2024 Long Range Utility Plan

City of Mebane, North Carolina

Date: July 15, 2024 (revised)

Prepared By:

alley, williams, carmen & king, Inc.
ENGINEERING • ARCHITECTURE • SURVEYING

NORTH CAROLINA
PROFESSIONAL SEAL
15816
ENGINEER
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ENGINEERING • ARCHITECTURE • SURVEYING

June 24, 2024

Mr. Chris Rollins, City Manager
City of Mebane
106 E Washington St.
Mebane, NC 27302

Re: 2024 Long Range Utility Plan

Dear Mr. Rollins,

Alley, Williams, Carmen, and King, Inc. has completed its study of water and wastewater needs for the City of Mebane as provided in the following Long Range Utility Plan (LRUP). The LRUP includes contributions from engineers with Hazen, McGill, and city staff with a planning window from 2024 to 2050.

Hazen Engineers' work includes a review of the Graham-Mebane water supply (treatment and raw water), and the city's water distribution system needs based on the anticipated future water demand of a growing population and expanded service area.

McGill Engineers have provided the vision for the planned and future expansion of the Water Resource Recovery Facility and related phased discharge permitting.

City staff, management, and Council have provided direction and decisions on items that affect the ability to serve current and future economic development and residential growth.

We believe the new LRUP will offer continued guidance on future planning and decision making and we look forward to reviewing the study with you and the Mebane City Council.

Respectfully,

Franz Holt

Franz Holt, P.E.

Mebane City Engineer

President – AWCK, Inc.

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Contents

1. ***Executive Summary***

The 2024 Long Range Utility Plan is a study of the City of Mebane's current and future water and sewer infrastructure needs. The planning of these needs considers:

- Growth within existing service boundaries and an expanded service area.
- Meeting new regulatory requirements.
- Rehabilitating, replacing, and eliminating aging components to the system.
- Providing system reliability to existing service areas.

WATER NEEDS

Mebane's water needs are met daily from the Graham-Mebane Water Plant and Lake and through its water distribution system. The following addresses the current and future needs of each.

A. Graham-Mebane Water Treatment Plant expansion:

Hazen Engineers have modeled the system and determined improvements needed based on projected demands from the 2023 local water supply plans of Graham and Mebane. Hazen recommends starting expansion planning in 2026 and bringing new capacity online in 2036. However, Mebane and Graham reducing peaking factors through water conservation measures (alternating lawn watering days as does Raleigh) could defer expansion planning to 2036 and bringing new online capacity near 2049.

Hazen also reviewed the hydraulic feasibility of buying water from the City of Burlington (a regional water provider). The City of Graham currently buys water from Burlington through two emergency connections. According to Hazen, Mebane and Graham buying Burlington water at 2.5 MGD is hydraulically feasible and along with water conservation could defer expansion of the WTP for decades.

B. Graham-Mebane Lake (raw water supply expansion):

A new safe yield study has been completed by Hazen (included in the appendices). They determined a 50-year safe yield withdrawal from the lake at 9.4 MGD. Based on future water demands of Mebane and Graham raw water supply planning should start in 2041 (80% of safe yield) with added online supply needed by 2055. Based on initial review by AWCK, expanding the raw water supply appears to be feasible. Alternatively, Mebane and Graham buying water from Burlington at 2.5 MGD could delay the need for additional water supply beyond 2070.

C. *Water Storage:* A new Mebane 1 million gallon (MG) elevated water storage tank is currently under construction and anticipated to be operational in 2025. Once online Mebane's total water storage will be 4.3 MG with the 3.0 MG Clearwell storage at the WTP and 0.3 MG elevated water storage tank at 11th Street. This total storage exceeds the NCDEQ- Public Water Supply half day demand storage requirements to an expected future demand beyond 2050.

D. *Water Distribution System*: Additional transmission water main improvements have been identified by Hazen (described further in the report). The need for these improvements is based on future maximum day demand increases. The 10-year capital improvements plan includes various 12-inch water extensions to increase system reliability with the completion of looped mains. The plan also includes line rehabilitation of older cast iron mains, and the elimination of galvanized small water mains with new larger ductile iron pipe water mains. In addition, the city will need to replace water service piping containing lead (current study is underway to determine these services).

E. *Boosted Pressure Zone:* Mebane currently operates as one water pressure zone controlled by the tank overflow elevation of 840 feet and its related operational range. Higher ground elevations in the eastern service area will require boosted water pressure creating a new pressure zone generally just north, south, and east of the Buckhorn Interchange. Booster pump stations will supply desired domestic pressures and eventually fill a future 1.0 MG elevated water storage tank with an approximate overflow elevation of 880 feet.

F. *Extension of Water Distribution System:* New service areas will require the extension of 12-inch water mains along NCDOT roads that are not dead ends. Mebane's water extension policy addresses extending service to existing developed areas not currently served, proposed new development, and economic and community development. Water system development fees will be used to aid in funding capital projects that add new capacity to the system including the oversizing of water lines per Mebane's policy.

WASTEWATER NEEDS

Mebane's wastewater needs are met daily from the Water Resource and Recovery Facility (WRRF), the City of Graham's WWTP (Mebane's purchased allocation), and through its collection and pumping system. The following addresses the current and future needs of each.

A. *Mebane's Water Resource Recovery Facility (WRRF):* McGill Engineers have completed the design and permitting of a 1.5 MGD expansion/upgrade of the WRRF with a new treatment capacity to 4.0 MGD from 2.5 MGD. The new plant, expected to be in service in 2026**,** is designed to meet nutrient (nitrogen and phosphorus) limits of the future Jordan Lake Rules and can be expanded to a future capacity of 6.0 MGD. The WRRF expansion/upgrade to 4.0 MGD with the Graham WWTP allocation of 0.75 MGD should meet the wastewater treatment needs post 2050 (dependent on rate of growth).

B. *Wastewater Pump Stations/Force Mains/Gravity Collection Lines:* To meet future system needs, it is expected that the city will complete projects that address wastewater pump station upgrades, the elimination of pump stations, and reroutes of wastewater flows. The 10-year Capital Improvement Plan (CIP) projects are further described in the report.

C. *Extension of wastewater system*: New service areas will require extension of gravity lines, new pump stations and related force mains. Mebane's wastewater extension policy addresses extending service to existing developed areas not currently served, proposed new development, and economic and community development. Wastewater system development fees will be used to aid in the funding of capital projects that add new capacity to the system including oversizing of waterlines per Mebane's policy.

SERVICE AREA

The future service area has been expanded to approximately 51.2 square miles due to interest being shown for Mebane water and sewer service beyond the current boundaries. In general, the existing service area abuts future limits with the Town of Haw River, City of Graham, Town of Swepsonville, and the Graham-Mebane Lake to the west and Buckhorn Road I-40/85 Interchange to the east. Mebane has seen an increase in growth and interest in service eastward (north and south) which is captured with the expanded service area.

WATER DEMAND & WASTEWATER FLOW PROJECTIONS

Future water demand is based on the current demand and anticipated growth (residential and non-residential) of both Mebane and Graham. Graham also sells water to the Town of Green Level and the Town of Swepsonville. It is expected that by 2050 the average daily treated water pumped to Mebane will be 4.0 MGD and 4.0 MGD to Graham totaling 8.0 MGD.

Future wastewaters use projections are based on current use and anticipated growth with a high demand from residential development. Mebane has also seen a resurgence in industrial growth. The new industrial users to date are mostly distribution and warehousing using less water. Commercial growth is also expected to follow the residential growth. In addition, Mebane is the provider of wastewater to the unincorporated Efland Community.

When making future wastewater projections we have assigned an equivalent residential unit (ERU) at 215 gallons per day (gpd). This assigned unit flow is then used as a multiplier for non-residential use. With an anticipated population of 48,200 by 2050 we expect an additional 10,833 ERUs generating wastewater flows up to 4.0 MGD to the Mebane WRRF and Graham WWTP.

SUMMARY AND RECOMMENDED ACTION ITEMS

The City of Mebane is addressing their primary wastewater needs with the expansion of the WRRF to 4.0 MGD. This WRRF expansion with the previous purchase of Graham allocation of 0.75 MGD will serve Mebane post 2050.

The City of Graham is currently studying how the WTP can be expanded to address future demand. In addition, studies have begun for the possible expansion of the Lake. As an alternative to expanding the treatment plant and raw water supply, we also recommend continued study of the possible purchase of Burlington water. Others purchasing water from Burlington include the City of Greensboro, the Towns of Whitsett, Gibsonville, Elon, Ossipee, Haw River, Village of Alamance, and Orange-Alamance Water System, Inc.. The City of Graham also purchases water from Burlington on an emergency basis. While infrastructure is in place through two emergency connections, additional improvements will be required in Graham's distribution system (with Mebane assistance) to provide daily water purchases from Burlington. Buying water from Burlington may defer the need for expansion of the WTP and Supply for decades.

As water and sewer funds are limited, we recommend a ranking of capital improvement projects advancing those that are most critical to Mebane. Water and sewer rates should continue to be reviewed annually and system development fees analyzed every 3 to 5 years. Mebane and Graham should continue applying for grants and State and Federal appropriations that assist with capacity needs, infrastructure analysis, and regulatory review.

In summary, Mebane is in an advantageous position to address their future water and wastewater needs with previous planning and actions taken by Graham and Mebane City Councils.

2. Introduction

In 2016, the City of Mebane (Mebane) completed a study to evaluate near and long-term capital needs of the water distribution system and sewer collection and pumping systems and water/sewer treatment facilities for a growing population by the year 2035. Items that have been realized since adoption are as follows:

- Acquired 0.75 MGD wastewater allocation in the Graham Wastewater Treatment Plant (WWTP).
- Adoption of System Development Fees with updates in 2021 and 2024.
- Byrd's Pump Station (PS) replacement and Farrar Lane PS upgrade/reroute.
- Acceptance of Orange County wastewater improvements and Efland flow.
- Adoption of an Accumulated Paper Flow Policy.
- Renovation of the Water Resource Recovery Facility (WRRF).
- Replaced and rehabilitated water and sewer mains.
- Received new discharge permit for WRRF expansions to 4.0 and 6.0 MGD.
- Construction of a 1 million gallon (MG) elevated water storage tank online 2025.
- Completed the Design/Permitting of the WRRF expansion/upgrade.
- Completed a new safe yield study of the Graham-Mebane Lake.

This new 2024 study addresses water and wastewater needs that will serve Mebane's residential and non-residential growth to 2050 and beyond. Items addressed in this report are as follows:

- Graham-Mebane Water Supply and Treatment.

- Water Distribution and Pumping System.
- Boosted Water Pressure Zone.
- Water Resource Recovery Facility.
- Wastewater Collection and Pumping System.
- Service Area.
- Water Demand Projections.
- Wastewater Flow Projections.
- Extension of the Water and Wastewater Systems.

3. Water

A. Graham-Mebane Water Treatment Plant

Existing Treatment Capacity and Current Water Use - Mebane has 50% ownership in the Graham-Mebane Water Treatment Plant (WTP) located on US Hwy. 70 between east of Haw River and west of Mebane (see Figure 1). The permitted capacity is 12 million gallons per day (MGD) with each city having 6.0 MGD available to serve the respective water demand. The City of Graham (Graham) operates the WTP and is the main water provider to the Town of Green Level, Town of Swepsonville, and City of Mebane.

Last year an average of 5.0 MGD was withdrawn from the lake with a maximum day of 6.2 MGD. Mebane's water demand averaged 2.1 MGD with a maximum day demand of 2.7 MGD.

Future Treatment Capacity Needs - Based on the projected rate of growth from the 2023 Local Water Supply Plans of Mebane and Graham, planning should start in 2026 for an expansion of the WTP to bring new capacity online by 2036.

Deferring expansion to later years can be achieved by reducing peak use through water conservation measures (lawn watering on alternate days as Raleigh does). As future water demand increases the goal would be to reduce the peak use to 140% of the average daily use. Doing so could defer expansion planning to 2036 and bringing new online capacity near 2049.

Mebane and Graham buying Burlington water at 2.5 MGD along with implementing water conservation measures could delay the need for plant expansion by decades.

Other Capital needs (10 year) - Capital needs at WTP include rehabbing the clear well storage and disc filters as well as other identified items.

Future Regulatory Requirements and Study - The EPA has finalized drinking water standards for Polyfluoroalkyl Substances (PFAS) contaminants with maximum contaminant levels (MCLs). The City of Graham has received grant funds for a PFAS study. Graham has also started studies on WTP expansion, filter backwashing, and expansion of the lake.

Figure 1. Graham-Mebane Water Treatment Plant 12.0 MGD

B. Graham-Mebane Lake

Existing Water Supply and Safe Yield - The Graham-Mebane Lake is a WS-II protected water supply watershed on Back Creek. The drainage area of the reservoir is 66 square miles. Graham and Mebane recently completed a new safe yield study of the reservoir for a major draught (50-year). The usable storage at full pool is approximately 2.5 billion gallons. The 50-year safe yield is 9.4 MGD as determined by Hazen.

Future Water Supply Needs – Hazen Engineers project that by 2055 water demand will reach or exceed the 50-year safe yield of 9.4 MGD. Mebane and Graham should start planning for added raw water supply storage (Graham-Mebane Lake) by 2041**.** The ability to expand Graham-Mebane Lake appears to be feasible based on initial review by AWCK.

Alternatively, Mebane and Graham initially buying 1.0 MGD of water from Burlington in 2041 (once 80% of 9.4 MGD safe yield is reached) and increasing to 2.5 MGD in 2049 may defer the need for added water supply post 2070**.**

C. Water Distribution and Storage

Existing System - Mebane has 137 miles of public water lines ranging in size from 2-inch to 24-inch and pumping capacity at the Graham-Mebane WTP of 5.2 MGD. Additionally, the city has elevated and ground water storage as follows:

- 300,000-gallon elevated storage tank at 11th Street.
- 3,000,000-gallon clear well ground storage at the Graham-Mebane WTP.
- New 1-million-gallon elevated Water Storage Tank (online in 2025, see Figure 2)

and connections with other water systems:

- Graham at the WTP and via Burlington (emergency).
- Graham at Senator Ralph Scott parkway (with Mebane pressure drop).
- Orange-Alamance Water System (emergency).

Figure 2. New 1-million-gallon Elevated Water Storage Tank is under construction.

Future System Needs – Improvements to meet maximum day demand and fire flow needs are as follows (see Figure 3):

- 2030 Replace the existing 1800 gpm pump at WTP with a 3,500-gpm pump. *Improvements driven by maximum daily demand needs.*
- 2040 Replace the second existing 1,800 gpm pump at WTP with a 3,500-gpm pump. *Improvements driven by maximum daily demand needs.*
- 2040 Extend 24-inch main along US 70 (Center Street). *Improvements driven by maximum daily demand needs.*
- 2043 Extend16-inch main (1st to 11th). *Improvements driven by fire flow needs.*
- 2043 Extend 12-inch main (9th to Lebanon with connection to Ashbury via York Road). *Improvements driven by fire flow needs.*

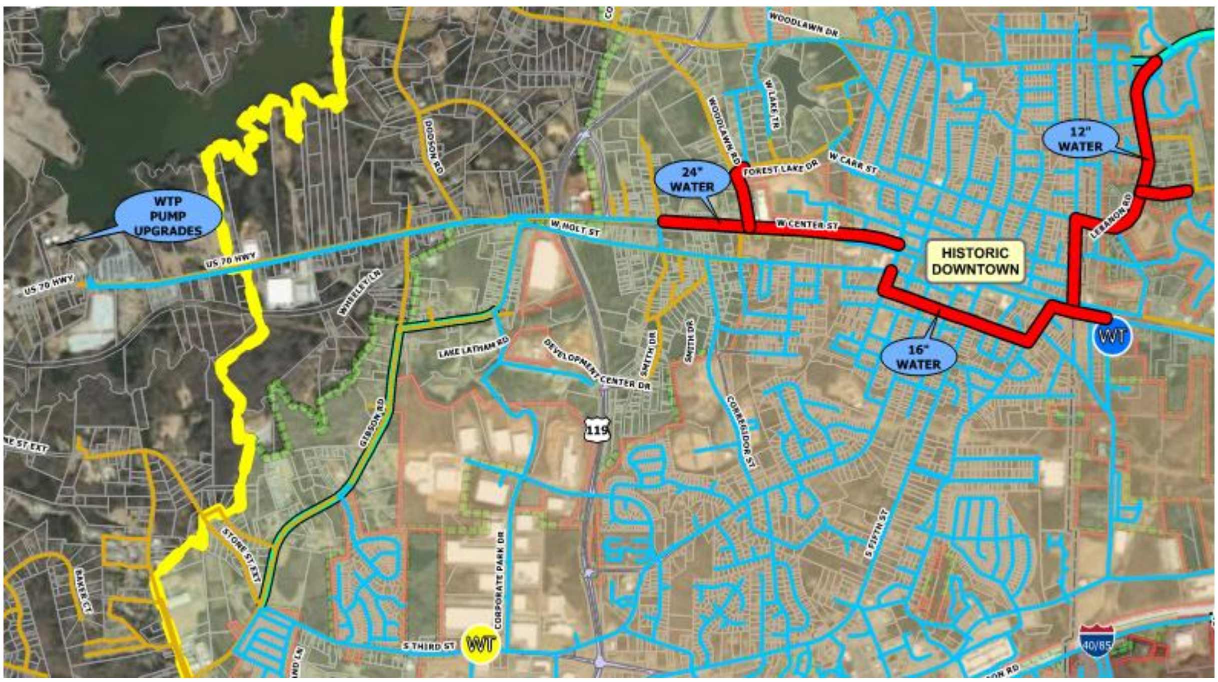


Figure 3. Transmission line and pump requirements to meet future max. day demand.

Mebane's 10-Year plus Water System Capital Improvement Plan (CIP) includes proposed 12-inch water main extensions to complete loops providing redundancy in domestic and fire flows as follows:

- 12-inch Bowman Road to West Ten Road loop to boost fire flows to the Buckhorn Economic Development Zone.
- 12-inch Gibson Road Lake Latham Road from Holt Street to 3rd Street Ext. (development driven).
- 12-inch Development Center Drive to Holt Street (provides redundancy at NCIC).
- The CIP also includes rehabbing older lines, eliminating galvanized water lines, eliminating service lines containing lead, and continuing participation in line

oversizing with development (see Figure 4). These improvements will be public installations as opposed to developer installed.

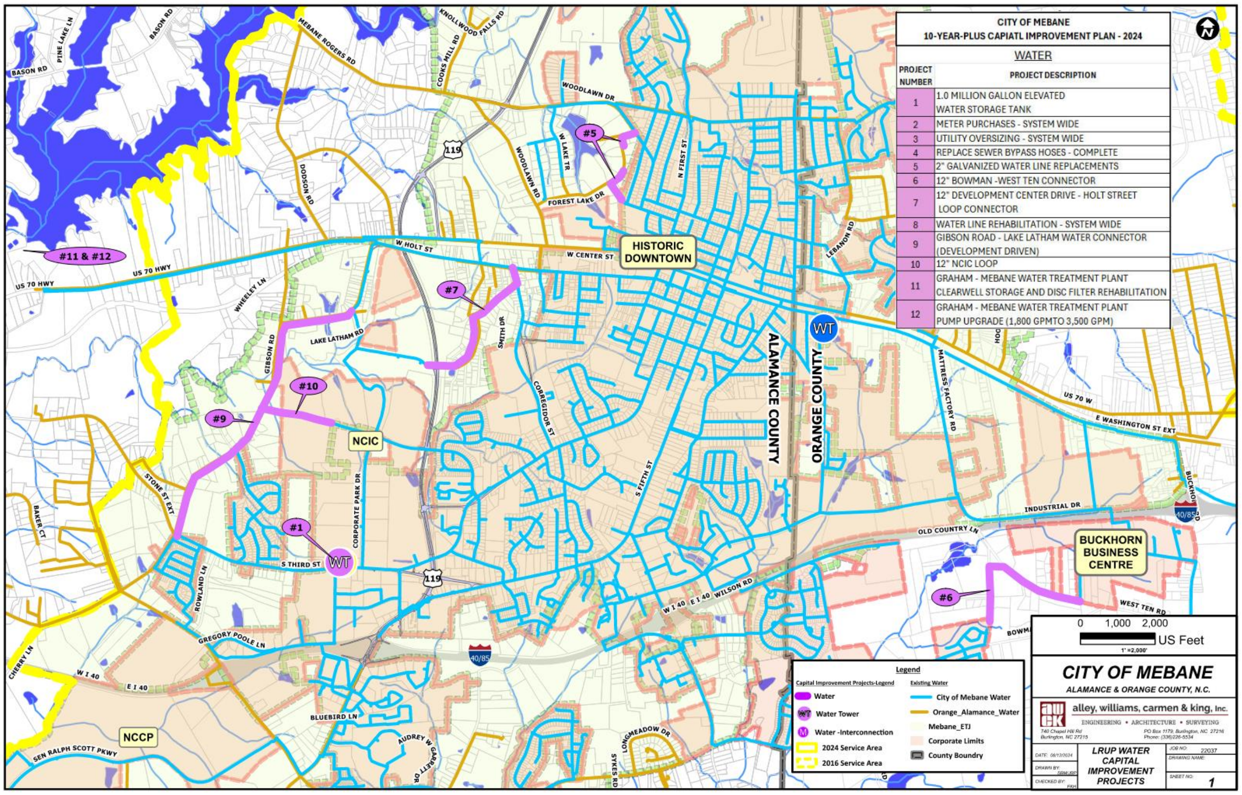


Figure 4. 10-Year Plus CIP Water Improvement Projects.

D. Boosted Pressure Zone

Mebane currently operates as one water pressure zone controlled by the tank overflow elevation of 840 feet. A boosted pressure zone has been identified to serve the higher ground elevations in the Buckhorn Interchange area (north/south/east) which would provide domestic water pressure similarly experienced by most Mebane residents and businesses (see Figure 5).

Residential development may be limited to areas that can be served with adequate domestic pressure and fire flows until the boosted zone is in operation. This could include limiting development to single story homes or if multi-family having an individual pump system boosting water pressure. Industrial Development can continue without a boosted zone as fire flows are adequate with fire pumps in most facilities as well as ground storage at others.

Two booster pump stations with boundary check valves have been identified at or near specific locations. A 1.5 MGD booster pump station near 6800 Washington Street is proposed for the southern area and a 0.8 MGD booster pump station near 6411 Lebanon Road for the northern area. The booster pump stations would be designed to fill a future 1.0-million-gallon post 2050 elevated water storage tank with an approximate overflow elevation of 880 feet. Water transmission main improvements and pump replacements at the WTP are required prior to providing a new boosted pressure zone.

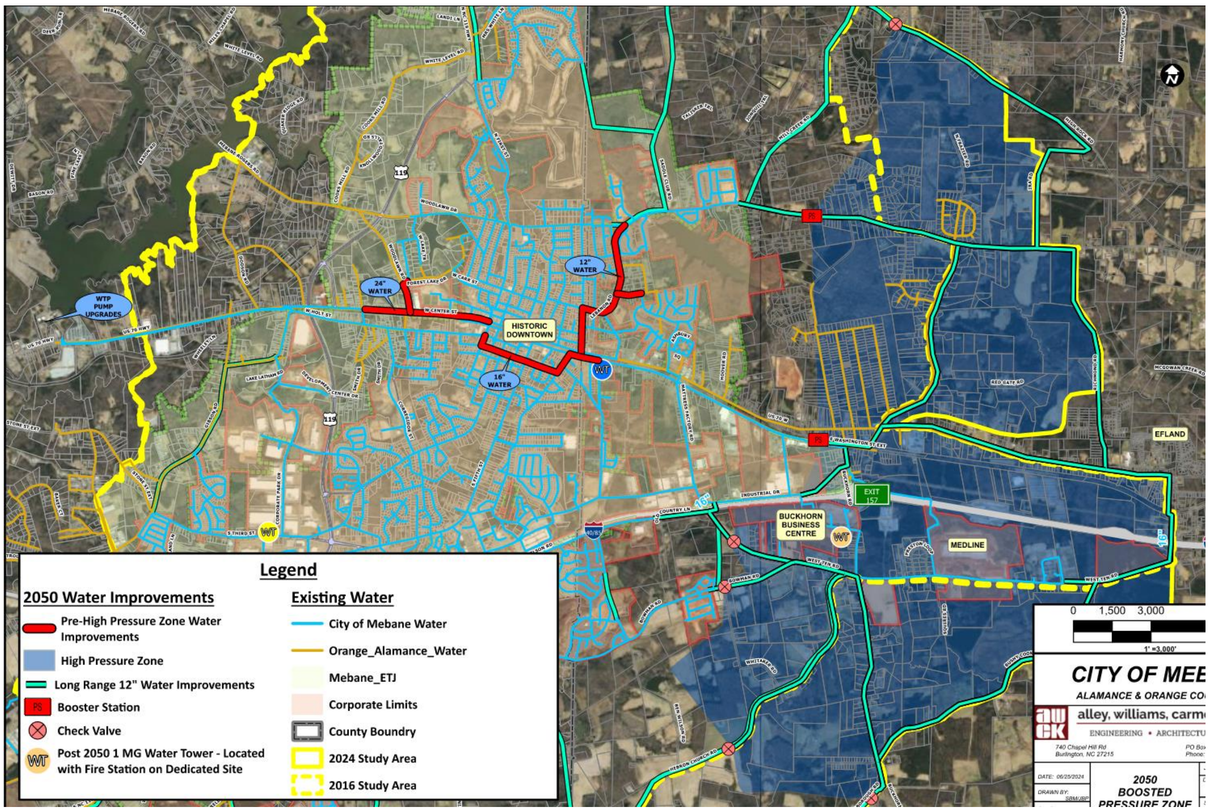


Figure 5. Boosted Pressure Zone.

E. Extensions of Water Distribution System

New service areas will require the extension of mostly 12-inch water mains along state road right-of-way. Mebane's water extension policy addresses extending service to existing developed areas not currently served, proposed new development, and economic and community development.

Mebane has an oversizing policy that considers possible participation in identified improvements that provide benefit beyond what may be needed for a development (residential or non-residential). Collected water system development fees would be used to aid in funding capital projects that add new capacity to the system including oversizing of water lines.

4. Wastewater

A. Water Resource Recovery Facility (WRRF)

Existing Treatment Capacity and Current Wastewater Flows - Mebane owns and operates the 2.5 MGD WRRF located on Corregidor Drive. A renovation of the WRRF was completed last year (see Figure 6). Improvements included a new headworks screening process (expanded with new facility), modification of the clarifiers (repurposed with new facility) and the addition of new air and mixers to the aerobic digesters (used with new facility).

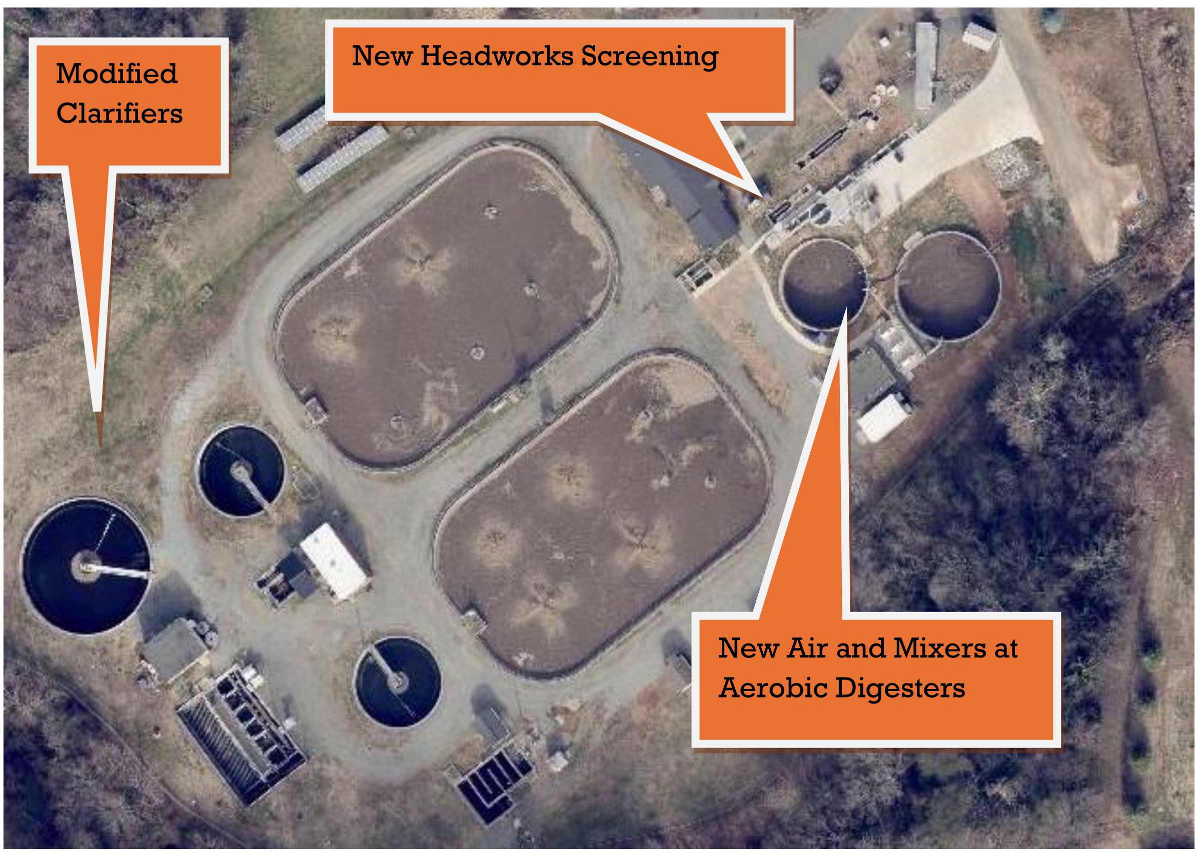


Figure 6. Renovated WRRF – Current

Current wastewater flows at the WRRF are approximately 1.75 MGD. The city also owns a 21.4% percentage of the 3.5 MGD Graham WWTP with an allocation of 0.75 MGD. Current wastewater flows to Graham are approximately 50,000 gallons per day. Flows at the North Carolina Commerce Park (NCCP) are not counted against the Graham allocation.

Future Treatment and Capacity Needs - McGill Engineers have completed the design and permitting of a 1.5 MGD expansion/upgrade of the WRRF with a new treatment capacity to 4.0 MGD from 2.5 MGD. The new plant is designed to meet nutrient (nitrogen and phosphorus) limits of the Jordan Lake Rules. Additionally, the facility can be expanded to 6.0 MGD. The major components of the new plant (see Figure 7) are as follows:

- Expansion of the renovated headworks.
- New Influent Pump Station.
- New plant generator.
- Two new 5 Stage Bardenpho Oxidation Ditches.
- Two new clarifiers and new Denitrification Filters.
- New UV Disinfection and Post Aeration Basin.
- Conversion of existing 1-million-gallon clarifier to sludge holding.

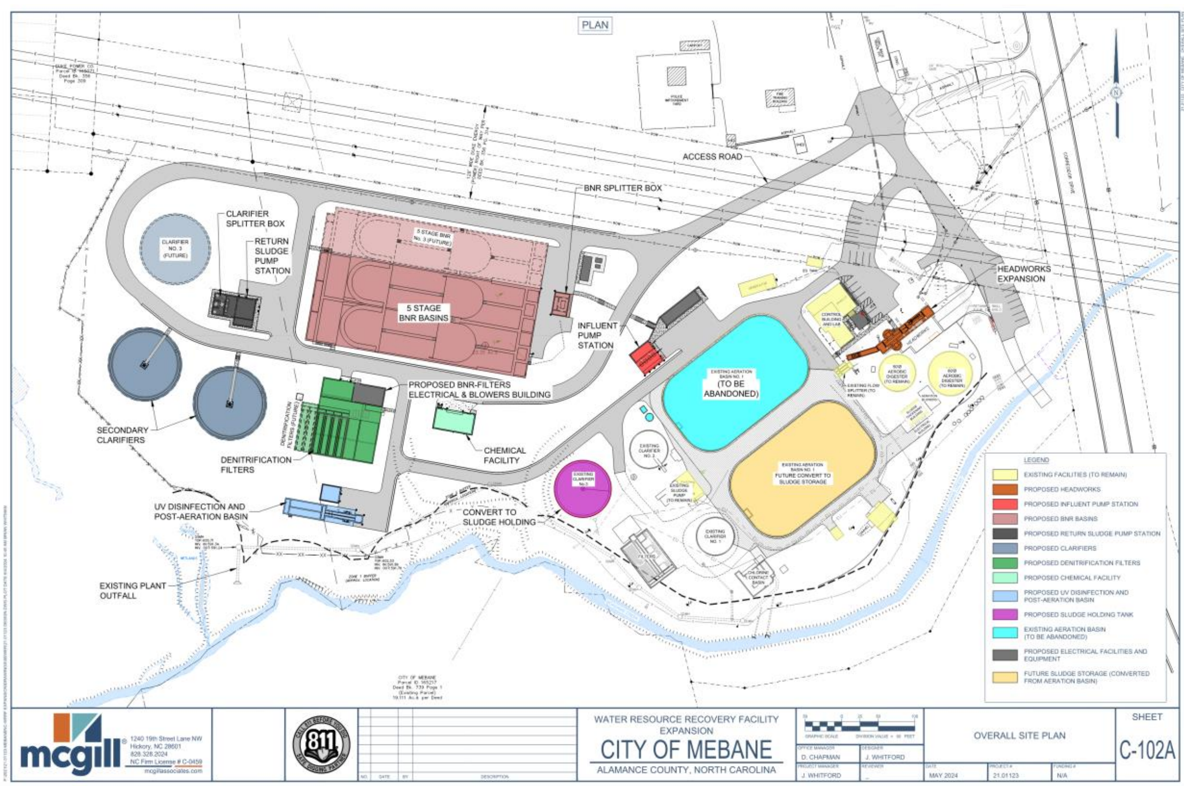


Figure 7. Proposed WRRF Expansion to 4.0 MGD and Future to 6.0 MGD

Bids are expected this August 2024 with construction starting in January 2025 and being completed within 3 years. The WRRF expansion/upgrade to 4.0 MGD with the Graham allocation of 0.75 MGD may provide the wastewater treatment needs until the year 2050 with a forecasted Mebane population of approximately 48,200. The design of the expansion/upgrade to 6.0 MGD should begin at 80% of capacity (3.2 MGD) and be under construction at 90% (3.6 MGD). The 6.0 MGD WRRF and 0.75 MGD Graham allocation should be capable of serving a Mebane population of 61,000 post 2070 (dependent on rate of growth).

Additional Future Needs – Solids handling/Odor Control/Flow Equalization

Solids handling. As future wastewater flow increases, residual solids (sludge) production will also increase. Mebane currently contracts with EMA resources to press and haul sludge. A study should be done to analyze if in-house sludge processing is more economical while continuing to contract hauling and disposing of the sludge.

Odor control. The WRRF renovation project replaced the existing mixing system in the digesters with blowers which has made a significant improvement to the odors that leave the plant site. However, as flow and sludge production increase so does the potential for odors. It may become necessary as the WRRF expands to install odor control facilities over the sludge storage tanks and at the wet wells where wastewater enters the plant. An odor control project could be considered after the WRRF expansion/upgrade is online.

Flow equalization. The purpose of flow equalization is to divert flow into storage basins during high flows and return the flow to the treatment process during low flows. This makes the process run more efficiently creating a better-quality effluent. This can also be used during storm events when flows are exceptionally high to protect the plants’ biology. The current planned expansion/upgrade will replace the existing aeration basins which will be left in place and able to be used in an emergency to store high flows. McGill envisioned these basins eventually being used as flow equalization.

B. Wastewater Pump Stations/Force Mains/Gravity Collection Lines

Existing System - Mebane owns and operates a wastewater pumping and collection system varying in size and capacity as follows:

- 21 duplex and triplex wastewater pump stations (50-gpm to 1745-gpm).
- 33 simplex pump stations (individual resident low pressure system).

- 28 miles of force main (3-inch to 16-inch).
- 126 miles of gravity collection lines (8-inch to 24-inch).

Future System Needs - To meet future system needs it is expected that the city will complete projects that address wastewater pump station upgrades, elimination, and reroutes of wastewater flows (see Figure 8). Collected wastewater system development fees will assist in funding projects that add new capacity to the system. These 10-year plus CIP projects are as follows:

- North Regional Triplex PS (add/permit 3rd pump to increase capacity).
- Terrell Street PS (rehab and increase capacity with Arbor Creek PS elimination).
- GKN PS (rehab and increase capacity with reroute to Graham).
- Fieldstone PS (rehab and increase capacity with GKN reroute to Graham).
- GE PS&FM (increase capacity with PS upgrade and force main rehab).
- Richmond Hill PS (rehab).
- Jones Road 10-inch outfall (eliminates Arbor Creek PS).
- Third Street 12-inch outfall (eliminates 3rd Street PS).
- Walmart 10-inch outfall (eliminates Walmart PS).
- Rehabilitation of sewer system in the 3rd Street and 5th Street sewer sheds.

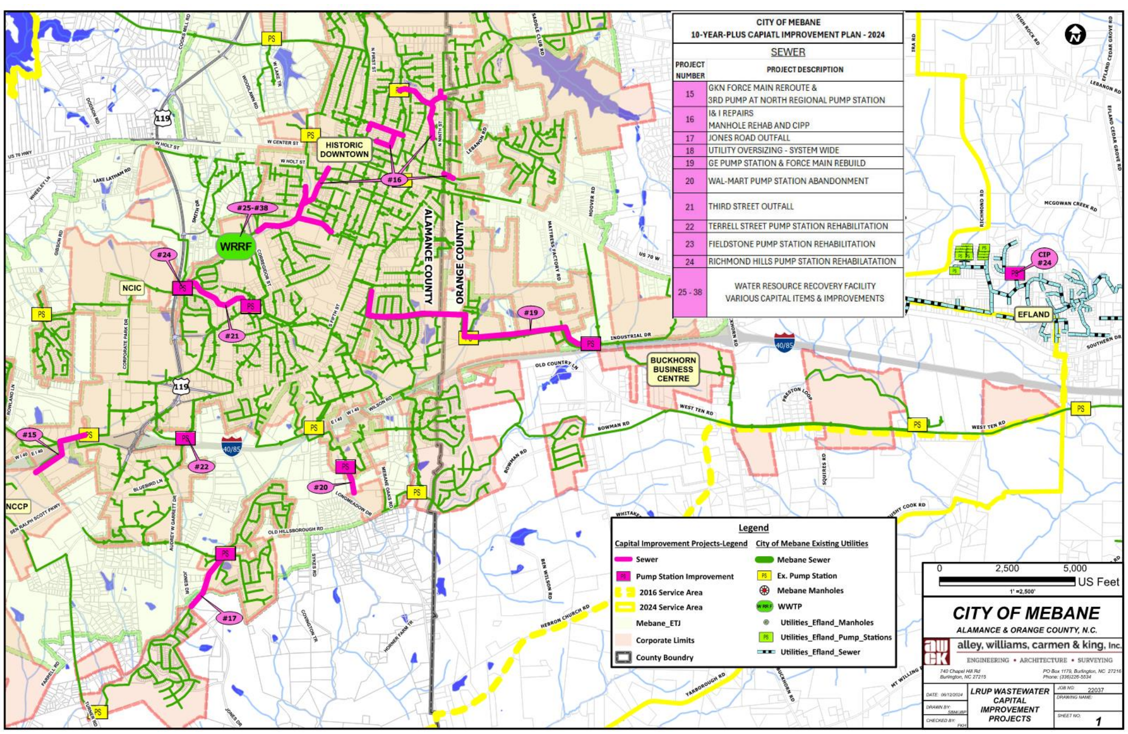


Figure 8. 10-Year Plus CIP Wastewater Improvement Projects.

Future Extensions of Wastewater System - New service areas will require extension of gravity lines, new pump stations and related force mains. Mebane's wastewater extension policy addresses extending service to existing developed areas not currently served, proposed new development, and economic and community development.

5. Service Area

The 2016 service area includes approximately 37.5 square miles of incorporated land, land within the ETJ, and other planned areas of service in Alamance and Orange Counties.

The 2024 expanded service area includes an additional 13.7 square miles where interest has been shown in the area for possible service. The new total service area is approximately 51.2 square miles (see Figure 9).

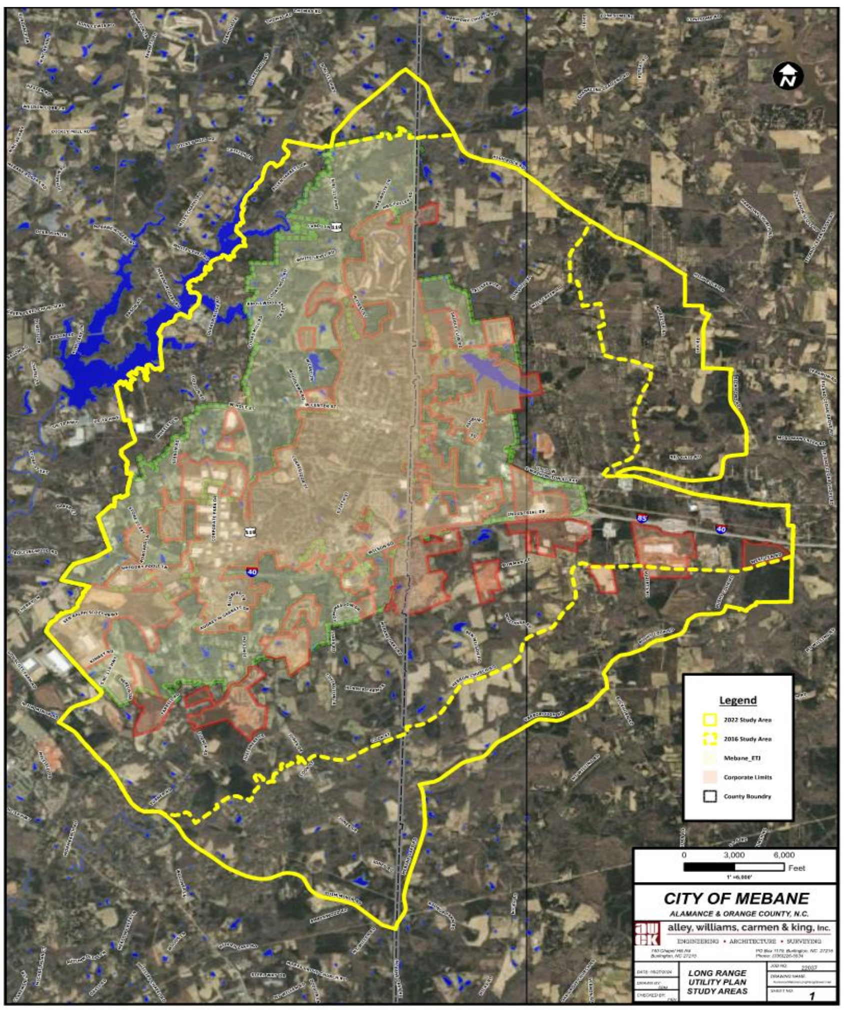


Figure 9. Service Area Map.

