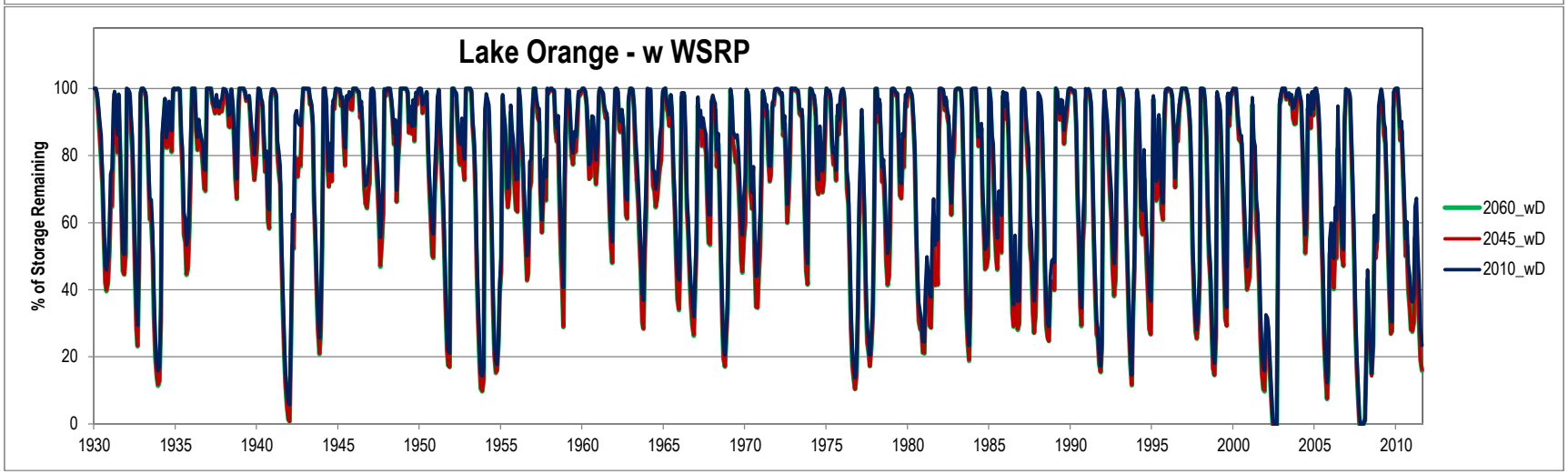




Partner: Hillsborough

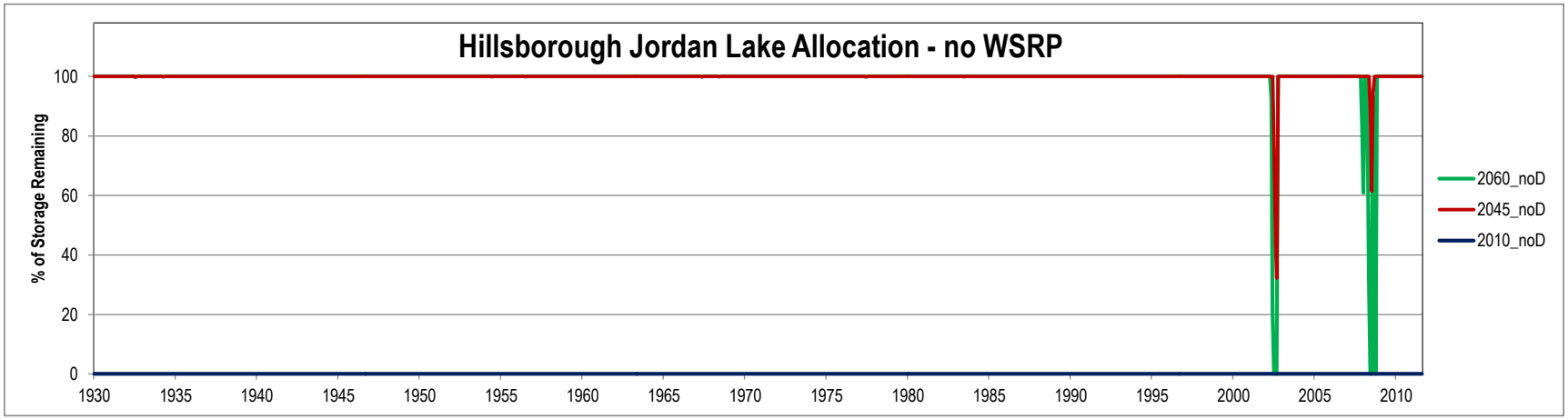
Lake Orange Node 1060 Notes: Operated by Orange County under Upper Eno operations plan

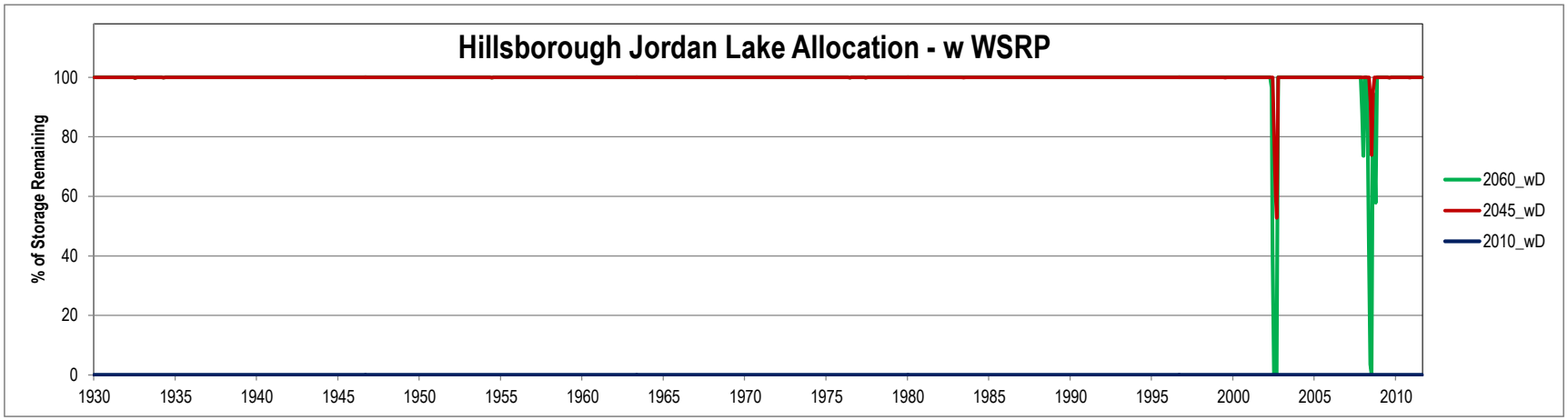




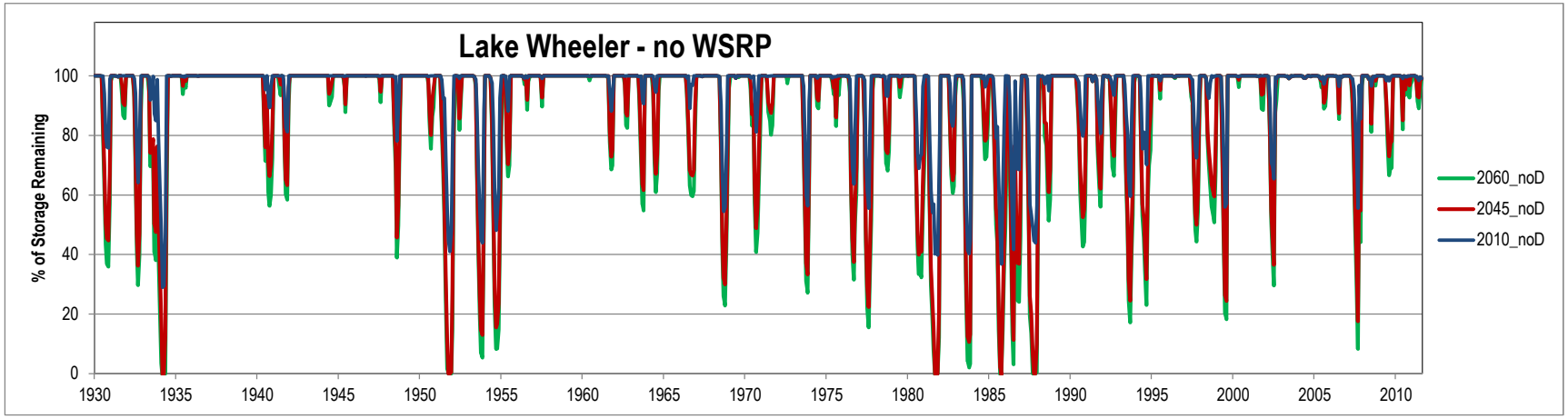
Hillsborough Jordan Lake Allocation
1% Allocation

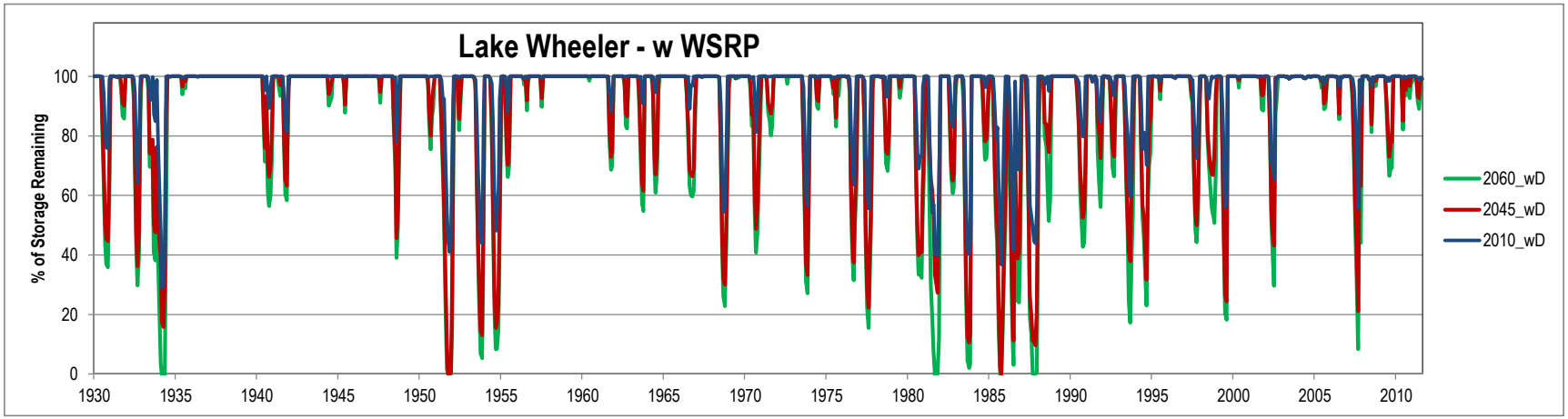
Notes: Emergency only. Active for 2045, 2060 scenarios.





