Executive Summary

The Town of Cary (Town) began operation of its reclaimed water system in 2001 and was the first utility in North Carolina to deliver reclaimed water for beneficial uses to homes and businesses to meet irrigation and cooling demands. Reclaimed water is a critical piece of the Town's overall water resources, serving the following goals:

- Reducing the peak demands on the potable water system to decrease or defer water treatment plant expansion;
- Reducing wastewater treatment plant discharge and loads into receiving waters;
- Assisting the Town's efforts to reduce per capita potable water use; and
- Reducing interbasin transfer (IBT).

To provide more current analysis and modeling of the reclaimed water system and create the basis for future planning decisions, the Town commissioned CDM Smith to perform a comprehensive Reclaimed Water Master Plan Update. The Reclaimed Water Master Plan Update was coordinated and integrated with the Town's Long Range Water Resources Plan (LRWRP) project.

E.1 Existing Reclaimed Water System

In 2010, the Town adopted an official policy, set forth in Policy Statement 132, to ensure the continued orderly expansion and effective utilization of the reclaimed water system. This policy defined three reclaimed water service areas**:** North Cary, South Cary, and West Cary. For new development occurring within those service areas, the developers are required to extend the reclaimed water system to the development and to install reclaimed water facilities for irrigation, cooling towers, and other potential secondary plumbing use within the property. If reclaimed water is not available to the site at the time of development, the secondary water use facilities may be temporarily supplied with potable water until reclaimed water is available, at which time they will be converted to the reclaimed system. A description of the three reclaimed water service areas and the existing facilities within those areas follows.

North Cary Reclaimed Water Service Area: The North Cary service area includes 12.5 miles of distribution pipeline ranging in diameter from 4 to 20 inches which provide reclaimed water to approximately 495 residences and 51 commercial customers. Commercial customers account for approximately 60 percent of the billed reclaimed water usage in the North Cary service area. Landscape and lawn irrigation makes up the majority of the reclaimed water demand, however, several commercial customers use reclaimed water for cooling towers. Reclaimed water in the North Cary service area is supplied from the North Cary Water Reclamation Facility (NCWRF). The historical maximum annual volume of reclaimed water pumped from the NCWRF (excluding the non-potable on-site usage at the NCWRF) is 187 million gallons.

South Cary Reclaimed Water Service Area: The South Cary service area includes 4.6 miles of pipeline ranging in diameter from 4 to 12 inches which provide reclaimed water for irrigation to approximately 85 residential customers in the West Lake area as well as irrigation of the homeowner's association common areas. The largest users in the service area are the Middle Creek

Park and Middle Creek School, which both use reclaimed water for irrigation of recreational fields. These two users account for approximately 40 percent of the billed usage in the South Cary service area. Reclaimed water in the South Cary service area is supplied from the South Cary Water Reclamation Facility (SCWRF). The historical maximum annual volume of reclaimed water pumped from the SCWRF, including reclaimed water for on-site usage at the SCWRF, is 125 million gallons.

West Cary Reclaimed Water Service Area: The Town of Cary, Wake County, and Durham County are jointly implementing the Jordan Lake Water Reclamation and Reuse (JLWR) Project. This project will initially provide reclaimed water from Durham County's Triangle Wastewater Treatment Plant (TWWTP) to customers within the West Cary service area. The JLWR pipeline is being constructed in two phases. Phase 1 delivers reclaimed water to McCrimmon Parkway, including RTP South. Construction of this phase is complete and, since the spring of 2012, reclaimed water from the TWWTP has been delivered through this portion of the pipeline. Phase 2 will deliver reclaimed water south from McCrimmon Parkway to Thomas Brooks Park, with construction expected to be complete in 2014. The planned distribution system consists of 21.8 miles of pipeline ranging in diameter from 4 to 20 inches which will provide reclaimed water for irrigation and cooling water to commercial and residential customers. In the future, the Town plans to provide reclaimed water to this service area from the NCWRF.

E.2 Analysis of Existing Reclaimed Water Demands

Recent reclaimed water billing and pumping records and individual customer metering data were analyzed to determine current demands on the reclaimed water system and system-specific peaking factors related to seasonal and diurnal variations in reclaimed water usage.

