NORTHWESTERN GUILFORD COUNTY WATER SYSTEM PRELIMINARY FEASIBILITY STUDY

SEPTEMBER 2018

PREPARED FOR:

Guilford County, Town of Oak Ridge, Town of Stokesdale, & Town of Summerfield
Marty Lawing, Guilford County Manager
Bill Bruce, Oak Ridge Town Manager
John Flynt, Stokesdale Mayor
Scott Whitaker, Summerfield Town Manager

PREPARED BY:

Timmons Group
5410 Trinity Road, Suite 102
Raleigh, NC 27607www.timmons.com

TIMMONS GROUP
YOUR VISION ACHIEVED THROUGH OURS.

Table of Contents

Executive Summary 3
1.0 Project Background 5
1.1 Community Goals & Needs 5
1.2 Guilford County 5
1.3 Oak Ridge 5
1.4 Stokesdale 6
1.5 Summerfield 6
2.0 Engineering Approach 7
2.1 Priority Area Projections 7
2.2 Proposed Utility Corridors 7
2.3 Demand Projection Methodology 8
2.4 Groundwater Availability 9
2.5 Surface Water 10
2.6 Supply Scenarios 11
3.0 Hydraulic Modeling 13
3.1 Model Build 13
3.1.1 Demand Allocation 13
3.1.2 Fire Flows 14
3.1.3 Storage Tanks 14
3.1.4 Pressure Zones 14
3.2 Model Findings 14
3.2.1 Thirty-year Buildout 15
3.2.2 Ten-year Buildout 15
3.2.2 Five-year Buildout 15
4.0 Infrastructure Costs 16
4.1 Five-year Buildout 16
4.2 Ten-year Buildout 16
4.3 Thirty-year Buildout 16
5.0 Potential Water Rates 17
5.1 Financial Considerations 17
5.2 Preliminary Rate/Fee Structure 17
5.3 Funding Sources 19
6.0 Water System Governance Summary 20
Section 6.1 Potential Organization Structures 20

Section 6.2 Governance Considerations 20
7.0 Conclusions and Next Steps 21
Section 7.1 Recommended Next Steps 21

Appendix 22
Appendix A – Study Area Maps
Appendix B – Strategic Infrastructure Summary
Appendix C – Groundwater Reports
Appendix D – Financial Analysis
Appendix E – Funding Analysis
Appendix F – Governance Outlines
Appendix G – Public Presentation Copy

Executive Summary

Timmons Group has completed an engineering study (Study) to aide in determining the feasibility of a regional water system to serve northwestern Guilford County. The participating localities include Guilford County, the Town of Stokesdale, the Town of Oak Ridge and the Town of Summerfield.

This Study included the following:

- An investigation by Golder and Associates to determine the availability of groundwater as a potential source of drinking water.
- Identification of a surface water source from neighboring localities
- Establishing the needs of a public water system for each locality
- Development of system-wide hydraulic model to determine the necessary infrastructure to support a 30-year growth period.
- Estimation of infrastructure costs.
- Estimation of potential water rates to connected customers.
- A high-level review of potential funding sources.
- A high-level review of the potential legal structure for the water system's controlling entity.

A groundwater investigation by Golder and Associates (Golder) concluded that groundwater in northwestern Guilford County may be more prevalent than previously believed. The estimated groundwater recharge rate within the study area is approximately 35 million gallons per day. The report states that it may be possible to develop water supply wells to yield 100 to 200 gpm (approximately 288,000 gallons per day). These wells could be strategically placed to support portions of the regional water system. Golder's analysis was limited to a desktop review of geological and surface features and no physical testing was conducted. Physical testing will be a necessary next step to determine if a public water system is feasible.

Due to the potential availability of groundwater, one of the least expensive ways a regional water system may originate would be with individual water systems for each locality, supplied by groundwater. Each locality would have an elevated storage tank and a focused network of water distribution mains located to maximize the number of connected customers. As growth occurs and when it makes sense, the systems could become interconnected. The NC-150 corridor has been identified as the most logical path for an interconnecting waterline for the regional system. Based on the hydraulic model developed for this Study, the main along NC-150 would likely be a 16-inch main.

In discussions with the surrounding water providers, Winston-Salem/Forsyth County (WSFC) and the City of Reidsville (Reidsville) were the most favorable to selling water to a public water system in Guilford County. At the time of writing this report, WSFC had proposed a bulk water rate of $5.65 per 1,000 gallons (kgal). The bulk water from Reidsville is not confirmed, but is likely to be around $3 per kgal. Due to the lower cost of water, this Study is based on purchasing water from Reidsville. Connecting to the Reidsville water system would be accomplished by extending a 16-inch waterline south through Rockingham County along Cunningham Mill and Spearman Roads.

As the number of water system customers grows, the reliance on finished water from Reidsville would also increase. For this Study, it is estimated that by year 10, there would be a 50/50 split between purchased water from Reidsville and groundwater wells to supply the proposed water system. It is likely that improvements to the Reidsville water system will be necessary to ensure adequate water availability.

Over the 30-year study period, the cost of infrastructure for the regional water system is estimated to be around $143M with an average monthly water bill over that time period of approximately $61, accounting

for inflation and escalating operating costs. Refer to **Appendix D** for more details regarding the break-even costs per customer.

Within the first five years, the estimated cost of infrastructure is approximately $52.4M to reach a potential customer base of around 8,500 ERCs (equivalent residential connections). The first few years are anticipated to have the highest monthly bills as the cost of starting infrastructure is high relative to the smaller, but growing customer base. The estimated monthly water bill for the first year is approximately $91, falling to $53 by year five.

By year ten, the estimated additional capital cost of infrastructure is $41.9M and the number of customers is approximately 13,000 ERCs. The estimated monthly water bill at year ten is approximately $56. By year thirty, the estimated monthly water bill would have stabilized around $61 as the customer base has grown to its largest size of around 25,000 ERCs.

More detail on the estiamated water system costs is available in **Section 5.0** and **Appendix D**.

The legal structure of the water system's governing body will most-likely be a Water Authority or Water District as defined by NCGS Chapter 162A. A more detailed description of these legal structures, along with their respective powers is provided in **Appendix F**.

Recommended Next Steps:

It is highly recommended that true geophysical testing be conducted to confirm the groundwater availability estimated in this report. This will be a significant factor in determining the feasibility of a regional water system.

It is recommended to initiate discussions with the Department of Environmental Quality (NCDEQ). One of the items required by NCDEQ will be a Preliminary Engineering Report (PER). The development of the PER will help reduce the number of unknown variables and increase the accuracy of both the hydraulic and financial models presented in this report.

It is recommended that all localities engage both legal and financial council/representation to further discussions about water system governance structure and financial feasibility.

1.0 Project Background

In mid-2017, Timmons Group was tasked to perform an engineering study (Study) to aid in determining the feasibility of developing a regional water system in northwestern Guilford County (the County). Included in the study are the Towns of Oak Ridge, Stokesdale, Summerfield, and certain unincorporated portions of Guilford County, bound by US Route 29 to the east. This Study will be used to examine some of the potential steps, challenges and likely costs of forming a public water system and the potential cost of water to the connected customers over a 30-year period. This Study should be used to help the participating localities determine a path forward that would develop a water system that provides the service required by each locality in a fiscally responsible manner.

The goal of this report is to provide a view of what a regional water system for this part of the County might look like and to estimate the cost to customers. Additionally, this report will outline the options for legal structure of water system's governing body. For this report, the term "Authority" will be used to describe the legal entity responsible for owning and operating the regional water system, but the exact legal structure will need to be determined if the participating localities choose to move forward with the development a regional water system.

Currently, the participating localities are served by a variety of groundwater-supplied water systems that are privately owned. The Town of Stokesdale has a municipal water system that serves portions of the Town, with water supplied by the City of Winston-Salem. However, the long-term sustainability and quality of these groundwater supplies, in addition to limited service area coverage, limit economic development and fire protection. A potential alternative to the existing water systems is to form a public Water Authority that purchases water from other sources and/or procures its own groundwater (wells) to distribute to its customers.

1.1 Community Goals & Needs

Timmons Group has endeavored to incorporate the goals and needs of each locality within the study area. This was performed by meeting with each municipality to identify the short-term and long-term needs through confirming water main routing corridors and areas with specific water needs and locating those corridors on schematic mapping. Timmons Group met with each community individually to discuss these items to aid in the Study.

1.2 Guilford County

Guilford County is interested in serving unincorporated areas adjacent to the municipalities and wishes to act as a facilitator for the municipalities. Northwest Guilford County is a high growth area as 60% of the County's permits occur in this area. To that end, it is an ideal portion of the County to focus on bringing water service. The County has expressed the desire to prioritize new infrastructure in the newer potential growth areas for the water system. They are less interested in focusing on the Colfax area as it is an older, established area with less growth.

1.3 Oak Ridge

The Town of Oak Ridge's overall goal is to provide water service to the entire town limits, including fire protection. They would require 700 gallons per minute (gpm) of fire flow, but 1,000 gpm is preferable. The town recognizes the benefits of a public water system, including less susceptibility to power outages, aids in the maintenance of fire equipment, and promotion of growth. However, Oak Ridge has several concerns that would have to be worked out through the course of the development of an Authority. These concerns include questions about groundwater, potential customers, existing private systems, and inter-basin transfer. They realize that a public water system would need to offer a compelling reason for potential customers
to connect.

1.4 Stokesdale

The Town of Stokesdale's water system is approximately 15 years old and was developed in response to contamination along US Hwy 158. The system is estimated to cover approximately 25% of the Town area, or approximately 22 square miles. The majority of Stokesdale's water mains are SDR 21 PVC. The system has one pressure zone with a 300,000 gallon elevated storage tank. Stokesdale has acknowledged the potential benefits for an inter-connection to a second public water system. Stokesdale requires a fire flow of 700 gpm at 20 psi.

1.5 Summerfield

The Town of Summerfield addresses water needs in its Comprehensive Plan. Its common objective for water supply stated: "The Town of Summerfield recognizes the singular importance of plentiful, safe, potable water to present and future residents and businesses. To preserve the availability of this resource, the Town shall make water supply, water conservation, and groundwater recharge very high priorities and shall encourage its citizens to do likewise."

Additionally, Summerfield developed several policies for water supply. Some of those policies include:

Policy 5.1: The Town should work regionally on a broad range of water supply options and approaches for the long term.

Policy 5.2: To improve short and long-range water supply projections, the Town shall support voluntary as well as institutional efforts to monitor groundwater supplies underlying the Summerfield community.

Policy 5.3: Recognizing that water and sewer services have a powerful influence on growth and development, the Town of Summerfield shall require that the design and location of water supply and sewage treatment facilities promote desirable development density and growth patterns.

Policy 5.8: New developments may be required to size and design water retention facilities to serve as water reservoirs to enhance nearby firefighting capabilities.

Summerfield has expressed the need to incorporate fire protection into the water system design. Their desired fire flow is 1,000 gpm at 20 psi.

Excellent schools will continue to drive growth in the Summerfield area. There are several areas with approved developments and future developments within and adjacent to Summerfield. The areas listed below must be taken into consideration when preparing future growth calculations.

2.0 Engineering Approach

One of the most significant factors in determining the feasibility of a public water system is the cost per gallon of water for the end users – also called the "water rate." The rate that water is charged to consumers is responsible for recovering the cost of procuring the water and the cost of the distribution infrastructure (pipes, pumps, tank, etc.), but also needs to cover the cost of repairs, operational expenses, overhead expenses, future infrastructure and even the salaries of the operating staff. In order to estimate the water rates for public water system in northwestern Guilford County, the following questions needed to be answered:

- *Where will the infrastructure be located?*
- *What size will the infrastructure be?*
- *How many customers will be connected?*
- *Where will the water come from?*
- *What new infrastructure will be needed as the system grows?*

The approach to answering these questions started with establishing the anticipated areas of priority, both immediate and future, for water distribution for each locality. Once the priority areas were established, the number of customers and the domestic and fire flow water demands were estimated using land use data and locality input. The potential system growth scenarios were determined and, finally, a computerized model of the distribution system was developed to aid in sizing of the infrastructure necessary to support the projected distribution needs.

2.1 Priority Area Projections

For each locality, the target water service areas were identified and prioritized according to immediate need and projected future need. To do this, each locality was asked to identify their water demand priority areas on a map in three categories; the 0-5 year priority, the 6-10 year priority, and any estimated priority beyond a 10-year timeframe. While each locality was able to identify service areas for the first ten years, none of the localities were comfortable providing service priorities beyond the 10-year timeline due to the unpredictability of locality growth. The priority areas identified by the localities are shown on the ***Locality-Determined Priority Areas Map*** in **Appendix A**. The 0-5 year priority is considered the immediate need.

Each of the four localities identified the 0-5 year demand priorities in areas that already have existing facilities in place, whether those facilities are residential, commercial, or industrial in nature. This helps to ensure a reasonable customer base early in the water system development. This customer base is necessary to keep the cost per customer as low as possible.

In an effort to maximize customer base and reduce initial infrastructure costs, Timmons Group has identified a smaller sub-set of the 0-5 year priority areas that is intended to provide a higher ratio of customer-to-infrastructure installed. These areas are shown in ***Appendix A*** *and are labeled as the Strategic 0-5 Year Service Areas.* ***All financial analyses for this study was performed using these areas****. A list of all identified subdivisions in these areas is provided in* ***Appendix B.***

2.2 Proposed Utility Corridors

Based on the locations of the water demand priority areas, a primary "backbone" to the proposed utility corridor was identified. It was determined that North Carolina Highway 150 (NC-150) would best serve as the primary utility corridor to most efficiently bring water to each of the locality's priority areas. NC-150 generally runs Northeast/Southwest within the northwestern part of Guilford County. This primary utility corridor would run northeast through the heart of Oak Ridge and Summerfield before ultimately terminating at the intersection with U.S. Route 29.

2.3 Demand Projection Methodology

Domestic demand projections for the water system serving this portion of the County were developed for a 30-year period, but were broken down to match the 0-5 year, 6-10 year and 10-30 year demand priority areas for each locality. The methodology for these water demands is based on several factors to accurately reflect projected growth, changing land use, and existing conditions. It is anticipated that new customers will be connecting to the water system in first five years at a rate that will far outpace the subsequent years. The New Customer Growth Trends used for this study are shown below in **Table 2.3.1**.

Table 2.3.1 – Water System New Customer Growth Trends		
0-5-yr Annual Average	***6-10-yr Annual Average***	***11-30-yr Annual Average***
15%	9%	3%
0-5-yr Annual Average	***0-10-yr Annual Average***	***0-30-yr Annual Average***
15%	12%	6%

All land within each locality was assigned one of five land use designations: agricultural, commercial, industrial, residential, or a sub-system area (SSA). Areas identified as SSA are defined as areas which there is existing water infrastructure that is privately owned and operated, either by a private utility company or a Homeowners Association. Land use designations for Guilford County and Stokesdale were assigned based on the Guilford County GIS Data Download Zoning shapefiles from their GIS Portal. Oak Ridge and Summerfield directly provided their own land use designations for use in this Study.

Each zoning classification was assigned a flow factor. A flow factors is defined as water demand generated for every unit area of developed land and is expressed in gallons per day per acre (gpd/ac). Land designated as agricultural was assigned a flow factor of zero gpd/ac. The residential land use designation was assigned a flow factor of 200 gpd/ac. This flow factor is based on the allowable number of dwelling units per acre times the average daily water demand per dwelling unit. The dwelling unit per acre, or residential density, is based on each locality's governing regulations. The average daily water demand per dwelling is based on engineering experience. The SSA land use designation was also given a flow factor of 200 gpd/ac because these systems most often serve residential areas. The commercial and industrial land use designations were given flow factors of 300 and 500 gpd/ac, respectively, because these facilities are often more intensive water users.

It is assumed that 50% of each land parcel is developable based on sound engineering and land planning judgement. Of this 50% developable area, unbuildable area is subtracted out to account for any environmental features such as lakes, streams, wetlands, buffer areas, etc. to yield a final developable area for each parcel.

For this Study, it is assumed that the Sub-System Areas would be incorporated into the public distribution system as the overall service areas grow over time. This "climbing" SSA model is presented, as opposed to a model in which no SSA demand is included, because it is believed there are three major benefits to the customer to switching to an Authority-owned water system: (1) water quality, (2) water quantity, and (3) reliability. Water quality will be better on the Authority's system than a private system because there is a greater level of water treatment, more operator attention, and a lower water quality age. Sufficient water quantity will be available on the Authority's system to provide

fire protection. The authority's system will be more reliable in the cases of power outages. Water service will be uninterrupted when the private systems well pumps will most likely go offline. Additionally, the added customer base will generate more revenue for the Authority, helping to reduce the overall water rates.

Finally, the average daily demand for a given area is calculated by adding the demands for each land use type. Each area's demand is then summed to yield a total average daily demand for the locality, for each projection year. The average daily demands for each locality are shown below in **Table 2.3.2**.

Table 2.3.2 – Projected Domestic Demands

Locality	5 year Total Projected Water Demand			10 year Total Projected Water Demand			30 year Total Projected Water Demand		
	GPD	*GPM*	*ERC*	*GPD*	*GPM*	*ERC*	*GPD*	*GPM*	*ERC*
Oak Ridge	616,200	428	3,081	790,000	549	3,950	1,081,429	751	5,407
Stokesdale	176,400	123	882	290,180	202	1,451	725,123	504	3,626
Summerfield	730,800	508	3,654	940,495	653	4,702	1,450,030	1,007	7,250
North Guilford	189,800	132	949	570,220	396	2,851	1,773,305	1,232	8,867
TOTAL	1,713,200	1,190	8,566	2,590,895	1,799	12,954	5,029,887	3,493	25,149

ERC = Equivalent Residential Connection; 1 ERC = 200 gallons per day (GPD)
GPM = gallons per minute

2.4 Groundwater Availability

Timmons Group has partnered with Golder & Associates (Golder) to perform preliminary groundwater supply identification and research. Golder provided a technical review of a *USGS Groundwater Recharge and Storage Study of Guilford County* and a *Preliminary Groundwater Resource Evaluation Report for Northwest Guilford County*.

Summarizing the *USGS Groundwater Recharge and Storage Study of Guilford County*, Golder states the article generally supports an opinion that groundwater withdrawal should not exceed groundwater recharge on an individual lot or subdivision basis to avoid long-term net losses in groundwater storage. Golder highlights an example from the article that suggests a minimum of 1.05 acres was required to support a typical residential housing lot with a water demand of 400 gpd. Accounting for further reductions, up to 2.34 acres per lot may be required to maintain no net loss from long term groundwater storage from rural residential homes on well and septic.

In their discussion on the article, Golder state the article's estimates are overly conservative and applying more current views of groundwater infiltration and water usage, a typically single family home should have minimal impact on groundwater recharge. Golder goes on to say that minimum lot sizes are often set by local governments based on assimilation of wastewater from on-site sewage systems to protect the groundwater and nearby surface water resources from elevated nitrogen loading. Scientific literature indicates that minimum lot size to prevent nitrogen degradation of the groundwater is roughly 0.5 to 1.0 acres. Groundwater recharge is typically not used to guide or regulate minimum lot sizes.

The total volume of water stored within Guilford County is estimated to be billions of gallons stored in the saprolite and bedrock. Even if only a small portion of this groundwater recharge and storage is available for development and use, Guilford County would have a generous supply so restricting land use based on groundwater recharge does not appear to be reasonable and does not address the real issue of inadequate groundwater availability and impact to existing groundwater users.

Golder concludes by saying it may be worthwhile to evaluate the possible range of groundwater study requirements that Guildford County could adapt as part of their subdivision regulations to ensure that adequate groundwater supplies are available for new subdivisions and that these future withdrawals do not impact existing groundwater users or effect environmentally sensitive habitats.

The *Preliminary Groundwater Resource Evaluation Report for Northwest Guilford County*, prepared by Golder, was designed to preliminarily identify areas that may be favorable for developing groundwater wells that can support local water supply needs in an economically sustainable manner. Based upon the findings of their preliminary groundwater investigation, Golder believes that the overall potential of developing groundwater resources in northwestern Guilford County is moderately good. This assessment is based on favorable fracture development characteristics of the granitic rocks, which make up the majority of the bedrock type in the study area, good water storage attributes of the thick unconsolidated soil and saprolite overlying the bedrock, high lineament density and the coincidence of many of these lineaments with expected bedrock structures, a moderately high groundwater recharge estimate of over 35 million gallons per day, and moderately productive wells of between 100 to 200 gpm. Potential groundwater development areas have been identified using a groundwater favorability model. Favorable groundwater development areas correspond with areas underlain by granitic rocks; are proximal to lineament, lineament intersections, and cross-strike lineament orientations; are situated in river lowland areas; and are not near potential contamination sites or high-density development areas.

As next steps, Golder recommends that focused non-intrusive electrical resistivity imaging geophysical survey should be conducted at selected groundwater exploration sites to confirm and better locate potential subsurface fractured bedrock aquifers and to help optimize future exploratory test well locations. Following completion of the geophysical survey and selection of potentially favorable well sites, exploratory test wells should be drilled to determine whether the yield and quality of the groundwater will be suitable to meet the needs of the proposed development. Following the successful completion of the wells, long-term, multiple-well aquifer stress test should be conducted to assess the sustainable yields from the completed wells.

The *USGS Groundwater Recharge and Storage Study of Guilford County* and the *Preliminary Groundwater Resource Evaluation Report for Northwest Guilford County,* as delivered by Golder & Associates, are provided in **Appendix C**.

2.5 Surface Water

Meetings with the surrounding Counties, Towns, water utilities, and water authorities were performed to find a possible surface water source for the Northwest Guilford water system. Summaries of those meetings and each organization's interest in providing water is presented here.

2.5.1 City of Greensboro and Rockingham County

The City of Greensboro and Rockingham are not favorable due to both having a limited availability of water. Greensboro would require that the source water be from the Piedmont Triad Regional Water Authority and wheeled through the City's water system, requiring pumping upgrades and other costs. Rockingham County receives water from municipalities in the County, and has limited hydraulic capacity to bring water to NW Guilford County (and their supply would be similarly limited).

2.5.2 PTRWA

Piedmont Triad Regional Water Authority (PTRWA) is a wholesale water supplier and only provides water to its constituent owners: Greensboro, High Point, Randolph County, Archdale, Jamestown, and Randleman. If any of the PTRWA capacity were to be used for Northwest

Guilford County regional water system, it would have to be purchased from one of the current owners. It has been indicated that none of the owners wishes to sell any of their current or future allotted capacity.

2.5.3 Winston-Salem/Forsyth County

The City of Winston Salem/Forsyth County (WSFC) Utilities department has been favorable towards selling water to a regional system in Guilford County. The WSFC system consists of a water treatment capacity up to 91 million gallons per day (MGD). The City's current average usage is approximately 36 MGD, leaving an excess of approximately 55 MGD. WSFC staff and their consulting engineer, Hazen-Sawyer, have indicated the two most favorable points of connection would be a new interconnection along NC Hwy 150 and the existing interconnection with Stokesdale along US Hwy 158. At the time of writing this report, the proposed bulk sale price for water from WSFC is $5.65 per 1,000 gallons, or "kgal."

2.5.4 City of Reidsville

The City of Reidsville (Reidsville) was initially hesitant to commit to selling water for a NW Guilford County water system due to their limited 1 MGD supply, however, they in the process of making improvements to their distribution system that will increase they system's available yield. Reidsville's water treatment plant has capacity of 9 MGD but is currently treating just under 4.5 MGD on average. To covey water from Reidsville to NW Guilford County, new water mains would be required through Rockingham County. The preferred route for this main is along Cunningham Mill and Spearman Roads. Due to Reidsville being lower in average elevation than a large majority of the Guilford County study area, it is likely that booster pumps would be necessary to pump water to higher elevations within the County.

At the time of writing this report, the exact bulk water purchase rate from Reidsville is not known, but is estimated to be around $3 per kgal based on conversations held between Reidsville and Guilford County staff. Due to this low bulk water purchase rate, this study has assumed a Reidsville water supply.

2.6 Supply Scenarios

For this Study, two theoretical water system growth scenarios were developed to explore the potential cost implications of each. Those scenarios are:

Supply Scenario 1

Supply Scenario 1 is based around the NW Guilford water system originating by establishing smaller, individual water systems within each locality that would eventually grow and connect with one another. The water supply for each system would each start with central wells and central elevated storage tanks that would supply a small, centralized distribution system in each locality. *Stokesdale has similar infrastructure already in place.*

Because this approach would not require any interconnections between the localities, it would not require the interconnection piping along NC-150 as described in *Section 2.2* and would help to minimize the initial capital expenditure for infrastructure. As the individual water systems grow, either by developer-driven growth or "Authority-driven" growth, the interconnections along NC-150 can be made when appropriate. The interconnections will strengthen the flow of water to all parts of the system and will greatly improve reliability to the connected customers.

Eventually, the demand for water <u>may</u> out-pace the yield of the Authority's wells. If this happens, a connection to the Reidsville water system could be made. This connection could be made along Cunningham Mill or Spearman Roads. This connection would supplement the groundwater sources and would further strengthen the system's reliability.

For this Study, it is assumed that by year 10, the public water system is using half groundwater and half purchased water form Reidsville and that all interconnections between the locality systems along NC-150 have been made.

Supply Scenario 2

Supply Scenario 2 is based on purchasing 100% of the drinking water supply from Reidsville. This scenario is anticipated to grow in the same manner as *Scenario 1*, however, it will require that the primary NC-150 interconnection main and connection to the Reidsville water system be made immediately. All elevated storage tanks would still be required.

For this Study, it is assumed that after the first 10 years, the water system "Authority" will have to pay to upgrade some of Reidsville's infrastructure to increase the available yield within the city's distribution system.

3.0 Hydraulic Modeling

A master plan water model (model) was developed using Bentley's WaterGEMS V8i software. The model's primary purpose is to assist in the preliminary design of the water system. The hydraulic simulations help confirm necessary water line sizes and help identify the size and location of major water system features such as elevated storage tanks and pressure zone boundaries. This section documents the means and methods of the hydraulic modeling effort.

The developed model is considered a "skeletonized" model because it is a simplified distribution model that includes only the primary distribution mains along major corridors. Smaller waterlines, or waterlines serving individual subdivisions or business were not modeled, but their domestic water demands where accounted for. This eliminates an excessive amount of modeling detail and input, but still allows for an accurate review of primary distribution pipe sizes, storage tank performance as well as they system's residual pressures.

3.1 Model Build

A hydraulic model was created to coincide with the demand priority areas and the two growth scenarios outlined in ***Section 2.0***. The model includes all elevated storage tanks, necessary pressure control valves and primary distribution mains and calculated water demands through the 30-year study period.

Because the distribution model is theoretical, the specific material of the distribution mains has not been identified but will mostly likely be a combination of C900 PVC or ductile iron. All water mains in the model were assigned a Hazen-Williams roughness coefficient of 120, which is a conservative representation of either material.

3.1.1 Demand Allocation

Junctions were strategically placed along the distribution mains to capture the major high and low elevations along the mains and so the calculated water demands could be applied in the appropriate locations. Demands were not applied to individual houses or individual commercial properties, rather "demand centers" were formed to aggregate demands located in close proximity to one another. Thus, all the demands of one neighborhood development (or commercial center) were represented at a single junction in the model. The junction is located along the main road at the entrance to the given residential or commercial center.

For this study, all demand scenarios modeled were steady-state snapshots of various demand intensity. The following demand scenarios were developed within the model:

- **Static:** No active demands in the model.
- **Average Day Demand (ADD):** The average rate of daily (24-hour) water usage
- **Max Day Demand (MDD):** The rate of water usage during the day (24-hour) of maximum water use. This is represented by multiplying the ADD by a factor of 1.6.
- **Peak Hour Demand (PHD):** The rate of water usage during the peak hour. This is represented by multiplying the ADD by a factor of 2.5.
- **Maximum Day Demand plus Fire Flow (MDD + FF):** Refer to **Section 3.1.2** for additional information on how fire flow demands were applied to the model.

In order for the water system to function correctly and be considered acceptable, certain residual pressures must be met in the system for a given flow. The **ADD**, **MDD**, and **PHD** scenarios should maintain a residual gauge pressure of at least 30 pounds per square inch (psig) per 15A NCAC 18C .0901. The **MDD + FF** scenario should retain a residual gauge pressure of at least 20 psig per 15A NCAC 18C .0901.

3.1.2 Fire Flows

For the **MDD + FF** scenario, the distribution system was designed to meet 1,000 gallons per minute (gpm) at 30 psig within any part of the modeled system. Targeting a 30 psig residual in the system allows for additional pressure loss through the smaller distribution mains that were not included in the model. This level of available fire flow may or may not meet the actual fire flow requirement for a given building or development. In the case where the needed fire flows exceed what the distribution system can supply, special considerations may be required for on-site water storage and fire pumps. The appropriate fire regulations and codes should be consulted and applied on a case by case basis.

3.1.3 Storage Tanks

Elevated storage tanks act to provide adequate pressure throughout the system and deliver stored water during periods of high demand. 15A NCAC 18C .0805 requires elevated storage capacity for a municipality to be sufficient to minimize the effect of fluctuating demand and provide a reserve for fire protection, but not be less than 75,000 gallons in capacity. It also requires that the combined elevated and ground storage capacity of the finished water for community and non-transient, non-community water systems shall be a minimum of one-half day's supply of the average annual daily demand.

In the model, storage tanks were placed near Oak Ridge Town Hall, Summerfield Elementary School, Stokesdale Elementary School, and near the intersection of NC-150 and North Church St. Tanks were sized to hold one-half day's supply of the average annual daily demand, for the area it serves, and to provide a fire flow of 1,000 gpm for 120 minutes. The size of the storage tanks is discussed in ***Section 3.2.1***.

3.1.4 Pressure Zones

The average ground elevation across the study area is decreasing from west to east. This means that pressures in the distribution system will naturally climb as the systems expands to the east. Due to this increase in pressure, it is necessary to separate the water system into two pressure zones – a western zone and an eastern zone.

During initial model setup and test model runs, the delineation of the east and west pressure zones was performed. It was determined the northern and western town limits of Summerfield would be the dividing line from the western pressure zone to the eastern pressure zone. Pressure Reducing Valves (PRVs) were placed in the model at the Summerfield/Oak Ridge town limits on the NC-150 backbone and the secondary waterline along Brookbank Rd. A PRV was also added at the northern Summerfield town limits along US-220.

Due to Reidsville being lower in average elevation than a large majority of the Guilford County study area, it is likely that booster pumps would be necessary to pump water into the county's water system. Booster pumps would likely be located at the Rockingham/Guilford border along Spearman Rd. Additionally, pumps would be necessary to pump form the eastern pressure zone into the western pressure zone. These pumps would likely be located on NC-150 at the boundary between the pressure zones.

3.2 Model Findings

After building the model with all of the physical assets and water demand information, the model was run to determine the performance characteristics of the system. In order to confirm the proposed waterlines are sized to accommodate the ultimate buildout of the water system, the modeling effort started with the 30-year buildout.

3.2.1 Thirty-year Buildout

For the 30-year buildout, the water system layout is the same for either Supply Scenario as outlined in ***Section 2.6.*** The following results apply to *both* Supply Scenarios.

The 30-year buildout scenario represents the highest level of domestic demand that the water system would be required to supply. By sizing the pipelines and storage tanks appropriately for this scenario, they will be able to accommodate any preceding levels of the water system's buildout/growth.

The 30-year buildout has an average domestic demand of just over 5,000,000 GPD. Out of the demand scenarios modeled, the worst-case scenario is the Maximum Day Demand plus Fire Flow (**MDD+FF**). In order for the model to convey the Maximum Day demand plus the 1,000 GPM fire flows while maintaining at 30 psig at all points in the system, it was determined the primary NC-150 distribution main is appropriately sized as a 16-inch main. All other secondary mains were modeled as 12-inch mains.

Based on average demands, the Oak Ridge and Summerfield tanks were both sized for 750,000 gallons, the existing Stokesdale tank was kept at 300,000 gallons, and the North Guilford tank was sized for 1,000,000 gallons.

The elevation of water inside each tank will affect the pressures within the surrounding distribution system. In order to prevent over-pressurizing the distribution system, the High Water Level (HWL) for each tank was set to target no more than 80 psig during a static, no-demand scenario. Based on the model results, the proposed Oak Ridge tank was set at 1,075 feet above mean sea level (AMSL) to match the existing Stokesdale tank. Moving east towards Summerfield and Rte-29, the average ground elevations fall. Due to this decrease in elevation, the HWLs for the proposed Summerfield and Guilford County tanks were set to 1,040 ft AMSL. A summary of tank sizes and modeled elevations can be found in **Appendix B**.

3.2.2 Ten-year Buildout

For the 10-year buildout, the water system layout is the same for either Supply Scenario outlined in ***Section 2.6.*** The following results apply to *both* Supply Scenarios.

For the 10-year buildout scenario, the model was run with all infrastructure and demands that fall outside of the 10-yr priority areas made inactive. All pipe and tank sizes were left the same as the 30-year buildout model. All domestic and fire flow demand scenarios were tested with each supply scenario to ensure the system could still meet the desired performance criteria. No performance problems were identified.

3.2.2 Five-year Buildout

For the 5-year buildout, the water system layouts for the Supply Scenario outlined in ***Section 2.6*** are different. Because the primary source of water for ***Supply Scenario 1*** are the local wells, only the water systems around the tanks are active. For ***Supply Scenario 2***, the water systems around the tanks are active, however, the full length of the NC-150 primary supply main must be active to connect the individual water systems to the water source (the City of Reidsville water system).

For this buildout scenario, the model was run with all pipes and demands that fall outside of the 5-year priority areas made inactive. All pipe and tank sizes were left the same as the 30-year buildout model.
For each *Supply Scenario*, all domestic and fire flow demand scenarios were tested with each supply scenario to ensure the system could still meet the desired performance criteria. No performance problems were identified.

4.0 Infrastructure Costs

Based on the priority service areas and the sizing requirement determined by the hydraulic modeling, the total infrastructure cost for a public water system to serve northwest Guilford County is anticipated to cost the water "authority" between $143M-$159M, for *Supply Scenario 1* and *Supply Scenario 2*, respectively. The costs listed below include an assumed 2.5% annual inflation rate.

4.1 Five-year Buildout

The regional water system is anticipated to grow in vary similar ways regardless of the Supply Scenario, however, the most significant change in cost would occur at the start-up of the system. *Supply Scenario 1* would allow the elevated storage tanks and limited distribution systems for each locality to be served by groundwater (wells) and would NOT require the 16-inch primary distribution main along NC-150 to connect the individual systems nor the 16" supply main from the Reidsville water system.

Supply Scenario 2 would rely solely on the Reidsville water system to supply all water to the proposed water system within the County. This would require the 16-inch primary distribution main along NC-150 and 16" supply main in along Cunningham Mill and Spearman Roads to be installed immediately to convey water to all areas of the system.

The total 5-year estimated cost of infrastructure for *Supply Scenario 1* is approximately $52.4M.
The total 5-year estimated cost of infrastructure for *Supply Scenario 2* is approximately $58.3M.

4.2 Ten-year Buildout

It is anticipated that the cost of the 6-10 year buildout of the water system would be similar to the expense for the first 5 years. However, for this study, it is assumed that approximately 50% of that cost will be paid by developers as the currently undeveloped land in this service area is developed.

For *Supply Scenario 1*, there are some additional costs at this time for the 16" supply main from Reidsville, as well as for water booster stations to pump water into the County's two pressure zones. The anticipated cost for these improvements adds approximately $15.6M to *Supply Scenario 1* by year ten.

Due to *Supply Scenario 2* relying solely on the Reidsville water system, at year ten, there is an assumed $12.4M cost of improvements to the Reidsville system to ensure it can continue to meet the growing demands within the County's system.

The total 10-year estimated cost of infrastructure for *Supply Scenario 1* is $41.9M.
The total 10-year estimated cost of infrastructure for *Supply Scenario 2* is $41.5M.

4.3 Thirty-year Buildout

For the 30-year buildout of the water system, the infrastructure cost for *Supply Scenario 2* is assumed to have a $10.0M increase over *Supply Scenario 1.* This additional cost is for improvements to the Reidsville water system and booster pumps within the County.

The total 30-year estimated cost of infrastructure for *Supply Scenario 1* is $48.6M.
The total 30-year estimated cost of infrastructure for *Supply Scenario 2* is $58.6M.

5.0 Potential Water Rates

Timmons Group has teamed with Raftelis Financial Consultants to develop a preliminary rate and fee structure to help determine feasibility of development of the regional water system. All costs to customers given below are based on a break-even financial model. This analysis assumes no additional grants or exterior funding sources to the participating localities. If additional funding is procured, it could reduce the cost to the "authority" and ultimately to the end-users/customers.

Some of the major financial assumption for this analysis are listed below:

- Funding Assumptions:
  - The inception of the water system and the first round of funding occurs in year 2020
  - Traditional Loans or Bond Sales
    - Loan Terms – 25-year financing
    - Interest Rate – 4.5%
  - Capital Costs
    - Inflated at 2.5% annually

5.1 Financial Considerations

It is important to understand the cost of starting a regional water distribution system will not be limited to the physical infrastructure. Along with the cost of the construction of the water mains and storage tanks, the following costs should be expected:

- Survey/Engineering Design
- Property Acquisition
- Easement Acquisition
- Permitting
- Legal and Administrative

5.2 Preliminary Rate/Fee Structure

Raftelis looked at the potential water rates for each Supply Scenario. For both scenarios, a best-case scenario was assumed for the number of connected customers to provide a view of what might be the least cost to potential customers. The scenario assumptions include:

- Strategic infrastructure buildout to target the higher-density areas to pick up the most customers.
- 100% service connection for all currently-built homes and businesses in the 5-year priority areas by year 5.
- 50% service connections for all undeveloped areas in the 5-year priority areas by year 5.
- No additional infrastructure improvements in Stokesdale.
- The average residential customer uses 200 gallons per day (GPD)
  - 200 GPD is considered an Equivalent Residential Connection (ERC)

For *Supply Scenario 1*, the average monthly cost to customers (per equivalent residential connection, ERC) over the first five years is approximately $68.31. The average monthly cost over the first five years per ERC for *Supply Scenario 2* is approximately $88.10. For both Supply Scenarios, the cost per ERC for the first year is the highest expected due to the limited customer base. As more customers connect to the water system, the cost per ERC decreases. The cost per ERC over the first five years for both Supply Scenarios is shown in **Figure 5.2.1**.

Figure 5.2.1

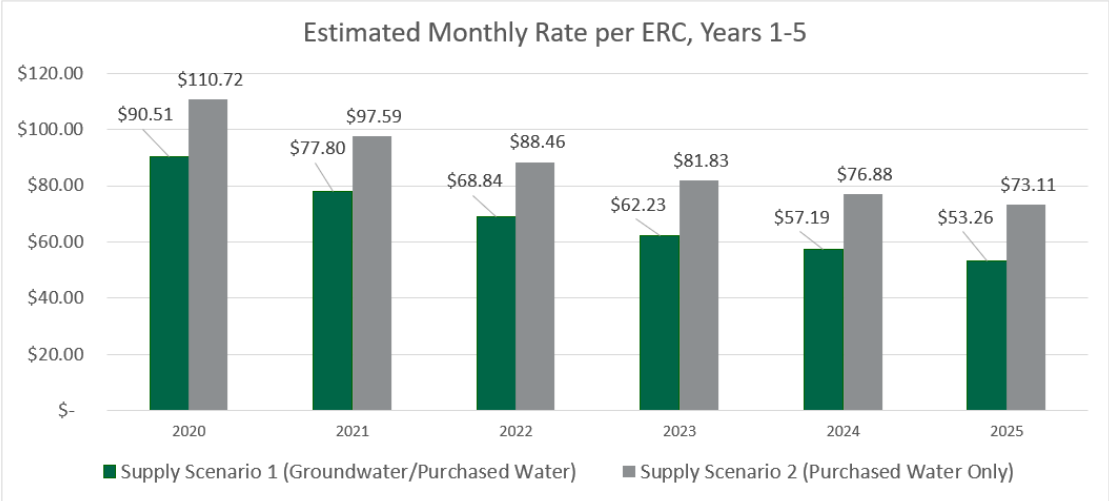


Figure 5.2.2 shows the estimated monthly costs per ERC over the 30-year study period. **Figure 5.2.3** shows the same monthly estimates, but without annual escalation to demonstrate the potential costs in terms of 2020 dollars to better demonstrate the reduction in customer costs over time.