6. Water Demand Projections

Future water demand is based on the current demand and anticipated growth (residential and non-residential) of both Mebane and Graham. Graham also sells water to the Town of Green Level and the Town of Swepsonville.

The water demand data below is taken from the most recent Local Water Supply Plan Mebane submitted to the NC Public Water Supply (See Figures 10 & 11). Graham's totals were adjusted to reflect improved system process and unaccounted for water. As shown below, by 2050 it is expected that 8 MGD will be pumped to Mebane and Graham.

Average Day Water Demand Projections From Mebane's 2023 Local Water Supply Plan

	2023	2030	2040	2050	2060	2070
Year-Round Population from 2023 LWSP	21,397	30,896	40,164	48,197	55,427	60,969
Residential	0.926	1.355	1.736	2.052	2.325	2.520
Commercial	0.237	0.281	0.366	0.476	0.618	0.804
Industrial	0.384	0.446	0.557	0.697	0.871	1.089
Institutional	0.226	0.153	0.168	0.185	0.204	0.224
System Process	0.012	0.295	0.310	0.325	0.342	0.359
Unaccounted-for	0.284	0.217	0.228	0.239	0.251	0.264
Service Area Demand	2.068	2.747	3.365	3.974	4.611	5.260
Sales (OAWS)	0	0	0	0	0	0
Future Sales	0	0	0	0	0	0
2023 LWSP Average Day - mgd	2.068	2.747	3.365	3.974	4.611	5.260

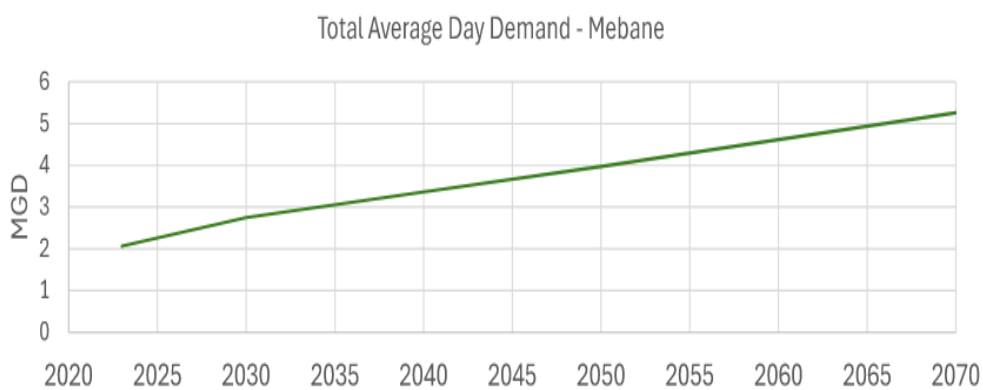


Figure 10. Mebane Water Demand from 2023 Local Water Supply Plan.

Water Summary for Graham, Mebane and WTP

Graham

Water Use by Type	2023	2030	2040	2050	2060	2070
Residential	0.713	0.861	1.076	1.346	1.548	1.702
Commercial	0.385	0.496	0.620	0.776	0.892	0.981
Industrial	0.206	0.303	0.378	0.473	0.544	0.598
Institutional	0.044	0.080	0.100	0.125	0.144	0.158
System Process (Flushing)	0.120	0.132	0.165	0.206	0.237	0.261
Unaccounted-for	0.594	0.330	0.413	0.516	0.594	0.653
Service Area Total	2.062	2.203	2.753	3.442	3.958	4.354
Water Sales						
Burlington	0.002	0.000	0.000	0.000	0.000	0.000
Green Level	0.107	0.365	0.365	0.365	0.365	0.365
Haw River	0.001	0.000	0.000	0.000	0.000	0.000
Orange Alamance	0.000	0.000	0.000	0.000	0.000	0.000
Swepsonville	0.201	0.300	0.300	0.300	0.300	0.300
Total Sales	0.310	0.665	0.665	0.665	0.665	0.665
Total Pumped to Graham System	2.372	2.867	3.417	4.106	4.622	5.018
Total Pumped to Mebane System	2.068	2.747	3.365	3.974	4.611	5.260
Total Finished Water Pumped	4.440	5.614	6.782	8.081	9.233	10.278
WTP Process Water	0.400	0.488	0.590	0.703	0.803	0.894
Total Raw Water Withdrawal	4.840	6.102	7.372	8.783	10.036	11.172

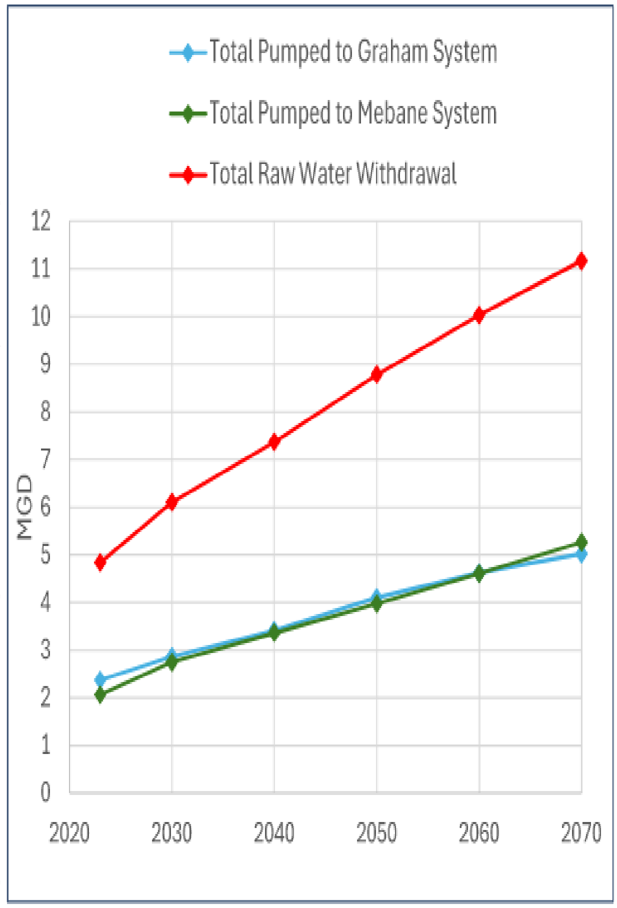


Figure 11. Water Summary for Graham, Mebane and WTP.

7. Wastewater Flow Projections

Future wastewaters flow projections are based on current use and anticipated growth with a high demand from residential development. Mebane has seen a resurgence in industrial growth. The new industrial users to date are mostly distribution and warehousing using less water. Commercial growth is also expected to follow the high residential growth. In addition, Mebane is the provider of wastewater to the unincorporated Efland Community.

As noted previously, the Mebane WRRF is the primary provider of wastewater treatment at 2.5 MGD and is planned to be expanded to 4.0 MGD. Most future wastewater flows will be from continued infill growth around Mebane's central business area and historic downtown, and to the north with the completion of the 119 by-pass and to the east and southeast along the I-40/85 corridor.

Mebane also has 0.75 MGD allocated in the Graham WWTP which currently serves the NCCCP and Cambridge Park. With the reroute of wastewater from the GKN and Arbor Creek Pump Stations it is expected that the use will rise to approximately 0.25 MGD. This leaves approximately 0.50 MGD for future south Mebane growth.

When making future wastewater projections we have assigned an equivalent residential unit (ERU) at 215 gpd, slightly less than the permitted flow for a 3-bedroom home at 225 gpd. This assigned unit flow is then used as a multiplier for non-residential use. With an anticipated population of 48,200 by 2050 we expect an additional 10,833 ERUs generating wastewater flows within the system as shown below (See Table 1).

MEBANE WRRF		**2050**	**GRAHAM WTP**	
TYPE	PROJECTED ERUs	TOTAL	TYPE	PROJECTED ERUs
APPROVED/SUBMITTED PROJECTS	3,471	4,709	APPROVED/SUBMITTED PROJECTS	1,238
SERVING EXISTING HOMES WITH SEPTIC TANKS (10%)	222	285	SERVING EXISTING HOMES WITH SEPTIC TANKS (10%)	63
FUTURE NON-RES. AREA	748	1,027	FUTURE NON-RES. AREA	279
FUTURE RESIDENTIAL AREAS (15%)	4076	4,812	FUTURE RESIDENTIAL AREAS (15%)	736
TOTAL	8,517		TOTAL	2,316
	TOTAL	**10,833**	**ERUs**	

Table 1. Projected ERUs to Mebane WRRF and Graham WTP.

The ability to serve planned and future ERUs is largely dependent on pump station capacity. As the WRRF is centrally located most wastewater flows are pumped to the facility. Below is a current review of the pump stations and their current utilization percentage to their capacity. Also included below is the current percentage utilization of the WRRF and Graham WWTP to their capacity (See Table 2).

EXISITING FLOW CAPACITY ANALYSIS (2024)				
PUMP STATION	**PUMPS TO**	**DESIGN CAPACITY (GPD)**	**EXISTING FLOWS (GPD)**	**CAPACITY %**
Fifth Street	WRRF	259,200	5,403	2%
Woodlawn Estates	North Regional	28,800	2,164	8%
North Regional	WRRF	1,005,120	361,358	36%
Brookhollow	West Ten	316,800	30,130	10%
Richmond Hills	West Ten	46,080	5,512	12%
West Ten	Southeast Regional	403,200	49,812	12%
Southeast Regional	WRRF	1,002,240	274,100	27%
Arbor Creek	Terrell Street	144,000	59,551	41%
Terrell Street	Fieldstone	230,400	174,094	76%
Governor's Green	GKN	115,200	37,429	32%
GKN	Fieldstone	187,200	142,675	76%
Fieldstone	WRRF	633,600	445,712	70%
L.J. Rogers	G.E.	115,200	5,924	5%
Gravelly Hill	G.E.	115,200	27,431	24%
G.E.	WRRF	172,800	82,441	48%
Walmart	Farrar Lane	51,840	18,385	35%
Farrar Lane	WRRF	288,000	126,564	44%
Third Street	WRRF	316,800	149,024	47%
Byrd’s	WRRF	57,600	3,995	7%
Mebane City Park	WRRF	80,640	1,088	1%
Cambridge Park	City of Graham	288,000	54,715	19%
City of Mebane WRRF		2,500,000	1,750,000	70%
City of Graham WWTP		750,000	54,715	7%

Table 2. Percent Utilization of Mebane Pump Stations, WRRF, and Graham WWTP.

As shown below an asterisk (*) beside the pump station’s future design capacity denotes there will be an increase in capacity. Increases in pump station capacity are made by either an impeller change, a planned 3rd pump being added, wastewater flow being rerouted, or the pump station being rehabilitated. Also reflected are the elimination of the Wal-Mart, Arbor Creek, Fifth Street, and Third Street pump stations with gravity sewer outfall extensions and I/I rehabilitation and WRRF expansion (See Table 3).

FUTURE FLOW CAPACITY ANALYSIS (2050)				
PUMP STATION	PUMPS TO	DESIGN CAPACITY (GPD)	EXISTING & FUTURE FLOWS (GPD)	FUTURE CAPACITY %
Woodlawn Estates	North Regional	28,800	2,164	8%
North Regional	WRRF	*1,600,000	956,316	60%
Brookhollow	West Ten	316,800	106,724	34%
Richmond Hills	West Ten	46,080	5,512	12%
West Ten	Southeast Regional	*518,400	275,515	53%
Southeast Regional	WRRF	*1,600,000	1,137,586	71%
Terrell Street	Fieldstone	*230,400	119,274	52%
Governor's Green	Fieldstone	115,200	56,457	49%
GKN	City of Graham	*288,000	174,590	61%
Fieldstone	WRRF	*633,600	453,698	72%
Gravelly Hill	West Ten	115,200	61,304	53%
G.E.	WRRF	*403,200	78,075	19%
Farrar Lane	WRRF	288,000	212,669	74%
Byrd’s	WRRF	57,600	10,445	18%
Mebane City Park	WRRF	80,640	1,088	1%
Cambridge Park	City of Graham	*403,200	261,460	65%
City of Mebane WRRF		*4,000,000	3,394,244	85%
City of Graham WWTP		750,000	713,522	95%

Table 3. Future Percent Utilization of Mebane Pump Stations, WRRF, and Graham WWTP.

Once the WRRF reaches 90% of design capacity the planned expansion from 4.0 MGD to 6.0 MGD must be permitted and under construction.

8. Summary and Recommended Action Items

The City of Mebane is addressing their primary wastewater needs with the expansion/upgrade of the WRRF to 4.0 MGD. This capital project with the previous purchase of capacity and planned flow reroutes to Graham’s WWTP will serve Mebane until 2050.

The City of Graham is currently studying how the WTP can be expanded to address future demand. In addition, studies have begun for the possible expansion of the Lake. As an alternative to expanding the treatment plant and raw water supply, we also recommend continued study of the possible purchase of Burlington water. Others purchasing water from Burlington include the City of Greensboro, the Towns of Whitsett, Gibsonville, Elon, Ossipee, Haw River, Village of Alamance, and Orange-Alamance Water System, Inc.. The City of Graham also purchases water from Burlington on an emergency basis. While infrastructure is in place through two emergency connections, additional improvements will be required in Graham's distribution system (with Mebane assistance) to provide daily water purchases from Burlington. Mebane and Graham buying water from Burlington may defer the need for expansion of the Treatment Plant and Supply for decades.

As water and sewer funds are limited, we recommend a ranking of CIP projects advancing those that are most critical to Mebane. Water and sewer rates should continue to be reviewed annually and system development fees analyzed every 3 to 5 years. Mebane and Graham should continue applying for grants and State and Federal appropriations that assist with capacity needs, infrastructure analysis, and regulatory review.

In summary, the City of Mebane is in an advantageous position to address their future water and wastewater needs with previous planning and actions taken by Graham and Mebane Councils.

9. <u>Appendices</u>:

Exhibit A - Service Area (AWCK)

Exhibit B - 10-year plus CIP for Wastewater (AWCK)

Exhibit C - 10-year plus CIP for Water (AWCK)

Exhibit D - Boosted Pressure Zone (AWCK)

Exhibit E - Overall Wastewater (AWCK)

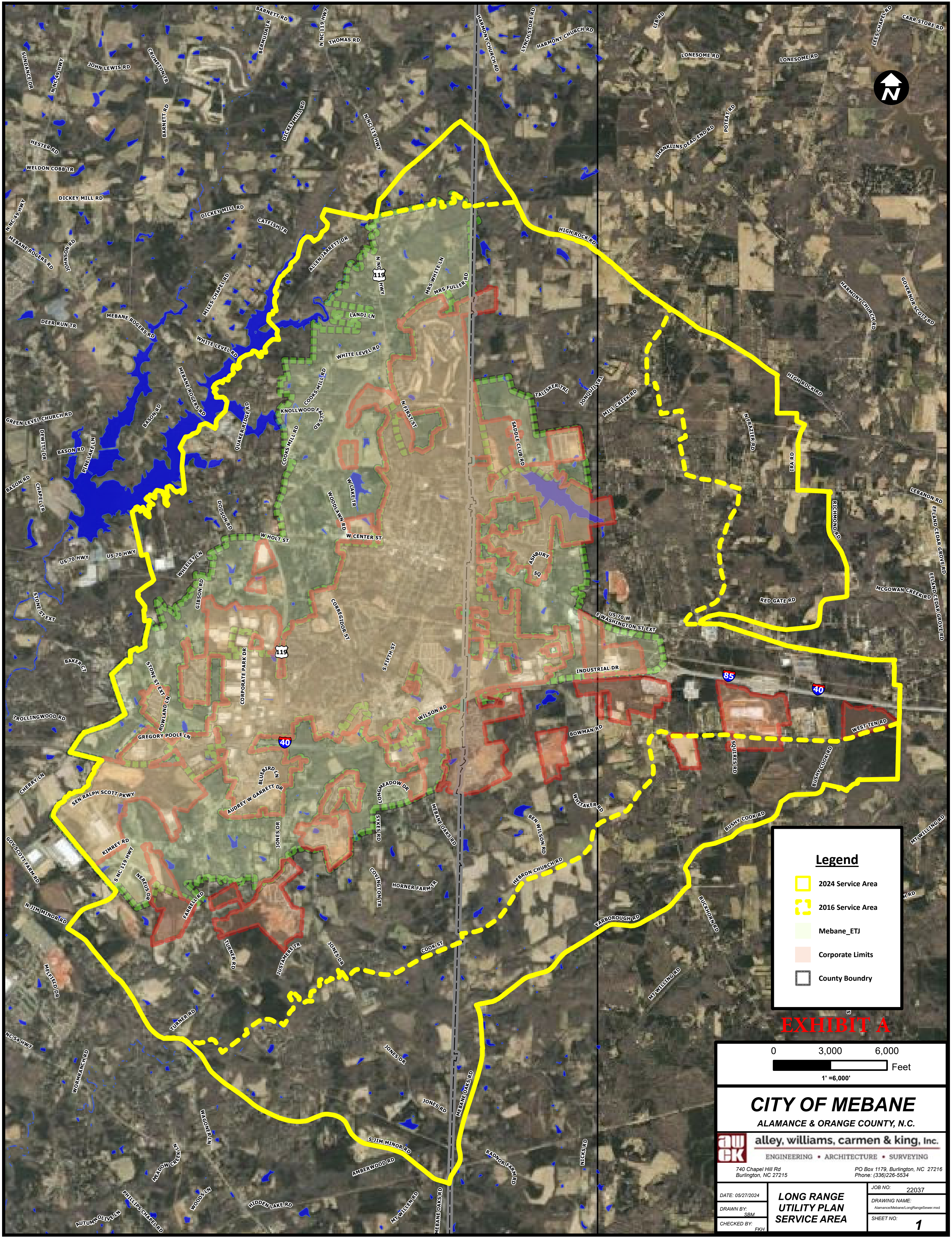
Exhibit F - Overall Water (AWCK)

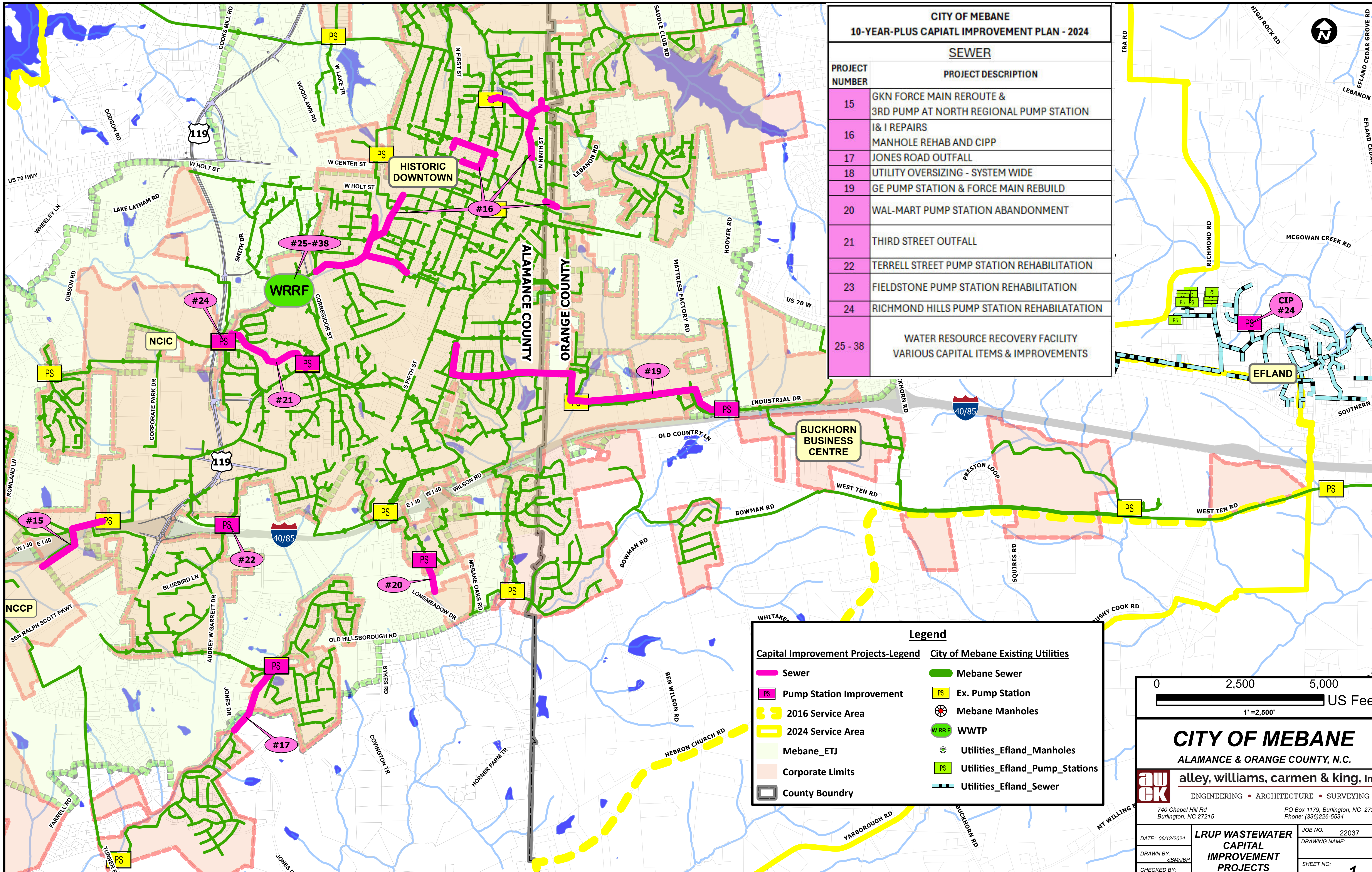
Exhibit G - Graham-Mebane Water Supply 2023 LWSP July 15, 2024 (Hazen rev.)

Exhibit H - 2023-24 Safe Yield Modeling for Graham-Mebane Lake (Hazen)

Exhibit I - Mebane WRRF Visioning Letter (McGill)

Exhibit J - Overall Site Plan for WRRF expansion (McGill)


N
Legend
2024 Service Area
2016 Service Area
Mebane_ETJ
Corporate Limits
County Boundry
EXHIBIT A
0
3,000
6,000
Feet
1' =6,000'
CITY OF MEBANE
ALAMANCE & ORANGE COUNTY, N.C.
alley, williams, carmen & king, Inc.
ENGINEERING • ARCHITECTURE • SURVEYING
740 Chapel Hill Rd
Burlington, NC 27215
PO Box 1179, Burlington, NC 27216
Phone: (336)226-5534
DATE: 05/27/2024
DRAWN BY: SBM
CHECKED BY: FKH
LONG RANGE UTILITY PLAN SERVICE AREA
JOB NO: 22037
DRAWING NAME: Alamance/Mebane/LongRangeSewer.mxd
SHEET NO: 1
BARNETT RD
BERMUDA TR
N NC 119 HWY
THOMAS RD
HARMONY CHURCH RD
LYNCH STORE RD
LEB RD
LEES CHAPEL RD
CARR STORE RD
LONESOME RD
SUNDANCE DR
N NC 49 HWY
JOHN LEWIS RD
CRUMPTON TR
DICKEY MILL RD
HESTER RD
WELDON COBB TR
CATFISH TR
POTEAT RD
SHANKLINS DEAD END RD
HIGH ROCK RD
MEBANE ROGERS RD
JOHNSON RD
MILES CHAPEL RD
ALLEN JARRETT DR
MRS WHITE LN
MRS FULLER RD
LANDI LN
DEER RUN TR
WHITE LEVEL RD
COOKS MILL RD
KNOLLWOOD FALLS RD
GREEN LEVEL CHURCH RD
BASON RD
QUAKER RIDGE RD
N FIRST ST
SADDLE CLUB RD
TALISKER TRL
JONQUIL TRL
MILL CREEK RD
HARMONY CHURCH RD
GOVERNOR SCOTT RD
N FRAZIER RD
IRA RD
RICHMOND RD
LEBANON RD
EFLAND CEDAR GROVE RD
DEWITT DR
PINE LAKE LN
CHAPEL TR
DODSON RD
W LAKE TR
WOODLAWN RD
W CENTER ST
W HOLT ST
ASHBURY SQ
US 70 HWY
WHEELEY LN
GIBSON RD
CORREGIDOR ST
US 70 W
E WASHINGTON ST EXT
MCGOWAN CREEK RD
RED GATE RD
STONE ST EXT
BAKER CT
STONE ST EXT
CORPORATE PARK DR
S FIFTH ST
INDUSTRIAL DR
TROLLINGWOOD RD
ROWLAND LN
GREGORY POOLE LN
WILSON RD
BOWMAN RD
WEST TEN RD
SQUIRES RD
BUSHY COOK RD
CHERRY LN
SEN RALPH SCOTT PKWY
BLUEBIRD LN
AUDREY W GARRETT DR
LONGMEADOW DR
WHITAKER RD
MT WILLING RD
GOV SCOTT FARM RD
KIMREY RD
S NC 119 HWY
JONES DR
SYKES RD
MEBANE OAKS RD
BEN WILSON RD
HEBRON CHURCH RD
COVINGTON TR
HORNER FARM TR
BUCKHORN RD
NEREUS DR
FARRELL RD
N JIM MINOR RD
TURNER RD
JUSTAMERE TR
JONES DR
COOK ST
YARBOROUGH RD
MT WILLING RD
MELFIELD DR
NC 54 HWY
TURNER RD
WORMRANCH RD
JONES DR
JONES RD
MEBANE OAKS RD
WAGONER LN
MEADOW CREEK LN
S JIM MINOR RD
AMBERWOOD RD
RADNOR FARM RD
NICKS RD
PHILLIPS CHAPEL RD
WOODS LN
HIDDEN LAKE RD
MT WILLEN RD
AUTUMN OLIVE LN
85
40
119



PROJECT NUMBER	PROJECT DESCRIPTION
15	GKN FORCE MAIN REROUTE & 3RD PUMP AT NORTH REGIONAL PUMP STATION
16	I& I REPAIRS MANHOLE REHAB AND CIPP
17	JONES ROAD OUTFALL
18	UTILITY OVERSIZING - SYSTEM WIDE
19	GE PUMP STATION & FORCE MAIN REBUILD
20	WAL-MART PUMP STATION ABANDONMENT
21	THIRD STREET OUTFALL
22	TERRELL STREET PUMP STATION REHABILITATION
23	FIELDSTONE PUMP STATION REHABILITATION
24	RICHMOND HILLS PUMP STATION REHABILITATION
25 - 38	WATER RESOURCE RECOVERY FACILITY VARIOUS CAPITAL ITEMS & IMPROVEMENTS

EXHIBIT B

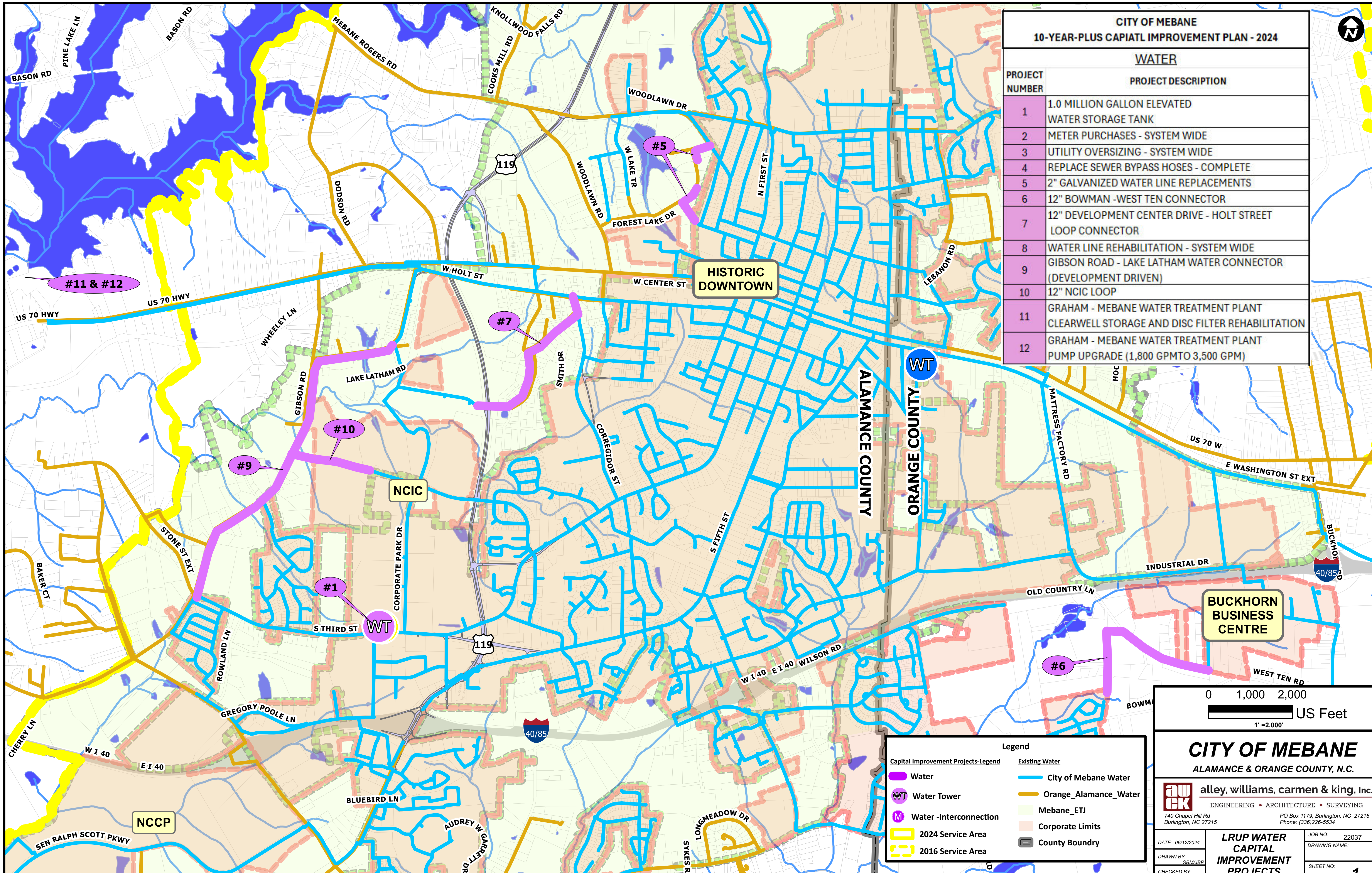
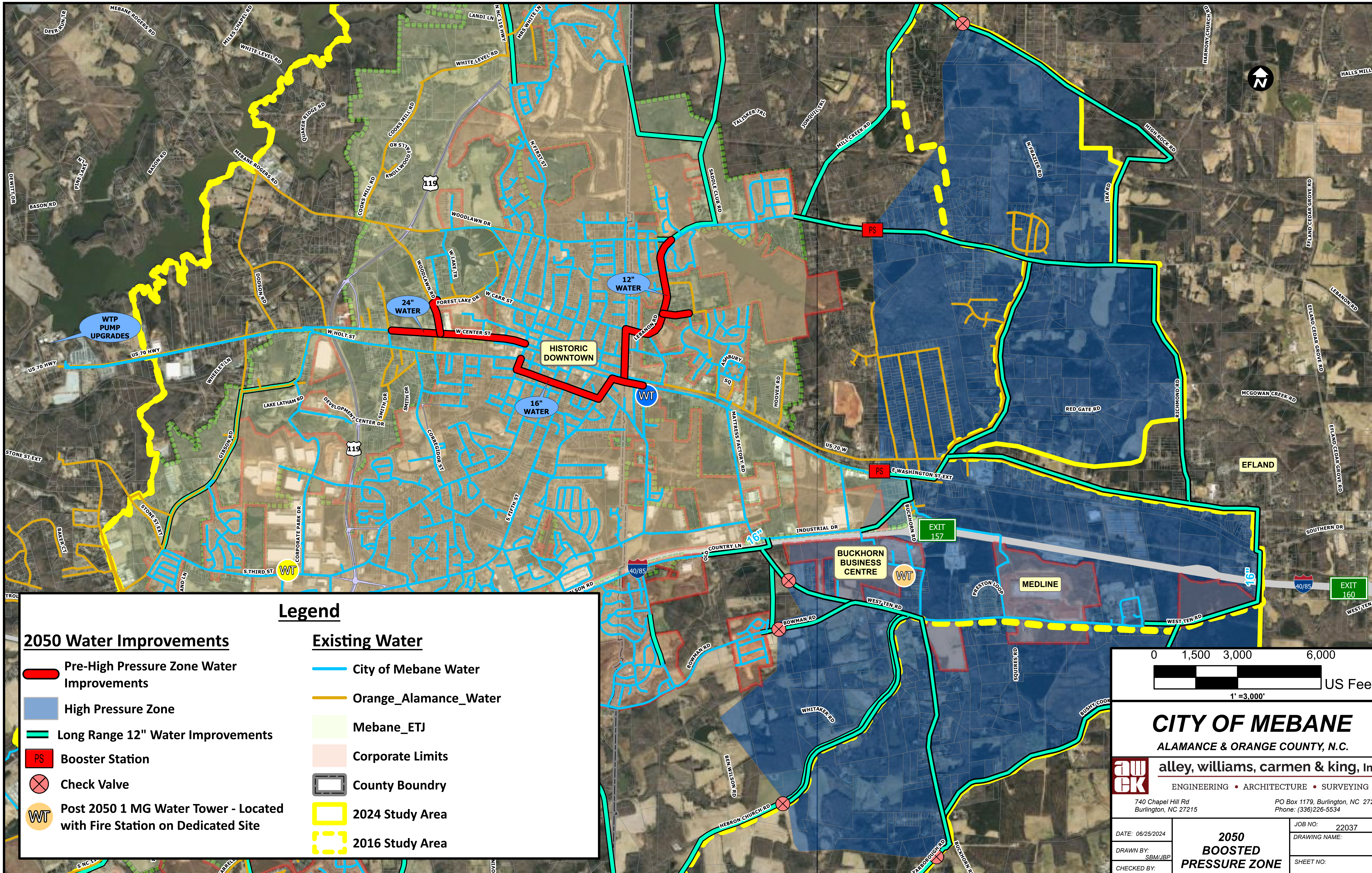

CITY OF MEBANE
10-YEAR-PLUS CAPIATL IMPROVEMENT PLAN - 2024
WATER
PROJECT NUMBER
PROJECT DESCRIPTION
1 1.0 MILLION GALLON ELEVATED WATER STORAGE TANK
2 METER PURCHASES - SYSTEM WIDE
3 UTILITY OVERSIZING - SYSTEM WIDE
4 REPLACE SEWER BYPASS HOSES - COMPLETE
5 2" GALVANIZED WATER LINE REPLACEMENTS
6 12" BOWMAN -WEST TEN CONNECTOR
7 12" DEVELOPMENT CENTER DRIVE - HOLT STREET LOOP CONNECTOR
8 WATER LINE REHABILITATION - SYSTEM WIDE
9 GIBSON ROAD - LAKE LATHAM WATER CONNECTOR (DEVELOPMENT DRIVEN)
10 12" NCIC LOOP
11 GRAHAM - MEBANE WATER TREATMENT PLANT CLEARWELL STORAGE AND DISC FILTER REHABILITATION
12 GRAHAM - MEBANE WATER TREATMENT PLANT PUMP UPGRADE (1,800 GPMTO 3,500 GPM)
HISTORIC DOWNTOWN
NCIC
NCCP
BUCKHORN BUSINESS CENTRE
ALAMANCE COUNTY
ORANGE COUNTY
#1
#5
#6
#7
#9
#10
#11 & #12
WT
BASON RD
PINE LAKE LN
MEBANE ROGERS RD
KNOLLWOOD FALLS RD
COOKS MILL RD
WOODLAWN DR
W LAKE TR
N FIRST ST
DODSON RD
FOREST LAKE DR
W HOLT ST
W CENTER ST
US 70 HWY
WHEELEY LN
LAKE LATHAM RD
GIBSON RD
SMITH DR
LEBANON RD
MATTRESS FACTORY RD
US 70 W
E WASHINGTON ST EXT
CORREGIDOR ST
S FIFTH ST
STONE ST EXT
BAKER CT
CORPORATE PARK DR
S THIRD ST
ROWLAND LN
INDUSTRIAL DR
OLD COUNTRY LN
WEST TEN RD
BOWMAN
W I 40
E I 40
WILSON RD
GREGORY POOLE LN
CHERRY LN
BLUEBIRD LN
AUDREY W GARRETT DR
LONGMEADOW DR
SYKES RD
SEN RALPH SCOTT PKWY
BUCKHORN RD
119
40/85
0 1,000 2,000
US Feet
1' =2,000'
Legend
Capital Improvement Projects-Legend
Water
Water Tower
Water -Interconnection
2024 Service Area
2016 Service Area
Existing Water
City of Mebane Water
Orange_Alamance_Water
Mebane_ETJ
Corporate Limits
County Boundry
CITY OF MEBANE
ALAMANCE & ORANGE COUNTY, N.C.
alley, williams, carmen & king, Inc.
ENGINEERING • ARCHITECTURE • SURVEYING
740 Chapel Hill Rd Burlington, NC 27215
PO Box 1179, Burlington, NC 27216 Phone: (336)226-5534
DATE: 06/12/2024
DRAWN BY: SBM/JBP
CHECKED BY: FKH
LRUP WATER CAPITAL IMPROVEMENT PROJECTS
JOB NO: 22037
DRAWING NAME:
SHEET NO: 1

EXHIBIT C


Legend
2050 Water Improvements
Pre-High Pressure Zone Water Improvements
High Pressure Zone
Long Range 12" Water Improvements
PS Booster Station
Check Valve
WT Post 2050 1 MG Water Tower - Located with Fire Station on Dedicated Site
Existing Water
City of Mebane Water
Orange_Alamance_Water
Mebane_ETJ
Corporate Limits
County Boundry
2024 Study Area
2016 Study Area
WTP PUMP UPGRADES
24" WATER
12" WATER
16" WATER
HISTORIC DOWNTOWN
BUCKHORN BUSINESS CENTRE
MEDLINE
EFLAND
EXIT 157
EXIT 160
40/85
119
16"
W HOLT ST
W CENTER ST
US 70 HWY
WOODLAWN DR
FOREST LAKE DR
W CARR ST
LEBANON RD
MEBANE ROGERS RD
WHITE LEVEL RD
COOKS MILL RD
N FIRST ST
SADDLE CLUB RD
MILL CREEK RD
HIGH ROCK RD
N FRAZIER RD
IRA RD
RED GATE RD
E WASHINGTON ST EXT
US 70 W
MATTRESS FACTORY RD
HOOVER RD
INDUSTRIAL DR
OLD COUNTRY LN
S THIRD ST
CORPORATE PARK DR
S FIFTH ST
CORREGIDOR ST
DEVELOPMENT CENTER DR
LAKE LATHAM RD
GIBSON RD
STONE ST EXT
BUCKHORN RD
WEST TEN RD
BOWMAN RD
WHITAKER RD
HEBRON CHURCH RD
BEN WILSON RD
SQUIRES RD
PRESTON LOOP
YARBOROUGH RD
BUSHY COOK RD
RICHMOND RD
MCGOWAN CREEK RD
LEBANON RD
EFLAND CEDAR GROVE RD
SOUTHERN DR
HALLS MILL RD
HARMONY CHURCH RD
LANDI LN
MRS WHITE LN
DEWITT DR
BASON RD
DODSON RD
QUAKER RIDGE RD
0 1,500 3,000 6,000
US Feet
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CITY OF MEBANE
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Phone: (336)226-5534
DATE: 06/25/2024
DRAWN BY: SBM/JBP
CHECKED BY: FKH
2050 BOOSTED PRESSURE ZONE
JOB NO: 22037
DRAWING NAME:
SHEET NO:

EXHIBIT D

RESIDENTIAL PROJECTS

MAP KEY	APPROVED PROJECT/ UNDER CONSTRUCTION	REMAINING ERUs
A-1	TUPELO JUNCTION	170
A-2	STAGECOACH CORNER	35
A-3	OAKWOOD STREET SUBDIVISION	195
A-4	OAKWOOD SQUARE TOWNS	45
A-5	MEBANE TOWNE CENTER - T1	471
A-6	HAWFIELDS LANDING	436
A-7	CAMBRIDGE PARK	477
A-8	MAGNOLIA GLEN	130
A-9	MEADOWSTONE TOWNHOMES	147
A-10	BOWMAN VILLAGE	18
A-11	BOWMAN PLACE	91
A-12	KINGSDOWN	218
A-13	MEADOWS	114
A-14	VILLAS ON 5TH	15
A-15	ST BARTS PLACE	12
A-16	11TH STREET APARTMENTS	48
A-17	MONTCLAIR	6
A-18	LOT 8A	22
A-19	DRPBS	183
A-20	GILES ST APARTMENTS	8
A-21	STATION 206	30
A-22	N FIRST STREET TOWNHOMES	150
A-23	PEARTREE TOWNHOMES	70
A-24	TUPELO NORTH	207
A-25	POTTERS MILL TOWNHOMES	42
S-1	NORTH MEBANE VILLAGE	161
S-2	PRESERVE AT MILL CREEK	586
S-3	MILL RUN	18
S-4	SADDLE CLUB	125
S-5	MEBANE OAKS DEVELOPMENT (EVOLVE)	389
S-6	DEEP RIVER	90
TOTAL SUBMITTED OR APPROVED PROJECT ERUS REMAINING		4,709