Historically, the billed customer usage accounts for only approximately 20 to 35 percent of the annual pumped reclaimed water. The remainder is attributed to non-revenue water (NRW) uses such as on-site non-potable use at the Town's WRFs, bulk water distribution, blowoffs to maintain water quality in the system, and system losses. The 2010 customer meter billing data serves as a baseline for projecting future demand as well as allocating customer demands in the hydraulic model because it represents the historical maximum demand. In 2010, the average annual pumped reclaimed water was 1.06 mgd and average annual billed reclaimed water was 0.26 mgd.

The following peaking factors were determined for the Town's reclaimed water system and represent recent trends of overall reclaimed water use by customers within both the North Cary and South Cary service areas:

- Winter Seasonal Factor (November through April: Average Annual) = 0.3
- Summer Seasonal Peaking Factor (May through October: Average Annual) = 1.6
- Maximum Month Peaking Factor (Max Month: Average Annual) = 2.4
- Maximum Day Peaking Factor (Max Day: Average Annual) = 3.4
- Peak Hour Factor (Maximum Hour: Average Annual) = 8.5

These peaking factors describe existing demands for reclaimed water on a system-wide basis. However, reclaimed water usage can vary significantly among individual customers. To quantify reclaimed water usage patterns of specific large volume customers, the Town performed monitoring of reclaimed water use during the summers of 2010 and 2011 for a total of 26 customers. The meter monitoring data was summarized into hourly flow and compared to the daily average flow in order to

develop unit diurnal patterns for reclaimed water usage throughout the day for the monitored customers. A generalized diurnal pattern was developed for all remaining residential and commercial customers within each service area that were not monitored directly using an hourly mass balance approach. For most monitored customers, peak reclaimed water usage occurs between the hours of 8 p.m. and 6 a.m. The generalized diurnal pattern peaks at 5 a.m. The diurnal curves were used for hydraulic modeling of the reclaimed water system.

E.3 Future Reclaimed Water Demand Scenarios

In conjunction with the Town's LRWRP project, several future scenarios for expansion of the Town's reclaimed water system were developed through the year 2060. For all scenarios, it was assumed that reclaimed water from the Durham County TWWTP would not be supplied to the Town in the future and a new pipeline will be constructed to join the North and West service areas (NW Connector) in order to enable the supply of reclaimed water from the NCWRF into the West Cary service area. The scenarios are described as follows:

Scenario 1: Reclaimed water system to provide reclaimed water for non-potable demands for existing customers and future customers located adjacent to existing and already funded reclaimed water lines, as well as the proposed NW Connector. This includes the JLWRP Phase 1 and 2 reclaimed water pipelines in the current West Cary service area.

Scenario 2: Reclaimed water system to provide reclaimed water for all end uses of water that can be met by non-potable water (existing and future customers) throughout the Town's entire Urban Service Area.

Scenario 3: Reclaimed water system to provide reclaimed water for all end uses of water that can be met by non-potable water (existing and future customers) throughout the 2010 adopted reclaimed water service area, as defined in the Town's Policy Statement 132, as well the service area extension adjacent to the proposed NW Connector.

Scenario 4: Balance the extent of the reclaimed water service area and targeted end uses with the future available reclaimed water supply. Reclaimed water is provided for as much of the 2010 adopted service area and NW Connector service area extension as is available through 2060. This scenario was developed in two parts. Scenario 4.1 represents the primary portion of the area to be served under Scenario 4. Additional secondary demands that may potentially be added to the reclaimed water system on a first-come, first-served basis are identified under Scenario 4.2.

As part of the LRWRP, average annual reclaimed water demands were developed specific to each scenario for various planning years through 2060 (buildout). Future reclaimed water demands were developed for existing reclaimed water customers, existing potable water customers that may be retrofitted to use reclaimed water, and future customers. Reclaimed water demands include irrigation use for all customer types and cooling/heating and toilet flushing use for institutional/commercial/industrial customer types. Maximum day demand projections were developed by applying the peaking factors determined through analysis of the existing system demands: 3.4 for irrigation, 2.5 for cooling/heating (based on metering of existing cooling tower use), and 1.0 for toilet flushing since it is not seasonal in nature. Estimates of non-revenue reclaimed water including WRF non-potable water use and miscellaneous water use were added to the demand projections.

