R-2015-03

RESOLUTION
ADOPTING THE POWHATAN COUNTY WATER AND WASTEWATER MASTER PLAN

WHEREAS, in December 2013 Dewberry Engineers was awarded a contract to develop a Water and Wastewater Master Plan; and

WHEREAS, the scope of the project was to evaluate existing public water and wastewater systems, evaluate future water and wastewater capacity demands, recommend a plan to address operational and capital needs of the existing systems to include estimated costs and recommend a plan to address future demands for the next 20 years to include estimated costs; and

WHEREAS, County staff and Dewberry Engineers presented the final draft plan on October 27, 2014 at a joint workshop of the Powhatan County Board of Supervisors and the Powhatan County Planning Commission; and

WHEREAS, the Powhatan County Planning Commission held a workshop on December 2, 2014 to discuss the final draft with County staff and Dewberry Engineers and the Powhatan County Board of Supervisors held a workshop on January 20, 2015 to discuss the final draft with County staff and Dewberry Engineers; and

WHEREAS, on January 6, 2015, the Powhatan County Planning Commission, by consensus vote, recommended unanimously to the Board of Supervisors the approval of the Water and Wastewater Master Plan on the basis that it is consistent with the findings of the 2010 Powhatan County Comprehensive Land Use Plan and it implements a recommendation of the Comprehensive Plan to develop a 20-year financial plan to reflect the need for ongoing upgrades and expansion of the existing water and sewer system.

NOW, THEREFORE, BE IT RESOLVED that the Powhatan County Board of Supervisors does hereby adopt the Water and Wastewater Master Plan prepared by Dewberry Engineers Inc. dated October 2014 with the Revised Tables 1-1, 9-1, 9-1a, 9-2 and 9-2a dated January 28, 2015.

BE IT FURTHER RESOLVED that the Water and Wastewater Master Plan is a plan and, as such, is not to be construed as the Board of Supervisors approval of any project nor the budget and appropriation of funds for any project.

ADOPTED BY THE POWHATAN COUNTY BOARD OF SUPERVISORS ON FEBRUARY 2, 2015.

William E. Melton, Chairman
Powhatan County Board of Supervisors

ATTEST:

Patricia A. Weiler, Clerk
Powhatan County Board of Supervisors

Recorded Vote:

David T. Williams	*Nay*	*William E. Melton*	*Aye*
Jason Moore	*Aye*	*Carson L. Tucker*	*Aye*
Barry C. Hodge	*Nay*		

WATER AND WASTEWATER MASTER PLAN

POWHATAN COUNTY, VIRGINIA

Prepared for:
Powhatan County Department of Public Works
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Powhatan, VA 23139

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October 2014

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Chapter 1
Executive Summary

1.1 Purpose and Scope

The purpose of this Water and Wastewater Master Plan is to provide the Powhatan County Department of Public Works with a road map for planning improvements and upgrades to meet future needs in maintaining cost-effective water and wastewater service to a growing number of County customers.

This Plan provides a comprehensive evaluation of the County's water and wastewater system within the Water and Sewer Service Area (WSSA) and identifies recommended improvements projected to be required through the Year 2035.

The general approach for development of this Plan incorporated the following steps:

1. Collect and review available information on the County's existing water and wastewater systems.
2. Conduct workshops with representatives from Public Works, Administration, and Planning Departments to gather information and develop concurrence regarding the methodologies used to develop the Plan.
3. Obtain information from Powhatan County on proposed land use, targeted growth areas, and population projections.
4. Develop demand projections through 2035 and distribute the demand projections throughout the Water and Sewer Service Area (WSSA) in areas projected to be developed during several future time steps. Note that data from 2013 was used as the baseline year for demand projections, since this time frame was the latest year that complete data was available when the population demand projections were developed.
5. Develop models of the water and wastewater systems to identify existing system deficiencies and to identify Master Plan Capital Improvement Projects (CIPs) based on demand projections that will address growth within the County
6. Develop the Water and Wastewater Master Plan to summarize project activities and provide costs and recommendations for CIPs throughout the planning period.

1.2 Existing Water System

There is one existing public water system within Powhatan County, the Flat Rock Water System, that is located along Route 60 at the eastern portion of the County, adjacent to Chesterfield County. The Courthouse Service Area is provided with water supply through a private system owned and operated by Aqua Virginia.

The Flat Rock Water System is owned and operated by Powhatan County and is currently supplied by one connection point to Chesterfield County's water system. The agreement with Chesterfield County provides the County with a maximum day capacity of 572,000 gallons per day (gpd). The water distribution system consists of approximately 26 miles of waterlines, ranging in diameter from 3 to 12 inches, and is generally located along Route 60 from Rocky Oak Road to County Line Road.

The water system has two pressure zones, with the higher elevation pressure zone being supplied with water by a booster pump station. This booster pump station pumps water from the lower pressure zone, which is fed by the Chesterfield Connection, into a 500,000 gallon elevated storage tank with an overflow elevation of 571 feet, located in the higher elevation pressure zone. This tank, along with the connection from Chesterfield County, provides water to meet maximum day water demands and supply water to meet fire flow demands of the system.

For 2013, (baseline time period for this report since it was the most recent data available when the population and demand projections were developed), the County provided water service to 77 residential, commercial, and public/municipal customers as follows:

- Residential customers: 3
- Commercial customers: 70
- Public/Municipal customers: 4
- Total customers: 77

In 2013, based on billing records, the average day demand for the Flatrock Water System was approximately 71,000 gallons per day (gpd). During this same period, the average day water supplied from the Chesterfield Connection was approximately 180,000 gpd. After including the estimated average daily water flushing volume, approximately 50,000 gpd (27%) of water that is entering the system is unaccounted for.

The Courthouse Water System is currently owned and operated by Aqua Virginia. This system currently has a permitted maximum capacity of 118,400 gallons per day (gpd) through the Virginia Department of Health and obtains its water supply through several wells connected to the system. There is a draft amendment to this permit at the time of this report that could allow for a maximum capacity of 134,400 gpd at some point in the future. The existing system currently supplies an estimated average demand of approximately 59,000 gpd and a maximum day demand of approximately 118,000. This system consists of approximately 9 miles of waterlines, ranging in diameter from 1 to 12 inches and is generally located along Route 60 from Route 522 east to Academy Road including the Courthouse Historic District.

1.3 Existing Wastewater System

Powhatan County's public wastewater system in the WSSA provides wastewater service with two wastewater treatment facilities: the 0.25 MGD Dutoy Wastewater Treatment Plant (WWTP) and the 0.1 MGD Fighting Creek Wastewater Treatment Plant (WWTP).

Wastewater flows within the Water and Sewer Service Area are collected in two service areas: the Flat Rock Area and the Courthouse Area. The Dutoy Creek WWTP provides treatment for wastewater flows in the Flat Rock Service Area and the Fighting Creek WWTP provides treatment for wastewater flows in the Courthouse Service Area.

The public wastewater collection system is comprised of approximately 13 miles of gravity sanitary sewer and four wastewater pump stations. In 2013 within the WSSA, a total combined average flow of 66,000 gpd passed through the Fighting Creek WWTP and Dutoy WWTP for treatment.

In 2013 (baseline time period for this report since it was the most recent data available when the population and demand projections were developed), the County provided wastewater service to 136 residential, commercial, and public/municipal customers as follows:

- Residential customers: 54
- Commercial customers: 63
- Public/Municipal customers: 19
- Total customers 136

1.4 Future Demand Projections

Future conditions in Powhatan County were evaluated to identify water and wastewater system improvements required to meet future needs. Recommended improvements within the planning period (2015-2035) were identified based on land use phasing within the WSSA and the development and geographic distribution of demand projections throughout the WSSA. These projections were developed utilizing methodologies consistent with the provisions of Powhatan County's 2010 Comprehensive Plan and input from the County's Public Works and Planning Departments.

1.5 System Modeling

Water and wastewater system computer models were developed in order to evaluate system conditions throughout the planning period and to identify improvements required to meet future needs. InfoWater, developed by Innovyze, was used to model the water system and InfoSewer, also developed by Innovyze, was used to model the wastewater system.

The models were calibrated to reflect actual conditions, and average, maximum day, and peak hour scenarios were run for each of the time increments within the planning period to evaluate the scope and timing of system improvement requirements. This modeling analysis led to the development of the water and wastewater system improvement programs through 2035.

1.6 Water System Improvements

Water system improvements that are proposed to provide water service within the WSSA through the Year 2035 are identified on the **Proposed Water Improvements Map in Appendix A**. Improvements shown on the Proposed Water Improvements map are color coded by the year that the improvement is needed and corresponds to the water system cost estimate table (Table 9-1) for cross-referencing.

The County generally constructs projects required to provide an adequate water supply to an area, and the private sector constructs projects required to provide water service to a specific area. Both the Virginia Department of Health (VDH) and County requirements were considered when developing this plan.