*'REMAINING ERUs' BASED ON PRELIMINARY PLANS SUBMITTED TO CITY OF MEBANE OR REMAINING LOTS TO BE BUILT IN PROJECTS UNDER CONSTRUCTION

DEVELOPED RESIDENTIAL AREAS FOR POSSIBLE FUTURE SERVICE

MAP KEY	PARCELS
E-1	265
E-2	93
E-3	656
E-4	212
E-5	140
E-6	323
E-7	48
E-8	332
E-9	47
E-10	152
E-11	191
E-12	211
E-13	55
E-14	29
E-15	38
E-16	34
E-17	25
TOTAL PARCELS	2,851
PROJECTED ERUS	285

*'PROJECTED ERUs' CALCULATED BY 10% OF TOTAL PARCELS

POSSIBLE FUTURE NON-RESIDENTIAL DEVELOPMENT

MAP KEY	APPROVED PROJECT/ UNDER CONSTRUCTION	BUILDING SIZE(S) (SF)	ACRES	EQUIVALENT ERUS
I-1	POSSIBLE INDUSTRIAL	900,000		84
I-2	POSSIBLE INDUSTRIAL	450,000		42
I-3	ARMACELL - INDUSTRIAL	241,362		22
I-4	BUCKHORN BUSINESS CENTER - COMMERCIAL	805,200		82
I-5	EXETER - INDUSTRIAL	533,181		78
I-6	SKYWALKER - INDUSTRIAL	900,000		84
I-7	ROWLAND LANE - COMMERCIAL		60	140
I-8	EFLAND INDUSTRIAL CENTER (NOT SHOWN ON MAP)		100	233
I-9	WEST TEN INDUSTRIAL	375,000		50
I-10	BUCKHORN INDUSTRIAL	793,640		74
I-11	TROLLINGWOOD HAWFIELDS - COMMERCIAL		60	140
			TOTAL PROJECTED NON-RESIDENTIAL ERUs	1,027

*BUILDING SIZE DATA BASED ON PRELIMINARY PLANS SUBMITTED TO CITY OF MEBANE OR CONSTRUCTION PLANS

POSSIBLE FUTURE AREAS FOR RESIDENTIAL DEVELOPMENT

MAP KEY	PROJECTED ERUs
NR-1	263
NR-2	563
NR-3	315
NR-4	14
TR-1	403
TR-2	36
TR-3	173
TR-4	30
SE-1	472
SE-2	110
SE-3	39
SE-4	19
JR-1	443
JR-2	882
BH	356
BC	405
WRRF-1	17
WRRF-2	5
WRRF-3	8
WRRF-4	19
WRRF-5	8
WRRF-6	15
WRRF-7	19
WRRF-8	6
WRRF-9	11
GG-1	17
GG-2	72
COG-1	51
COG-2	44
TOTAL PROJECTED FUTURE ERUS	4,811

*'PROJECTED ERUs' BASED ON ACREASE OF STUDY AREA, CALCULATED AT 15% DEVELOPED AT 2.5 ERUS PER ACRE

***ALL FUTURE SEWER SHOWN IS TO BE 10", 12", OR 16" IN DIAMETER AS DETERMINED DURING DESIGN**

PLANNED WRRF EXPANSION FROM 2.5 MGD TO 4.0 MGD

ONCE 80% CAPCITY REACHED, START PLANNING FOR EXPANSION FROM 4.0 MGD TO 6.0 MGD

Legend

2024 Long Range Utility Plan
- Future Forced Sewer
- Future Gravity Sewer
- PS Future Pump Station

2024 Long Range Utility Plan Update
- AREA FOR POTENTIAL FUTURE SERVICE - TYPICALLY DEVELOPER DRIVEN
- AREA FOR POTENTIAL FUTURE SERVICE - TYPICALLY OWNER/COMMUNITY DRIVEN
- 2024 APPROVED RESIDENTIAL DEVELOPMENT
- 2024 SUBMITTED RESIDENTIAL DEVELOPMENT
- FUTURE INDUSTRIAL DEVELOPMENT
- FUTURE INDUSTRIAL BUILDING
- 2024 Service Area
- 2016 Service Area

10-yr-plus Capital Improvements
- Sewer Projects
- PS Pump Station Improvement

City of Mebane Existing Utilities
- Mebane Sewer
- WRRF WWTP
- PS Ex. Pump Station
- PS Efland Pump Station
- Efland Sewer
- Corporate Limits
- Mebane_ETJ
- County Boundry
- Stream
- Surface Water
- Conservation Land

LONG RANGE UTILITY PLAN - 2050 SUMMARY

SEWER TO WRRF		
SUBMITTED OR APPROVED PROJECTS	3,471	ERUS
DEVELOPED RESIDENTIAL AREAS FOR POSSIBLE FUTURE SERVICE	222	ERUS
POSSIBLE FUTURE NON-RESIDENTIAL DEVELOPMENT	748	ERUS
POSSIBLE FUTURE AREAS FOR RESIDENTIAL DEVELOPMENT	4,076	ERUS
TOTAL ERUS ADDED BY 2050	**8,517**	**ERUS**
EXISTING WRRF ADF (INCLUDING PUMP STATION RE-ROUTES)	1,585,204	GPD
ADDITIONAL FLOW - 2050	1,831,063	GPD
TOTAL WRRF ADF - 2050	**3,416,267**	GPD

SEWER TO CITY OF GRAHAM WASTEWATER TREATMENT PLANT		
SUBMITTED OR APPROVED PROJECTS	1,238	ERUS
DEVELOPED RESIDENTIAL AREAS FOR POSSIBLE FUTURE SERVICE	63	ERUS
POSSIBLE FUTURE NON-RESIDENTIAL DEVELOPMENT	279	ERUS
POSSIBLE FUTURE AREAS FOR RESIDENTIAL DEVELOPMENT	736	ERUS
TOTAL ERUS ADDED BY 2050	**2,316**	**ERUS**
EXISTING CITY OF GRAHAM ADF (INCLUDING PUMP STATION RE-ROUTES)	219,511	GPD
ADDITIONAL FLOW - 2050	497,987	GPD
TOTAL GRAHAM ADF (AGREEMENT OF 750,000 GPD) - 2050	**717,498**	GPD

PROJECTED TOTAL ERUS ADDED BY 2050	10,833
PROJECTED POPULATION ADDED BY 2050	**27,082**
CITY OF MEBANE EXISTING POPULATION 2024	21,397
CITY OF MEBANE PROJECTED POPULATION 2050	**48,479**

1 ERU = 215 GPD EACH

0 1,000 2,000 4,000 US Feet

1" =1,500'

CITY OF MEBANE

ALAMANCE & ORANGE COUNTY, N.C.

AWCK alley, williams, carmen & king, Inc.

ENGINEERING • ARCHITECTURE • SURVEYING

740 Chapel Hill Rd
Burlington, NC 27215

PO Box 1179, Burlington, NC 27216
Phone: (336)226-5534

DATE: 6/24/2024	LONG RANGE UTILITY PLAN WASTEWATER (2050)	JOB NO:	22037
DRAWN BY: SBM/JBP		DRAWING NAME:	
CHECKED BY: FKH		SHEET NO:	1

EXHIBIT E


NOTE: PORTIONS OF EXISTING DEVELOPMENTS ARE CURRETNLY SERVED BY ORANGE-ALAMANCE WATER
Legend
10-yr-plus Capital Improvements
Water
Booster Station
PS
Check Valve
Boosted Pressure Zone
Pre-High Pressure Zone Water Improvements
Proposed Water
2024 Long Range Utility Plan Update
AREA FOR POTENTIAL FUTURE SERVICE - TYPICALLY DEVELOPER DRIVEN
AREA FOR POTENTIAL FUTURE SERVICE - TYPICALLY OWNER/COMMUNITY DRIVEN
2024 APPROVED RESIDENTIAL DEVELOPMENT
2024 SUBMITTED RESIDENTIAL DEVELOPMENT
FUTURE INDUSTRIAL DEVELOPMENT
FUTURE INDUSTRIAL BUILDING
LRUP Service Area
2016 Study Area
2024 Study Area
City of Mebane Water
Orange_Alamance_Water
Corporate Limits
Mebane_ETJ
County Boundry
Surface Water
Stream
0
1,000
2,000
4,000
US Feet
1' =1,500'
CITY OF MEBANE
ALAMANCE & ORANGE COUNTY, N.C.
alley, williams, carmen & king, Inc.
ENGINEERING • ARCHITECTURE • SURVEYING
740 Chapel Hill Rd
Burlington, NC 27215
PO Box 1179, Burlington, NC 27216
Phone: (336)226-5534
DATE: 06/03/2024
DRAWN BY: SBM/JBP
CHECKED BY: FKH
LONG RANGE UTILITY PLAN WATER (2050)
JOB NO: 22037
DRAWING NAME: Alamance/Mebane/LongRangeSewer.mxd
SHEET NO: 1

EXHIBIT F

Graham-Mebane Water Supply Update

City of GRAHAM North Carolina

Mebane
Positively Charming

July 11, 2024

EXHIBIT G

Background

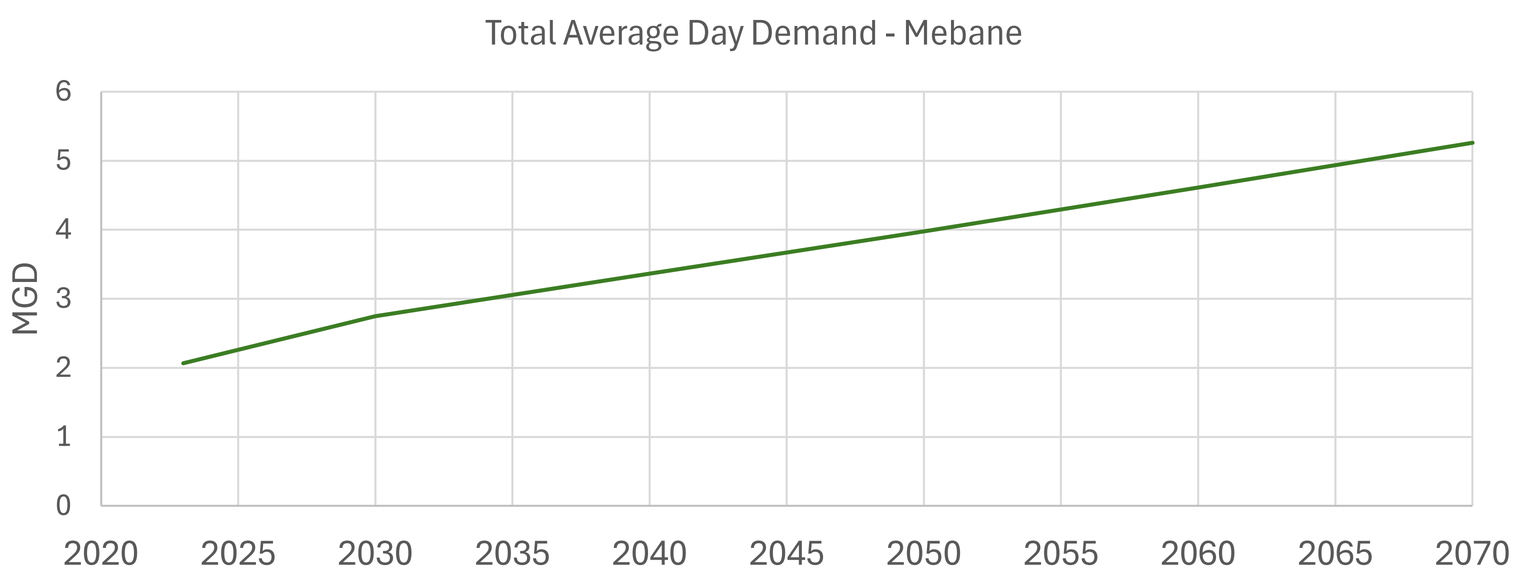
- In April 2021 Hazen completed a project for Mebane focusing on a new tank to sustain fire flows as water demand increases
- In October 2021 Hazen completed a storage and transmission main evaluation for Graham using new population projections reflecting significant growth
- In January 2022, Hazen met with Graham, Mebane and AWCK staff to review findings after integrating the two projects and to assess impacts on raw water supply and water treatment plant capacity
- Hazen's January 2024 report updated the safe yield of the raw water supply
- In June 2024 Hazen updated the water supply study using the updated safe yield and the population and demand projections in the 2023 Local Water Supply Plans (LWSPs) submitted by Mebane and Graham with adjustments for unaccounted-for water, flushing and backwash
- The following presentation revises the water supply study assuming Graham and Mebane implement conservation policies for lawn irrigation similar to those enacted by the City of Raleigh

Topics

1. Water Demand Projections
2. Raw Water Supply
3. Water Treatment
4. Project Timeline

Average Day Water Demand Projections From Mebane's 2023 Local Water Supply Plan

	2023	2030	2040	2050	2060	2070
Year-Round Population from 2023 LWSP	21,397	30,896	40,164	48,197	55,427	60,969
Service Area Demand	2.068	2.747	3.365	3.974	4.611	5.260
Sales (OAWS)	0	0	0	0	0	0
Future Sales	0	0	0	0	0	0
2023 LWSP Average Day - mgd	2.068	2.747	3.365	3.974	4.611	5.260



Average Day Demand Projections with Revised Estimates for Flushing, Unaccounted-for Water and Process Water

Graham Revised

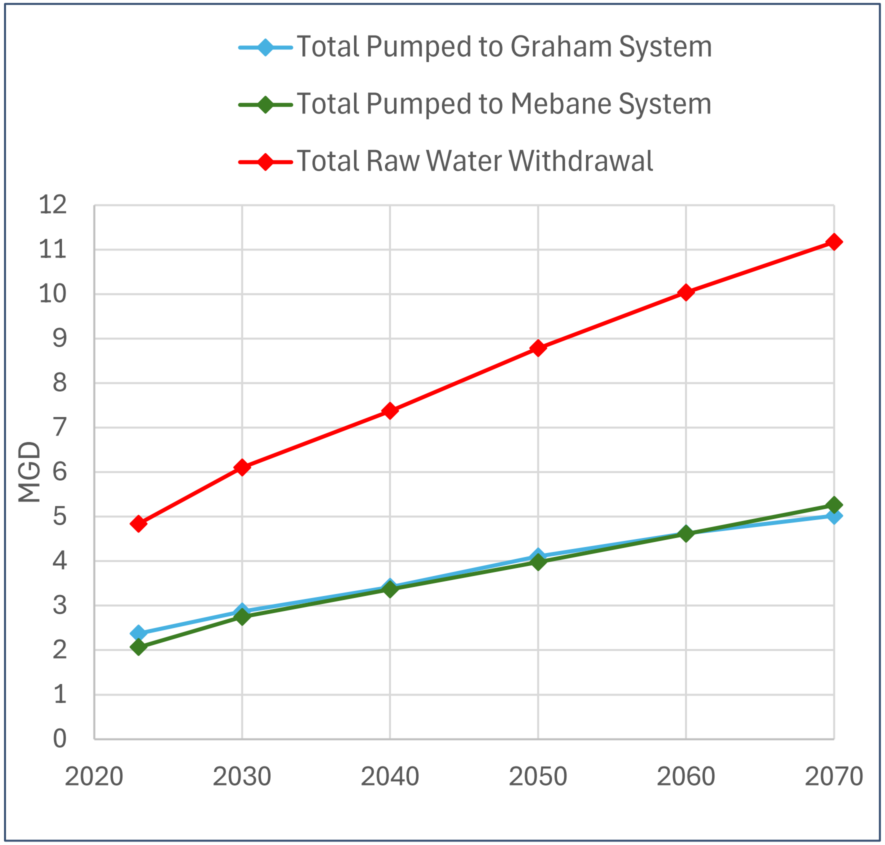
Water Use by Type	2023	2030	2040	2050	2060	2070
Residential	0.713	0.861	1.076	1.346	1.548	1.702
Commercial	0.385	0.496	0.620	0.776	0.892	0.981
Industrial	0.206	0.303	0.378	0.473	0.544	0.598
Institutional	0.044	0.080	0.100	0.125	0.144	0.158
System Process (Flushing)	0.120	0.132	0.165	0.206	0.237	0.261
Unaccounted-for	0.594	0.330	0.413	0.516	0.594	0.653
Graham Service Area Total	2.062	2.203	2.753	3.442	3.958	4.354
Water Sales						
Burlington	0.002	0.000	0.000	0.000	0.000	0.000
Green Level	0.107	0.365	0.365	0.365	0.365	0.365
Haw River	0.001	0.000	0.000	0.000	0.000	0.000
Orange Alamance	0.000	0.000	0.000	0.000	0.000	0.000
Swepsonville	0.201	0.300	0.300	0.300	0.300	0.300
Total Sales	0.310	0.665	0.665	0.665	0.665	0.665
Total Pumped to Graham System	**2.372**	**2.867**	**3.417**	**4.106**	**4.622**	**5.018**
Total Pumped to Mebane System	**2.068**	**2.747**	**3.365**	**3.974**	**4.611**	**5.260**
Total Finished Water Pumped	**4.440**	**5.614**	**6.782**	**8.081**	**9.233**	**10.278**
WTP Process Water	**0.400**	**0.488**	**0.590**	**0.703**	**0.803**	**0.894**
Total Raw Water Withdrawal	**4.840**	**6.102**	**7.372**	**8.783**	**10.036**	**11.172**

Assumptions for future years:

6% for flushing

15% for unaccounted for water

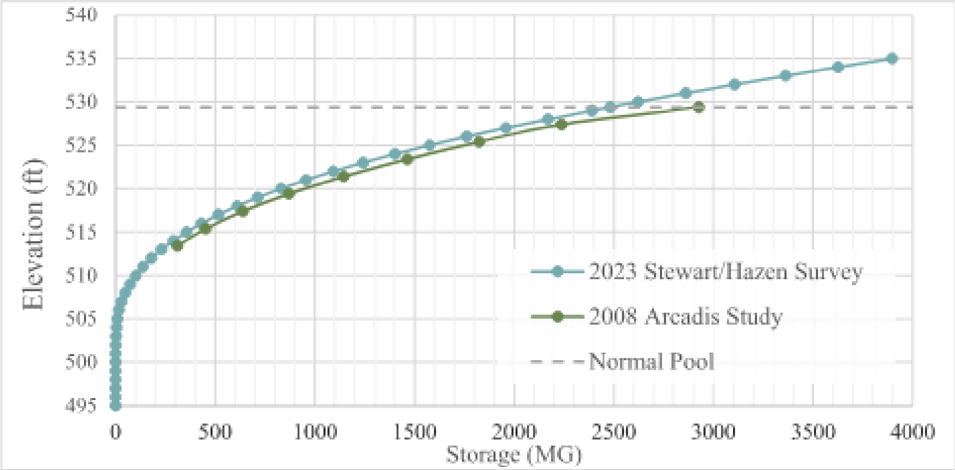
8% for WTP process water

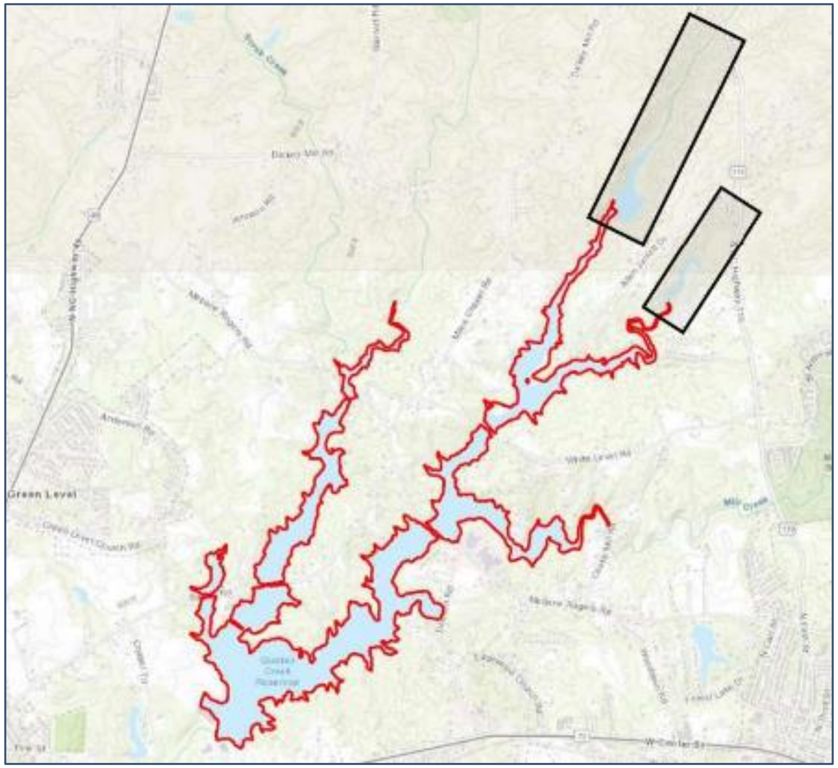


Topic 2: Safe Yield of Raw Water Supply Updated Using Bathymetic Survey and Reservoir Modeling

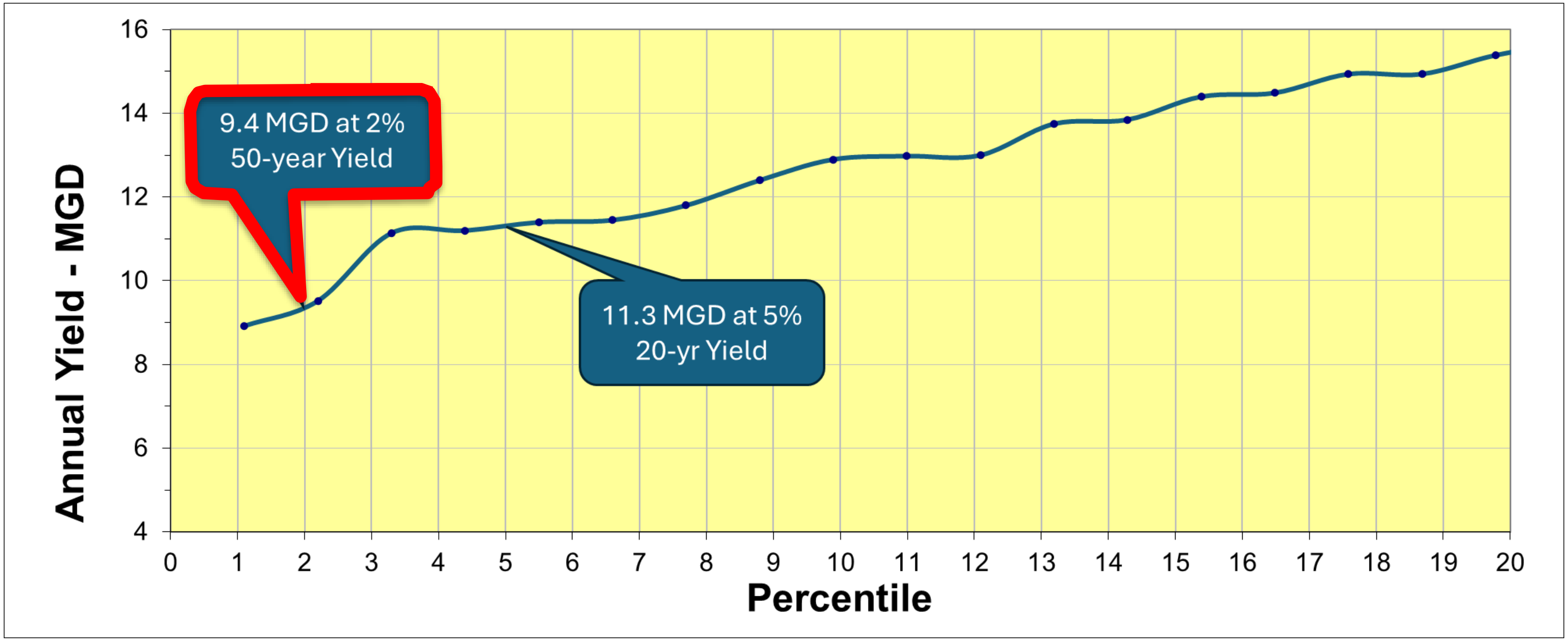
Stewart's reservoir study involved a comprehensive survey of the lake floor and surrounding areas up to the 535-foot contour line

Hazen's hydrologic modeling used OASIS software to evaluate safe yield of the raw water supply for the Graham-Mebane Water Plant



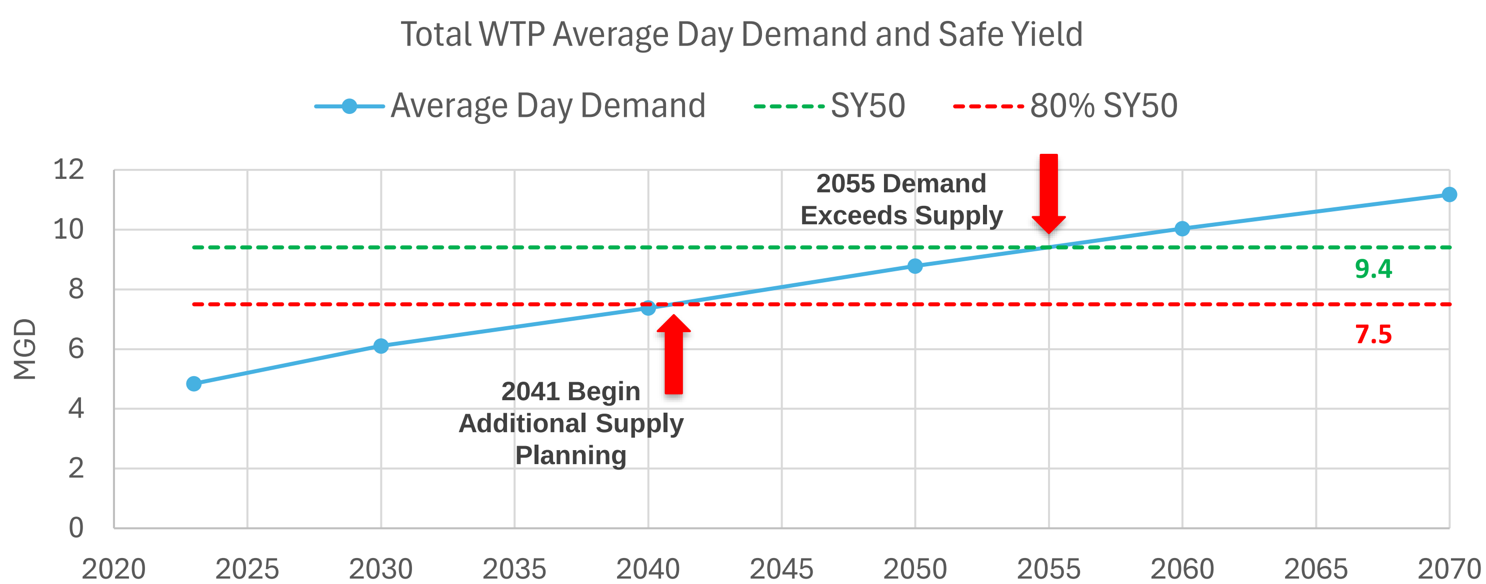


Yield Return Frequency from OASIS Model
9.4 mgd is the 50-year Safe Yield



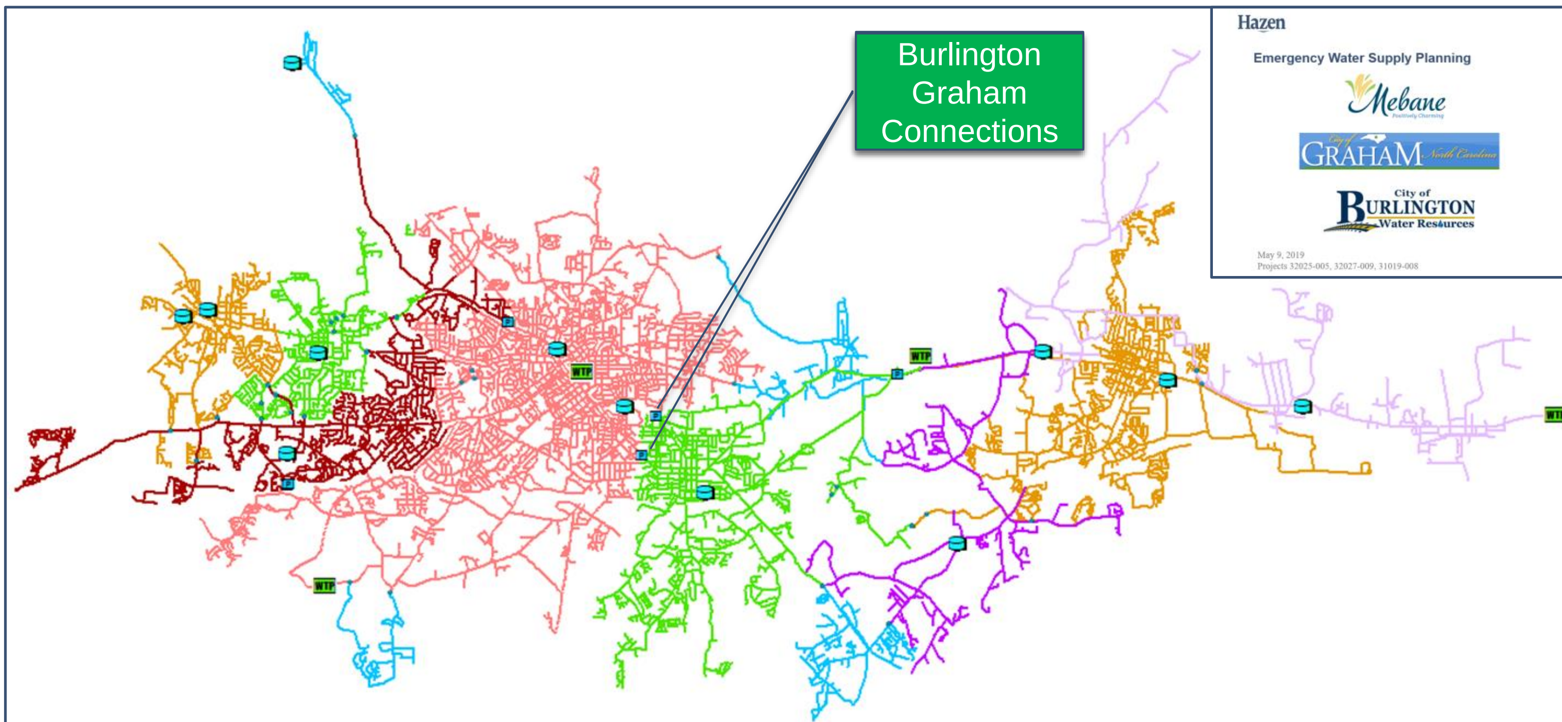
Combined Mebane and Graham Average Day Demand Exceeds Safe Yield of Raw Water Supply by 2055

	2023	2030	2040	2050	2060	2070
Average Water Use -mgd:						
Mebane Service Area (2023 LWSP)	2.068	2.747	3.365	3.974	4.611	5.260
Graham Service Area (Revised)	2.062	2.203	2.753	3.442	3.958	4.354
Green Level & Swepsonville (contract limits)	0.310	0.665	0.665	0.665	0.665	0.665
Total Average Day Demand - mgd	4.440	5.614	6.782	8.081	9.233	10.278
WTP Process Water at 8% - mgd	0.400	0.488	0.590	0.703	0.803	0.894
Total Raw Water Withdrawal - mgd	4.840	6.102	7.372	8.783	10.036	11.172
2024 HAZEN 50-Year Safe Yield - mgd	9.4	9.4	9.4	9.4	9.4	9.4
80% of 50-Yr Safe Yield - mgd	7.5	7.5	7.5	7.5	7.5	7.5



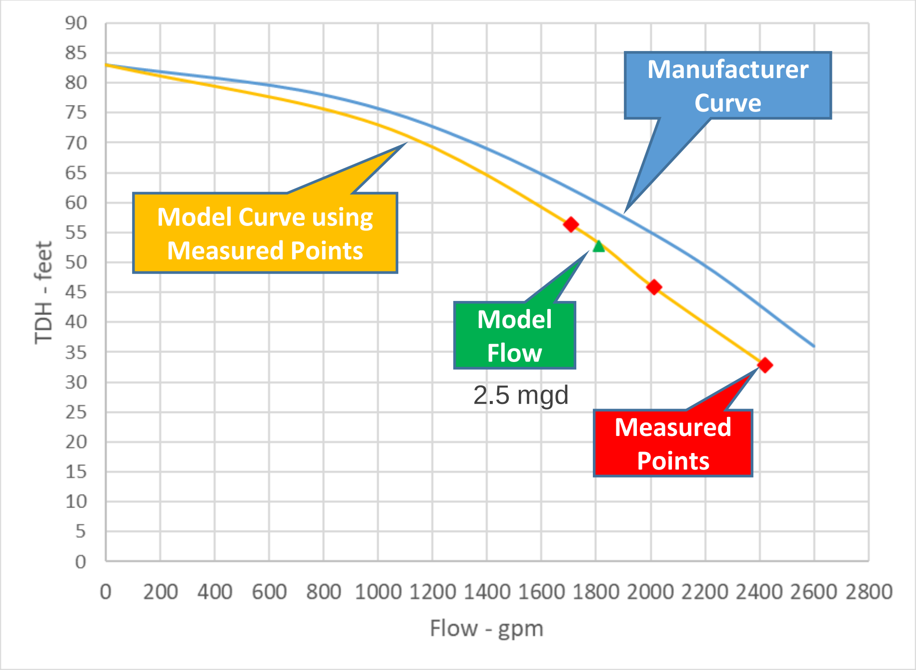
How to Delay the Need for Additional Raw Water Supply

Purchase water continuously from Burlington using two existing connections based on modeling from 2019 Emergency Water Supply Study

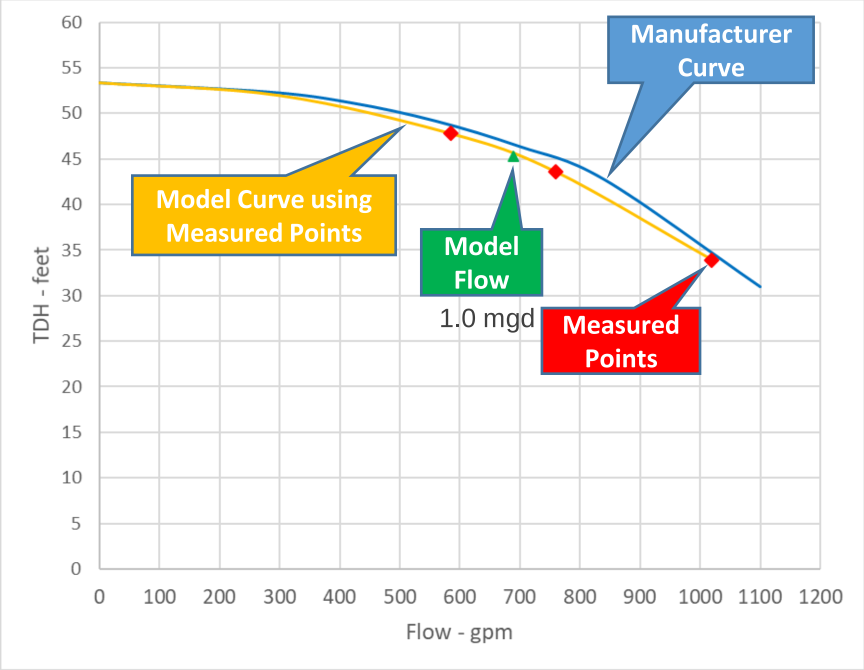


Transferring Water from Burlington to Graham Frees Up Plant Capacity to Supply Mebane and Delays Need for Additional Raw Water Supply

Graham-Hopedale Pump Station

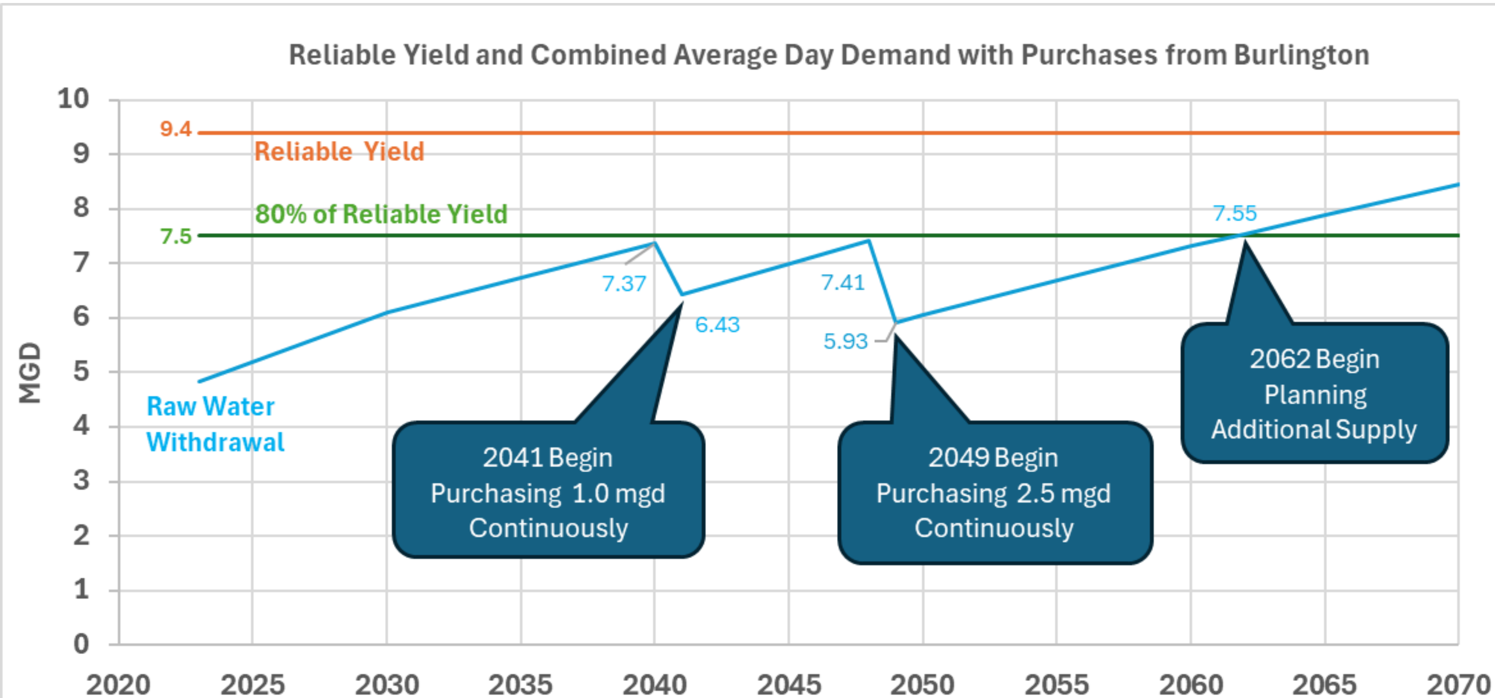


Webb Pump Station



Purchasing Water from Burlington Continuously By 2041 Delays Need for Additional Water Supply Beyond 2070

Year		2023	2030	2035	2040	2041	2045	2048	2049	2050	2055	2060	2062	2065	2070
Mebane Average Day Demand		2.07	2.75	3.06	3.37	3.43	3.67	3.85	3.91	3.97	4.29	4.61	4.74	4.94	5.26
Graham Average Day Demand		2.06	2.20	2.48	2.75	2.82	3.10	3.30	3.37	3.44	3.70	3.96	4.04	4.16	4.35
Graham Sales to Other Purchasers		0.31	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67
Combined Average Day Demand		4.44	5.62	6.20	6.78	6.91	7.43	7.82	7.95	8.08	8.66	9.23	9.44	9.76	10.28
Continuous Purchase from Burlington		0.00	0.00	0.00	0.00	-1.00	-1.00	-1.00	-2.50	-2.50	-2.50	-2.50	-2.50	-2.50	-2.50
Water Supplied from WTP		4.44	5.62	6.20	6.78	5.91	6.43	6.82	5.45	5.58	6.16	6.73	6.94	7.26	7.78
WTP Process Water	8%	0.39	0.49	0.54	0.59	0.51	0.56	0.59	0.47	0.49	0.54	0.59	0.60	0.63	0.68
Total Raw Water Withdrawal		4.83	6.10	6.74	7.37	6.43	6.99	7.41	5.93	6.07	6.69	7.32	7.55	7.89	8.46
2024 Hazen 50-Year Reliable Yield		9.4	9.4	9.4	9.4	9.4	9.4	9.4	9.4	9.4	9.4	9.4	9.4	9.4	9.4
New Supply Plan at	80%	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5