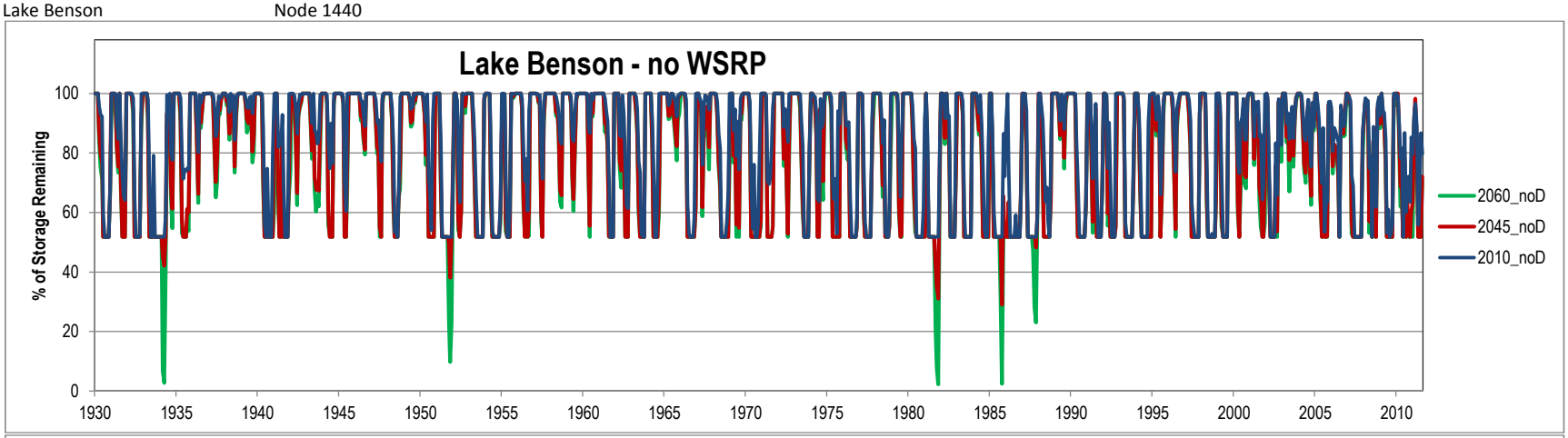
Partner: Raleigh
Lake Wheeler Node 1420

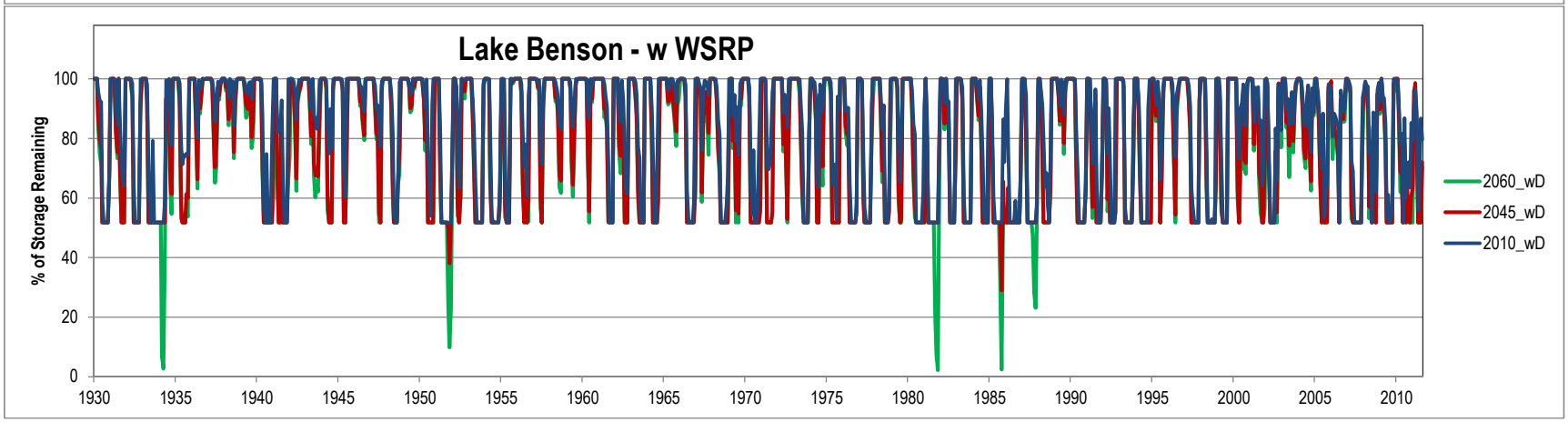




Partner: Raleigh

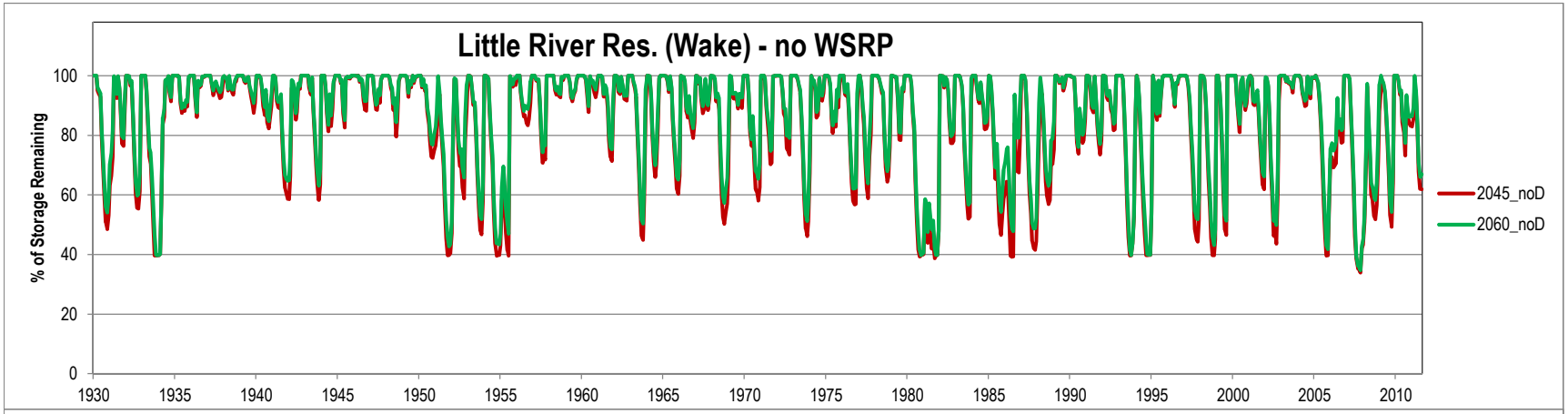
Lake Benson Node 1440

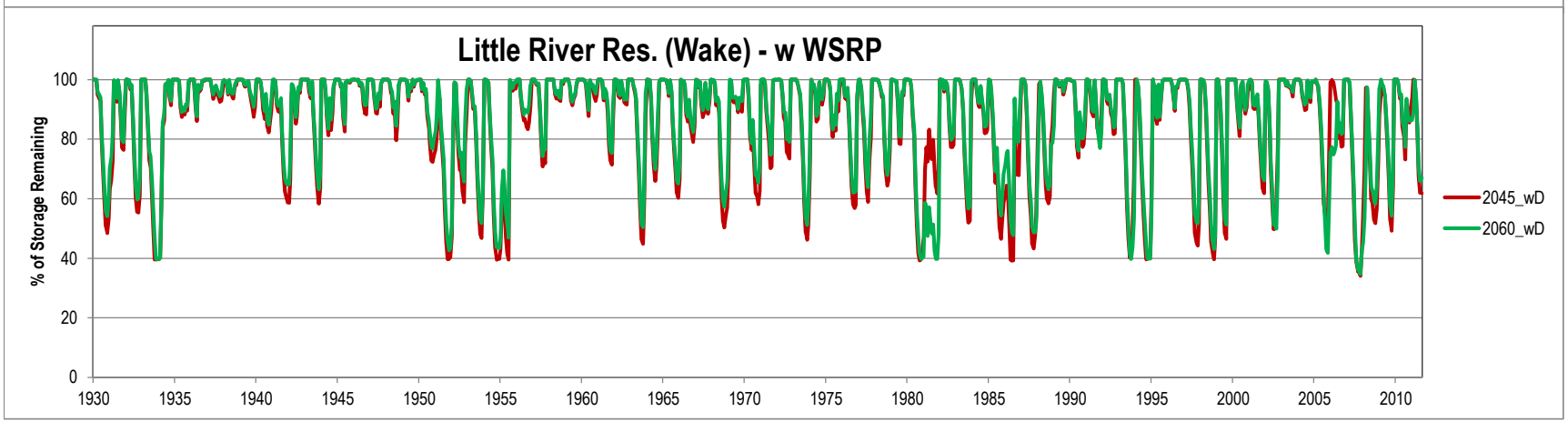




Partner: Raleigh

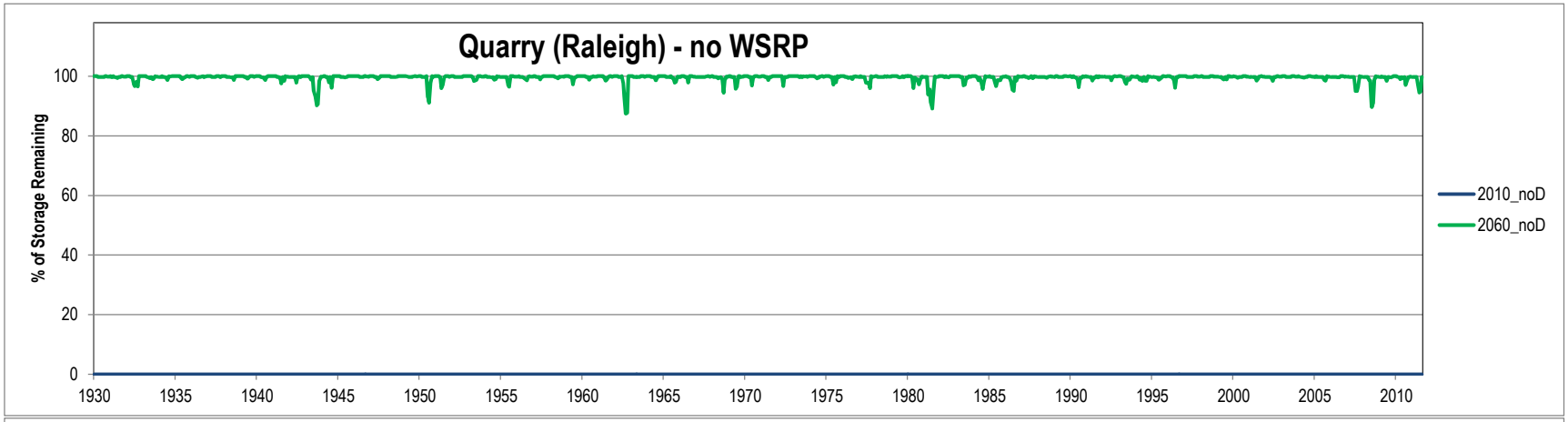
Little River Reservoir Node 1740 Notes: Active for 2045, 2060 scenarios