Figure 5.2.2

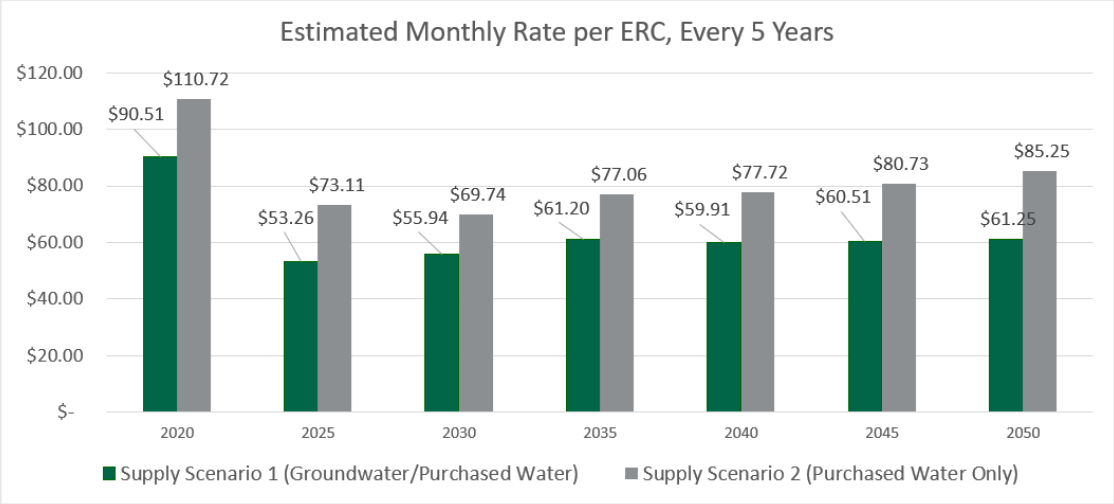
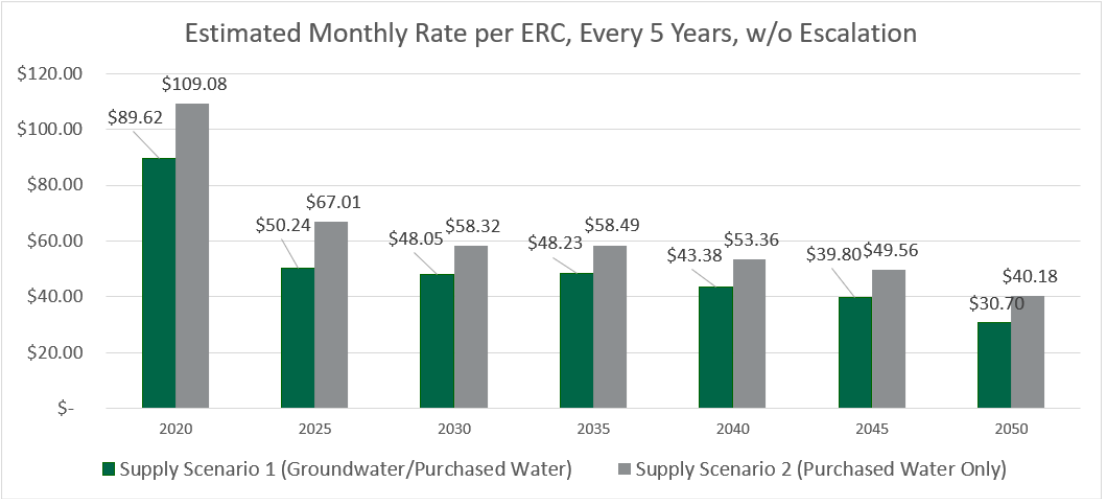


Figure 5.2.3



A sensitivity analysis was also performed for key variables. Each additional $1 million in capital project costs increases the monthly water bill for residential customers by approximately $1.32 per month. A 10% increase/reduction in the Reidsville bulk water rate increases/decreases the monthly water bill for residential customers by approximately $2.15 per month.

A detailed review of the financial analysis is provided in **Appendix D.**

5.3 Funding Sources

Timmons Group has teamed with Skip Green and Associates to perform a high-level funding alternatives analysis to identify potential state and federal grant/loan funding options for the water system development.
Skip Green and Associates indicated that each organization that provides funding requires a certain need for funding to be demonstrated, whether that is public need or economic development.

Skip Green and Associates provide a list of potential funding sources and details the eligibility requirements, assistance, loan terms, and demonstrated need requirements for each loan option. The funding organizations include United States Department of Agriculture (USDA) Rural Development, North Carolina Department of Environmental Quality (NCDEQ), United States Environmental Protection Agency (USEPA), North Carolina Department of Commerce, Golden Leaf Foundation Inc., and United States Department of Commerce. Refer to their report for additional information.

As the proposed project is to meet a Public Need, Skip Green and Associates recommend that potential funding packages could include a combination of special water project funds and installment purchase and/or bond financing; and Rural Development, USDA Water & Waste Disposal Loan and Grant Program. It would appear that the use of Rural Development financing in sections of the overall water system where there is less dense population could reduce the need for residents in more densely populated areas to subsidize construction in rural areas. In recent discussions with Rural Development, USDA, the agency has funds and is looking to develop projects. During the design stage, economic development grants should be sought to help finance specific components that will directly benefit new or expanding industries.

6.0 Water System Governance Summary

Timmons Group has teamed with Tuggle Duggins to provide a high-level governance options summary for the municipalities to use for planning water system governance structure. With any governance option, there are benefits and drawbacks. The participating localities should weigh the alternatives carefully before deciding on appropriate legal structure for governing a regional water system.

Section 6.1 Potential Organization Structures

Tuggle Duggins identified the following statutory provisions that can be used to organize and operate a multi-jurisdictional water utility.

1. Extension of Existing Municipal Service where municipalities provide water service beyond their political boundaries and in addition to providing the water would also operate the system.
2. Interlocal Agreement which allows local governments to form joint agencies to operate the system. The joint agency may employ its own staff, but may not own property, which can make financing difficult.
3. Water Authorities and Districts which are essentially special purpose local governments, with the power to tax, adopt and enforce ordinances, and issue bonds.
4. Special Legislation which allows for the enactment of a law or charter that is a “customized” form of district or authority.

Section 6.2 Governance Considerations

Factors to be considered in deciding which arrangement to use include:

(a) degree of autonomy for the system operator;
(b) desire of participating governments to participate directly in operation of system administratively and financially;
(c) whether there are multiple sources of water supply;
(d) desire of participating governments to use the system to guide growth;
(e) how much governmental power the district or authority should have;
(f) the water assets that each government will be contributing to the new entity (reservoirs, treatment facilities, distribution lines, equipment);
(g) which entity will own property and equipment, manage personnel, and secure financing (bonds).

As the local governments of Northwest Guilford County develop their ideas for the combined system, some of the organizational structures models described will emerge as better suited the participants’ needs than others.

7.0 Conclusions and Next Steps

The goal of this report was to provide a view of what a regional water system in Northwest Guilford County might look like and to estimate the cost to customers. It is important to understand that there are several variables that could affect the way a regional water system is initiated, operated and grown. Each of those variables influences infrastructure costs and the costs to customers. This Study has focused on only two of the almost infinite possible combinations of variables. As such, the information contained in this report should be considered an approximation.

Section 7.1 Recommended Next Steps

Listed below are the recommended next steps that should be considered.

- **Groundwater Geophysical Investigation**
  - The groundwater investigation provided by Golder & Associates for this report was a desktop-level analysis based on topographical features, geologic research and scientific experience and judgement. It is highly recommended that true geophysical testing be conducted to confirm the groundwater availability estimated in this report.

- **Preliminary Engineering Report**
  - It is recommended to begin involving the Department of Environmental Quality (NCDEQ) in the discussions related to a future water public water system. One of the items required by NCDEQ will be a Preliminary Engineering Report (PER). The development of the PER will help reduce the number of unknown variables and increase the accuracy of both the hydraulic and financial models, further assisting in the determination of water system feasibility.

- **Engagement of Legal and Financial Council**
  - It is recommended that all localities engage both legal and financial council/representation to further discussions about water system governance structure and financial feasibility.

Appendix

Appendix A – Study Area Maps

Appendix B – Strategic Infrastructure Summary

Appendix C – Groundwater Reports

Appendix D – Financial Analysis

Appendix E – Funding Analysis

Appendix F – Governance Outlines

Appendix G – Public Presentation Copy

APPENDIX A

STUDY AREA MAPS

LEGEND

EXISTING INFRASTRUCTURE

RAILROAD

PROPOSED INFRASTRUCTURE

ELEVATED STORAGE TANK

POTENTIAL PRIORITY AREAS

0 - 5 YEARS

6 - 10 YEARS

ADMINISTRATIVE

GOVERNMENT BUILDING

SCHOOL BUILDING

SCALE 1"= 6,500'

0 6,500' 13,000'

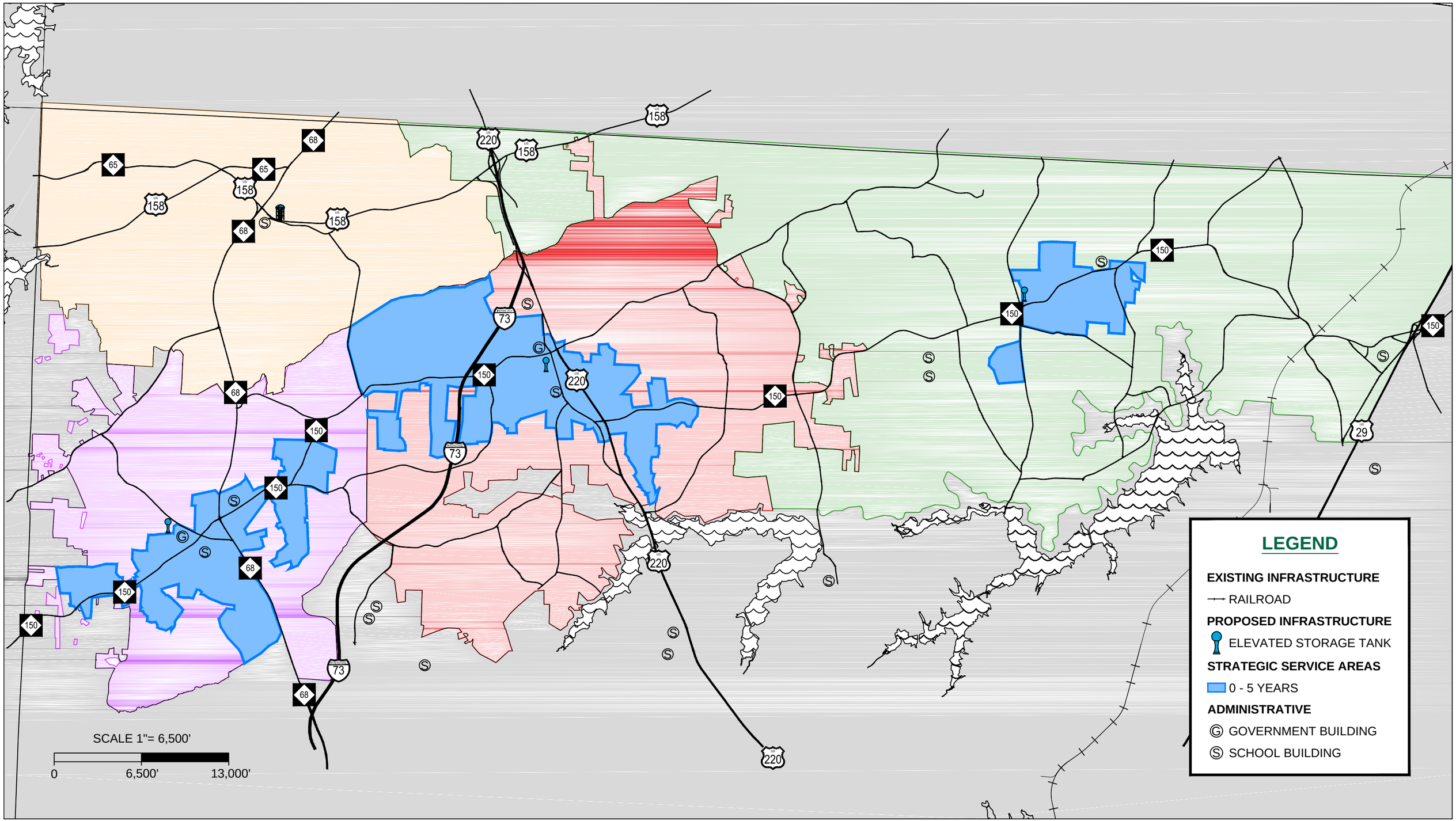
LOCALITY-DETERMINED PRIORITY AREAS MAP

NW REGIONAL WATER SYSTEM - JULY 17, 2018

GUILFORD COUNTY WATER SYSTEM FEASIBILITY STUDY

TIMMONS GROUP

YOUR VISION ACHIEVED THROUGH OURS.



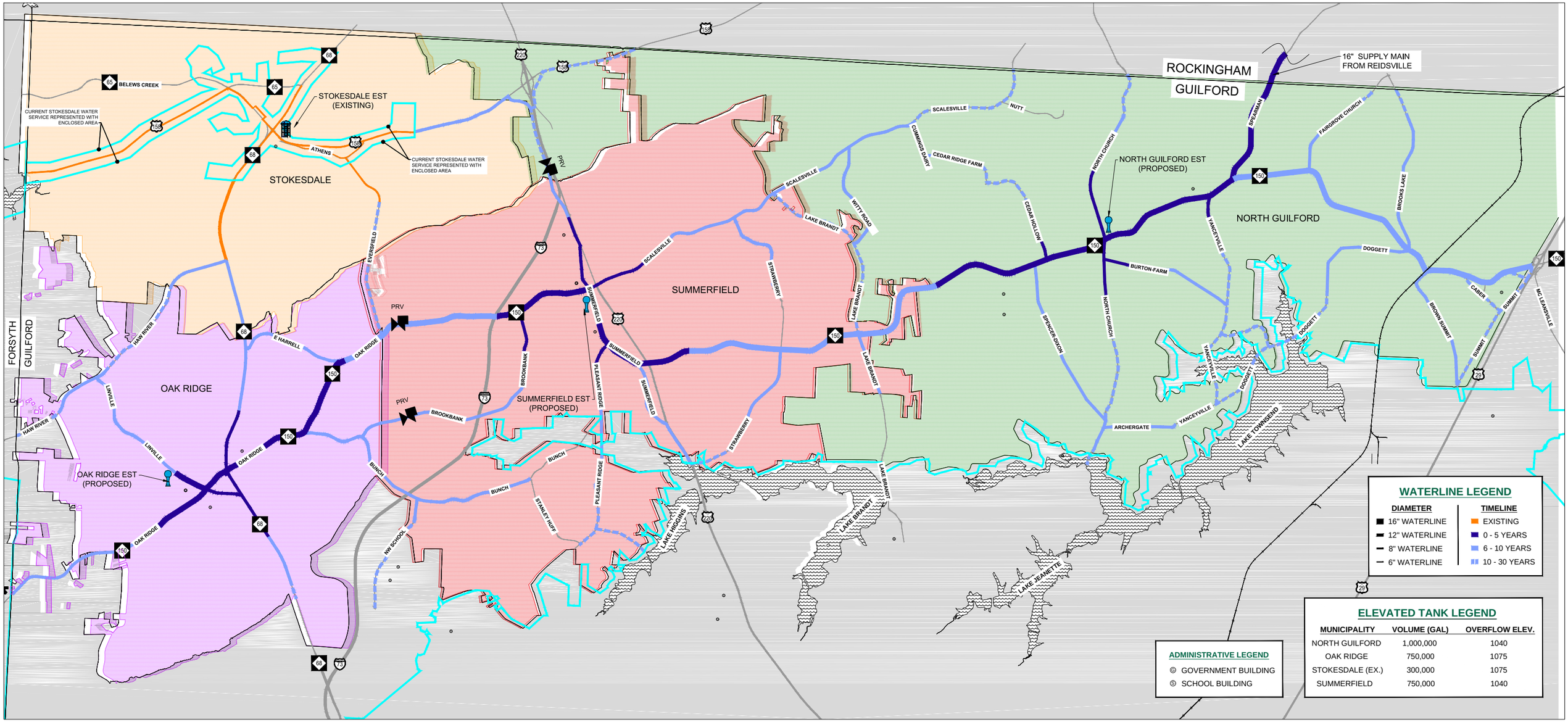
STRATEGIC 0-5 YEAR SERVICE AREAS

NW REGIONAL WATER SYSTEM - JULY 17, 2018

GUILFORD COUNTY WATER SYSTEM FEASIBILITY STUDY

TIMMONS GROUP

YOUR VISION ACHIEVED THROUGH OURS.



POTENTIAL WATER INFRASTRUCTURE GROWTH MAP

GUILFORD WATER SYSTEM FEASIBILITY STUDY - SEPTEMBER 19, 2018

TIMMONS GROUP
YOUR VISION ACHIEVED THROUGH OURS.

APPENDIX B

STRATEGIC INFRASTRUCTURE SUMMARY

Northwestern Guilford County Water System Feasibility Study

Phase 1 (0-5 Year) Priority Service Area Infrastructure Costs

Oak Ridge

ERC/sch.	ERC/com	ERC/ind
15	35	75

Project Segment	Tank		Primary Distribution Pipeline		Existing Residential							Existing School		Existing Commercial		Existing Industrial		Potential Residential				Potential Commercial		Total Associated Cost ($)
	Capacity (GAL)	*Cost*	*Length (FT)*	*Project Segment Cost ($)*	*Is Aqua? (Y/-)*	*Neighborhoods: Name*	*# Lots*	*Length of Road (FT)*	*Cost ($)*	*Cost per Lot*	*Misc. Individual Lots along Project Segment (#)*	*Name*	*Acres*	*# Parcels*	*Acres*	*# Parcels*	*Acres*	*# Lots*	*Acres*	*Potential Number of Lots*	*Length of Road (FT)*	*# Parcels*	*Acres*	
OR-5-01	750,000	$ 2,811,250	2,363	$ 339,690	-	-	-	-	$ -		3	Oak Ridge Elementary School	3.3	7	30.6	-	-	-	-	-	-	-	-	$ 3,150,940
OR-5-02	-	-	1,984	$ 281,420	-	Dunbar	7	357	$ 32,130	*$ 4,590.00*	5	-	-	19	35.8	-	-	-	-	-	-	-	-	$ 313,550
OR-5-03	-	-	6,273	$ 894,990	- -	Whitaker Estates Ashton Park	21 21	1,477 2,729	$ 169,855 $ 313,835	*$ 8,088.33* *$ 14,944.52*	30	Oak Ridge Military	68	10	29.1	-	-	4	108.8	218	00	-	-	$ 1,378,680
OR-5-04	-	-	5,815	$ 820,950	Y - - - -	Oak Ridge Lake Stonehenge Fox Glen Bugle Run Fairview Acres	99 89 49 18 47	12,746 7,364 5,822 3,511 5,847	$ 1,465,836 $ 662,760 $ 669,530 $ 315,990 $ 672,405	*$ 14,806.42* *$ 7,446.74* *$ 13,663.88* *$ 17,555.00* *$ 14,306.49*	44	-	-	3	1.4	1	3.41	-	-	-	-	-	-	$ 4,607,471
OR-5-05	-	-	5,378	$ 764,140	Y Y Y Y - -	Foxbury Meadows Willard Oaks Merriman Estates & Billet Place Twelve Oaks Stafford Place Oakridge Plantation	97 49 38 86 12 55	16,569 4,504 3,916 9,255 1,170 9,245	$ 1,905,435 $ 517,968 $ 450,386 $ 1,064,325 $ 134,550 $ 1,063,175	*$ 19,643.66* *$ 10,570.78* *$ 11,852.26* *$ 12,375.87* *$ 11,212.50* *$ 19,330.45*	27	-	-	-	-	-	-	3	78.5	157	00	-	-	$ 5,899,979
OR-5-06	-	-	2,441	$ 349,830	-	Linville Estates	20	0	$ -	*$ -*	-	-	-	4	5.5	-	-	3	41.3	83	0	-	-	$ 349,830
OR-5-07	-	-	3905	$ 430,500	- -	Old Mill Homesteads Estates at Oak Ridge Lake (Phase I) and surrounding lots along Fogleman Rd	32 51	4,550 8,037	$ 409,500 $ 723,330	*$ 12,796.88* *$ 14,182.94*	2	-	-	-	-	-	-	1	40.2	80	0	-	-	$ 1,563,330
OR-10-03	-	-	2,998	$ 327,050	Y -	Staffordshire Northwest Valley	194 34	20,969 5,028	$ 1,887,210 $ 452,520	*$ 9,727.89* *$ 13,309.41*	2	-	-	2	1.4	-	-	-	-	-	-	-	-	$ 2,666,780
Town Totals:	*750,000*	*$ 2,811,250*	*31,157*	*$ 4,208,570*			*1,019*	*123,097*	*$ 12,910,740*	*$ 12,670*	*113*			*45*						*538*		**Total Cost**		**$ 19,930,560**

Northwestern Guilford County Water System Feasibility Study

Phase 1 (0-5 Year) Priority Service Area Infrastructure Costs

TIMMONS GROUP
YOUR VISION ACHIEVED THROUGH OURS.

Summerfield

Project Segment	Tank		Primary Distribution Pipeline		Existing Residential							Existing School		Existing Commercial		Existing Industrial		Potential Residential				Potential Commercial		Total Associated Cost ($)
	Capacity (GAL)	*Cost*	*Length (FT)*	*Project Segment Cost ($)*	*Is Aqua?*	*Neighborhoods*					*Misc.*	*Name*	*Acres*	*# Parcels*	*Acres*	*# Parcels*	*Acres*	*# Lots*	*Acres*	*Potential Number of Lots*	*Length of Road (FT)*	*# Parcels*	*Acres*	
					(Yes)	*Name*	*# Lots*	*Length of Road (FT)*	*Cost ($)*	*Cost per Lot*	*Individual Lots along Project Segment (#)*													
SU-5-01	750,000	$ 2,811,250	6,759	$ 958,170	-	Whispering Pines	18	1,539	$ 138,510	*$ 7,695.00*	25	-	-	9	10.2	-	-	5	107.9	216	0	5	79.5	$ 4,799,470
					-	Highfill	73	9,906	$ 891,540	*$ 12,212.88*														
SU-5-02	-	-	6,366	$ 907,080	-	Elmhurst Estates	40	5,640	$ 507,600	*$ 12,690.00*	68	Summerfield Elementary School	23.9	22	12.6	4	8.5	1	52.7	105	0	-	-	$ 3,939,180
					-	Summerwoods	18	3,717	$ 334,530	*$ 18,585.00*														
					-	Morehampton Place	29	2,000	$ 180,000	*$ 6,206.90*														
					-	Elmhurst Estates 2	154	22,333	$ 2,009,970	*$ 13,051.75*														
SU-5-03	-	-	3,790	$ 539,700	Y	The Vineyards at Summerfield	112	12,269	$ 1,104,210	*$ 9,859.02*	48	-	-	6	24.5	-	-	2	76.7	153	0	-	-	$ 2,238,810
					-	Rayle Heights	23	2,809	$ 252,810	*$ 10,991.74*														
					-	Somerset	58	3,801	$ 342,090	*$ 5,898.10*														
SU-5-06	-	-	5,394	$ 593,900	Y	Henson Farms	90	13,129	$ 1,181,610	*$ 13,129.00*		-	-	-	-	-	-	4.00	40.0	80	0	-	-	$ 2,420,180
					Y	Armfield Phase 2	39	5,413	$ 487,170	*$ 12,491.54*														
					-	Tuscany at Henson Meadows	15	1,750	$ 157,500	*$ 10,500.00*														
SU-10-01	-	-	8,176	$ 1,160,380	Y	Auburndale	27	2,656	$ 239,040	*$ 8,853.33*	59	-	-	-	-	-	-	10	159.6	319	0	1	3	$ 8,545,390
					Y	Wilson Farms	151	12,039	$ 1,083,510	*$ 7,175.56*														
					Y	Henson Forest	127	14,749	$ 1,327,437	*$ 10,452.26*														
					Y	Armfield	60	8,559	$ 770,343	*$ 12,839.06*														
					-	Whitaker Farms	152	25,475	$ 2,292,750	*$ 15,083.88*														
					-	Frog's Leap	50	8,895	$ 800,550	*$ 16,011.00*														
					-	Birkhaven	66	9,682	$ 871,380	*$ 13,202.73*														
Town Totals:	*750,000*	*$ 2,811,250*	*30,485*	*$ 4,159,230*			*1,302*	*166,362*	*$ 14,972,550*	*$ 11,500*	*200*			*037*		*004*				*874*		**Total Cost**		**$ 21,943,030**

Northwestern Guilford County Water System Feasibility Study

Phase 1 (0-5 Year) Priority Service Area Infrastructure Costs

TIMMONS GROUP
YOUR VISION ACHIEVED THROUGH OURS.

North Guilford

Project Segment	Tank		Primary Distribution Pipeline		Existing Residential							Existing School		Existing Commercial		Existing Industrial		Potential Residential				Potential Commercial		Total Associated Cost ($)
	Capacity (GAL)	Cost	*Length (FT)*	*Project Segment Cost ($)*	*Is Aqua?*	*Neighborhoods*					*Misc.*	*Name*	*Acres*	*# Parcels*	*Acres*	*# Parcels*	*Acres*	*# Lots*	*Acres*	*Potential Number of Lots*	*Length of Road (FT)*	*# Parcels*	*Acres*	
					(Yes)	*Name*	*# Lots*	*Length of Road (FT)*	*Cost ($)*	*Cost per Lot*	*Individual Lots along Project Segment (#)*													
NG-5-01	1,000,000	$ 3,311,250	9,874	$ 1,395,620	Y	Beacon Hill	56	4,880	$ 439,200	*$ 7,842.86*	65	Northern Elementary School	59	4	20.1	-	-	2	33.0	66	0,000	-	-	$ 8,025,440
					Y	Triple Lakes	128	12,533	$ 1,127,970	*$ 8,812.27*														
					-	Moorefield Acres	8	0	$ -	*$ -*														
					-	Stonewood	18	1,491	$ 134,190	*$ 7,455.00*														
					-	Magnolia Estates	29	2,209	$ 198,810	*$ 6,855.52*														
					-	Oak Grove Forest	157	15,760	$ 1,418,400	*$ 9,034.39*														
NG-5-04	-	-	4,164	$ 463,650	-	Mitchell's Landing	35	4,257	$ 383,130	*$ 10,946.57*	19	-	-	-	-	-	-	3	137.3	275	0,000	-	-	$ 953,970
					-	Willow Hills	14	5,185	$ 107,190	*$ 7,656.43*														
NG-5-06	-	-	3,160	$ 356,000	-	Church Meadows	24	1,057	$ 480,330	*$ 20,013.75*	5	-	-	-	-	-	-	-	-	-	-	-	-	$ 1,595,390
					-	Whitestone	66	845	$ 759,060	*$ 11,500.91*														
Town Totals:	*1,000,000*	*$ 3,311,250*	*17,198*	*$ 2,215,270*			*535*	*48,217*	*$ 5,048,280*	*$ 9,436*	*89*		*4*	*4*		*2*				*341*		**Total Cost**		**$ 10,574,800**

APPENDIX C

GROUNDWATER REPORTS

GOLDER MEMO

TECHNICAL MEMORANDUM

Date:	January 9, 2018 revised	**Project No.:**	1778575
To:	David Saunders, P.E. David.Saunders@timmons.com	**Company:**	Timmons Group 1001 Boulders Parkway, Suite 300 Richmond, VA 23225
From:	Brent Waters, P.G. Brent_Waters@golder.com		Golder Associates Inc. 2108 W. Laburnum Ave., Ste 200 Richmond, VA 23227
cc:			

RE: REVIEW OF USGS GROUNDWATER RECHARGE AND STORAGE STUDY OF GUILFORD COUNTY, NORTH CAROLINA

Introduction

Golder Associates has reviewed an investigation report prepared by the U.S. Geological Survey (USGS) in cooperation with the Guilford County Health Department and Soil and Water Conservation District in 1997 titled *"Groundwater Recharge to and Storage in the Regolith-Fractured Crystalline Rock Aquifer System, Guilford County, North Carolina" by Charles Daniel and Douglas Harned*. The authors of this study in the abstract state that "in order to determine the maximum populations that can be supplied by groundwater, planners and managers of suburban development must know the amount of groundwater that can be withdrawn without exceeding recharge and/or overdrafting water in long-term storage". As such, this study may be seen by local planners, developers, and water supply providers as a guide for making decisions on land use, minimum lot sizes for residential developments, and maximum sustainable groundwater yields. However, this information could be misused or misinterpreted if not fully understood. The purpose of this memo is to provide some additional insight in how this data can be used to help manage groundwater resources in Guilford County.

Review of Daniel and Harned (1997) Paper

Daniel and Harned (1997) supports minimum residential lot sizes of 1 to 3 acres based primarily on estimated groundwater recharge rates. Using streamflow baseflow separation methodology, annual groundwater recharge rates range from 4.0 to 9.7 inches per year (in/yr) in stream basins across Guilford County with an average recharge rate of 6.3 in/yr. The highest recharge estimates occur in the northwestern portion of Guilford County in areas underlain by felsic igneous intrusive rocks. Infiltrating groundwater is stored in the underlying regolith (soil, alluvium, and saprolite) and bedrock and flows through this aquifer material to eventually discharge to local and regional surface water bodies. The average thickness of regolith is 52 feet and the average saturated thickness of regolith is 24 feet according to Daniel and Harned (1997). Average porosities range from over 30% for the unconsolidated regolith to 1-3% for the underlying bedrock. The article generally supports an opinion that groundwater withdrawal should not

exceed groundwater recharge on an individual lot or subdivision basis to avoid long-term net losses in groundwater storage.

This minimum lot size was established using a low recharge rate of 5.51 in/yr to establish a recharge rate of 412 gallons per day per acre (gpd/ac). After accounting for impervious cover, Daniel and Harned (1997) suggest that a minimum of 1.05 acres was required to support a typical residential housing lot with a water demand of 400 gpd. The water demand is based on a water usage rate of 100 gpd per capita and 4 people per house. Accounting for a reduction in groundwater recharge rates due to changed land use from woodland and pasture to maintained lawns, Daniels and Harned state that up to 2.34 acres may be required to maintain no net loss from long term groundwater storage from rural residential homes on well and septic. In their second example, they state that a community water system would require a total of 93 acres to support water demand from an estimated 38 homes to maintain no net loss from long term groundwater storage. This is equivalent to average lot size of 2.45 acres.

Discussion

In their first example, they use a recharge rate of 412 gpd/ac (5.51 in/yr), which is considered low. We can cite several studies that indicate effective recharge rates in the Piedmont are more typically between say 670 to 740 gpd/ac (9 to 10 in/yr). This is especially true for northwestern Guilford County that is underlain by felsic igneous rocks, which weather to a more permeable quartz-rich sandy loam soil and saprolite. The study also did not account for recharge from the septic drainfield. Typically, 85 to 90% of the water usage is returned to the groundwater via the drainfield with the remaining being used consumptively from evapotranspiration of irrigation water. Therefore, the consumptive water use is only around 40 to 60 gpd instead of 400 gpd. Current building codes and municipal stormwater regulations require pre-development groundwater infiltration rates to be preserved therefore minimizing reductions in recharge due to increased impervious areas or changes in land use. Lastly, building codes and conservation efforts have greatly reduced residential water demand from a maximum of 400 gpd to typically less than 200 to 250 gpd. Applying these more current views of groundwater infiltration and water usage, a typical single-family home should have minimal impact on groundwater recharge to surficial aquifer systems.

Minimum lot sizes are often set by local governments based on assimilation of wastewater from on-site sewage systems to protect the groundwater and nearby surface water resources from elevated nitrogen loading. Scientific literature indicates that minimum lot size to prevent nitrogen degradation of the groundwater is roughly 0.5 to 1.0 acres. For more sensitive areas with sandy soil, shallow water table and critical aquifer and aquatic habitats, 1 to 3 acres minimum lot sizes are often cited as the minimum lot size required. For example, a minimum lot size of 3.2 acres is required for unsewered lots in the New Jersey Pinelands.

Groundwater recharge is typically not used to guide or regulate minimum lot sizes. Estimates of groundwater recharge cannot be effectively measured at a single site and are not defensible at the size of a residential lot or an entire residential community. Even using regional estimates of groundwater recharge rates may not be a defensible method of guiding minimum residential lot sizes. Using an average recharge rate of 6.3 in/yr, which we consider low for this region, an annual average recharge rate of 197 million gallons per day (MGD) is calculated for the 658 square mile area occupied by Guilford County. The estimated recharge rate increases to over 300 MGD using a rate of 9.7 in/yr. Similarly, the total volume of water stored within Guilford County is large with an estimated 1.350 trillion gallons stored in the saprolite and bedrock. Even if only a small portion of this groundwater recharge and storage is available for development and use, Guilford is clearly a water-rich County so restricting land use based on groundwater recharge does not appear to be reasonable and does not address the real issue of inadequate groundwater availability and impact to existing groundwater users.

American water law is based on reasonable use allowing a landowner to extract as much water as they want if it does not unreasonably damage other wells or the aquifer system. This doctrine protects historic uses and prevents new uses that interfere with prior use. Often, state and even county governments regulate and permit who gets a well and sometimes how much water is pumped to ensure adequate water is available for the proposed use and to protect future reasonable use of the water if it is somehow limited by quantity or quality. Groundwater use and withdrawal amounts is often determined through a permitting process and require hydrogeologic studies to show that adequate groundwater supplies are available and that the proposed withdrawal does not impact neighboring groundwater users, stream baseflow, or other ecologically sensitive or important habitats. Counties in growing rural suburban areas surrounding city centers where groundwater is often the main source of water supply have developed regulations that require groundwater availability and drawdown impact studies prior to approval of a subdivision plan. Such regulations may directly or indirectly dictate minimum lot sizes to ensure that adequate water supplies can be developed for the subdivision and that withdrawals from individual wells cumulatively do not impact existing groundwater users nearby.

Recommendations

Guilford County could consider conducting a study to evaluate the possible range of Subdivision regulations that the County could adopt to help ensure that adequate groundwater supplies are available for new subdivisions and that these future withdrawals do not impact existing groundwater users or effect environmentally sensitive habitats such as stream flow, lake levels, or wetlands. This would be accomplished by reviewing and presenting what other municipal and state governments have adapted to manage groundwater resources to ensure groundwater availability and summarize the total number and density of homes in a subdivision that have been shown to be sustainable in different geologic settings.

GOLDER REPORT

REPORT

Preliminary Groundwater Resource Evaluation

Northwest Guilford County, North Carolina

Submitted to:

Timmons Group
5410 Trinity Rd #102,
Raleigh, NC 27607

Submitted by:

Golder Associates NC, Inc.
2108 W. Laburnum Avenue, Suite 200,
Richmond, Virginia, USA 23227
Engineering Lic. No. C-2862/Geology Lic. No. C-399

+1 336 852-4903

April 10, 2018

Table of Contents

1.0 INTRODUCTION 1

1.1 Study Objectives and Evaluation Criteria 1

1.2 Scope of Work Completed 1

2.0 GROUNDWATER RESOURCE EVALUATION 3

2.1 Location and Description of Study Area 3

2.2 Bedrock Geology 3

2.3 Hydrogeologic Characteristics of Bedrock Formations 8

2.4 Lineament Analysis 8

2.5 Inventory and Description of Area Wells 9

2.6 Groundwater Flow and Recharge Estimates 12

2.7 Groundwater Quality Issues 13

3.0 GROUNDWATER FAVORABILITY MODEL 15

4.0 CONCLUSIONS AND RECOMMENDATIONS 17

4.1 Overall Assessment of Groundwater Availability 17

4.2 Recommendations 17

5.0 REFERENCES 19

LIST OF FIGURES

Figure 1 – Study Area Location Map 4

Figure 2 – Land Use and Land Cover Map 5

Figure 3 – Topography and Hydrology Map 6

Figure 4 – Geology Map 7

Figure 5 – Lineament Map 10

Figure 6 – Well Yield 11

Figure 7 – Potential Contamination Sites 14

Figure 8 – Groundwater Favorability Model Results 16

EXECUTIVE SUMMARY

Golder Associates NC, Inc. (Golder) in association with the Timmons Group have completed a preliminary groundwater resource evaluation to assess the overall feasibility of developing groundwater supplies to support the local water supply needs of the towns and unincorporated areas of northwestern Guilford County, including Stokesdale, Oak Ridge, Summerfield, and unincorporated portions of Guilford County east of Summerfield to State Route 29. Groundwater is seen as a viable interim or supplemental water supply source for the less densely populated areas of northwestern Guilford County. Our study is designed to preliminarily identify areas that may be favorable for developing groundwater wells that can support local water supply needs in an economically sustainable manner.

The feasibility of developing groundwater resources of suitable quantity and quality are controlled by numerous interrelated factors, including the water-producing and water quality characteristics of the underlying bedrock formations; the presence of geologic structures favorable to groundwater development such as folds, faults or fracture zones; surface topography and drainage patterns; soil thickness and character; the configuration of the groundwater table; the amount of available groundwater recharge; and the effects of existing land usage on groundwater recharge and water quality. These factors were evaluated to assess the overall availability of groundwater resources and the potential of developing suitable high yielding wells within the study area.

Based upon the findings of our preliminary groundwater investigation, Golder believes that the overall potential of developing groundwater resources in northwestern Guilford County is good. This assessment is based on favorable fracture development characteristics of the granitic rocks, which make up the majority of the bedrock type in the study area, good water storage attributes of the thick unconsolidated soil and saprolite overlying the bedrock, high lineament density and the coincidence of many of these lineaments with expected bedrock structures, a moderately high groundwater recharge estimate of over 35 million gallons per day, and productive well yields of between 100 to 200 gpm.

Potential groundwater development areas have been identified using a groundwater favorability model. Favorable groundwater development areas correspond with areas underlain by granitic rocks; are proximal to lineament, lineament intersections, and cross-strike lineament orientations; are situated in river lowland areas; and are not near potential contamination sites or high-density development areas.

We recommend that focused non-intrusive electrical resistivity imaging geophysical surveys be conducted at selected groundwater exploration sites to confirm and better locate potential subsurface fractured bedrock aquifers and to help optimize future exploratory test well locations. Electrical resistivity is widely used by Golder with great success at numerous sites to locate fracture zones that can store and transport significant volumes of groundwater. Following completion of the geophysical survey and selection of potentially favorable well sites, exploratory test wells should be drilled to evaluate well yield and groundwater quality. Test wells that meet the needs of Guilford County should be converted into public water supply wells.