In general, the water system improvements program involves improvements to water supply, water storage, and water distribution to ensure adequate supply and pressures throughout the planning period. A brief overview of improvements is provided in the following sections.

1.6.1 Water Supply

Throughout the planning period from 2015 to 2035, Powhatan County could continue to purchase water from Chesterfield County at the existing Route 60 connection point.

However, as population grows within the WSSA, it is anticipated that the 0.572 MGD maximum day supply from Chesterfield County will not be sufficient to meet peak system demands between 2020 and 2025. In addition to the existing connection point to Chesterfield County, a new water supply source will be required.

In order to provide additional water supply, Powhatan County signed a Memorandum of Understanding (MOU) with the Virginia Department of Corrections (VDOC) and Goochland County. The MOU allows for Powhatan to receive up to 10 million gallons per day (MGD) of treated water from the DOC water treatment plant (WTP). A revised water withdrawal permit issued by the State would be required for additional water withdrawal and treatment. The WTP currently holds a permit for 2 MGD. In 2013 the WTP produced on average of 0.66 MGD and a maximum day of 0.89 MGD with a capacity to treat up to 3 MGD. DOC will continue to own and maintain the WTP and hold the permit.

The Cobbs Creek Reservoir, located in Cumberland County, is currently in the design and land acquisition phase. Henrico County is the permit holder and has a signed MOU with Cumberland County. The

reservoir will augment the James River during periods of low flows, discharging water back into the river from the reservoir. During times of higher flows water will be pumped out of the James River for storage. The permit for the reservoir accounts for future water needs of Henrico, Cumberland, and Powhatan Counties. Goochland County will indirectly benefit as it purchases water from Henrico County for use on its eastern boundary. A 10 MGD water withdrawal allocation for Powhatan County was accounted for in the Cobbs Creek permit. A signed MOU between Powhatan County and Henrico County will be necessary for Powhatan County to utilize water benefits from the reservoir in a future water withdrawal at the DOC water treatment plant. To utilize this supply, Powhatan County will be required to construct a booster station and finished water transmission main along Route 522 to transfer the water to the Powhatan County water service areas.

The Courthouse Service Area water system is privately owned by Aqua Virginia and currently has a permitted maximum day capacity of 118,400 gallons per day (gpd). There is a draft amendment to this permit that could allow for a maximum day capacity to be increased to 134,400 gpd. However, based on the demand projections within this service area, the maximum day supply will be exceeded before 2020. It is unknown whether Aqua Virginia will be able to increase the water supply beyond 134,400 gpd with additional wells; however, it is not anticipated that Aqua Virginia will be able to increase the water supply to meet the projected maximum day demands of the Courthouse Service Area through the end of the planning period. To ensure that the Courthouse Service Area is provided with the estimated maximum day water demand by 2020, the County will be required to construct the Route 522 water supply project.

Another area that will require water service is the Route 711 Area, which can be supplied by one of three options:

- Option 1: Connection to Chesterfield County along Route 711
- Option 2: Connection to Goochland County via a water main that is directionally drilled under the James River
- Option 3: Connection to Route 60 waterline along eastern side of Powhatan County. This option can be supplied by the current connection to Chesterfield County.

Based on the evaluation, the optimal water supply option is to connect to the Chesterfield County water system at Route 711. However, since Chesterfield County has indicated that they do not have the capacity to provide water supply to Powhatan County at Route 711, the Goochland County connection is recommended because it would provide for a lower capital cost than the Flat Rock connection. Additionally, maintaining the current 572,000 gpd water supply allocation from Chesterfield County at the Flat Rock water system would reduce the amount of water that would have to be supplied from the Route 522 water supply.

1.6.2 Water Storage

Equalization storage is needed to meet daily peak demands and at a minimum is equal to 20 percent of the maximum day demand over 24 hours. System storage required for fire flow is equal to 240,000 gallons, which is the volume of water needed to fight the County's design standard 2,000 gpm, 2-hour duration fire event in a non-residential area.

To address the County's needs for water storage during the planning period, the following improvements are recommended:

- 500,000 gallon Courthouse Elevated Water Storage Tank
- 500,000 gallon Route 711 Elevated Storage Tank

1.6.3 Water Distribution

Master Plan Capital Improvement Projects (CIPs) associated with the water distribution system are generally required to address one or more of the following issues:

- Improvements needed to meet growing system demands in areas already served.
- Improvements desired to improve system reliability and/or service.
- Improvements needed to provide service to new areas or existing subdivisions within the Water and Sewer Service Area.

A majority of the CIPs associated with the water distribution system are required for distribution of the water supply from Goochland County along Route 522 and Route 60, and to supply the required fire flows within the Courthouse Area (if acquired by Powhatan County). Existing subdivisions that could potentially be served by public water are described in **Appendix C** and have not been included in Table 1-1.

1.7 Wastewater System Improvements

Wastewater system improvements that are proposed to provide wastewater service within the County's WSSA through the Year 2035 are identified on the **Proposed Sewer Improvements Map in Appendix B.** Improvements shown on the Proposed Sewer Improvements map are color coded by the year that the improvement is needed and corresponds to the wastewater system cost estimate table (Table 9-1) for cross-referencing.

In general, the wastewater improvement program involves improvements to treatment capacity, pump stations and force mains, and gravity interceptor pipes.

1.7.1 Wastewater Treatment

Wastewater treatment improvements were evaluated for both the Fighting Creek WWTP and Dutoy Creek WWTP. Based on the evaluation, it was recommended that the Fighting Creek WWTP be taken offline and a pump station and force main be constructed to pump the wastewater flows from the Courthouse Service Area to the Flat Rock Service Area for treatment by the Dutoy Creek WWTP.

The Dutoy Creek WWTP will require upgrades for enhanced nutrient removal expansion to 0.5, 0.75, and 1.0 MGD to provide adequate wastewater treatment capacity for the Courthouse and Flat Rock Service Areas through the end of the planning period in 2035.

Based on input from VDEQ, except for nutrient limits which are not receiving stream dependant, the effluent limits for the Dutoy Creek WWTP are expected to minimally change as the plant increases capacity up to 1.0 MGD. Therefore, based on the information available, it is assumed that the existing outfall locations will continue to be used for future WWTP upgrades through end of the planning period in 2035.

For the Route 711 Service Area, the construction of an additional WWTP was not recommended. Therefore, three options were evaluated to include a pump station and force main for wastewater collection and disposal.

- Option 1: Pump Station and Force Main to Chesterfield at Route 711
- Option 2: Pump Station and Force Main to Goochland County via a forcemain that is directionally drilled under the James River
- Option 3: Pump Station and Force Main to the Flat Rock wastewater collection system.

Based on the evaluation, the optimal wastewater disposal option is to connect to the Chesterfield County wastewater collection system at Route 711. However, since Chesterfield County has indicated that they do not have the capacity to accept wastewater flows from Powhatan County at Route 711, the Goochland County connection is recommended because it would provide for a lower capital cost than the Dutoy Creek WWTP connection and would not require additional treatment plant capacity.

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1.7.2 Wastewater Collection and Conveyance

Master Plan Capital Improvement Projects (CIPs) associated with the wastewater collection system are generally required to address one or more of the following issues:

- Improvements needed to meet growing system demands in areas already served.
- Improvements desired to improve system reliability and/or service.
- Improvements needed to provide service to new areas or existing subdivisions within the Water and Sewer Service Area.

The majority of the CIPs associated with the wastewater collection system are required for collecting and conveying proposed wastewater flows to the Dutoy Creek WWTP. Existing subdivisions that could potentially be served by public wastewater are described in **Appendix C** and have not been included in Table 1-1.

1.8 Implementation

Table 1-1 outlines the implementation plan for the water and wastewater system improvement program recommended in this Master Plan by providing a summary of the different projects, location, and construction cost, distributed by the year by which the project is proposed to be completed.