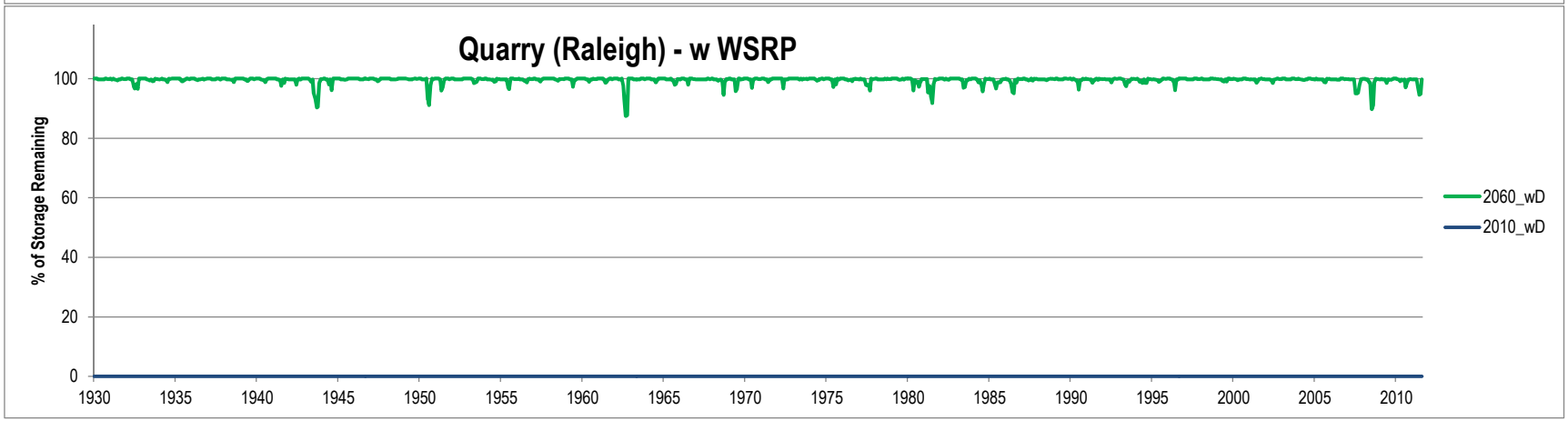




Partner: Raleigh

Quarry Reservoir Node 1295 Notes: Not active until 2060 scenario

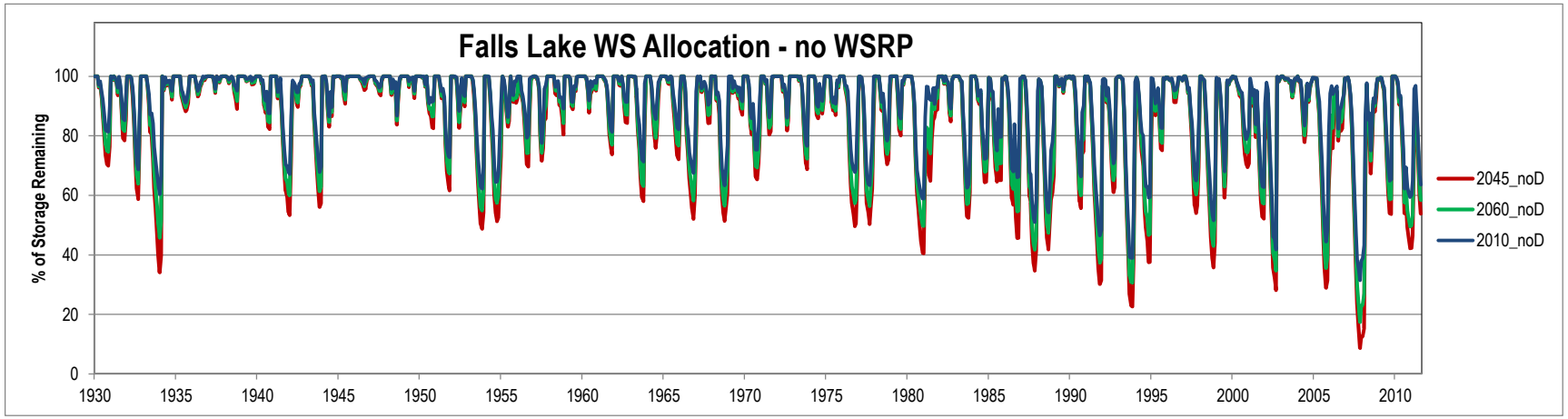


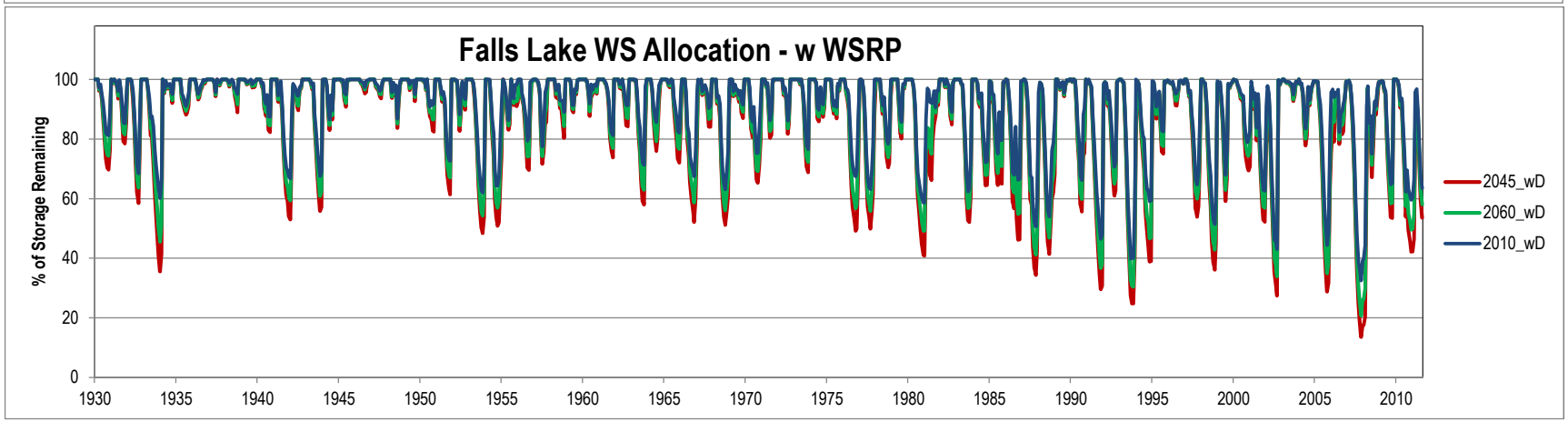


Partner: Raleigh

Falls Lake Storage Allocation

Notes: Allocation is larger in 2045 and 2060 than in 2010.