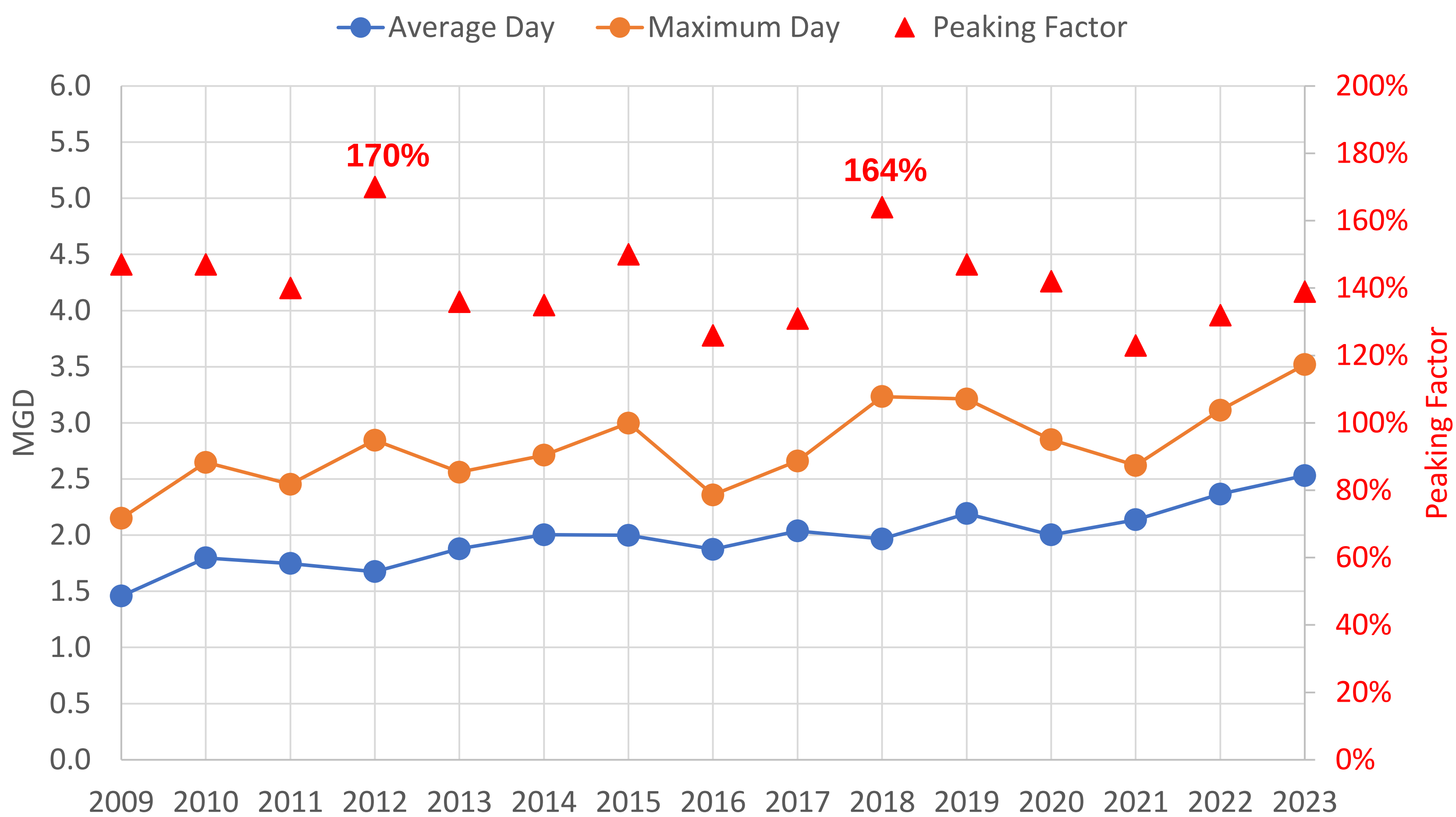


Topic 3: Water Treatment Plant Capacity Must Keep Pace With Maximum Day Demand

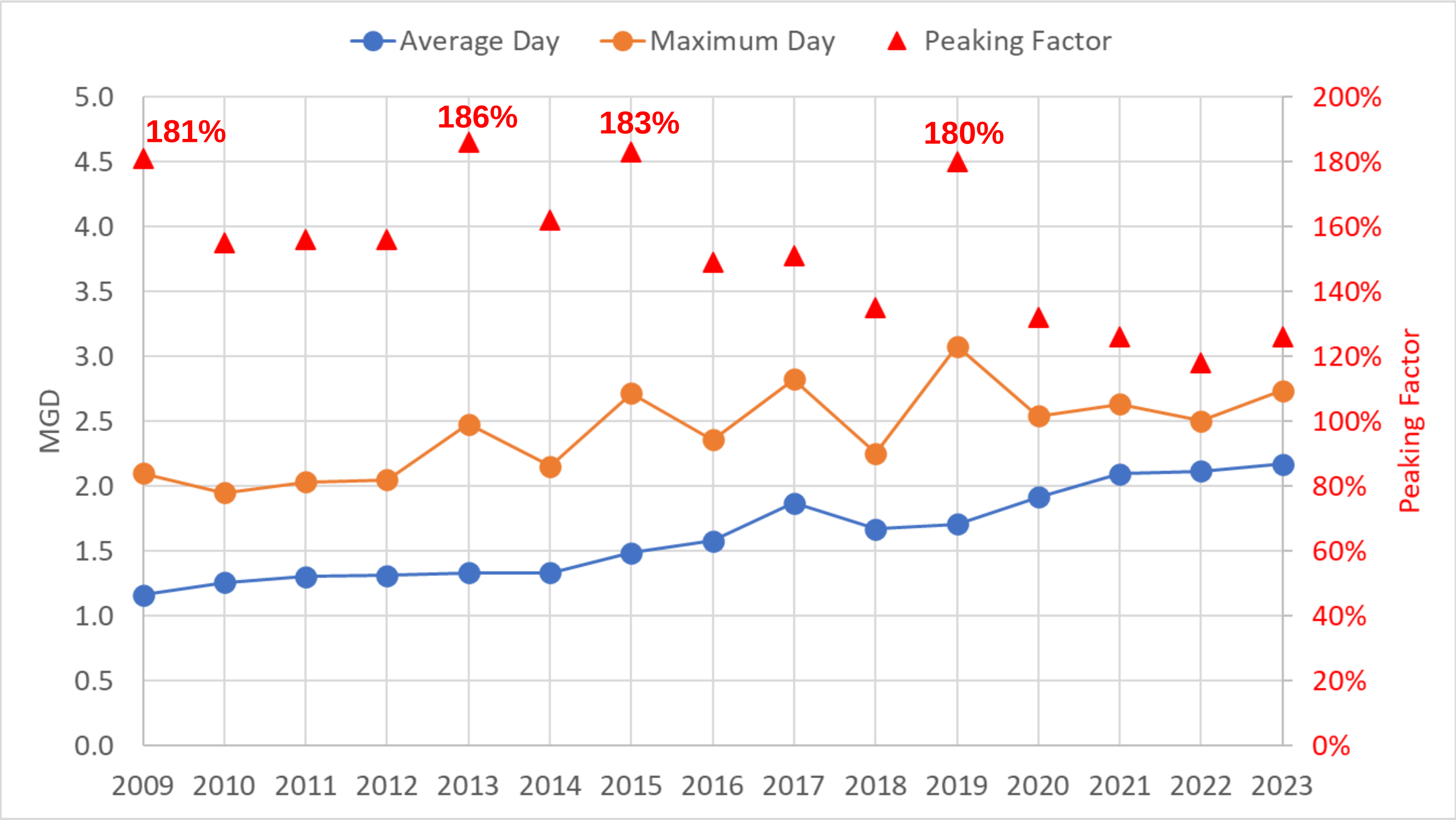
Water plant production must supply total maximum day demand in both systems concurrently to prevent emptying tanks and depleting reserves for fires

Maximum day demand for future years estimated by applying peaking factors to average day demand projections

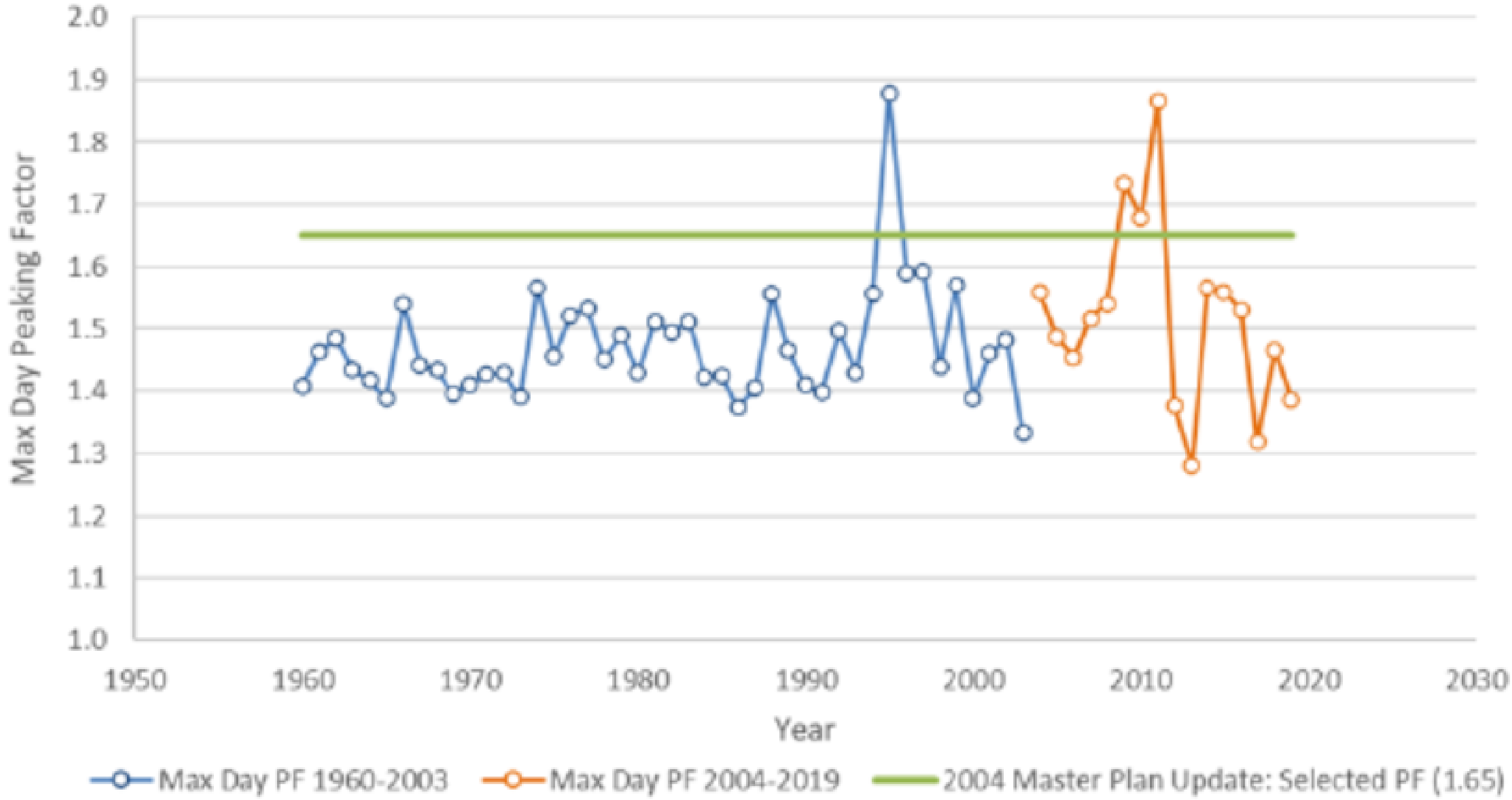
Graham's Demand Projections Use 165% Max Day Peaking Factor Based on Past Use in Drought Years



Mebane's Demand Projections Use 185% Max Day Peaking Factor Based on Past Use in Drought Years



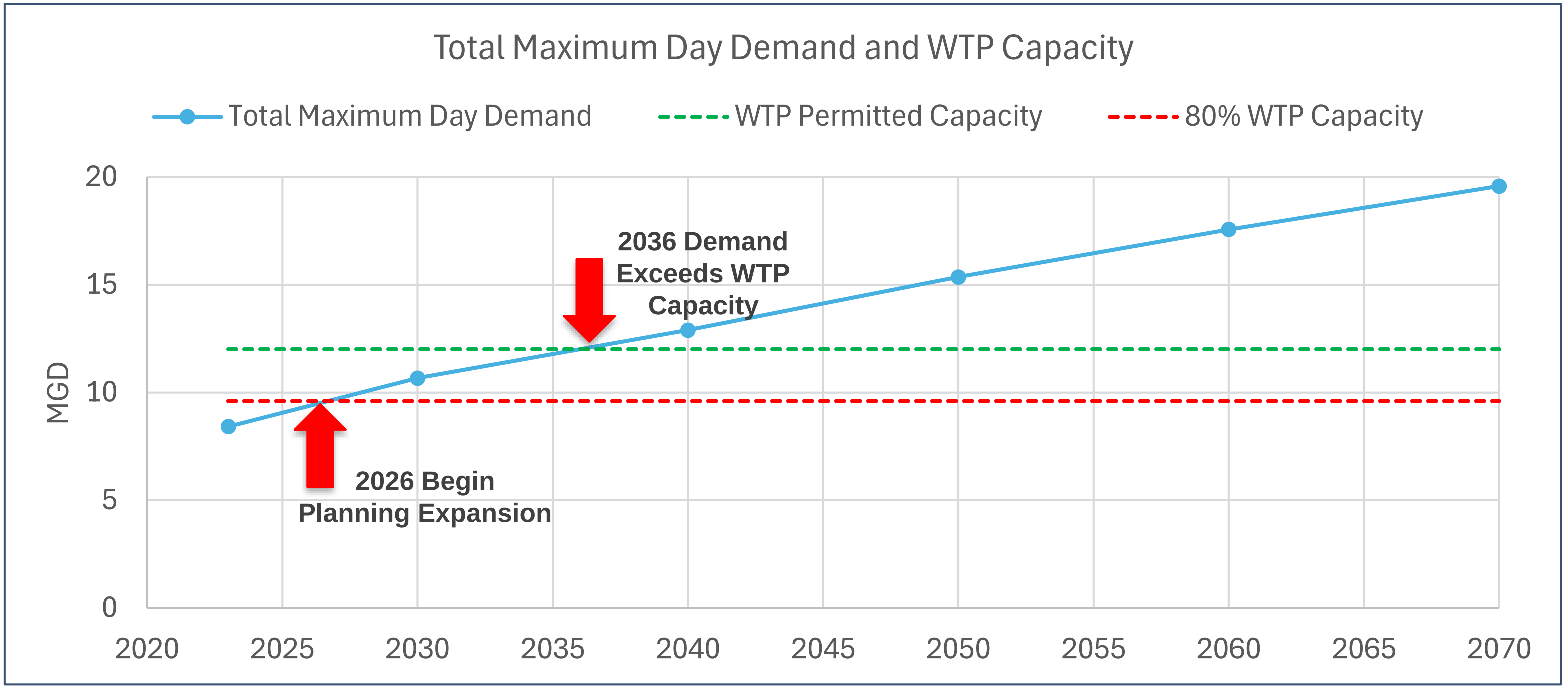
Burlington's Maximum Day Peaking Factors Similar to Mebane's Even Though System is Larger



Max Day Demand Projections with Historical Peaking Factors Exceed 12 MGD Permitted Capacity of Water Plant by 2036

Start Planning Expansion in 2026 When Max Day Hits 80% Capacity

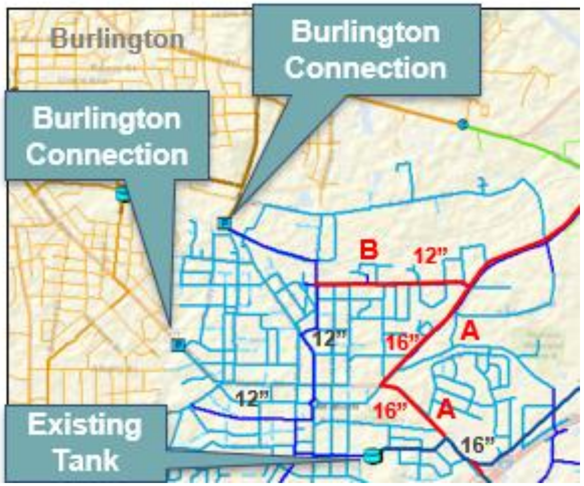
		2023	2030	2040	2050	2060	2070
Water Use -mgd:	-						
Mebane Maximum Day Demand at	185%	3.826	5.082	6.225	7.353	8.530	9.731
Graham Maximum Day Demand at	165%	3.914	4.731	5.638	6.775	7.627	8.280
Total Maximum Day Demand - mgd		7.740	9.813	11.863	14.128	16.157	18.011
WTP Process Water at 8% - mgd		0.673	0.853	1.032	1.229	1.405	1.566
Total Water Treated - mgd		8.413	10.666	12.895	15.357	17.562	19.577
WTP Permitted Capacity		12	12	12	12	12	12
80% WTP Capacity		9.6	9.6	9.6	9.6	9.6	9.6



Need for Additional Water Treatment Plant Capacity Can Be Deferred by Conservation or Purchased Supply

Mandatory conservation such as irrigating lawns on alternating days would reduce maximum day peaking factors

Purchasing finished water from Burlington would decrease needed supply from water plant

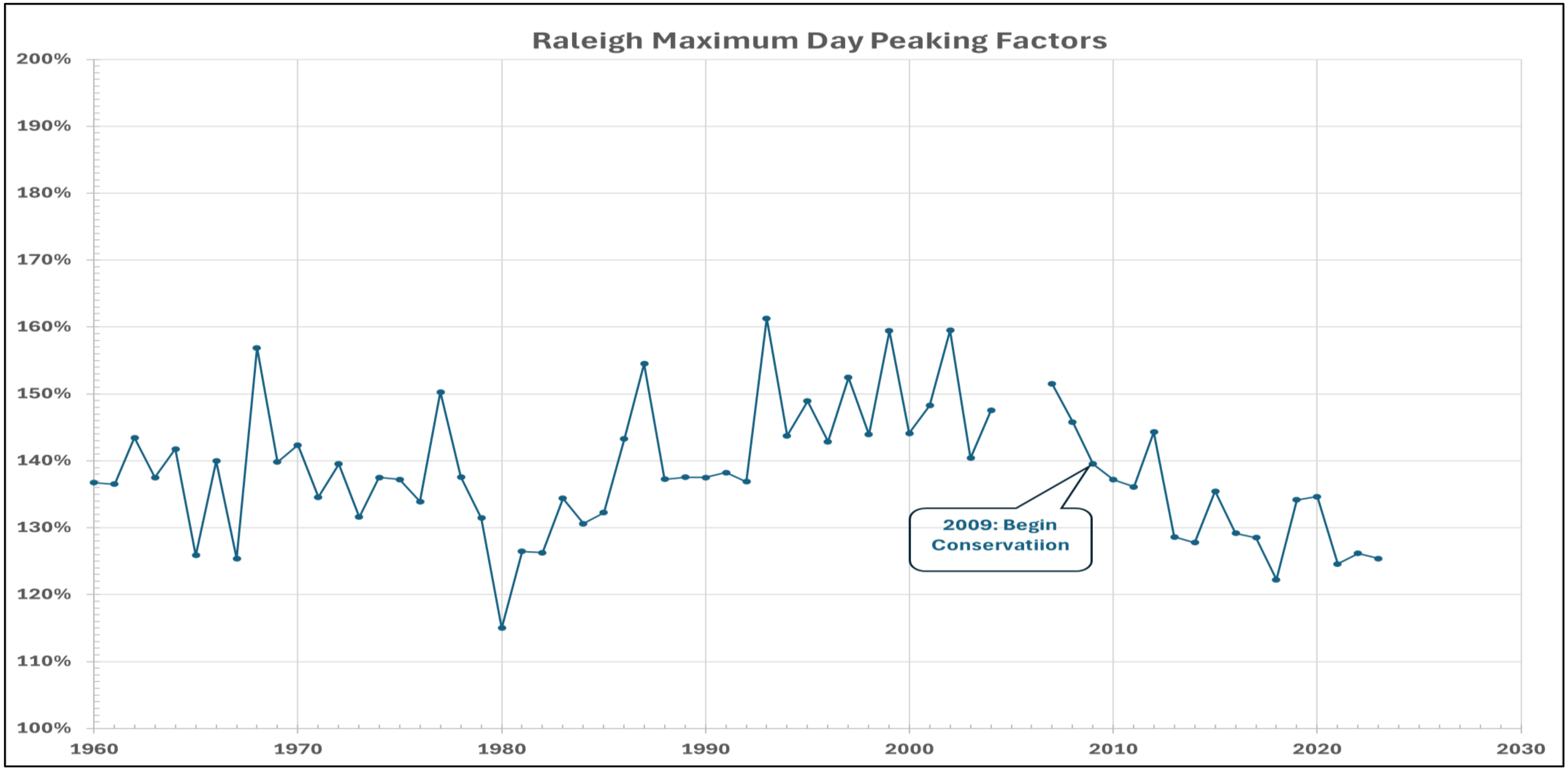


Conservation Suppresses Maximum Day Peaking Factors 140% is Reasonable Target Based on Raleigh's Program

Lawn irrigation in Raleigh permanently limited to three days per week:

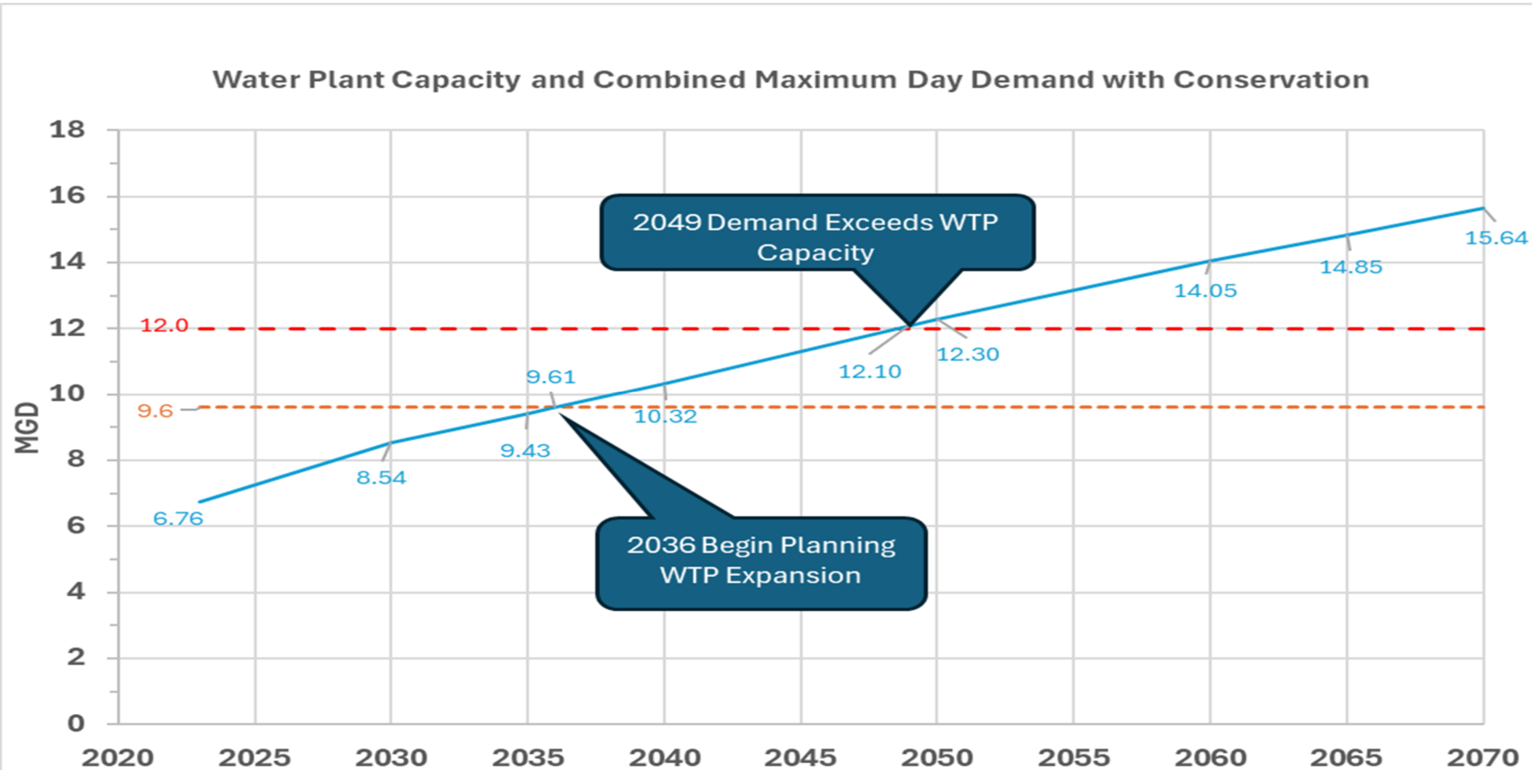
- Tuesdays, Thursdays and Saturdays for odd-numbered addresses
- Wednesdays, Fridays and Sundays for even numbered addresses

Peaking factor exceeded 140% only once in 15 years since enacting this program



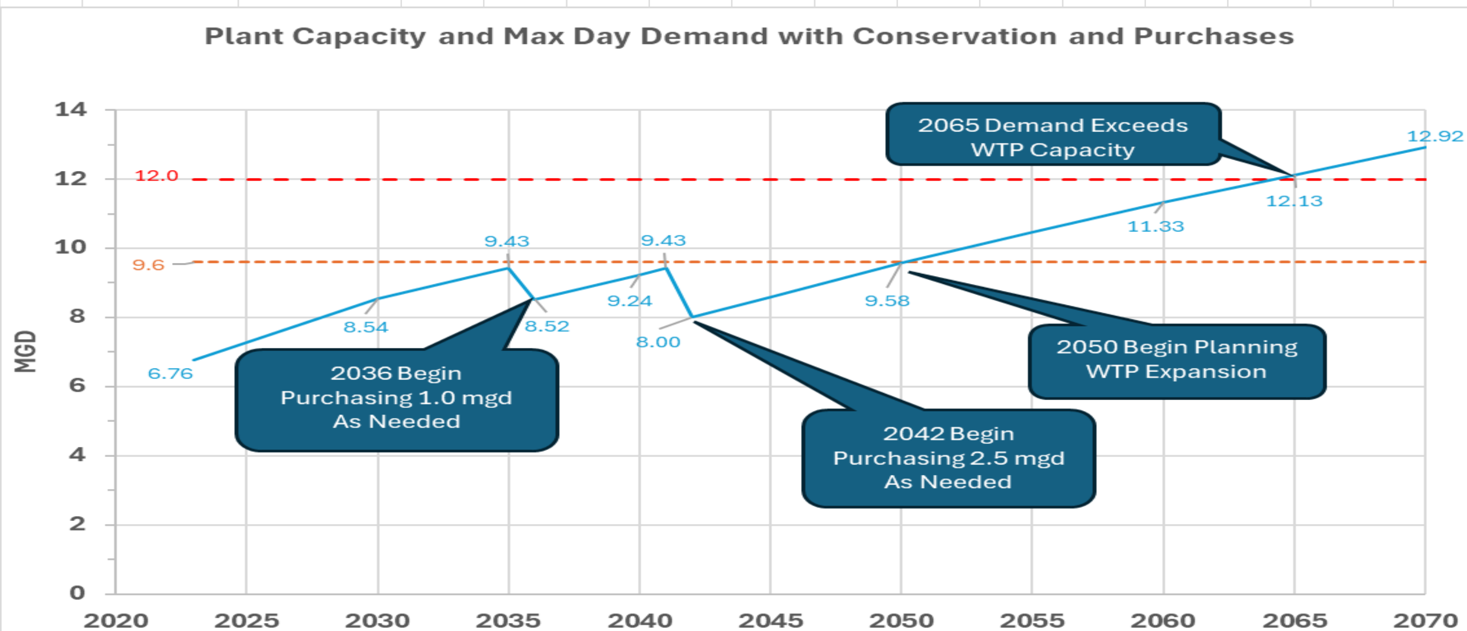
Conservation Could Defer Plant Expansion to 2049

Year		2023	2030	2035	2036	2040	2045	2049	2050	2055	2060	2065	2070
Mebane Average Day Demand - mgd		2.07	2.75	3.06	3.12	3.37	3.67	3.91	3.97	4.29	4.61	4.94	5.26
Graham Average Day Demand - mgd		2.06	2.20	2.48	2.53	2.75	3.10	3.37	3.44	3.70	3.96	4.16	4.35
Graham Sales to Others - mgd		0.31	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67
Mebane Max Day @	140%	2.90	3.85	4.28	4.36	4.71	5.14	5.48	5.56	6.01	6.46	6.91	7.36
Graham Max Day @	140%	3.32	4.02	4.40	4.48	4.79	5.27	5.65	5.75	6.11	6.47	6.75	7.03
Combined Max Day Demand - mgd		6.22	7.86	8.68	8.84	9.50	10.40	11.13	11.31	12.12	12.93	13.66	14.39
WTP ProcessWater@	8%	0.54	0.68	0.75	0.77	0.83	0.90	0.97	0.98	1.05	1.12	1.19	1.25
Total Water Supplied from WTP - mgd		**6.76**	**8.54**	**9.43**	**9.61**	**10.32**	**11.31**	**12.10**	**12.30**	**13.17**	**14.05**	**14.85**	**15.64**
WTP Capacity - mgd		12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0
WTP Planning Study@	80%	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6

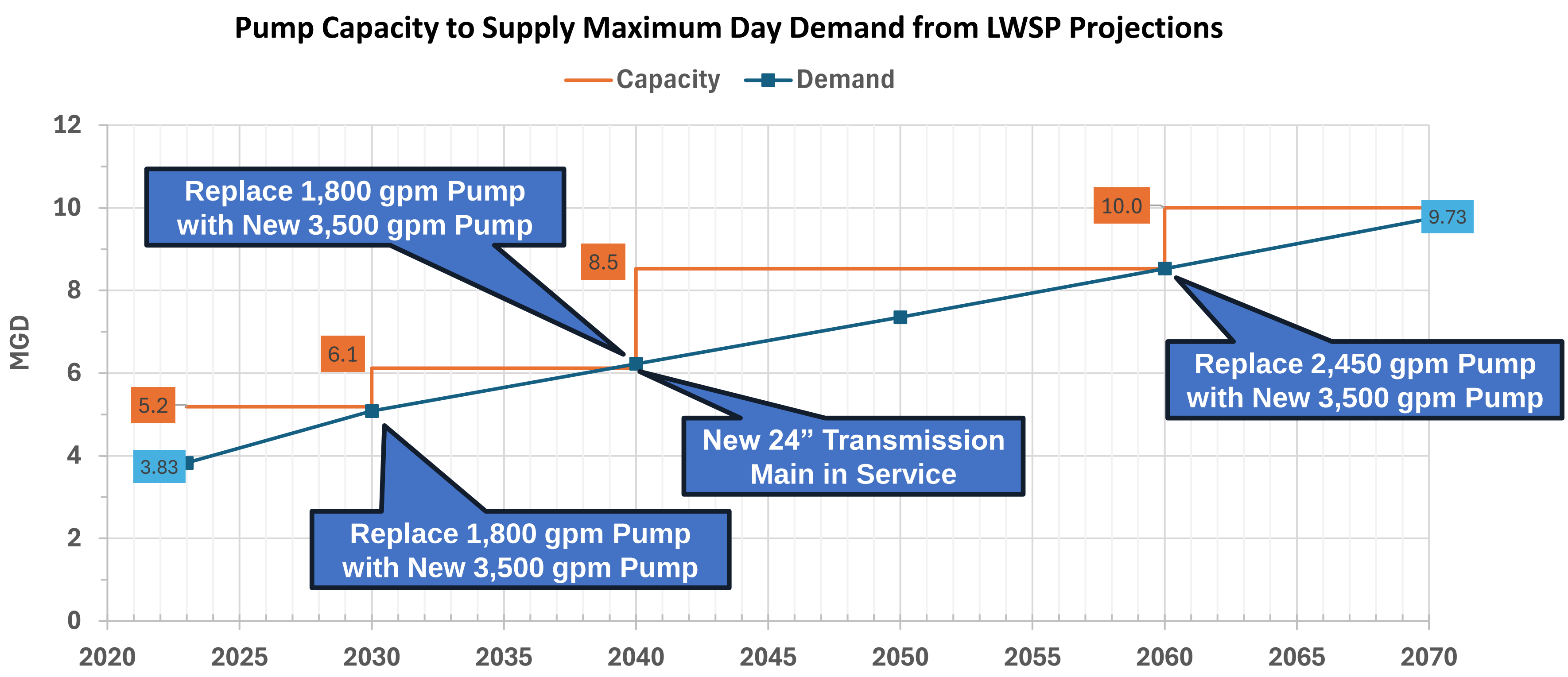


Purchasing Water from Burlington and Conservation Defers Need for Water Plant Expansion to 2065

Year		2023	2030	2035	2036	2040	2041	2042	2045	2050	2055	2060	2065	2070
Mebane Average Day Demand - mgd		2.07	2.75	3.06	3.12	3.37	3.43	3.49	3.67	3.97	4.29	4.61	4.94	5.26
Graham Average Day Demand - mgd		2.06	2.20	2.48	2.53	2.75	2.82	2.89	3.10	3.44	3.70	3.96	4.16	4.35
Graham Sales to Others - mgd		0.31	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67
Mebane Max Day @	140%	2.90	3.85	4.28	4.36	4.71	4.80	4.88	5.14	5.56	6.01	6.46	6.91	7.36
Graham Max Day @	140%	3.32	4.02	4.40	4.48	4.79	4.88	4.98	5.27	5.75	6.11	6.47	6.75	7.03
Combined Max Day Demand - mgd		6.22	7.86	8.68	8.84	9.50	9.68	9.86	10.40	11.31	12.12	12.93	13.66	14.39
Purchase from Burlington - mgd		0.00	0.00	0.00	-1.00	-1.00	-1.00	-2.50	-2.50	-2.50	-2.50	-2.50	-2.50	-2.50
Max Day Demand from WTP - mgd		6.22	7.86	8.68	7.84	8.50	8.68	7.36	7.90	8.81	9.62	10.43	11.16	11.89
WTP ProcessWater@	8%	0.54	0.68	0.75	0.68	0.74	0.75	0.64	0.69	0.77	0.84	0.91	0.97	1.03
Total Water Supplied from WTP - mgd		**6.76**	**8.54**	**9.43**	**8.52**	**9.24**	**9.43**	**8.00**	**8.59**	**9.58**	**10.46**	**11.33**	**12.13**	**12.92**



Mebane Finished Water Pump Capacity Must Keep Pace with Maximum Day Demand



Topic 4: Timeline for Improvements For Mebane's Distribution System by 2050

		Year	Maximum Day Demand mgd
★	Complete New 1 MG Elevated Tank	2025	4.18
•	Replace Existing 1,800 gpm Pump with New 3,500 gpm Pump	2030	5.08
•	Replace Existing 1,800 gpm Pump with New 3,500 gpm Pump	2040	6.23
•	24-inch Pipe – Center St (US 70)	2040	6.23
★	12-inch Pipe – Ninth St to Lebanon Rd	2043	6.62
★	16-inch Pipe – First St & Holt St to Eleventh St	2043	6.62

Last two improvements can be installed in 2043 to defer costs after installation of the 24-inch pipe.

- Improvements driven by Maximum Day Demands
- ★ Improvements driven by Fire Flows

Timing of Improvements for Graham-Mebane Water Supply

Raw Water Supply

Without Purchasing Water from Burlington

2041 Begin Planning Additional Water Supply
2055 Average Day Demand Exceeds Safe Yeild

With Purchased Water from Burlington

2041 Begin Purchasing 1 MGD Continuously
2049 Begin Purchasing 2.5 MGD Continuously
2062 Begin Planning Additional Water Supply

Water Treatment Plant

Without Conservation or Purchasing Water from Burlington

2026 Begin Planning Water Plant Expansion
2036 Maximum Day Demand Exceeds Water Plant Capacity

With Conservation

2036 Begin Planning Water Plant Expansion
2049 Maximum Day Demand Exceeds Water Plant Capacity

With Conservation and Purchasing Water from Burlington

2036 Begin Purchasing 1 MGD As Needed
2042 Begin Purchasing 2.5 MGD Burlington As Needed
2050 Begin Planning Water Plant Expansion
2065 Maximum Day Demand Exceeds Water Plant Capacity

Hazen

January 12, 2024

To: Tonya Mann, PE, Utilities Director, City of Graham, NC

From: Reed Palmer, PE, Senior Associate, Hazen and Sawyer
Yoko Koyama, EI, Assistant Engineer, Hazen and Sawyer
John Clayton, PE, Senior Associate, Hazen and Sawyer
Steven Nebiker, PE, Senior Associate, Hazen and Sawyer

cc: Aaron Babson, PE, Associate Vice President. Hazen and Sawyer
Jeff Cruickshank, PE, Associate Vice President. Hazen and Sawyer

Graham/Mebane Safe Yield Modeling

NORTH CAROLINA
PROFESSIONAL
SEAL
35092
ENGINEER
REED N. PALMER

1-12-2024

EXHIBIT H

Hazen

Table of Contents

1. Introduction

The Triangle and Triad Regions of North Carolina are experiencing accelerated growth, necessitating the adaptation of their water supply infrastructure to meet expanding demands. It is essential for the City of Graham's water supply to stay ahead of this growth and in control of its water supply future. Doing so requires a comprehensive understanding of the safe yield of Graham-Mebane Lake.

The safe yield of the reservoir, in conjunction with the service area demand forecast, will significantly influence the City's ability to obtain permits for expanding its water treatment plant (WTP). Determining the permissible size of the WTP and projecting demand growth will play a pivotal role in identifying the appropriate timing and location for expanding the distribution system. Additionally, it will determine whether the City needs to reinforce its supply system by expanding purchase contracts from neighboring utilities.

Graham-Mebane Lake currently serves as the drinking water source for a population of approximately 40,000 in the towns of Graham and Mebane. To ensure a sustainable water supply, the City of Graham selected Hazen and Sawyer to conduct a Reservoir Water Supply Study to assess supply reliability. The study included a hydrographic survey the reservoir.

2. Basic Introduction to Reservoir Modeling

The Cape-Fear Neuse River basin Hydrologic Model using OASIS software was used to evaluate the safe yield of the Graham-Mebane Reservoir. Hydrologic models like OASIS are mass balance models that track the movement of water along stream and river networks and in and out of reservoirs. Figure 2-1 shows the mass balance components for a typical reservoir like Graham-Mebane Lake. This diagram shows the volumetric units in million gallons (MG) and flow in million gallons per day (MGD). Components include:

- Storage, $S_t\ and S_{t-1}$: the amount of water stored in the Graham-Mebane Lake at the end of day t or the previous day, *t-1*
- Inflows, I_t: the amount of surface water runoff into the lake during day t
- Net evaporation loss, L_t: the difference between the amount of evaporation from and precipitation onto the lake during day t
- Flow out of reservoir, O_t: during day t, any minimum releases when the lake is below full and any spills when the lake is full
- Demand, D_t: the amount of raw water withdrawn through the intake for drinking water supply on during day t

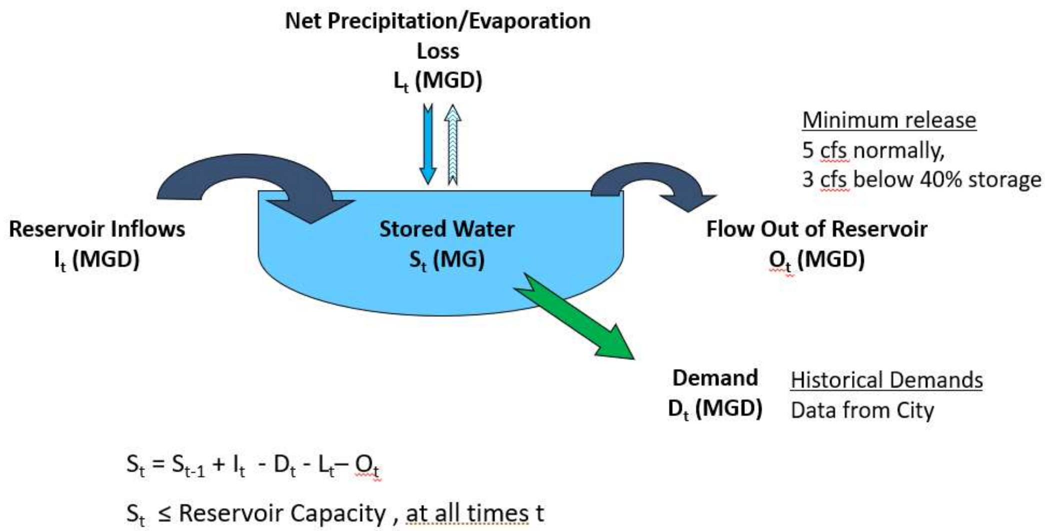


Figure 2-1: Basic Reservoir Storage Modeling.

The resulting final equation for the mass balance model is:

Equation 2-1

$$S_t = S_{t-1} + I_t - D_t - L_t - O_t$$

Together with a mathematical relationship between reservoir storage, surface area, and elevation (SAE), storage can be translated into reservoir elevation and surface area.

The key to accurately simulating the water level in such a mass balance model is the data quality of each component in the equation shown in Equation 2-1. Accuracy in the storage component of the model was improved via the hydrographic survey that was conducted at the beginning of this study and is described in detail in Section 3. However, the greatest uncertainty in hydrologic mass balance models is typically in the inflow portion of the equation. A significant effort went into arriving at an accurate facsimile of inflow to the reservoir. Streamflow gages are often not located in close proximity to reservoirs, so estimates need to be made. These are tested through the process of inflow verification which is described in Section 4.

3. Bathymetric Survey & Sedimentation Rates

A proper hydrographic survey will serve two main goals in estimating an accurate safe yield for Graham-Mebane Lake, which are:

1. Provide an accurate estimate of the accessible storage volume in the lake – a key parameter for the reservoir model
2. Allow estimation of the average sedimentation rate by comparing this survey with prior reservoir volume estimates: This is important for estimating the safe yield decades into the future

To serve the above goals, the bathymetric (underwater) portion of the survey employed *echosound technology* by Stewart Inc. A combination of conventional on-the-ground and aerial survey techniques was utilized to capture areas above the water line. The survey took place during the winter when leaves were off the trees, providing a better view of the ground from the air and enhancing accuracy. A complete hydrographic contour map of the reservoir and its littoral boundaries with 2-foot contours was developed following the survey.

3.1 Bathymetric Survey of Graham-Mebane Lake

The reservoir survey involved a comprehensive survey covered the lake floor and surrounding areas up to the 535-foot contour line. The study utilized bathymetric and aerial surveys, as well as data from North Carolina's Spatial Data Download Program. The survey equipment included single beam and dual-frequency echosounders linked with GPS receivers, as well as lidar and photogrammetric sensors on crewed aircraft. Data collection involved mapping the lake perimeter using aerial data and confirming it in the field, collecting underwater and sediment depth points at specified intervals, and investigating stream features. Data processing and mapping were performed using AutoCad Civil 3D to create contour and volume data for the underwater and adjacent terrestrial surfaces.

The survey results provided information on the project area, top of dam elevation, normal pool level, lake surface area, lake volume, and sediment volume. Quality control measures were implemented throughout the project, including multiple observations on control points, evaluation of results from different equipment types, and independent review of calculations. The deliverables for the project included CAD survey drawings, a point database, CAD surface TIN, a stage-storage-surface area curve, and heat maps of water and sediment depths and a brief technical memorandum.