Costs include 15% contractor overhead and profit and 25% construction contingency, and 15% engineering fees. A summary of the costs for each time step can be found below:

Water Improvements
2015 - $80,000
2020 - $29,030,000
2025 - $0
2030 - $500,000
2035 - $0

Wastewater Improvements
2015 - $1,125,000
2020 - $4,590,000
2025 - $12,350,000
2030 - $2,700,000
2035 - $3,350,000

Grand Total
2015 - $1,205,000
2020 - $33,620,000
2025 - $12,350,000
2030 - $3,200,000
2035 - $3,350,000

Table 1-1
Water and Wastewater Improvement Costs by Service Area

	Fiscal Year				
	2015[1]	2020	2025	2030	2035
Water Improvements					
Courthouse Area					
Route 522 Water Supply Project to Courthouse		$ 17,580,000			
Courthouse Area Subtotal	***$ -***	***$ 17,580,000***	***$ -***	***$ -***	***$ -***
Flat Rock Area					
Chloramine Booster Station		$ 250,000			
Flat Rock Elevated Tank Mixing System	$ 80,000				
Route 522 Water Supply Project Extension to Flat Rock		$ 5,580,000			
Flat Rock Area Subtotal	***$ 80,000***	***$ 5,830,000***	***$ -***	***$ -***	***$ -***
Route 711 Area					
Option 1 - Connect to Chesterfield County via Route 711		$ 5,400,000			
Option 2 - Connect to Goochland County		$ 5,620,000		$ 500,000	
Option 3 - Connect to Route 60		$ 7,450,000			
Route 711 Subtotal[2]	***$ -***	***$ 5,620,000***	***$ -***	***$ 500,000***	***$ -***
Water Improvements Subtotal	**$ 80,000**	**$ 29,030,000**	**$ -**	**$ 500,000**	**$ -**
Wastewater Improvements					
Courthouse Area					
Fighting Creek WWTP Influent Pump Station Upgrade incl. Screening	$ 730,000				
Fighting Creek WWTP Pump Station and Force Main			$ 5,670,000		
Courthouse Area Subtotal	***$ 730,000***	***$ -***	***$ 5,670,000***	***$ -***	***$ -***
Flat Rock Area					
Portable Belt Press	$ 175,000				
Dutoy Creek WWTP Improvements (Lime Feeder & Davit Crane)	$ 220,000				
Dutoy Creek WWTP 0.50 MGD Expansion (Including Dewatering Bldg)			$ 6,680,000		
Dutoy Creek WWTP 0.75 MGD Expansion				$ 2,700,000	
Dutoy Creek WWTP 1.0 MGD Expansion					$ 2,840,000
Dutoy Interceptor Upgrade					$ 510,000
Flat Rock Area Subtotal	***$ 395,000***	***$ -***	***$ 6,680,000***	***$ 2,700,000***	***$ 3,350,000***
Route 711 Area					
Option 1 - Connect to Chesterfield County via Route 711		$ 2,530,000			
Option 2 - Connect to Goochland County		$ 4,590,000			
Option 3 - Connect to Route 60		$ 7,010,000			
Route 711 Area Subtotal[2]	***$ -***	***$ 4,590,000***	***$ -***	***$ -***	***$ -***
Wastewater Improvements Total	**$ 1,125,000**	**$ 4,590,000**	**$ 12,350,000**	**$ 2,700,000**	**$ 3,350,000**
Grand Total	**$ 1,205,000**	**$ 33,620,000**	**$ 12,350,000**	**$ 3,200,000**	**$ 3,350,000**

1. 2015 Fiscal Year projects indicate existing system improvements to be implemented within the next 3 years. The remaining timesteps assume that the projects will be completed by the indicated year.
2. For planning purposes, it was asssumed that Option No. 2 would be constructed to provide water and wastewater service to the Route 711
3. Budgetary cost estimates for water supply or wastewater disposal connections do not include potential connections fees.

The above listed capital improvement projects are based upon the population projections contained in the Water and Wastewater Master Plan

Chapter 2
Introduction

2.1 Purpose

The Powhatan County Department of Public Works provides water and wastewater service to a growing number of County customers. Cost efficient, environmentally sound water and wastewater service is a major contributor to the County's quality of life. To ensure a continued high quality of service, while keeping pace with the challenges of a growing community, the County has developed this Water and Wastewater Master Plan. The purpose of the Plan is to assist the County with its planning for improvements, upgrades, extensions, and expansions that are required to meet future needs. The Plan addresses improvements and upgrades projected to be needed through the Year 2035.

This Water and Wastewater Master Plan is based on the best information available at this time. The plan serves as a road map for the County's Department of Public Works. It will need to be modified and refined based on actual development in the County and in response to changes that the County makes to its Comprehensive Plan in the future.

2.2 Scope

Preparation of the Water and Wastewater Master Plan involved extensive coordination with the Powhatan County Department of Public Works to incorporate available information into the plan, including existing water and wastewater system records, design information for planned projects, and methodologies for demand projections and system modeling.

The general approach for development of the Water and Wastewater Master Plan incorporated the following steps:

7. Collect and review available information on the County's existing water and wastewater systems.
8. Conduct workshops with representatives from Public Works, Administration, and Planning Departments to gather information and develop concurrence regarding the methodologies used to develop the Plan.
9. Obtain information from Powhatan County on proposed land use, targeted growth areas, and population projections.
10. Develop demand projections through 2035 and distribute the demand projections throughout the Water and Sewer Service Area (WSSA) in areas projected to be developed during several future time steps. Note that data from 2013 was used as the baseline year for demand projections, since this time frame was the latest year that complete data was available when the population demand projections were developed.

11. Develop models of the water and wastewater systems to identify existing system deficiencies and to identify Master Plan Capital Improvement Projects (CIPs) based on demand projections that will address growth within the County
12. Develop the Water and Wastewater Master Plan to summarize project activities and provide costs and recommendations for CIPs throughout the planning period.

Projects that were identified as improvements and upgrades to the County's existing water and wastewater systems are summarized in Chapters 7 and 8. The implementation plan for these improvements, outlining cost estimates and implementation schedules for each individual project, is included in Chapter 9.

Chapter 3
Existing Water System

This chapter of the Master Plan provides an overview of Powhatan County's existing water systems.

3.1 Water System Overview

There is one existing public water system within Powhatan County, the Flat Rock Water System, that is located along Route 60 at the eastern portion of the County, adjacent to Chesterfield County. The Courthouse Service Area is provided with water supply through a private system owned and operated by Aqua Virginia. More detailed information on the County's water supply facilities, storage facilities, and pumping facilities is provided in the following sections.

3.2 Flat Rock Water System

The Flat Rock Water System is owned and operated by Powhatan County and is currently supplied by a single connection point at Route 60, through a water supply agreement with Chesterfield County. This water supply agreement with Chesterfield County allow for a maximum day water supply allocation of 0.572 MGD.

This system consists of approximately 26 miles of waterlines, ranging in diameter from 3 to 12 inches, and is generally located along Route 60 from Rocky Oak Road to County Line Road.

The water system has two pressure zones, with the higher elevation pressure zone being supplied with water by a booster pump station.

Table 3-1 Booster Pump Station Summary

No. of Pumps	Design Flow	Design Head	Firm Capacity
2[1]	500 GPM	92.4 FT	500 GPM

1. Pump station has room to add a third pump

The booster pump station pumps water from the lower pressure zone, which is fed by the Chesterfield Connection, into a 500,000 gallon elevated storage tank with an overflow elevation of 571 feet, located in the higher elevation pressure zone. This tank, along with the connection from Chesterfield County, provides water to meet maximum day water demands and supply water to meet fire flow demands of the system.

For 2013, (baseline time period for this report since it was the most recent data available when the population and demand projections were developed), the County provided water service to 77 residential, commercial, and public/municipal customers as follows:

- Residential customers: 3
- Commercial customers: 70
- Public/Municipal customers: 4
- Total customers: 77

In 2013, based on billing records, the average day demand for the Flatrock Water System was approximately 52,000 gallons per day (gpd). During this same period, the average day water supplied from the Chesterfield Connection was approximately 180,000 gpd. After including the estimated average daily water flushing volume, approximately 69,000 gpd (38%) of water that is entering the system is unaccounted for. Refer to Table 3.2 for additional information.

Table 3-2 Average Day Demand Summary[1]

Water Supply[2] (gpd)	Powhatan Billing (gpd)	Estimated Flushing[3] (gpd)	Estimated Unaccounted for Water (gpd)
180,000	52,000	59,000	69,000

1. Based on 2013 data.
2. Based on SCADA data provided by Chesterfield County at the water supply connection point.
3. Estimate based on metered auto-flusher, tank flushing data, and hydrant flushing information provided by Powhatan County.

Powhatan County staff has been active in working to identify the sources of unaccounted for water. These activities have included inspecting the water system to look for evidence of leaks, requesting overnight meter readings from Chesterfield County during times of low water use to verify meter accuracy during low flows, and the installation of a meter on the tank drain line to verify the actual volume of flushing from the tank. To date, these activities have not found a significant source of unaccounted for water. Within the next few months, staff is planning to obtain a pitot tube for accurate measurement of flushing flow rates. This information, along with currently available information, will be used to develop a water balance throughout the system to try to account for all water usage.

Based on meter data at the Chesterfield County water supply connection, the maximum day demand in the system was 540,000 gpd. Therefore, the existing maximum day capacity of 572,000 gpd is sufficient for the current demand.

A plan schematic of the Flat Rock Water System is shown in Figure 3-1 and Figure 3-2.

3.3 Courthouse Water System

The Courthouse Water System is a privately owned system by Aqua Virginia. This system currently has a permitted maximum capacity of 118,400 gallons per day (gpd) through the Virginia Department of Health and obtains its water supply through several wells connected to the system. At the time of this report, there is a draft amendment to this permit that could allow for a maximum capacity of 134,400 gpd at some point in the future. The existing system currently supplies an estimated average daily demand of approximately 59,000 gpd and a maximum day demand of 118,000 gpd.