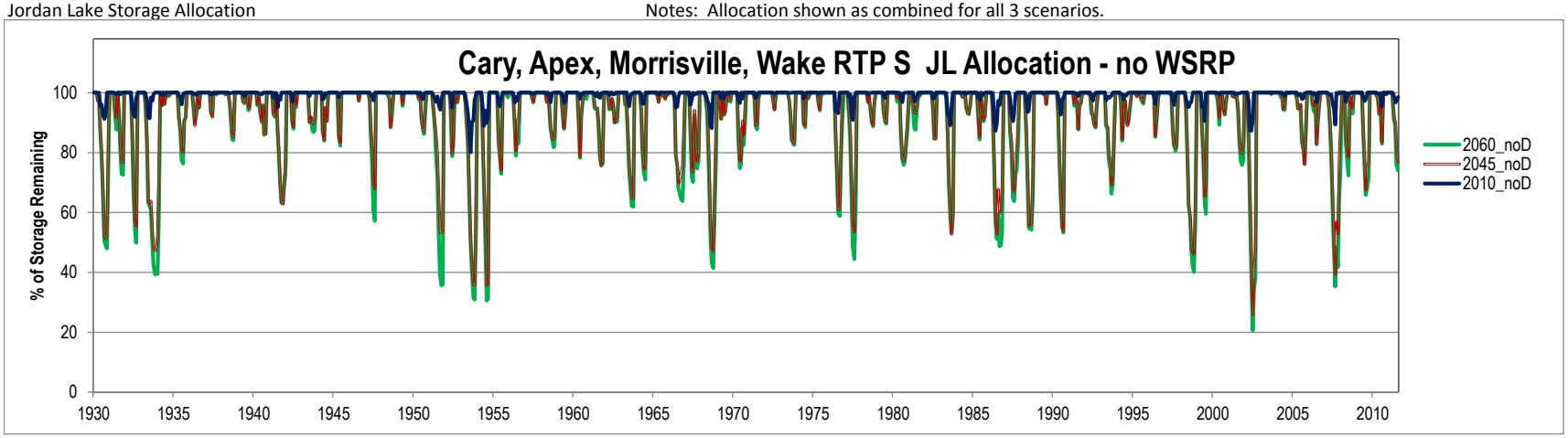


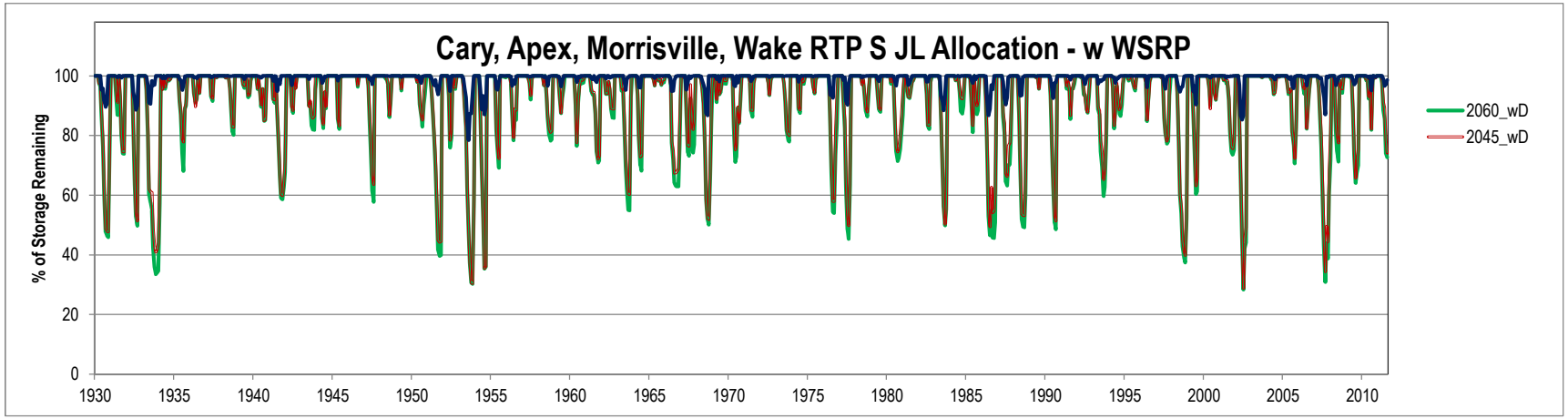


Partner: Cary, Apex, Morrisville and Wake County - RTP South

Jordan Lake Storage Allocation

Notes: Allocation shown as combined for all 3 scenarios.

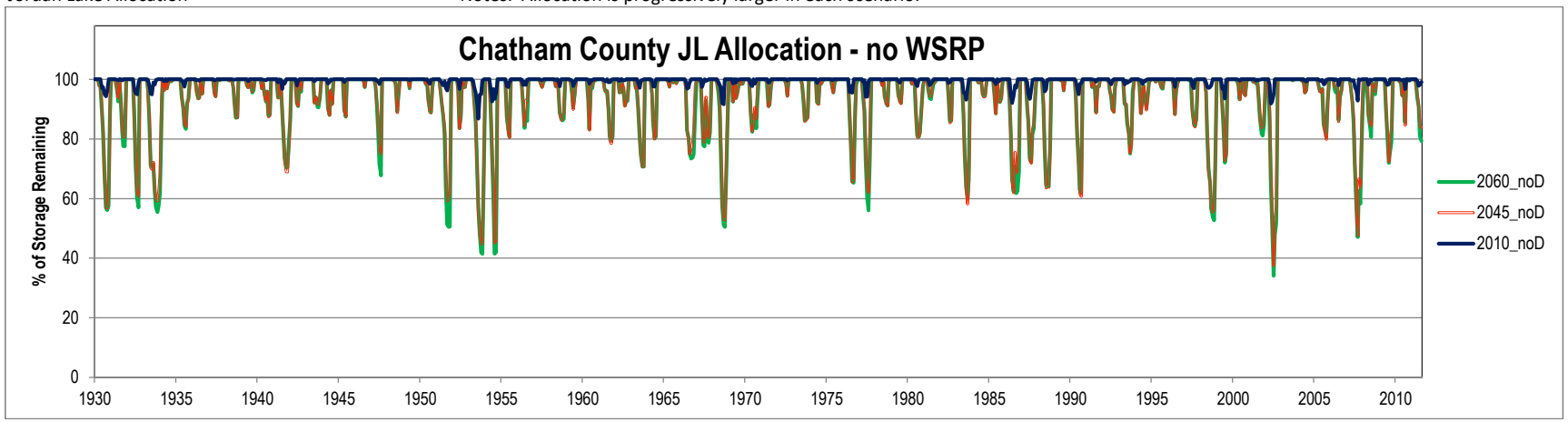


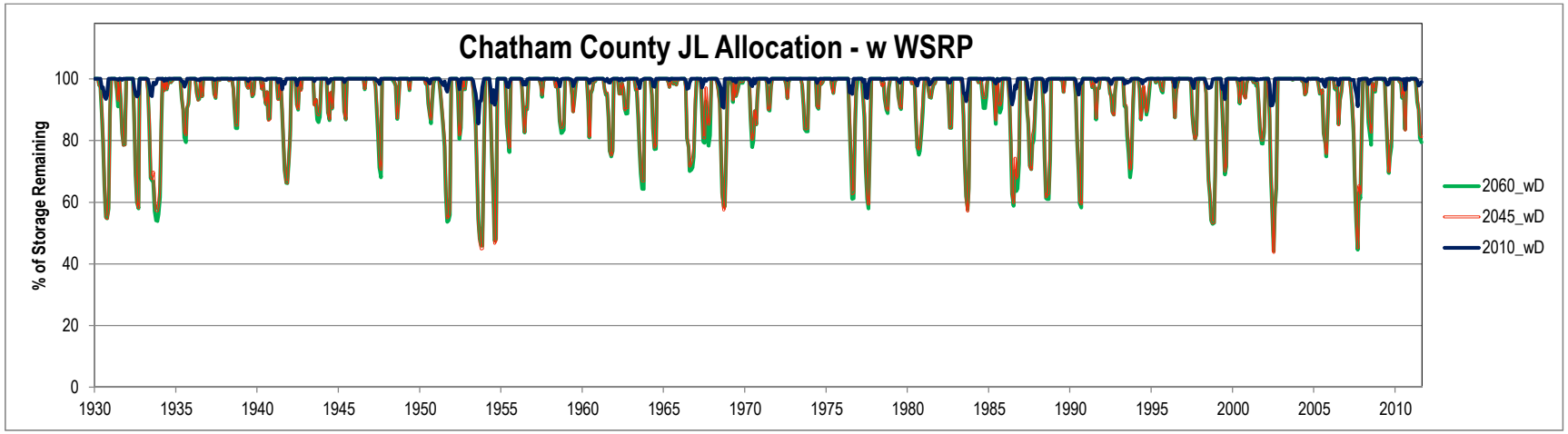


Partner: Chatham County North

Jordan Lake Allocation

Notes: Allocation is progressively larger in each scenario.