The maximum day demands were then compared with the maximum reclaimed water supply from the NCWRF and SCWRF. The Western Wake WRF was not considered as a potential supply of reclaimed water at this time due to the cost of infrastructure that would be required to convey reclaimed water from the Western Wake WRF to the Town's service areas.

Table E-1 gives the 2060 maximum day demand in comparison with the maximum reclaimed water supply for each scenario. Demands in the South Cary service area can be met with reclaimed water supply from the SCWRF for all scenarios through 2060. In addition, demands in the Northwest Cary service area can be met with reclaimed water supply from the NCWRF for Scenarios 1 and 4 through 2060. However, the reclaimed water demands in the Northwest Cary service area exceed the supply for Scenario 3. In order to meet Scenario 3 demands, the Town would need to: 1) supplement the reclaimed water supply, 2) employ demand management techniques to reduce the maximum day irrigation peaking factor from 3.4 to 2.3, 3) implement onsite customer storage for large users and supply daily demand at a flat rate over a 24 hour period, or 4) implement a large volume of seasonal storage. In the future, it may be possible to reduce the peaking factor significantly due to technological advances in irrigation water conservation or changes in water usage patterns.

Scenario 2 demands exceed the combined reclaimed water supply from both the NCWRF and SCWRF by approximately 9.9 mgd. Due to the cost of infrastructure to extend the reclaimed water system to the entire Town and the lack of reclaimed water supply, this scenario is not a viable option for the Town.

Table E-1. 2060 Maximum Day Demand and Available Supply for Reclaimed Water Scenarios

Scenario	Maximum Day Demand (mgd)	Maximum Day Supply (mgd)	Deficit/ Surplus (mgd)
Northwest Cary Service Area (supplied from NCWRF)			
Scenario 1	5.3	9.6	4.3
Scenario 3	13.0	9.6	-3.4
Scenario 4[1]	9.6	9.6	0.0
Northwest Cary Service Area (supplied from NCWRF)			
Scenario 1	0.6	6.3	5.7
Scenario 3 / Scenario 4[2]	1.7	6.3	4.6
Urban Service Area (supplied from both NCWRF & SCWRF)			
Scenario 2	25.8	15.9	-9.9

1) Includes Scenario 4.1 demands and Scenario 4.2 additional demands up to the maximum supply capacity from NCWRF
2) South Cary Service Area demands are the same for Scenario 3 and Scenario 4

Based on the evaluation of the demand scenarios developed through the LRWRP, Scenario 4 is the most practical approach to maximizing the reclaimed water system based on current information. Therefore, the Town selected Scenario 4 as the preferred scenario for master planning purposes.

E.4 Hydraulic Modeling and Evaluation of Future System Infrastructure Needs

A hydraulic model of the reclaimed water distribution system was developed using Innovyze InfoWorks WS computer modeling software. Two distinct model networks were developed – one for the Northwest Cary service areas and one for the South Cary service area. The model was calibrated to field data and used as the basis for evaluating future infrastructure needs for each scenario. Simulated conditions included summer average demand, maximum day demand, and peak hour demand. Evaluation criteria including system pressures, velocity, headloss, and storage requirements are discussed in Section 7 of the master plan report.

As a first step, skeletonized improvements including new transmission, storage, and pumping facilities were identified to meet the evaluation criteria for the build-out (2060) planning year. Additional hydraulic analyses were performed to refine the sizing and phasing of recommended improvements for the preferred scenario.

E.4.1 Northwest Cary Service Area

The future infrastructure recommendations for the Scenario 4 reclaimed water system expansion in the Northwest Cary service area are described in the following paragraphs.

Transmission/Distribution

New transmission/ distribution main extensions are routed along existing and planned transportation thoroughfares to serve demands throughout the extent of the service area (as shown in Figure 9-1). The primary transmission improvement in the near-term is the NW Connector pipeline to convey reclaimed water from the NCWRF to the western portion of the service area. Improvements to existing pipelines (upsize or parallel) are required for the transmission mains along the following routes:

- NCWRF along Weston Parkway to Evans Road
- RTP South along Development Drive
- Western section of McCrimmon Parkway through the Amberly neighborhood.