1.0 INTRODUCTION

1.1 Study Objectives and Evaluation Criteria

The following task report has been prepared by Golder Associates NC, Inc. (Golder) for Timmons Group as part of their engineering study to determine the feasibility of developing a regional water system in Northwestern Guilford County, North Carolina including the Towns of Oak Ridge, Stokesdale, Summerfield and certain unincorporated portions of Guilford County. The objectives of this preliminary groundwater resource evaluation are to collect and analyze available scientific data on groundwater resources to assess the overall feasibility of developing groundwater supplies to support the local water supply needs of the towns and unincorporated areas of northwestern Guilford County. Groundwater is seen as a viable interim or supplemental water supply source for the less densely populated areas of northwestern Guilford County. Our study is designed to preliminarily identify areas that may be favorable for developing groundwater wells that can support local water supply needs in an economically sustainable manner.

The principal criteria for evaluating the feasibility of developing suitable public water supplies within the study area relate to the yield and water quality characteristics of the geologic formations and geologic structures underlying the study area as determined by an evaluation of geologic and topographic maps; completion of remote sensing analyses to locate potential fractured bedrock aquifers; review of area well log records; estimation of long-term recharge potential of the underlying aquifers; identification of potential contaminant sources; and evaluation of potential impacts that the proposed withdrawal may cause on existing groundwater users or environmentally sensitive areas.

1.2 Scope of Work Completed

This scope of work has been developed in part based on discussions between Timmons and Golder and our understanding of the hydrogeologic conditions and water supply needs of northwestern Guilford County. The scope of work completed for this study included:

- Publications Review. Golder obtained and reviewed published geologic maps, topographic maps, soil reports, hydrogeologic reports, and water supply/water use information prepared by the North Carolina Geological Survey (NCGS), the U.S. Geological Survey (USGS), and the North Carolina Department of Environment Quality (NCDEQ) Water Resources Division.
- Development of a GIS Base Map. Golder compiled relevant data onto a geographic information system (GIS) base map. The GIS base map was generated from publically-available data sources such as roads, streams, topography, soils, and geology coverages, as well as data from publically available state and federal databases on well yield, groundwater quality, hazardous waste and leaking underground storage tank sites. The GIS base map was used to spatially analyze hydrogeologic data sets and will be used in the future to facillitate the transfer and analysis of GPS-located field data.
- Lineament Analysis. Golder completed a reconnaissance-level remote sensing analysis to identify linear topographic features. These features are recognized on topographic maps, shaded relief digital elevation models, aerial photos, and satellite imagery and often represent the surface expression of zones of high fracture density or other lithologic contrast in the underlying bedrock. Because there is little primary porosity in most rock types, wells that intersect numerous and/or extensive fracture zones which are hydraulically connected to the overall fracture network in the rock are more likely to be productive compared to wells drilled at random.

- Well Inventory and Water Quality Evaluation. Golder compiled information on the yield and water quality of existing water supply wells in the area from the NCDEQ geodatabases. This information was analyzed to evaluate well yield and water quality characteristics that may be associated with specific hydrogeologic factors such as underlying geology, topographic position, distance from mapped fracture zones, faults or geologic contacts, etc. Potential contamination sources in the area were identified by searching available public environmental databases from the NCDEQ and EPA.
- Groundwater Recharge Estimates. Golder estimated groundwater recharge potential for the study area and surrounding watersheds based on published runoff and evapotranspiration estimates, local stream baseflow calculations, soil maps, and surface water drainage maps.
- Groundwater Availability Assessment. Golder assessed the overall availability of groundwater resources within the study area and provided recommendations on the feasibility of developing sufficient groundwater resources from locations within the study area to meet estimated water supply needs.
- Identification of Favorable Groundwater Exploration Areas. Based on this Preliminary Groundwater Resource Evaluation, Golder identified areas considered favorable for further groundwater exploration and development. Favorable groundwater exploration areas (GWEAs) were identified using a Groundwater Favorability Model (GWFM), a customized spatial analyst computer program developed specifically for this project, based on an analysis of the following hydrogeologic parameters:
  - Location, density and orientation of mapped fracture traces
  - Location of bedrock units considered favorable for water supply development
  - Location of geologic structures with associated fracture patterns favorable to water supply development
  - The proximity to existing public water supply wells or springs
  - The proximity to and location of known potential sources of groundwater contamination
  - Existing well yield and water quality data

2.0 GROUNDWATER RESOURCE EVALUATION

The feasibility of developing groundwater resources of suitable quantity and quality are controlled by numerous interrelated factors, including the water-producing and water quality characteristics of the underlying bedrock formations; the presence of geologic structures favorable to groundwater development such as folds, faults or fracture zones; surface topography and drainage patterns; soil thickness and character; the configuration of the groundwater table; the amount of available groundwater recharge; and the effects of existing land usage on groundwater recharge and water quality. These factors are relevant to assessing the overall potential of developing suitable groundwater resources within the study area and are summarized in this section.

2.1 Location and Description of Study Area

The study area includes the northwestern corner Guilford County, north of the City of Greensboro and northeast of the City of Winston-Salem. The towns of Stokesdale, Oak Ridge, Summerfield, and unincorporated portions of Guilford County east of Summerfield to State Route 29 are included within the designated study area. Figure 1 is a road travel map illustrating the extent of the study area, township boundaries and major transportation corridors.

Land use and land cover within the study area consists of mixed use from high intensity developed areas associated with town centers and located along high use transportation corridors, to rural residential, woodland and farmland. Land use and land cover within the study area is shown in Figure 2.

The land is moderately hilly with broad uplands dissected by steeply-sided, incised streams. The highest elevations are found in the western and northwestern portion of the study area where upland ground elevations reach approximately 970 to 990 feet above mean sea level (ft msl) in Stokesdale and Oak Ridge. The land surface gently decreases towards the northeast to elevation lows of 670 to 700 ft msl, where the main streams cross into Rockingham County to the north or State Route 29 to the east. The study area is drained northeastward by three main river tributaries: Haw River, Mears Fork (of the Haw River), and Reedy Creek. These three rivers converge into the Haw River which drains into the Cape Fear River and flows southeastward across the coastal plain eventually discharging into the Atlantic Ocean near Wilmington. Figure 3 presents a topographic map and shaded relief map illustrating the topography and surface hydrology in the study area.

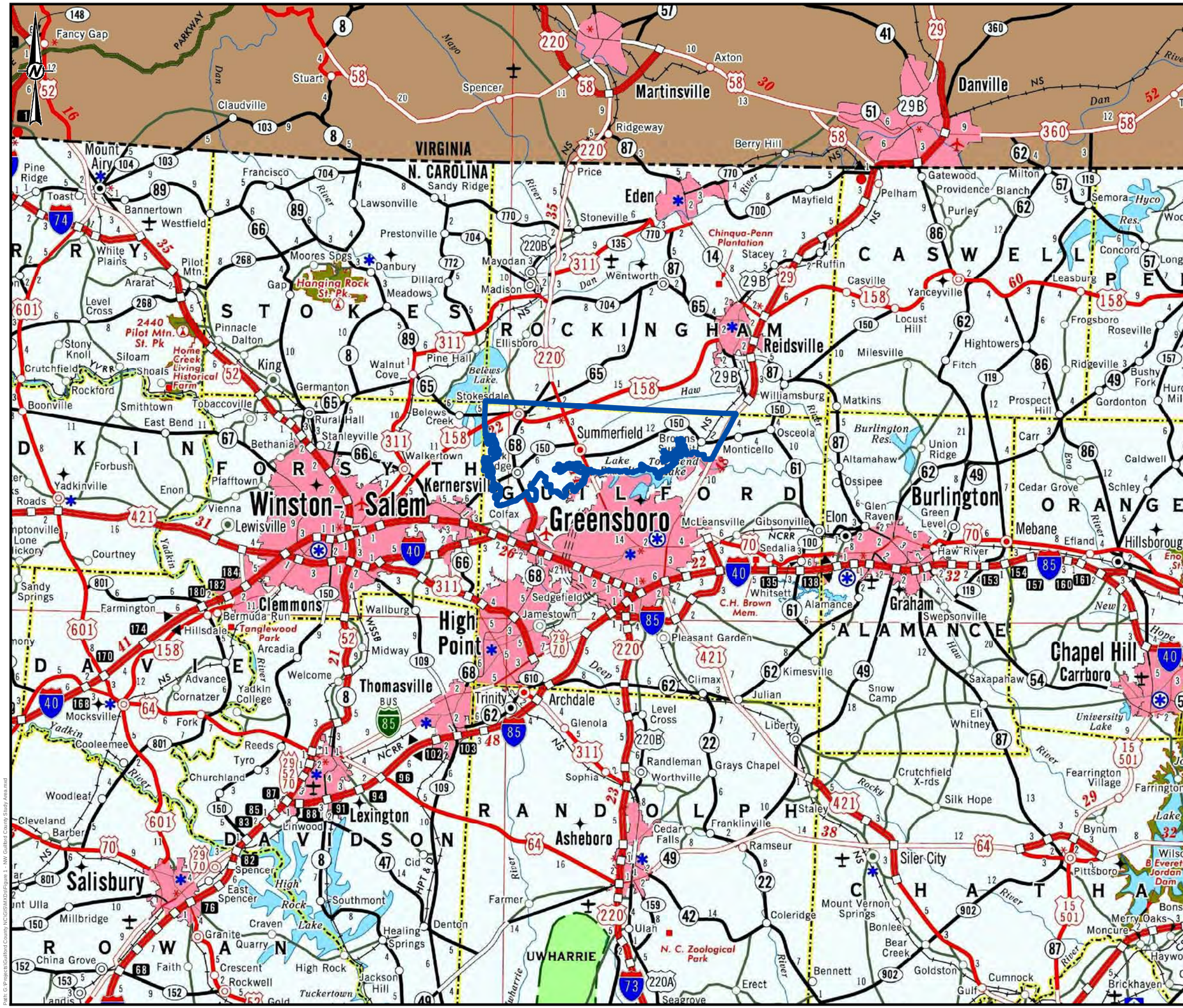
2.2 Bedrock Geology

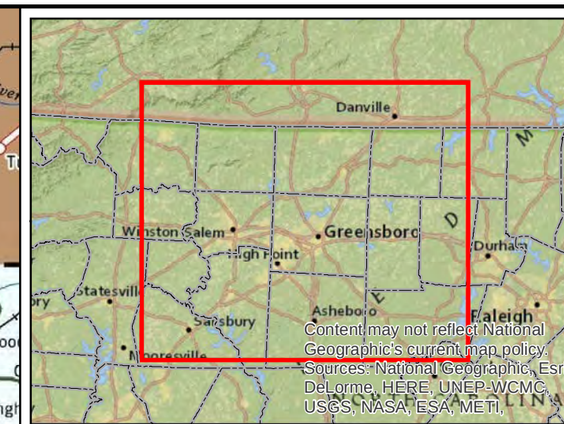
The geology underlying the study area is shown in Figure 4 and is based on the 1985 geologic map of North Carolina (NCGS, 1985). The geology of the study area is diverse and complex reflecting the multiple phases of compressional and extensional deformation experienced in this area. There are three main geologic formations mapped within the study area: 1) highly metamorphosed biotite gneiss and schist (CZbg), 2) coarse-grained granitic rocks (PPg), and 3) Jurassic diabase dikes (Jd). Each map unit is described further below.

CZbg – Biotite Gneiss and Schist (520-650 my) – highly metamorphosed and foliated biotite gneiss and schist, dark colored, medium to coarse grained to porphyroblastic, locally contains hornblende and is chiefly composed of biotite, quartz, potassium feldspar, muscovite and hornblende. Interlayered with mica schist and amphibolite. Locally intruded by pegmatite dikes.

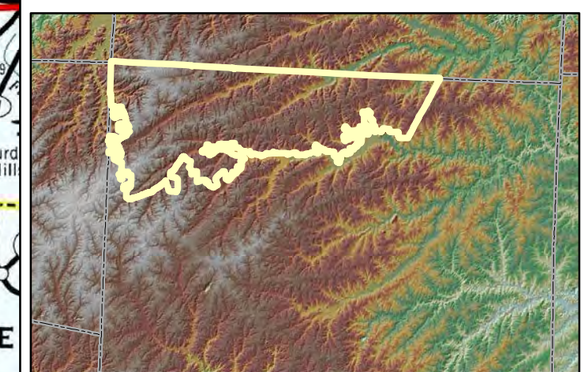
PPg Porphyritic Granite (265-325 my) – Light gray, medium to coarse-grained porphyritic granite, granodiorite and quartz monzonite. Composed of microcline phenocrysts up to 13 cm in diameter in a matrix of quartz, oligoclase and biotite.

Jd Diabase Dike (265-325 my) – Black to greenish dark gray, fine to medium-grained, dense rock composed of plagioclase, augite, and olivine. Occurs as dikes up to 200-ft wide. Typically occurs as spheriodally weathered boulders with a grayish-brown weathering rind.





KEY MAP



INSET MAP

LEGEND

Study Area

0 5.5 11 16.5 22 Miles

1 inch = 8 miles

NOTES

1. BASE MAP FROM NC TRAVEL MAP,
2. INSET MAP FROM NATGEO ONLINE WORLD MAP
3. ELEVATION HILLSHADE FROM USGS NED 10M

PROJECTION: NAD 83 STATE PLANE FOR NORTH CAROLINA FT

CLIENT
TIMMONS GROUP

PROJECT
PRELIMINARY GROUNDWATER RESOURCE EVALUATION
NORTHWEST GUILFORD COUNTY, NORTH CAROLINA

TITLE
STUDY AREA LOCATION MAP

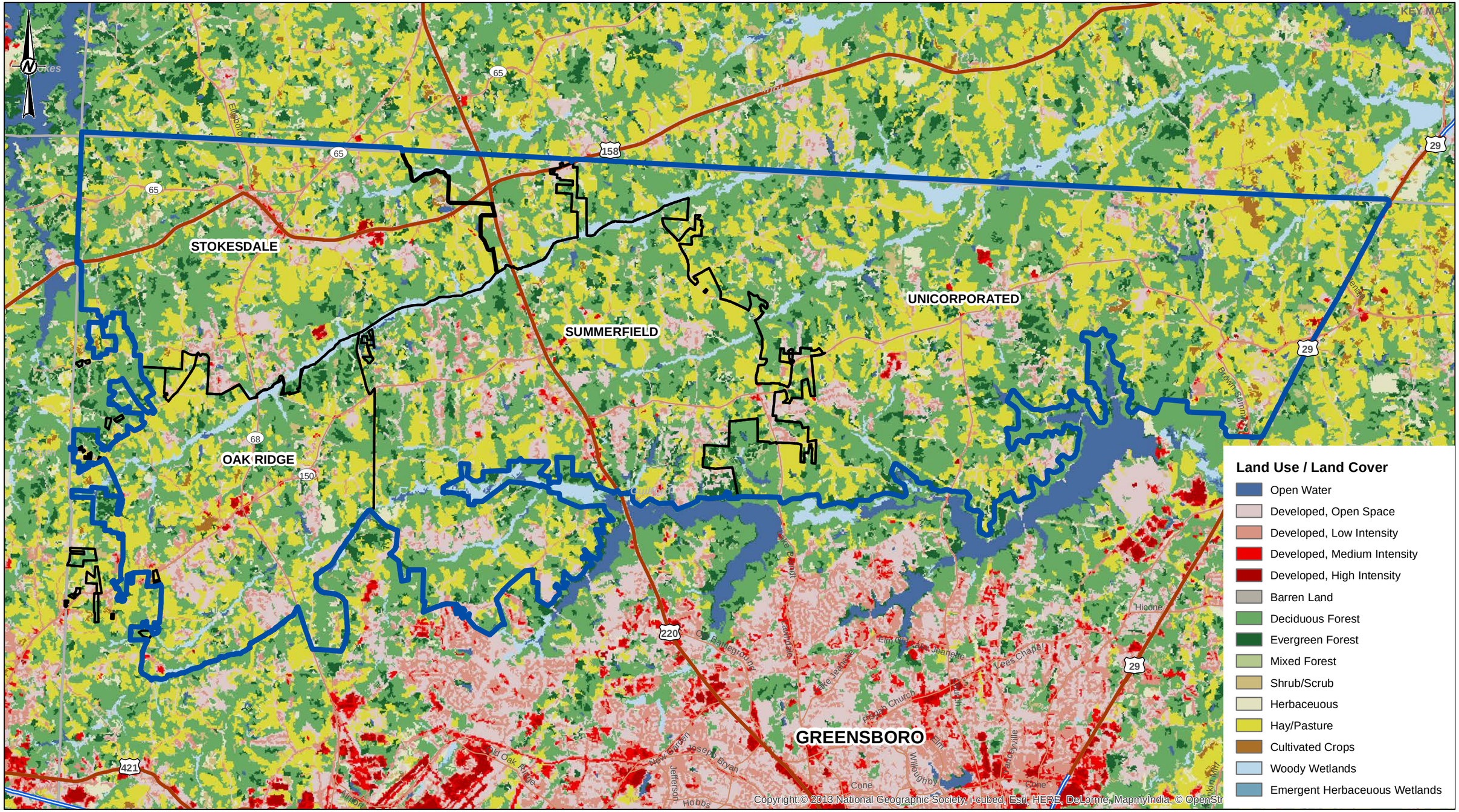
CONSULTANT
GOLDER
2108 W. LABURNUM AVE., SUITE 200
RICHMOND, VIRGINIA, USA, 23227
(804) 358-7900

YYYY-MM-DD	2018-04-10
PREPARED	MGM
DESIGN	BBW
REVIEW	PWN
APPROVED	BBW

PROJECT No.	PHASE	Rev.	FIGURE
1778575	100	01	1

Path: G:\Projects\Guilford County NC\GIS\MXD\s\Figure 1 - NW Guilford County Study Area.mxd

1 in IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET HAS BEEN MODIFIED FROM: ANSI B



LEGEND

- Study Area
- Municipal Boundaries within Study Area

NOTE(S)
1. HYDROLOGY DATA FROM NHD24KST AND NHD24KWB SHAPEFILES
2. SHADED RELIEFT FROM NED 10M

REFERENCE(S)
SOURCE: DIGITAL TOPOGRAPHY PROVIDED BY ESRI ONLINE SERVERS (WWW.ESRI.COM).
PROJECTION: NAD 83 STATE PLANE FOR NORTH CAROLINA IN FEET

0 0.5 1 2 3 4 Miles
1 inch = 1.44 miles

CLIENT
TIMMONS GROUP

CONSULTANT
GOLDER
2108 W. LABURNUM AVE., SUITE 200
RICHMOND, VIRGINIA, USA, 23227
(804) 358-7900

YYYY-MM-DD	2018-04-10
DESIGNED	BBW
PREPARED	MGM
REVIEWED	PWN
APPROVED	BBW

PROJECT
PRELIMINARY GROUNDWATER RESOURCE EVALUATION
NORTHWEST GUILFORD COUNTY, NORTH CAROLINA

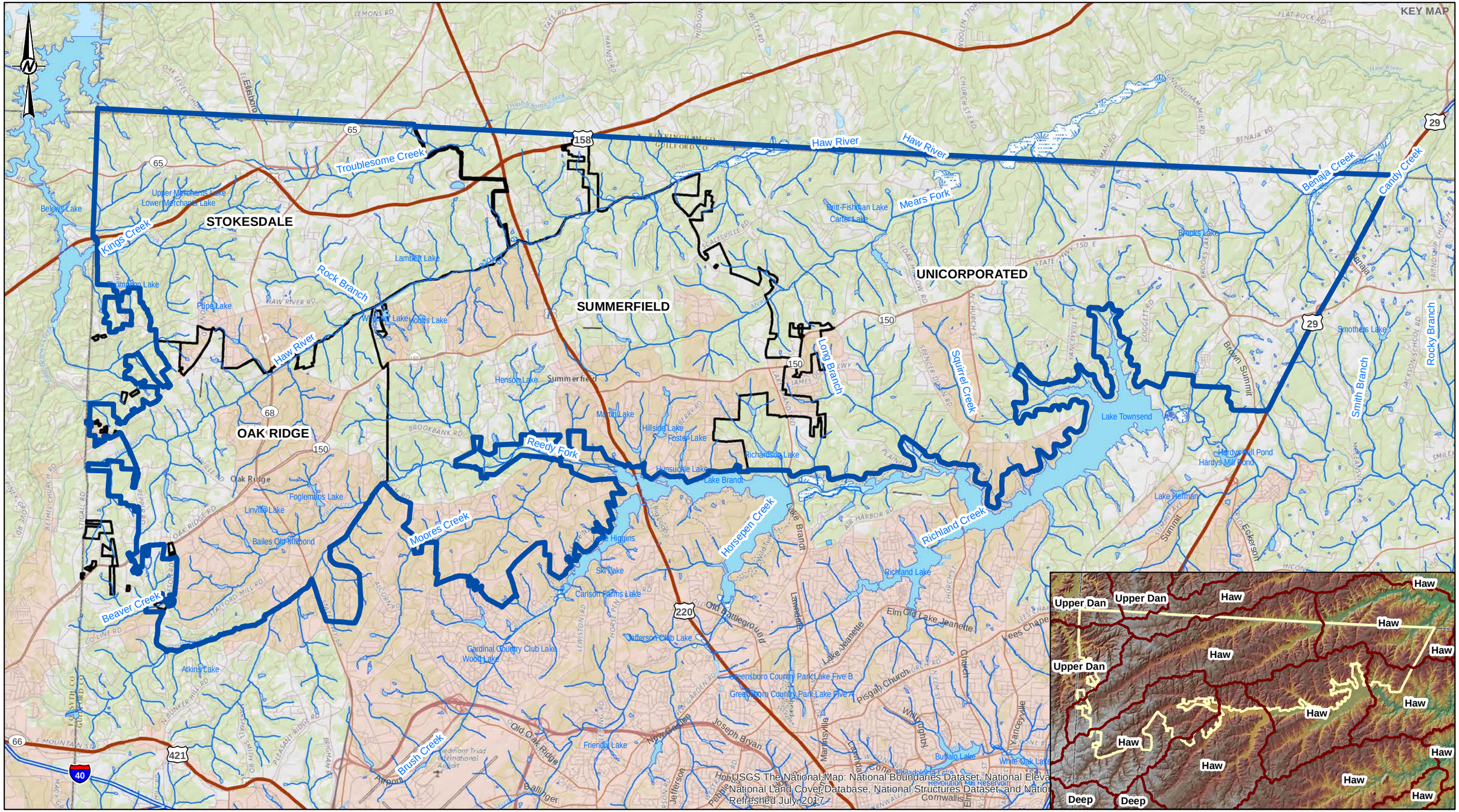
TITLE
LAND USE - LAND COVER

PROJECT NO.	PHASE	REV.	FIGURE
1778575	100	01	2

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

25mm

PATH: G:\Projects\Guilford County NC\GIS\MXDs\Figure 2 - Land Use Land Cover.mxd



LEGEND

- Study Area
- Stream
- Lake/Pond
- Reservoir
- Swamp/Marsh
- River Sub-Basins

NOTE(S)
1. HYDROLOGY DATA FROM NHD24KST AND NHD24KWB SHAPEFILES
2. SHADED RELIEFT FROM NED 10M

REFERENCE(S)
SOURCE: DIGITAL TOPOGRAPHY PROVIDED BY ESRI ONLINE SERVERS (WWW.ESRI.COM).
PROJECTION: NAD 83 STATE PLANE FOR NORTH CAROLINA IN FEET

0 0.5 1 2 3 4 Miles
1 inch = 1.45 miles

CLIENT
TIMMONS GROUP

CONSULTANT
GOLDER
2108 W. LABURNUM AVE., SUITE 200
RICHMOND, VIRGINIA, USA, 23227
(804) 358-7900

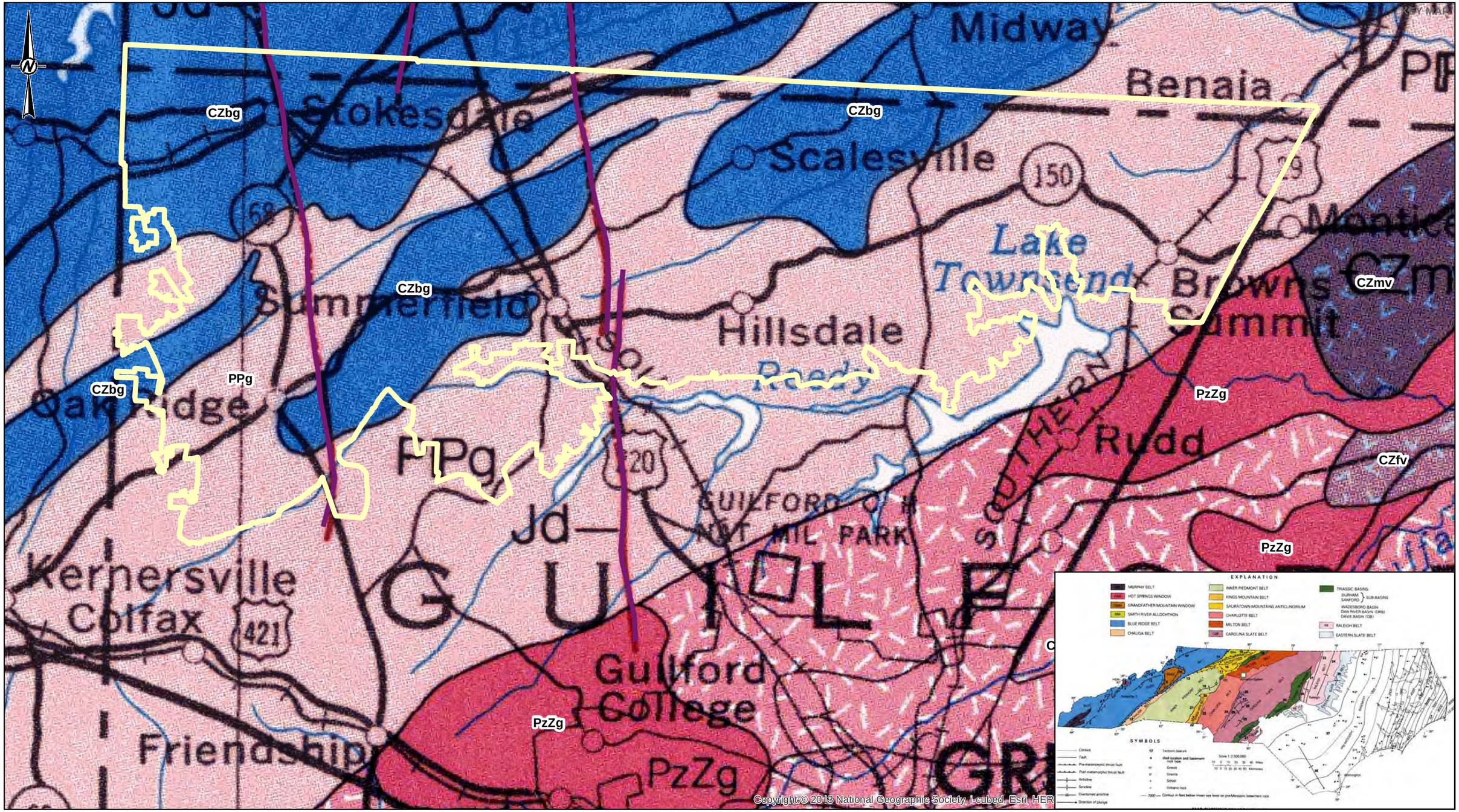
YYYY-MM-DD	2018-04-10
DESIGNED	BBW
PREPARED	MGM
REVIEWED	PWN
APPROVED	BBW

PROJECT
PRELIMINARY GROUNDWATER RESOURCE EVALUATION
NORTHWEST GUILFORD COUNTY, NORTH CAROLINA

TITLE
HYDROLOGY AND TOPOGRAPHY

PROJECT NO.	PHASE	REV.	FIGURE
1778575	100	01	3

PATH: G:\Projects\Guilford County NC\GIS\MXDs\Figure 3 - Hydrology Map.mxd
IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B
25mm



LEGEND

Study Area

Geology

- CZbg *Biotite Gneiss and Schist*
- PPg *Granite*
- Jd *Diabase Dike*

NOTE(S)
1. SOURCE: GEOLOGIC MAP OF NORTH CAROLINA (NCGS, 1985)

REFERENCE(S)
PROJECTION: NAD 83 STATE PLANE FOR NORTH CAROLINA IN FEET

0 0.5 1 2 3 4 Miles
1 inch = 1.58 miles

CLIENT
TIMMONS GROUP

CONSULTANT
GOLDER
2108 W. LABURNUM AVE., SUITE 200
RICHMOND, VIRGINIA, USA, 23227
(804) 358-7900

YYYY-MM-DD	2018-04-10
DESIGNED	BBW
PREPARED	MGM
REVIEWED	PWN
APPROVED	BBW

PROJECT
PRELIMINARY GROUNDWATER RESOURCE EVALUATION
NORTHWEST GUILFORD COUNTY, NORTH CAROLINA

TITLE
GEOLOGY

PROJECT NO.	PHASE	REV.	FIGURE
1778575	100	01	4

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B
25mm
PATH: G:\Projects\Guilford County NC\GIS\MXDs\Figure 4 - Geologic Map.mxd

The CZbg biotite gneiss and schist unit underlies the northwestern portion of the study area beneath much of Stokesdale and portions of Oak Ridge and Summerfield. It is late Proterozoic to early Paleozoic in age, is part of the Milton terrane (Hibbard and others, 2006) and consists of clastic metasedimentary rocks and meta-ultramafic rocks. The PPg unit represents younger Pennsylvanian to Permian granitic intrusive rocks and is part of the Churchland Plutonic Suite and the Charlotte terrane (Hibbard and others, 2006). These granitic rocks underlie the majority of the southern and eastern portions of the study area. Ultra-mafic Jurassic diabase dikes intrude both of these formations. These dikes trend north-northwest and are typically steeply to vertical dipping.

2.3 Hydrogeologic Characteristics of Bedrock Formations

Within most bedrock aquifers, groundwater is stored and transmitted along secondary openings in the rock mass called fractures. These fractures include joints, faults, bedding, shear zones, and foliation partings. The occurrence and hydrogeologic significance of bedrock fractures (length, density, orientation and openness) is typically dependent on the lithology of the rock and the type of stresses exhibited on the rock mass that formed the fracture permeability.

The granite (PPg) should have the most favorable hydrogeologic characteristics for developing groundwater supplies within the study area. Fractures that form in these more massive, competent and coarse-grained rocks will tend to be longer, with larger aperture openings, and will tend to remain open due to the rougher fracture surfaces and absence of less resistant clay-forming minerals. Additionally, near-horizontal sheet fractures attributed to the removal of overburden by erosion are often well developed in granitic and more massive metamorphic rocks. Sheet fractures and low-angle shear zones associated with thrust faults may greatly increase the hydraulic interconnections between sub-vertical fracture sets, improving the overall water-producing characteristics of these rocks.

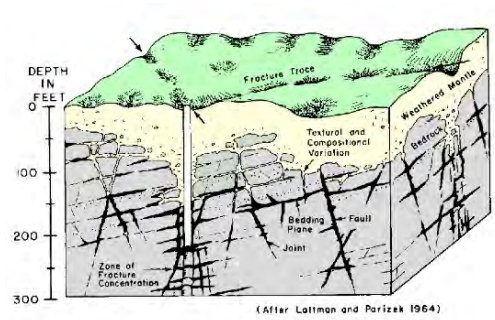
In contrast, fractures present within the more fine-grained, argillaceous and mafic rocks such as banded or interlayered biotite gneiss and schist and the diabase dikes generally have less favorable water-producing characteristics because of their fine-grained texture and the tendency for fractures to be relatively short and disconnected. Fractures within these rocks tend to be smooth, closed at depth, or will be filled with secondary mineral coatings, clay or impermeable gouge. These fracture characteristics result in an aquifer that lacks interconnectivity and results in an inability to transmit water to a pumping well or receive substantial recharge following a pumping event. However, there are likely to be some areas within these rocks where there is a high density of interconnected fractures resulting in substantial well yields. For example, the contacts between the different rock types may act as a location where differential weathering is more pervasive and fracturing may be intensified due to the contrast in competency between the two rock types. This is common along the contacts of diabase dikes and the surrounding parent rock material or between gneiss and amphibolites. These contacts can produce favorable hydrogeologic conditions for locating a water supply well.

2.4 Lineament Analysis

Subsurface geologic features such as mineral segregations due to gneissic banding, fracture zones, geologic contacts, jointing, and faults often have ground surface expressions that can be detected through remote sensing analysis of photographic and topographic images. Fracture zones are probably the most important hydrogeologic features because they represent potential areas of increased, localized fracture concentrations. Fracture zones are typically narrow (5 to 60 feet wide), long (100s to 1000s of feet), linear, and vertical to near-vertical. These zones commonly have enhanced porosity and permeability and therefore represent important pathways for groundwater flow in bedrock. Because fracture zones are typically less resistant to weathering, they are often expressed as natural topographic lows, such as straight stream valley segments, swales, aligned depressions and gaps in ridges or as linear tonal or vegetative alignments due to variations in soil thickness and moisture. These

surface manifestations are referred to as fracture traces or lineaments (Inset 2) and were identified for this project by remote-sensing techniques using topographic maps and shaded relief digital elevation models.

A total of 747 lineaments were identified within the study area and are shown in Figure 5. Mapped lineaments primarily correspond with tributary stream valleys and other linear topographic depressions. The lineament data were analyzed and plotted onto rose diagrams to display the dominant orientations of the lineaments. The prominent lineament orientations are approximately N23ºW and N57ºE. Lineament orientations are approximately at right angles (orthogonal) to each other and are generally parallel and perpendicular to the geologic strike. Variations are likely caused by changes in local geologic strike and the formation of conjugate fractures at small angles to the principal direction of stress.



Inset 2. Example of "fracture trace" lineament representing surface manifestation of underlying bedrock fracture zone.

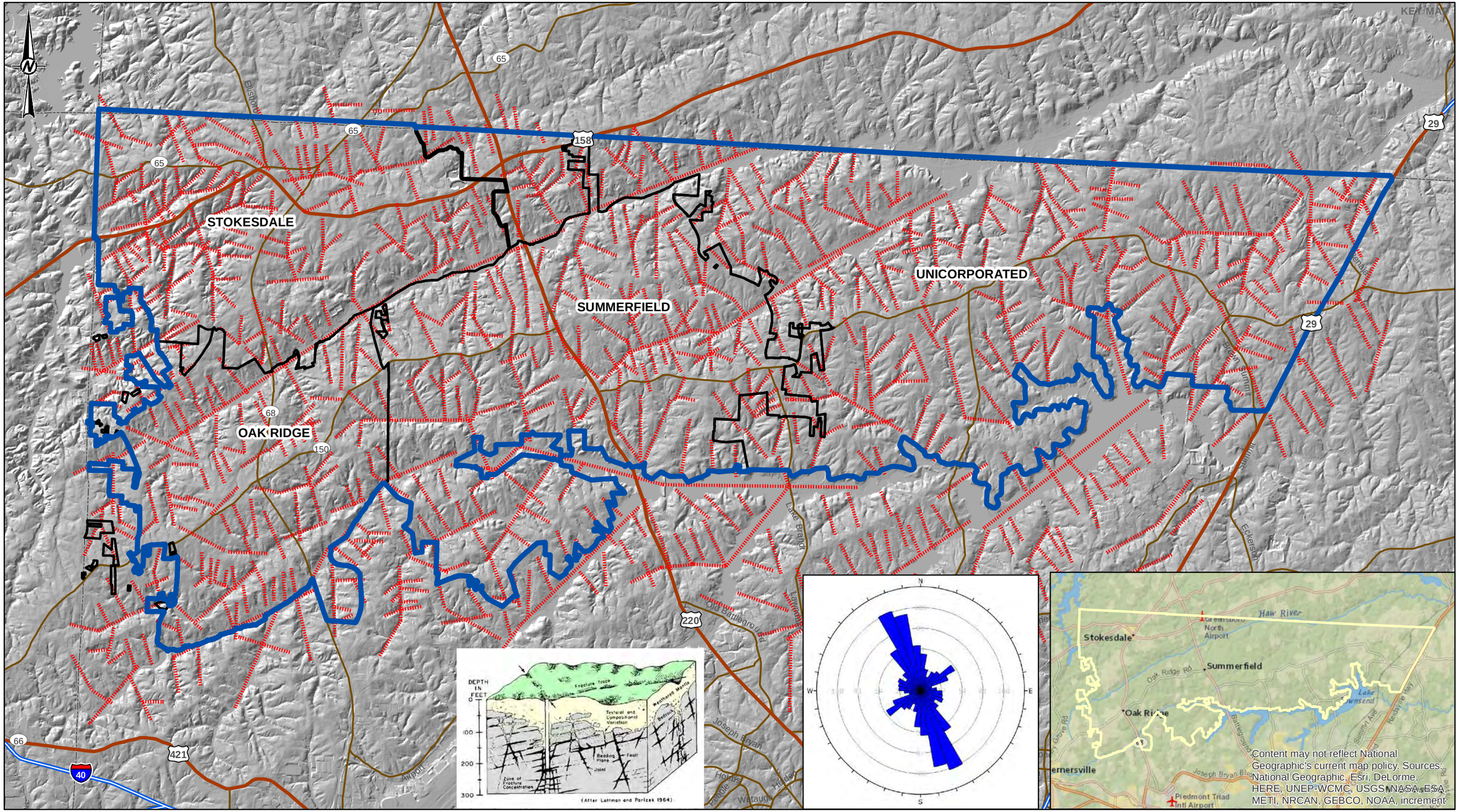
The coincidence of the lineaments with known geologic structures and processes suggests that most of the mapped lineaments likely represent underlying fractures zones, thus facilitating the use of lineaments as a component for groundwater exploration. Lineaments oriented parallel to strike may result from less resistant interlayered pelitic schist units and therefore may not exhibit favorable water-bearing characteristics. Across-strike (northwest-trending) lineaments are more likely to favorably influence well yield.

2.5 Inventory and Description of Area Wells

Groundwater is used for most of private and public drinking water sources in the study area. Most of the wells are drilled into the underlying bedrock using air rotary rigs. They are typically completed to depths of several hundreds of feet and are constructed with 6-inch steel or PVC casing set and grouted into competent rock with the remainder of the borehole open to water-bearing fractures. The other type of well that may be present in the study area are shallow surficial wells, which are bored into unconsolidated alluvium or saprolite (weathered bedrock) and often completed with 30-inch concrete caissons. Shallow bored wells are vulnerable to drought and to potential contamination from surface sources. Shallow bored wells cannot be used for public drinking water supplies in the Piedmont of North Carolina.

An inventory of approximately 300 wells has been compiled using data from the NCDEQ. The database includes information on well ownership, construction, well yield, and geologic formation. The data have been statistically analyzed to determine spatial relationships between well yield, well depth, and geology. A summary of the statistical analysis is provided in Table 1. Well locations are shown in Figure 6. It should be noted that the reported well yield is a function of both the hydrogeologic conditions and water demand and therefore may not necessarily reflect maximum well yield potential in this area. The 90th-percentile statistics (i.e., 90 percent of the wells yield less than this value) is believed to provide a good upper end estimate of well yields that may be achievable following a detailed and successful groundwater exploration program.