The survey techniques and methods used in the project adhered to contract specifications and regulations outlined in the North Carolina Administrative Code. The bathymetric data collection techniques followed guidelines published by the US Army Corps of Engineers in EM 1110-2-1003 – Hydrographic Surveying Standards.

The surveyed area included the lake indicated by the lake border and supplemental study areas denoted by boxes in Figure 3-1. Data from the Civil 3D volume processing was used to populate a spreadsheet with reservoir volume and reservoir surface area at one-foot intervals. The vertical datum used for all data was NAVD 88 and horizontal datum used was NAD83. A separate dataset was developed specifically for the lake area north of the “Old Dam”, which was submerged upon construction of the current dam. The old dam crest is at 519’ elevation. The volume retained upstream of the “Old Dam” and below 519’ elevation was recorded as 97 MG. The survey of the Graham-Mebane Lake was conducted in early 2023 and the detailed report is included as Appendix A.

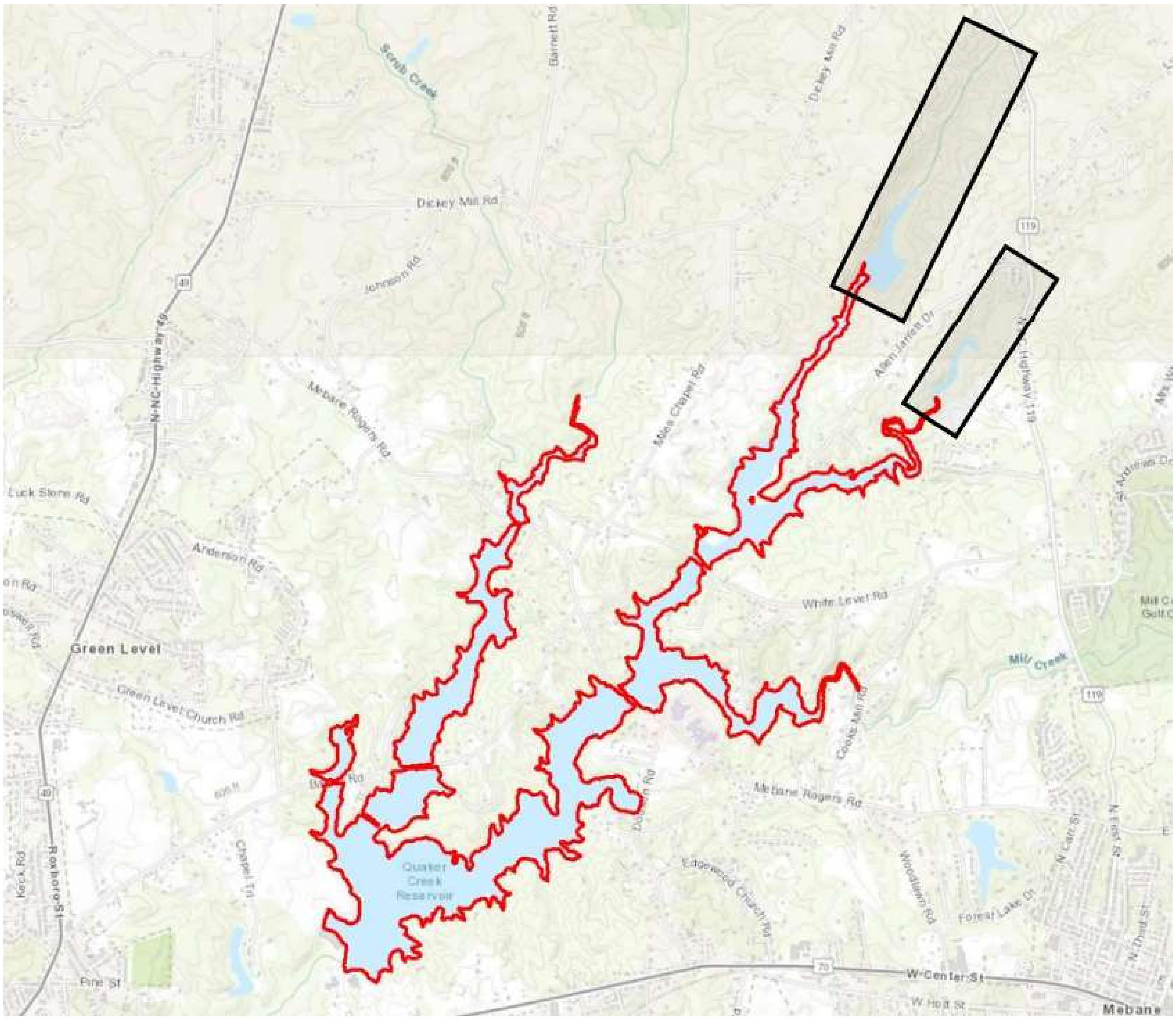


Figure 3-1: Focus Areas for the Graham-Mebane Lake Bathymetric Survey.

3.2 Survey Results

The drainage area of the Graham-Mebane Lake was found to be 66 mi^2 via watershed delineation completed using USGS Streamstats Version 4. The area map of the watershed draining to Graham-Mebane Lake is shown below in Figure 3-2.

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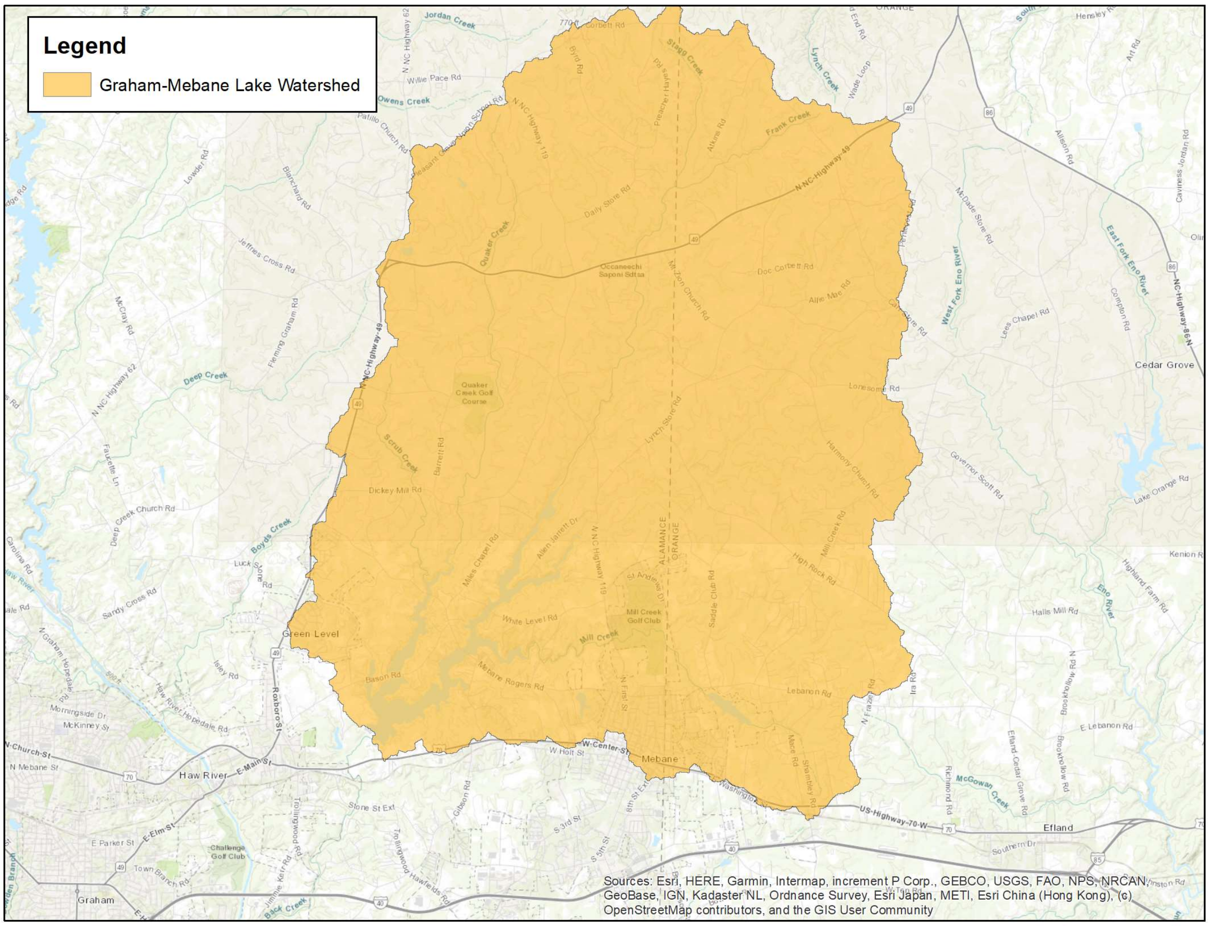


Figure 3-2: Watershed area of Graham-Mebane Lake.

A storage-area-curve (SAE) was developed from the survey results and presented in Figure 3-3. In Figure 3-3, the old SAE curve from the Arcadis study (2008) is also presented for comparison. The previous SAE curve included in the Arcadis study did not indicate any accounting for the inaccessible area/volume below the elevation of the Old Dam. In this study, the volume of the storage that is not accessible due to the old dam has been removed from the storage curve. The area that is upstream of the old dam is illustrated in Figure 3-4.

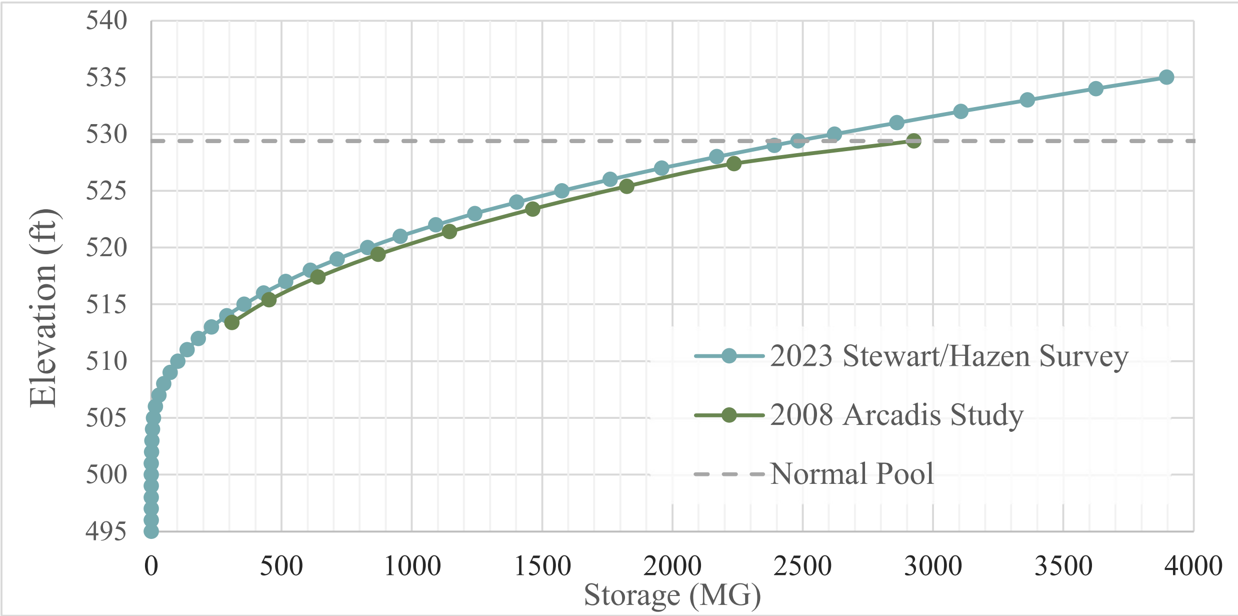


Figure 3-3: Storage-Area-Elevation (SAE) curve

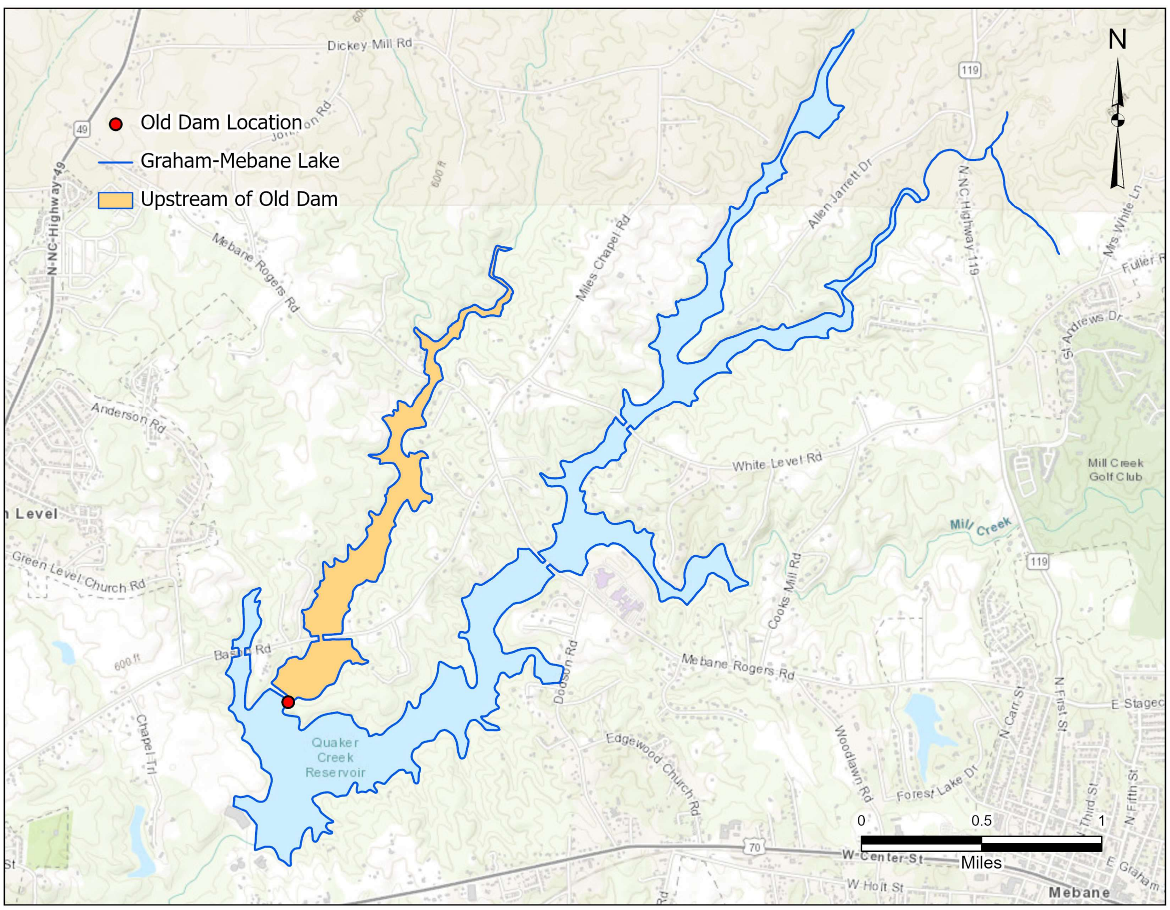


Figure 3-4: Graham-Mebane Lake Areas Upstream and Downstream of Old Dam

3.3 Sedimentation Rate Findings

Sedimentation transportation and deposition is a natural process in most water bodies but has a deleterious impact on most reservoirs because the decreased water velocities within reservoirs allows much of the sediment load from tributaries to accumulate and displace volume intended to store water.

Table 3-1 Summary of reservoir storage findings

Property	Value
Back-calculated Pre-impoundment Storage Estimate	2926 MG
2023 Survey Total Storage	2499 MG
Drainage Area of Reservoir	66.1 sq. miles

Sedimentation rates were calculated via three methods. The first method used the difference in storage between the pre-impoundment storage estimate and the hydrographic survey done as part of this study. It results in a high calculated value of the sediment accumulation rate. The second and third methods employed the estimated volume of sediment on the bottom of the lake based on the recent hydrographic survey. Details on the three methods can be found in Appendix B.

Table 3-2: Summary of Sedimentation Rate Calculations

Property	Value
Elapsed time since impoundment	29 -47 years
Implied Lost Storage from Post & Pre-impoundment studies	427 MG (1306 AF)
Implied Sedimentation Rate from Post & Pre-impoundment studies (first method, Appendix B)	0.41 – 0.71 AF/yr/sq. mi.
Sediment Volume from dual frequency hydrographic survey	572,318 cubic yards or 355 acre-feet (AF) or 116 MG
Implied Sedimentation Rate from (second method, Appendix B)	0.11~0.19 AF/yr/sq. mi.
Implied Sedimentation Rate from (third method, Appendix B)	0.16 AF/yr/sq. mi

Prior experience as well as a comparison of the calculated sedimentation rates to available literature values (Figure 3-5) led us to conclude that the second and third methods are more representative of the ongoing sediment deposition process in the lake. The range in methods 1 and 2 as shown on Figure 3-5 represent an assumption that the sediment accumulated over a 47 year period (lower bound) or 29 year period (upper bound). Since the area upstream of the Old Dam has been impounded for 47 years and the remainder of the reservoir for the last 29 years, the overall sedimentation rate is between these bounds and for Method 2, a uniform sedimentation rate would be 0.16 AF/year/mi^2.

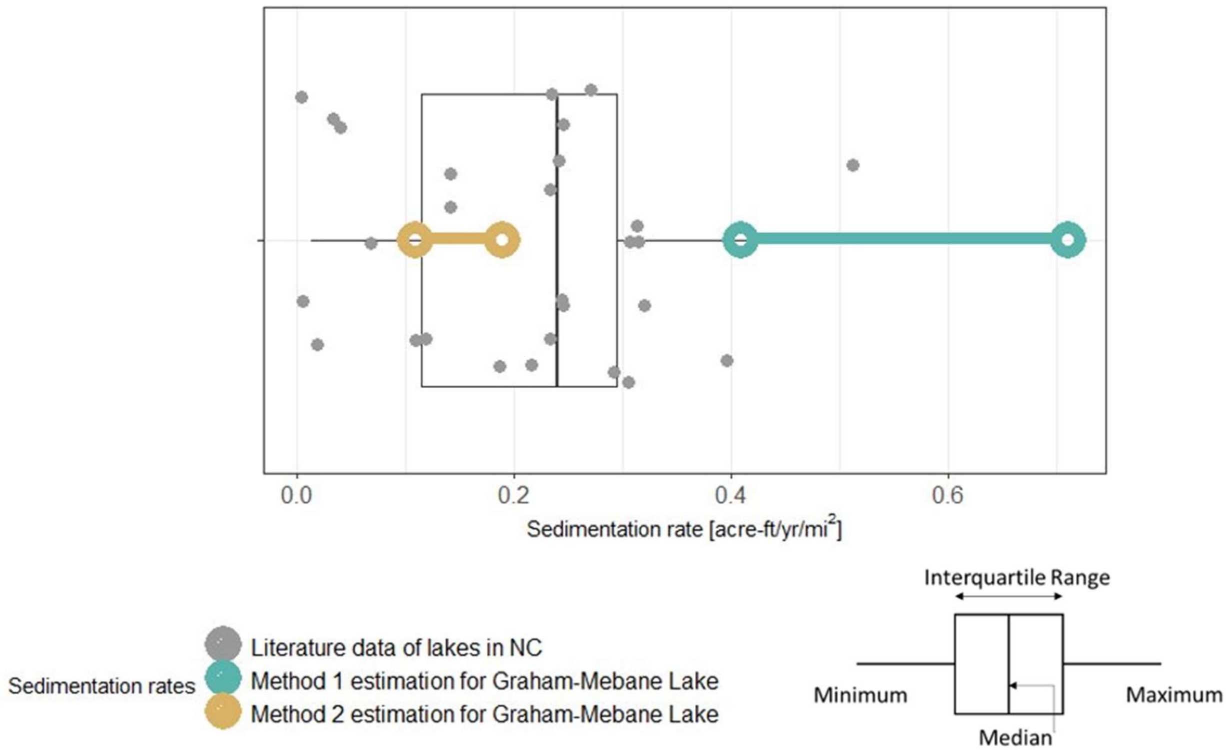


Figure 3-5: Comparisons of Three Sedimentation Methods Calculations to Typical Regional Sedimentation Rates[1]

[1] Anna J. Petryniak and Apple B. Loveless, "B. Everett Jordan Dam Sedimentation Rates and Reservoir Capacity", Duke University – Nicholas Institute for Environmental Policy Solutions (June 2013).

4. OASIS Model & Modeling Assumptions

The safe yield analysis utilized the Cape Fear/Neuse OASIS model developed by Hazen in 2010 for the NC Division of Water Resources to help with basin-wide planning (Figure 4-1). This model simulates streams, rivers, and reservoir and other water management operations throughout the basin based on naturalized inflow observations and estimates spanning from January 1, 1930 to September 30, 2020, or roughly 90 years. Hazen updated the portions of the model related to Graham-Mebane Lake (Figure 4-2) to incorporate the new SAE information and updated lake inflows based on model validation specific to Graham Mebane Lake.

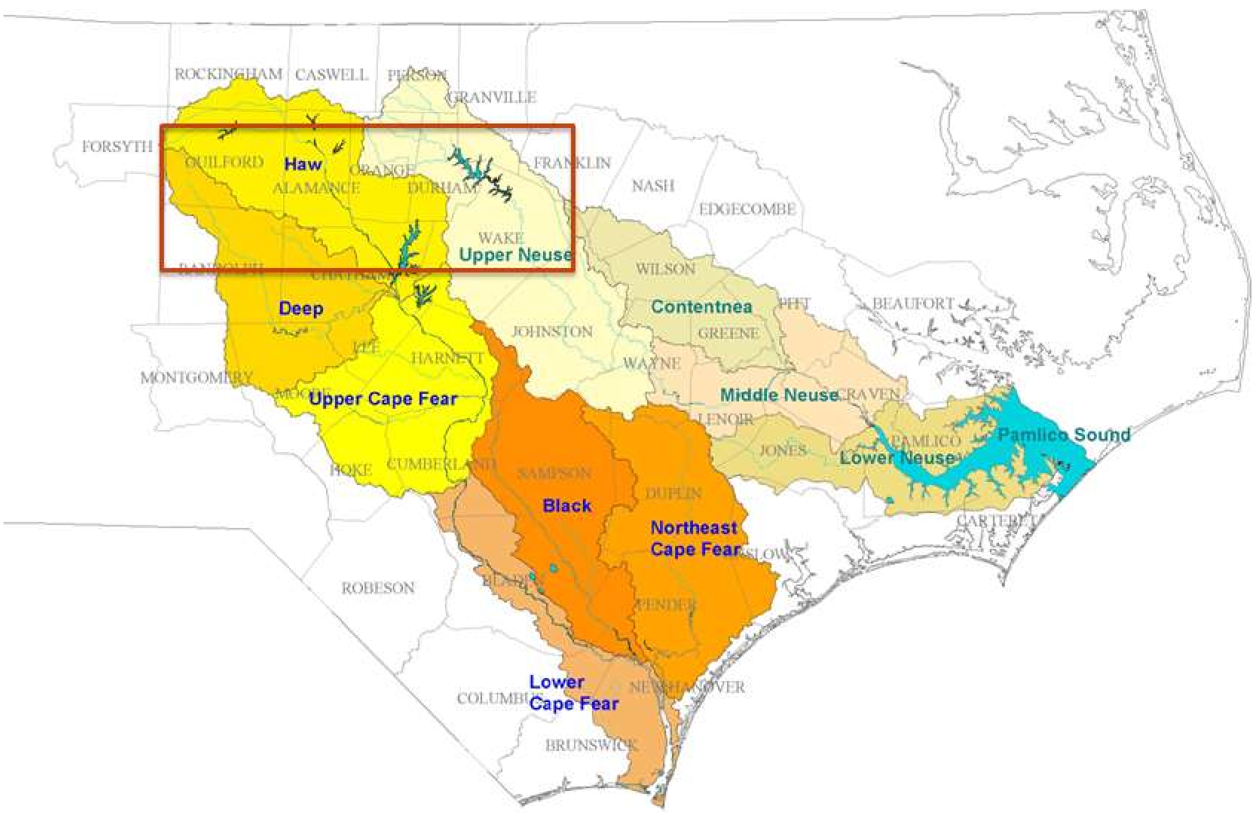


Figure 4-1: The Cape Fear/Neuse OASIS Model (Basins Shown Without Schematic Detail). Box Shows Extent of Detail Map in Figure 4-2.

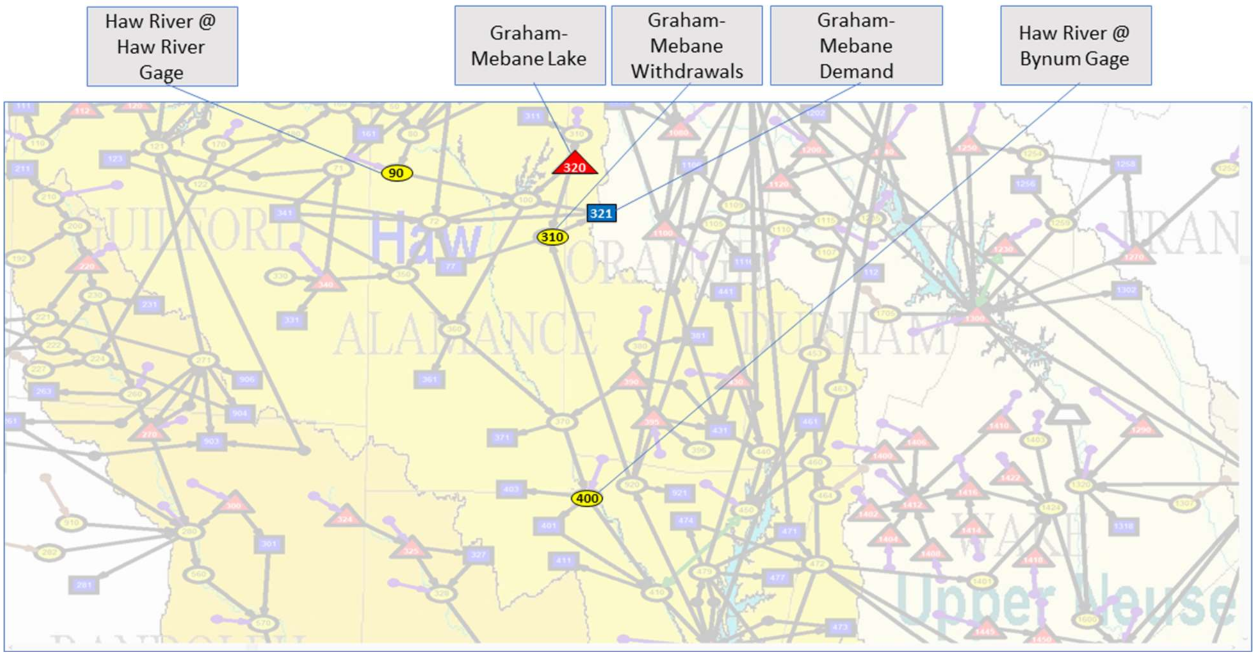


Figure 4-2: Schematic Detail in Region Surrounding Graham-Mebane Lake with Nodes Relevant to Safe Yield Study.

4.1 Reservoir SAE Relationship

Updates to the reservoir SAE curve incorporated the bathymetry work from this study provided in Figure 3-3. The total storage volume at the normal pool elevation of the reservoir, 529.4 ft, is 2481 MG. However, the accessible (i.e. usable) storage volume is marginally less than this total volume. Figure 4-3 calls out the invert elevations of intake gate #2 and intake gate #3 on the 1973 Piatt drawing set for the Raw Water Pump Station (Sheet GM / 114). Figure 4-4 shows the intake depths for intakes 2 and 3 within context of the new SAE curve. The usable storage at full pool is approximately 2475 MG assuming Intake #3 is used for withdrawals. About 2300 MG can be accessed via Intake Gate #2. For the safe yield estimates, we have assumed that the 175 MG below Gate #2 would be held in reserve. In other words, the model is only drawing the reservoir down to the bottom of Gate #2 when determining the safe yield.

4.2 Lake Inflow Estimation

The Graham-Mebane Lake inflows contained in the original Cape Fear/Neuse Model were originally developed in 2004 as part of original model development and were subsequently updated in 2011. At that time no precise information on reservoir elevation and withdrawals was available. Historical lake elevation data were made available for the current safe yield study, allowing a more informed estimate of lake inflows to be developed.

Ideally, lake inflow estimates would be based on stream discharge at gages within the lake's upstream drainage area. Since no such stations exist, inflows had to be estimated using flow records for nearby gages outside the lake drainage area. Inflow time series estimates were calculated from these flow records using drainage area ratios:

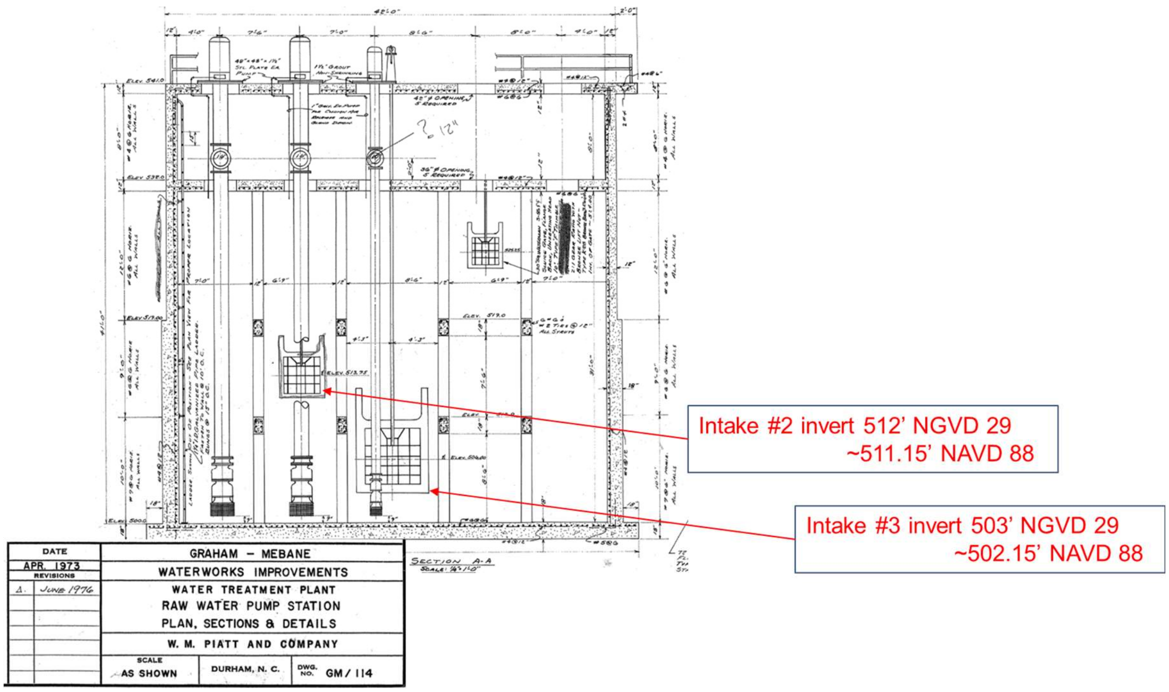


Figure 4-3: Elevations of Middle and Lower Intakes.

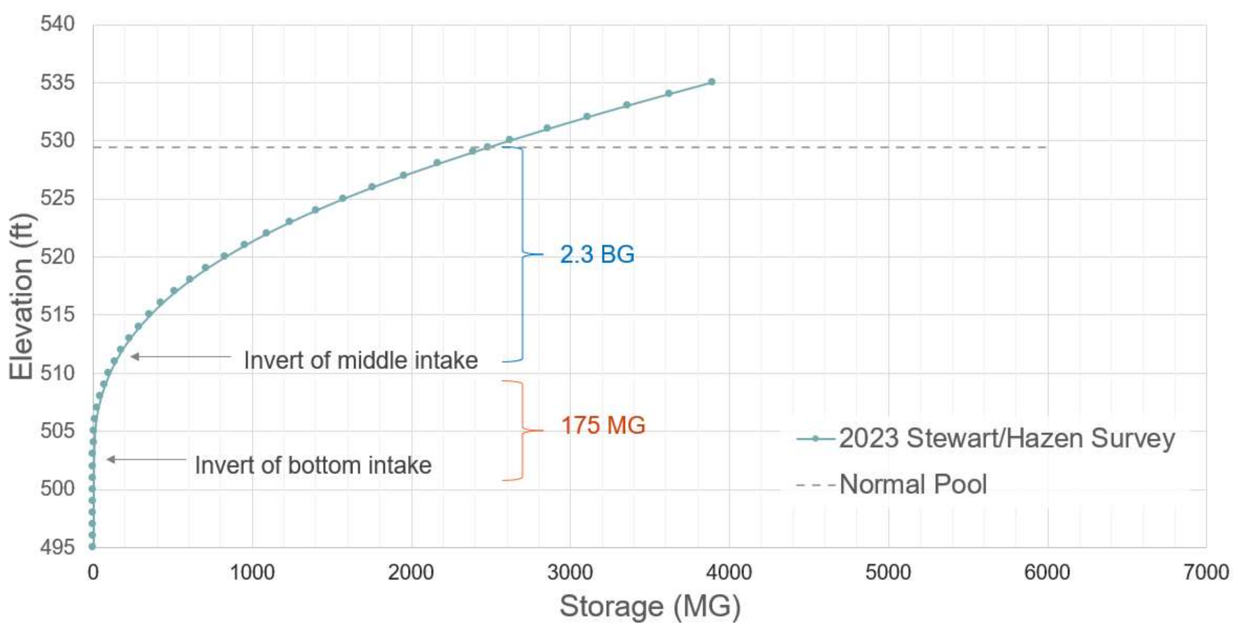


Figure 4-4: Elevations of Normal Pool and Middle and Lower Intakes Within Context of the New SAE Curve.

Equation4-1

$$I_t = Q_{gage,t} \times \frac{A_{lake}}{A_{gage}}$$

where I_t is lake inflow on day t, $Q_{gage,t}$ is flow on day t at the reference gage, and A_{lake} and A_{gage} are the watershed areas upstream of the dam and reference gage, respectively. Four reference data sets were identified as potential references (Table 4-1, Figure 4-5) including

- "Haw River" option: Haw River flow at Haw River, NC (USGS gage 02906500)
- "Haw River to Bynum Gain" option: Incremental flow between Haw River at Haw River, NC and Haw River at Bynum, NC (02096960) / Haw River at Pittsboro (02097000)
- "Cane Creek" option: Cane Creek flow near Orange Grove, NC (02096846)
- "Reedy Fork" option: Reedy Fork flow near Gibsonville, NC (02094500)

The suitability of each was then assessed by a verification exercise. Given the period of observed lake elevations (Figure 4-6), OASIS was used to simulate elevations over that same time period using each inflow series in turn. Simulated elevations from each inflow assumption were then compared to observed elevations. Each simulation was performed with assumptions of

- Estimated inflows based on one of the reference gages
- Withdrawals equal to historic observations (only available since 2003)
- Dam releases set at minimum required rates (since controlled-release data are generally not available) when the water elevation is below the top of the dam
- Spill releases of any storage that would otherwise bring reservoir storage over maximum capacity

The verification period was limited to 2009-present as this was the period over which elevation observations (which were not reported every day) were mostly available (Figure 4-6).

Figure 4-7 through Figure 4-10 show verification results from the four inflow options. In each figure, observed and simulated elevations are plotted for comparison.

- The Haw River option (Figure 4-7) consistently underpredicted the degree of drawdown during dry periods.
- The Haw River to Bynum Gain (Figure 4-8) and Reedy Fork (Figure 4-9) options both occasionally overpredicted and underpredicted drawdown. For the 2007 drought, the Haw River to Bynum Gain and Reedy Fork options respectively under- and overpredicted drawdown by approximately the same amounts. In the 2018 drought, the Haw River to Bynum Gain option elevations matched observations well while the Reedy Fork option overpredicted drawdown. These two options were considered the best performers.
- The Cane Creek option (Figure 4-10) consistently overpredicted drawdown during dry periods.

Hazen

Table 4-1: Reference Gage Candidates for Estimating Lake Inflows

Gage Name (USGS ID)	Drainage Area (sq mi)	Period of Record	Comment
Haw River at Haw River, NC (02096500)	606	1928-present	Regulation from upstream reservoirs
Incremental flow between Haw River at Haw River, NC and Haw River at Bynum, NC (02096960) / Haw River at Pittsboro (02097000)	704 (incremental) using Pittsboro location	1973-present for the Bynum gage (1930 to 1973 for the Pittsboro gage)	Little regulation within incremental drainage area
Cane Creek near Orange Grove (02096846)	7.5	1988-present	No regulation, but limited period of record
Reedy Fork near Gibsonville (02094500)	131	1928-present	Regulation from upstream reservoirs

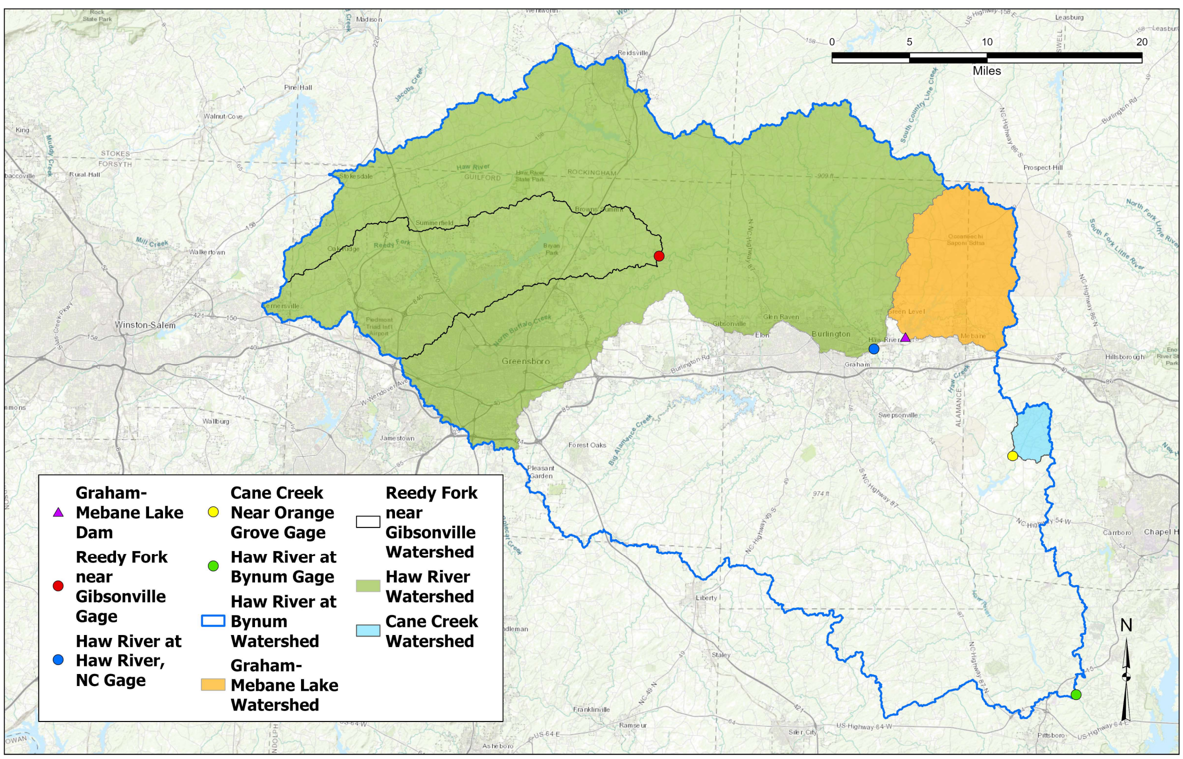


Figure 4-5: Map of Reference Gage Candidates and Watersheds for Estimating Lake Inflows

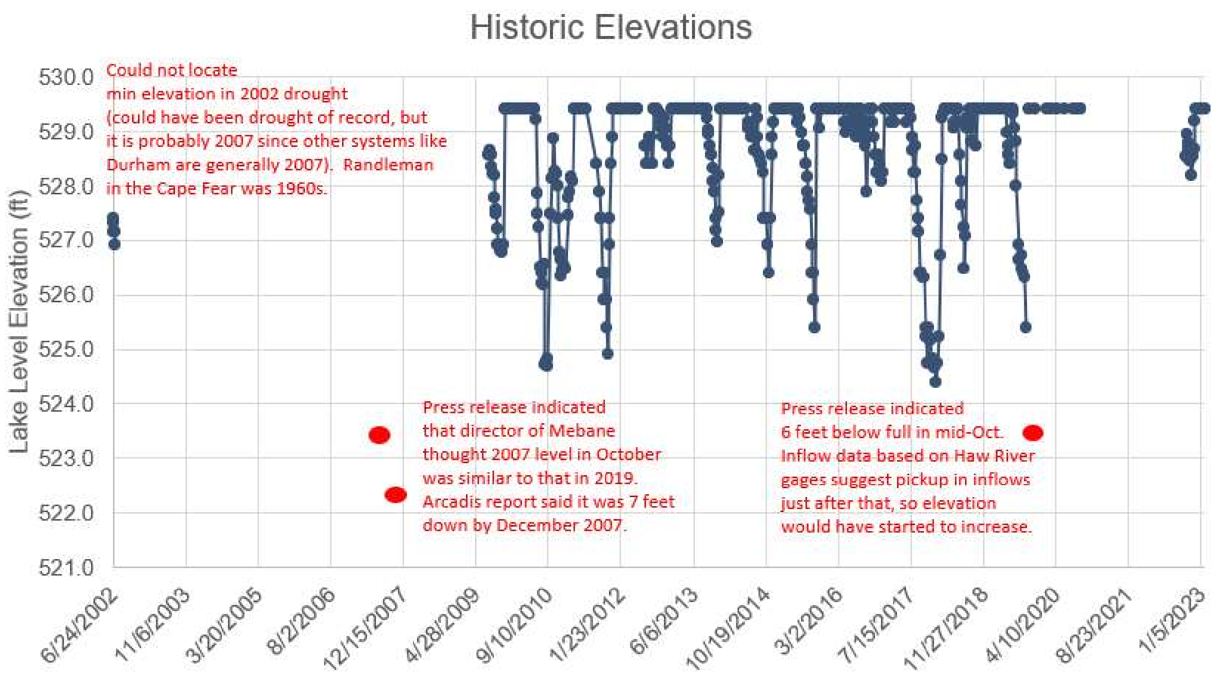


Figure 4-6: Historic Lake Level Observations (blue) and Estimates from Anecdotal Evidence (red).