Water supply, storage, and pumping is provided to the Courthouse water system by three wells, a 10,000 gallon and a 40,000 gallon storage tank, iron and manganese treatment facilities, two 5,000 gallon hydropneumatic tanks, and booster pumps. The distribution system consists of approximately 9 miles of waterlines, ranging in diameter from 1 to 12 inches and is generally located along Route 60 from Route 522 east to Academy Road including the Courthouse Historic District.

A plan schematic of the existing Courthouse Water System is shown in Figure 3-3.

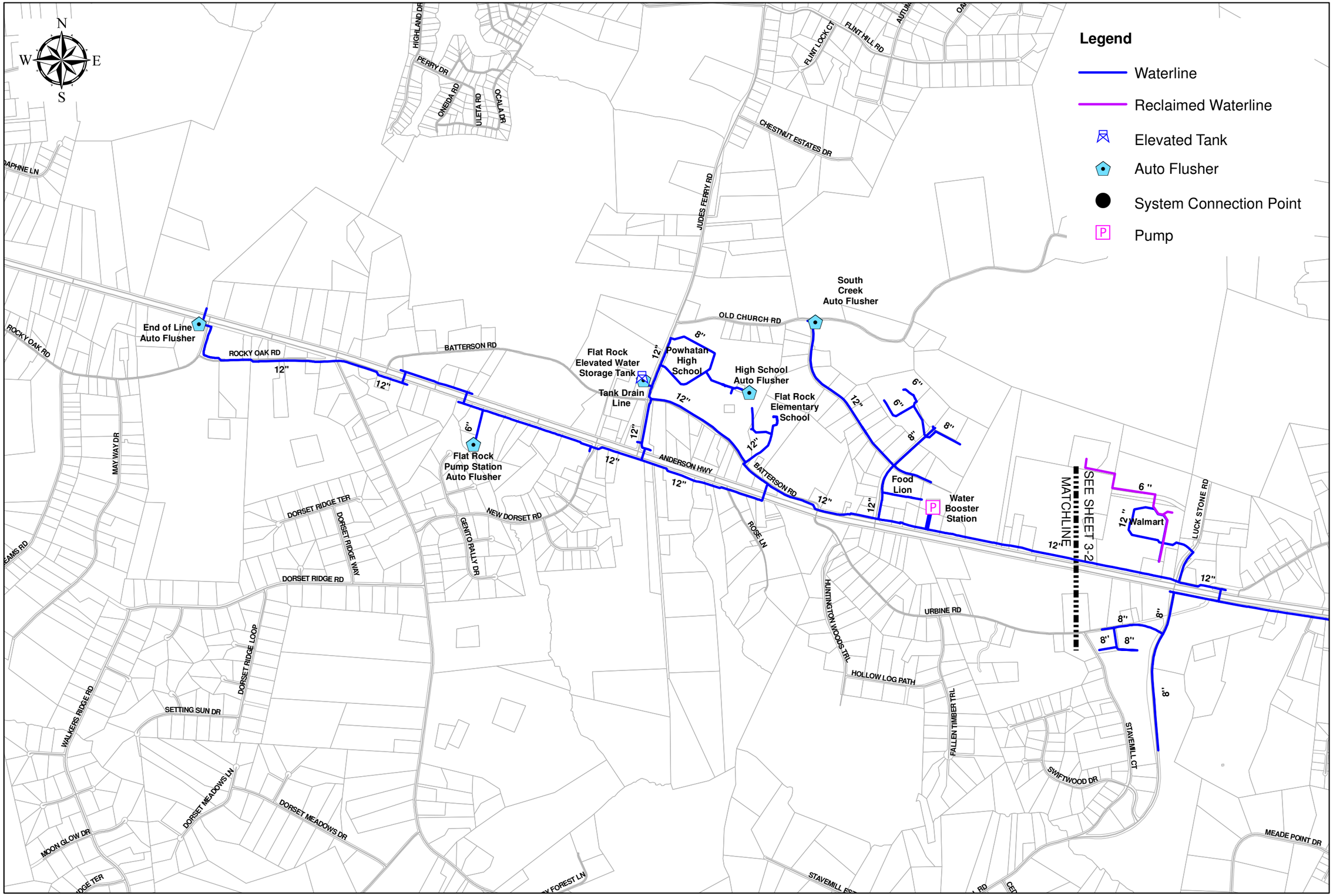

FIGURE NO. 3-1

TITLE EXISTING WATER SYSTEM WESTERN FLAT ROCK AREA

SCALE 1 inch = 1,500 feet

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DATE OCT 2014

PROJ. NO. 50063290

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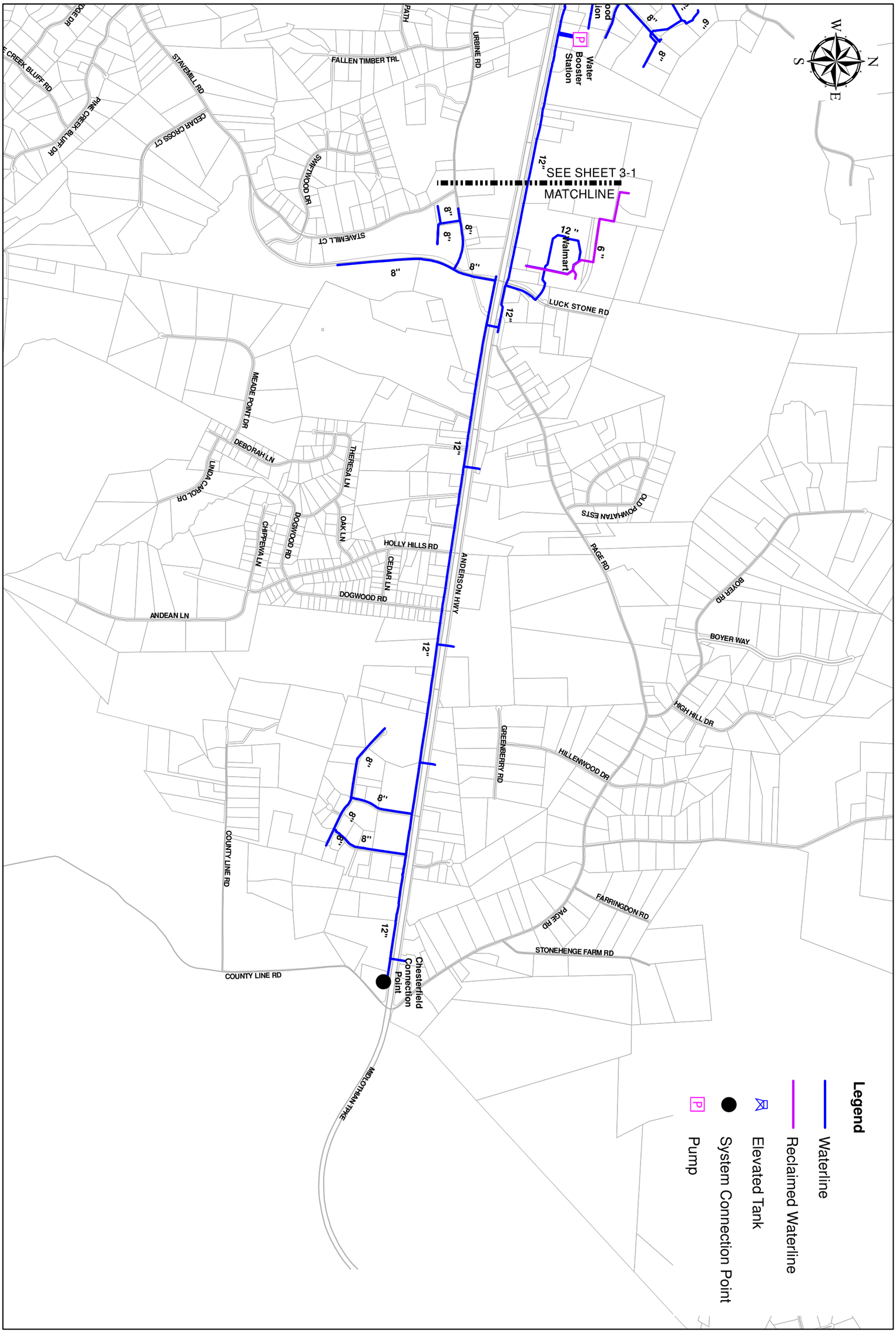

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DATE	SCALE	TITLE	FIGURE NO.
OCT 2014	1 inch = 1,500 feet	EXISTING WATER SYSTEM EASTERN FLAT ROCK AREA	3-2
PROJ. NO. 50063290	PROJECT WATER AND WASTEWATER MASTER PLAN POWHATAN, VIRGINIA		