Based on this analysis, relatively high yielding wells have been completed in the Churchland granite (PPg). This confirms our assumption that wells in granitic rock will typically have higher yields than wells in the less favorable geologic formations in the study area (biotite gneiss/schist and diabase dike). Wells completed in the granite range from 2 to 200 gallons per minute (gpm) with an average well yield of 46 gpm and a 90th percentile yield of 100 gpm. Well depths ranged from 88 to 902 feet deep and average 363 feet. Wells completed in the biotite gneiss and schist unit (CZbg) range in yield from 2 to 93 gpm with an average well yield of approximately 40 gpm and a 90th percentile yield of approximately 50 gpm. Well depths range from 46 to 1,504 feet deep and average



Schematic of a Fracture Trace

Rosette Diagram of Lineament Orientations

LEGEND

- Study Area
- Municipal Boundaries
- Lineaments

NOTE(S)

1. TOPOGRAPHIC LINEAMENTS MAPPED BY GOLDER PERSONNEL
2. SHADED RELIEFT FROM NED 10M

REFERENCE(S)

PROJECTION: NAD 83 STATE PLANE FOR NORTH CAROLINA IN FEET

0 0.5 1 2 3 4 Miles

1 inch = 1.45 miles

CLIENT
TIMMONS GROUP

CONSULTANT
GOLDER
2108 W. LABURNUM AVE., SUITE 200
RICHMOND, VIRGINIA, USA, 23227
(804) 358-7900

YYYY-MM-DD	2018-04-10
DESIGNED	BBW
PREPARED	MGM
REVIEWED	PWN
APPROVED	BBW

PROJECT
PRELIMINARY GROUNDWATER RESOURCE EVALUATION
NORTHWEST GUILFORD COUNTY, NORTH CAROLINA

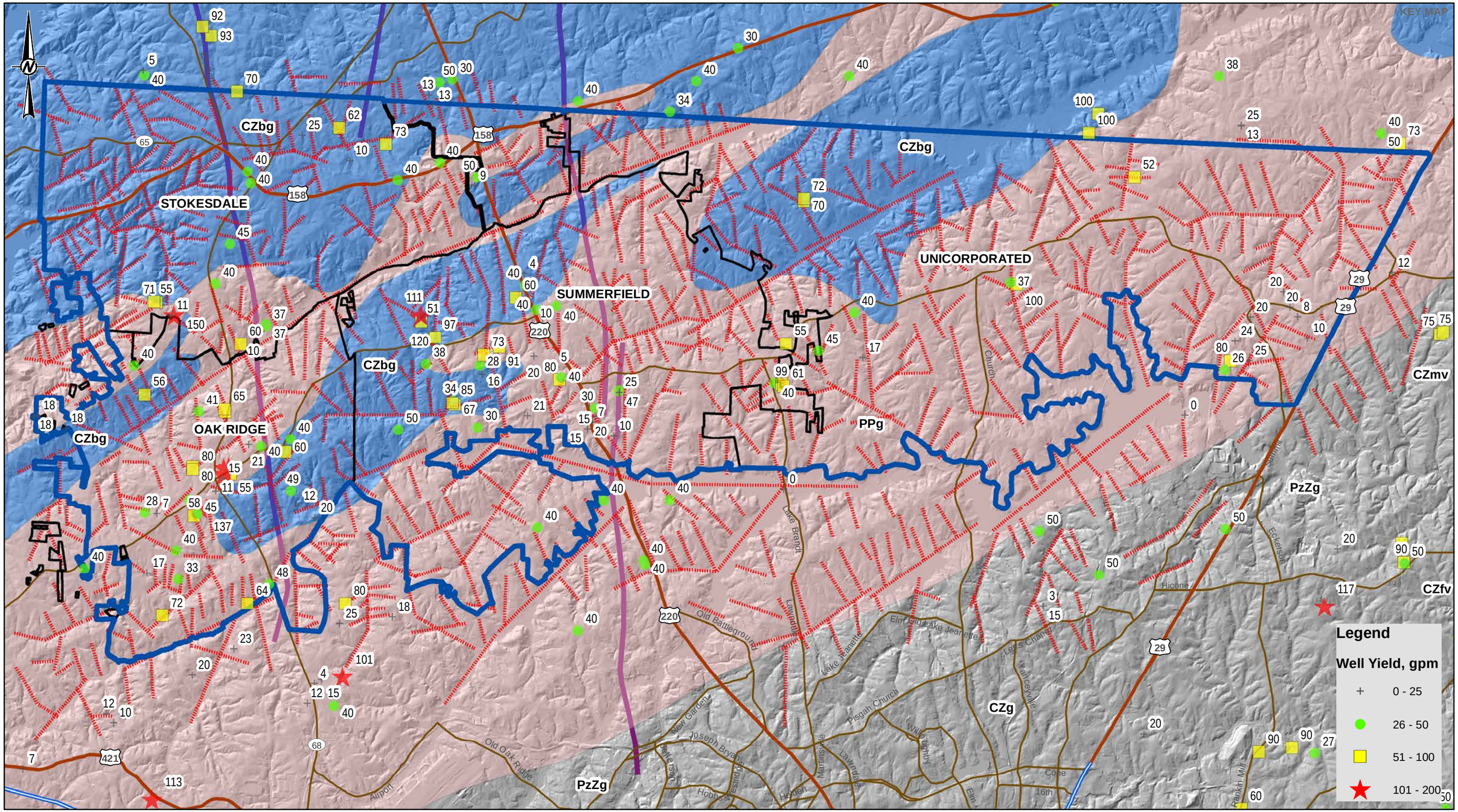
TITLE
BEDROCK FRACTURE LINEAMENT MAP

PROJECT NO.	PHASE	REV.	FIGURE
1778575	100	01	5

PATH: G:\Projects\Guilford County NC\GIS\MXD\Figure 5 - Lineament Map.mxd

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

25mm



LEGEND

- Study Area
- Lineaments
- CZbg *Biotite Gneiss and Schist*
- PPg *Granite*
- Jd *Diabase Dike*

NOTE(S)
1. PUBLIC WATER SUPPLY WELLS FROM NCDENR DEH PWSS DATE: 20060901
2. POTENTIAL CONTAMINATION SITES (PCS) AND LANDFILLS FROM NCDENR

REFERENCE(S)
PROJECTION: NAD 83 STATE PLANE FOR NORTH CAROLINA IN FEET

0 0.5 1 2 3 4 Miles
1 inch = 1.36 miles

CLIENT
TIMMONS GROUP

CONSULTANT
GOLDER
2108 W. LABURNUM AVE., SUITE 200
RICHMOND, VIRGINIA, USA, 23227
(804) 358-7900

YYYY-MM-DD	2018-04-10
DESIGNED	BBW
PREPARED	MGM
REVIEWED	PWN
APPROVED	BBW

PROJECT
PRELIMINARY GROUNDWATER RESOURCE EVALUATION
NORTHWEST GUILFORD COUNTY, NORTH CAROLINA

TITLE
WELL YIELD AND POTENTIAL CONTAMINATION SITES

PROJECT NO.	PHASE	REV.	FIGURE
1778575	100	01	6

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B
25mm
PATH: G:\Projects\Guilford County NC\GIS\MXD\sFigure 6 - Well Yield Map.mxd

approximately 295 feet. The highest observed yield of 200 gpm could produce up to a maximum of 288,000 gallon per day (gpd), but would only have a permitted safe yield (i.e., 12-hour yield as defined by NCDEQ) of 144,000 gpd. To achieve the desired capacity using groundwater wells will require several high yielding wells. By evaluating the favorable hydrogeologic attributes of the study area, the likelihood of finding high yielding wells will be greater.

Table 1: Table 1. Summary of Well Yield and Depths within the Study Area

	Gneiss/Schist (CZbg)		Granite (PPg)	
	Yield (gpm)	Depth (ft)	Yield (gpm)	Depth (ft)
Minimum	2	46	2	88
Maximum	93	1504	200	902
Average	35	295	46	363
Median	40	235	40	357
90 Percentile	50	476	100	600
Count	93	58	198	160

Source: NCDEQ Public Water Supply Well Database

2.6 Groundwater Flow and Recharge Estimates

In the Piedmont, groundwater occurs in two basic horizons: in the soils, alluvium, and weathered bedrock collectively referred to as the regolith or overburden, and within the underlying fractured bedrock. In Guilford County, the average thickness of regolith is approximately 52 feet and the average saturated thickness of regolith is approximately 24 feet according to Daniel and Harned (1997). In the overburden soils, groundwater generally occurs under water table conditions and will flow in much the same way as surface water runoff would from topographically high areas to low areas. Groundwater in the water table aquifer generally travels short distances, discharging to nearby streams, seeps or springs, or leaks downward into the underlying bedrock aquifer. A large volume of groundwater (generally between 20 and 40 percent of the total volume) is stored in overburden sediments and saprolite. If this material is reasonably permeable, it can provide a continuous source of recharge to the fractures in the underlying bedrock.

Groundwater in the bedrock aquifer occurs within fractures found in the rock. Flow is controlled by the frequency and orientation of these bedrock fractures, but for the most part will move from surface water basin and interbasin divides towards areas of discharge at springs and tributary streams, lakes, and rivers. Within the study area, groundwater within the fractured bedrock likely flows towards and downstream within the major river valleys. Groundwater within the Dan River Basin in the far northwestern corner is likely northward.

Groundwater is continually replenished by recharge from infiltrating rainfall. Most of the rainfall returns to the atmosphere by evaporation and transpiration from plants or flows overland to nearby streams. The remainder recharges the groundwater system and is available to a pumping well. The amount of water that recharges a groundwater system can be estimated by examining stream flow hydrographs and separating out the contribution from groundwater called baseflow. It is assumed that over long periods of time, groundwater discharge in a basin in the form of stream baseflow equals groundwater recharge. Baseflow measurements and groundwater recharge estimates from various USGS stream flow monitoring stations in Guildford County indicate an effective average groundwater recharge rate of between 4.0 to 9.7 inches per year (in/yr) in stream basins across Guilford

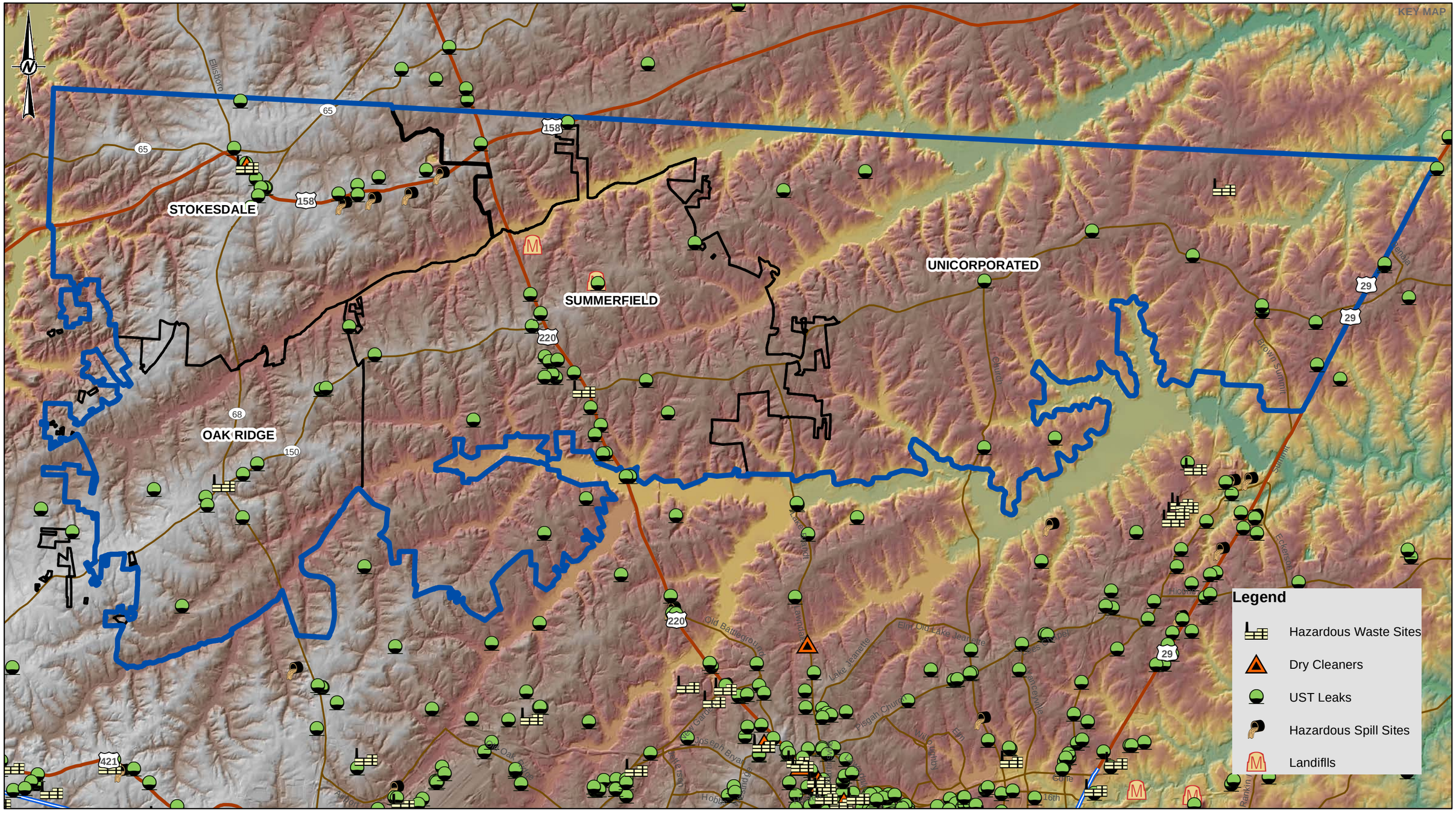
County with an average recharge rate of 6.3 in/yr (Daniel and Harned, 1997). The highest recharge estimates occur in the northwestern portion of Guilford County in areas underlain by felsic igneous intrusive rocks. Here, the average recharge rate based on estimates made by Daniel and Harned (1997) is approximately 7 in/yr. Infiltrating groundwater is stored in the underlying regolith (soil, alluvium, and saprolite) and bedrock and flows through this aquifer material to eventually discharge to local and regional surface water bodies.

An average effective recharge rate of 7 in/yr is equal to approximately 333,000 gpd per square mile or 521 gpd per acre. For the entire 107 square mile study area, there is approximately **35.6 million gallons per day** of recharge occurring daily on an average annual basis. A large portion of this recharge remains in the saprolite and does not leak into the underlying bedrock fractures. Even then, only a portion of the water recharging the bedrock aquifer can be captured by water wells. This portion is dependent on fracture density, interconnectivity and permeability. The actual amount of groundwater that can be developed will be more a function of individual well yield and the number of wells that can be feasibly developed within the study area without impact on each other.

2.7 Groundwater Quality Issues

Land use within the study area is still predominately agricultural (cropland and pastures) with interspersed woodlands and low-density residential development. There is higher density residential and commercial/industrial development along the major transportation corridors and within the town centers. Potential contamination sources (PCS) may include point sources such as underground fuel storage tanks, landfills, wastewater treatment facilities, industrial sites, and non-point sources such as residential septic systems, roadway runoff, agricultural fertilizers, and pesticides. A search of the publically available EPA and NCDEQ databases was completed to identify potential sources of groundwater contamination within the study area. The PCS databases include regulated facilities that store, generate, or treat hazardous waste in compliance with state and federal regulations. NCDEQ database includes hazardous waste (RCRA) storage sites, registered dry cleaner sites, permitted active landfills, pre-regulatory dump sites, hazardous (TRI) spill sites, and leaking underground storage tank sites. A total of 82 potential contamination sites were found within the study area (Figure 7).

Overall, the potential for contamination is considered to be moderately low due to the sparse commercial and industrial presence in the County. The most likely threat to groundwater contamination is from agricultural fertilizer/chemical runoff, leaking underground storage tanks, failing septic system(s), and naturally occurring contaminants like arsenic or radionuclides. Ultimately, the environmental risk will depend on current and historical management of hazardous substances, hydrogeologic characteristics of the local groundwater flow regime, and the distance of a potential contamination source from the selected well location.



LEGEND

Study Area

NOTE(S)
1. PUBLIC WATER SUPPLY WELLS FROM NCDENR DEH PWSS DATE: 20060901
2. POTENTIAL CONTAMINATION SITES (PCS) AND LANDFILLS FROM NCDENR

REFERENCE(S)
PROJECTION: NAD 83 STATE PLANE FOR NORTH CAROLINA IN FEET

0 0.5 1 2 3 4 Miles
1 inch = 1.36 miles

CLIENT
TIMMONS GROUP

CONSULTANT
GOLDER
2108 W. LABURNUM AVE., SUITE 200
RICHMOND, VIRGINIA, USA, 23227
(804) 358-7900

YYYY-MM-DD	2018-04-10
DESIGNED	BBW
PREPARED	MGM
REVIEWED	PWN
APPROVED	BBW

PROJECT
PRELIMINARY GROUNDWATER RESOURCE EVALUATION
NORTHWEST GUILFORD COUNTY, NORTH CAROLINA

TITLE
POTENTIAL CONTAMINATION SITES

PROJECT NO.	PHASE	REV.	FIGURE
1778575	100	01	7

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B
25mm
0

PATH: G:\Projects\Guilford County NC\GIS\MXD\s\Figure 7 - Potential Contamination Sites.mxd

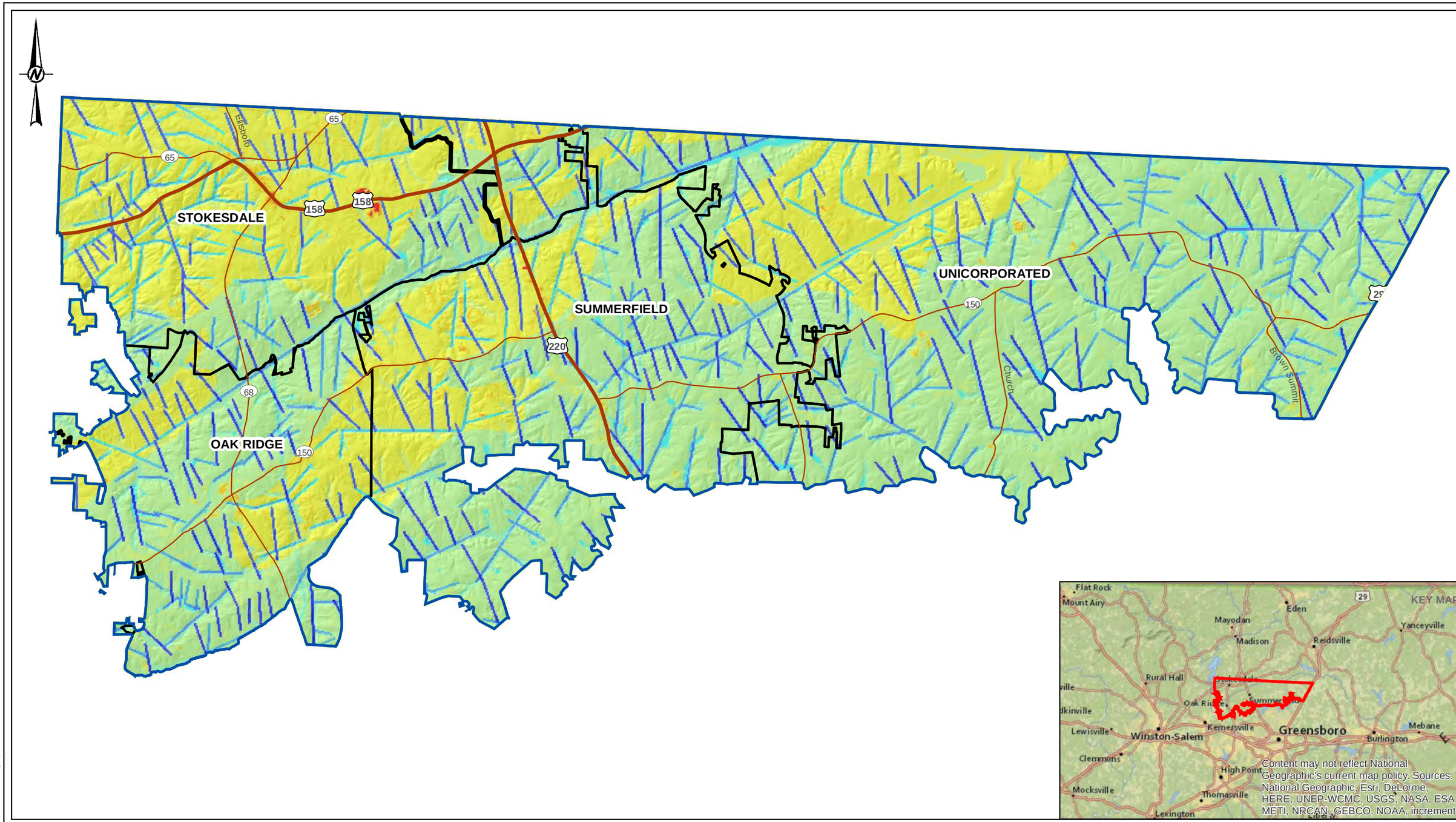
3.0 GROUNDWATER FAVORABILITY MODEL

Elements of the groundwater system described in Section 2 have been compiled into a spatial database of hydrogeologic attributes. Data coverages include geologic formations, geologic structures, proximity to lineaments and lineament intersections, hydrology, topography, and proximity to high density development and potential contamination sites. These spatial coverages were used to assess and select the most favorable locations to develop the groundwater resources within the study area. Using spatial analysis capabilities of geographic information systems, Golder has developed a weighted raster model using ESRI's Model Builder to select and rank areas where several of the favorable hydrogeologic features described above are present, thereby increasing the chances of finding favorable groundwater development sites.

Model Builder is a geoprocessing tool used to develop the Groundwater Favorability Model (GWFM), which was developed uniquely for this project. Hydrogeologic attributes described above are given different weightings that correspond to their importance with respect to groundwater availability. When the GWFM is run, the various hydrogeologic attributes are selected from a geospatial database and are assigned specific weights based on their relative significance to groundwater exploration. The result is a weighted raster map where the grid node values are equal to the cumulative weightings of the hydrogeologic attributes. The GWFM allows automation of the processes so that manipulation and analysis of large amounts of interrelated data can be performed together in a smooth and repeatable workflow.

The Guilford GWFM accounts for the water-producing characteristics of the underlying geologic formations, geologic contacts, geologic structures, the density of mapped lineaments, the length and orientation of lineaments, the density of lineament intersections, topographic position, the proximity to groundwater discharge areas (i.e., streams), and the proximity to potential contamination sites and densely developed urban areas (negative attributes). The granitic rock type and diabase contacts were weighted more favorably than the metasedimentary rocks. Mapped lineaments were weighted so that lineament intersections, lineaments with preferred cross-strike orientations, and lineaments with longer trace lengths were given additional favorability weighting.

Figure 8 displays the results of the Guilford Groundwater Favorability Model. The most favorable areas are shown as darker blue colors while less favorable areas are shown as yellow to red colors. The high favorability areas, as expected, tend to follow favorable geologic units (i.e., granite and diabase contact zones), are in stream valley positions, are proximal to lineaments, lineament intersections and cross-strike lineament orientations, and are more distal from potential contamination sites and densely developed urban areas. The highest ranked contoured intervals represent areas inclusive of the most favorable hydrogeologic attributes.



LEGEND

Study Area

Groundwater Favorability

High : 101

Low : 0

NOTE(S)

1. TOPOGRAPHIC LINEAMENTS MAPPED BY GOLDER PERSONNEL
2. SHADED RELIEFT FROM NED 10M

REFERENCE(S)

PROJECTION: NAD 83 STATE PLANE FOR NORTH CAROLINA IN FEET

0 0.5 1 2 3 4 Miles

1 inch = 1.36 miles

CLIENT

TIMMONS GROUP

CONSULTANT

GOLDER

2108 W. LABURNUM AVE., SUITE 200
RICHMOND, VIRGINIA, USA, 23227
(804) 358-7900

YYYY-MM-DD	2018-04-10
DESIGNED	BBW
PREPARED	MGM
REVIEWED	PWN
APPROVED	BBW

PROJECT

PRELIMINARY GROUNDWATER RESOURCE EVALUATION
NORTHWEST GUILFORD COUNTY, NORTH CAROLINA

TITLE

GROUNDWATER FAVORABILITY MAP

PROJECT NO.	PHASE	REV.	FIGURE
1778575	100	01	8

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B
25mm
0
PATH: G:\Projects\Guilford County NC\GIS\MXDs\Figure 8 - Groundwater Favorability Map.mxd

4.0 CONCLUSIONS AND RECOMMENDATIONS

4.1 Overall Assessment of Groundwater Availability

Golder has completed a preliminary evaluation on the feasibility of developing groundwater supply wells in northwestern Guilford County, North Carolina. This study is part of a larger study evaluating the feasibility of developing a regional water system in northwestern Guilford County, including the Towns of Oak Ridge, Stokesdale, Summerfield and certain unincorporated portions of Guilford County. Groundwater is seen as a potential interim water supply or even permanent water supply in the more rural portions of the study area that could be developed in conjunction with regional surface water or purchased water supplies from adjacent public water systems. This study considered existing geologic and hydrogeologic data obtained from a variety of sources, completion of a detailed lineament analysis, compilation and analysis of well yield and potential contamination sources, and construction of a Groundwater Favorability Model that weighted several different hydrogeologic factors considered favorable to the development of high yielding wells.

Based upon the findings of our preliminary groundwater investigation, Golder believes that the overall potential of developing groundwater resources in northwestern Guilford County is moderately good. This assessment is based on favorable fracture development characteristics of the granitic rocks, which make up the majority of the bedrock type in the study area, good water storage attributes of the thick unconsolidated soil and saprolite overlying the bedrock, high lineament density and the coincidence of many of these lineaments with expected bedrock structures, a moderately high groundwater recharge estimate of over 35 million gallons per day, and moderately productive wells of between 100 to 200 gpm.

Potential groundwater development areas have been identified using a groundwater favorability model. Favorable groundwater development areas correspond with areas underlain by granitic rocks; are proximal to lineament, lineament intersections, and cross-strike lineament orientations; are situated in river lowland areas; and are not near potential contamination sites or high-density development areas.

4.2 Recommendations

A focused non-intrusive electrical resistivity imaging geophysical survey should be conducted at selected groundwater exploration sites to confirm and better locate potential subsurface fractured bedrock aquifers and to help optimize future exploratory test well locations. Electrical resistivity is widely used by Golder with great success at numerous sites to locate fracture zones that are capable of storing and transporting significant volumes of groundwater. The electrical resistivity of a geologic formation is a measure of the resistance to an applied electrical current. Under saturated conditions, resistivity is largely dependent on the density and openness of the secondary fractures in the bedrock. Since electrical current is facilitated by the presence of water in the ground, these fracture zones will typically appear as low resistivity zones in contrast to the surrounding more resistive, dry, unfractured bedrock. The results of the geophysical survey should be used in conjunction to select and rank potentially favorable well sites.

Following completion of the geophysical survey and selection of potentially favorable well sites, exploratory test wells should be drilled to determine whether the yield and quality of the groundwater will be suitable to meet the needs of the proposed development. After permits and property access are obtained, test wells should be drilled to depths between approximately 400 and 600 feet. The wells should be drilled using air rotary methods. After the drilling is completed, the casing is removed exposing the multiple fracture zones and resulting in a more highly productive well. Following the successful completion of the wells, long-term, multiple-well aquifer stress tests should be conducted to assess the sustainable yields from the completed wells. This will involve setting temporary submersible pumps in each of the wells with the appropriate valves, flow meters and water level monitoring devices. The test wells should be pumped simultaneously at maximum rates for a minimum period of 48 to 72

hours to determine maximum sustainable well yields, aquifer properties, water quality, area of influence, and potential impact of the withdrawal on area groundwater users, streamflow and environmentally sensitive areas. Equipment such as pressure transducers, data loggers, and electronic water level recorders can be used to make frequent measurements of pump discharge rates, groundwater levels in the production well and associated observation wells before, during, and after the aquifer test. Water quality samples should be collected during the test for a suite of chemical and microbiological parameters that may be required by the NCDEQ.

5.0 REFERENCES

Daniel, C C, and Harned, D A, Hibbard, 1997, Ground-water recharge to and storage in the regolith-fractured crystalline rock aquifer system, Guilford County, North Carolina. US Geological Survey Water-Resources Investigations Report 97-4140. 65 pp.

North Carolina Dept. of Environment, Health, and Natural Resources, Division of Land Resources, NC Geological Survey, in cooperation with the NC Center for Geographic Information and Analysis, 1998, Geology - North Carolina (1:250,000), coverage data file geol250. The data represents the digital equivalent of the official State Geology map (1:500,000 scale), but was digitized from (1:250,000 scale) base maps.

North Carolina Geological Survey, 1985, Geologic map of North Carolina: North Carolina Geological Survey, General Geologic Map, scale 1:500000.

Hibbard, J P; van Staal, C R; Rankin, D W; Williams, H, 2006, Lithotectonic map of the Appalachian Orogen, Canada-United States of America, Geological Survey of Canada, "A" Series Map 2096A.

Signature Page

Golder Associates NC, Inc.

Brent B. Waters, CPG
Principal Hydrogeologist/Practice Leader

Rachel Kirkman, PG
Associate and Senior Consultant

BBW/RPK/mjf:

Golder Associates NC, Inc. is a licensed user of the Golder trademark, and an associated operating entity.
Golder and the G logo are trademarks of Golder Associates Corporation

g:\projects\guilford county nc\250 phase 1 report\preliminary hydrogeologic report guilford county nc.docx

GOLDER

golder.com

APPENDIX D

FINANCIAL ANALYSIS

SUPPLY SCENARIO 1
(GROUNDWATER/PURCHASED WATER COMBINATION)

Northwestern Guilford County Water System Feasibility Study

Estimated Water Rate Determination 30-Aug-18

Supply Scenario 1 (Groundwater supplemented by Purchased Finished Water from Reidsville)

OPERATION AND MAINTENANCE COSTS

	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Total ERCs			*4,283*	*5,140*	*5,996*	*6,853*	*7,709*	*8,566*	*9,444*	*10,321*	*11,199*	*12,077*	*12,954*	*13,832*	*14,398*	*14,964*	*15,530*	*16,096*
Daily Average Water Demand (gal)			856,600	1,027,920	1,199,240	1,370,560	1,541,880	1,713,200	1,888,739	2,064,278	2,239,817	2,415,356	2,590,895	2,766,438	2,879,610	2,992,783	3,105,955	3,219,128
Annual kgal			312,659	375,191	437,723	500,254	562,786	625,318	689,390	753,461	817,533	881,605	945,677	1,009,750	1,051,058	1,092,366	1,133,674	1,174,982
Annual Demand to be Purchased from Winston-Salem (kgal):			**43,800**	**47,304**	**51,088**	**55,175**	**59,589**	**64,357**	**69,505**	**75,066**	**81,071**	**87,556**	**472,838**	**504,875**	**525,529**	**546,183**	**566,837**	**587,491**
Annual Demand NOT Purchased (kgal):			**268,859**	**327,887**	**386,634**	**445,079**	**503,197**	**560,961**	**619,885**	**678,396**	**736,462**	**794,049**	**472,838**	**504,875**	**525,529**	**546,183**	**566,837**	**587,491**
Operation and Maintenance Costs:																		
1 - O&M Cost - Distribution		*Escalation*																
Cost per kgal per day	**$ 0.566**	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%
Escalated O&M Cost per kgal/day	$ 0.566	$ 0.58	$ 0.59	$ 0.61	$ 0.62	$ 0.64	$ 0.66	$ 0.67	$ 0.69	$ 0.71	$ 0.72	$ 0.74	$ 0.76	$ 0.78	$ 0.80	$ 0.82	$ 0.84	$ 0.86
Assumed Annual Salaries	**$ 82,500**	2.50%	$ 82,500	$ 84,563	$ 86,677	$ 88,843	$ 91,065	$ 93,341	$ 95,675	$ 98,067	$ 100,518	$ 103,031	$ 105,607	$ 108,247	$ 110,953	$ 113,727	$ 116,570	$ 119,485
Annual O&M Costs - Dist. + Personnel			**$ 268,423.85**	**$ 313,248.83**	**$ 360,147.30**	**$ 409,194.91**	**$ 460,469.81**	**$ 514,052.71**	**$ 571,088.93**	**$ 630,655.67**	**$ 692,843.82**	**$ 757,747.21**	**$ 825,462.75**	**$ 896,091.57**	**$ 951,529.61**	**$ 1,009,179.49**	**$ 1,069,117.16**	**$ 1,131,420.98**
2 - O&M Cost - Pumping/Chemicals for Groundwater		*Escalation*																
Cost per kgal per day	**$ 0.750**	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%
Escalated O&M Cost per kgal/day	$ 0.750	$ 0.77	$ 0.79	$ 0.81	$ 0.83	$ 0.85	$ 0.87	$ 0.89	$ 0.91	$ 0.94	$ 0.96	$ 0.98	$ 1.01	$ 1.03	$ 1.06	$ 1.09	$ 1.11	$ 1.14
Annual O&M Costs - Pumping/Chemicals for Groundwater			**$ 211,852**	**$ 264,824**	**$ 320,079**	**$ 377,675**	**$ 437,665**	**$ 500,105**	**$ 566,452**	**$ 635,418**	**$ 707,051**	**$ 781,395**	**$ 476,936**	**$ 521,982**	**$ 556,919**	**$ 593,277**	**$ 631,104**	**$ 670,453**
3 - Cost to Purchase Water from Winston-Salem:		*Escalation*																
Purchased Water Rate ($/kgal)	**$ 5.560**	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%
Escalated Purchase Rate per kgal	$ 5.560	$ 5.73	$ 5.90	$ 6.08	$ 6.26	$ 6.45	$ 6.64	$ 6.84	$ 7.04	$ 7.25	$ 7.47	$ 7.70	$ 4.28	$ 4.41	$ 4.54	$ 4.67	$ 4.81	$ 4.96
Assumed Average Annual Water Loss		**5%**																
Annual O&M Costs - Purchased Water			**$ 271,277**	**$ 301,768**	**$ 335,687**	**$ 373,418**	**$ 415,391**	**$ 462,080**	**$ 489,541**	**$ 544,566**	**$ 605,775**	**$ 673,864**	**$ 2,022,463**	**$ 2,224,277**	**$ 2,384,729**	**$ 2,552,805**	**$ 2,728,820**	**$ 2,913,098**
		Escalation																
4 - Authority Administrative Costs	**$ 178,000**	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%
	$ 178,000	**$182,450**	**$ 187,011**	**$ 191,687**	**$ 196,479**	**$ 201,391**	**$ 206,425**	**$ 211,586**	**$ 216,876**	**$ 222,298**	**$ 227,855**	**$ 233,551**	**$ 239,390**	**$ 245,375**	**$ 251,509**	**$ 257,797**	**$ 264,242**	**$ 270,848**
5 - Billing, Collection, Meter Reading, Cust. Service	**$ 1.25**	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%
	$ 1.25	$ 1.28	$ 1.31	$ 1.35	$ 1.38	$ 1.41	$ 1.45	$ 1.49	$ 1.52	$ 1.56	$ 1.60	$ 1.64	$ 1.68	$ 1.72	$ 1.77	$ 1.81	$ 1.86	$ 1.90
Assumed Annual Salaries	**$ 132,000**	2.50%	$ 132,000	$ 135,300	$ 138,683	$ 142,150	$ 145,703	$ 149,346	$ 153,080	$ 156,907	$ 160,829	$ 164,850	$ 168,971	$ 173,195	$ 177,525	$ 181,963	$ 186,513	$ 191,175
			$ 176,367.47	**$ 189,871.99**	**$ 203,941.50**	**$ 218,595.82**	**$ 233,855.40**	**$ 249,741.33**	**$ 286,149.03**	**$ 305,979.39**	**$ 326,622.43**	**$ 348,106.38**	**$ 370,460.39**	**$ 393,714.84**	**$ 412,804.49**	**$ 432,602.55**	**$ 453,132.52**	**$ 474,418.60**
Total Annual Administrative Costs			*$ 363,379*	*$ 381,559*	*$ 400,420*	*$ 419,986*	*$ 440,281*	*$ 461,327*	*$ 503,025*	*$ 528,277*	*$ 554,477*	*$ 581,658*	*$ 609,851*	*$ 639,090*	*$ 664,314*	*$ 690,400*	*$ 717,375*	*$ 745,267*
TOTAL ANNUAL O&M COSTS			**$ 1,114,932**	**$ 1,261,399**	**$ 1,416,333**	**$ 1,580,274**	**$ 1,753,807**	**$ 1,937,566**	**$ 2,130,107**	**$ 2,338,916**	**$ 2,560,147**	**$ 2,794,664**	**$ 3,934,713**	**$ 4,281,441**	**$ 4,557,491**	**$ 4,845,661**	**$ 5,146,416**	**$ 5,460,239**
O&M Cost per kgal			*$ 3.57*	*$ 3.36*	*$ 3.24*	*$ 3.16*	*$ 3.12*	*$ 3.10*	*$ 3.09*	*$ 3.10*	*$ 3.13*	*$ 3.17*	*$ 4.16*	*$ 4.24*	*$ 4.34*	*$ 4.44*	*$ 4.54*	*$ 4.65*

CAPITAL COSTS

		2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
$142,940,135	TOTAL Capital Costs Paid	**$52,448,390**						**$18,144,503**					**$23,729,051.00**				
	O&M Costs	$ 1,114,932	$ 1,261,399	$ 1,416,333	$ 1,580,274	$ 1,753,807	$ 1,937,566	$ 2,130,107	$ 2,338,916	$ 2,560,147	$ 2,794,664	$ 3,934,713	$ 4,281,441	$ 4,557,491	$ 4,845,661	$ 5,146,416	$ 5,460,239
	Capital Cost Revenue Bonds																
	Years: **25** Rate: **4.50%**																
	Series 2020 Revenue Bonds	$ 3,537,068	$ 3,537,068	$ 3,537,068	$ 3,537,068	$ 3,537,068	$ 3,537,068	$ 3,537,068	$ 3,537,068	$ 3,537,068	$ 3,537,068	$ 3,537,068	$ 3,537,068	$ 3,537,068	$ 3,537,068	$ 3,537,068	$ 3,537,068
	Series 2025 Revenue Bonds							$ 1,223,648	$ 1,223,648	$ 1,223,648	$ 1,223,648	$ 1,223,648	$ 1,223,648	$ 1,223,648	$ 1,223,648	$ 1,223,648	$ 1,223,648
	Series 2030 Revenue Bonds												$ 1,600,264	$ 1,600,264	$ 1,600,264	$ 1,600,264	$ 1,600,264
	Series 2045 Revenue Bonds																
	Subtotal	***$ 3,537,068***	***$ 3,537,068***	***$ 3,537,068***	***$ 3,537,068***	***$ 3,537,068***	***$ 3,537,068***	***$ 4,760,716***	***$ 4,760,716***	***$ 4,760,716***	***$ 4,760,716***	***$ 4,760,716***	***$ 6,360,980***	***$ 6,360,980***	***$ 6,360,980***	***$ 6,360,980***	***$ 6,360,980***
	Total O&M and Capital Costs	**$ 4,652,000**	**$ 4,798,468**	**$ 4,953,402**	**$ 5,117,343**	**$ 5,290,875**	**$ 5,474,634**	**$ 6,890,823**	**$ 7,099,632**	**$ 7,320,863**	**$ 7,555,380**	**$ 8,695,429**	**$ 10,642,421**	**$ 10,918,471**	**$ 11,206,641**	**$ 11,507,396**	**$ 11,821,219**
	Total Connected Customers	4283	5140	5996	6853	7709	8566	9444	10321	11199	12077	12954	13832	14398	14964	15530	16096
	Break-Even Monthly Water Bill	**$ 90.51**	**$ 77.80**	**$ 68.84**	**$ 62.23**	**$ 57.19**	**$ 53.26**	**$ 60.81**	**$ 57.32**	**$ 54.48**	**$ 52.13**	**$ 55.94**	**$ 64.12**	**$ 63.19**	**$ 62.41**	**$ 61.75**	**$ 61.20**