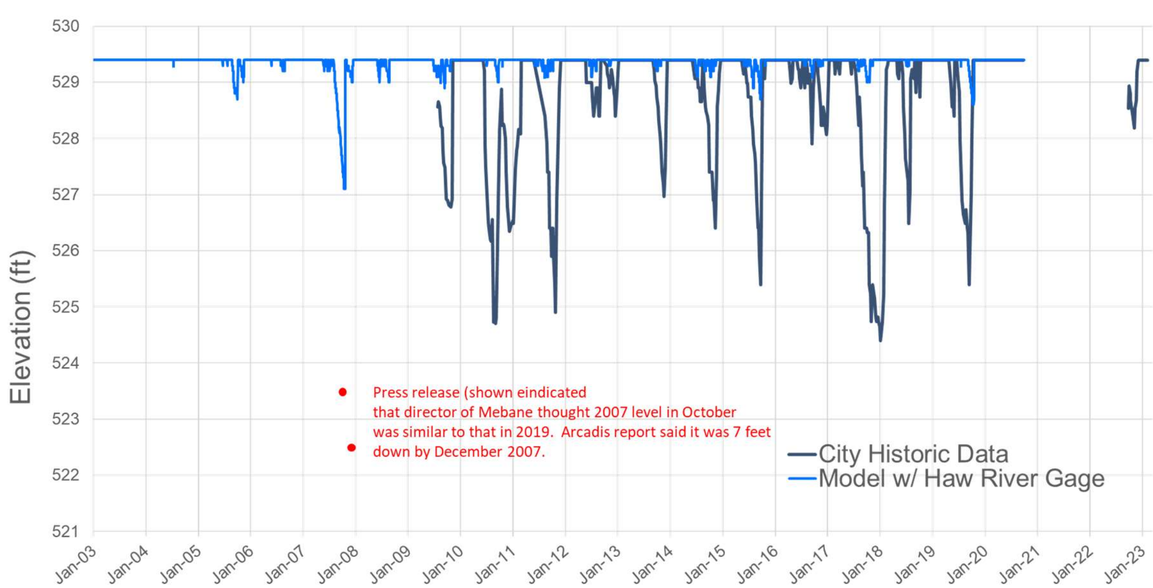


Figure 4-7: Verification Test Using Inflows Based on Haw River Gage @ Haw River, NC

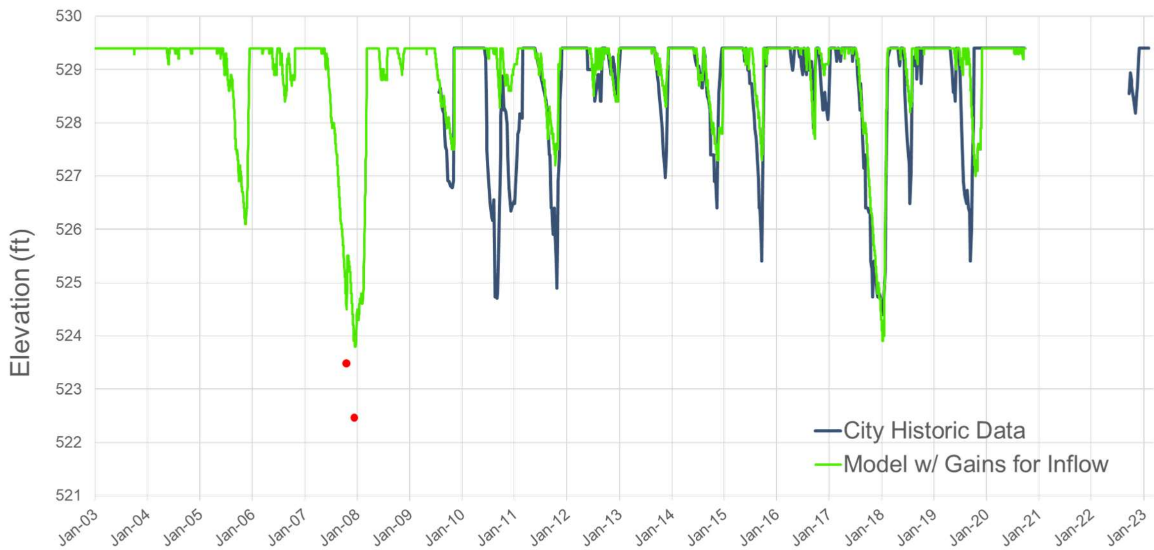


Figure 4-8: Verification Test Using Haw River Gage to Bynum Gage Gain for Inflows

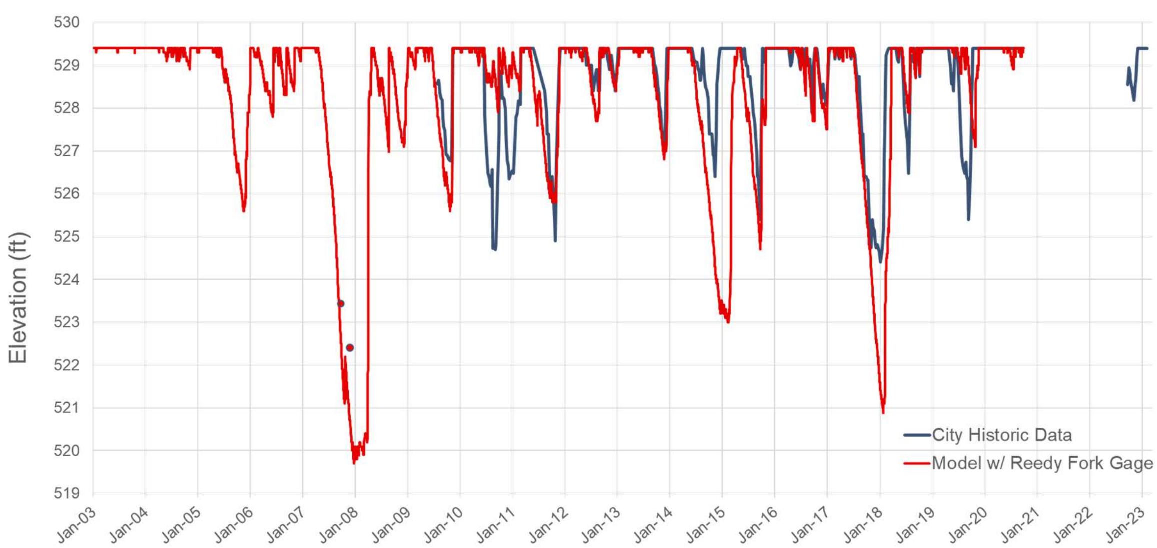


Figure 4-9: Verification Test Using Inflows Based on Reedy Fork Gage

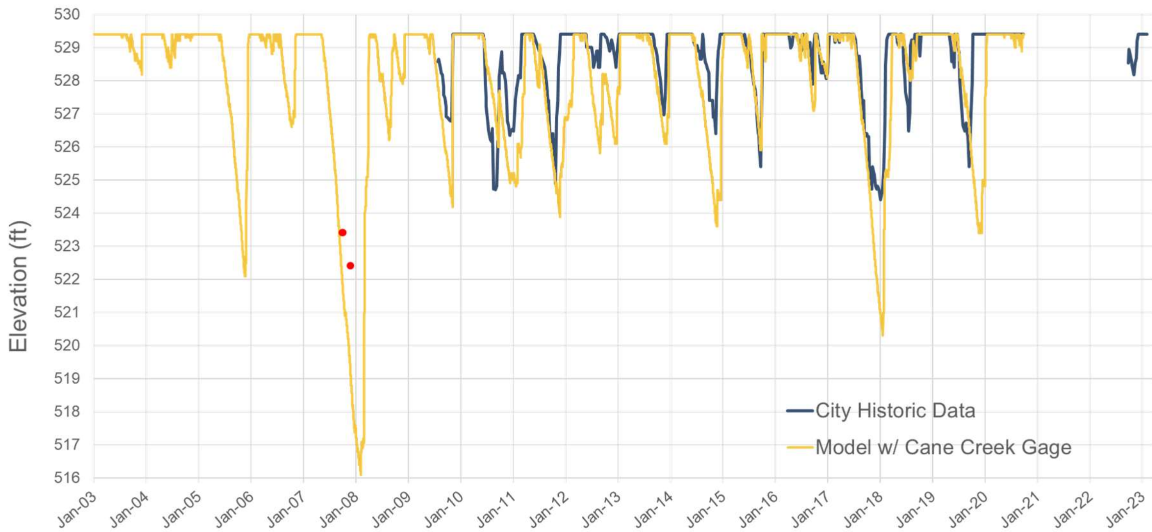


Figure 4-10: Verification Test Using Inflows Based on Cane Creek Gage

It was ultimately decided to adopt the Haw River to Bynum Gain option over the Reedy Fork option. The watershed upstream of the Reedy Fork gage contained significant reservoir regulation which disrupts the flow patterns at the downstream gage. While these same regulations impact Haw River and Bynum gages, reservoir regulations in the drainage area between the two are much smaller than above Reedy Fork gage. The most significant regulation signals in Haw River and Bynum gage flow data conceptually “cancel”, or offset one another, when calculating the incremental flow difference between the gages, thereby better representing an unimpaired inflow pattern as should be expected in the lake’s drainage area. Thus, inflows based on the Haw River to Bynum Gain option were adopted for the remainder of the study.

5. Results

The general safe yield analysis procedure was as follows:

- First, use the Graham-Mebane Lake inflows over the 90-year period with estimates based on the "Haw River to Bynum Gain" method
- Execute the model over the 90-year period multiple times, incrementally increasing simulated withdrawals from Graham-Mebane Lake until, at some point in the 90-year record, simulated usable lake storage is depleted to the bottom of Gate #2.

The demand producing that storage exhaustion condition is then considered the safe yield. A monthly demand pattern was included to capture the typical variation in demand throughout the year. Note the local water shortage response plan for the utility – which would result in demand reductions as storage triggers are reached during reservoir drawdown-- is not simulated for safe yield evaluation. Also, to be conservative, it was assumed that water treatment process water (like filter backwash) was not counted towards meeting the minimum release requirements. However, in practice the process return flows go back to the river where the minimum flows are required and the City should get credit for those return flows.

New inflow estimates. Inflow estimates for Graham-Mebane Lake (node 320 in Figure 4-2) were produced by applying Equation4-1 with drainage areas for the lake watershed (66.1 sq. mi., see Table 3-1) and the incremental stream reach between Haw River and Bynum/Pittsboro gages (704 sq. mi., see Table 4-1) to incremental inflow estimates for Bynum/Pittsboro gage within the Cape Fear-Neuse model inputs (node 400 in Figure 4-2). Note the Bynum gage only became operational in 1973. Prior to this, the nearby Pittsboro gage was active. For the inflow estimate, we combined the records to form a continuous record from 1930 to present representing the flow at the old Pittsboro gage location (meaning when Bynum flows were available, they were scaled up by the drainage area ratio to the Pittsboro location (1310 sq.mi at Pittsboro location /1275 sq.mi at the Bynum location). The resulting incremental drainage area between the upstream Haw River gage and the Pittsboro gage location is 1310 – 606 = 704 sq.mi.

Equation 5-1

$$(\text{Graham Mebane Inflow})_t = (\text{Incremental Bynum/Pittsboro Inflow})_t \times \frac{66.1}{704}$$

where *t* represents days from January 1, 1930 to September 30, 2020.

Determination of Safe Yield. System reliability was evaluated by running the full 90-year simulation with different levels of demand from Graham-Mebane Lake (node 321 in Figure 4-2) while enforcing minimum flow releases from the lake. Figure 5-1 shows percent of usable storage remaining versus time for assumed annual average demands of 4.1, 6.5, and 8.5 MGD. The percentage of usable storage remaining is with reference to the 2300 MG of storage that can be withdrawn from intake Gate #1 and Gate#2. As expected, higher demands led to heavier storage drawdowns during dry periods. The demand can be increased to 8.9 MGD before storage is depleted, as shown in Figure 5-2. This occurs during the 1933-34 drought, when remaining usable storage reached 0.3% on February 25th, 1934. If the model used the storage between intake Gate #2 and Gate #3, the reported yield would be about a half MGD greater, but there would be no margin for error to account for difficulties that could be encountered when pursuing the withdrawal of the remaining water in the lake, including hydraulic restrictions (the flow rate into the pump station) and water quality concerns among others.

The minimum release was assumed to be 5 cfs anytime the dam was not spilling at least 5 cfs and storage was greater than 40%. When storage falls below 40% the minimum release is reduced to 3 cfs.

Distribution of Annual Safe Yields. As a secondary measure, the distribution of safe yield for each individual year of the record was determined. Climate years were modeled from April 1 to March 31 of the following year. The model was iterated with increasing demands until storage is depleted. That demand level is then the yield for that particular year. Details of this procedure include:

- restarting the lake at full capacity on April 1, then
- repeatedly simulating forward to the next March 31, increasing assumed demand until usable storage is exhausted at some point during the year.
- In the event of over-year storage events (i.e. multi-year droughts), the simulation length was extended until the drought ends and the full length of the drought was simulated to determine the yield for the year in which the drought begins.

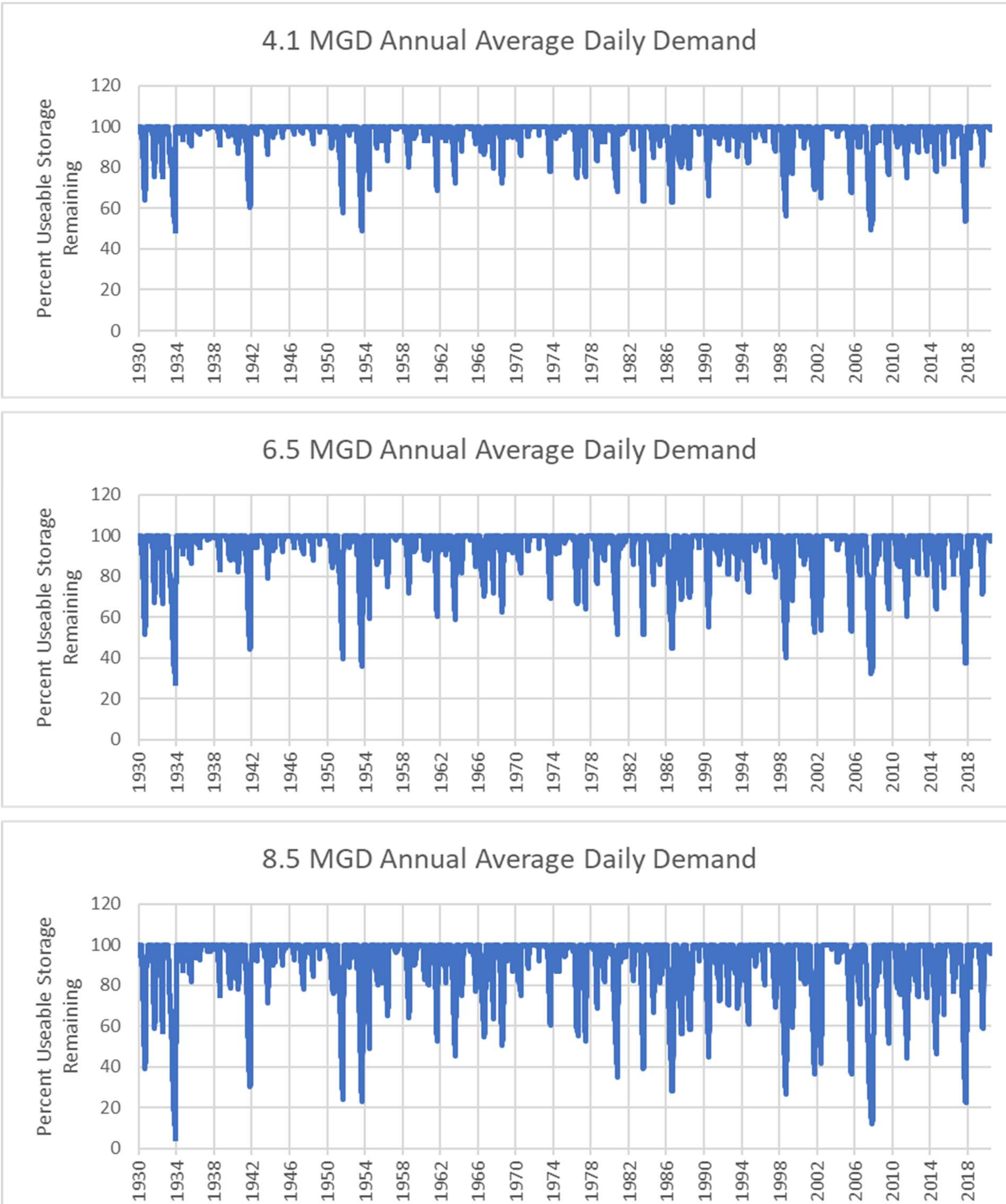


Figure 5-1: Simulated Percent Usable Remaining Storage in Graham-Mebane Lake for Annual Average Demands of 4.1, 6.5, and 8. MGD.

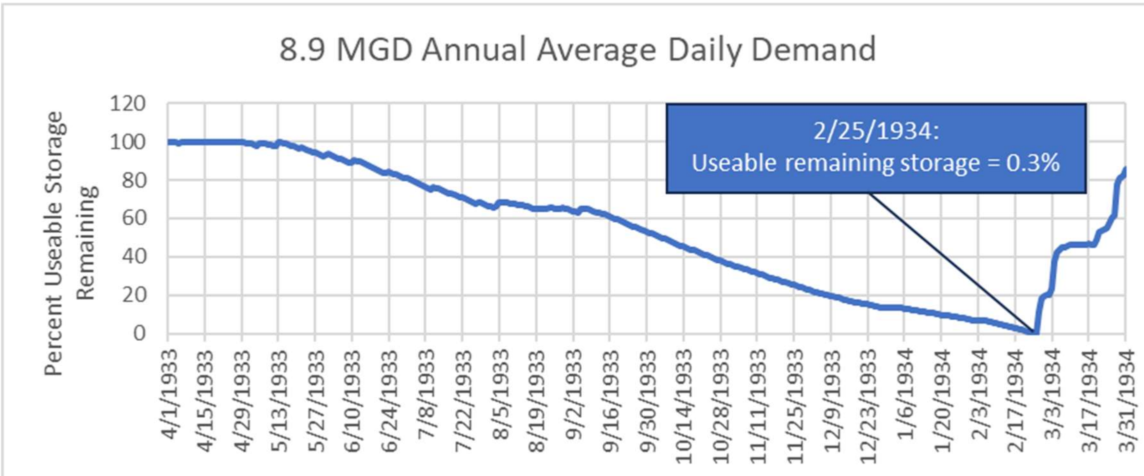


Figure 5-2: Storage Curve at System Yield, 8.9 MGD, during the 1933-34 drought.

These annual safe yield values were ranked from lowest to highest and presented as a frequency distribution allowing a yield to be assigned to desired return interval (e.g. 1 in 20 years, or 1 in 50 years)[2]. Figure 5-3 shows the full distribution with low-to-high rank of annual safe yield on the x-axis. Annual safe yields ranged from a low of 8.9 MGD (occurring in 1933) to a high of 46.9 MGD (occurring in 2003). Note that all yields provided are raw water yields, and will differ from the finished water produced by an amount equivalent to the process loss at the WTP. Figure 5-4 focuses on the lowest-ranked 20 years of this distribution and provides percentiles and return periods equivalent to year ranks. For example,

- The 2nd worst drought (2007-08) had an estimated yield of 9.5 MGD. By interpolating between the worst and second worst droughts, the 50-year safe yield is estimated at 9.4 MGD. This slightly less than the 50-year yield of 10 MGD from the prior study.
- The 4th and 5th lowest-ranked years, which correspond to return periods of 22.5 and 18 years, respectively, had annual safe yields of 11.2 and 11.4 MGD. The 20-year safe yield can therefore be estimated as 11.3 MGD; this is lower than the 20-year yield of 12.5 MGD from the prior study.

Both results are reasonable given the update of the SAE curve and the corresponding reduction in usable storage due to sedimentation (described in Section 3). However, another difference is that prior safe yield calculations were made on a monthly timestep. The OASIS model uses a daily timestep which should provide a more accurate estimate especially since the length of most droughts in this region are relatively short (less than 1 year), unlike in the western US.

[2] Technically these are best expressed as a probability of occurrence in any given year. So what we call a 1 in 50 year drought really has a 2% chance of occurring in any given year. And a 20-year safe yield represents a withdrawal rate that cannot be met in 5% of years. This avoids providing the impression only one such event will occur in 20 or 50 years. It is entirely possible to get 2 or more such events close together in time.

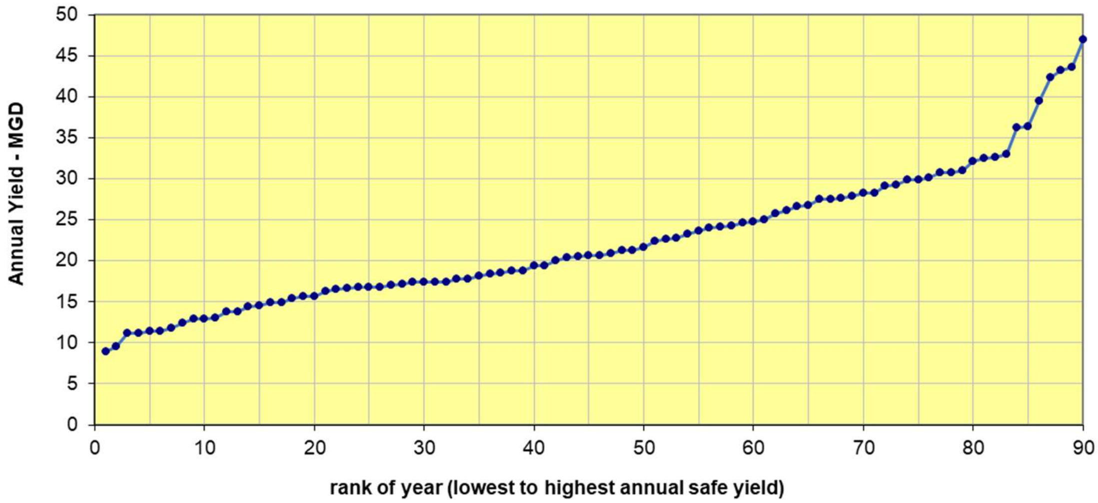
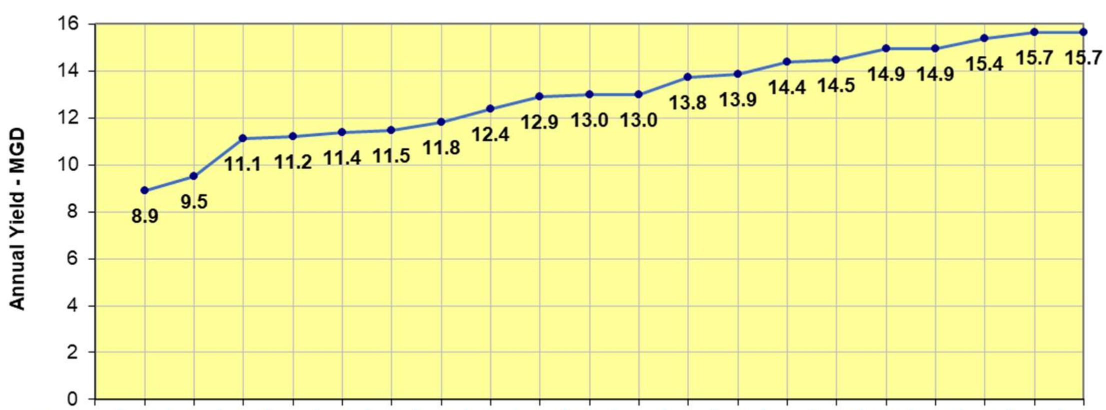


Figure 5-3: Distribution of Annual Safe Yields for Each of the 90 Years in Simulation.



rank of year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
percentile (rank/90)	1.1	2.2	3.3	4.4	5.5	6.6	7.7	8.8	9.9	11.0	12.1	13.2	14.3	15.4	16.5	17.6	18.7	19.8	20.9	22.0
return pd, years	90	45	30	22.5	18	15	12.9	11.3	10	9	8.2	7.5	6.9	6.4	6	5.6	5.3	5	4.7	4.5
ann safe yield, MGD	8.9	9.5	11.1	11.2	11.4	11.5	11.8	12.4	12.9	13.0	13.0	13.8	13.9	14.4	14.5	14.9	14.9	15.4	15.7	15.7
year occurs	1933	2007	2017	1951	1953	1986	1998	1941	2005	1980	2001	1930	2014	2011	1963	1994	1983	1966	2002	1987

Figure 5-4: Distribution of Annual Safe Yields for the Lowest-Yield 20 Years in Simulation.

Finally, the future impacts of sedimentation on safe yield were evaluated. The 2070 safe yield was estimated by reducing today's usable storage by a projected sedimentation rate shown of 0.16 AF/yr/sq. mi. (See Table 3-2). The safe yield with the additional 47-years of sediment accumulation would decline from 8.9 MGD to 8.2 MGD in 2070. Yield shown are raw water yields. Converting these yields to finished water yields can be done by reducing the raw water yield by the WTP's process water fraction.

6. Conclusions and Recommendations

This project represents a significant step forward in the long-range water supply planning process. Establishing a more accurate reservoir storage estimate significantly reduces the uncertainty in planning for the region's water supply future based on the continued use of Graham-Mebane Lake. An updated water supply model that has been validated over a 10-year period provides confidence that the safe yield estimate has a sound basis. The yield estimate was produced using the Cape Fear/Neuse OASIS model developed for the NC Division of Water Resources with model revisions in and around Graham-Mebane Lake to reflect the updated lake SAE relationship and better match historical lake elevation data. The new safe yield analysis indicated that the drought of record occurred in 1933-1934, slightly exceeding the intensity of the 2007-2008 drought in terms of the limits on withdrawing water supply from Graham-Mebane Lake. The yield available during the 1933-1934 drought was estimated at 8.9 MGD. Return frequency drought intensities of 50-year and 20-year yields are 9.4 MGD and 11.3 MGD, respectively. These values are all based on historical inflow estimates. Estimation of future inflows due to climate change or other deviation from historical hydrology were not considered. A direct comparison to the 2008 yield study shows that the current estimate of the 20-year yield (11.3 mgd) is 1.2 mgd (about 10%) less than the estimate in 2008. The difference in yield between the two studies can be attributed to the estimate of storage in the reservoir and the method for estimating reservoir inflows.

Factoring in the projected sedimentation rate, the safe yield in 2070 is expected to decline by about 10% if sedimentation rates between now and 2070 are similar to the surveyed rate. In order to preserve long-term water supply storage in the lake, the City should encourage neighboring jurisdictions to enforce their respective ordinances that preserve water quality within waters that that drain to Graham-Mebane Lake.

The current model of Graham-Mebane Lake is fair to good based on the validation plot shown in Figure 4-8. There is room for improving the model and planning for that improvement may have value for the City. One consideration for long-term improvement in the supply modeling efforts would be to improve the inflow estimation method for Graham-Mebane Lake. The most effective means for doing so would require some new instrumentation. The first option would be to sponsor one or more USGS gages in the Graham-Mebane Lake watershed to provide a more direct runoff estimate into the lake. Figure 6-1 shows four potential creek watersheds that could be gaged at roadway crossings to provide this data. A single gage may be sufficient. However, since none of proposed locations could individually capture a majority of the Lake's watershed area, another option that has been used successfully elsewhere involves deductively calculating the inflow estimate for the entire lake by rearranging Equation 2-1 and solving for inflow. However, this requires making all the other variables "known". This would require detailed record keeping for pumping, minimum release, and lake level operations. The lake level could be recorded with an ultrasonic lake level sensor installed somewhere on the lake to provide hourly or sub-hourly readings, providing a high-resolution storage record. The recording frequency must be high (ideally hourly or sub-hourly) to provide accurate reservoir outflow estimates since reservoir levels can change quickly during transient flow conditions as water flows over the dam and lake elevations change quickly. This record could be then combined with withdrawal and minimum release information to back-calculate inflows. Either method (new gage or lake level sensor) can take time to bear results with respect to model improvement. The use of the gages noted in Section 4.2 would not be entirely discounted. However, as seasonal and conditional (dry, normal, wet period) correlations between the existing gages and the new inflow estimate are developed over a period of years, the prior records can be adjusted according to the observed relationships. These adjustments would better reflect what is happening in Graham-Mebane Lake and provide increased confidence in the model's predictive capabilities which has a host of benefits from improved yield estimates to more sophisticated drought management techniques.

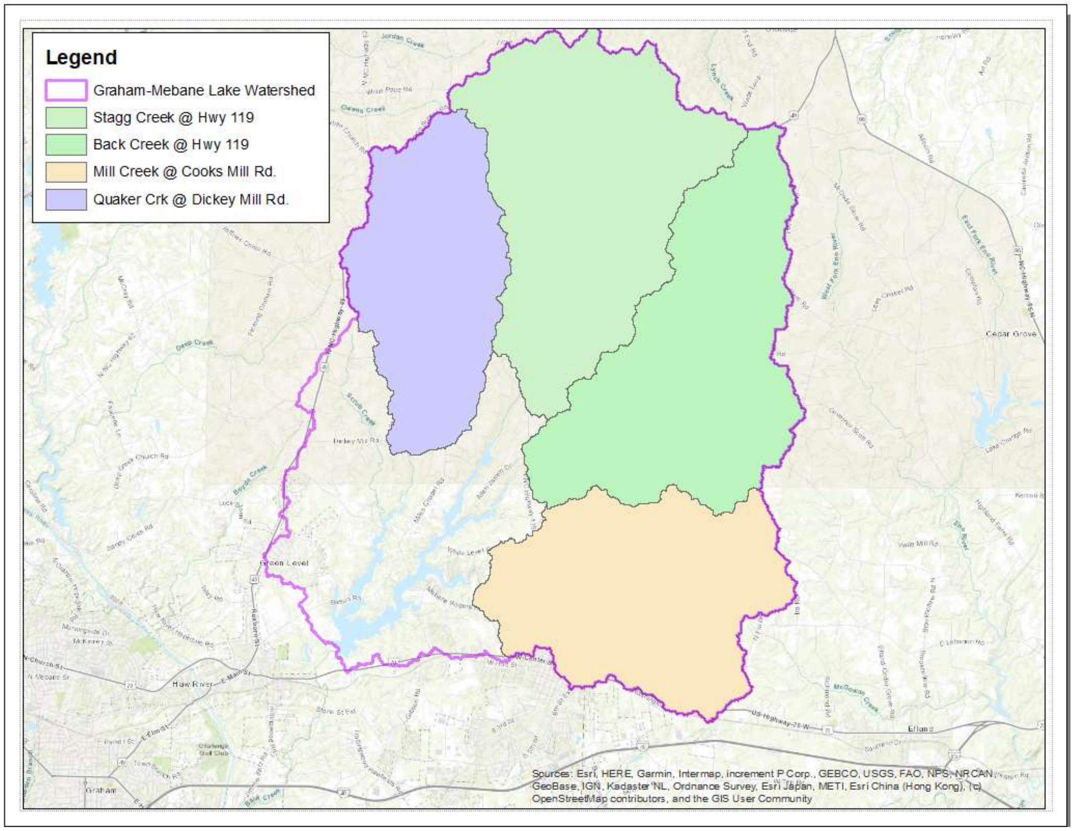


Figure 6-1: Potential Future Stream Gaging Sites to Support Calculations of Lake Inflows.

Moving forward, the cities of Graham and Mebane may wish to build on this safe yield study by developing a comprehensive long-range water supply study to continue planning for a secure water supply future. A comprehensive supply study would incorporate the cities' demand projections and the safe yield of Graham-Mebane Lake to identify any gaps in water supply in the future. The study would identify alternatives for meeting any projected supply gaps making use of water supply information on options and alternatives the City has already studied, as well as investigating new supply solutions. Options for consideration would include preserving, reclaiming, or even expanding storage in Graham-Mebane Lake. The study should include an evaluation of cost and yield of supply options so that the City is well prepared to maximize supply reliability while minimizing costs to its rate payers.

Hazen

Appendix A

STEWART
STRONGER BY DESIGN

Raleigh – Geomatics
T 919.380.8750

5410 Old Poole Road
Raleigh, NC 27310

May 19, 2023

Reed Palmer, PE
Senior Associate
Hazen and Sawyer
4011 Westchase Blvd, Suite 500
Raleigh, NC 27607

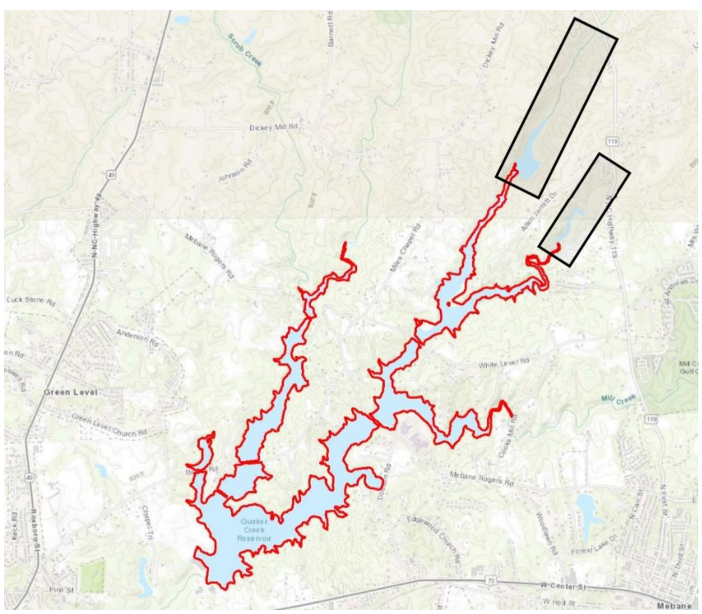
RE: Graham-Mebane Lake Bathymetric Survey Report

Dear Mr. Palmer,

The following information details Stewart's scope of work and technical approach for the Graham-Mebane Bathymetric Survey performed in January-April 2023.

PROJECT CONTACTS
Reed Palmer – Hazen and Sawyer (Project Manager)
Tonya Mann – Graham Mebane Water Plant (Utilities Director and site contact)

SCOPE OF WORK
The Graham-Mebane Lake Water Supply Reservoir Study includes a comprehensive survey of the lake floor elevations and surrounding lands up to the 535-contour line. Stewart conducted bathymetric and aerial surveys in order to create contours and volumetric calculations including storage curve figures. Data from North Carolina's Spatial Data Download Program was also utilized to supplement the study. The sketch below depicts a general location of the lake border in addition to the supplemental study areas noted by the boxes.



PROJECT INFORMATION (Results from this survey)
Project Area: 47,413,656sf (1,088ac)
Top of Dam: 529.4'
Normal Pool (NP): 529.4'
Lake Surface Area (at NP): 31,002,959sf (711.7ac)
Lake Volume (at NP): 12,374,345cy (2499.3 MG)
Sediment Volume: 572,318cy

SURVEY EQUIPMENT
Bathymetric data was collected using a single beam echosounder for bottom elevations and a dual frequency echosounder for sediment measurements. Echosounders were linked with GPS receivers to provide horizontal and vertical locations. A remote-controlled boat and crewed boat were used to carry equipment. Aerial data was collected by crewed aircraft equipped with lidar and photogrammetric sensors.

CONTROL SETUP
Horizontal datum is NAD83(2011) and vertical datum is NAVD88 tied to NCGS "AL H028 1" and "AL H0278 4". Base control points (benchmarks) 1-12 are rebar and were set using North Carolina Virtual Reference Station (VRS) Realtime Network. Aerial data control panel points 101-111 were set with temporary materials. All points were occupied at a minimum of two (2) observations. Base control points were occupied and checked daily.

DATA COLLECTION
All field work was performed with a 2–3-person crew. The perimeter of the lake was mapped using aerial data and confirmed in the field. Underwater points were collected at an average of fifty feet (50') apart. Apparent thalwegs and remnants of stream features were investigated by running perpendicular cross sections. Sediment depth survey points were collected at an average of 100' apart.

DATA PROCESSING AND MAPPING
AutoCad Civil 3d was used to process and create contour and volume data. The underwater surface is comprised of spot elevations and 3d breaklines. Areas that contained adequate information resembling a drainage feature were mapped with breaklines. The terrestrial surface was created using the lidar point cloud data. Both the underwater and terrestrial surfaces were combined to make a complete surface with contours. From there, volumetric calculations were run in Civil 3d. The planimetric features consist of buildings, roads, bridges, wood lines, fences, dam and overhead utility lines.

Sediment depth points were used to create a separate surface which was compared to the base underwater surface.

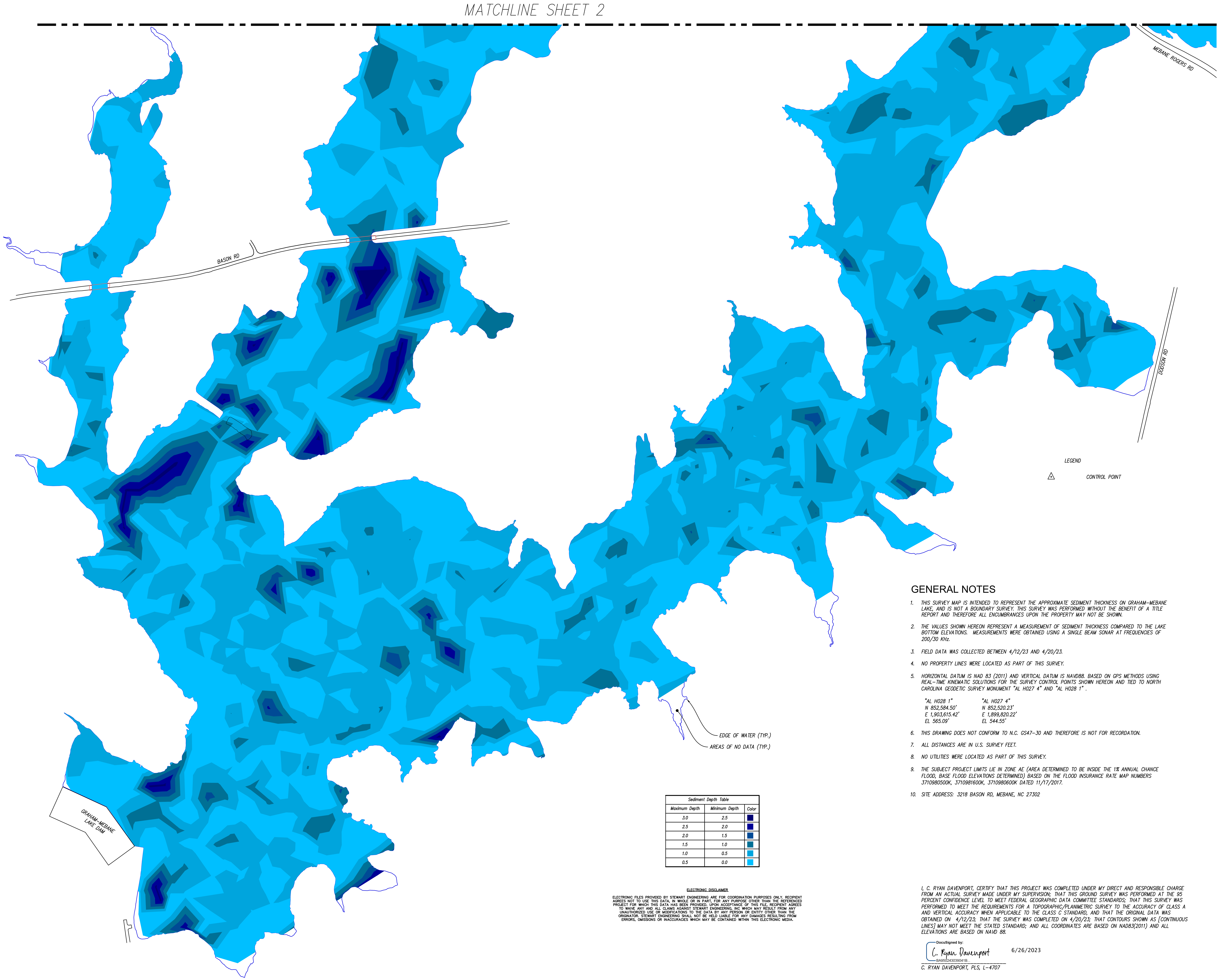
STORAGE CURVE DATA
Data from the Civil 3d volume processing was used to populate a spreadsheet with reservoir volume and reservoir surface area at one-foot intervals. A separate dataset was reported specifically for the lake area north of the "Old Dam" since the lowest point there is at the 519' elevation. The volume retained upstream of the "Old Dam" and below 519' elevation was recorded.

QUALITY CONTROL
Quality control measures were in place throughout the duration of the project. Multiple observations on control points were collected to ensure repeatable results per survey specifications. Underwater elevations were confirmed by evaluating results from two (2) different datasets from two (2) different types of equipment - the single beam (single frequency) remote controlled boat and the single beam (dual frequency) echosounder-equipped crewed boat. Areas and volumes were computed from two (2) separate workflows in Civil 3d to ensure matching results. Calculations were reviewed independently by separate team members.

DELIVERABLES
The following deliverables were submitted for this project.

- CAD survey drawing in Civil 3d
- Point database in Northing, Easting, Elevation (comma delimited) text file
- CAD surface TIN in Land XML format
- Stage-storage-surface area curve in Excel format
- Heat maps of water depths and sediment depths in PDF format
- Technical Memo of technical methods and equipment used
- USB flash drive containing all files including signed and sealed pdfs of survey

CERTIFICATION
The survey techniques and methods used to perform this project adhere to the contract specifications and the rules and regulations per North Carolina Administrative Code – 21 NCAC 56.1606 – Specifications for Topographic and Planimetric Mapping, Including Ground, Airborne, and Spaceborne Surveys. Bathymetric data collection techniques used for this project align with the USACE guidelines as published in ER 1110-2-8164.