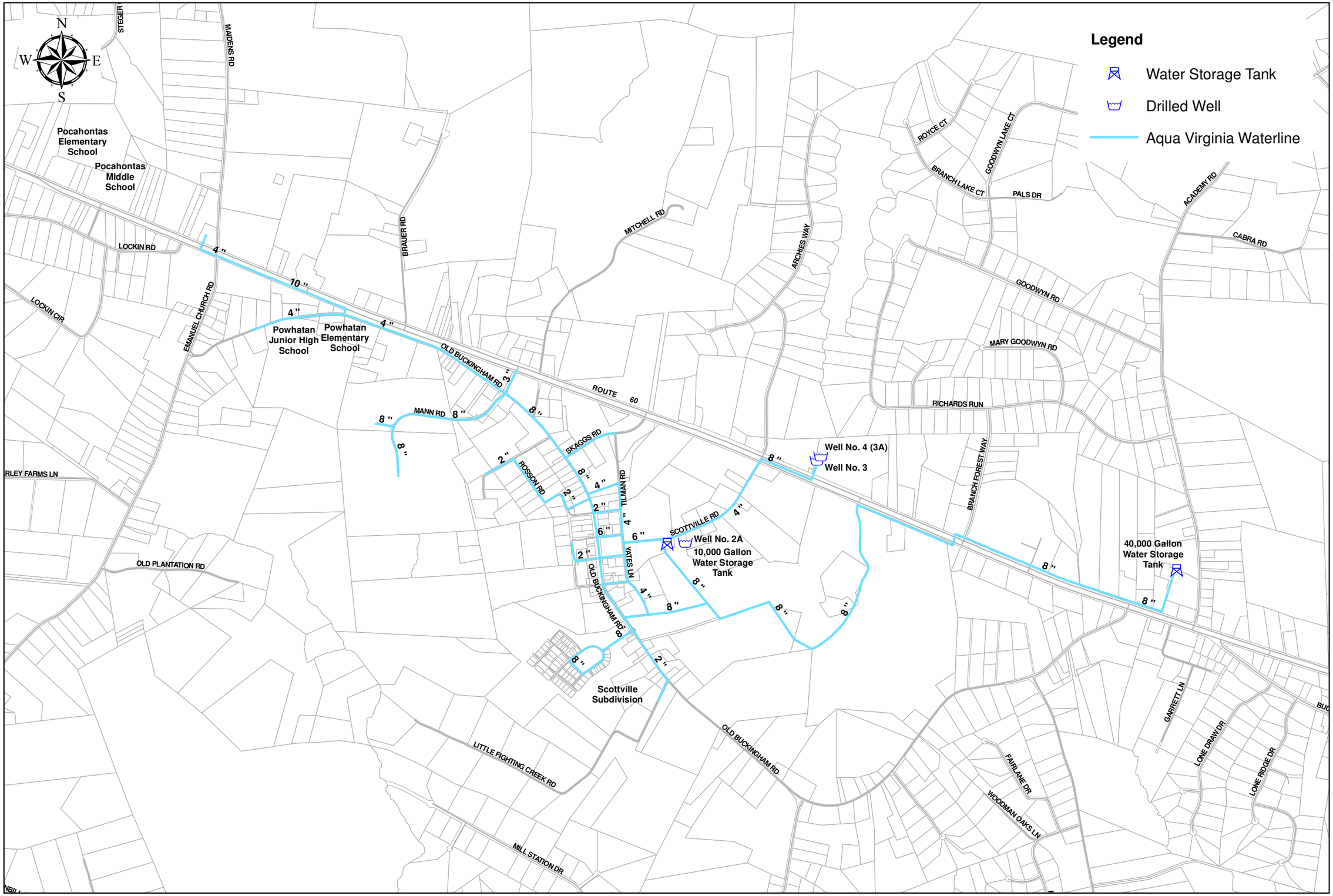

FIGURE NO. 3-3

TITLE EXISTING WATER SYSTEM COURTHOUSE AREA

SCALE 1 inch = 1,500 feet

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Chapter 4
Existing Wastewater System

This chapter of the Master Plan provides an overview of Powhatan County's existing wastewater system.

4.1 Wastewater System Overview

Powhatan County's public wastewater system in the Water and Sewer Service Area (WSSA) provides wastewater service with two wastewater treatment facilities: 250,000 gpd Dutoy Creek Wastewater Treatment Plant and the 100,000 gpd Fighting Creek Wastewater Treatment Plant.

Wastewater flows within the WSSA are collected in two service areas: Flat Rock Service Area and Courthouse Service Area. The Dutoy Creek WWTP provides treatment of wastewater flows in the Flat Rock Service Area and the Fighting Creek Wastewater Treatment Plant (WWTP) provides treatment of wastewater flows in the Courthouse Service Area.

In 2013 (baseline time period for this report since it was the most recent data available when the population and demand projections were developed), the County provided wastewater service to 136 residential, commercial, and public/municipal customers as follows:

- Residential customers: 54
- Commercial customers: 63
- Public/Municipal customers: 19
- Total customers 136

During this time within the WSSA, a total combined average daily flow of 66,000 gpd passed through the Fighting Creek WWTP and Dutoy WWTP for treatment. The wastewater flows were approximately split 50/50 between the two WWTPs.

4.2 Flat Rock Wastewater System

The Flat Rock Wastewater System is owned and operated by Powhatan County. This system consists of approximately 6 miles of gravity sanitary sewer, ranging in diameter from 8 to 16 inches, 6 miles of force main, ranging in diameter from 6 to 12 inches, and two wastewater pump stations. The collection system conveys wastewater flows to the Dutoy Creek WWTP for treatment.

4.2.1 Dutoy Creek Wastewater Treatment Plant

The Dutoy Creek WWTP has up to a permitted capacity of 250,000 gpd through the Virginia Pollutant Discharge Elimination System (VPDES) Permit No. VA0090727 and includes 50,000 gpd, 125,000 gpd, and 250,000 gpd flow tiers. Currently, the plant is operating at the 50,000 GPD tier.

The treatment process consists of an influent pump station, screening, pre-equalization basin, sequencing batch reactor (SBR), post equalization/re-aeration basin, cloth media disk filters, and ultraviolet disinfection. A gravity outfall conveys the effluent to a tributary of Dutoy Creek which combines with Norwood Creek and discharges to the James River.

The solids handling process consist of two aerobic digester basins with liquid sludge being hauled periodically by a contractor to be land applied.

4.2.2 Flat Rock Wastewater Pump Stations

The Flat Rock wastewater system mostly consists of gravity sewer but also includes two (2) county owned pump stations.

Flat Rock Pump Station is located near the western end of the Flat Rock service area and serves the surrounding area. This pump station consists of two suction lift pumps designed to pump 600 gallons per minute at 100 feet of head. The pumps convey wastewater out of a 10-foot diameter wetwell and discharge through approximately 7,900 feet of 10-inch and 12-inch force main to gravity sewer located near the intersection of South Creek One and Route 60.

Frisby's Pump Station is located near the intersection of Batterson Road and Route 60 and serves the Powhatan High School and Flat Rock Elementary School area. This pump station consists of two suction lift pumps designed to pump 700 gallons per minute at 55 feet of head. The pumps lift wastewater out of an 8-foot diameter wetwell and discharge through approximately 165 feet of 12-inch force main and share a common force main along Route 60 with the Flat Rock Wastewater Pump Station.

A plan schematic of the existing Flat Rock Wastewater System is shown in Figure 4-1 and Figure 4-2.

4.3 Courthouse Wastewater System

The Courthouse Wastewater System is owned and operated by Powhatan County. This system consists of approximately 8 miles of gravity sanitary sewer, ranging in diameter from 8 to 15 inches, 2 miles of force main, ranging in diameter from 6 to 8 inches, and two wastewater pump stations. The collection system conveys wastewater flows to the Fighting Creek WWTP for treatment.

4.3.1 Fighting Creek Wastewater Treatment Plant

The Fighting Creek WWTP has up to a permitted capacity of 100,000 gpd through the Virginia Pollutant Discharge Elimination System (VPDES) Permit No. VA0089206.

The treatment process consists of an influent grinder, pump station, pre-equalization basin, sequencing batch reactor (SBR), post equalization/re-aeration basin, and ultraviolet disinfection. A gravity outfall conveys the effluent to an unnamed tributary of Fighting Creek which combines with Rocky Ford Creek and flows to the Appomattox River.

The solids handling process consist of two aerobic digester basins with liquid sludge being hauled periodically by a contractor to be land applied.

4.3.2 Courthouse Wastewater Pump Stations

The Pocahontas Pump Station is located at the western end of the Courthouse service area and serves the Pocahontas Elementary School and the Pocahontas Middle School. This pump station consists of two suction lift pumps designed to pump 200 gallons per minute at 70 feet of head. The pumps lift wastewater out of a 6-foot diameter wetwell and discharge through approximately 6,000 feet of 6-inch force main to gravity sewer located behind the Powhatan Junior High School.