Northwestern Guilford County Water System Feasibility Study
Estimated Water Rate Determination 31-Jul-18
Supply Scenario 1 (Groundwater supplemented by Purchased Finished Water)
OPERATION AND MAINTENANCE COSTS

	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050
Total ERCs	*16,662*	*17,227*	*17,793*	*18,359*	*18,925*	*19,491*	*20,057*	*20,623*	*21,188*	*21,754*	*22,320*	*22,886*	*23,452*	*24,018*	*25,149*
Daily Average Water Demand (gal)	3,332,300	3,445,473	3,558,645	3,671,818	3,784,990	3,898,162	4,011,335	4,124,507	4,237,680	4,350,852	4,464,025	4,577,197	4,690,370	4,803,542	5,029,887
Annual kgal	1,216,290	1,257,597	1,298,905	1,340,213	1,381,521	1,422,829	1,464,137	1,505,445	1,546,753	1,588,061	1,629,369	1,670,677	1,711,985	1,753,293	1,835,909
Demand to be Purchased from Winston-Salem (kgal):	**608,145**	**628,799**	**649,453**	**670,107**	**690,761**	**711,415**	**732,069**	**752,723**	**773,377**	**794,031**	**814,685**	**835,338**	**855,992**	**876,646**	**917,954**
Demand NOT Purchased (kgal):	**608,145**	**628,799**	**649,453**	**670,107**	**690,761**	**711,415**	**732,069**	**752,723**	**773,377**	**794,031**	**814,685**	**835,338**	**855,992**	**876,646**	**917,954**
Operation and Maintenance Costs:															
1 - O&M Cost - Distribution															
Cost per kgal per day	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%
Escalated O&M Cost per kgal/day	$ 0.88	$ 0.90	$ 0.93	$ 0.95	$ 0.97	$ 1.00	$ 1.02	$ 1.05	$ 1.08	$ 1.10	$ 1.13	$ 1.16	$ 1.19	$ 1.22	$ 1.25
Assumed Annual Salaries	$ 122,472	$ 125,534	$ 128,672	$ 131,889	$ 135,186	$ 138,566	$ 142,030	$ 145,580	$ 149,220	$ 152,950	$ 156,774	$ 160,694	$ 164,711	$ 168,829	$ 173,049
Annual O&M Costs - Dist. + Personnel	**$ 1,196,171.79**	**$ 1,263,453.00**	**$ 1,333,350.67**	**$ 1,405,953.56**	**$ 1,481,353.25**	**$ 1,559,644.20**	**$ 1,640,923.86**	**$ 1,725,292.72**	**$ 1,812,854.45**	**$ 1,903,715.96**	**$ 1,997,987.50**	**$ 2,095,782.81**	**$ 2,197,219.13**	**$ 2,302,417.41**	**$ 2,463,026.83**
			f												
2 - O&M Cost - Pumping/Chemicals for Groundwater															
Cost per kgal per day	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%
Escalated O&M Cost per kgal/day	$ 1.17	$ 1.20	$ 1.23	$ 1.26	$ 1.29	$ 1.32	$ 1.36	$ 1.39	$ 1.43	$ 1.46	$ 1.50	$ 1.53	$ 1.57	$ 1.61	$ 1.65
Annual O&M Costs - Pumping/Chemicals for Groundwater	**$ 711,374**	**$ 753,922**	**$ 798,153**	**$ 844,124**	**$ 891,895**	**$ 941,527**	**$ 993,084**	**$ 1,046,629**	**$ 1,102,231**	**$ 1,159,960**	**$ 1,219,885**	**$ 1,282,082**	**$ 1,346,627**	**$ 1,413,597**	**$ 1,517,211**
3 - Cost to Purchase Water from Winston-Salem:															
Purchased Water Rate ($/kgal)	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%
Escalated Purchase Rate per kgal	$ 5.11	$ 5.26	$ 5.42	$ 5.58	$ 5.75	$ 5.92	$ 6.10	$ 6.28	$ 6.47	$ 6.66	$ 6.86	$ 7.07	$ 7.28	$ 7.50	$ 7.73
Assumed Average Annual Water Loss															
Annual O&M Costs - Purchased Water	**$ 3,105,977**	**$ 3,307,807**	**$ 3,518,952**	**$ 3,739,788**	**$ 3,970,707**	**$ 4,212,115**	**$ 4,464,434**	**$ 4,728,102**	**$ 5,003,571**	**$ 5,291,314**	**$ 5,591,818**	**$ 5,905,590**	**$ 6,233,155**	**$ 6,575,060**	**$ 7,091,425**
4 - Authority Administrative Costs	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%
	$ 277,619	**$ 284,560**	**$ 291,674**	**$ 298,966**	**$ 306,440**	**$ 314,101**	**$ 321,953**	**$ 330,002**	**$ 338,252**	**$ 346,708**	**$ 355,376**	**$ 364,261**	**$ 373,367**	**$ 382,701**	**$ 392,269**
5 - Billing, Collection, Meter Reading, Cust. Service	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%
	$ 1.95	$ 2.00	$ 2.05	$ 2.10	$ 2.15	$ 2.21	$ 2.26	$ 2.32	$ 2.38	$ 2.43	$ 2.50	$ 2.56	$ 2.62	$ 2.69	$ 2.75
Assumed Annual Salaries	$ 195,955	$ 200,854	$ 205,875	$ 211,022	$ 216,297	$ 221,705	$ 227,247	$ 232,929	$ 238,752	$ 244,721	$ 250,839	$ 257,110	$ 263,537	$ 270,126	$ 276,879
	$ 496,485.78	**$ 519,359.81**	**$ 543,067.23**	**$ 567,635.43**	**$ 593,092.61**	**$ 619,467.89**	**$ 646,791.25**	**$ 675,093.60**	**$ 704,406.84**	**$ 734,763.79**	**$ 766,198.35**	**$ 798,745.40**	**$ 832,440.93**	**$ 867,322.02**	**$ 917,848.71**
Total Annual Administrative Costs	*$ 774,105*	*$ 803,920*	*$ 834,741*	*$ 866,601*	*$ 899,532*	*$ 933,569*	*$ 968,744*	*$ 1,005,096*	*$ 1,042,659*	*$ 1,081,472*	*$ 1,121,574*	*$ 1,163,006*	*$ 1,205,808*	*$ 1,250,023*	*$ 1,310,117*
TOTAL ANNUAL O&M COSTS	**$ 5,787,628**	**$ 6,129,102**	**$ 6,485,196**	**$ 6,856,466**	**$ 7,243,488**	**$ 7,646,855**	**$ 8,067,186**	**$ 8,505,119**	**$ 8,961,316**	**$ 9,436,462**	**$ 9,931,265**	**$ 10,446,460**	**$ 10,982,809**	**$ 11,541,097**	**$ 12,381,781**
O&M Cost per kgal	*$ 4.76*	*$ 4.87*	*$ 4.99*	*$ 5.12*	*$ 5.24*	*$ 5.37*	*$ 5.51*	*$ 5.65*	*$ 5.79*	*$ 5.94*	*$ 6.10*	*$ 6.25*	*$ 6.42*	*$ 6.58*	*$ 6.74*

CAPITAL COSTS

	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050
TOTAL Capital Costs Paid											**$48,618,191**				
O&M Costs	$ 5,787,628	$ 6,129,102	$ 6,485,196	$ 6,856,466	$ 7,243,488	$ 7,646,855	$ 8,067,186	$ 8,505,119	$ 8,961,316	$ 9,436,462	$ 9,931,265	$ 10,446,460	$ 10,982,809	$ 11,541,097	$ 12,381,781
Capital Cost Revenue Bonds															
Years: **25** Rate: **4.50%**															
Series 2020 Revenue Bonds	$ 3,537,068	$ 3,537,068	$ 3,537,068	$ 3,537,068	$ 3,537,068	$ 3,537,068	$ 3,537,068	$ 3,537,068	$ 3,537,068	$ 3,537,068					
Series 2025 Revenue Bonds	$ 1,223,648	$ 1,223,648	$ 1,223,648	$ 1,223,648	$ 1,223,648	$ 1,223,648	$ 1,223,648	$ 1,223,648	$ 1,223,648	$ 1,223,648	$ 1,223,648	$ 1,223,648	$ 1,223,648	$ 1,223,648	$ 1,223,648
Series 2030 Revenue Bonds	$ 1,600,264	$ 1,600,264	$ 1,600,264	$ 1,600,264	$ 1,600,264	$ 1,600,264	$ 1,600,264	$ 1,600,264	$ 1,600,264	$ 1,600,264	$ 1,600,264	$ 1,600,264	$ 1,600,264	$ 1,600,264	$ 1,600,264
Series 2045 Revenue Bonds											$ 3,278,764	$ 3,278,764	$ 3,278,764	$ 3,278,764	$ 3,278,764
Subtotal	***$ 6,360,980***	***$ 6,360,980***	***$ 6,360,980***	***$ 6,360,980***	***$ 6,360,980***	***$ 6,360,980***	***$ 6,360,980***	***$ 6,360,980***	***$ 6,360,980***	***$ 6,360,980***	***$ 6,102,675***	***$ 6,102,675***	***$ 6,102,675***	***$ 6,102,675***	***$ 6,102,675***
Total O&M and Capital Costs	**$ 12,148,608**	**$ 12,490,082**	**$ 12,846,176**	**$ 13,217,447**	**$ 13,604,468**	**$ 14,007,835**	**$ 14,428,166**	**$ 14,866,100**	**$ 15,322,296**	**$ 15,797,442**	**$ 16,033,940**	**$ 16,549,136**	**$ 17,085,484**	**$ 17,643,772**	**$ 18,484,456**
Total Connected Customers	16662	17227	17793	18359	18925	19491	20057	20623	21188	21754	22320	22886	23452	24018	25149
Break-Even Monthly Water Bill	**$ 60.76**	**$ 60.42**	**$ 60.16**	**$ 60.00**	**$ 59.91**	**$ 59.89**	**$ 59.95**	**$ 60.07**	**$ 60.26**	**$ 60.51**	**$ 59.86**	**$ 60.26**	**$ 60.71**	**$ 61.22**	**$ 61.25**

SUPPLY SCENARIO 2
(PURCHASED WATER ONLY)

Northwestern Guilford County Water System Feasibility Study

Estimated Water Rate Determination 30-Aug-18

Supply Scenario 2 (100% Purchase of Finished Water from Reidsville)

OPERATION AND MAINTENANCE COSTS

	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Total ERCs			*4,283*	*5,140*	*5,996*	*6,853*	*7,709*	*8,566*	*9,444*	*10,321*	*11,199*	*12,077*	*12,954*	*13,832*	*14,398*	*14,964*	*15,530*	*16,096*
Daily Average Water Demand (gal)			856,600	1,027,920	1,199,240	1,370,560	1,541,880	1,713,200	1,888,739	2,064,278	2,239,817	2,415,356	2,590,895	2,766,438	2,879,610	2,992,783	3,105,955	3,219,128
Annual kgal			312,659	375,191	437,723	500,254	562,786	625,318	689,390	753,461	817,533	881,605	945,677	1,009,750	1,051,058	1,092,366	1,133,674	1,174,982
Annual Demand to be Purchased from Winston-Salem (kgal):			**312,659**	**375,191**	**437,723**	**500,254**	**562,786**	**625,318**	**689,390**	**753,461**	**817,533**	**881,605**	**945,677**	**1,009,750**	**1,051,058**	**1,092,366**	**1,133,674**	**1,174,982**
Operation and Maintenance Costs:																		
1 - O&M Cost - Distribution		*Escalation*																
Cost per kgal per day	**$ 0.566**	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%
Escalated O&M Cost per kgal/day	$ 0.566	$ 0.58	$ 0.59	$ 0.61	$ 0.62	$ 0.64	$ 0.66	$ 0.67	$ 0.69	$ 0.71	$ 0.72	$ 0.74	$ 0.76	$ 0.78	$ 0.80	$ 0.82	$ 0.84	$ 0.86
Assumed Annual Salaries	**$ 82,500**	2.50%	$ 82,500	$ 84,563	$ 86,677	$ 88,843	$ 91,065	$ 93,341	$ 95,675	$ 98,067	$ 100,518	$ 103,031	$ 105,607	$ 108,247	$ 110,953	$ 113,727	$ 116,570	$ 119,485
Annual O&M Costs - Dist. + Personnel			**$ 268,423.85**	**$ 313,248.83**	**$ 360,147.30**	**$ 409,194.91**	**$ 460,469.81**	**$ 514,052.71**	**$ 571,088.93**	**$ 630,655.67**	**$ 692,843.82**	**$ 757,747.21**	**$ 825,462.75**	**$ 896,091.57**	**$ 951,529.61**	**$ 1,009,179.49**	**$ 1,069,117.16**	**$ 1,131,420.98**
2 - O&M Cost - Pumping/Chemicals for Groundwater		*Escalation*																
Cost per kgal per day	**$ 0.250**	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%
Escalated O&M Cost per kgal/day	$ 0.250	$ 0.26	$ 0.26	$ 0.27	$ 0.28	$ 0.28	$ 0.29	$ 0.30	$ 0.30	$ 0.31	$ 0.32	$ 0.33	$ 0.34	$ 0.34	$ 0.35	$ 0.36	$ 0.37	$ 0.38
Annual O&M Costs - Pumping/Chemicals for Groundwater			**$ 82,122**	**$ 101,010**	**$ 120,791**	**$ 141,498**	**$ 163,165**	**$ 185,827**	**$ 209,989**	**$ 235,243**	**$ 261,628**	**$ 289,186**	**$ 317,957**	**$ 347,988**	**$ 371,279**	**$ 395,518**	**$ 420,736**	**$ 446,968**
3 - Cost to Purchase Water from Winston-Salem:		*Escalation*																
Purchased Water Rate ($/kgal)	**$ 3.000**	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%
Escalated Purchase Rate per kgal	$ 3.000	$ 3.09	$ 3.18	$ 3.28	$ 3.38	$ 3.48	$ 3.58	$ 3.69	$ 3.80	$ 3.91	$ 4.03	$ 4.15	$ 4.28	$ 4.41	$ 4.54	$ 4.67	$ 4.81	$ 4.96
Assumed Average Annual Water Loss		**5%**																
Annual O&M Costs - Purchased Water			**$ 1,044,855**	**$ 1,291,441**	**$ 1,551,881**	**$ 1,826,786**	**$ 2,116,788**	**$ 2,422,546**	**$ 2,619,895**	**$ 2,949,289**	**$ 3,296,089**	**$ 3,661,042**	**$ 4,044,926**	**$ 4,448,555**	**$ 4,769,458**	**$ 5,105,611**	**$ 5,457,640**	**$ 5,826,197**
		Escalation																
4 - Authority Administrative Costs	**$ 178,000**	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%
	$ 178,000	**$182,450**	**$ 187,011**	**$ 191,687**	**$ 196,479**	**$ 201,391**	**$ 206,425**	**$ 211,586**	**$ 216,876**	**$ 222,298**	**$ 227,855**	**$ 233,551**	**$ 239,390**	**$ 245,375**	**$ 251,509**	**$ 257,797**	**$ 264,242**	**$ 270,848**
5 - Billing, Collection, Meter Reading, Cust. Service	**$ 1.25**	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%
	$ 1.25	$ 1.28	$ 1.31	$ 1.35	$ 1.38	$ 1.41	$ 1.45	$ 1.49	$ 1.52	$ 1.56	$ 1.60	$ 1.64	$ 1.68	$ 1.72	$ 1.77	$ 1.81	$ 1.86	$ 1.90
Assumed Annual Salaries	**$ 132,000**	2.50%	$ 132,000	$ 135,300	$ 138,683	$ 142,150	$ 145,703	$ 149,346	$ 153,080	$ 156,907	$ 160,829	$ 164,850	$ 168,971	$ 173,195	$ 177,525	$ 181,963	$ 186,513	$ 191,175
			$ 176,367.47	**$ 189,871.99**	**$ 203,941.50**	**$ 218,595.82**	**$ 233,855.40**	**$ 249,741.33**	**$ 286,149.03**	**$ 305,979.39**	**$ 326,622.43**	**$ 348,106.38**	**$ 370,460.39**	**$ 393,714.84**	**$ 412,804.49**	**$ 432,602.55**	**$ 453,132.52**	**$ 474,418.60**
Total Annual Administrative Costs			*$ 363,379*	*$ 381,559*	*$ 400,420*	*$ 419,986*	*$ 440,281*	*$ 461,327*	*$ 503,025*	*$ 528,277*	*$ 554,477*	*$ 581,658*	*$ 609,851*	*$ 639,090*	*$ 664,314*	*$ 690,400*	*$ 717,375*	*$ 745,267*
TOTAL ANNUAL O&M COSTS			**$ 1,758,779**	**$ 2,087,258**	**$ 2,433,239**	**$ 2,797,465**	**$ 3,180,703**	**$ 3,583,753**	**$ 3,903,997**	**$ 4,343,464**	**$ 4,805,038**	**$ 5,289,633**	**$ 5,798,197**	**$ 6,331,724**	**$ 6,756,580**	**$ 7,200,707**	**$ 7,664,868**	**$ 8,149,853**
O&M Cost per kgal			*$ 5.63*	*$ 5.56*	*$ 5.56*	*$ 5.59*	*$ 5.65*	*$ 5.73*	*$ 5.66*	*$ 5.76*	*$ 5.88*	*$ 6.00*	*$ 6.13*	*$ 6.27*	*$ 6.43*	*$ 6.59*	*$ 6.76*	*$ 6.94*

CAPITAL COSTS

		2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
$158,521,185	TOTAL Capital Costs Paid	**$58,298,390**						**$16,489,818.00**					**$25,057,139.00**				
	O&M Costs	$ 1,758,779	$ 2,087,258	$ 2,433,239	$ 2,797,465	$ 3,180,703	$ 3,583,753	$ 3,903,997	$ 4,343,464	$ 4,805,038	$ 5,289,633	$ 5,798,197	$ 6,331,724	$ 6,756,580	$ 7,200,707	$ 7,664,868	$ 8,149,853
	Capital Cost Revenue Bonds																
	Years: **25** Rate: **4.50%**																
	Series 2020 Revenue Bonds	$ 3,931,587	$ 3,931,587	$ 3,931,587	$ 3,931,587	$ 3,931,587	$ 3,931,587	$ 3,931,587	$ 3,931,587	$ 3,931,587	$ 3,931,587	$ 3,931,587	$ 3,931,587	$ 3,931,587	$ 3,931,587	$ 3,931,587	$ 3,931,587
	Series 2025 Revenue Bonds							$ 1,112,057	$ 1,112,057	$ 1,112,057	$ 1,112,057	$ 1,112,057	$ 1,112,057	$ 1,112,057	$ 1,112,057	$ 1,112,057	$ 1,112,057
	Series 2030 Revenue Bonds												$ 1,689,829	$ 1,689,829	$ 1,689,829	$ 1,689,829	$ 1,689,829
	Series 2045 Revenue Bonds																
	Subtotal	***$ 3,931,587***	***$ 3,931,587***	***$ 3,931,587***	***$ 3,931,587***	***$ 3,931,587***	***$ 3,931,587***	***$ 5,043,644***	***$ 5,043,644***	***$ 5,043,644***	***$ 5,043,644***	***$ 5,043,644***	***$ 6,733,473***	***$ 6,733,473***	***$ 6,733,473***	***$ 6,733,473***	***$ 6,733,473***
	Total O&M and Capital Costs	**$ 5,690,366**	**$ 6,018,844**	**$ 6,364,826**	**$ 6,729,052**	**$ 7,112,290**	**$ 7,515,340**	**$ 8,947,641**	**$ 9,387,108**	**$ 9,848,682**	**$ 10,333,277**	**$ 10,841,841**	**$ 13,065,197**	**$ 13,490,053**	**$ 13,934,181**	**$ 14,398,341**	**$ 14,883,326**
	Total Connected Customers	4283	5140	5996	6853	7709	8566	9444	10321	11199	12077	12954	13832	14398	14964	15530	16096
	Break-Even Monthly Water Bill	**$ 110.72**	**$ 97.59**	**$ 88.46**	**$ 81.83**	**$ 76.88**	**$ 73.11**	**$ 78.96**	**$ 75.79**	**$ 73.28**	**$ 71.30**	**$ 69.74**	**$ 78.71**	**$ 78.08**	**$ 77.60**	**$ 77.26**	**$ 77.06**

Northwestern Guilford County Water System Feasibility Study
Estimated Water Rate Determination 31-Jul-18
Supply Scenario 2 (100% Purchase of Finished Water)
OPERATION AND MAINTENANCE COSTS

	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050
Total ERCs	*16,662*	*17,227*	*17,793*	*18,359*	*18,925*	*19,491*	*20,057*	*20,623*	*21,188*	*21,754*	*22,320*	*22,886*	*23,452*	*24,018*	*25,149*
Daily Average Water Demand (gal)	3,332,300	3,445,473	3,558,645	3,671,818	3,784,990	3,898,162	4,011,335	4,124,507	4,237,680	4,350,852	4,464,025	4,577,197	4,690,370	4,803,542	5,029,887
Annual kgal	1,216,290	1,257,597	1,298,905	1,340,213	1,381,521	1,422,829	1,464,137	1,505,445	1,546,753	1,588,061	1,629,369	1,670,677	1,711,985	1,753,293	1,835,909
Demand to be Purchased from Winston-Salem (kgal):	**1,216,290**	**1,257,597**	**1,298,905**	**1,340,213**	**1,381,521**	**1,422,829**	**1,464,137**	**1,505,445**	**1,546,753**	**1,588,061**	**1,629,369**	**1,670,677**	**1,711,985**	**1,753,293**	**1,835,909**
Operation and Maintenance Costs:															
1 - O&M Cost - Distribution															
Cost per kgal per day	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%
Escalated O&M Cost per kgal/day	$ 0.88	$ 0.90	$ 0.93	$ 0.95	$ 0.97	$ 1.00	$ 1.02	$ 1.05	$ 1.08	$ 1.10	$ 1.13	$ 1.16	$ 1.19	$ 1.22	$ 1.25
Assumed Annual Salaries	$ 122,472	$ 125,534	$ 128,672	$ 131,889	$ 135,186	$ 138,566	$ 142,030	$ 145,580	$ 149,220	$ 152,950	$ 156,774	$ 160,694	$ 164,711	$ 168,829	$ 173,049
Annual O&M Costs - Dist. + Personnel	**$ 1,196,171.79**	**$ 1,263,453.00**	**$ 1,333,350.67**	**$ 1,405,953.56**	**$ 1,481,353.25**	**$ 1,559,644.20**	**$ 1,640,923.86**	**$ 1,725,292.72**	**$ 1,812,854.45**	**$ 1,903,715.96**	**$ 1,997,987.50**	**$ 2,095,782.81**	**$ 2,197,219.13**	**$ 2,302,417.41**	**$ 2,463,026.83**
			f												
2 - O&M Cost - Pumping/Chemicals for Groundwater															
Cost per kgal per day	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%
Escalated O&M Cost per kgal/day	$ 0.39	$ 0.40	$ 0.41	$ 0.42	$ 0.43	$ 0.44	$ 0.45	$ 0.46	$ 0.48	$ 0.49	$ 0.50	$ 0.51	$ 0.52	$ 0.54	$ 0.55
Annual O&M Costs - Pumping/Chemicals for Groundwater	**$ 474,249**	**$ 502,615**	**$ 532,102**	**$ 562,750**	**$ 594,597**	**$ 627,685**	**$ 662,056**	**$ 697,753**	**$ 734,821**	**$ 773,306**	**$ 813,257**	**$ 854,721**	**$ 897,751**	**$ 942,398**	**$ 1,011,474**
3 - Cost to Purchase Water from Winston-Salem:															
Purchased Water Rate ($/kgal)	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%
Escalated Purchase Rate per kgal	$ 5.11	$ 5.26	$ 5.42	$ 5.58	$ 5.75	$ 5.92	$ 6.10	$ 6.28	$ 6.47	$ 6.66	$ 6.86	$ 7.07	$ 7.28	$ 7.50	$ 7.73
Assumed Average Annual Water Loss															
Annual O&M Costs - Purchased Water	**$ 6,211,955**	**$ 6,615,614**	**$ 7,037,903**	**$ 7,479,575**	**$ 7,941,413**	**$ 8,424,230**	**$ 8,928,869**	**$ 9,456,204**	**$ 10,007,143**	**$ 10,582,628**	**$ 11,183,635**	**$ 11,811,179**	**$ 12,466,310**	**$ 13,150,119**	**$ 14,182,851**
4 - Authority Administrative Costs	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%
	$ 277,619	**$ 284,560**	**$ 291,674**	**$ 298,966**	**$ 306,440**	**$ 314,101**	**$ 321,953**	**$ 330,002**	**$ 338,252**	**$ 346,708**	**$ 355,376**	**$ 364,261**	**$ 373,367**	**$ 382,701**	**$ 392,269**
5 - Billing, Collection, Meter Reading, Cust. Service	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%
	$ 1.95	$ 2.00	$ 2.05	$ 2.10	$ 2.15	$ 2.21	$ 2.26	$ 2.32	$ 2.38	$ 2.43	$ 2.50	$ 2.56	$ 2.62	$ 2.69	$ 2.75
Assumed Annual Salaries	$ 195,955	$ 200,854	$ 205,875	$ 211,022	$ 216,297	$ 221,705	$ 227,247	$ 232,929	$ 238,752	$ 244,721	$ 250,839	$ 257,110	$ 263,537	$ 270,126	$ 276,879
	$ 496,485.78	**$ 519,359.81**	**$ 543,067.23**	**$ 567,635.43**	**$ 593,092.61**	**$ 619,467.89**	**$ 646,791.25**	**$ 675,093.60**	**$ 704,406.84**	**$ 734,763.79**	**$ 766,198.35**	**$ 798,745.40**	**$ 832,440.93**	**$ 867,322.02**	**$ 917,848.71**
Total Annual Administrative Costs	*$ 774,105*	*$ 803,920*	*$ 834,741*	*$ 866,601*	*$ 899,532*	*$ 933,569*	*$ 968,744*	*$ 1,005,096*	*$ 1,042,659*	*$ 1,081,472*	*$ 1,121,574*	*$ 1,163,006*	*$ 1,205,808*	*$ 1,250,023*	*$ 1,310,117*
TOTAL ANNUAL O&M COSTS	**$ 8,656,481**	**$ 9,185,602**	**$ 9,738,097**	**$ 10,314,879**	**$ 10,916,896**	**$ 11,545,128**	**$ 12,200,593**	**$ 12,884,345**	**$ 13,597,477**	**$ 14,341,122**	**$ 15,116,454**	**$ 15,924,689**	**$ 16,767,088**	**$ 17,644,958**	**$ 18,967,469**
O&M Cost per kgal	*$ 7.12*	*$ 7.30*	*$ 7.50*	*$ 7.70*	*$ 7.90*	*$ 8.11*	*$ 8.33*	*$ 8.56*	*$ 8.79*	*$ 9.03*	*$ 9.28*	*$ 9.53*	*$ 9.79*	*$ 10.06*	*$ 10.33*

CAPITAL COSTS

	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050
TOTAL Capital Costs Paid											**$58,675,838**				
O&M Costs	$ 8,656,481	$ 9,185,602	$ 9,738,097	$ 10,314,879	$ 10,916,896	$ 11,545,128	$ 12,200,593	$ 12,884,345	$ 13,597,477	$ 14,341,122	$ 15,116,454	$ 15,924,689	$ 16,767,088	$ 17,644,958	$ 18,967,469
Capital Cost Revenue Bonds															
Years: **25** Rate: **4.50%**															
Series 2020 Revenue Bonds	$ 3,931,587	$ 3,931,587	$ 3,931,587	$ 3,931,587	$ 3,931,587	$ 3,931,587	$ 3,931,587	$ 3,931,587	$ 3,931,587	$ 3,931,587					
Series 2025 Revenue Bonds	$ 1,112,057	$ 1,112,057	$ 1,112,057	$ 1,112,057	$ 1,112,057	$ 1,112,057	$ 1,112,057	$ 1,112,057	$ 1,112,057	$ 1,112,057	$ 1,112,057	$ 1,112,057	$ 1,112,057	$ 1,112,057	$ 1,112,057
Series 2030 Revenue Bonds	$ 1,689,829	$ 1,689,829	$ 1,689,829	$ 1,689,829	$ 1,689,829	$ 1,689,829	$ 1,689,829	$ 1,689,829	$ 1,689,829	$ 1,689,829	$ 1,689,829	$ 1,689,829	$ 1,689,829	$ 1,689,829	$ 1,689,829
Series 2045 Revenue Bonds											$ 3,957,041	$ 3,957,041	$ 3,957,041	$ 3,957,041	$ 3,957,041
Subtotal	***$ 6,733,473***	***$ 6,733,473***	***$ 6,733,473***	***$ 6,733,473***	***$ 6,733,473***	***$ 6,733,473***	***$ 6,733,473***	***$ 6,733,473***	***$ 6,733,473***	***$ 6,733,473***	***$ 6,758,928***	***$ 6,758,928***	***$ 6,758,928***	***$ 6,758,928***	***$ 6,758,928***
Total O&M and Capital Costs	**$ 15,389,954**	**$ 15,919,075**	**$ 16,471,570**	**$ 17,048,352**	**$ 17,650,369**	**$ 18,278,601**	**$ 18,934,066**	**$ 19,617,818**	**$ 20,330,950**	**$ 21,074,595**	**$ 21,875,382**	**$ 22,683,617**	**$ 23,526,016**	**$ 24,403,885**	**$ 25,726,397**
Total Connected Customers	16662	17227	17793	18359	18925	19491	20057	20623	21188	21754	22320	22886	23452	24018	25149
Break-Even Monthly Water Bill	**$ 76.97**	**$ 77.00**	**$ 77.14**	**$ 77.38**	**$ 77.72**	**$ 78.15**	**$ 78.67**	**$ 79.27**	**$ 79.96**	**$ 80.73**	**$ 81.67**	**$ 82.60**	**$ 83.60**	**$ 84.67**	**$ 85.25**

APPENDIX E

FUNDING ANALYSIS

The construction of public water infrastructure falls into two general categories to address public and economic development needs. Sources of potential public water infrastructure financing is dependent upon the need to be addressed. Special project funds financed through rates, impact fees, and other sources of local revenue, installment purchase and bonds may be used to meet actual and anticipated needs in both categories. Federal and State water infrastructure financing programs are to meet specific needs. A summary of general infrastructure need categories and major funding sources that can finance projects in Guilford County follow.

GENERAL INFRASTRUCTURE NEED CATEGORIES

1. Public Need:

   a) Residents want convenience of public water and/or sewer.
   b) Health & Safety – Residents must have infrastructure improvements due to health/safety concerns including contaminated wells, undersized water lines, etc.

2. Economic Development:

   a) Infrastructure to promote/support economic development.
   b) Infrastructure to meet specific business/industrial requirements.

MAJOR FUNDING SOURCES

1) General Public Need:

   a) Special water project funds (capital improvement funds included in water rates/impact fees, etc.).
   b) Installment Purchase.
   c) Bond financing (General Obligation or Revenue Bond).
   d) Water & Waste Disposal Loan and Grant Program, Rural Development, USDA.
   e) Water & Waste Disposal Loan Guarantee Program, Rural Development, USDA.
   f) Drinking Water State Revolving Fund, Division of Water Infrastructure, NC Department Environmental Quality. *Note: Priority given to projects addressing health and safety needs.*
   g) State Wastewater and Drinking Water Reserve Program, Division of Water Infrastructure, NC Department Environmental Quality.
   h) Water Infrastructure Finance and Innovation Act Program, US Environmental Protection Agency.

   Health & Safety:

   h) Small Cities Community Development Block Grant (CDBG)– Infrastructure (excludes Greensboro), Division of Water Infrastructure, NC Department Environmental Quality.

2) Economic development:

   a) Special water project funds (capital improvement funds included in water rates/impact fees, etc.).
   b) Bond financing (General Obligation or Revenue Bond – usually to meet anticipated needs).
   c) Installment Purchase.
   d) Tax Increment Financing (TIF).
   e) Economic Infrastructure Program, Rural Economic Development Division, NC Department of Commerce.
   f) CDBG-Economic Development (excludes Greensboro), Rural Economic Development Division, NC Department of Commerce.
   g) Economic Catalyst Program, Golden LEAF Foundation.
   h) Economic Adjustment – Public Works, Economic Development Administration, US Department of Commerce.

MAJOR FEDERAL AND STATE LOAN AND GRANT PROGRAMS – GENERAL SUMMARY

Water & Wastewater Disposal Loan and Grant Program, Rural Development, USDA

Type of Assistance: Loan and Grant.

Eligibility:
- Applicant: State, local governments and private nonprofits.
- Area: Rural areas and towns with populations of 10,000 or less.

Assistance:
- Long term, low interest loans.
- Fixed interest rates.
- Maximum: Loan – no maximum; Grant - $50,000 (based on need and availability).

Loan terms:
- Up to 40-year payback period, based on the useful life of the facilities financed.
- Fixed interest rates, based on the need for the project and the median household income of the area served. Rates (current interest rates for the 3rd Quarter FY 2018, effective April 1, 2018 to June 31, 2018) are: Poverty – 2.375%; Intermediate – 3.125%; and Market – 3.875%.

Purpose/use of funds (Public Need):
- The purpose of the program is to fund clean and reliable drinking water systems, sewage disposal, sanitary solid waste disposal, and storm water drainage to households and businesses in eligible rural areas. Funds may be used to finance the acquisition, construction or improvement of eligible activities. In some cases, funding may be used for legal and engineering fees.

Water & Wastewater Disposal Loan Guarantee Program, Rural Development, USDA

Type of Assistance: Loan Guarantee.

Eligibility:
- Applicant: State, local governments and private nonprofits.
- Area: Rural areas and towns with populations of 10,000 or less.

Assistance:
- Maximum guarantee is typically 90 percent of the loan amount.
- Maximum: No maximum.

Loan terms:
- Interest rates may be fixed or variable as negotiated between the lender and the borrower, subject to USDA approval.
- Up to 40-year payback period, based on the useful life of the facilities financed.
- Balloon payments are prohibited.

Purpose/use of funds (Public Need).
- The purpose of the program is to fund clean and reliable drinking water systems, sewage disposal, sanitary solid waste disposal, and storm water drainage to households and businesses in eligible rural areas. Funds may be used to finance the acquisition, construction or improvement of eligible activities. In some case funding may be used for legal and engineering fees, land acquisition and equipment, start-up operations and maintenance, capitalized interest, and other costs determined to be necessary for the completion of the project.

Drinking Water State Revolving Fund (DWSRF), Division of Water Infrastructure, NC Department Environmental Quality

Type of Assistance: Loan.

Eligibility:
- Applicant: Local government units (counties, cities, towns, sanitary districts, etc.); Non-profit Water Corporations; and Investor Owned Drinking Water Corporations.
- Area: Statewide.

Assistance:
- Low interest loans.
- Maximum: Loan – No maximum but amount of loan request must be weighed in consideration of total funding request and DWSRF budget.

Loan terms:

- Payback period determined by Local Government Commission.
- Fixed interest rates, based on ½ of market interest rate.
- Limited amount of principal forgiveness.

Purpose/use of funds (Public Need - Health/Safety).

- The purpose of the program is to finance water source, treatment, storage, or transmission and distributions with funding priority given to projects that address specific health and safety needs. Funds may be used to finance eligible project acquisition, legal, engineering and construction costs.

<u>State Wastewater and Drinking Water Reserve Programs, Division of Water Infrastructure, NC Department Environmental Quality</u>

Type of Assistance: Grants and Loans.

Eligibility:

- Applicant: Local government units (counties, cities, towns, sanitary districts, etc.).
- Only available to the extent that other funding sources are not reasonably available to the applicant.
- Area: Statewide.

Assistance:

- Maximum: The amount of grant or loan awarded for each system for three consecutive years cannot exceed $3,000,000.

Purpose/use of funds (Public Need).

- The purpose of the program is to finance the planning, design and construction of critical infrastructure that includes public water system and wastewater collection system and treatment works projects. Grant dollars are awarded according to affordability criteria. Affordability criteria are used to determine eligibility for grant funding and the percentage of the project that could be funded by grants.

<u>Water Infrastructure Finance and Innovation Act Program, US Environmental Protection Agency</u>

Type of Assistance: Loan.

Eligibility:

- Applicant: Local, state, tribal, federal government entities, partnerships and joint ventures, corporations and trusts, and Clean Water and Drinking Water State Revolving Fund programs.
- Area: Statewide.

Match:

- Loan recipient must provide 51% of eligible project costs.

Assistance:

- $5,000,000 the minimum project size for small communities (population of 25,000 or less).
- $20,000,000 the minimum project size for large communities.

Loan terms:

- Up to 35-year payback period after project substantial completion.
- Payments may be deferred up to 5 years after project substantial completion.
- Fixed interest rates that will be equal or greater to the US Treasury rate of a similar maturity.

Purpose/use of funds (Public Need):

- The purpose of the program is to accelerate investment in our nations water infrastructure by providing long-term low-cost supplemental loans for regionally and nationally significant projects. Funding priorities follow:
    - Adaptation to extreme weather and climate change including enhanced infrastructure resiliency, water recycling and reuse, and managed aquifer recovery,
    - Enhanced energy efficiency of treatment works, public water systems, and conveyance systems, including innovative, energy efficient nutrient treatment,
    - Green infrastructure, and
    - Repair, rehabilitation, and replacement of infrastructure and conveyance systems.

Funds may be used to finance acquisition, engineering, and construction activities.

<u>Community Development Block Grant-Infrastructure, Division of Water Infrastructure, NC Department Environmental Quality</u>

Type of Assistance: Grants.

Eligibility:

- Non-entitlement units of General Local Government, excluding water/sewer districts and other single purpose government units.
- The water/sewer infrastructure project service area must meet US Housing and Urban Development (HUD) low and moderate threshold.

Assistance:

- Maximum: The maximum award is $2,000,000 over a three-year period.

Purpose/use of funds (General Public Need – Health/Safety)

- The purpose of the program is to construct public water and sewer infrastructure to mitigate public and environmental health problems in areas where the percentage of low to moderate income persons is at least 51%. Funds may be used to finance eligible planning, administration, acquisition, legal, engineering, and construction activities.

Infrastructure Program, Rural Economic Development Division, NC Department of Commerce

Type of Assistance: Performance Based Grants.

Eligibility:
- Counties, municipalities and towns.
- In Tier 3 counties, assistance is restricted to rural census tracts (census tracts having less than 500 persons per square mile based on the most recent decennial US census).
- Projects must directly benefit a new or expanding private business.

Match Requirement:
- The local government must provide a match equal to 5% of the grant amount. The source of the match must be local funds.

Assistance:
- Maximum: The maximum award in Tier 1 and 2 counties is $500,000 with a $250,000 maximum award in a Tier 3 county. The amount of grant per new full-time job created is based on the type of business, average annual wage, and if the employer provides at least 51% employer paid health benefits.
- Job Creation: Jobs must be created within eighteen months of the grant award and retained for six consecutive months.
- Repayment: If job creation/retention does not occur, a pro-rata share of the grant must be repaid based on the job shortfall. The grant recipient (local government) is ultimately responsible for repayment.