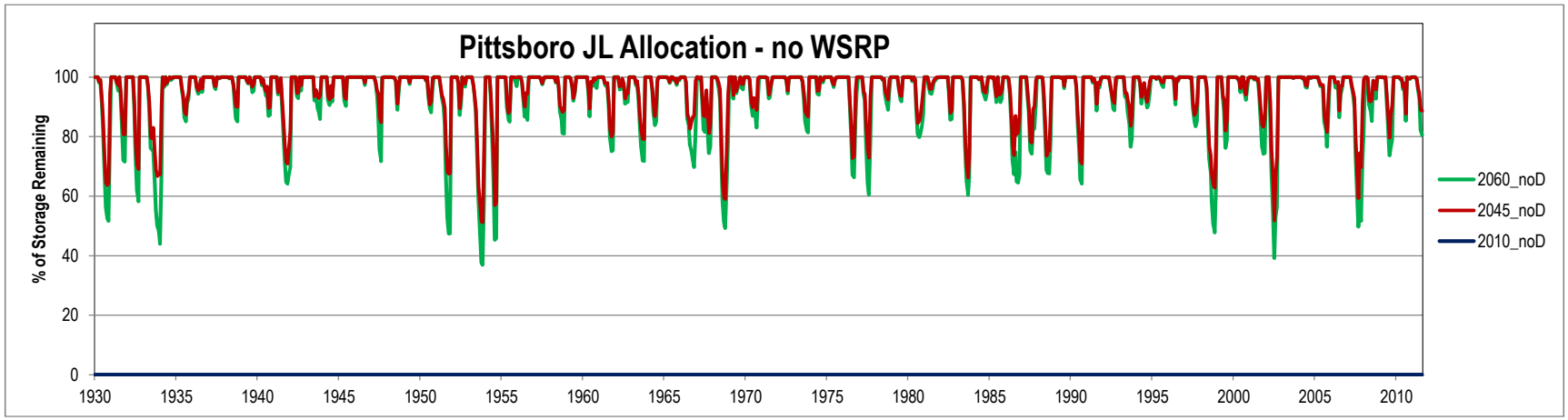


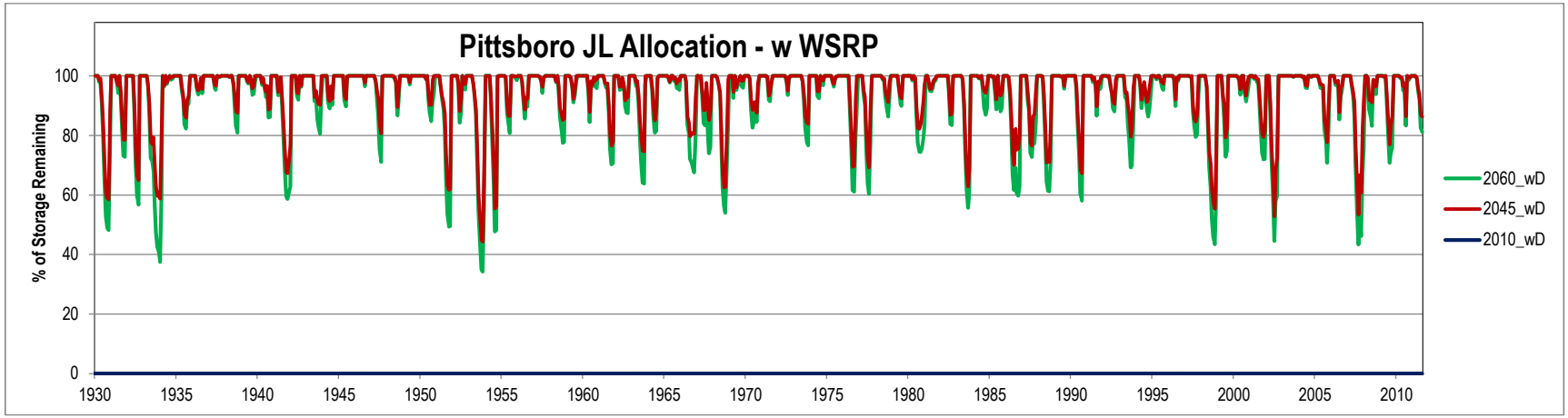


Partner: Pittsboro

Jordan Lake Allocation

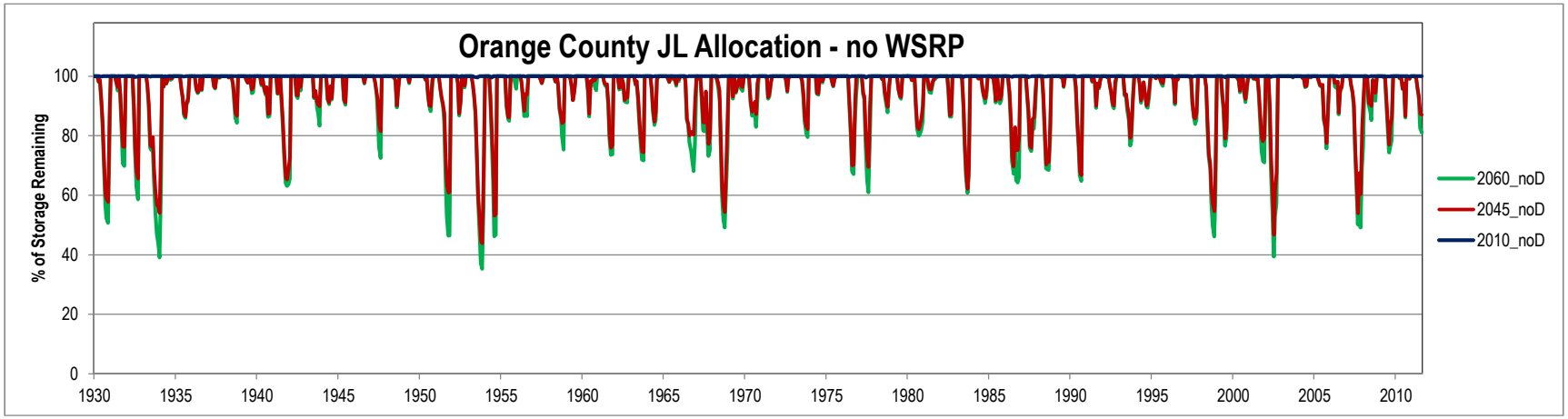
Notes: Pittsboro does not have an allocation in 2010.

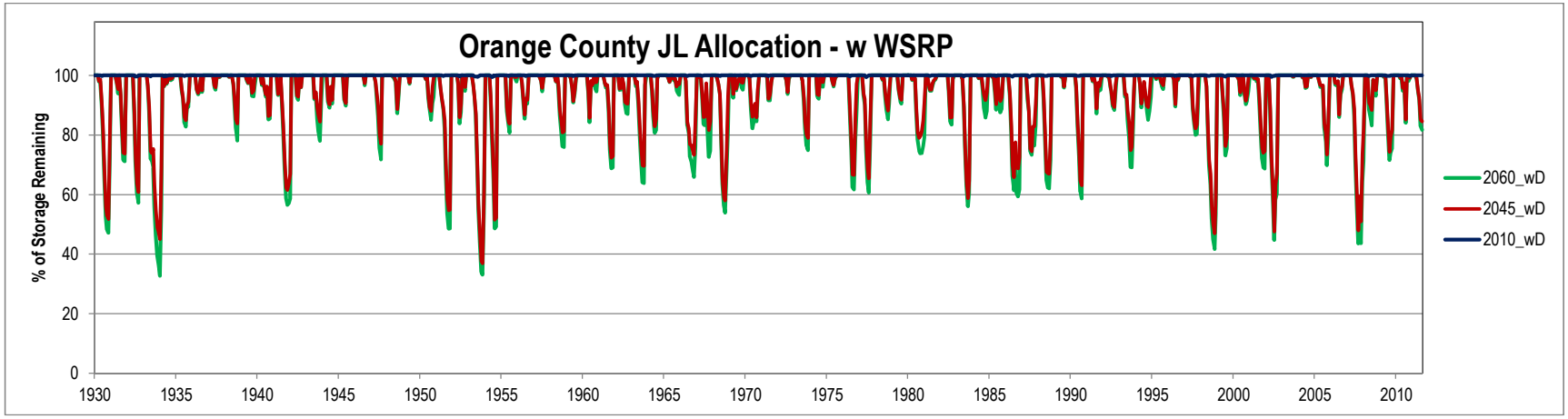




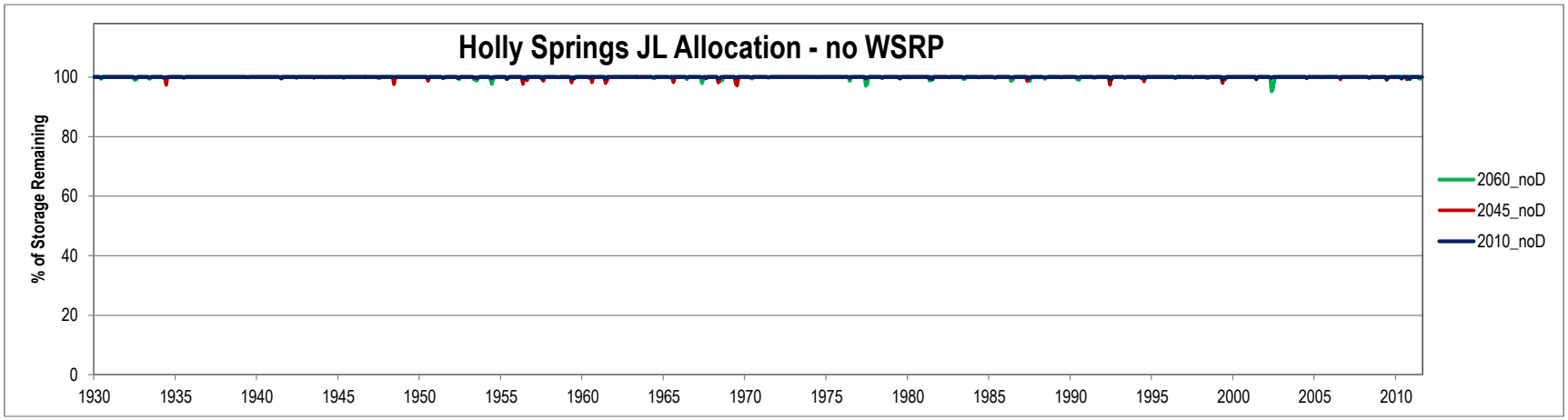
Partner: Orange County
Jordan Lake Allocation

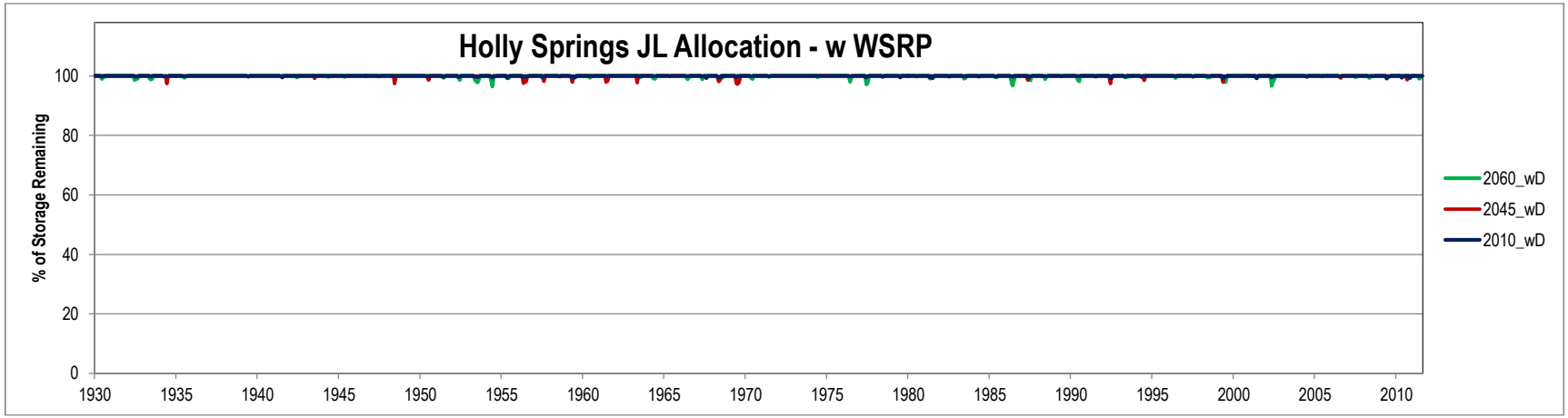
Notes: Orange County does not have a water system. Allocation will be transferred to other entities (Durham, Hillsborough).





Partner: Holly Springs
Jordan Lake Allocation





Appendix F.3 - Flow Changes on the Cape Fear and Neuse Rivers

This Appendix examines flow changes at several key locations on the Cape Fear and Neuse Rivers. The most upstream and downstream locations on each effectively bound the zone of influence of the JLP. In the Cape Fear, the zone of influence starts in the Haw River basin where Orange County gets some water from the Town of Mebane system. The most downstream location is the Cape Fear at Lillington. Below this point, any additional flow changes are not a result of JLP operations.