Pressure Zone

Establishment of a lower pressure zone in the western portion of the system (West pressure zone) is recommended to mirror the potable water pressure zone boundary. The Town anticipates moving the potable water pressure zone boundary to Highway 55. Therefore, Highway 55 was considered the dividing line between the two reclaimed water pressure zones. Three pressure reducing valves (PRVs) would be required to establish the new pressure zone, one along the proposed connector pipeline on Little Drive/ O'Kelly Chapel Road at Highway 55, one along the NW Connector at Highway 55, and one along Green Level Church Road just south of Kit Creek Road. The placement of the Green Level Church Road/ Kit Creek Road PRV would allow reclaimed water from the TWWTP to be provided as an emergency backup to the primary pressure zone (Central pressure zone).

Storage

Storage is recommended at the following locations to meet the projected demands of the Northwest Cary reclaimed water system.

- Thomas Brooks Park Baseball Tank – A 0.5 MG storage tank is recommended to serve the West pressure zone. The Town would like this to be a "signature" elevated sphere-shaped tank that would be painted to look like a baseball. Based on pressure requirements through the USA Baseball field irrigation system, the minimum operating level of the tank should be a hydraulic grade line (HGL) elevation of 515 feet. Hydraulic modeling indicated that this tank may experience difficulty with turnover, which may lead to water quality issues, during periods of lower demands. Therefore, it is recommended that flow control valves are installed with the PRVs on Little Drive/ O'Kelly Chapel Road at Highway 55 and on the NW Connector at Highway 55 to control flow into the West pressure zone to improve operations of the Thomas Brooks Park Baseball Tank. The valves should be throttled to limit flow into the West pressure zone during peak hours to allow the tank to drain. The valves can be opened to allow the tank to fill during off-peak hours. This tank should be removed from service in the winter when demands are minimal.

- Highway 54 Ground Storage Facility – A 2.0 MG storage tank is recommended to serve the central portion of the reclaimed water system in the Central pressure zone and serve the West pressure zone. An elevated tank is not hydraulically effective at this site without provisions for pumping due to the hydraulic grade line changes in different planning periods. In addition, an elevated tank at this location would be greater than 220 feet in height, which could present a significant issue with FAA regulations due to its proximity to the Raleigh Durham International airport. Therefore, a ground storage/ re-pump facility is recommended to provide flexibility in operation with hydraulic grade line changes in the system and responding to changes in water demand of the service area.

- NCWRF Storage – An additional 1.0 MG of ground storage is recommended at the NCWRF to supplement the existing one-million-gallon ground storage tank and proposed distribution system storage, especially for the eastern portion of service area.

Pumping

An upgrade of the reclaimed water pumps at the NCWRF will be required to provide firm capacity of 12.0 mgd by 2060.

E.4.2 South Cary Service Area

The future infrastructure recommendations for the Scenario 4 reclaimed water system expansion in the South Cary service area are described in the following paragraphs. The recommended phasing of improvements is shown in Figure 9-1.

Transmission/Distribution

New transmission/ distribution main extensions are routed along existing and planned transportation thoroughfares to serve demands throughout the extent of the service area (as shown in Figure 9-1). Improvements to existing pipelines (upsize or parallel) are required for the transmission main from the SCWRF along West Lake Road to Optimist Farm Road and west along Optimist Farm Road.

Storage

In order to meet the projected demands of the South Cary reclaimed water system and maintain adequate pressures during periods of peak demand as the reclaimed water system expands north of the proposed Highway 540 corridor, a 0.5 MG elevated storage tank is recommended near West Lake Road and Floresta Drive. To maintain node pressures greater than 50 psi in the north portion of the

service area, the minimum operating level of the tank should be a hydraulic grade line elevation of 585 feet. It is recommended that the SCWRF reclaimed water pumps be controlled by the level in the West Lake storage tank. During periods of lower demand, the pumping at the SCWRF can be decreased or turned off, allowing the system demands to be satisfied from the water in the storage tank. Operating in this manner will help maintain water quality in the tank since the volume of storage is large compared with seasonal demand.

Pumping

An upgrade of the reclaimed water pumps at the SCWRF will be required to provide firm capacity of 2.0 mgd by 2060.

E.4.3 Phasing

The reclaimed water infrastructure recommendations were developed in three phases:

- Phase 1 (implementation by 2020)
- Phase 2 (implementation between 2020 and 2030)
- Phase 3 (implementation between 2030 and 2060)

The recommended phasing of improvements is shown in Figure 9-1. The projected reclaimed water demands based on the extent of the reclaimed water system expansion recommended in each phase is presented in Table E-2.