Purpose/use of funds (Economic Development)
- The purpose of the program is to construct public infrastructure that directly supports private sector job creation. Funds may be used to finance eligible administration, acquisition, legal, engineering, and construction activities.

Small Cities Community Development Block Grant (CDBG) Economic Development Program, Rural Economic Development Division, NC Department of Commerce

Type of Assistance: Performance Based Grants.

Eligibility:
- Non-entitlement units of General Local Government, excluding water/sewer districts and other single purpose government units.
- Project must directly create new or retain private sector jobs.
- At least 61% of jobs created or retained must benefit low and moderate-income individuals based on US Housing and Urban Development (HUD) income limits.

Match Requirement:
- The local government must provide a match equal to 25% of the grant amount.

Assistance:

- Maximum: The maximum award in Tier 1 and 2 counties is $1,000,000 with a $750,000 maximum award in a Tier 3 county. The amount of grant per new full-time job created is based on the type of business, average annual wage, and if the employer provides at least 51% employer paid health benefits.
- Job Creation: Jobs must be created within twenty-four months of the grant award.
- Repayment: If job creation/retention does not occur, a pro-rata share of the grant must be repaid based on the job shortfall. The grant recipient (local government) is ultimately responsible for repayment.

Purpose/use of funds (Economic Development)

- The purpose of the program is to construct public infrastructure that directly supports private sector job creation or retention. Funds may be used to finance eligible planning, administration, acquisition, legal, engineering, and construction activities.

<u>Economic Catalyst Program, Golden Leaf Foundation, Inc.</u>

Type of Assistance: Performance Based Grants.

Eligibility:

- Governmental entities and 501 (c)(3) non-profit organizations.
- Projects must be at risk without Golden Leaf participation.
- Statewide eligibility to economically distressed or tobacco-dependent communities.
- Project must be coordinated with the N.C Department of Commerce, the appropriate regional economic development partnership, and local officials
- Benefiting company must provide at least 50% of the cost of employee-only health insurance.

Match Requirement:

- None.

Assistance:

- Maximum: Project amount as determined by Golden Leaf and N.C. Department of Commerce.
- Job Creation: Project must create new jobs.
- An inducement agreement is required that demonstrates the company is obligated to meet the job creation projections and wage goals and provides appropriate consequences should the company fail to satisfy its obligations.

Purpose/use of funds (Economic Development)

- The purpose of the program is to support activities that will lead to job creation by a company that will commit to create the jobs. Funds may be used to finance construction including engineering and construction activities, workforce development, etc.

Economic Adjustment – Public Works, Economic Development Administration (EDA), US Department of Commerce

Type of Assistance: Grants.

Eligibility:
- Governmental entities and non-profit organizations.
- Statewide.
- Must meet EDA Economic Adjustment or Public Works eligibility (job loss (actual or threatened); unemployment, median family income, etc.).

Match Requirement:
- 50% to 80%.

Assistance:
- Maximum: No maximum but amount of grant request must be weighed in consideration of total funding request and EDA budget.
- Job Creation and/or Retention. Projects demonstrating direct job creation and/or retention in growth sectors that provide high wages with benefits receive priority funding consideration.

Purpose/use of funds (Economic Development)
- The purpose of the program is to support activities that will lead to job creation and/or retention. Funds may be used to finance construction including engineering and construction activities, workforce development, etc.

COMMENTS

1. All debt financing requires Local Government Commission (LGC) oversight and approval.

2. Special water project funds; installment purchase; and bond (General Obligation or Revenue Bond) are standard means for municipalities, county governments and Authorities created under NC Statutes to finance general water improvement project.

3. Rural Development, USDA Water & Waste Disposal Loan & Grant Program provides up to a 40-year loan toward the design and construction of water and sewer facilities. To be eligible the applicant (local government or non-profit) must show a financial need to use Federal loan financing and the population of the town/city or the rural area be served must be less than 10,000 persons. The rural area must meet Rural Development, USDA population density requirements. A map showing eligible rural areas in the northern section of Guilford County is attached.

   If the population of the local government is over 10,000 and/or it has the financial capacity to finance public water and sewer improvements; the local government can create water, sewer and or water and sewer districts in eligible rural areas that can meet Rural Development, USDA rural population and financial need requirements.

4. When considering the use of Federal and State loan programs, one must factor in applicable application processing, closing fees and additional legal costs. When using Federal funds, consideration should also be given to the potential added cost due to Davis Bacon Wage and Buy American requirements.

5. There may be opportunities to seek economic development grant funds for a segment(s) of water infrastructure where economic development is occurring, especially if the benefiting company is a NC Department of Commerce priority industry whose average annual wage exceeds Guildford County's and whose employee benefits include at least 51% employee paid health insurance.

6. None of the above grant of loan sources can assist in the assessment and formation of an entity to plan, finance, construct and own/operate proposed water improvements. It is possible that a $20,000 Downtown and Economic Development Program, Rural Economic Development Division, NC Department of Commerce grant could be received to help fund these activities.

General Funding Options: The proposed project is to meet a Public Need. Potential funding packages could include a combination of special water project funds and installment purchase and/or bond financing; and Rural Development, USDA Water & Waste Disposal Loan and Grant Program. It would appear that the use of Rural Development financing in sections of the overall water system where there is less dense population could reduce the need for residents in more densely populated areas to subsidize construction in rural areas. In recent discussions with Rural Development, USDA, the agency has funds and is looking to develop projects.

If the project design incorporates adaptation to extreme weather and climate change, enhanced energy efficiency of treatment works, and/or green infrastructure, Water Infrastructure Finance and Innovation Act may be considered in addition to Rural Development, USDA Water & Waste Disposal Loan and Grant Program financing.

During the design stage, economic development grants should be sought to help finance specific components that will directly benefit new or expanding industries.

APPENDIX F

GOVERNANCE OUTLINES

MEMORANDUM

TO: Northwest Guilford County Water System Feasibility Study Group

FROM: Robert W. Oast, Jr.

DATE: July 9, 2018

RE: Proposed Water System Governance Structure

The local governments of Northwest Guilford County--the Towns of Oak Ridge, Summerfield, and Stokesdale, and Guilford County (herein "Participating Local Governments" or "PLGs")--have engaged the Timmons Group to perform a feasibility study and develop strategies for combining resources to provide safe and reliable water service to the areas within their respective jurisdictions.

CONSIDERATIONS and ASSUMPTIONS

On June 26, 2018, representatives of the PLGs met with the Timmons Group to review the status of the feasibility study. One of the items discussed was the governance structure for constructing and operating the system. Several options were reviewed. After some discussion, the following considerations were identified as important to the PLGs:

1. Each PLG wishes to retain the ability to control or direct growth and development within its respective jurisdiction.
2. The agency that operates the system should be politically independent, and not subject to the control of any one of the PLGs.
3. Representation of the PLGs on the governing board should be equitable, if not equal.

4. There must be a way of recognizing the asset contributions of the different PLGs without unfairly penalizing or favoring any of the PLGs.
5. There should be a means of acquiring existing private systems and incorporating them into the new system.
6. There should be a way to expand the service areas to include additional unincorporated areas, or to add other municipalities.
7. The entity should be able to purchase bulk water from multiple sources.
8. Other considerations include:

   (a) Only Stokesdale currently has a public water system, and equipment/staff with experience operating or maintaining water distribution facilities:

   (b) The system plans to obtain water from two sources: purchase of bulk treated water from another system, and ground water from wells—approximately 50 % from each source at full operation. Current plans are to purchase bulk water from Winston-Salem (other sources are being considered). The wells are not in operation yet, and water obtained from them will have to be treated, requiring a treatment facility.

   (c) Anticipated capacity of the system is ____ MGD upon commencement of operations, and ___ MGD within ___ years.

COMPARISON OF STRUCTURES

With these considerations in mind, the statutory models described in NCGS Chapter 162A (as opposed to an interlocal agreement or contracting for service from Winston-Salem)

quickly emerged as best suited to the needs of the PLGs. Among these, there are two that warrant strong condiseration:

1. Water and Sewer Authority, organized pursuant to Article 1 of NCGS Chapter 162A.
2. Metropolitan Water District organized pursuant to Article 4 of NCGS Chapter 162A.

These models differ from each other in several important respects:

A. **Creation:** Both Articles outline a procedure for creation.

1. A water district is created by the PLGs petitioning the county commissioners to create the district, and there is a process for including unincorporated areas.
2. An authority is created by the PLGs adopting a resolution of intent to form an authority. There is no requirement for the county commissioners to approve, but a county may participate as any other political subdivision.
3. Public hearings are required by each Article. In the case of a district, the public hearing is a joint hearing by the board of commissioners and a representative of the State Department of Environmental Quality. For an authority, each PLG is required to have a public hearing prior to incorporating.
4. Key Difference: An authority appears to have more autonomy as to the manner of its creation; it does not require permission or approval by the board of county commissioners.

A. **Representation on Governing Board:**

1. A district has a rigid, population-based formula for determining representation on the board by PLGs and unincorporated areas.
2. The members of an authority may agree among themselves as to their representation on the governing board. However, if and when another local government joins the authority, the formula for allocating representation on the board becomes more rigid.
3. Key Difference: Authority has more flexibility in representation on a governing board, at least at the point of formation.

B. **Powers:** An authority and a district have most of the same powers, including the power to adopt and enforce ordinances, set and revise rates, employ workers, enter into contracts, acquire property (including through eminent domain), make special assessments, enter into agreements with and accept grants from other governments (including purchase of system facilities).

1. Financial Matters. Authorities and districts may issue revenue bonds, but only districts may issue general obligation boards. As a corollary to this (and necessary for GO bonds), only districts may levy and collect taxes. Although the statutory authorization is somewhat unclear, it appears that both districts and authorities may utilize NCGS 160A-20 in the purchase of real or personal property, which provides for security interests and the use of certificates of participation (COPs) as a method of financing.
2. Key Difference: with the ability to issue general obligation bonds and levy taxes, the financial ability of a district seems a little more robust.

CONCLUSION and RECOMMENDATION

On the basis of the June 26 discussion with the PLGs and the review of the statutes, a water authority formed under Article 1 of NCGS Chapter 160A appears to best meet the needs and desires of the PLGs. Such authorities are autonomous, and have some flexibility in their initial membership. One significant difference is that authorities lack some of the financial tools – such as taxing and some board authority – that a district formed under Article 4 has. The study is not yet far enough along that a firm recommendation can be made, and the limited scope of this engagement does not allow for a more detailed analysis. When more information is available about the proposed configuration of the system, a more detailed analysis should be undertaken

NOTE: Because of the unique characteristics and requirements of each system and the area that the system serves, it is not unusual to seek special legislative authorization—in the form of a separate charter or an amendment to the existing statutes—to enable the creation of a particular system. In fact, that approach appears to explain some of the provisions already in the statutes. In consultation with each other and with the engineers, the PLGs should develop a structure that works for them, and then determine if one of the models in Chapter 162A will satisfy their needs. If none of the models in GS Chapter 162A discussed above are a good "fit" for Northwest Guilford County, representatives of the PLGs should consider consulting with members of the NC General Assembly that represent the area to obtain appropriate statutory authorization. Care should be taken regarding constitutional limitations on local legislation that affects public health and safety, but the legislative staff is well aware of these limitations.

A request will be made to the UNC School of Government for information on existing water (or water and sewer) authorities and districts – where they are, and what statutory

arrangements they have used. As soon as this information is provided, it will be made available to the PLGs.

Review of Options for Northwest Guilford Water Service Organizational Structure

The local governments of Northwest Guilford County have engaged the Timmons Group to develop strategies for combining their resources to provide safe and reliable water service to the areas within their respective political jurisdictions. This memorandum will identify and summarize the statutory provisions that can be used to organize and operate a multi-jurisdictional water utility.

1. Extension of existing municipal service. Article 16 of N.C.G.S. Chapter 160A is the statutory authority for municipalities to operate "public enterprises," including water systems. There is a parallel authority in Article 15 of Chapter 153A, the county government enabling act. Municipalities in North Carolina may, and frequently do, provide water service beyond their political boundaries, including into adjacent municipalities. There is no precise limit on how far this service can extend beyond the corporate limits; the statute allows for extension of service "within reasonable limitations." One reason for this limitation is to limit competition with private utilities, and to limit competition among municipalities. The extent of a system's reach into another jurisdiction is frequently established by agreement. The municipality that provides the water would also operate the system, and its workers and equipment would provide service in the receiving jurisdictions.
2. Purchase of bulk water. Some municipalities purchase their water in bulk from another – usually adjacent – local government that has excess capacity. Under this arrangement, the receiving government would buy the water but operate the system

itself, but even this can be done by contract. Many smaller cities, and some larger ones, operate their systems this way for at least a portion of their service areas.

These first two methods have the benefits of simplicity in administration and preserving autonomy for the participating governments. The following structures all involve turning the responsibility of operations a water system over to another entity. Not all local governments are equally willing to do this, and expectations are not always consistent.

3. Interlocal agreement. Article 20 of Chapter 160A authorizes local governments to enter into "interlocal agreements" with other local governments to perform any function that a unit of local government is authorized by law to engage in, including the operation of public enterprises. This arrangement allows for the formation of joint agencies to operate the system. The joint agency may employ its own staff, but may not own property, which can make financing difficult. N.C.G.S. 160A-464 outlines the provisions that a contract or agreement made pursuant to Article 20 must contain, and there are formal procedures for adoption of such agreements.
4. Water Authorities and Districts. N.C.G.S. Chapter 162A contains provisions for the formation of water and sewer authorities and districts. These are essentially special purpose local governments, with the power to tax, adopt and enforce ordinances, and issue bonds. There are two Articles in this Chapter of potential applicability to Northwest Guilford: (a) Article 1 – Water and Sewer Authorities, and (b) Article 4 – Metropolitan Water Districts. A third Article, Article 6 – County Water and Sewer Districts, may also be applicable. Though they vary in their details, these articles contain extensive and somewhat complicated procedures for establishing an authority or district, allocating representation on the governing boards, and management of the

authority or district. In many ways, they operate just like cities and counties. They can be composed entirely of local governments but also have provisions for including unincorporated areas.

5. Special legislation. The North Carolina General Assembly may establish a water authority by special act, subject to the constitutional limitations on such local legislation, and make provisions for all of the matters discussed above in connection with the existing statutory models (governance, powers, service area, etc.). This allows for the enactment of a law or charter that is a "customized" form of district or authority, or when the statutory models in Chapter 162A will not meet the needs of the participating governments. Some local utilities commissions are organized this way.

Each of the arrangements summarized above has particular benefits and drawbacks, and what will work best depends to a large degree on the needs and desires of the participating local governments and incorporated areas. Factors to be considered in deciding which arrangement to use include:

(a) degree of autonomy for the system operator;

(b) desire of participating governments to participate directly in operation of system administratively and financially;

(c) whether there are multiple sources of water supply;

(d) desire of participating governments to use the system to guide growth;

(e) how much governmental power the district or authority should have;

(f) the water assets that each government will be contributing to the new entity (reservoirs, treatment facilities, distribution lines, equipment);

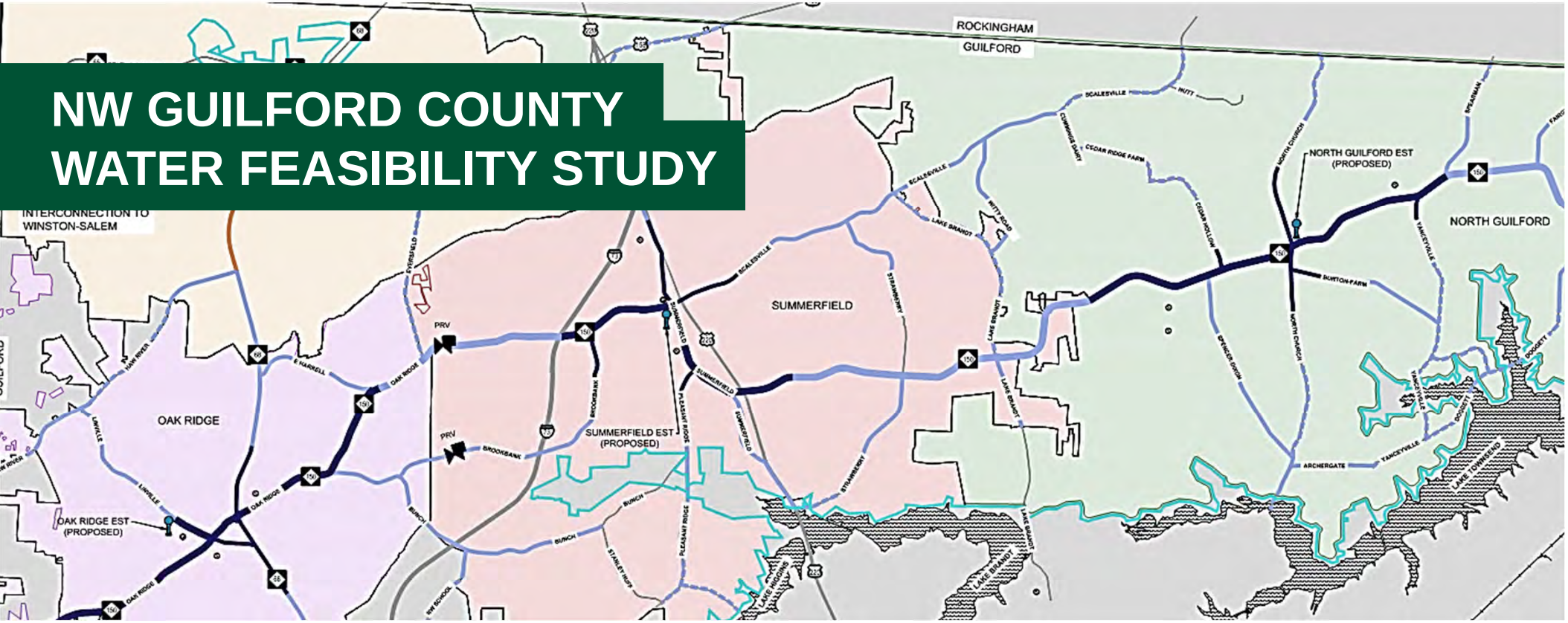
(g) which entity will own property and equipment, manage personnel, and secure financing (bonds).

Of course, there are other considerations, and not every organizational structure described above will work well in every situation. As the local governments of Northwest Guilford County develop their ideas for the combined system, some of the organizational structures models described will emerge as better suited the participants' needs than others. More detailed information on any of the structures discussed above can be provided on request, as well as examples of such models in North Carolina, and information on how well they have functioned.

APPENDIX G

PUBLIC PRESENTATION COPY

NW GUILFORD COUNTY WATER FEASIBILITY STUDY



STUDY SUMMARY PRESENTATION

September 6, 2018
Oak Ridge Town Hall

WWW.TIMMONS.COM

TIMMONS GROUP
YOUR VISION ACHIEVED THROUGH OURS.

HISTORY

- NC General Assembly Approved $14.5 million in FY 2017 Legislative Session
- Guilford County received $3,637,245.25 to develop regional water system
- Funds to be spent or encumbered by JUNE 2020
- Oak Ridge, Stokesdale, Summerfield, and Guilford County contracted for Feasibility Study
- The Timmons Group $175,000.00

PURPOSE

- To develop a public water system to improve public safety and public health
- Adequate water volume and pressure to enhance fire suppression capability
- Improve potable water quality and reliability for domestic use

DEVELOPING A REGIONAL WATER SYSTEM

- Participation commitments from local governments
- Determining a governance structure (Authority, District, Interlocal Agreement)
- Appointment of Board Members
- Determine service areas
- Determine water supply sources (Purchase treated water on a wholesale basis / groundwater)

DEVELOPING A REGIONAL WATER SYSTEM (cont.)

- Contract for more detailed Feasibility Study and Financial Model
- Determine funding and financing for project
- Contract for Engineering Design of System
- Permitting
- Construction

ADDITIONAL CONSIDERATIONS

- Establish systems specifications
- Establish system operating policies and standards
- Staffing: Administrative and Operations
- Customer Base / Critical Mass

ADDITIONAL CONSIDERATIONS (cont.)

- Need strong commitment from all participants
- System development will not be easy
- System development will not be inexpensive
- Development of a water system will be more costly in the future

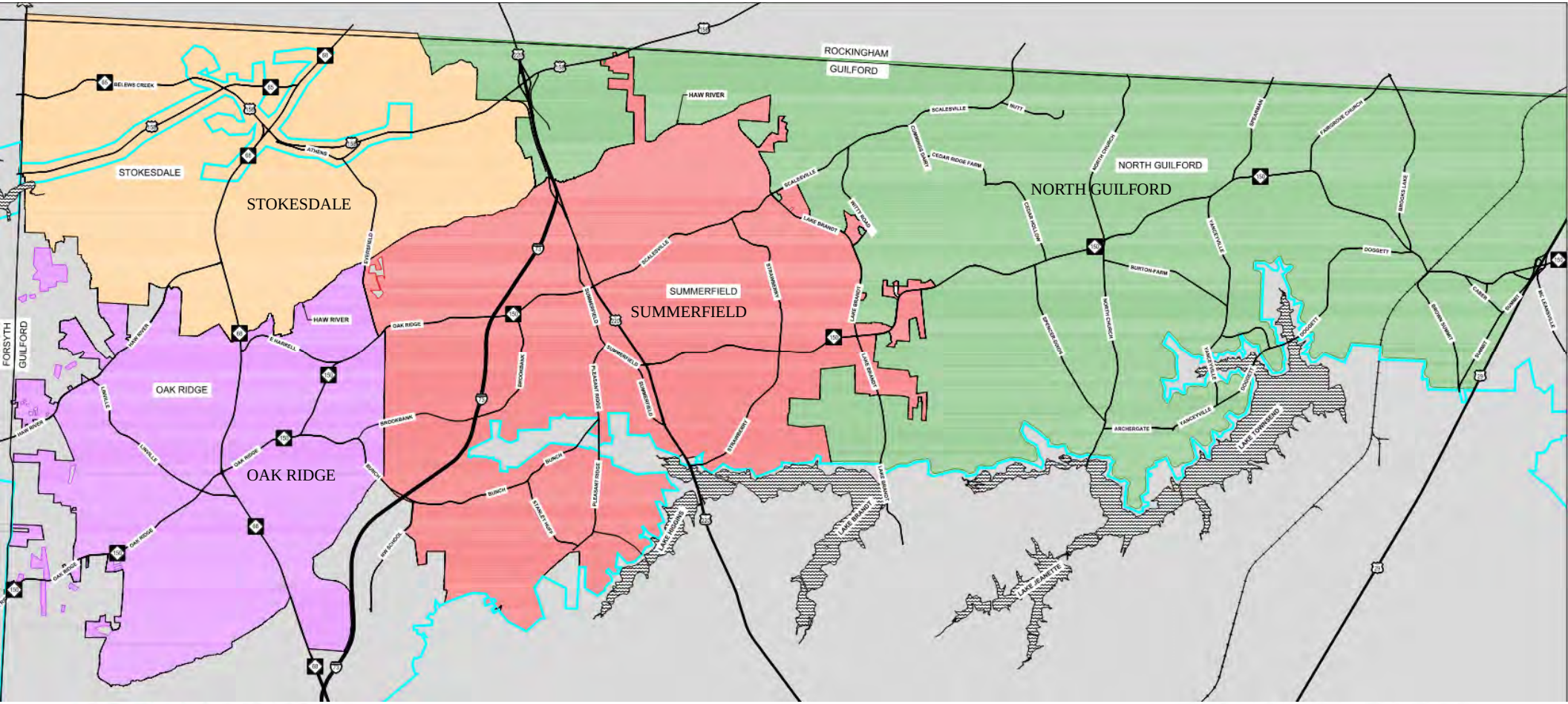
NW Guilford County Water Study

Discussion Outline

- Study Objectives
- Background Efforts
- Groundwater Investigation
- Engineering Approach
  - Water Model Development
- Financial Analysis
- System Governance
- Recommended Next Steps

TIMMONS GROUP
YOUR VISION ACHIEVED THROUGH OURS.

NW Guilford County Water Study



NW Guilford County Water Study

Study Objectives

- ***Identify Possible Water Supply Sources***
- ***Identify Service Area Priorities***
- ***Conceptual Water System Layout***
- ***Estimate Cost of Infrastructure***
- ***Estimate Water Rates for Customers***
- ***Summarize Governance Options***
- ***Determine Next Steps***

TIMMONS GROUP
YOUR VISION ACHIEVED THROUGH OURS.

NW Guilford County Water Study

Background Efforts

- Discussions for the bulk purchase of finished water:
  - Winston-Salem/Forsyth County
  - Reidsville
  - Greensboro
  - Piedmont Triad Regional Water Authority
- Performed preliminary groundwater availability analysis
- Met with each locality to identify service area priorities
- Developed distribution system hydraulic model

TIMMONS GROUP
YOUR VISION ACHIEVED THROUGH OURS.

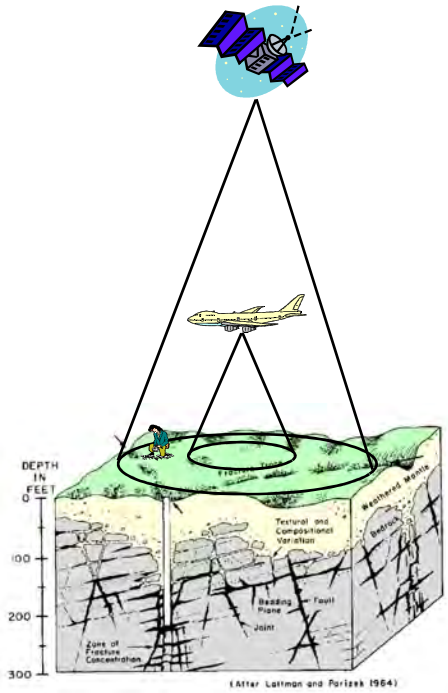
NW Guilford County Water Study

Groundwater Study Objectives & Approach

- Groundwater is seen as a viable interim or supplemental water supply source for the less densely populated areas of northwestern Guilford County
- Assess the feasibility of developing groundwater supplies to support the local water supply needs of the towns and unincorporated areas of northwestern Guilford County in a sustainable manner
- Identify areas that may be more favorable for developing public community groundwater supplies
- Use science to optimize the location of future water supply wells and to minimize impacts on existing groundwater users and ecologically sensitive areas

NW Guilford County Water Study

Integrated Approach to Groundwater Exploration

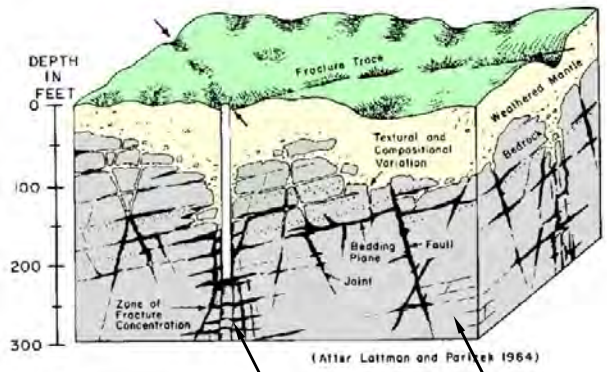


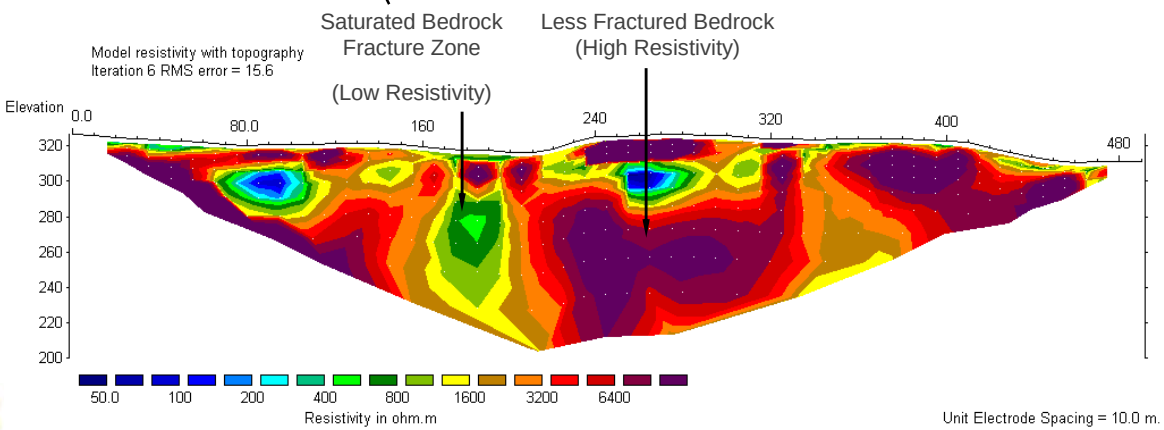
- Remote Sensing Lineament Analysis
- Detailed Geologic Mapping
- Bedrock Fracture Analysis
- Existing Well Data Review
- Groundwater Recharge Analysis
- Contaminant Threat Analysis
- Geophysical Imaging
- Test and Production Well Drilling
- Aquifer Testing and GW Modeling
- Source Water Protection Plans
- Well Rehabilitation
- Engineering Design
- Water Supply Plans

GOLDER

NW Guilford County Water Study

Groundwater Exploration Techniques



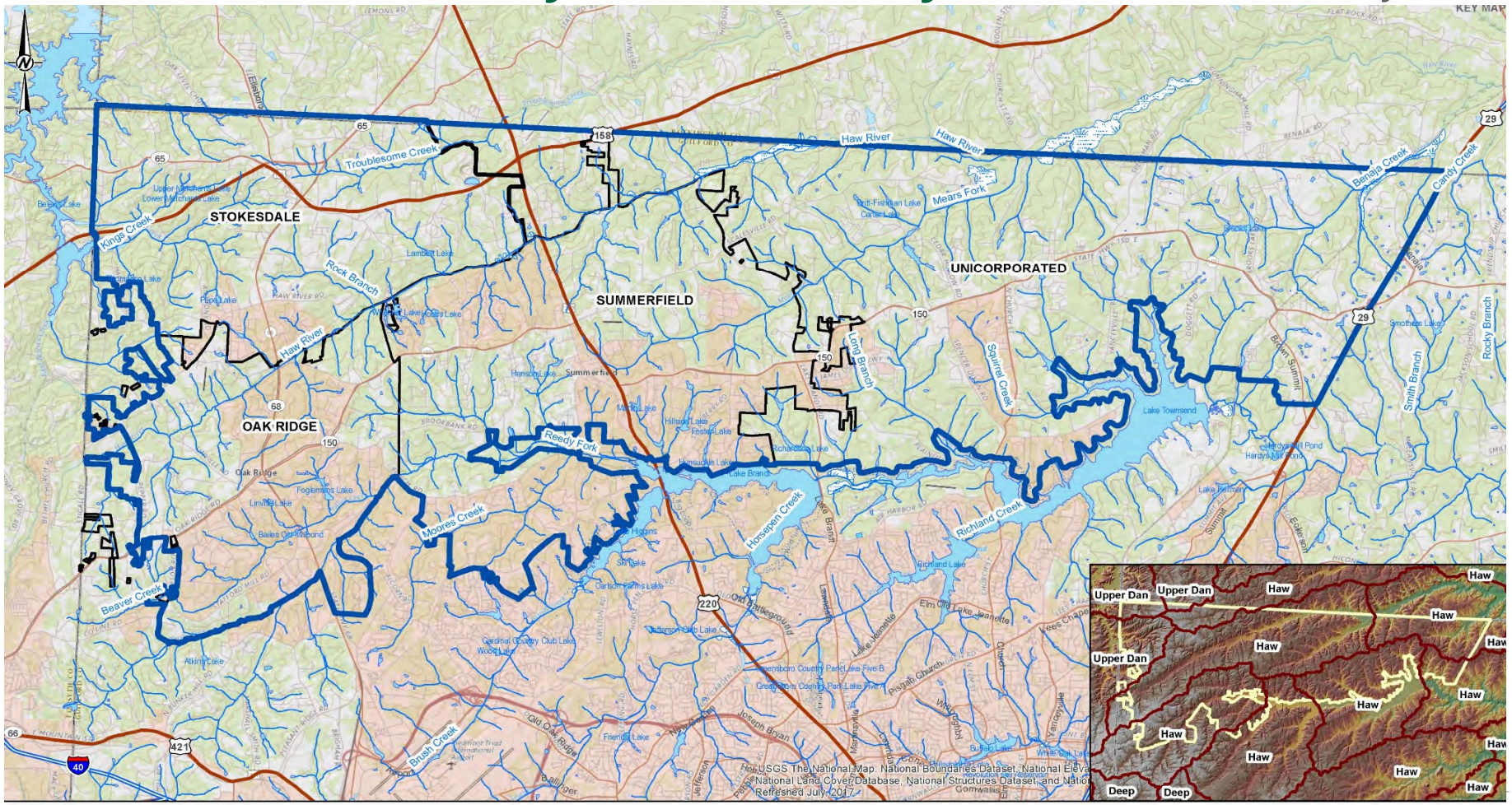


Golder maps out electrical properties of the subsurface to find water (i.e., areas of increased fracture density).