Academy Road Pump Station is located near the intersection of Branchway Creek Drive and Route 60 and serves the eastern end of the Courthouse service area. This pump station consists of two suction lift pumps designed to pump 350 gallons per minute at 95 feet of head. The pumps lift wastewater out of an 8-foot diameter wetwell and discharge discharges through approximately 5,000 feet of 8-inch force main to gravity sewer located along Route 60.

A plan schematic of the existing Courthouse Wastewater System is shown in Figure 4-3.

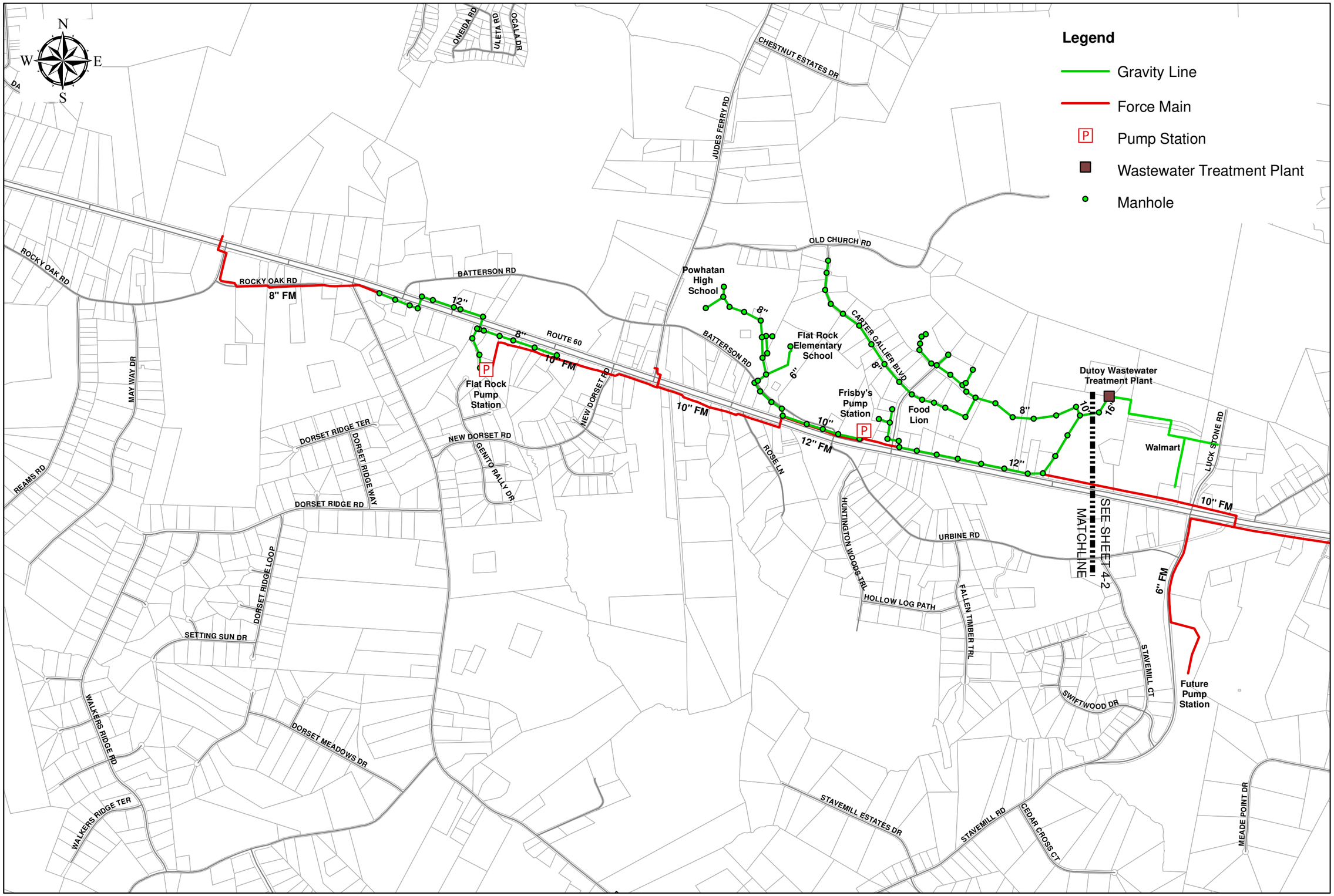

FIGURE NO. 4-1

TITLE EXISTING WASTEWATER SYSTEM WESTERN FLAT ROCK

SCALE 1 inch = 1,500 feet

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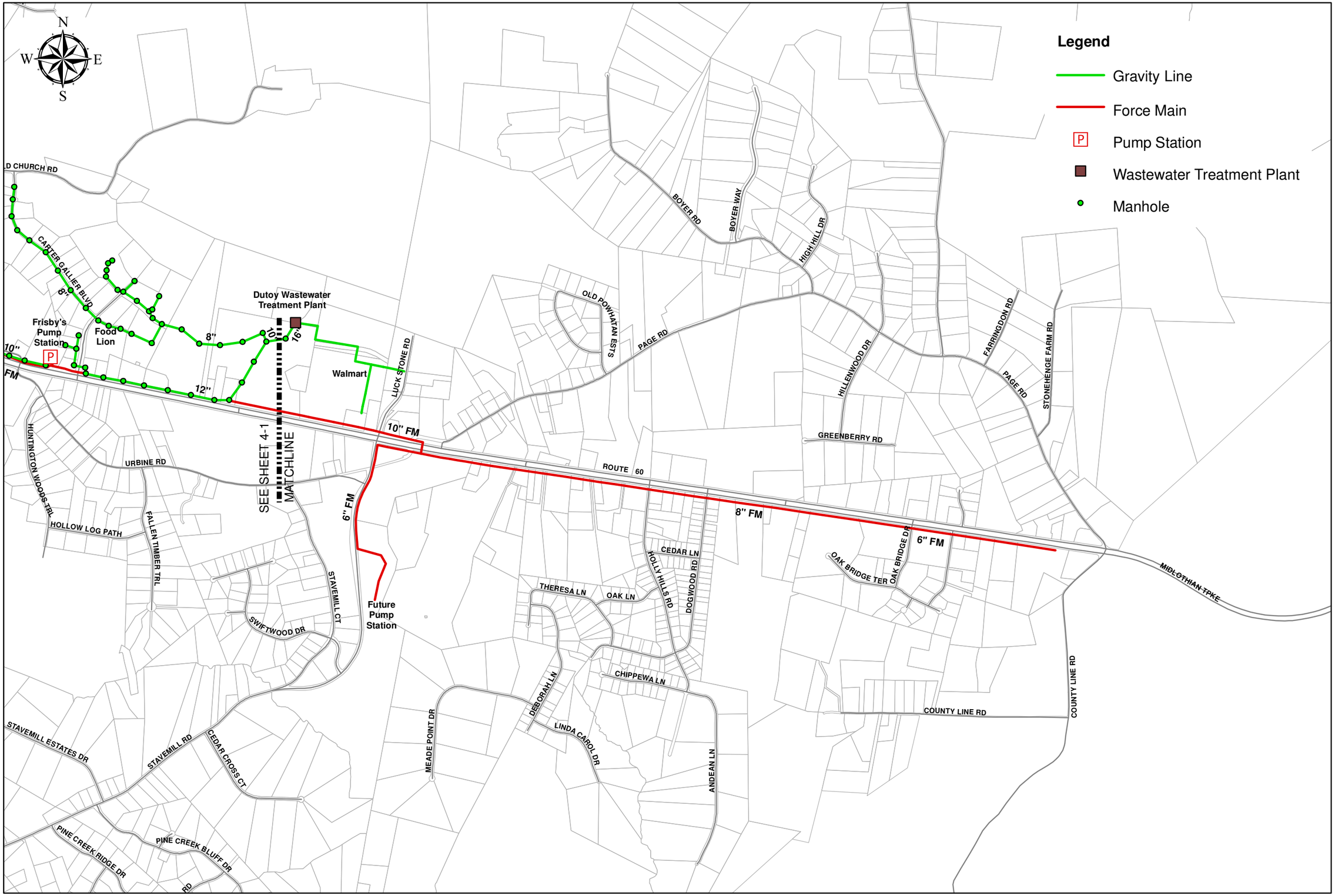