On the Neuse River, the entire Falls Lake contributing area is heavily influenced by the JLP, so it makes more sense to investigate locations below Falls Lake, starting at the Clayton gage. Below that point, most of the JLP influence stops at the Little River confluence, though a very small discharge into the Contentnea makes the zone of influence officially stop at the Neuse-Contentnea confluence.

Table F.3.1 - Key flow change locations on the Cape Fear River.

	Flow Statistic				
Cape Fear Station	20%	Median (50%)	Average	80%	Model Notes (arc)
C1 - Haw R upstream	121	301	688	810	0090>0100 + 0350>0360
C2 - Haw at Bynum	210	608	1196	1694	Inflow 0400
C3 - Jordan L. Inflow	256	729	1487	2066	0410>0470
C4 - Jordan L. Release	40	431	1539	2285	0470>0480
C5 - Cape Fear blw Sanford	554	993	2895	4596	0490>0495
C6 - Cape Fear blw Lillington	600	1149	3146	4996	0550>0555

Table F.3.2 - Key flow change locations on the Neuse River.

	Flow Statistic				
Neuse Station	20%	Median (50%)	Average	80%	Model Notes (arc)
N1 -at Clayton	276	465	1123	1461	1620>1630
N2 -at Smithfield	295	525	1155	1633	1640>1650
N3 - at Smith Cr. confluence	332	651	1338	1990	Inflow 1700
N4 -at Little R. confluence	523	1249	2422	3787	Inflow 1775
N5- at Goldsboro gage	517	1248	2420	3788	1780>1790
N6- Neuse at Kinston	644	1515	2771	4311	1800>1850
N7- blw Contentea confluence	899	2241	3996	6204	1850>1900

The flow changes are based on the flow in the 2010 scenario.

Several flow metrics are analyzed including the average flow, median (50th percentile), 20th percentile (20%), and 80th percentile (80%) flow. The following figures show these flow metrics at the indicated flow locations from the tables above. The 2010 scenario is shown.

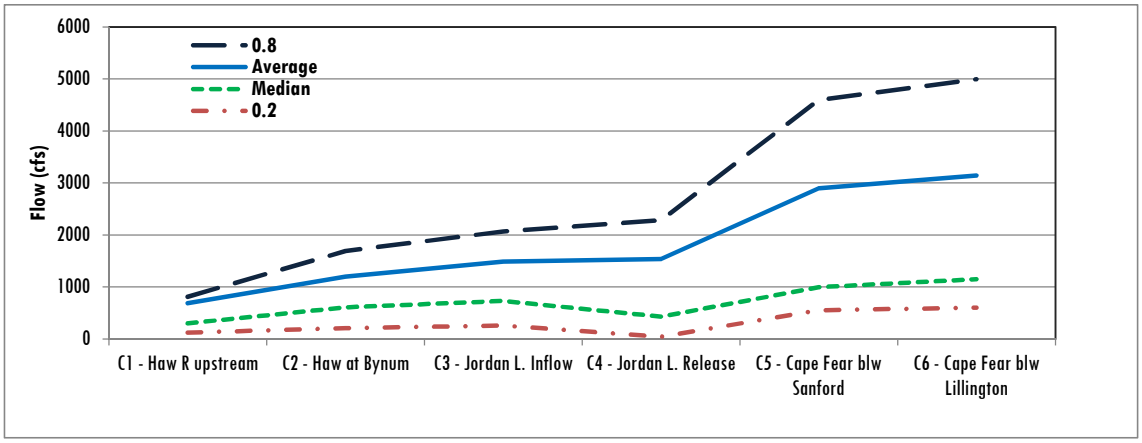


Figure F.3.1 -Plot of flow metrics versus location, Cape Fear River, 2010 scenario, no WSRP.

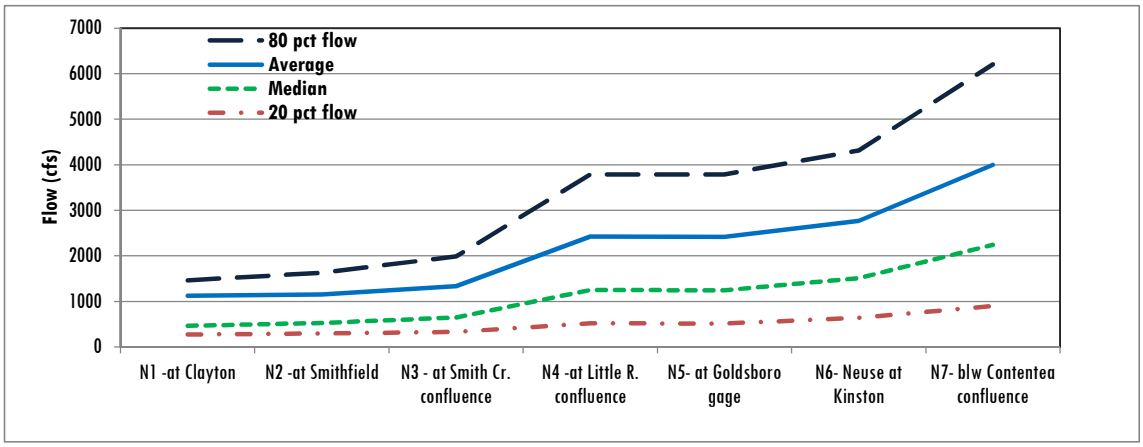


Figure F.3.1 -Plot of flow metrics versus location, Neuse River, 2010 scenario, no WSRP.

Changes in flow by scenario

The following plots show the difference in flow between scenarios for the flow statistics.
The difference is always current scenario minus 2010 scenario.
Scenarios with WSRP active are compared to 2010 scenario with WSRP.
Scenarios with no WSRP are compared to 2010 with no WSRP.
The left graph shows raw flow change, and the right graph the pecent change.

Average Flow

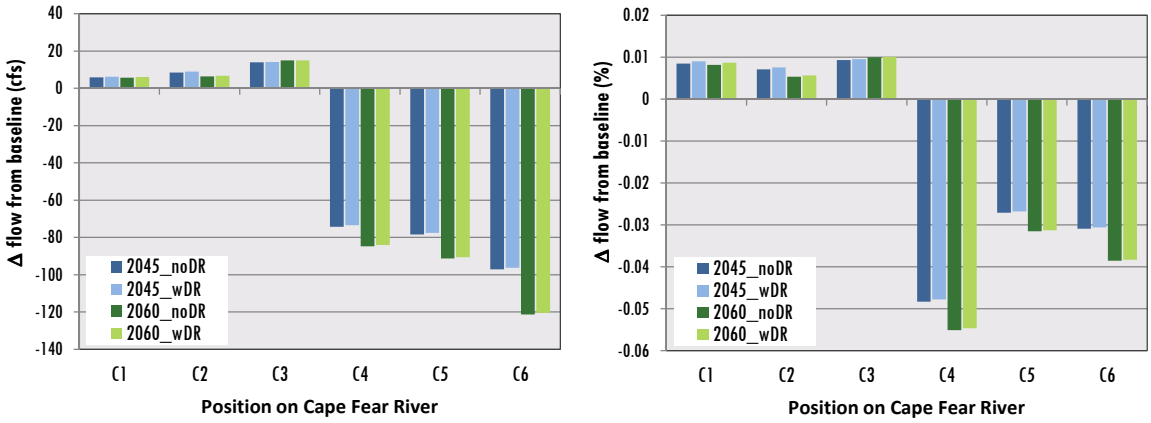


Figure F.3.3 - Change in average flow by scenario, Cape Fear River.

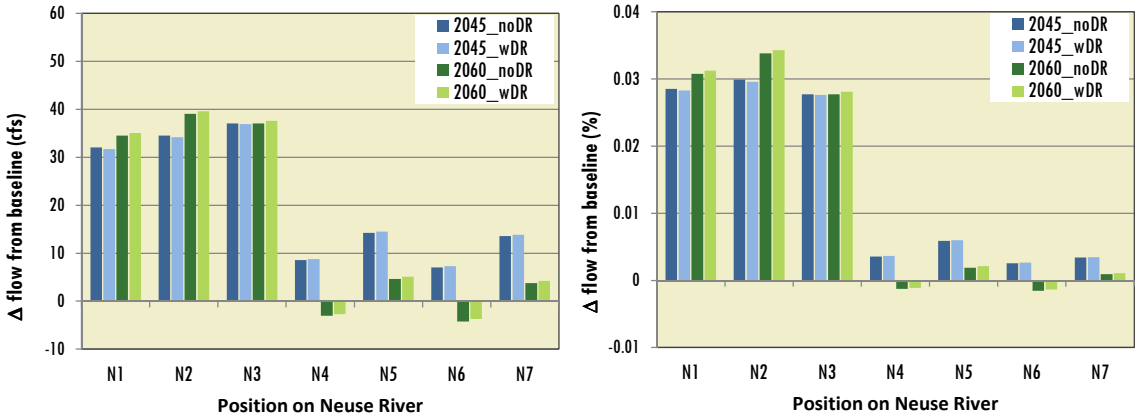


Figure F.3.4 - Change in average flow by scenario, Neuse River.

Median Flow

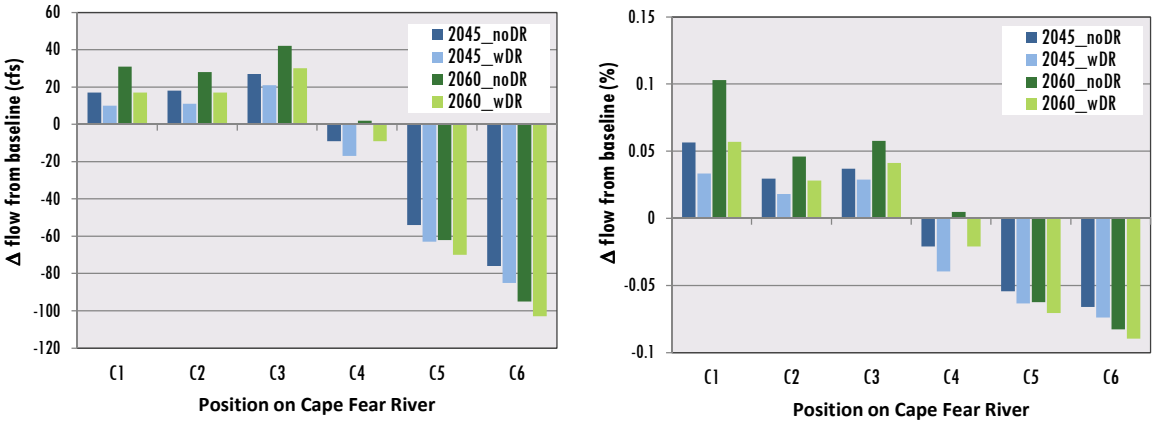


Figure F.3.5 - Change in Median flow by scenario, Cape Fear River.