GOLDER

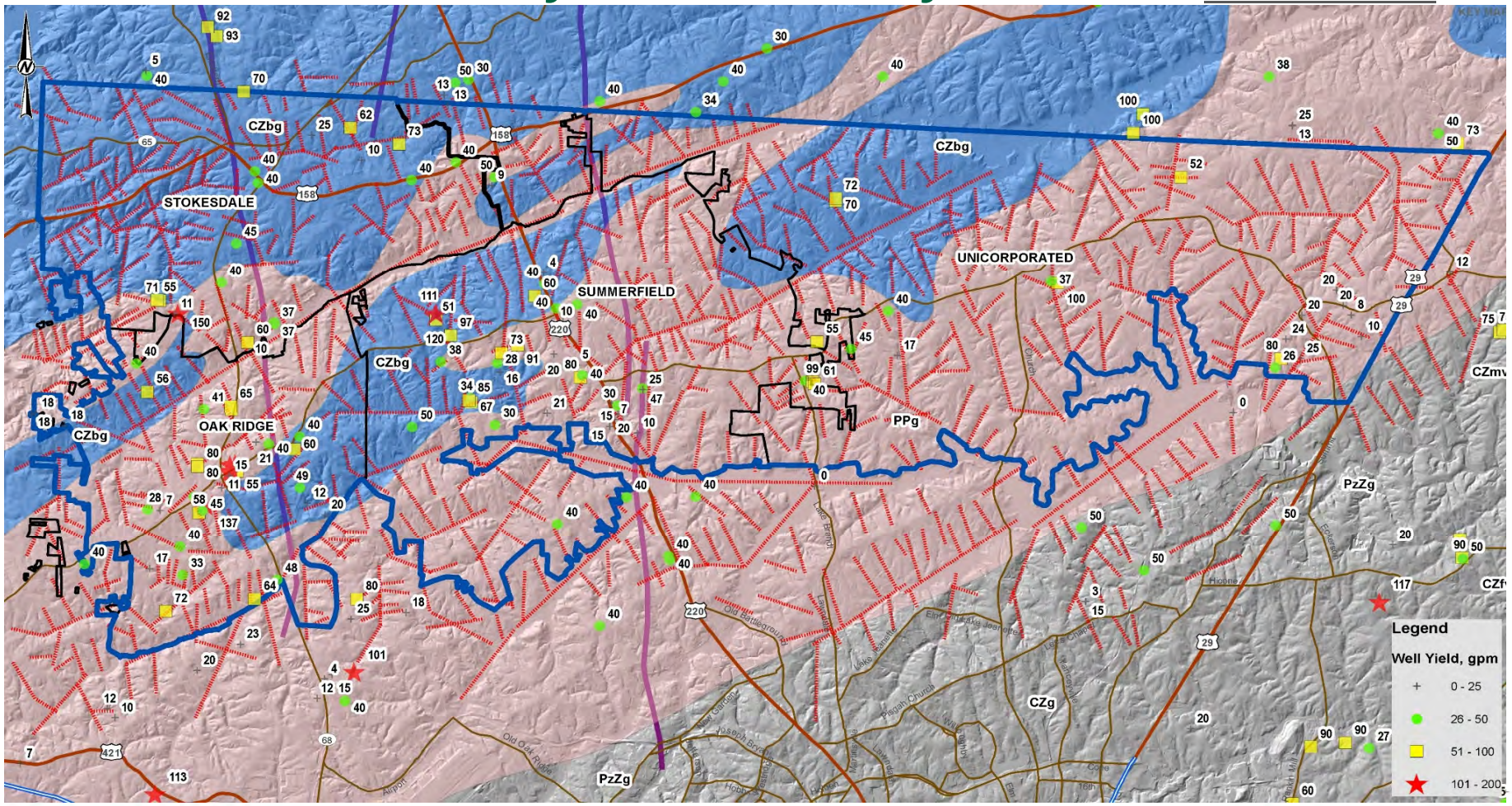
NW Guilford County Water Study

Study Area



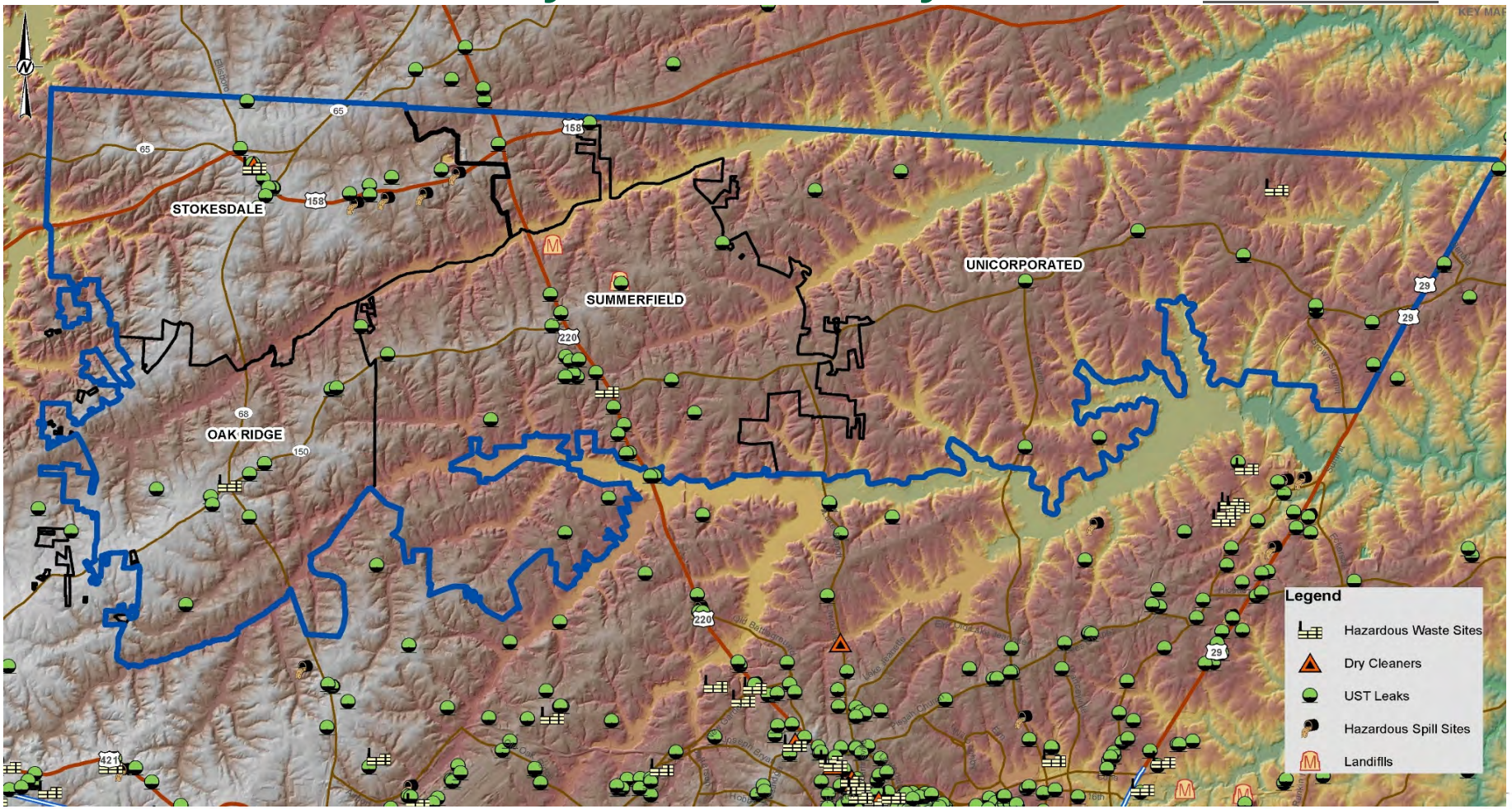
NW Guilford County Water Study

Geology, Lineaments and Well Yield



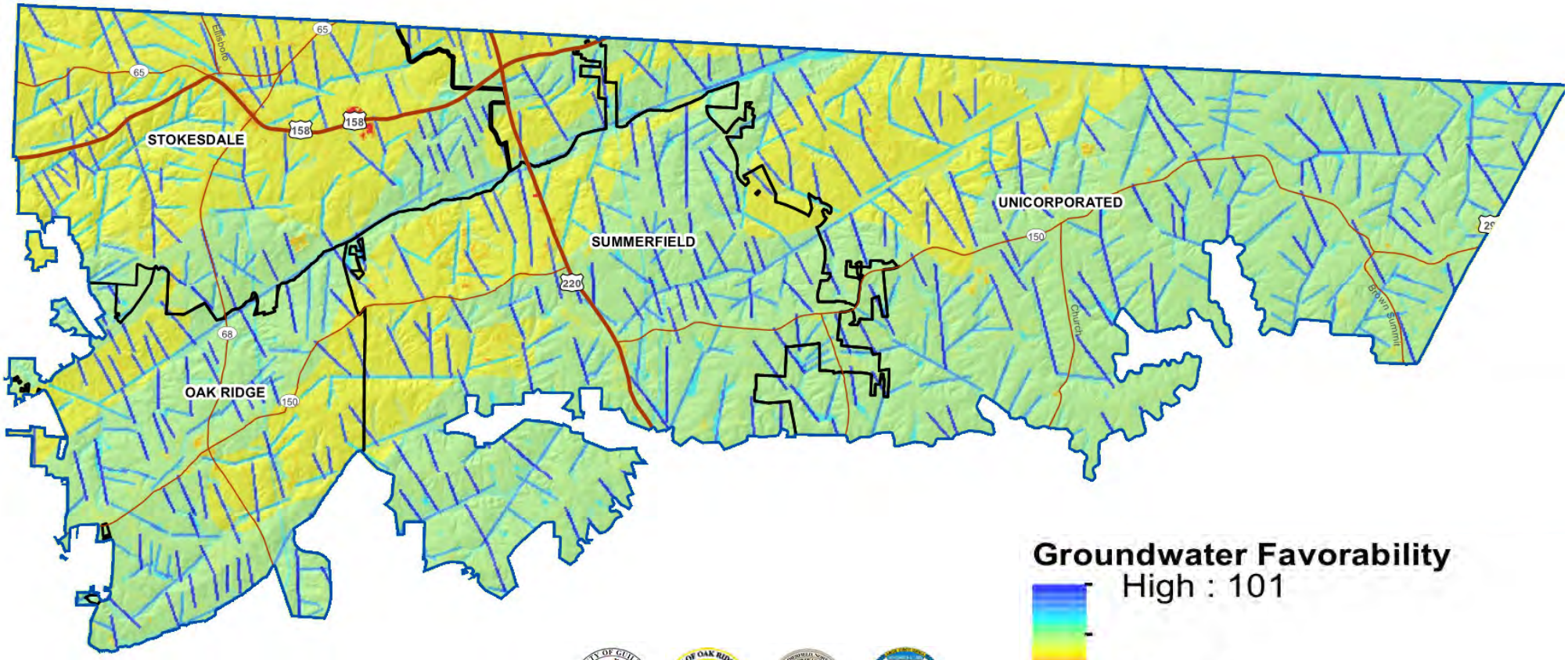
NW Guilford County Water Study

Potential Sources of Contamination



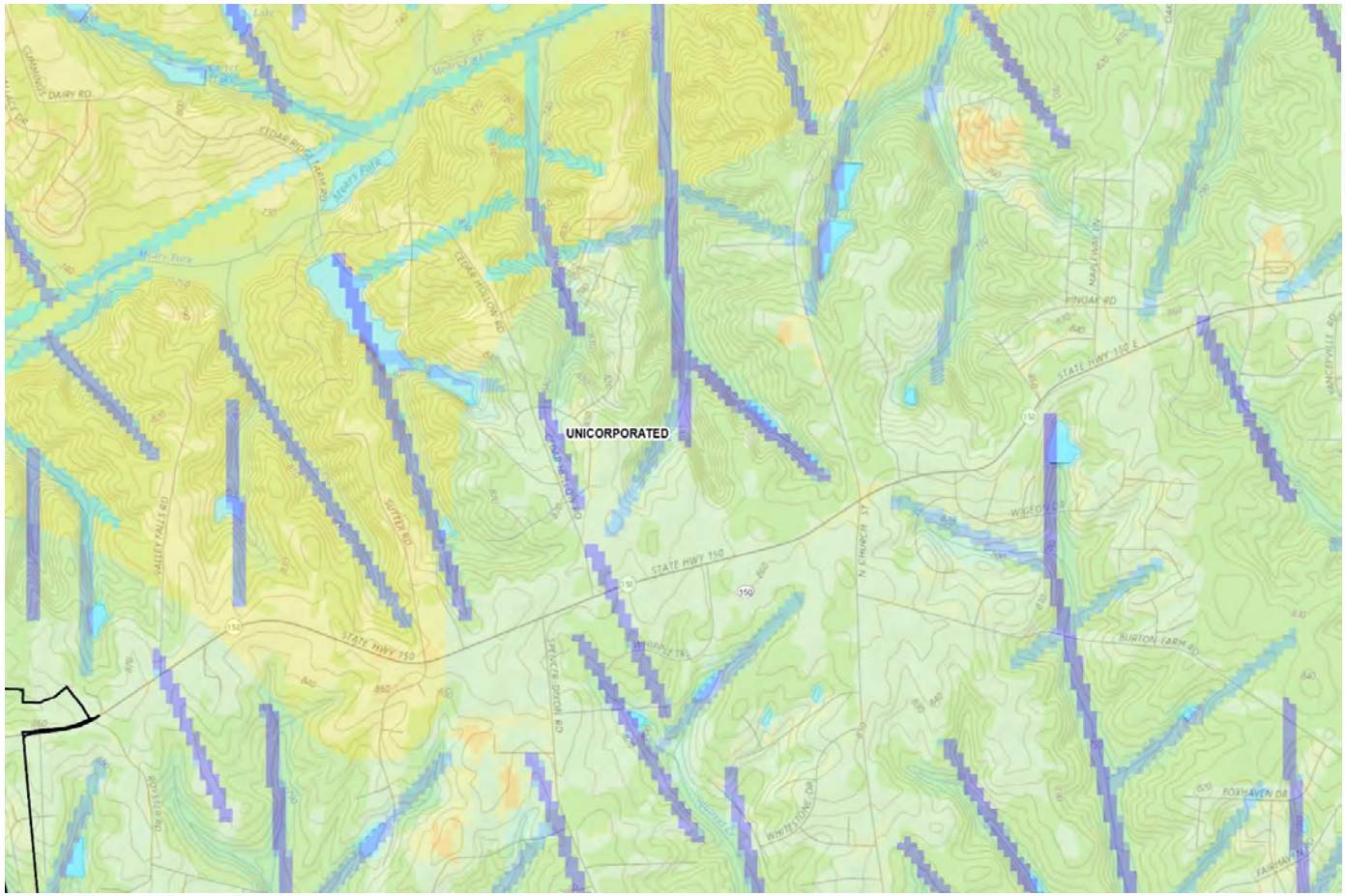
NW Guilford County Water Study

Groundwater Favorability Assessment



NW Guilford County Water Study

Groundwater Favorability Assessment



Groundwater Favorability

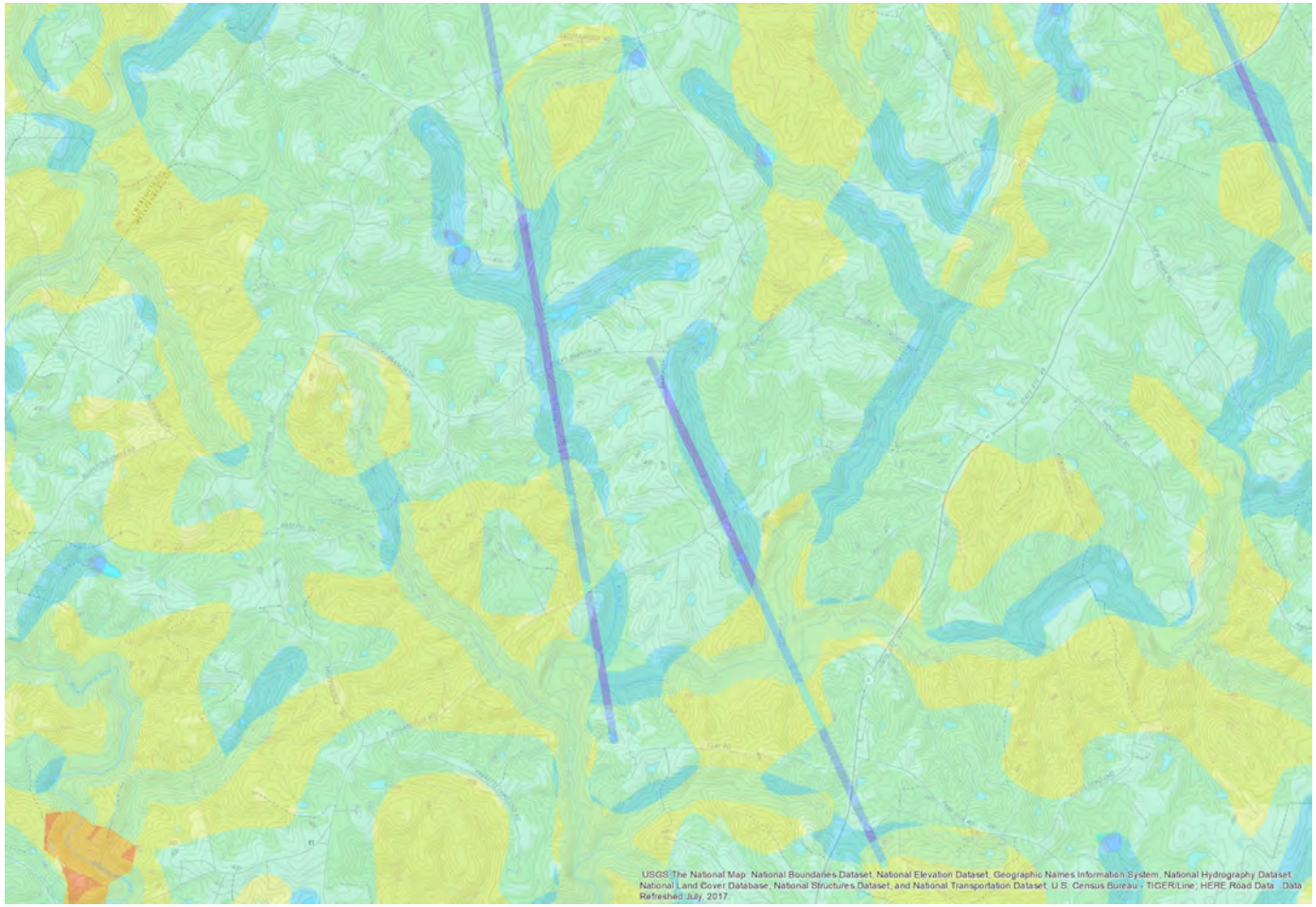
High : 101

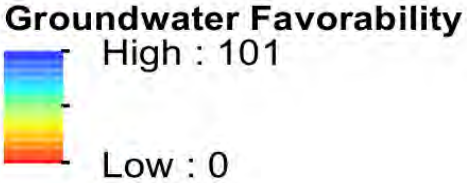
Low : 0

GOLDER

NW Guilford County Water Study

Groundwater Favorability Assessment





GOLDER

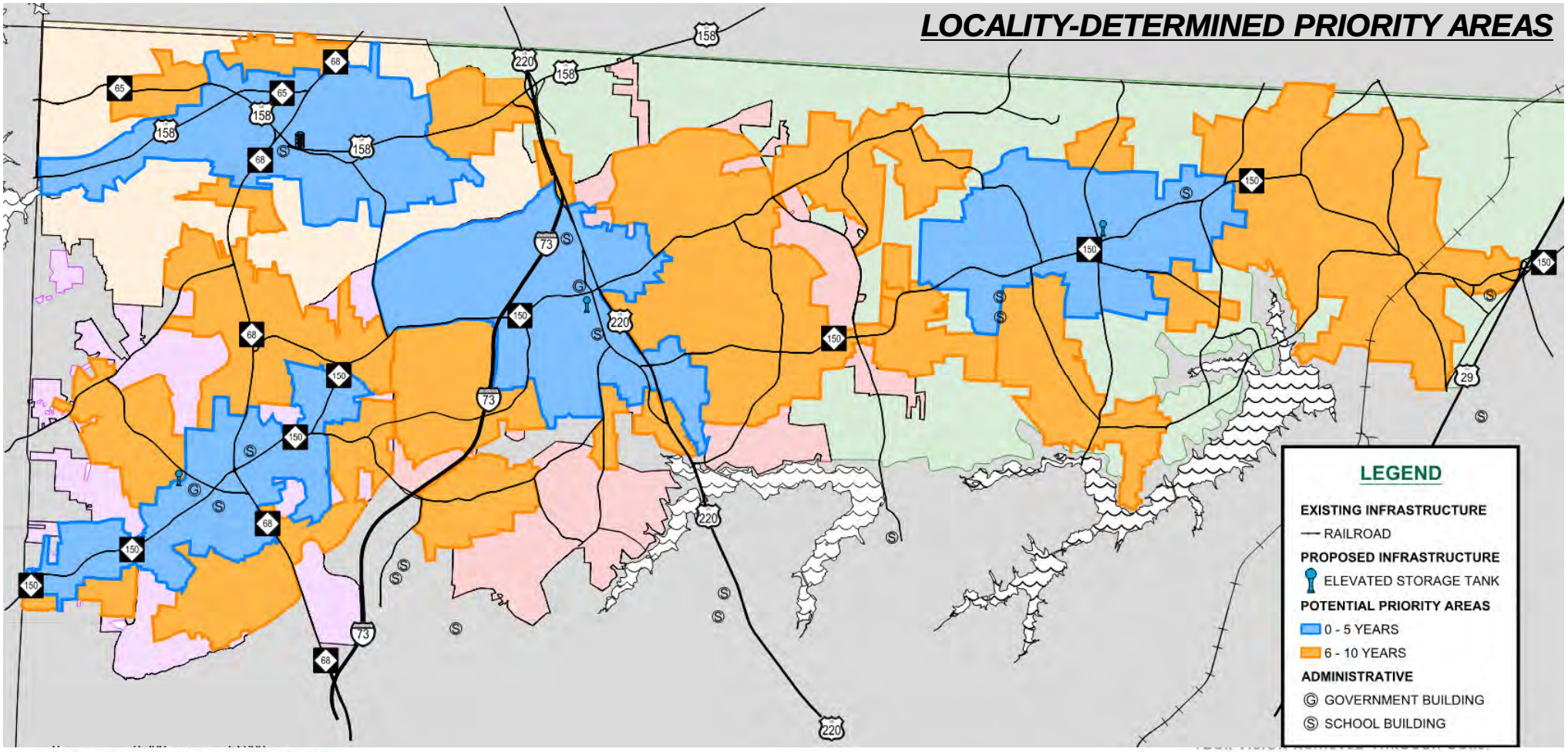
NW Guilford County Water Study

Background Efforts

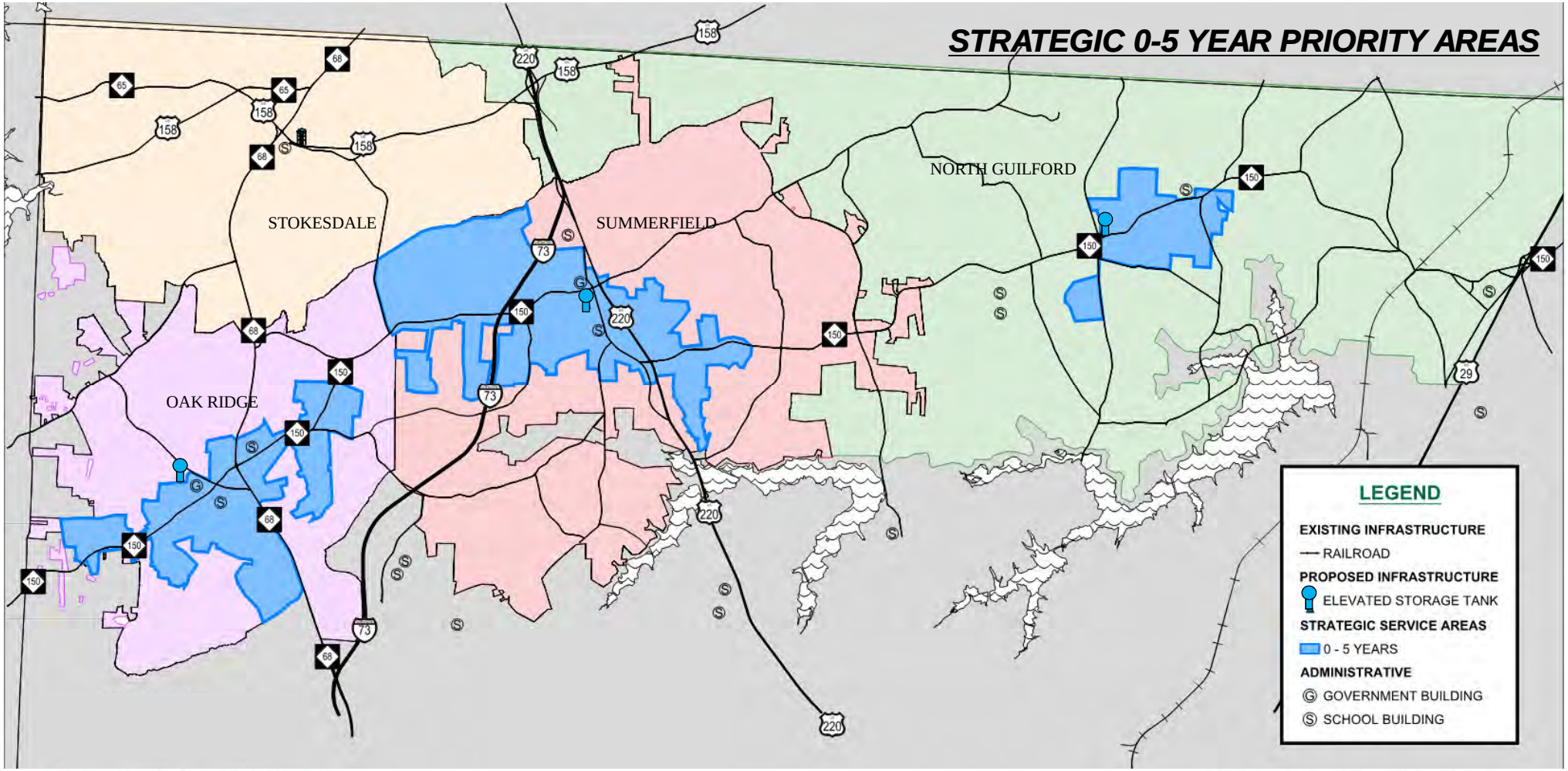
- Discussions for the bulk purchase of finished water:
  - Winston-Salem/Forsyth County
  - Reidsville
  - Greensboro
  - Piedmont Triad Regional Water Authority
- Performed preliminary groundwater availability analysis
- Met with each locality to identify service area priorities
- Developed distribution system hydraulic model

TIMMONS GROUP
YOUR VISION ACHIEVED THROUGH OURS.

NW Guilford County Water Study



NW Guilford County Water Study



NW Guilford County Water Study

Strategic 0-5 Year Priority Areas

N. Guilford Subdivisions

Beacon Hill
Triple Lakes
Moorefield Acres
Stonewood
Magnolia Estates
Oak Grove Forest
Mitchell's Landing
Willow Hills
Church Meadows
Whitestone

Summerfield Subdivisions

Whispering Pines
Highfill
Elmhurst Estates
Summerwoods
Morehampton Place
Elmhurst Estates 2
The Vineyards at Summerfield
Rayle Heights
Somerset
Henson Farms
Armfield Phase 2
Tuscany at Henson Meadows
Auburndale
Wilson Farms
Henson Forest
Armfield
Whitaker Farms
Frog's Leap
Birkhaven

Oak Ridge Subdivisions

Dunbar
Whitaker Estates
Ashton Park
Oak Ridge Lake
Stonehenge
Fox Glen
Bugle Run
Fairview Acres
Foxbury Meadows
Willard Oaks
Merriman Estates & Billet Place
Twelve Oaks
Stafford Place
Oakridge Plantation
Linville Estates
Old Mill Homesteads
Estates at Oak Ridge Lake (Phase I)
Staffordshire
Northwest Valley

NW Guilford County Water Study

Water Supply Sources

- Two Primary Supply Scenarios:
  - **Supply Scenario 1 (SS1)**
    - Primarily groundwater for the first 5 years (except for Stokesdale)
    - Transitioning to 50/50 split groundwater/purchased water after year ten
  - **Supply Scenario 2 (SS2)**
    - Purchased water only
      - Requires connection to Reidsville distribution system immediately

TIMMONS GROUP
YOUR VISION ACHIEVED THROUGH OURS.

NW Guilford County Water Study

Engineering Approach

- Identify priority areas
- Identify utility corridors
- Estimate water demands
- Develop hydraulic model to determine infrastructure size and special considerations (pressure zones, pumps, etc.)
- Estimate infrastructure capital and O&M costs
- Estimate water rates to customers

TIMMONS GROUP
YOUR VISION ACHIEVED THROUGH OURS.

NW Guilford County Water Study

Water Model Development

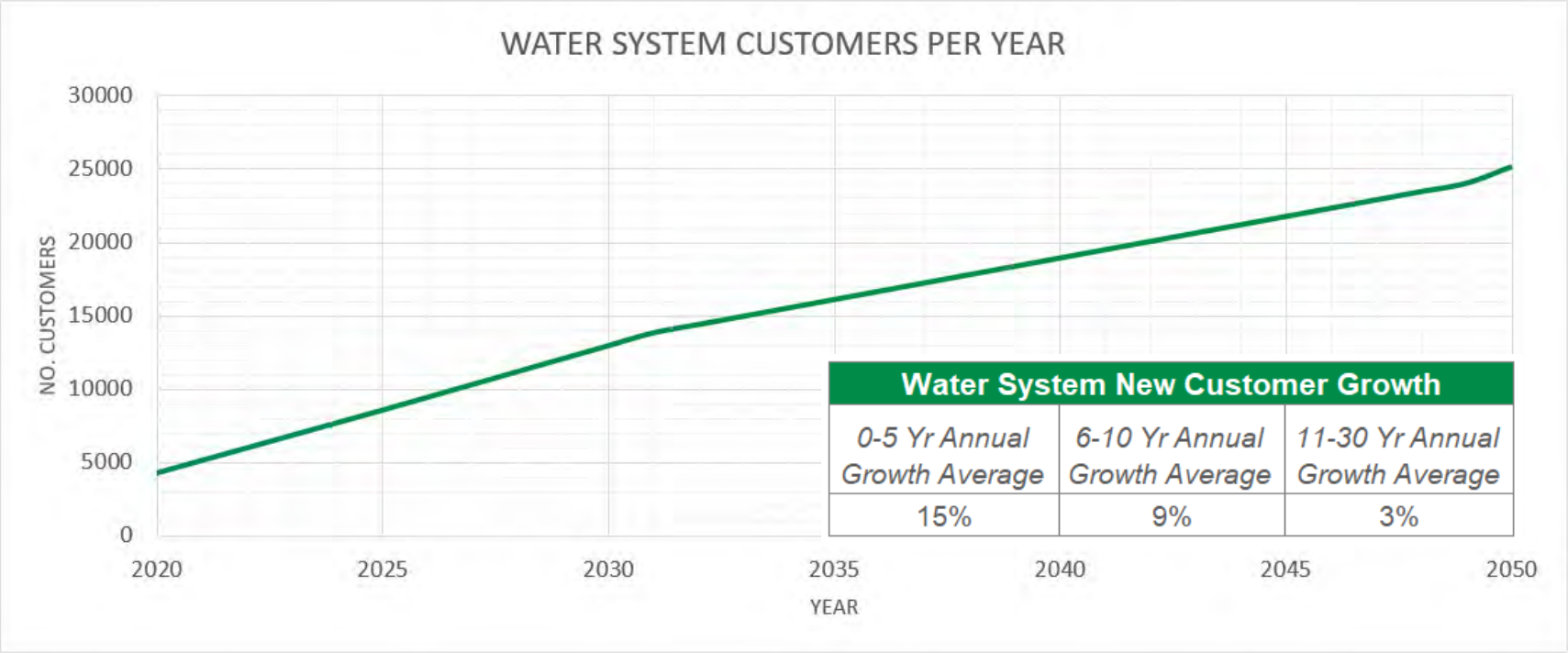
- Demand Projections:
  - Parcel counts for developed land
  - Area and zoning classifications for undeveloped land:
    - Assumed Flow Factors:
      - Residential: 200 gal/day (GPD) per acre
      - Commercial: 300 GPD/ac.
      - Industrial: 500 GPD/ac.

- ***All land zoned Agricultural was assumed to remain on private well systems***

TIMMONS GROUP
YOUR VISION ACHIEVED THROUGH OURS.

NW Guilford County Water Study

Water System New Customer Projections



Water System New Customer Growth		
0-5 Yr Annual Growth Average	*6-10 Yr Annual Growth Average*	*11-30 Yr Annual Growth Average*
15%	9%	3%

TIMMONS GROUP
YOUR VISION ACHIEVED THROUGH OURS.

NW Guilford County Water Study

Domestic Water Demand Projections

Locality	5 year Total Projected Water Demand			10 year Total Projected Water Demand			30 year Total Projected Water Demand		
	GPD	GPM	ERC	GPD	GPM	ERC	GPD	GPM	ERC
Oak Ridge	616,200	427.9	3,081	790,000	548.6	3,950	1,081,429	751.0	5,407
Stokesdale	176,400	122.5	882	290,180	201.5	1,451	725,123	503.6	3,626
Summerfield	730,800	507.5	3,654	940,495	653.1	4,702	1,450,030	1,007.0	7,250
North Guilford	189,800	131.8	949	570,220	396.0	2,851	1,773,305	1,231.5	8,867
TOTAL	1,713,200	1,189.7	8,566	2,590,895	1,799.2	12,954	5,029,887	3,493.0	25,149

ERC = Equivalent Residential Connection
1 ERC = 200 GPD (assumed)

TIMMONS GROUP
YOUR VISION ACHIEVED THROUGH OURS.

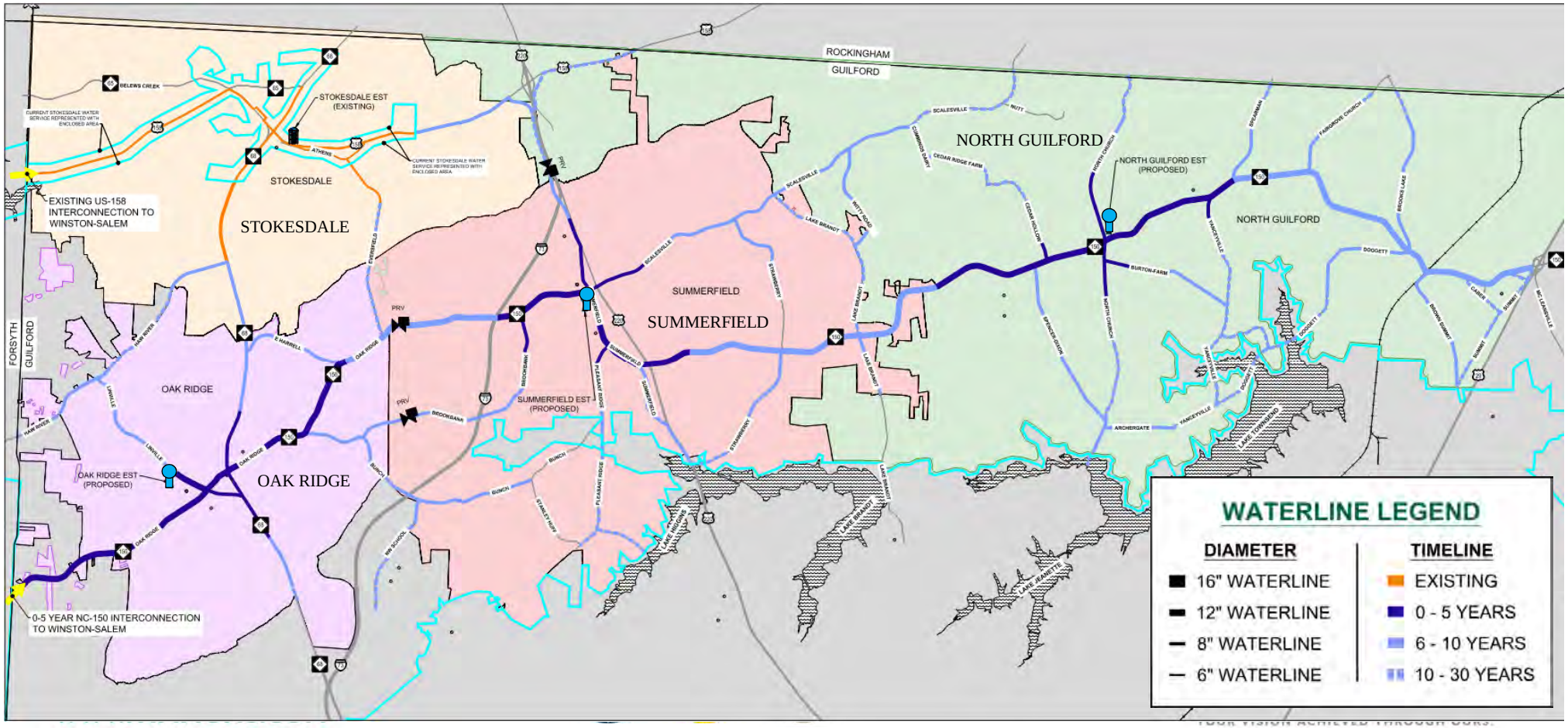
NW Guilford County Water Study

Elevated Storage and Utility Corridors

- Elevated Storage Tanks
  - One at central locations within 0-5-yr priority areas
    - Stokesdale: ***Existing 300k gallon tank***
    - Oak Ridge: New 750,000 gal
    - Summerfield: New 750,000 gal
    - Guilford Co.: New 1,000,000 gal
- Primary utility corridor
  - 16-inch main along SR-150
    - SS1 – Installed only within priority areas
    - SS2 – Full installation along SR-150 to connect all storage tanks

TIMMONS GROUP
YOUR VISION ACHIEVED THROUGH OURS.

NW Guilford County Water Study



NW Guilford County Water Study

Financial Analysis

- Estimated Infrastructure Cost:

0-5 Year

- SS1: $52.5M (Groundwater/Purchased Water)
- SS2: $58.3M (Purchased Water Only)

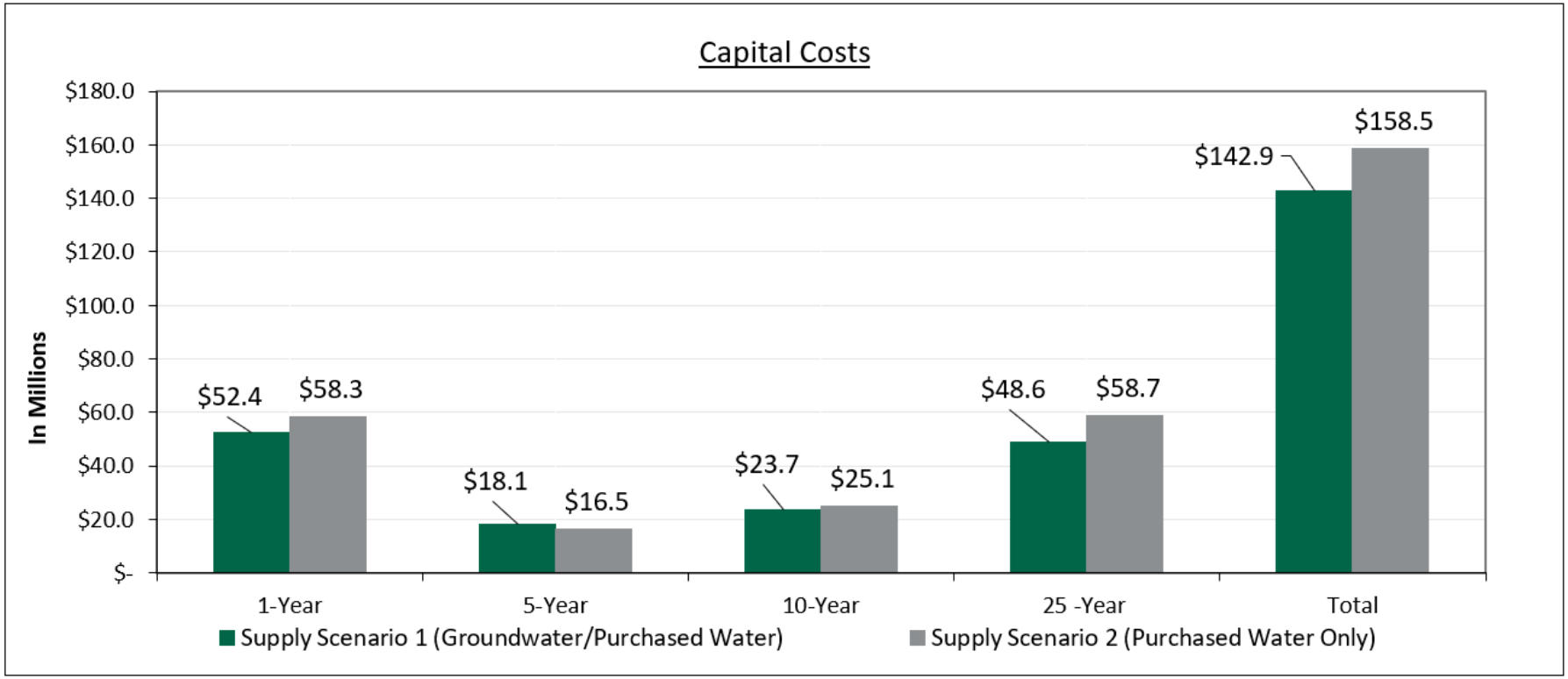
6-10 year cost

- Approximately half of the initial capital expense, split into to rounds of funding*

Actual infrastructure costs may be more, but this analysis assumes that developers will equally split the infrastructure costs after year five

TIMMONS GROUP
YOUR VISION ACHIEVED THROUGH OURS.

NW Guilford County Water Study



TIMMONS GROUP
YOUR VISION ACHIEVED THROUGH OURS.

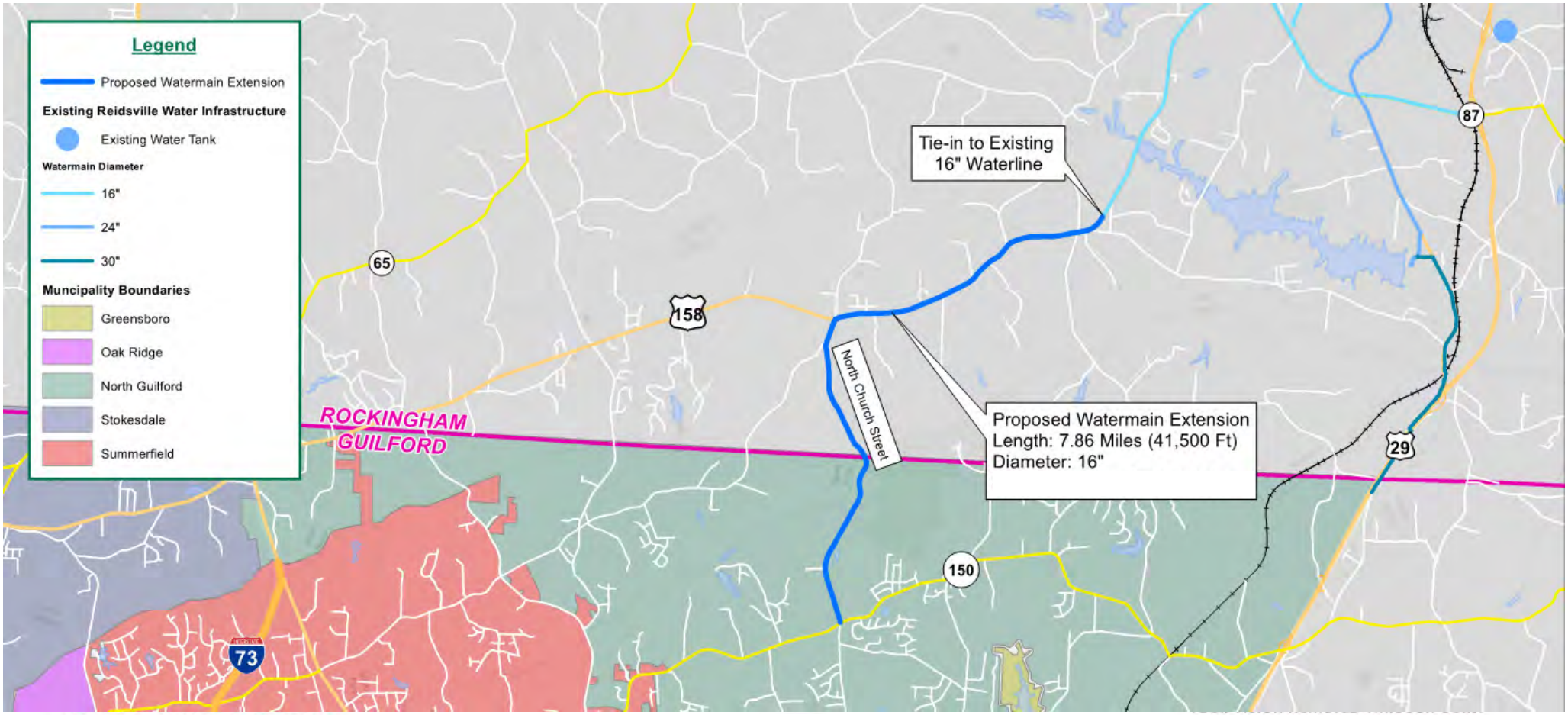
NW Guilford County Water Study

Financial Analysis

- **Potential Bulk Sale Water Rates:**
  - Winston-Salem/Forsyth County – currently $5.65 per kgal
  - Reidsville – estimated to be near $3.00 per kgal
  - Greensboro – not favorable to sale of water
  - Piedmont Triad Regional Water Authority – not favorable

TIMMONS GROUP
YOUR VISION ACHIEVED THROUGH OURS.