Table E-2. Scenario 4 Reclaimed Water Demand Projections by Phase (in mgd)

Phase	Demand	Northwest Cary Service Area			South Cary Service Area
		CPZ[4]	WPZ[5]	Total	
Phase 1 (2020)	AAD[1]	0.8	0.4	1.2	0.3
	Summer[2]	1.2	0.6	1.8	0.4
	MDD[3]	2.0	1.3	3.3	0.5
Phase 2 (2030)	AAD[1]	1.2	0.7	1.9	0.5
	Summer[2]	1.8	1.1	2.9	0.6
	MDD[3]	3.1	2.4	5.5	1.0
Phase 3 (2060)[6]	AAD[1]	2.2	1.1	3.3	0.7
	Summer[2]	3.3	1.9	5.2	0.9
	MDD[3]	5.7	3.9	9.6	1.7

1) AAD = Average Annual Demand
2) Summer = May-October Average Seasonal Demand = (1.6 x AAD)
3) MDD = Maximum Day Demand
4) CPZ = Central Pressure Zone. NCWRF demand included in the overall CPZ demand.
5) WPZ = West Pressure Zone.
6) Breakout between CPZ and WPZ is approximate for Phase 3. Actual demand in the pressure zone will depend on which areas of Scenario 4.2 are included in the reclaimed water system.

In the future, the Town may wish to revise some of the reclaimed water system phasing to more closely match the planned construction of major transportation thoroughfares when the schedule for transportation improvements is refined.

E.5 Capital Improvement Program (CIP)

A CIP was developed for implementing the recommended system improvements. The CIP prioritizes improvements into phases in accordance with the Town's financial schedule. A summary of the CIP is presented in **Table E-3**.

The costs presented in the CIP are for distribution/transmission mains along transportation thoroughfares and do not include the cost of smaller diameter neighborhood pipelines or retrofit within existing neighborhoods. For new development, it is assumed that the neighborhood pipes and service connections would be installed by the developer, per the Town's Policy Statement 132. However, the ultimate cost of providing reclaimed water service to customers within existing neighborhoods would include installation of smaller service lines and retrofit connections.

Table E-3. Summary of CIP Project Costs by Type and Year (in millions of dollars)[1]

Project Type	2015[3]	2017[3]	2020	2030	2060	Total
Storage	$3.3	-	-	$4.3	$2.5	$10.1
Pipelines[2]	$8.1	$6.6	$1.2	$17.6	$34.0	$67.5
Pumping	-	-	-	$2.1	$3.0	$5.1
Control Valves	-	$0.1	-	$0.1	-	$0.2
Total	**$11.4**	**$6.7**	**$1.2**	**$24.1**	**$39.5**	**$82.9**

1) Capital costs include 30% for construction contingencies and 25% for engineering, legal, and administration fees. All cost estimates are based on 2013 dollars without escalation.
2) Costs are for distribution/transmission mains along transportation thoroughfares and do not include the cost of smaller diameter pipelines, meters, appurtenances, etc. for retrofit within existing neighborhoods. The Town would likely fund retrofits. Developers may help fund some of the service area pipeline extensions included in the costs presented in this table.
3) There may be alternatives, including continuation of reclaimed water supply from Durham County, to delay the cost of construction of the NW Connector pipeline in the initial phases.

The intended use of this type of estimate is long-range planning and for comparing alternatives. The final cost of any project described in this master plan will depend on the project complexity, actual labor and material costs, competitive market conditions, actual site conditions, final scope of work, implementation schedule, continuity of personnel, and engineering.

Because unforeseen events affecting projected growth and expansion may occur, it is recommended that the reclaimed water system improvements implementation plan summarized in this master plan be reviewed and updated periodically, at least every 5 years, to ensure that the system improvements and associated funding are being cost-effectively spent on pace with growth and development patterns. Factors such as right-of-way acquisitions and new roadway construction or existing roadway repaving/repairs may also affect the implementation schedule and should be considered in updating the implementation plan. Patterns of reclaimed water use should also be re-evaluated to determine if peaking factors used for planning purposes may be reduced.