FIGURE NO. 4-2

TITLE EXISTING WASTEWATER SYSTEM EASTERN FLAT ROCK AREA

SCALE 1 inch = 1,500 feet

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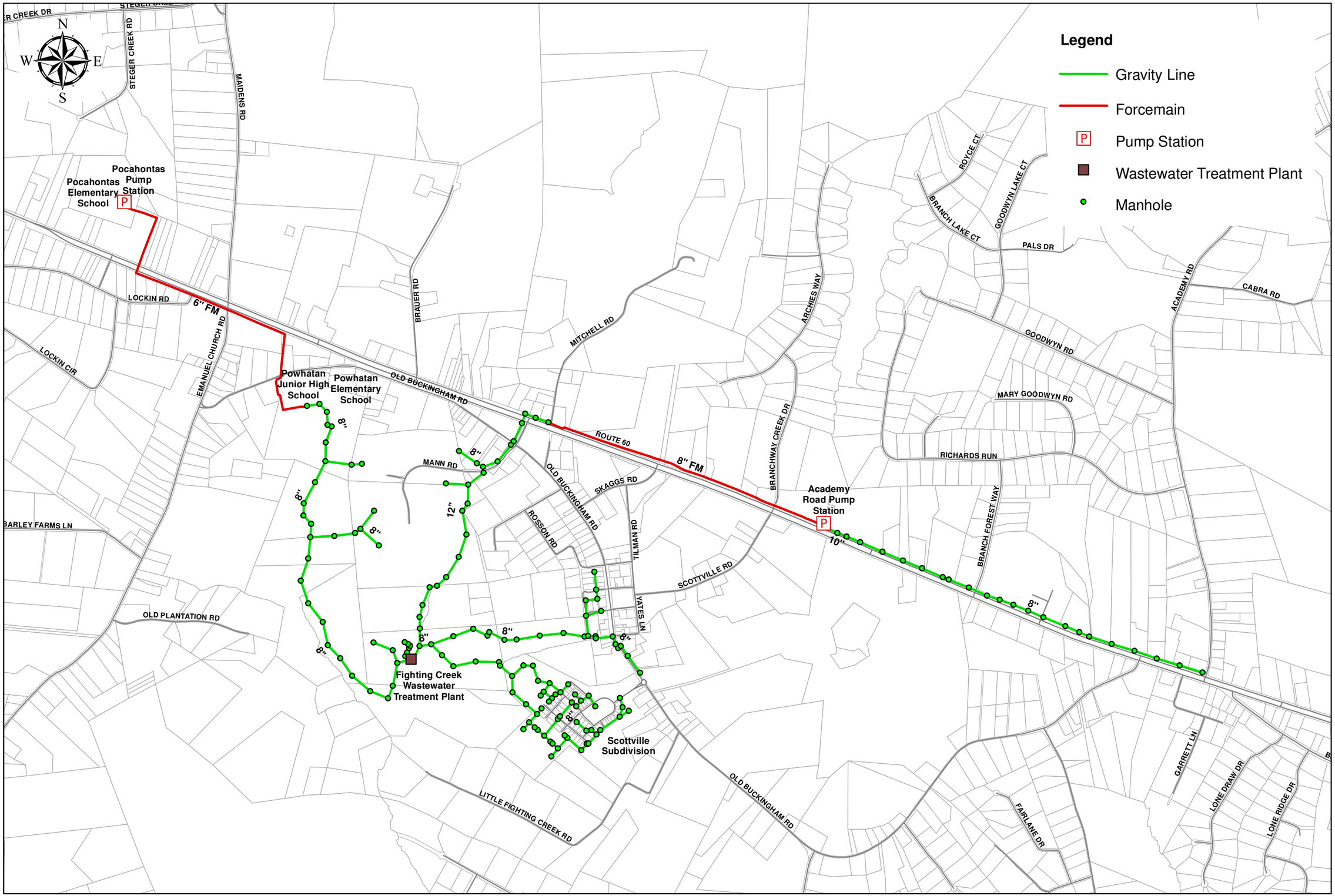

FIGURE NO. 4-3

TITLE EXISTING WASTEWATER SYSTEM COURTHOUSE AREA

SCALE 1 inch = 1,500 feet

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Chapter 5
Future Demand Projections

5.1 General

Future conditions in Powhatan County were evaluated to identify water and wastewater system improvements required to meet future needs associated with the projected growth of population within the Water and Sewer Service Area (WSSA).

This Master Plan addresses future conditions and identifies required water and wastewater system improvements based on development projections provided by the County throughout the WSSA for the planning period, which is defined as the Years 2015 through 2035. Note that data from 2013 was used as the baseline year for demand projections for Year 2015, since this time frame was the latest year that complete data was available when the population demand projections were developed.

Proposed projects are based on projections and will need to be adjusted based on actual growth patterns within the WSSA. This is particularly true of any project more than 3 years in the future.

The methodologies that were used to project and distribute demands are consistent with the provisions of Powhatan County's 2010 Comprehensive Plan and are described in the following sections.

5.2 Existing Demands

In order to develop future demand projections, it is important to research existing water demands, which is typically done by investigating several sources of water use. Baseline demands are estimated based on water meter data from the existing water customers including residents, commercial/industrial developments, and municipal customers, such as government buildings and schools. Another source of system demand includes auto flushers, which are periodically opened to improve water quality at dead end lines.

The estimated usage from metered connections and flushing is compared with water production and supply meter data to determine the amount of unaccounted for water. Typical sources of unaccounted for water include unrecorded flushing activities, water leakage in the line that results from aging pipes and loose connections, faulty meters, and unmetered connections.

Water meter data from 2013 was provided by Powhatan County for all of the water customers. The average daily water use at each meter was totaled and equaled approximately 52,000 gpd (including rented meters). The flow rates and locations of the auto flushers in the system were also provided by the County which equated to about 52,000 gpd. Based on information provided by the County, it was estimated that County staff manually flushed hydrants a few times a week, which resulted in an additional water usage

of approximately 5,000 to 10,000 gpd. The total metered water usage and estimated flushing volumes accounts for approximately 111,000 gpd.

These demands were compared with daily meter data provided by Chesterfield County at the master meter. During this same period, the daily meter data indicated an average water usage by Powhatan County of approximately 180,000 gpd, which indicates that approximately 69,000 gpd or 38% of the water entering the Flat Rock water system is unaccounted for. It is recommended that Powhatan County conduct a water system accountability study to determine the sources of unaccounted for water.

The Courthouse Water System is currently owned and operated by Aqua Virginia, a private company. This system currently has a permitted maximum capacity of 118,400 gallons per day (gpd) through the Virginia Department of Health and obtains its water supply through several wells connected to the system. There is a draft amendment to this permit that could allow for a maximum capacity of 134,400 gpd at some point in the future. Based on information obtained from VDH, the existing system currently supplies an estimated average demand of approximately 59,000 gpd and a maximum day demand of approximately 118,000 gpd. Based on this information, the Courthouse water system is at capacity with the current permit and has minimal expansion ability even with the expanded permit.

5.3 Future Population

To calculate the anticipated water demands, it is essential to understand the anticipated growth within the county and within the Water and Sewer Service Area (WSSA). Powhatan County provided county-wide population projections for the years 2020, 2030, and 2040 and census data was known for 2010. Since some of the time steps for this Master Plan fell in between years of predicted populations, linear interpolations were performed to determine the predicted populations for odd years (2015, 2025, and 2035).

The following table summarizes the predicted population based on information provided by Powhatan County:

Table 5-1: County-Wide Population

Year	County-Wide Population
2010 (Census)	28,046
2015 (Interpolated)	30,033
2020 (Given)	32,019
2025 (Interpolated)	33,861
2030 (Given)	35,702
2035 (Interpolated)	37,523
2040 (Given)	39,343

The population increase for each time step is given below:

Table 5-2: County-Wide Population Increase in 5 Year Increments

Time Step	County-Wide Population Increase	Assumed Population Increase within WSSA (Based on Demand Projections)
2010 – 2015	1,987	NA
2015 – 2020	1,987	224
2020 – 2025	1,842	1,192
2025 – 2030	1,841	1,539
2030 – 2035	1,821	1,545

5.4 Water and Sewer Service Area

As part of this Master Plan, Powhatan County revised the Water and Sewer Service Area (WSSA) from the 2010 Comprehensive Plan and determined a new service area based on tax parcel lines, geography, and targeted areas of growth within the County.

The WSSA was revised based on several meetings and input from Powhatan County staff and the Board of Supervisors as shown in **Figures 5.1, 5.2, 5.3, and 5.4.** The WSSA was divided into the following sub service areas:

- Route 711 Service Area
- Courthouse Service Area
- Flat Rock Service Area

It should be noted that the Courthouse and Flat Rock Service Area are combined into one service area. Future water and sewer demands, recommended improvements, and CIP projects have been organized based on these targeted growth areas.

5.5 Development of Future Water Demands

Several workshops were held with Powhatan County staff to develop the future development projections. During these workshops, areas of anticipated future growth were identified, such as residential neighborhoods, industrial parks, and commercial developments and timeframes as to when those areas would need water and sewer service. It was assumed that certain larger areas would need to be developed in phases due to their size and would span more than one time step as examined in this Master Plan. The percentage of development for each growth area at each time step was determined by Powhatan County staff and

is reflected in the future water demand projections. Each development area was assigned a development density based on anticipated future land use zoning.

In addition to new development, the feasibility of providing water and sewer service to several existing neighborhoods with older septic systems and well systems was evaluated. These neighborhoods included Holly Hills, Swiftwood, and Lake Shawnee developments and service to these neighborhoods have been included in this Master Plan and the future water demand projections.