NW Guilford County Water Study



NW Guilford County Water Study

Financial Analysis

- **Funding Assumption**
  - Traditional Loans or Bond Sales
    - Loan Terms: 25-year financing
    - Interest Rate: 4.5%

- **Capital Costs**
  - Inflated at 2.5% annually

TIMMONS GROUP
YOUR VISION ACHIEVED THROUGH OURS.

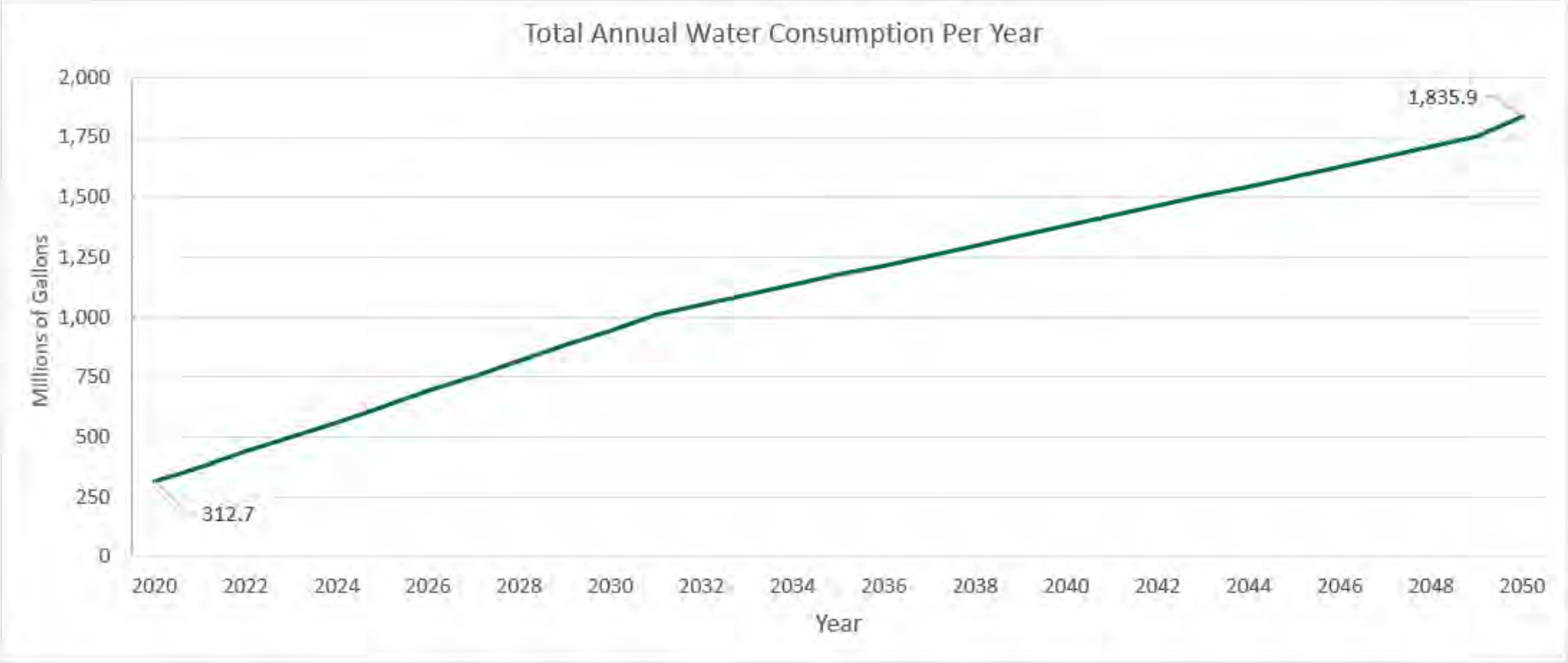
NW Guilford County Water Study

Financial Analysis

- **Distribution costs** – personnel to operate/maintain distribution system and capital outlay, escalated by 2.5% per year
- **Pumping and chemical costs** – pumping and treatment chemical costs, escalated by 2.5% per year
- **Purchased water costs** – Approximate Reidsville bulk water rate of $3 per kgal, escalated by 3% per year
- **Administrative Costs** – used Stokesdale administrative water budget as a proxy and escalated by 2.5% per year
- **Billing, Collection, Meter Reading, Customer Service Costs** – personnel to read meters and perform customer service plus per bill cost, escalated by 2.5% per year

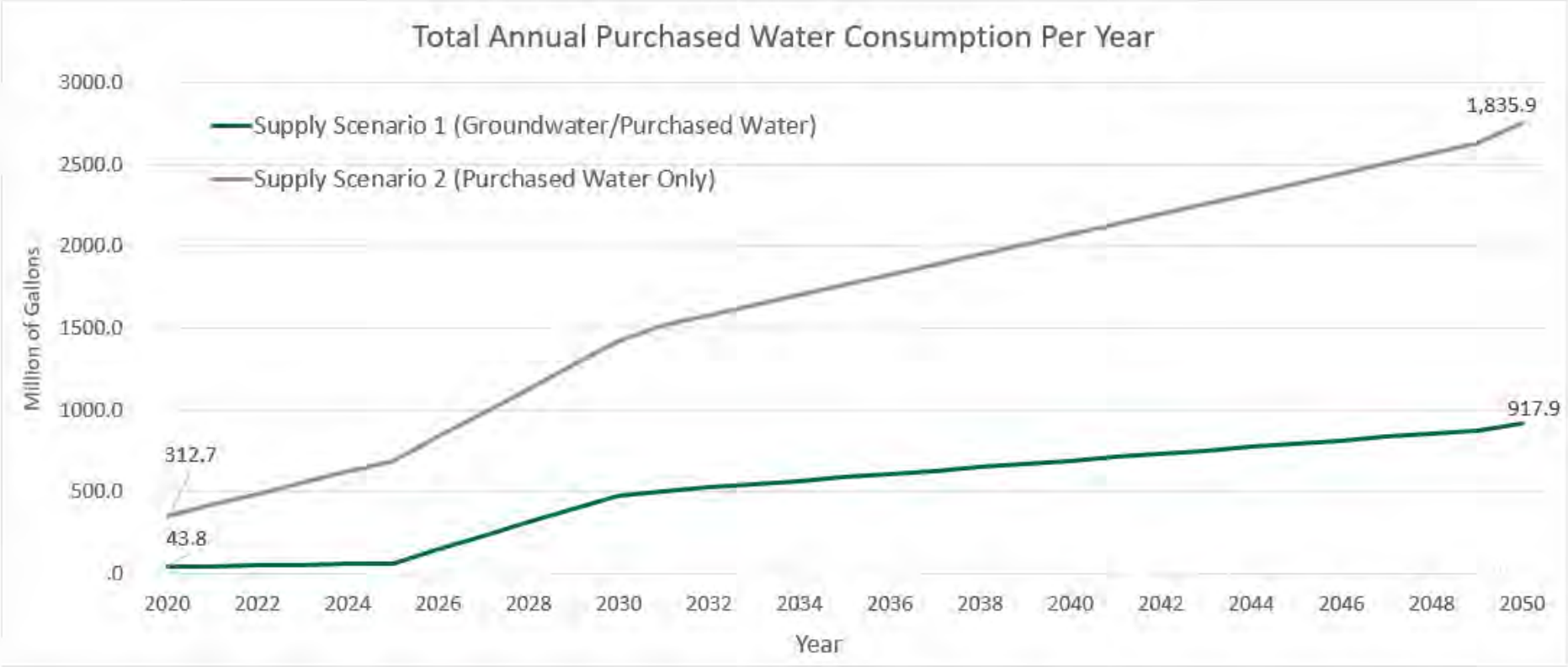
TIMMONS GROUP
YOUR VISION ACHIEVED THROUGH OURS.

NW Guilford County Water Study



TIMMONS GROUP
YOUR VISION ACHIEVED THROUGH OURS.

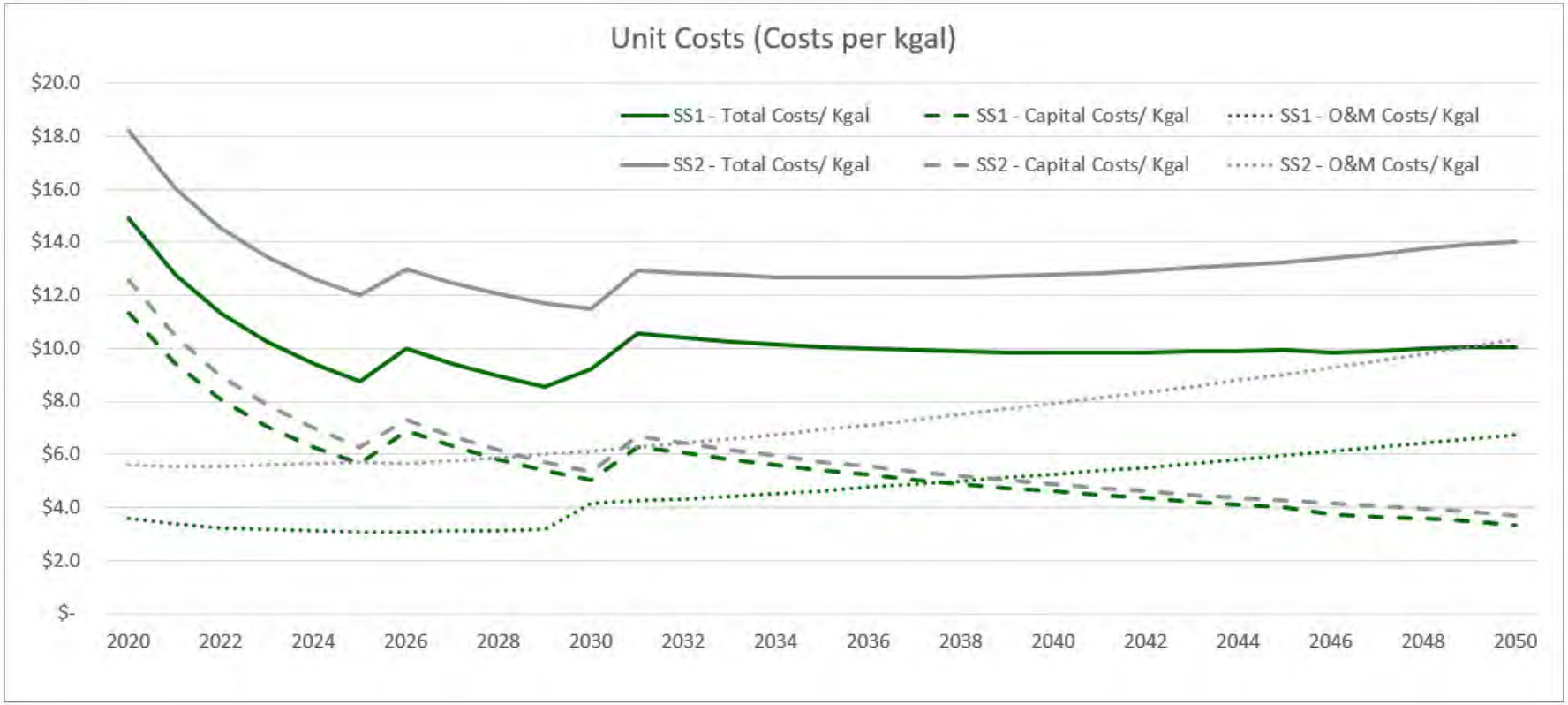
NW Guilford County Water Study



TIMMONS GROUP
YOUR VISION ACHIEVED THROUGH OURS.

NW Guilford County Water Study

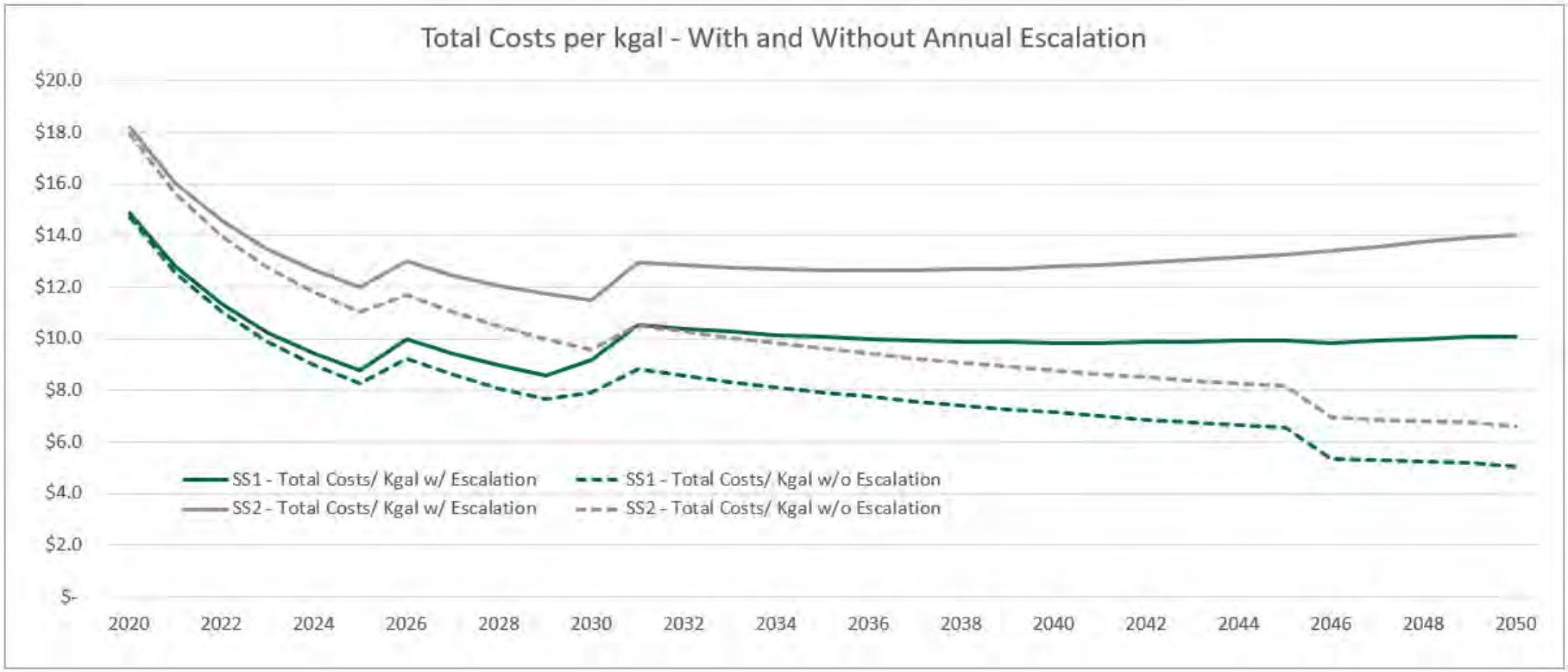
SS1 = Groundwater/Purchased Water
SS2 = Purchased Water Only



TIMMONS GROUP
YOUR VISION ACHIEVED THROUGH OURS.

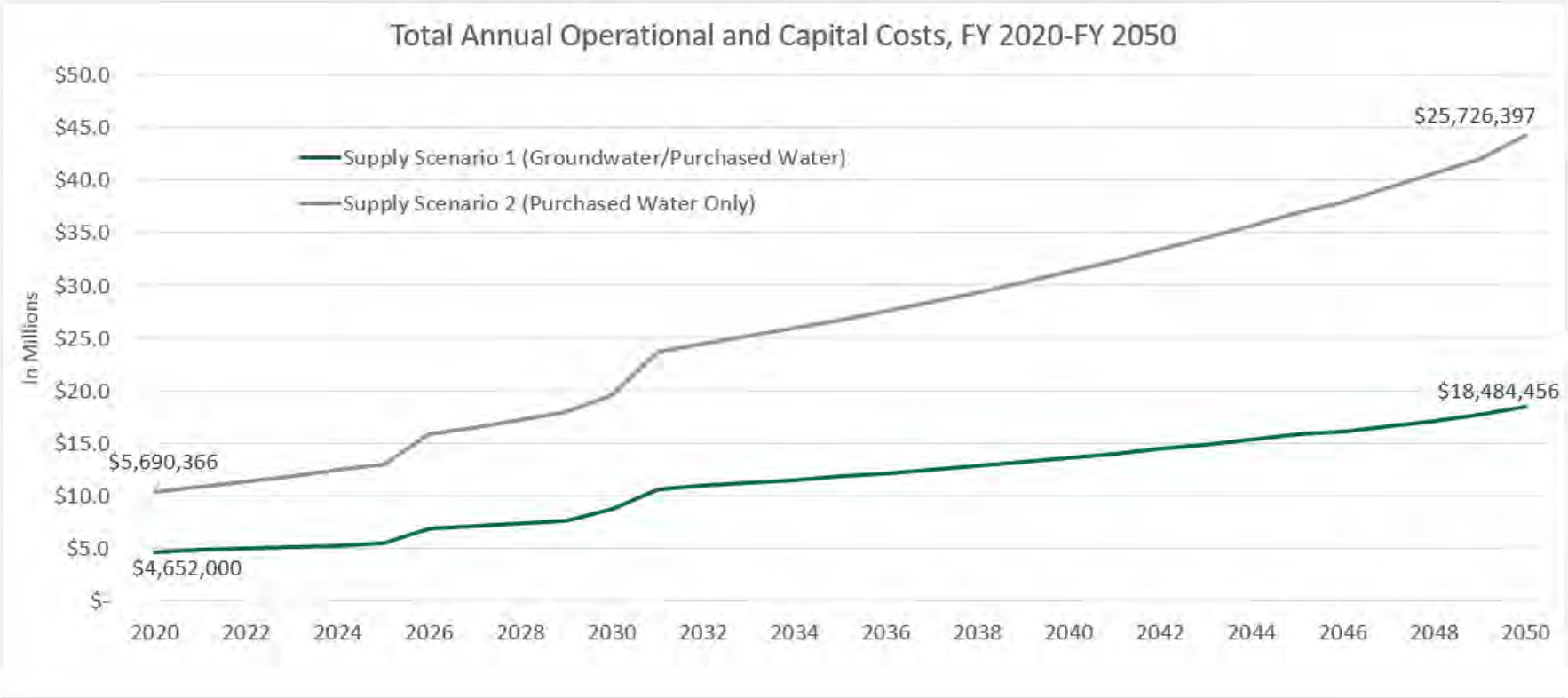
NW Guilford County Water Study

SS1 = Groundwater/Purchased Water
SS2 = Purchased Water Only



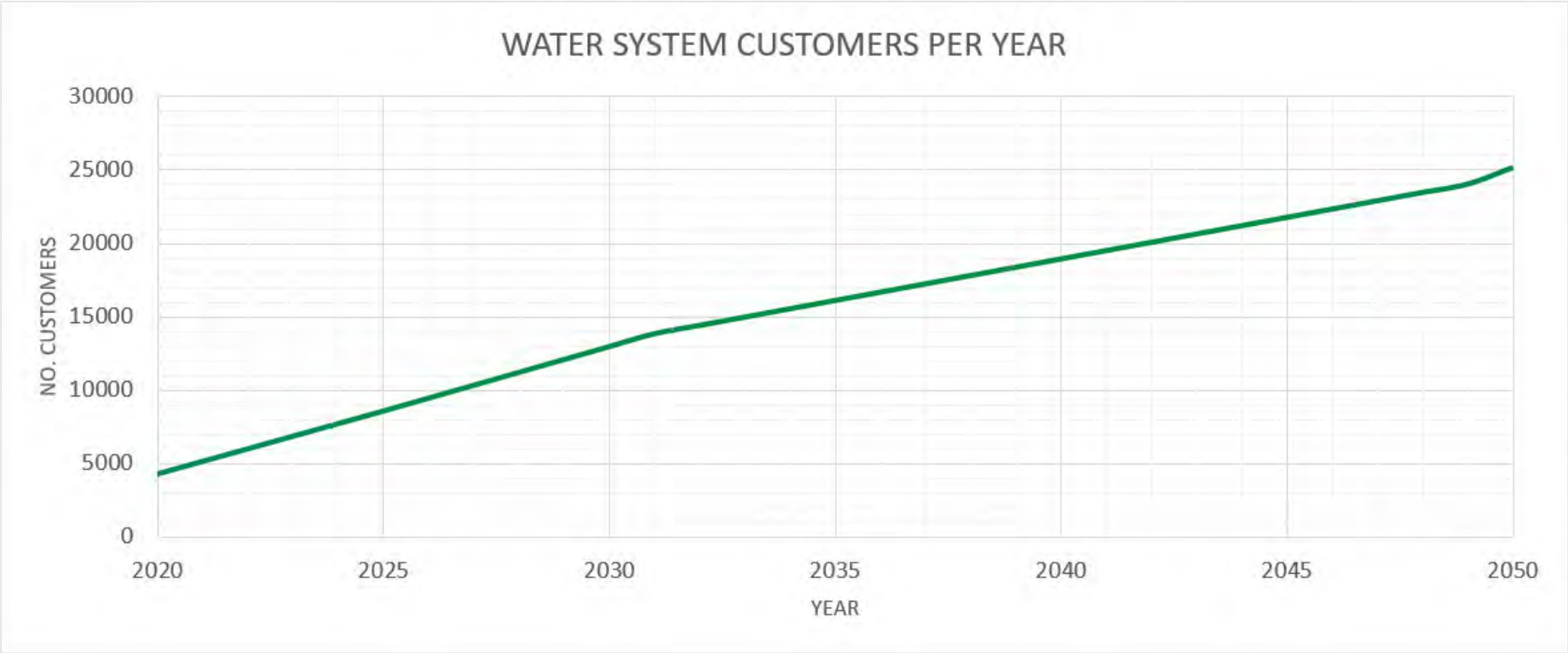
TIMMONS GROUP
YOUR VISION ACHIEVED THROUGH OURS.

NW Guilford County Water Study



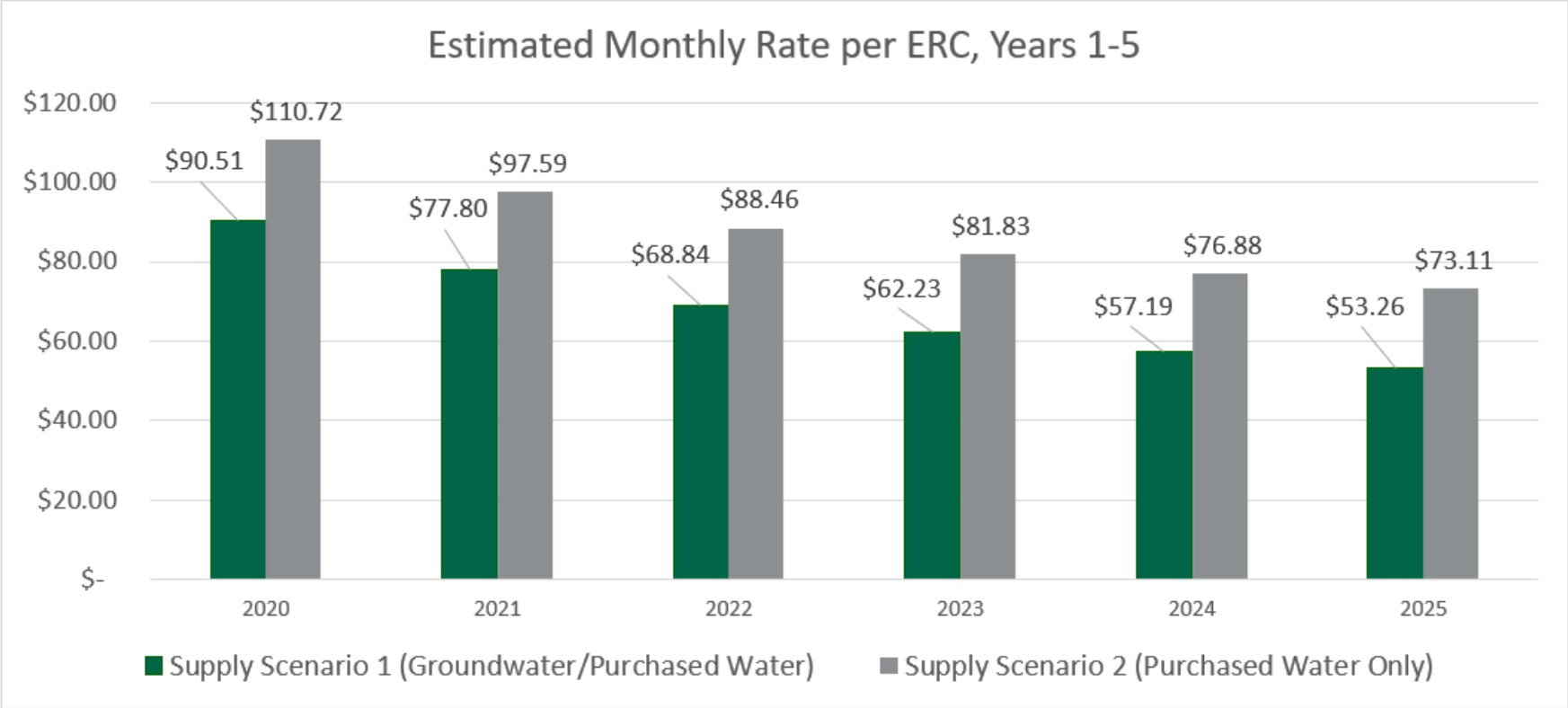
TIMMONS GROUP
YOUR VISION ACHIEVED THROUGH OURS.

NW Guilford County Water Study



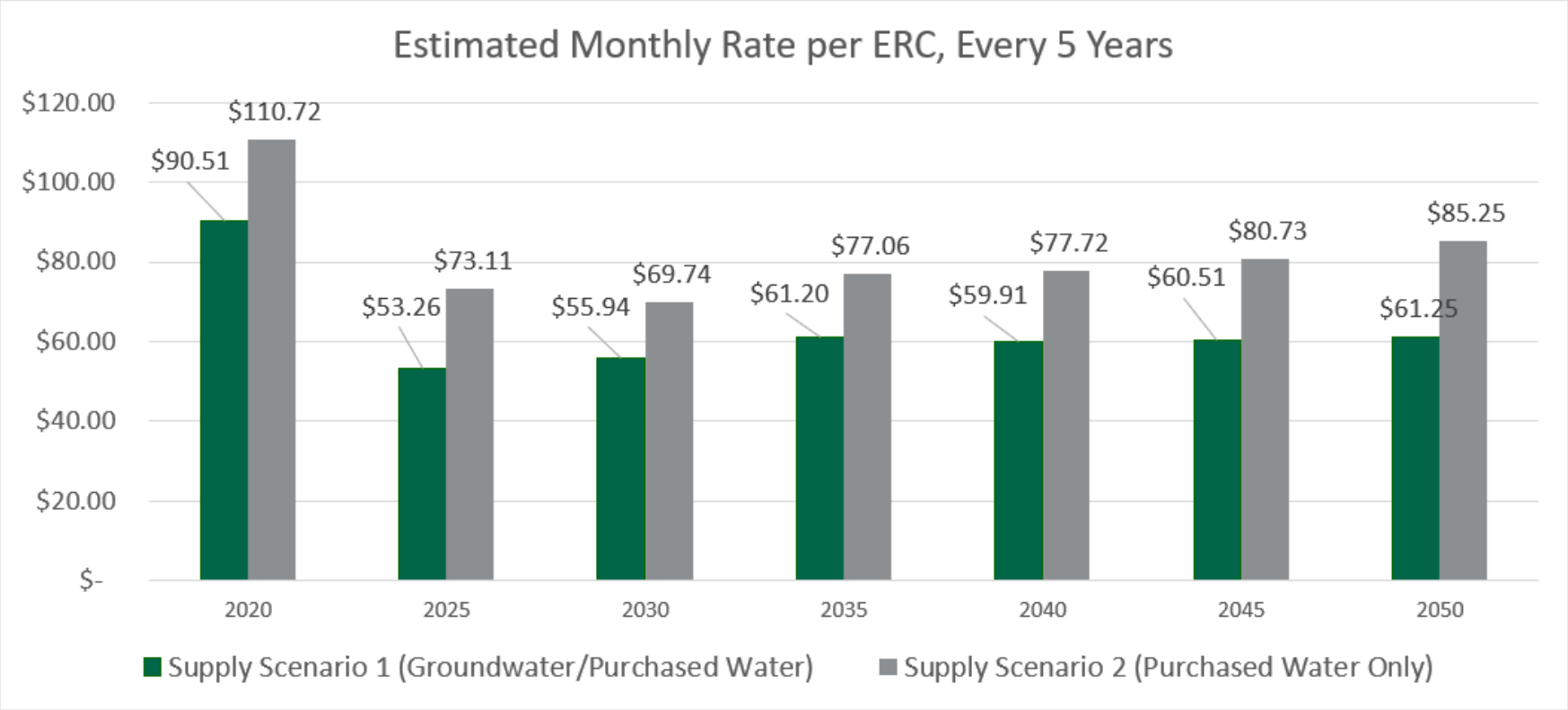
TIMMONS GROUP
YOUR VISION ACHIEVED THROUGH OURS.

NW Guilford County Water Study



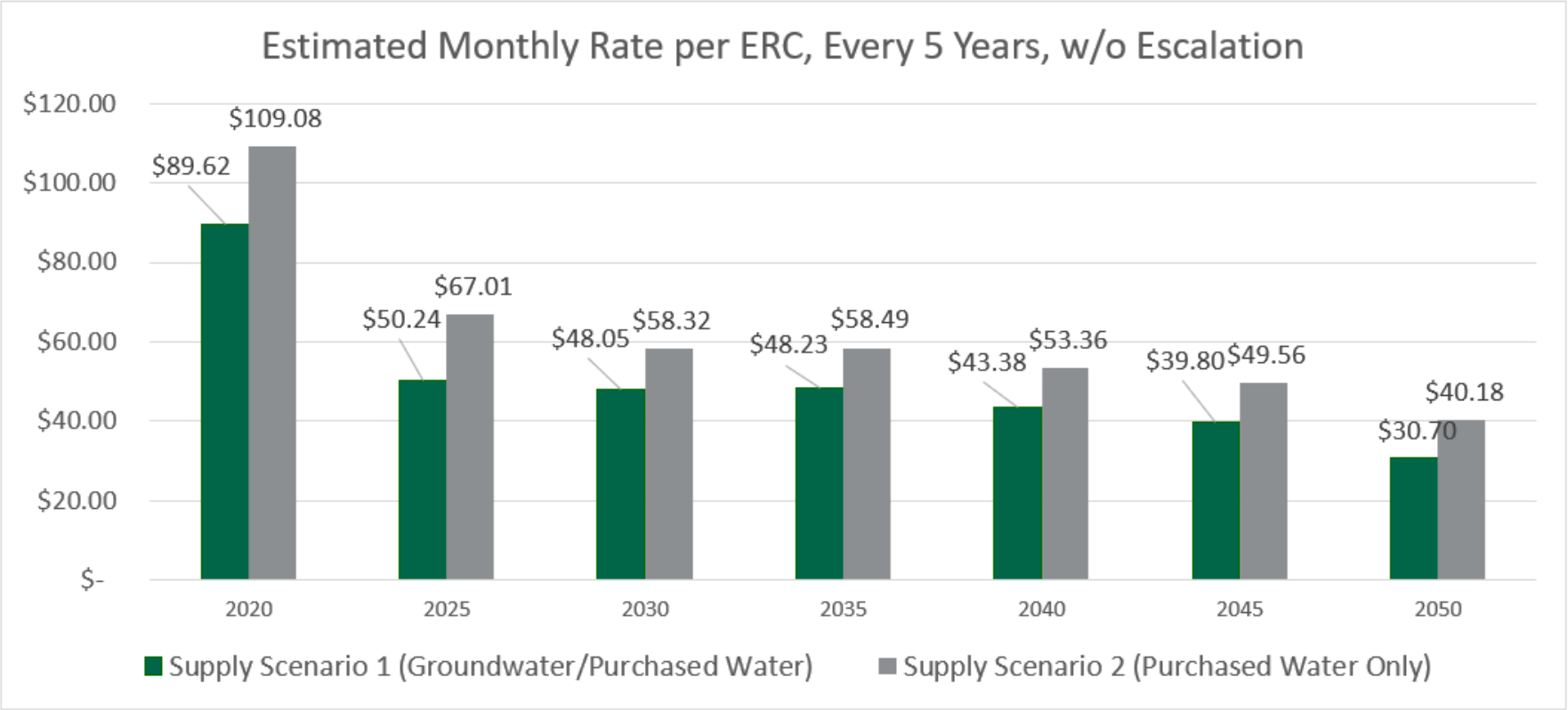
TIMMONS GROUP
YOUR VISION ACHIEVED THROUGH OURS.

NW Guilford County Water Study



TIMMONS GROUP
YOUR VISION ACHIEVED THROUGH OURS.

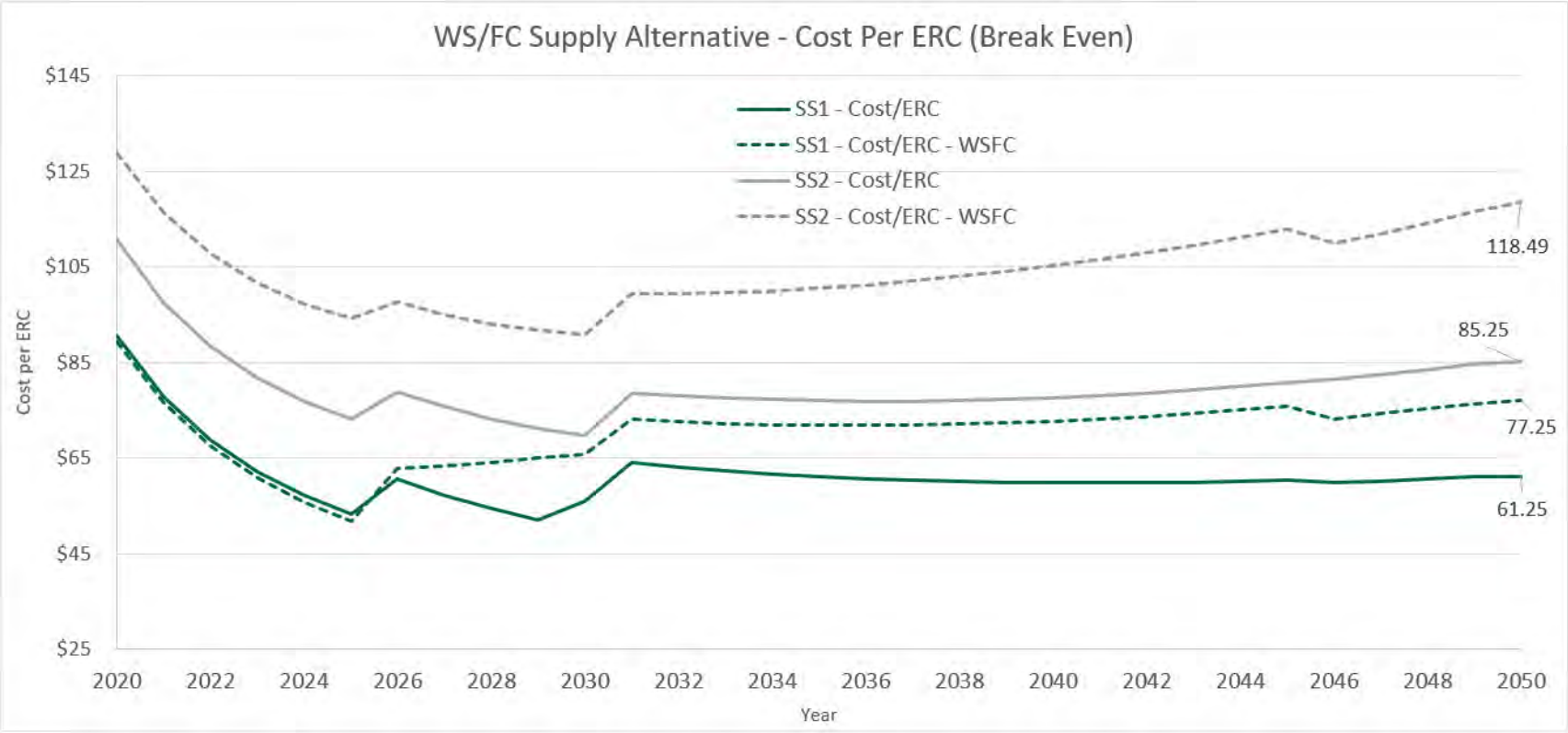
NW Guilford County Water Study



TIMMONS GROUP
YOUR VISION ACHIEVED THROUGH OURS.

NW Guilford County Water Study

SS1 = Groundwater/Purchased Water
SS2 = Purchased Water Only



TIMMONS GROUP
YOUR VISION ACHIEVED THROUGH OURS.

NW Guilford County Water Study

Water System Governance Summary

Metropolitan Water Districts and Metropolitan Water and Sewer Authorities are both “special purpose” local governments with their own governing boards.

- ***Districts*** are authorized by NCGS Chapter 162A, Article 4.
- ***Authorities*** are authorized by NCGS Chapter 162A, Article 1.

NW Guilford County Water Study

Water System Governance Summary

Districts and ***Authorities*** have many of the same powers, including—property ownership, employment of staff, use of eminent domain (condemnation), contracts (private and governmental), accept grants, take legal action, make special assessments, adopt ordinances regarding system, require connection to system.

NW Guilford County Water Study

Water System Governance Summary

Organization

- ***Districts*** are created by act of Board of County Commissioners
  - PLGs and unincorporated areas may petition
  - BOC notifies Dept of Environmental Quality
  - DEQ adopts resolution establishing district

NW Guilford County Water Study

Water System Governance Summary

Organization

- ***Authorities*** are created by the participating local governments
  - Each PLG adopts a resolution (public hearing required)
  - Send resolutions to Secretary of State
  - SOS issues certificate of incorporation

NW Guilford County Water Study

Water System Governance Summary

Governance

***Districts*:** Structure of governing boards is rigid; based on population

Authorities: Some flexibility in membership on governing board; initial representation determined by agreement

NW Guilford County Water Study

Water System Governance Summary

Finance

Districts may issue revenue bonds and general obligation bonds

- May levy and collect taxes

Authorities may issue only revenue bonds

Both can do Certificates of Participation

NW Guilford County Water Study

Water System Governance Summary

Districts have more robust financial capability

Authorities have more autonomy and more organizational and administrative flexibility

NW Guilford County Water Study

Recommended Next Steps

- Geophysical Groundwater Investigation to confirm groundwater availability and anticipated well yields
- Preliminary Engineering Report with NCDEQ
- Obtain Locality Participation Commitments and Determine Governance Structure
- Engagement of Legal and Financial Consultation

TIMMONS GROUP
YOUR VISION ACHIEVED THROUGH OURS.

NW Guilford County Water Study

Acknowledgements

Skip Green (Funding)

RAFTELIS

GOLDER

McGUIRE WOOD & BISSETTE
ASHEVILLE, NC
LAW FIRM

TUGGLE DUGGINS
ATTORNEYS AT LAW

TIMMONS GROUP
YOUR VISION ACHIEVED THROUGH OURS.

NW Guilford County Water Study

QUESTIONS

TIMMONS GROUP
YOUR VISION ACHIEVED THROUGH OURS.