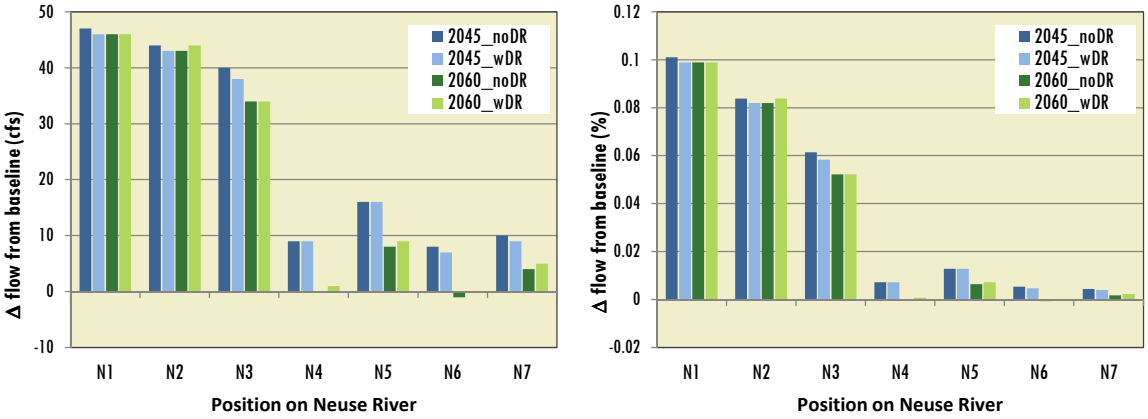


Figure F.3.6 - Change in Median flow by scenario, Neuse River.

80th percentile flow (high flows)

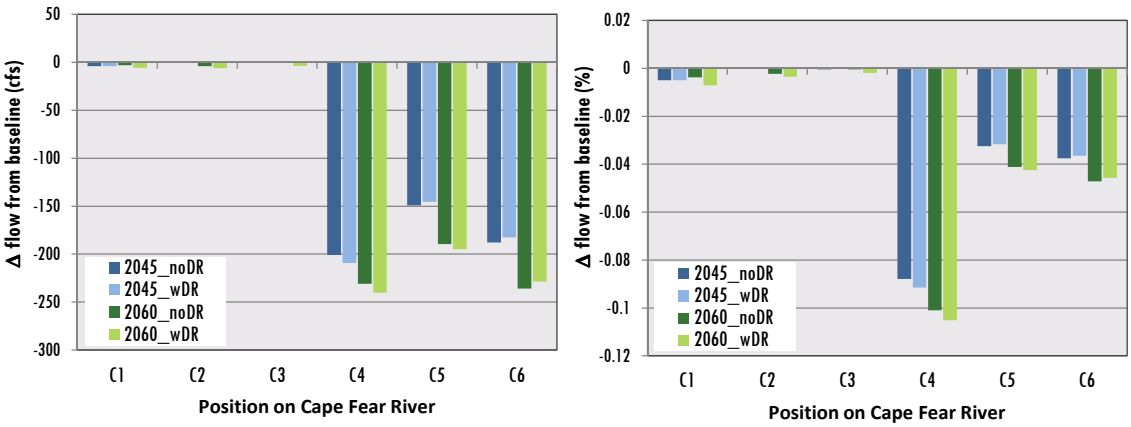


Figure F.3.7 - Change in 80th percentile flow by scenario, Cape Fear River.

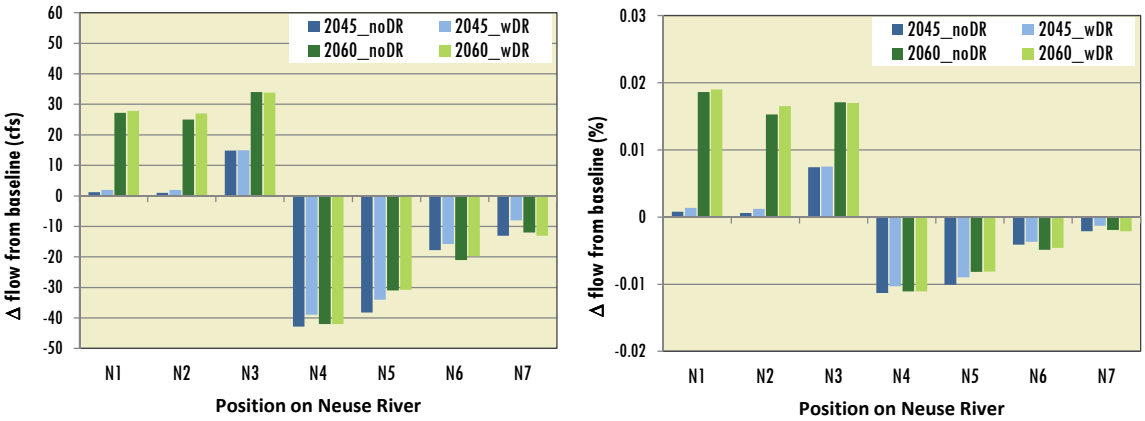


Figure F.3.8 - Change in 80th percentile flow by scenario, Neuse River.

20th percentile flow (low flow)

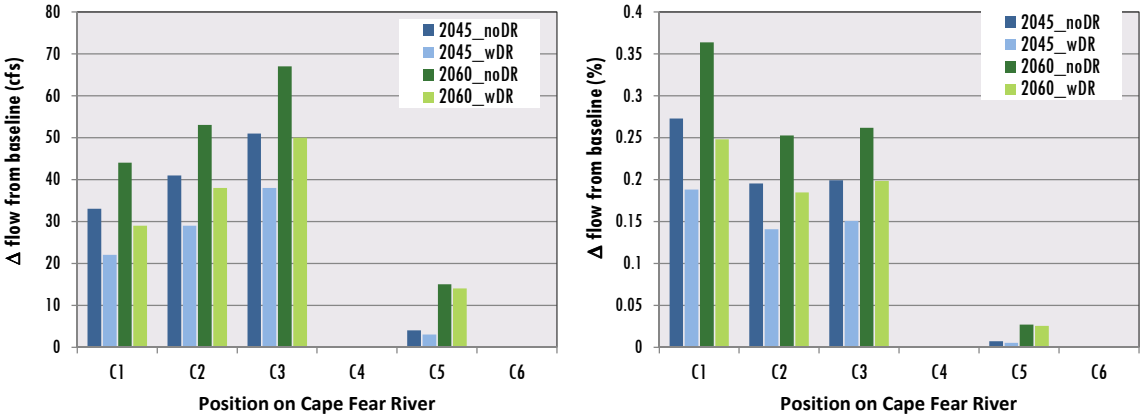


Figure F.3.9 - Change in 20th percentile flow by scenario, Cape Fear River.

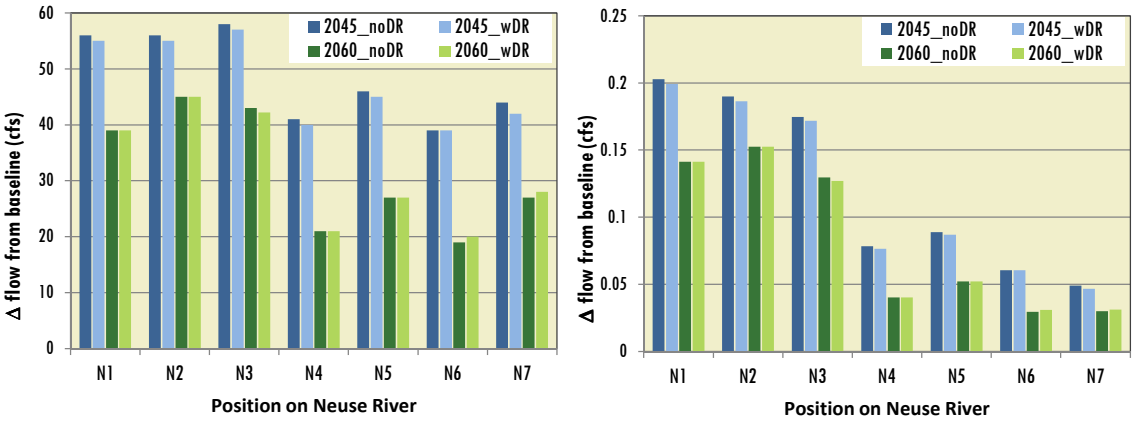


Figure F.3.10 - Change in 20th percentile flow by scenario, Neuse River.

Cumulative Distribution Plots for the Cape Fear and Neuse

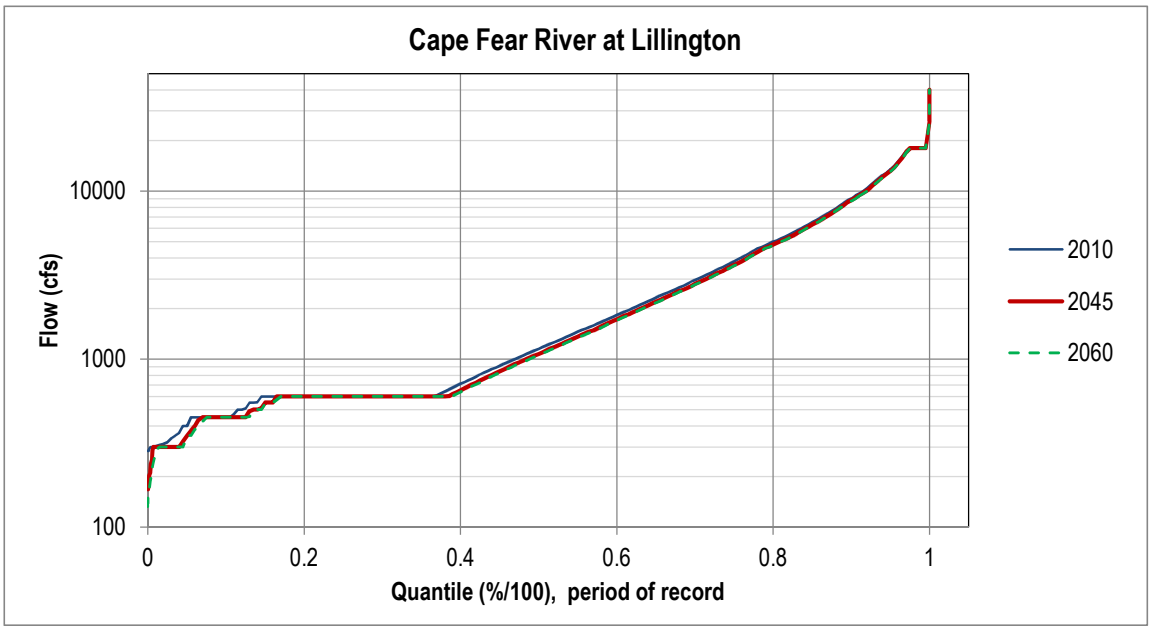


Figure F.3.11 - Cumulative distribution of flow, Cape Fear River at Lillington, by scenario.