GENERAL NOTES

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2. THE VALUES SHOWN HEREON REPRESENT A MEASUREMENT OF SEDIMENT THICKNESS COMPARED TO THE LAKE BOTTOM ELEVATIONS. MEASUREMENTS WERE OBTAINED USING A SINGLE BEAM SONAR AT FREQUENCIES OF 200/30 KHz.
3. FIELD DATA WAS COLLECTED BETWEEN 4/12/23 AND 4/20/23.
4. NO PROPERTY LINES WERE LOCATED AS PART OF THIS SURVEY.
5. HORIZONTAL DATUM IS NAD 83 (2011) AND VERTICAL DATUM IS NAVD88. BASED ON GPS METHODS USING REAL-TIME KINEMATIC SOLUTIONS FOR THE SURVEY CONTROL POINTS SHOWN HEREON AND TIED TO NORTH CAROLINA GEODETIC SURVEY MONUMENT "AL H027 4" AND "AL H028 1" .

"AL H028 1"	"AL H027 4"
N 852,584.50'	N 852,520.23'
E 1,903,615.42'	E 1,899,820.22'
EL 565.09'	EL 544.55'

6. THIS DRAWING DOES NOT CONFORM TO N.C. GS47-30 AND THEREFORE IS NOT FOR RECORDATION.
7. ALL DISTANCES ARE IN U.S. SURVEY FEET.
8. NO UTILITIES WERE LOCATED AS PART OF THIS SURVEY.
9. THE SUBJECT PROJECT LIMITS LIE IN ZONE AE (AREA DETERMINED TO BE INSIDE THE 1% ANNUAL CHANCE FLOOD, BASE FLOOD ELEVATIONS DETERMINED) BASED ON THE FLOOD INSURANCE RATE MAP NUMBERS 3710980500K, 3710981600K, 3710980600K DATED 11/17/2017.
10. SITE ADDRESS: 3218 BASON RD, MEBANE, NC 27302

Sediment Depth Table

Maximum Depth	Minimum Depth	Color
3.0	2.5	
2.5	2.0	
2.0	1.5	
1.5	1.0	
1.0	0.5	
0.5	0.0	

I, C. RYAN DAVENPORT, CERTIFY THAT THIS PROJECT WAS COMPLETED UNDER MY DIRECT AND RESPONSIBLE CHARGE FROM AN ACTUAL SURVEY MADE UNDER MY SUPERVISION; THAT THIS GROUND SURVEY WAS PERFORMED AT THE 95 PERCENT CONFIDENCE LEVEL TO MEET FEDERAL GEOGRAPHIC DATA COMMITTEE STANDARDS; THAT THIS SURVEY WAS PERFORMED TO MEET THE REQUIREMENTS FOR A TOPOGRAPHIC/PLANIMETRIC SURVEY TO THE ACCURACY OF CLASS A AND VERTICAL ACCURACY WHEN APPLICABLE TO THE CLASS C STANDARD, AND THAT THE ORIGINAL DATA WAS OBTAINED ON 4/12/23; THAT THE SURVEY WAS COMPLETED ON 4/20/23; THAT CONTOURS SHOWN AS [CONTINUOUS LINES] MAY NOT MEET THE STATED STANDARD; AND ALL COORDINATES ARE BASED ON NAD83(2011) AND ALL ELEVATIONS ARE BASED ON NAVD 88.

DocuSigned by:
C. Ryan Davenport
BA950243039041B...
6/26/2023

C. RYAN DAVENPORT, PLS, L-4707

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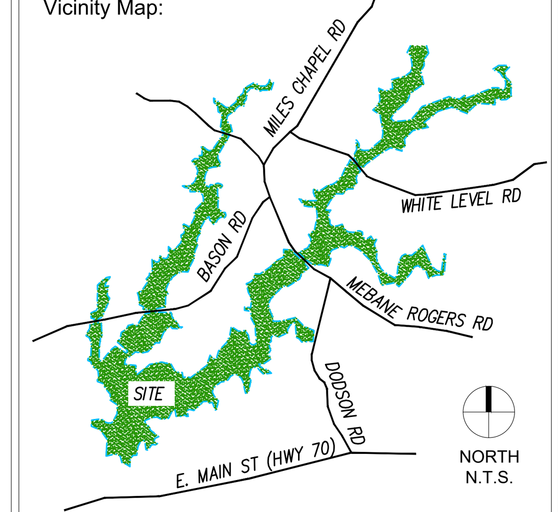
Vicinity Map:



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NAD83(2011)

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SCALE: 1" = 300'

Title:

BATHYMETRIC SURVEY FOR:

GRAHAM-MEBANE LAKE

ALAMANCE COUNTY, MEBANE, NORTH CAROLINA
DATE: 6/6/23
SCALE: 1" = 300' CONTOUR INTERVAL = NA
PREPARED FOR: HAZEN AND SAWYER

Revisions:

No.	Date	Description
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Seal:

NORTH CAROLINA PROFESSIONAL SEAL L-4707 LAND SURVEYOR C. RYAN DAVENPORT

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C. Ryan Davenport
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Project #:	G22136	Sheet:
Date:	6/6/23	
Drawn by:	CRD	1 of 3
Checked by:	CRD	

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GENERAL NOTES

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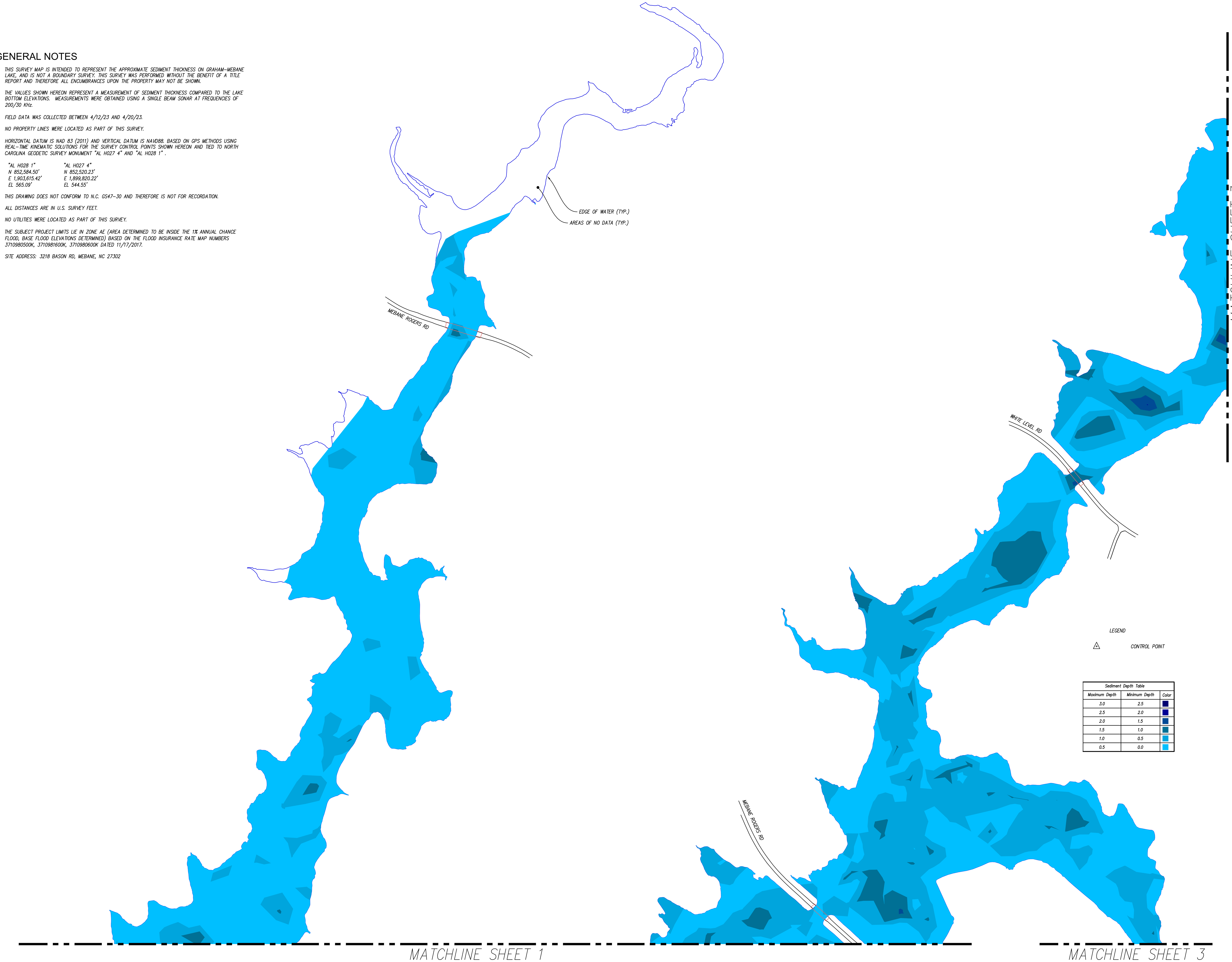

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2.5	2.0	
2.0	1.5	
1.5	1.0	
1.0	0.5	
0.5	0.0	

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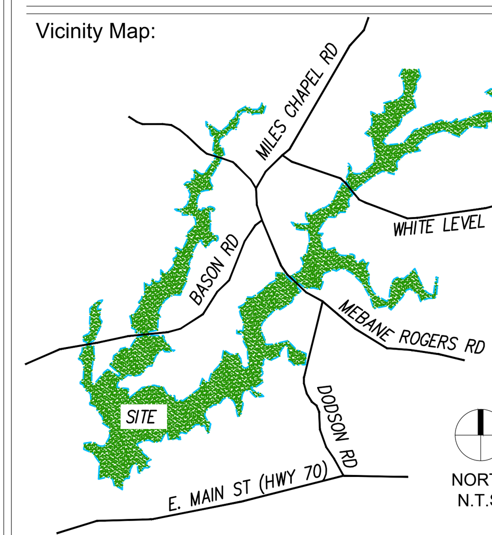

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SCALE: 1" = 300'

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BATHYMETRIC SURVEY FOR:

GRAHAM-MEBANE LAKE

ALAMANCE COUNTY, MEBANE, NORTH CAROLINA
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SCALE: 1" = 300' CONTOUR INTERVAL = NA
PREPARED FOR: HAZEN AND SAWYER

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C. Ryan Davenport
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6/26/2023

Project #:	G22136	Sheet:
Date:	6/6/23	
Drawn by:	CRD	**2 of 3**
Checked by:	CRD	

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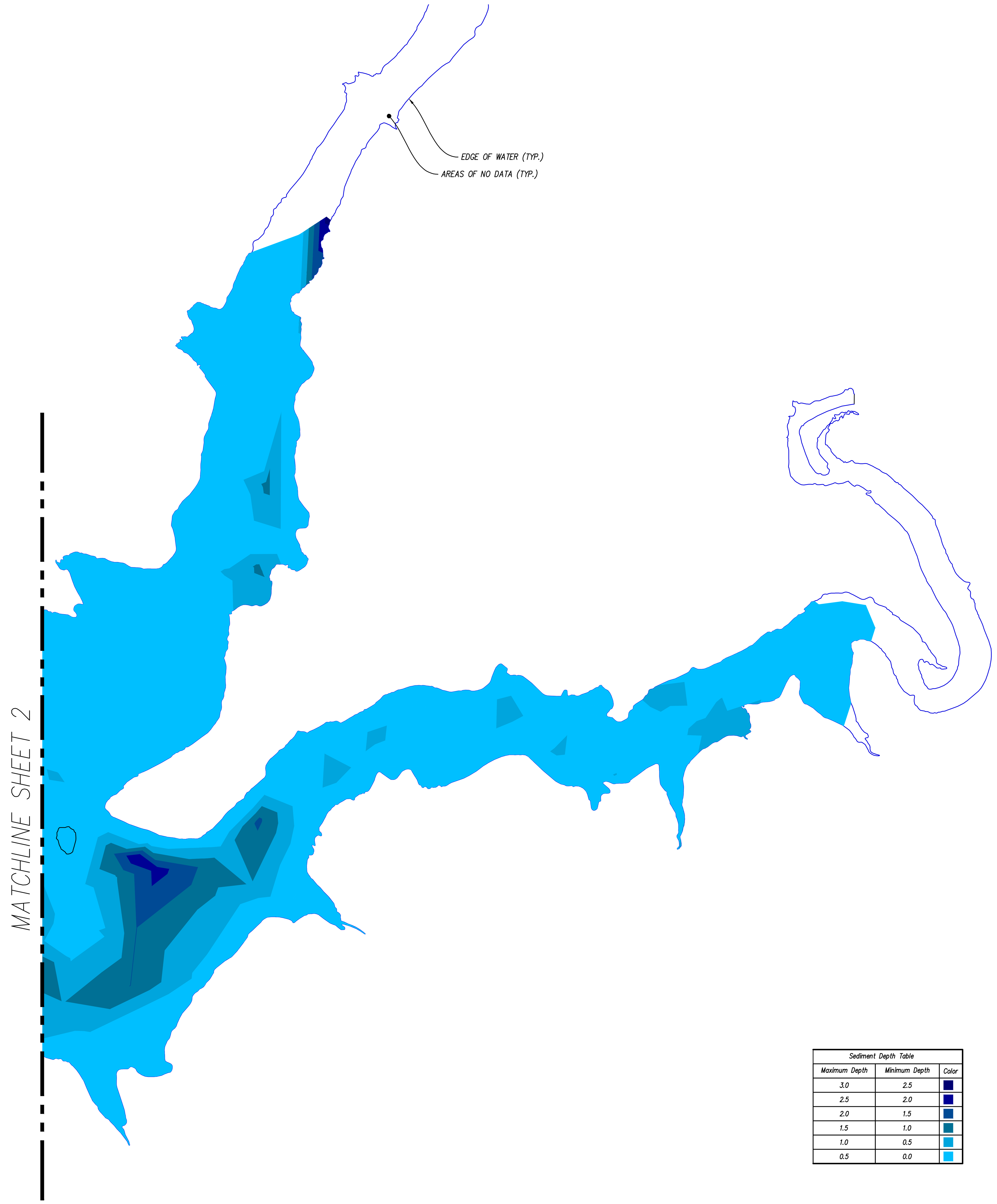

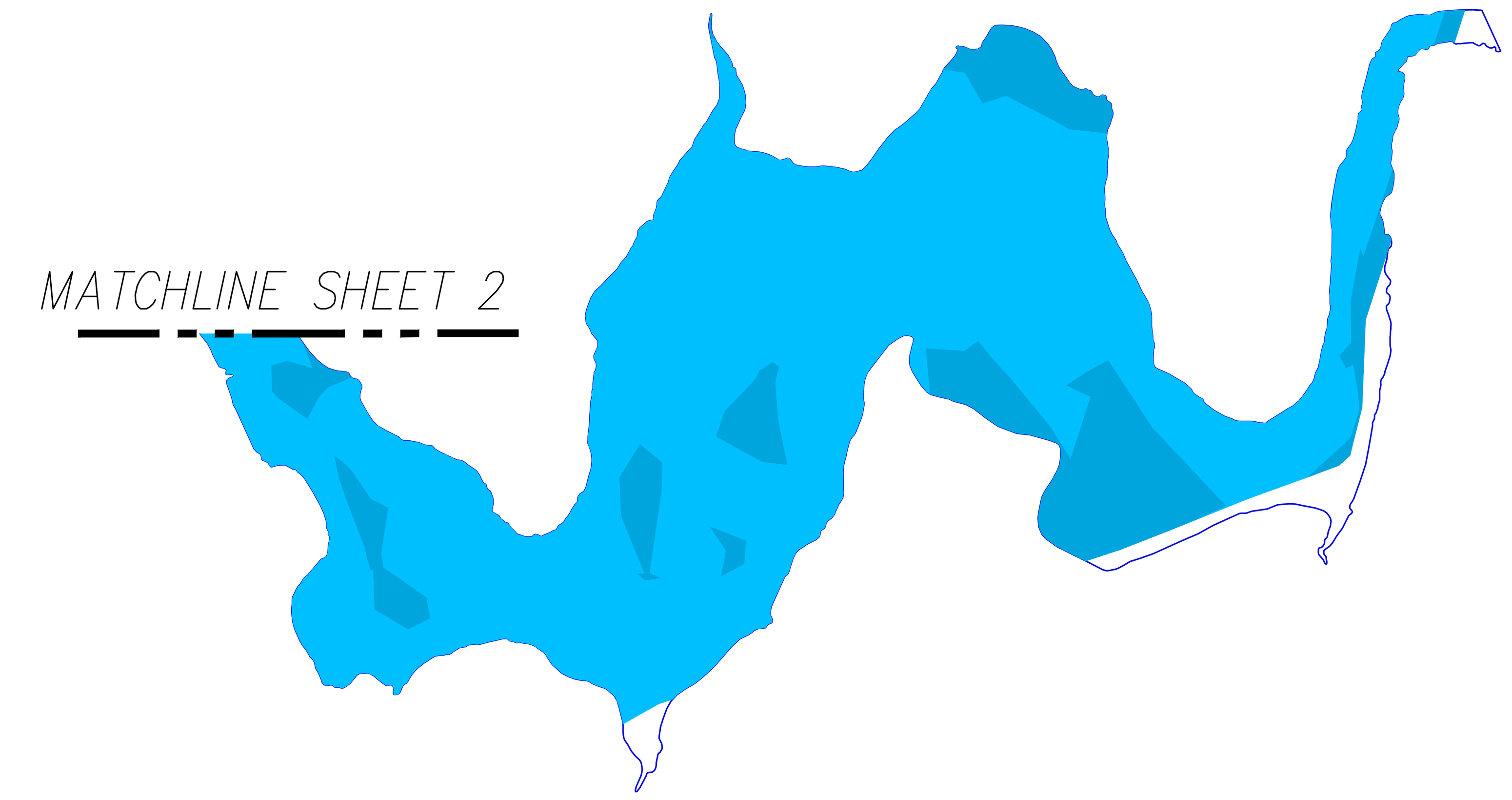

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2.0	1.5	
1.5	1.0	
1.0	0.5	
0.5	0.0	

LEGEND

CONTROL POINT

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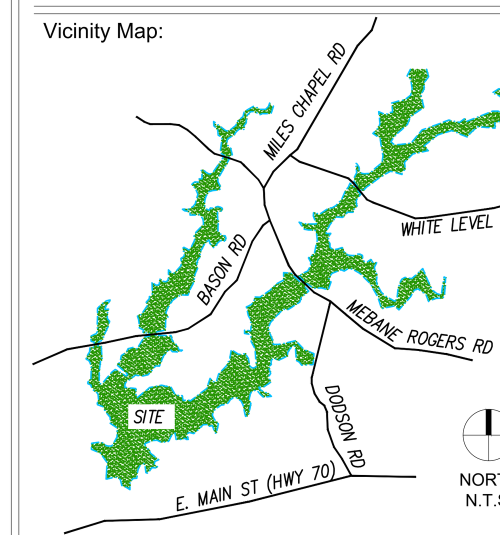

NORTH
NAD83(2011)

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SCALE: 1" = 300'

Title:

BATHYMETRIC SURVEY FOR:

GRAHAM-MEBANE LAKE

ALAMANCE COUNTY, MEBANE, NORTH CAROLINA
DATE: 6/6/23
SCALE: 1" = 300' CONTOUR INTERVAL = NA
PREPARED FOR: HAZEN AND SAWYER

Revisions:

No.	Date	Description
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Seal:

NORTH CAROLINA PROFESSIONAL SEAL L-4707 LAND SURVEYOR C. RYAN DAVENPORT

DocuSigned by:
C. Ryan Davenport
6/26/2023

Project #: G22136
Date: 6/6/23
Drawn by: CRD
Checked by: CRD

Sheet:
3 of 3

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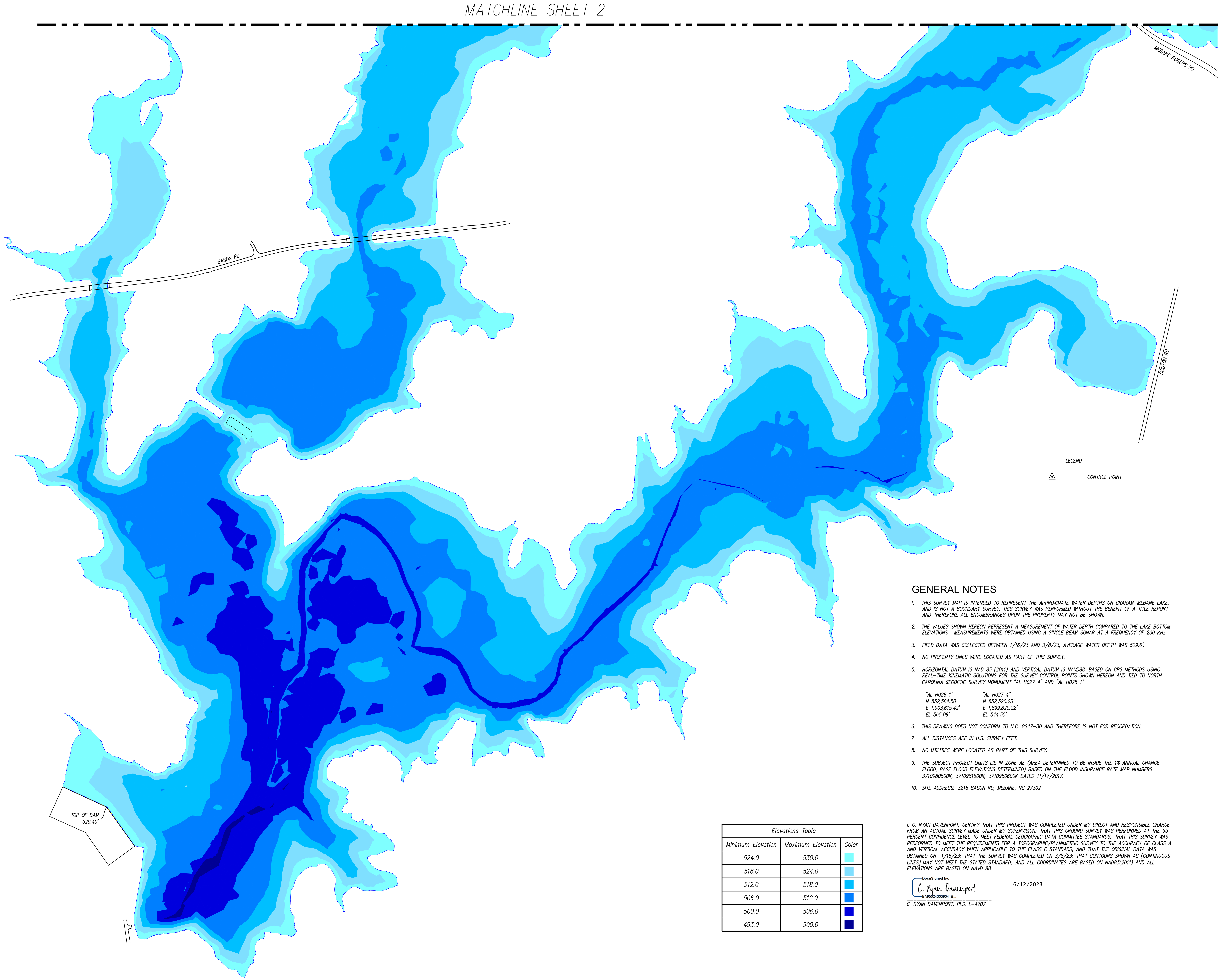

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3. FIELD DATA WAS COLLECTED BETWEEN 1/16/23 AND 3/8/23, AVERAGE WATER DEPTH WAS 529.6'.
4. NO PROPERTY LINES WERE LOCATED AS PART OF THIS SURVEY.
5. HORIZONTAL DATUM IS NAD 83 (2011) AND VERTICAL DATUM IS NAVD88. BASED ON GPS METHODS USING REAL–TIME KINEMATIC SOLUTIONS FOR THE SURVEY CONTROL POINTS SHOWN HEREON AND TIED TO NORTH CAROLINA GEODETIC SURVEY MONUMENT "AL H027 4" AND "AL H028 1" .

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Elevations Table		
Minimum Elevation	Maximum Elevation	Color
524.0	530.0	
518.0	524.0	
512.0	518.0	
506.0	512.0	
500.0	506.0	
493.0	500.0	

I, C. RYAN DAVENPORT, CERTIFY THAT THIS PROJECT WAS COMPLETED UNDER MY DIRECT AND RESPONSIBLE CHARGE FROM AN ACTUAL SURVEY MADE UNDER MY SUPERVISION; THAT THIS GROUND SURVEY WAS PERFORMED AT THE 95 PERCENT CONFIDENCE LEVEL TO MEET FEDERAL GEOGRAPHIC DATA COMMITTEE STANDARDS; THAT THIS SURVEY WAS PERFORMED TO MEET THE REQUIREMENTS FOR A TOPOGRAPHIC/PLANIMETRIC SURVEY TO THE ACCURACY OF CLASS A AND VERTICAL ACCURACY WHEN APPLICABLE TO THE CLASS C STANDARD, AND THAT THE ORIGINAL DATA WAS OBTAINED ON 1/16/23; THAT THE SURVEY WAS COMPLETED ON 3/8/23; THAT CONTOURS SHOWN AS [CONTINUOUS LINES] MAY NOT MEET THE STATED STANDARD; AND ALL COORDINATES ARE BASED ON NAD83(2011) AND ALL ELEVATIONS ARE BASED ON NAVD 88.

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C. Ryan Davenport
BA950243039041B...

6/12/2023

C. RYAN DAVENPORT, PLS, L–4707

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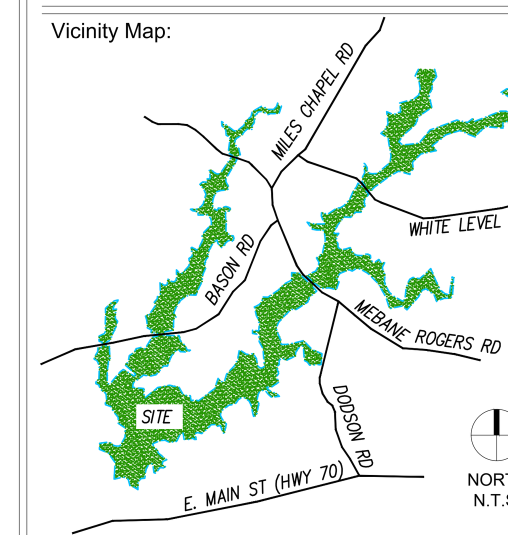
Vicinity Map:



NORTH
NAD83(2011)

0 150 300 600

SCALE: 1" = 300'

Title:

BATHYMETRIC SURVEY FOR:

GRAHAM-MEBANE LAKE

ALAMANCE COUNTY, MEBANE, NORTH CAROLINA
DATE: 6/6/23
SCALE: 1" = 300' CONTOUR INTERVAL = NA
PREPARED FOR: HAZEN AND SAWYER

Revisions:

No.	Date	Description
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Seal:

NORTH CAROLINA PROFESSIONAL SEAL L-4707 LAND SURVEYOR C. RYAN DAVENPORT

Project #: G22136
Date: 6/6/23
Drawn by: CRD
Checked by: CRD

Sheet: **1 of 3**

G:\Projects\2022\G22136 - Graham Mebane Lake\DWG\G22136 WATER DEPTH.dwg Jun 08, 2023 - 11:01pm

GENERAL NOTES

1. THIS SURVEY MAP IS INTENDED TO REPRESENT THE APPROXIMATE WATER DEPTHS ON GRAHAM–MEBANE LAKE, AND IS NOT A BOUNDARY SURVEY. THIS SURVEY WAS PERFORMED WITHOUT THE BENEFIT OF A TITLE REPORT AND THEREFORE ALL ENCUMBRANCES UPON THE PROPERTY MAY NOT BE SHOWN.
2. THE VALUES SHOWN HEREON REPRESENT A MEASUREMENT OF WATER DEPTH COMPARED TO THE LAKE BOTTOM ELEVATIONS. MEASUREMENTS WERE OBTAINED USING A SINGLE BEAM SONAR AT A FREQUENCY OF 200 KHz.
3. FIELD DATA WAS COLLECTED BETWEEN 1/16/23 AND 3/8/23, AVERAGE WATER ELEVATION WAS 529.6'.
4. NO PROPERTY LINES WERE LOCATED AS PART OF THIS SURVEY.
5. HORIZONTAL DATUM IS NAD 83 (2011) AND VERTICAL DATUM IS NAVD88. BASED ON GPS METHODS USING REAL–TIME KINEMATIC SOLUTIONS FOR THE SURVEY CONTROL POINTS SHOWN HEREON AND TIED TO NORTH CAROLINA GEODETIC SURVEY MONUMENT "AL H027 4" AND "AL H028 1" .

"AL H028 1"	"AL H027 4"
N 852,584.50'	N 852,520.23'
E 1,903,615.42'	E 1,899,820.22'
EL 565.09'	EL 544.55'

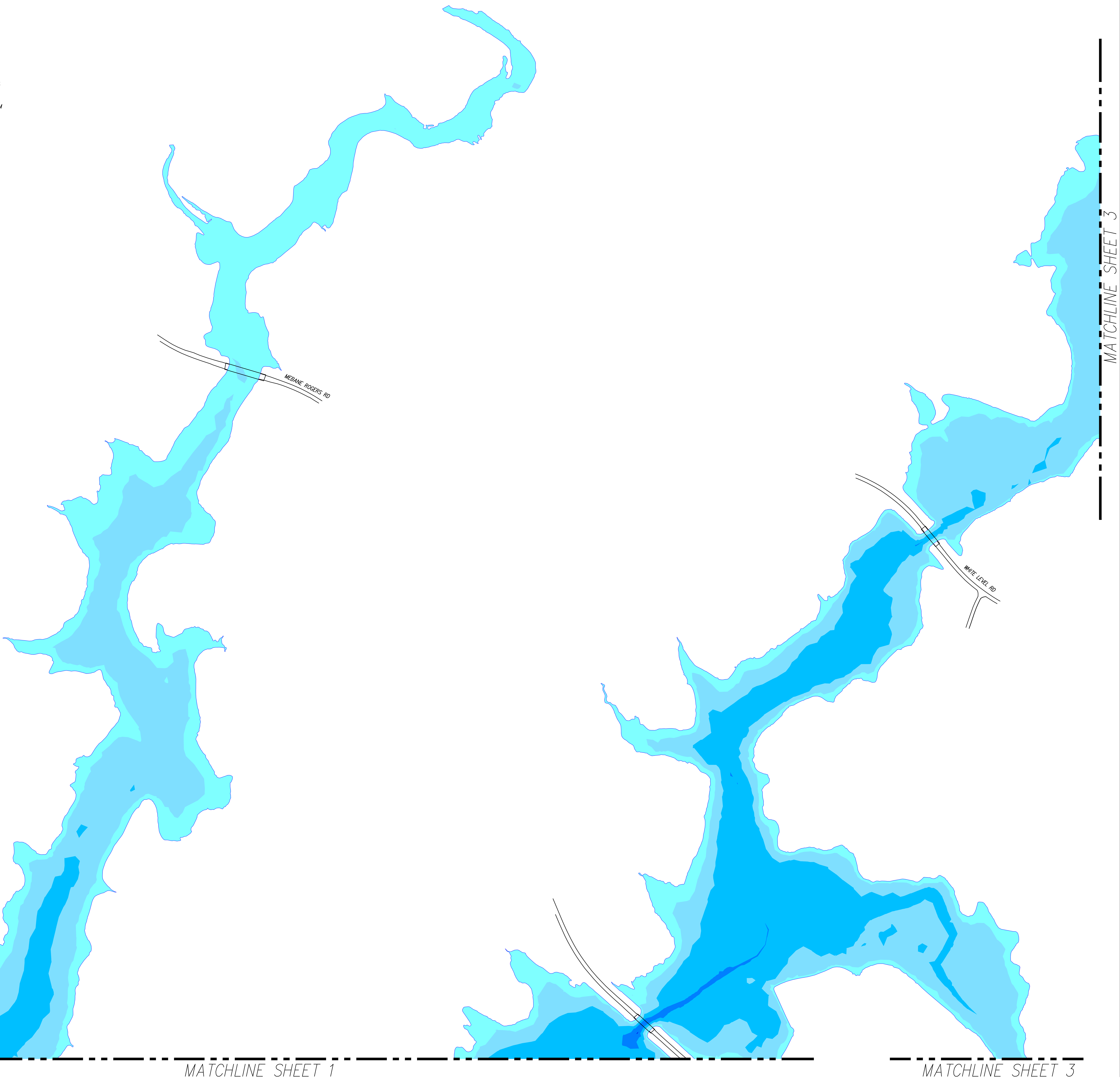
6. THIS DRAWING DOES NOT CONFORM TO N.C. GS47–30 AND THEREFORE IS NOT FOR RECORDATION.
7. ALL DISTANCES ARE IN U.S. SURVEY FEET.
8. NO UTILITIES WERE LOCATED AS PART OF THIS SURVEY.
9. THE SUBJECT PROJECT LIMITS LIE IN ZONE AE (AREA DETERMINED TO BE INSIDE THE 1% ANNUAL CHANCE FLOOD, BASE FLOOD ELEVATIONS DETERMINED) BASED ON THE FLOOD INSURANCE RATE MAP NUMBERS 3710980500K, 3710981600K, 3710980600K DATED 11/17/2017.
10. SITE ADDRESS: 3218 BASON RD, MEBANE, NC 27302

Elevations Table

Minimum Elevation	Maximum Elevation	Color
524.0	530.0	
518.0	524.0	
512.0	518.0	
506.0	512.0	
500.0	506.0	
493.0	500.0	

LEGEND

△ CONTROL POINT



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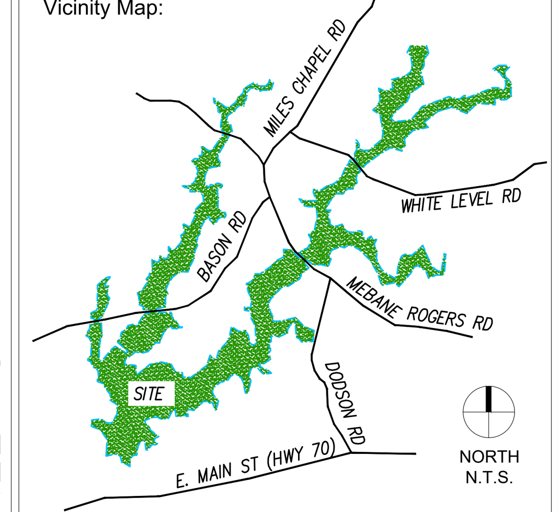
Vicinity Map:



NORTH
NAD83(2011)

0 150 300 600

SCALE: 1" = 300'

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GRAHAM-MEBANE LAKE

ALAMANCE COUNTY, MEBANE, NORTH CAROLINA
DATE: 6/6/23
SCALE: 1" = 300' CONTOUR INTERVAL = NA
PREPARED FOR: HAZEN AND SAWYER

Revisions:

No.	Date	Description
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NORTH CAROLINA PROFESSIONAL SEAL L-4707 LAND SURVEYOR C. RYAN DAVENPORT

DocuSigned by:
C. Ryan Davenport
6/12/2023

Project #:	G22136	Sheet:
Date:	6/6/23	
Drawn by:	CRD	**2 of 3**
Checked by:	CRD	

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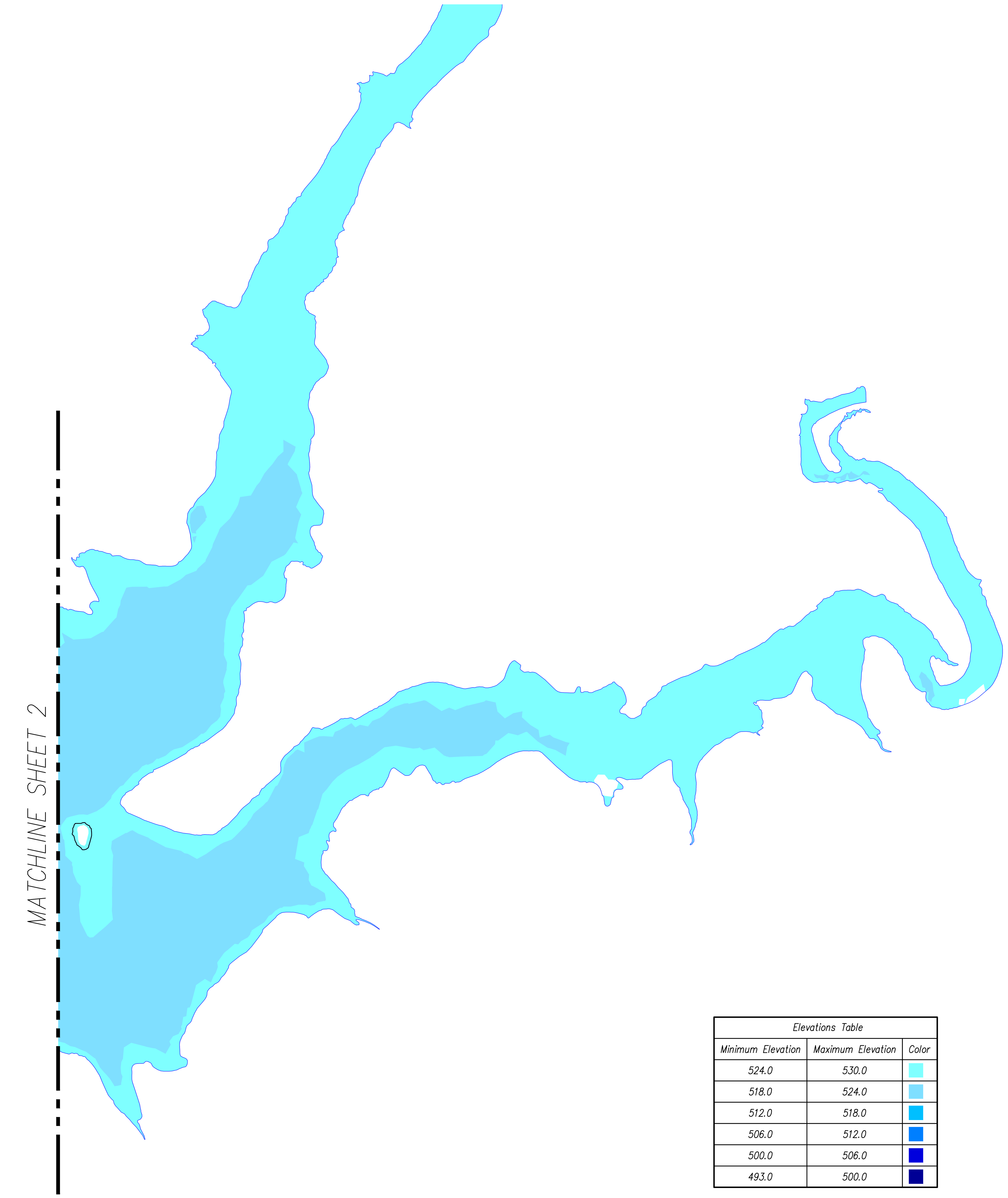

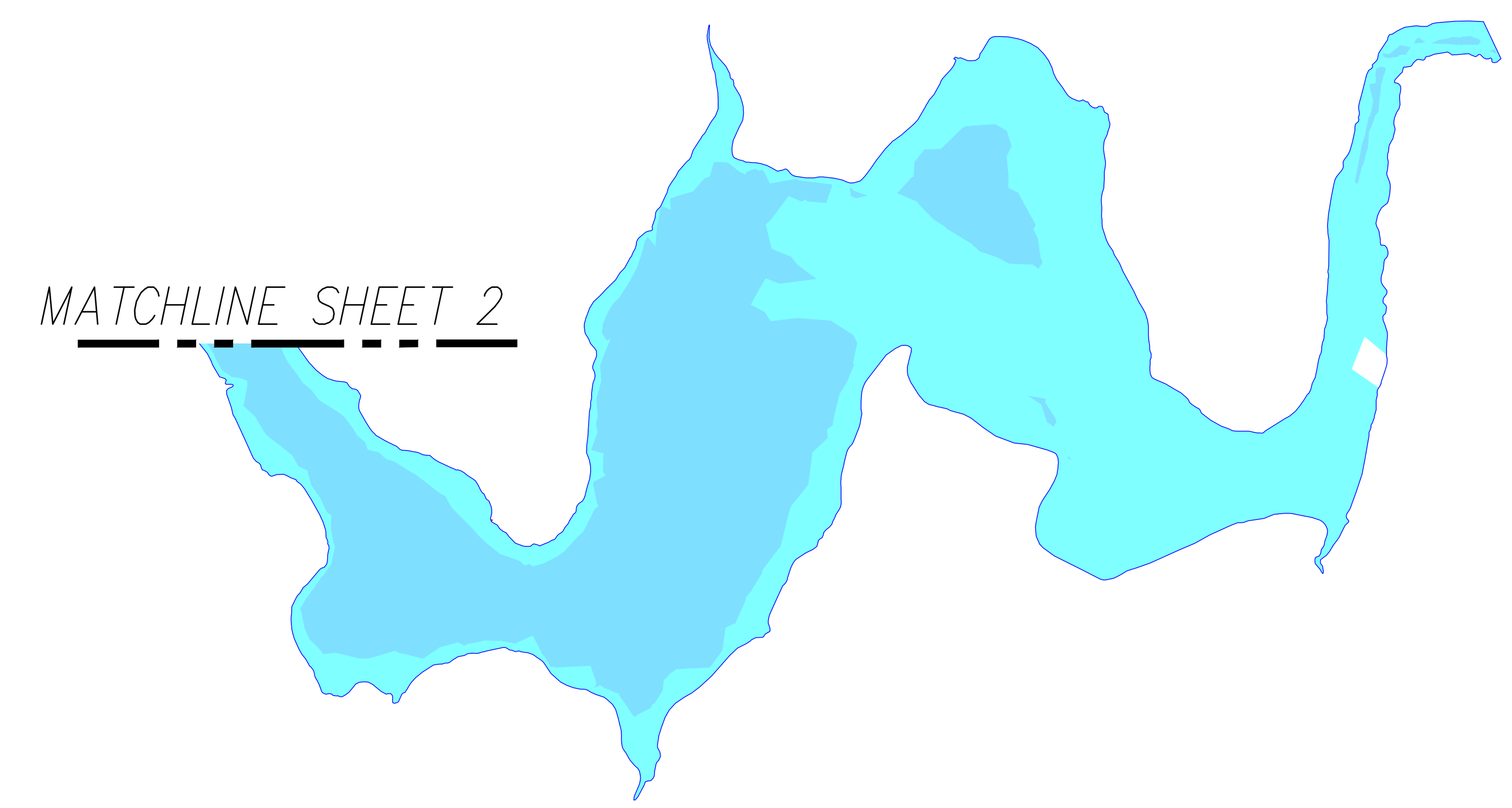

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LEGEND

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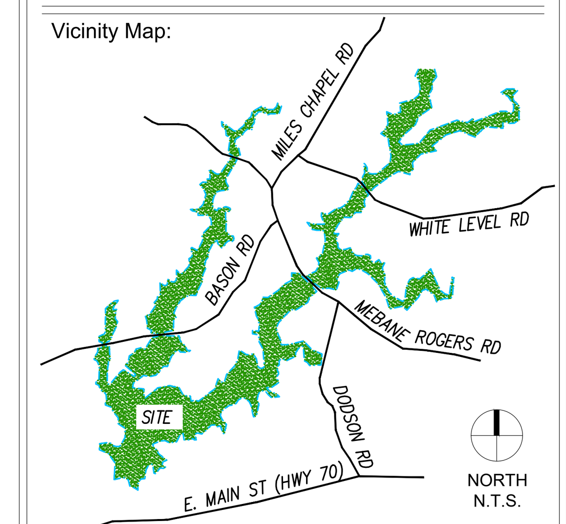

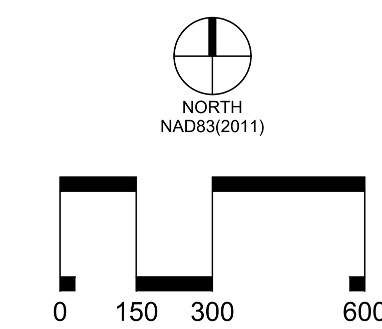

SCALE: 1" = 300'

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ALAMANCE COUNTY, MEBANE, NORTH CAROLINA
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NORTH CAROLINA PROFESSIONAL SEAL L-4707 LAND SURVEYOR C. RYAN DAVENPORT

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C. Ryan Davenport
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6/12/2023

Project #: G22136
Date: 6/6/23
Drawn by: CRD
Checked by: CRD

Sheet: 3 of 3

Appendix B

Three different methods were used to calculate the annual sediment accumulation rate in Graham-Mebane Lake. The first method involves a comparison of bathymetric surveys (Equation B-1). Loss of water storage capacity is derived from comparing storage volumes from two surveys from different time periods. Sedimentation rates can be calculated with respect to the watershed area using the loss of storage capacity. In Equation B-1, *S* represents the sedimentation rate, typically expressed in units of acre-feet per year per square mile of drainage area. *V* represents the maximum storage volume of the reservoir, *T* stands of the number of years elapsed between an earlier study and the more recent study, and *A* stands for the area of the watershed.