The plot above shows that there is very little difference between the scenarios. The flow axis is shown with a logarithmic scale, as the differences are even harder to discern with a standard scale. For completeness, the difference between the 2010 and future scenarios is also plotted below, both as a raw difference and as a percent difference. Note that on the right side of the plots, the raw difference increases, but the percentage difference continues to decline.

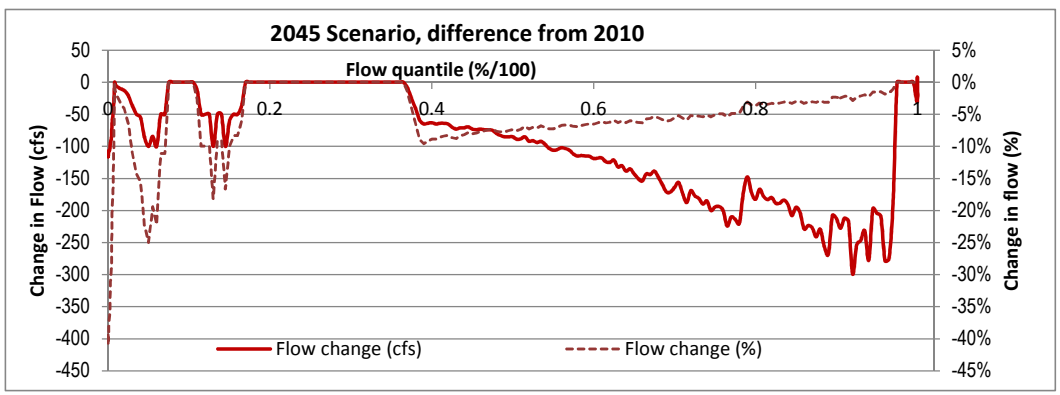


Figure F.3.12 -Difference between 2010 and 2045 cumulative flow distributions.

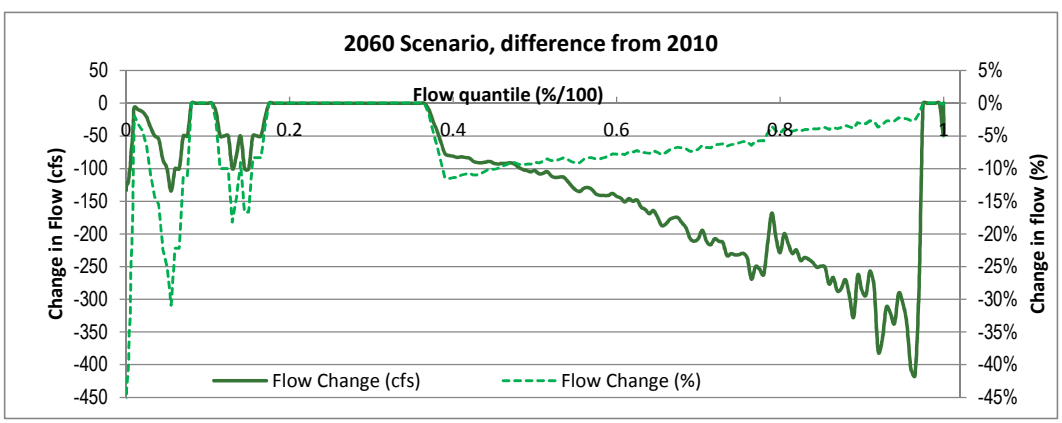


Figure F.3.13 - Difference between 2010 and 2060 cumulative flow distributions.

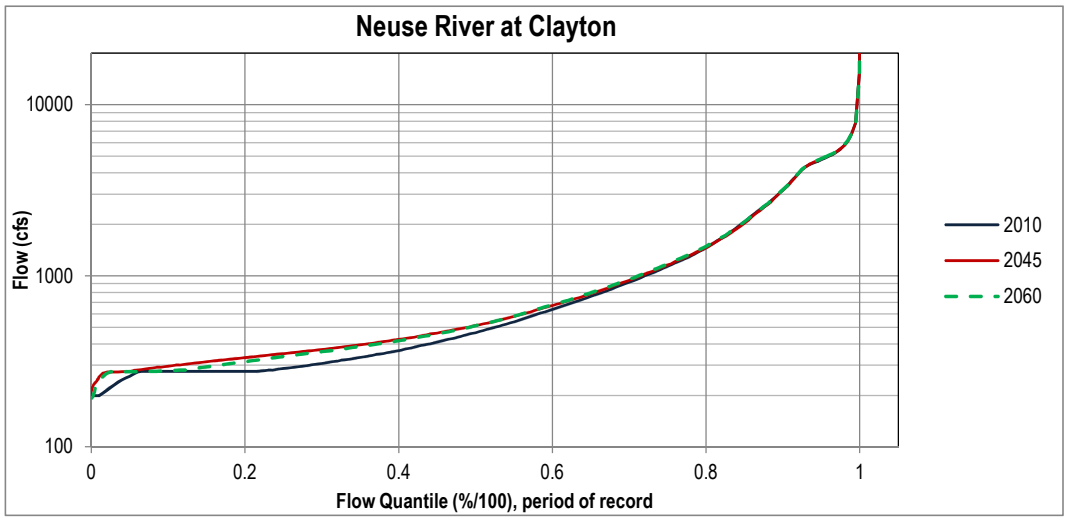


Figure F.3.14 - Cumulative distribution of flow, Neuse River at Clayton, by scenario.

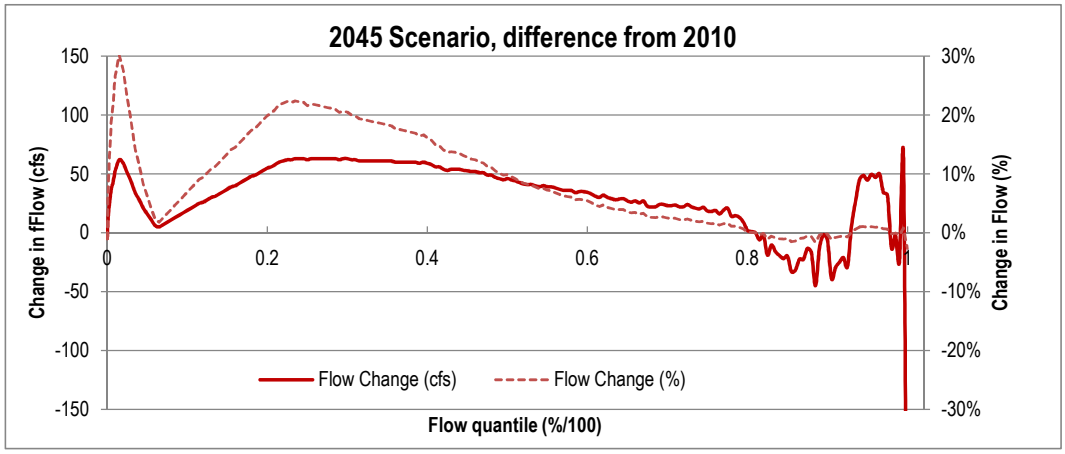


Figure F.3.15 - Difference between 2010 and 2045 cumulative flow distributions.

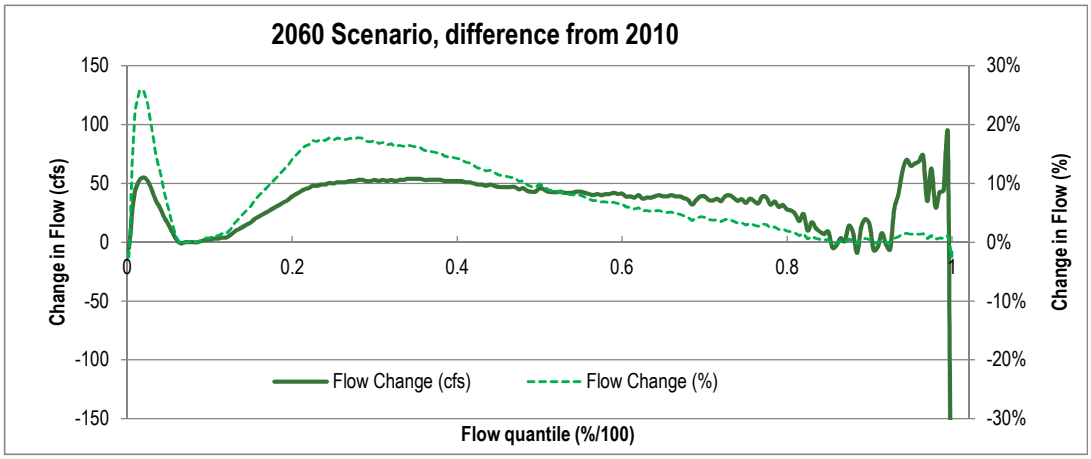


Figure F.3.16 - Difference between 2010 and 2060 cumulative flow distributions.

This page intentionally left blank.

This page intentionally left blank.

Prepared For:

Jordan Lake Partnership

http://www.jordanlakepartnership.org/

Prepared By:

Triangle J Council of Governments

http://www.tjcog.org

For more information contact:
Mike Schlegel
mschlegel@tjcog.org
(919) 295-0017