Equation B- 1

$$S = \left(V_{prior\ year} - V_{current\ year}\right) \div (T_{year\ elapsed}\ x\ A_{watershed})$$

The second method involves using the sediment volume from the bathymetric survey to compute the sedimentation rate (Equation B- 2). In this equation *v* represents sediment volume; other terms represent the same quantities as in Equation B- 1.

Equation B- 2

$$S = V_{sediment} \div T_{year\ elapsed} \div A_{watershed}$$

The third method elaborates upon Equation B-2 to account for the difference in lengths of time during which sedimentation occurred in areas of the lake impounded by the old and current dams (Equations B-3 and B-4). The elapsed time for sedimentation in the area upstream of the old dam is assumed to be 47 years and that for the area downstream of the old dam and upstream of the current dam is assumed to be 29 years. USGS StreamStats was used to delineate the watershed areas that are applied for the area upstream of the old dam and the area that applies to the entire watershed for the Graham-Mebane Lake separately as shown in Figure B-1.

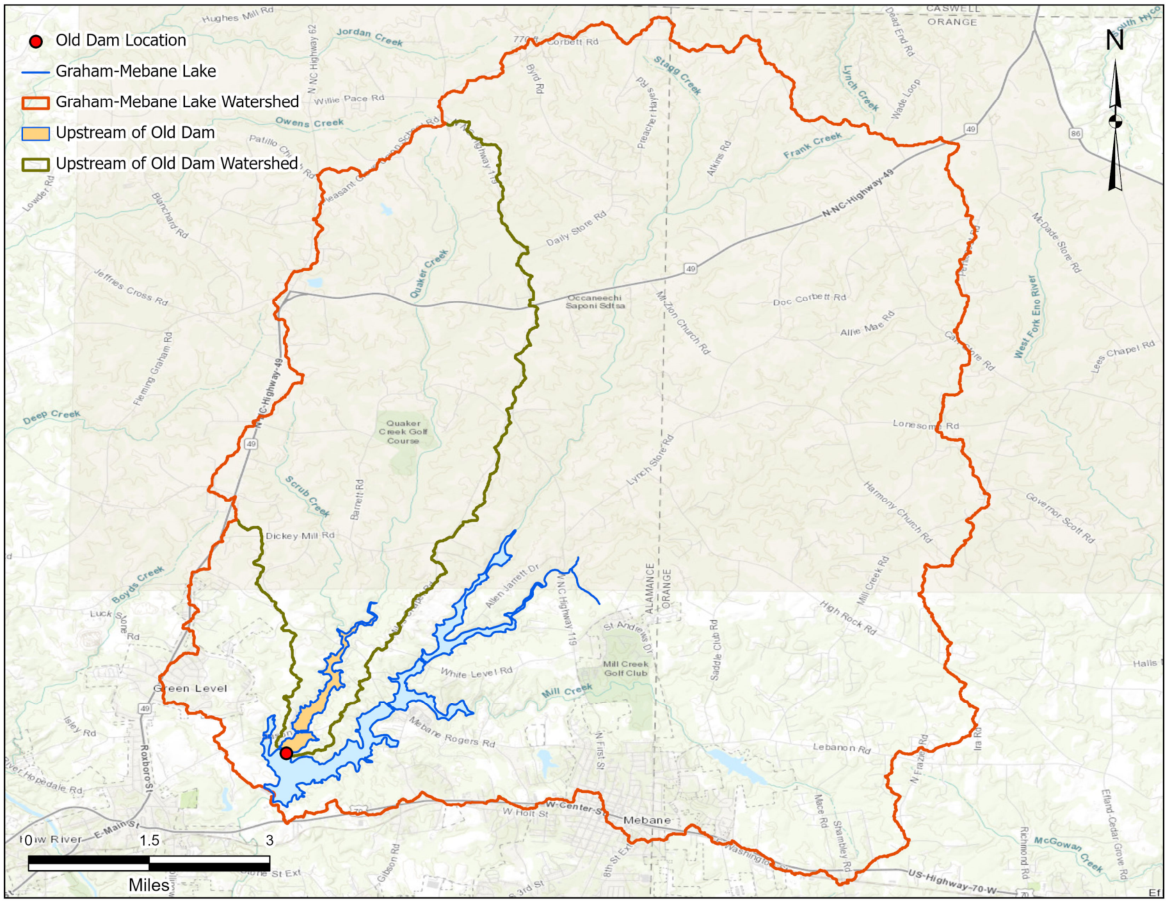


Figure B- 1: Drainage Basins for Old and Current Reservoir Dams

The watershed tied to the lake area above the dam was determined to be 14.4 square miles, and the entire watershed area was determined to be 66.1 square miles. Consequently, the total sediment volume, *V,* can be expressed as follows:

Equation B- 3

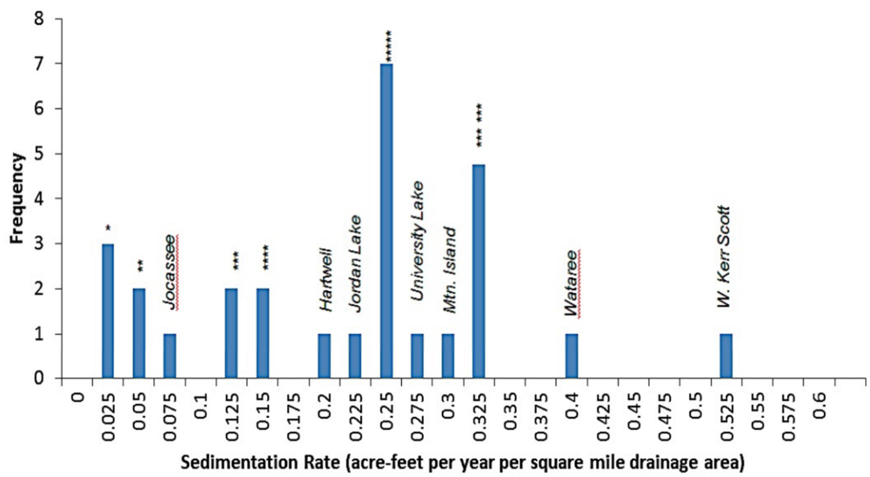
$$V = A_{upstream} \times T_{upstream} \times S + A_{downstream} \times T_{downstream} \times S$$

where $A_{upstream}$ is the watershed area tied to the lake area above the old dam (14.4 square miles), $A_{downstream}$ is the watershed area calculated by subtracting $A_{upstream}$ from the total watershed area (51.7 square miles), $T_{upstream}$ = 47 years, and $T_{downstream}$ = 29 years. Solving for sedimentation rate:

Equation B- 4

$$S = \frac{V}{A_{upstream} \times T_{upstream} + A_{downstream} \times T_{downstream}}$$

Sedimentation rates calculated by the three methods above are summarized in Table 3-2. The first method (Equation B- 1) could result in falsely high sedimentation rates that are statistically unlikely based on the distribution of known sedimentation rates of lakes in and around North Carolina (Figure B-2, statistically characterized in Figure B-3). One explanation is that high apparent sedimentation rates are common right after impoundment. Other reservoirs in the region have experienced high rates of apparent sedimentation after impoundment, followed by sharp reductions in sediment accumulation thereafter. The second and third methods, on the other hand, yielded sedimentation rates more in line with other reservoirs in the region.



*	Falls (Yadkin Pee Dee); Tiller; Blewett
**	Badin (Narrows); Tuckertown
***	Keowee; J. Strom Thurman
** **	Richard B. Russell; Stony Creek
*****	Bridgewater; Fishing Creek; Great Falls & Dearborn, Rocky Creek and Cedar Creek; High Rock; Lake Michie; Little River
*** ***	Rhodiss; Oxford (lake Hickory); Lookout; C. Ford (Lake Norman); Wylie

Figure B-2: Sedimentation Rates for Lakes in and around North Carolina[3]

[3] Anna J. Petryniak and Apple B. Loveless, "B. Everett Jordan Dam Sedimentation Rates and Reservoir Capacity", Duke University – Nicholas Institute for Environmental Policy Solutions (June 2013).

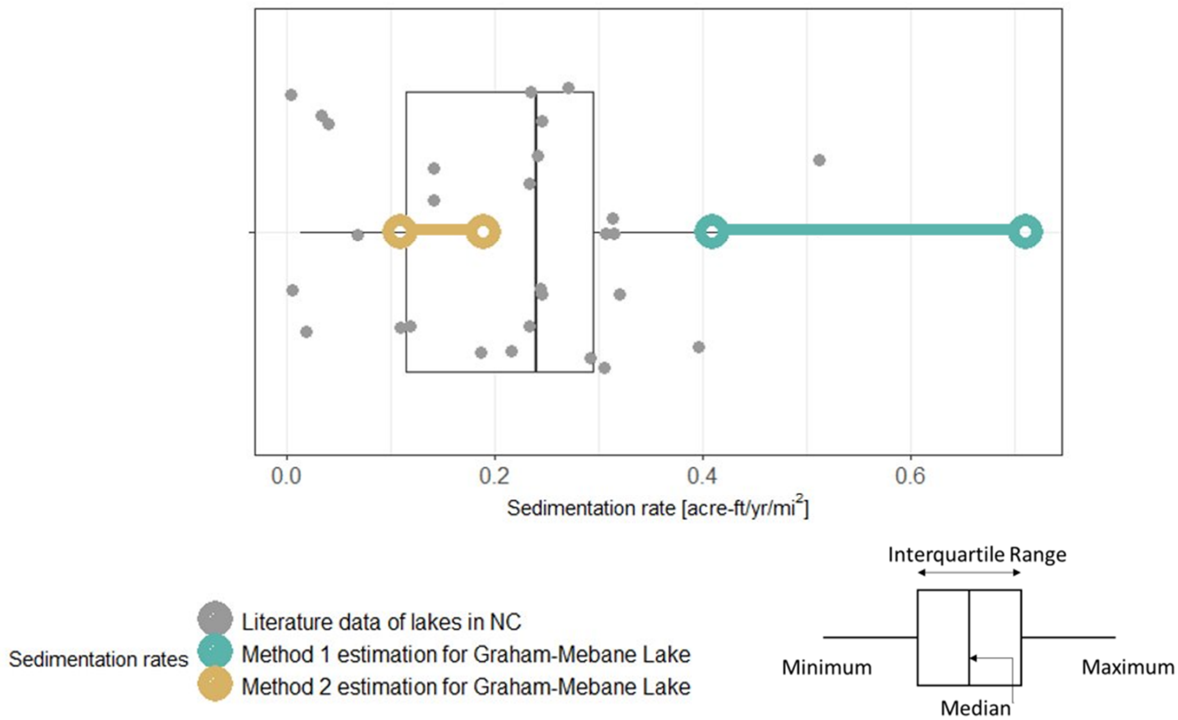


Figure B-3: Comparisons of Three Sedimentation Methods Calculations to Typical Regional Sedimentation Rates

TECHNICAL MEMORANDUM

TO: City of Mebane, North Carolina

FROM: Doug Chapman, McGill Associates

DATE: November 9, 2021

RE: Water Resource Recovery Facility Expansion

This technical memorandum serves as a synopsis of the Visioning Phase efforts of McGill Associates in regard to the Water Resource Recovery Facility (WRRF) Expansion Project.

Background

The City of Mebane owns and operates the Water Resource Recovery Facility (WRRF) — complete with preliminary treatment, activated sludge biological treatment, secondary clarification, tertiary filtration, disinfection, aerobic digestion, and sludge thickening. The WRRF has a permitted capacity to discharge up to 2.5 MGD to Moadams Creek. Many of the existing main treatment process are in older structures over 40 years old, with equipment well over 20 years old, having exceeded their useful life. The facility treats the majority of the City's wastewater, with a small portion flowing to the City of Graham where the City has 0.75 MGD of capacity. The WRRF had an average daily flow of 1.71 MGD during 2020. The city is about to begin construction on a project to improve the treatment and viability of the facility by constructing a new headworks (preliminary treatment) and improving residuals processing equipment.

Existing Facilities

When the original facility was constructed, it included a bar screen and grit collector, one (1) aeration basin, one (1) clarifier, sludge drying beds, and the administration building. Then in 1981, the WRRF was expanded to include one additional (1) aeration basin, two additional (2) clarifiers, the return sludge pump station, chlorine contact basin, and the existing clarifier was repurposed as a digestor. Beyond the structures, the equipment installed (process and electrical) in those basins have exceeded their service life. The next major project at the facility, constructed in 1991, included the addition of third larger clarifier and tertiary filters. This clarifier equipment is also well over 20 years old.

EXHIBIT I

Need For Project

Growth & Expansion

Currently, the average daily flow is growing at an approximate rate of 0.1 MGD per year. Based on projected growth of approximately 500 new users annually, representing approximately 1,000 new residents each year, the facility's remaining capacity will be quickly exhausted. As shown in the figure below, the projected growth in flow over the next 30 years is expected to exceed capacity, thus making expansion critical to the future of Mebane. Additionally, per North Carolina General Statutes, wastewater systems must submit an engineering evaluation of their future wastewater treatment, utilization, and disposal needs, prior to exceeding 80 percent of their systems hydraulic capacity. It is expected that Mebane will reach this point by 2023. Furthermore, prior to exceeding 90 percent of the systems hydraulic capacity, North Carolina General Statutes require the wastewater system to obtain all permits needed for the expansion of the wastewater treatment, utilization, or disposal system. It is expected that the city will reach this point by 2026.

Figure 1 - Growth Projections

Based on flow projections, McGill recommends a strategy to construct a biological treatment system with the first two trains having a capacity of 4.0 MGD and the second phase adding a third train for 6.0 MGD. The initial project would be planned to readily accommodate the second phase expansion, with further consideration of a future step to 8.0 MGD.

Aging Infrastructure.

Many of the existing treatment process are in older structures over 40 years old. Those include the existing aeration basins, the clarifiers, return sludge pump station, and chlorine contact basin. These processes will be relocated to new treatment process basins adjacent to the existing facility. Further, most of the equipment within the facility that is being taken out of service includes equipment well over 30 years old, having exceeded its useful life.

Floodplain

The project will provide resiliency for the treatment process by replacing aged infrastructure and equipment, and by providing equipment with effective and reliable treatment capabilities. Further, flood resiliency for treatment will be provided by relocating the main portion of the treatment facility (biological treatment and filtration) out of the 100-year floodplain. The project will move the aeration process from the existing structures, which are within the “1% annual chance floodplain” to a new location on the facility site, which is outside of the 500-year floodplain.

Further, while the existing clarifiers, filters, and chlorine contact basin are located outside of the mapped “1% annual flood chance”, they are located adjacent to the boundary and at a water elevation lower than the aeration basins. Therefore, they are also susceptible to flood risks.

Future Nutrient Limits

Beyond the urgent need to address flow capacity, McGill also understands that the facility is subject to phosphorus and nitrogen limits because of total maximum daily load (TMDL) restrictions related to the Jordan Lake Rules. The facility, when originally built and subsequently upgraded, was not designed to biologically reduce these nutrients; however, the City staff has performed a yeoman’s job at addressing both nutrients by use of creative process enhancements and diligence. The TMDL levels imposed by North Carolina Department of Environmental Quality (NCDEQ) are sufficiently restrictive to have a profound impact on what type of treatment technologies can be used for this project. McGill will utilize BioWin modeling during design to ensure that the processes planned and designed will adequately meet the National Pollutant Discharge Elimination System (NPDES) permit.

Alternatives Considered

A previous study proposed expansion of the facility by upgrading the existing aeration basins and adding a second parallel process. The two (2) treatment facilities would have provided a capacity of 5.3 MGD. Considering the age of the facility and the critical need to meet total nitrogen and total phosphorus limits, it is preferred to add a new five stage process. This section evaluates Project Alternatives that would enable the City of Mebane to ensure adequate wastewater treatment capacity and capability for area residents and businesses. The Alternatives evaluated are as follows:

Alternative No. 1 – Oxidation Ditch

This alternative would include the major components below. A conceptual drawing of this alternative is included in Appendix A.

- Headworks Expansion
- New Influent Pump Station
- Existing Aeration Basin repurposed for Flow Equalization
- ***New 5 stage Bardenpho Oxidation Ditches***
- ***New Secondary Clarifiers***
- ***New Return Pump Station***
- New Filters
- Existing Clarifier repurposed for Disinfection
- Existing Aeration Basin repurposed for Sludge Processing

Alternative No. 2 – Sequencing Batch Reactor (SBR)

This alternative would include the major components below. A conceptual drawing of this alternative is included in Appendix B.

- Headworks Expansion
- New Influent Pump Station
- Existing Aeration Basin repurposed for Flow Equalization
- ***New Sequencing Batch Reactors***
- ***New Post Equalization Basin***
- New Filters
- Existing Clarifier repurposed for Disinfection
- Existing Aeration Basin repurposed for Sludge Processing

Selection of Preferred Alternative

Based on flow projections, McGill has recommended a future strategy to construct a five-stage nutrient removal biological treatment system. The first two (2) trains would have a capacity of 4.0 MGD and the future third train would increase capacity to 6.0 MGD. New filtration would be added to reduce total nitrogen and total phosphorus levels. The first phase project would be planned to readily accommodate the second phase expansion.

Oxidation ditches are the preferred five stage biological treatment in this application for the following reasons:

- The control system of SBR units are more complicated than oxidation ditches due to their numerous automatic switches, valves and instrumentation. As these systems increase in capacity, they become increasingly more sophisticated, providing more opportunity for malfunctions. Due to these reasons, the vast majority of SBR installations in the United States are for wastewater systems of less than two (2) MGD.

- The oxidation ditch is inherently more stable and resistant to biological process upsets because of the longer detention time - ~20-24 hours compared to ~6 hours for SBRs.
- While the SBR is fully integrated in one (1) zone with time separating the stages of biological activity, oxidation ditches have different zones for different types of biological activity.
- Operating SBRs can be more energy intensive in contrast to the operation of oxidation ditches.
- SBR structures are relatively deep and require extensive excavation, possibly elevating capital cost in comparison to oxidation ditches.

Proposed Project

The proposed project will provide treatment of flows to 4.0 MGD and total nitrogen and total phosphorus removal to meet the speculative limits in the NPDES permit. Facility upgrades will be designed with piping and structures planned to accommodate a future expansion of 6.0 MGD. The project will include all necessary site grading, piping, electrical, SCADA, and access drives for a complete system. Below is a description of all major components of the project:

Influent Pump Station

A new influent pump station will be constructed, allowing for adequate hydraulics throughout the facility. Pumps will be designed for a firm capacity of 4.0 MGD. Space will be left for a future pump to achieve a firm capacity of 6.0 MGD.

Headworks

A new headworks is currently being constructed as a separate project. The headworks expansion will include adding one (1) mechanical screen and one (1) vortex grit removal unit, to accommodate flows and to provide redundancy.

Flow Equalization

The existing north aeration basin will be repurposed as a flow equalization tank. Flow equalization is needed due to high I/I and because most of the collection system flow is pumped to the WRRF.

Biological Treatment

Biological nutrient removal will be designed to comply with total TN and total TP limits from the Jordan Lake rules. A two (2) train, five stage Bardenpho process has been selected, this process includes anaerobic, anoxic, aeration, post anoxic, and reaeration stages. A third train will be planned and accounted for in piping, splitter boxes, and the hydraulic profile.

Secondary Clarifiers

Two (2) final clarifiers along with a with RAS pump station will be constructed as part of this project. A third final clarifier will be planned and accounted for in piping, splitter boxes, and the hydraulic profile. The RAS pump station will have space for a future pump.

Tertiary Filters

The City of Mebane currently uses and prefers “inside-out flow” disk filters. The conceptual phase of the project will investigate alternative tertiary filtration options, such as denitrification filters. Further, tertiary clarification may be needed for phosphorous removal.

Disinfection

Post treatment will include disinfection, and dechlorination. The existing clarifier might be repurposed as a chlorine contact basin. The City of Mebane currently uses sodium hypochlorite for chlorination.

Solids handling

The existing south aeration basin could possibly be repurposed to increase the sludge storage of the facility if needed. Furthermore, the existing WAS digester will be rehabilitated and a second rotary drum thickener will be added as part of the current improvements project. The WWRF currently has a thickener, two (2) sludge tanks, and digester, but an outside contractor is used to dewater and dispose of sludge. The conceptual phase of the project will review the increased sludge production with the assumption of maintaining their current disposal method. Lastly, sidestream treatment of supernatant will likely be necessary for the removal of phosphorus.

Project Costs

An application for Clean Water State Revolving Fund (CWSRF) funding through North Carolina Department of Environmental Quality (NCDEQ) was submitted as part of the visioning phase of this project. A detailed cost estimate was created for this application and is included in Appendix C. The major components of the estimate are shown below:

Project Component	Component Cost
General (Mobilization/Site Work/Electrical)	$12,435,000
Project Elements	$27,210,000
Contingency (10% Construction Cost)	$3,965,000
Construction Subtotal	**$43,610,000**
Engineering Costs	$5,023,000
Administration Costs	$2,367,000
Total Project Cost	**$51,000,000**

Schedule

Beyond the technical planning and design of the project, adhering to an aggressive schedule is paramount to project success. As part of the visioning stage of the project, McGill has developed a schedule to simultaneously progress through the NPDES expansion permitting, facility design, and funding solicitation. While most steps of this process are critical, NPDES expansion permitting is one that has significant items outside of the control of the City or its design team. Our experience, understanding of the Clean Water Act, and relationships with state and federal regulators will address this critical portion of the work scope and key schedule element. Further, McGill has committed the necessary resources to accomplish the necessary planning, design, and construction oversight to carry the City's WRRF Expansion project from vision to completion.

The following major project phases are outlined below with corresponding durations. A detailed project schedule is included in Appendix D.

Project Phase	**Phase Duration**
Conceptual Design	October 2021 – January 2022
Design	January 2022– September 2022
Funding	August 2021 – August 2022
NPDES Engineering Alternative Analysis	October 2021 – December 2021
NPDES Permitting Application	December 2021 – November 2022
Construction	December 2022 – July 2025

Conclusion – Next Steps

To address the growing need for capacity and cost impacts, McGill has assisted Mebane with visioning for the future of the WRRF and funding solicitation. As part of that effort, McGill reviewed previous studies of the facility, performed field reconnaissance at the facility, reviewed operating reports, considered available process treatment technologies, and developed a strategy for proceeding with the facility's future. That effort included developing a process vision for expansion of the facility's capacity, prioritizing reuse of existing facilities (to maintain past investment), analyzing the budget for the expansion, preparing a schematic site plan, and identifying funding resources to support the project. The culmination of the visioning effort is the development of a plan to construct an expanded facility adjacent to the existing facility including an expanded headworks, flow equalization, influent pumping station, a five-stage biological treatment process with final clarifiers, new tertiary filtration, and post-treatment (disinfection and post aeration).

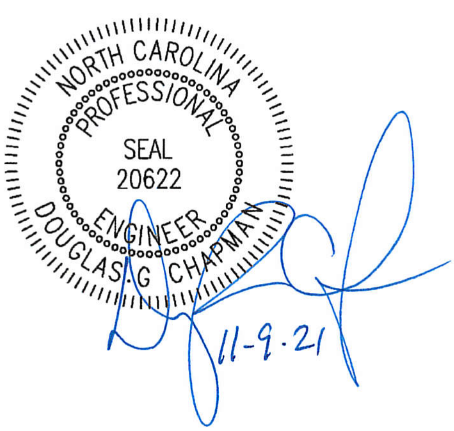
Next Project Steps – Conceptual Design

As part of the next stage of the project, the conceptual design phase, the following tasks will be completed:

1. Utilizing the preferred alternative from the Visioning stage, perform a more detailed preliminary analysis of expansion/upgrade elements needed.

2. Prepare BioWin treatment modeling for the process.
3. Prepare hydraulic modeling for the process to determine piping upgrades and hydraulic profile.
4. Develop a proposed site plan for the expansion.
5. Prepare an opinion of probable cost for the expansion.
6. Develop a technical memo to summarize the project.
7. Review proposed project with City staff at stages during development and upon completion to City Council as necessary.
8. Concurrently, the engineering alternative analysis and permit application for the NPDES permitting will be prepared and submitted.

Enclosures: Appendix A - Oxidation Ditch Alternative
Appendix B – SBR Alternative
Appendix C – CWSRF Cost Estimate
Appendix D – Project Schedule



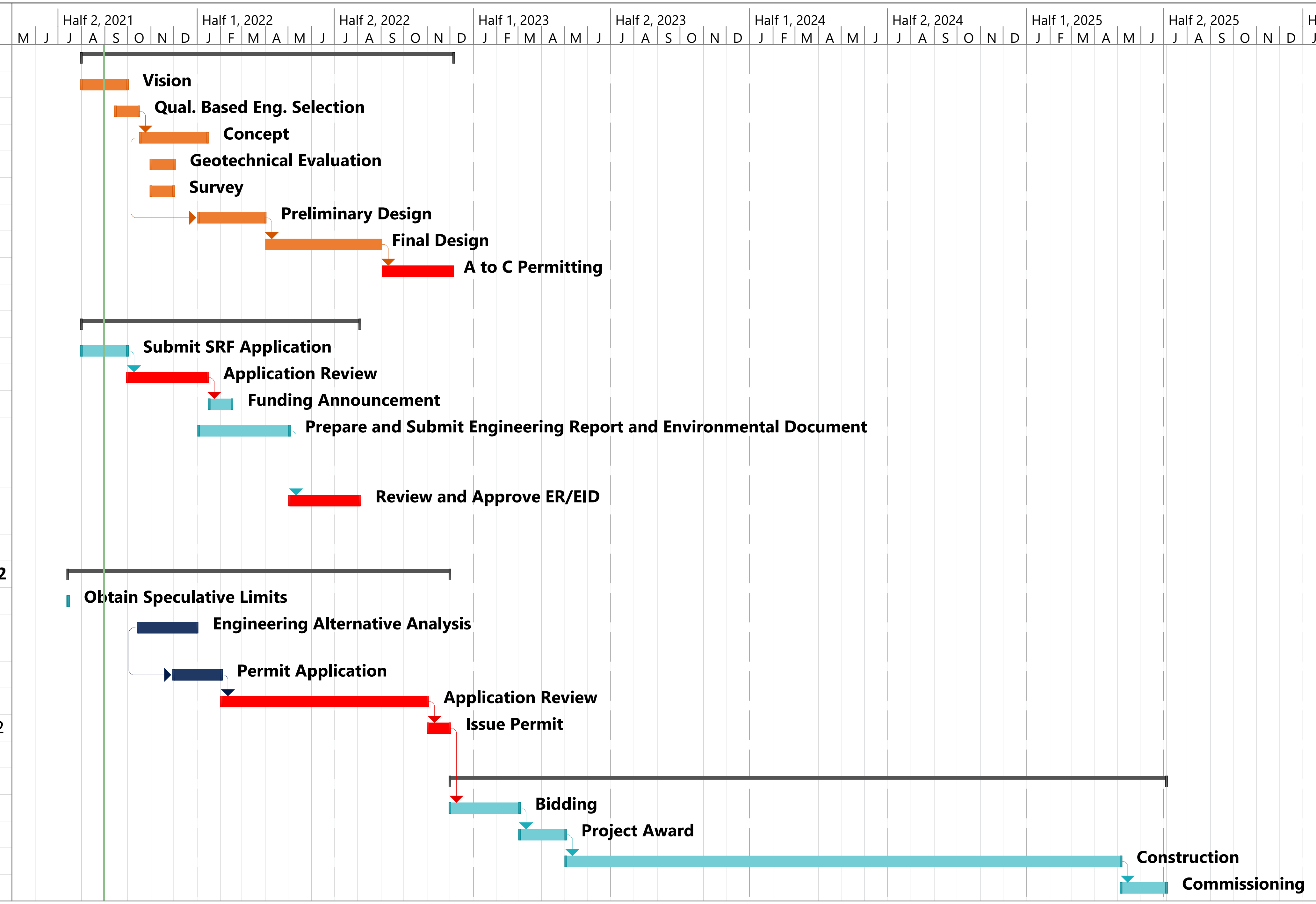

OXIDATION DITCH ALTERNATIVE
5 STAGE BARDENPHO OXIDATION DITCH
INFLUENT PUMP STATION
SECONDARY CLARIFIERS
EXPANDED HEADWORKS
BASINS REPURPOSED FOR FLOW EQUALIZATION
BASINS REPURPOSED FOR SLUDGE PROCESSING
FILTERS
EXISTING DISCHARGE
BASIN REPURPOSED FOR DISINFECTION
mcgill
Shaping Communities Together


SBR ALTERNATIVE
SEQUENCING BATCH REACTORS
INFLUENT PUMP STATION
POST EQUALIZATION
EXPANDED HEADWORKS
BASINS REPURPOSED FOR FLOW EQUAILIZATION
BASINS REPURPOSED FOR SLUDGE PROCESSING
FILTERS
EXISTING DISCHARGE
BASIN REPURPOSED FOR DISINFECTION
mcgill
Shaping Communities Together

8. **Project Budget (for Construction Projects Only)**			
Construction Costs	**Division Funding Requested**	**Other Funding**	**Total Cost Amount**
General Costs that Apply to Entire Project			
Mobilization	1,190,000		1,190,000
Site Work and Piping	6,445,000		6,445,000
Electrical and SCADA	4,800,000		4,800,000
Subtotal Costs	**12,435,000**		**12,435,000**
Project Elements Replacing Components less than 40 Years Old			
Headworks Expansion	1,760,000		1,760,000
Flow Equalization	1,400,000		1,400,000
Influent Pump Station	1,800,000		1,800,000
Tertiary Filters	4,200,000		4,200,000
Chemical Feeds	1,450,000		1,450,000
Digester Upgrades	900,000		900,000
Subtotal Costs	**11,510,000**	**42.3% of Project**	**11,510,000**
Project Elements Replacing Components greater than 40 Years Old			
Five Stage Treatment	9,900,000		9,900,000
Final Clarifiers	3,000,000		3,000,000
Return Pump Station	1,500,000		1,500,000
Disinfection	1,300,000		1,300,000
Subtotal Costs	**15,700,000**	**57.7% of Project**	**15,700,000**
Contingency (10% of construction costs):	3,965,000		3,965,000
Construction Subtotal:	***43,610,000***		***43,610,000***
Engineering Costs			
Engineering Design	4,773,000		4,773,000
Permitting	200,000		200,000
Land Surveying Costs	50,000		50,000
Engineering Subtotal:	***5,023,000***		***5,023,000***
Administration Costs			
Planning	100,000		100,000
Geotechnical Evaluation	57,000		57,000
Land Acquisition	750,000		750,000
Loan Administration (if applicable)	100,000		100,000
ER Preparation	100,000		100,000
Environmental Documentation Preparation	60,000		60,000
Legal Costs	200,000		200,000
Closing Costs		1,000,000	1,000,000
Administration Subtotal:	***1,367,000***	***1,000,000***	***2,367,000***
TOTAL PROJECT COST:	**50,000,000**	**1,000,000**	**51,000,000**
A PE Seal for the estimate *must be provided* in the space to the right for the application to be considered complete.		NORTH CAROLINA PROFESSIONAL SEAL 20622 ENGINEER DOUGLAS G. CHAPMAN	9-23-21

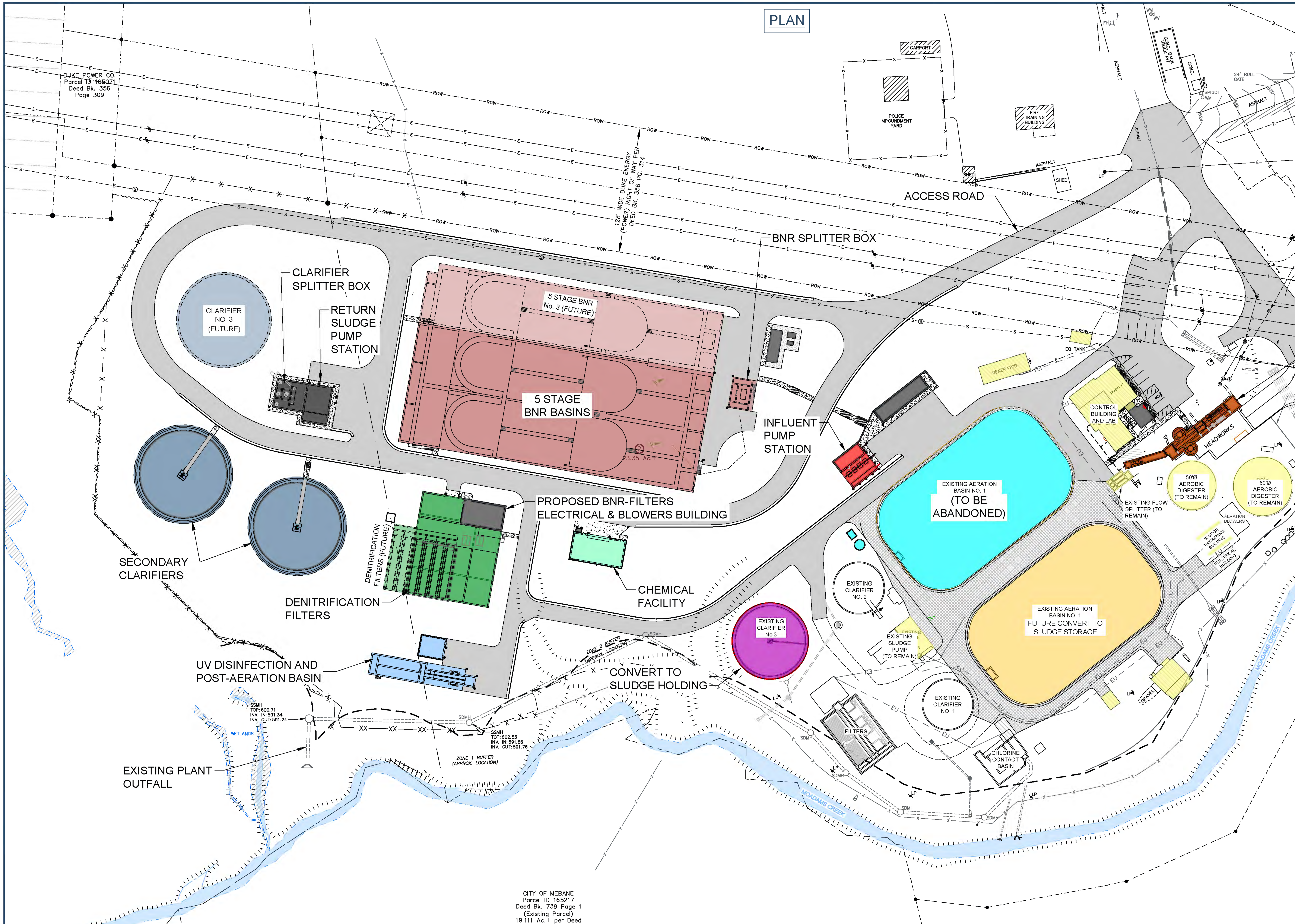
Mebane Water Resource Recovery Facility

ID	Task Name	Duration	Start	Finish
1	**Design**	**351 days?**	**Sun 8/1/21**	**Mon 12/5/22**
2	Vision	45 days	Sun 8/1/21	Thu 9/30/21
3	Qual. Based Eng. Selection	23 days	Wed 9/15/21	Fri 10/15/21
4	Concept	65 days	Mon 10/18/21	Fri 1/14/22
5	Geotechnical Evaluation	23 days	Mon 11/1/21	Wed 12/1/21
6	Survey	22 days	Mon 11/1/21	Tue 11/30/21
7	Preliminary Design	64 days	Mon 1/3/22	Thu 3/31/22
8	Final Design	110 days	Fri 4/1/22	Thu 9/1/22
9	A to C Permitting	67 days	Fri 9/2/22	Mon 12/5/22
10				
11	**Funding Timeline**	**263 days**	**Sun 8/1/21**	**Wed 8/3/22**
12	Submit SRF Application	45 days	Sun 8/1/21	Thu 9/30/21
13	Application Review	76 days	Fri 10/1/21	Fri 1/14/22
14	Funding Announcement	22 days	Mon 1/17/22	Tue 2/15/22
15	Prepare and Submit Engineering Report and Environmental Document	86 days	Mon 1/3/22	Mon 5/2/22
16	Review and Approve ER/EID	67 days	Tue 5/3/22	Wed 8/3/22
17				
18	**NPDES Permitting**	**361 days**	**Wed 7/14/21**	**Wed 11/30/22**
19	Obtain Speculative Limits	1 day	Wed 7/14/21	Wed 7/14/21
20	Engineering Alternative Analysis	56 days	Fri 10/15/21	Fri 12/31/21
21	Permit Application	45 days	Wed 12/1/21	Tue 2/1/22
22	Application Review	195 days	Wed 2/2/22	Tue 11/1/22
23	Issue Permit	21 days	Wed 11/2/22	Wed 11/30/22
24				
25	**Implementation**	**677 days**	**Thu 12/1/22**	**Fri 7/4/25**
26	Bidding	66 days	Thu 12/1/22	Thu 3/2/23
27	Project Award	43 days	Fri 3/3/23	Tue 5/2/23
28	Construction	524 days	Wed 5/3/23	Mon 5/5/25
29	Commissioning	44 days	Tue 5/6/25	Fri 7/4/25



Project: Mebane WRRF
Date: Tue 8/31/21

Task	Project Summary	Manual Task	Start-only	Deadline
Split	Inactive Task	Duration-only	Finish-only	Progress
Milestone	Inactive Milestone	Manual Summary Rollup	External Tasks	Manual Progress
Summary	Inactive Summary	Manual Summary	External Milestone	



LEGEND

- EXISTING FACILITIES (TO REMAIN)
- PROPOSED HEADWORKS
- PROPOSED INFLUENT PUMP STATION
- PROPOSED BNR BASINS
- PROPOSED RETURN SLUDGE PUMP STATION
- PROPOSED CLARIFIERS
- PROPOSED DENITRIFICATION FILTERS
- PROPOSED CHEMICAL FACILITY
- PROPOSED UV DISINFECTION AND POST-AERATION BASIN
- PROPOSED SLUDGE HOLDING TANK
- EXISTING AERATION BASIN (TO BE ABANDONED)
- PROPOSED ELECTRICAL FACILITIES AND EQUIPMENT
- FUTURE SLUDGE STORAGE (CONVERTED FROM AERATION BASIN)

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Hickory, NC 28601
828.328.2024
NC Firm License # C-0459
mcgillassociates.com

CALL 811 BEFORE YOU DIG — SAFE DIGGING PARTNER

NO.	DATE	BY	DESCRIPTION

WATER RESOURCE RECOVERY FACILITY EXPANSION

CITY OF MEBANE

ALAMANCE COUNTY, NORTH CAROLINA

GRAPHIC SCALE 50 0 25 50 100 — DIVISION VALUE = 50 FEET

OFFICE MANAGER	DESIGNER
D. CHAPMAN	J. WHITFORD
PROJECT MANAGER	REVIEWER
J. WHITFORD	_

OVERALL SITE PLAN

DATE	PROJECT #	FUNDING #
MAY 2024	21.01123	N/A

SHEET

C-102A

EXHIBIT J