5.5.1 Residential Water Demands

Several factors were utilized to calculate future residential water demands, including the useable area of each growth area, anticipated land use zoning density, and information contained in the Comprehensive Plan (2010). For each anticipated growth area, it was assumed that 75% of the area would be developable due to various features throughout the County, such as water bodies, wetlands, poor soils, or extreme elevation changes.

The residential areas were assumed to have a density of either 4 or 8 units per acre, or the existing number of units in the subdivision if the area was already a developed neighborhood. The Comprehensive Plan (2010) used an assumed capita rate of 2.73 people per unit, which resulted in an anticipated population per future residential growth area.

The Virginia Department of Health has capacity guidelines for water demands to use as a standard when designing waterlines and they recommend using 100 gpd per capita residential demand, which was used to estimate residential demand.

Using the size of each growth area, a percentage of developable land within the area, a density of units based on anticipated zoning, a capita rate per unit, and a daily water demand per capita, the total residential water demand was calculated for each targeted growth area or existing neighborhood.

In the case of the existing neighborhoods, it was assumed that the entire neighborhood would receive water service within one time step, while new developments could be fully built out over multiple time steps to become partially or fully developed by the end of this Master Plan. If that was the case, then a percentage of the total demand for the growth area was applied to determine the demand for the partially developed area for each time step.

5.5.2 Commercial/Industrial Water Demands

Future commercial and industrial demands were calculated based on existing commercial and industrial usage within the system. It was assumed that future growth in these areas would be similar to companies that are currently customers of the Powhatan water system, and therefore, their water usage would be sim-

ilar to historical meter data. For any industries that are significantly different than those that are already operating in the county, a separate capacity analysis will need to be performed.

Water meter data from 2013 was used to determine the average daily water use at each meter. The meters that were designated as commercial were separated and an average daily water demand was calculated to be about 847 gpd per acre. The industrial demands were calculated to be approximately 629 gpd per acre.

Similarly to determining the residential water demand, for each anticipated commercial/industrial growth area, it was assumed that 75% of the area would actually be developable.

Using the size of each growth area, a percentage of developable land within the area, and the demand per acre based on existing meter data, the total commercial/industrial water demand was calculated for each targeted growth area.

In the case of new developments, it was assumed that development of the parcel could be fully built out over multiple time steps to become partially or fully developed by the end of this Master Plan. If that was the case, then a percentage of the total demand for the growth area was applied to determine the demand for the partially developed area for each time step.

5.5.3 School Water Demands

Water meter data for the existing schools showed that each school has an average of approximately 4,200 gpd water demand per school.

To develop the future water demands at the existing schools, the anticipated increase in enrollment was used based on the "Powhatan County Public Schools, School Facilities Study, Steering Committee Meeting #2", dated May 21, 2014. This report showed that anticipated increase in enrollment does not occur until the year 2030 (this study only went through 2030). Between 2025 and 2030, the enrollment increased by approximately 7.75%.

To account for this increase, the existing average water demand at the schools was increased by 7.75% for 2030. It was assumed that this percentage increase in enrollment would continue and the 7.75% enrollment increase was applied to the average water demand in 2030 to determine the school demands in 2035.

5.5.4 Route 711 Area Commercial Demands

The Route 711 Area is anticipated to be developed as mainly a commercial/office building area. Due to its proximity to Henrico and Chesterfield County, it was assumed that the demands for this area would be similar to water demands of Henrico County. To simulate this for the Master Plan, Henrico County Commercial Sewer Flow Rates were used (1,400 gpd per acre).

5.5.5 Water Demand Factors

Maximum day demand projections were estimated based on reviewing daily water production and supply data for the Flat Rock and Courthouse water systems. Based on this data, the maximum day factors were estimated to be 3 times and 2 times the average daily demand for the Flat Rock and Courthouse water systems, respectively. Since the maximum day factor of 3 for the Flat Rock system is unusually high, it was assumed that the maximum day factor would be reduced incrementally by 0.25 at each 5-year time step with a final factor of 2 by the end of the planning period in 2035. A maximum day factor of 2 was assumed for planning purposes for the Route 711 Service Area.

For the peak hour factor, a diurnal pattern was used in the water model to simulate the increase and decrease in peak demands throughout a typical day that was applied on top of the peak day demand. These peak hour factors varied between 0.4 and 1.6.

5.5.6 Water Demand Calibration

Based on the projected water demands within the WSSA for each of the time steps, the population projections that were provided by Powhatan County were used to determine the approximate percentage of the population growth within the WSSA. This was used as a check to calibrate the developed percentage within each targeted growth area. The developed percentage information was used to adjust growth projections for each parcel.

The calibration was performed by calculating the increase in new residential development demand between each time step and dividing that by 100 gpd per capita as used in the demand projections discussed in earlier sections. This resulted in an anticipated increase in number of people within the service area for each time step. It should be noted that the increased residential demand for new service to existing residential neighborhoods was not included in these calculations.

When comparing the population numbers within the service area, to the county-wide population projections as provided by Powhatan County, a percentage of growth within the WSSA was determined. **Table 5.3** below provides a summary of the population projections calibration:

Table 5-5 and 5-6 summarize water demand distributions for each five-year time increment throughout the planning period (2015, 2020, 2025, 2030, and 2035).

Table 5-3: Demand Calibration Summary

	2015	2020	2025	2030	2035
County-Wide Residential Population Predictions (From Comp. Plan)	30,033	32,019	33,861	35,702	37,523
Projected Population Increase (From Comp. Plan)	1,987	1,987	1,842	1,841	1,821
Assumed Population Increase (Based on Demand Projections)	NA	224	1,192	1,539	1,545
Percent Growth Estimated in Service Area (Based on Demand Projections)	NA	11.3%	64.7%	83.6%	84.8%

5.5.7 Water Demand Summary

A summary of average water system demand projections is provided in **Table 5-9.**

Table 5-5: Water Demand Projections - Flat Rock and Courthouse Areas - Page 1

Total Flat Rock Area & Courthouse Area Water Demands (gpd)					
	2015	**2020**	**2025**	**2030**	**2035**
Existing Aqua VA Demands	58,978	58,977	58,978	58,978	58,978
Existing Residential Lot Connections	279	279	279	279	150,975
New Residential Lot Connections	-	22,386	141,632	295,550	450,013
Commercial/Industrial	39,516	62,323	136,855	194,237	251,616
Schools	7,827	7,827	7,827	8,434	9,087
Estimated Flushing/Unaccounted Water	133,345	133,345	133,345	133,345	133,345
Total	239,945	285,137	478,916	690,822	1,054,014

Flat Rock Area Water Demands (gpd)					
	2015	**2020**	**2025**	**2030**	**2035**
Existing Residential Lot Connections	279	279	279	279	150,975
New Residential Lot Connections	-	-	68,796	172,263	276,276
Commercial/Industrial	39,516	62,323	136,855	194,237	251,616
Schools	7,827	7,827	7,827	8,434	9,087
Estimated Flushing/Unaccounted Water	**133,345**	**133,345**	**133,345**	**133,345**	**133,345**
Total	180,967	203,774	347,102	508,558	821,299

Courthouse Area Water Demands (gpd) [Fighting Creek]					
	2015	**2020**	**2025**	**2030**	**2035**
Existing Aqua VA Demands	58,978	58,978	58,978	58,978	58,978
Existing Residential Lot Connections	-	-	-	-	-
New Residential Lot Connections	-	22,386	72,836	123,287	173,737
Commercial/Industrial	-	-	-	-	-
Schools	-	-	-	-	-
Total	58,978	81,364	**131,814**	**182,265**	**232,715**

Notes: Anticipated growth areas and development timelines were determined by County staff during 5/5/14 and 6/13/14 meeting
Parcels that are anticipated to be rezoned to residential were assumed to have a portion of usable area and that amount of usable land will be divided into lots at the designated lot density
**Assuming 2.73 people per residential lot and 100 gpd per person demand

Existing Residential Lot Connections

	Subdivision Area (AC)	Zoned (AC per Unit)	Anticipated Number of Lots	Existing Residential Lots within Subidivision	Percent Served by 2020	Lots Served by 2020	Demand by 2020 (gpd)**	Percent Served by 2025	Lots Served by 2025	Demand by 2025 (gpd)**	Percent Served by 2030	Lots Served by 2030	Demand by 2030 (gpd)**	Percent Served by 2035	Lots Served by 2035	Demand by 2035 (gpd)**
Holly Hills Subdivision	187	R-U	N/A	206	0%	0	-	0%	0	-	0%	0	-	100%	206	56,238
Swiftwood Subdivision	94	2	N/A	49	0%	0	-	0%	0	-	0%	0	-	100%	49	13,377
Lake Shawnee Subdivision	220	R-U	N/A	297	0%	0	-	0%	0	-	0%	0	-	100%	297	81,081
Total Demand (gpd)[1]							**-**			**-**			**-**			**150,696**

1. Water and Wastewater service for existing subdivisions shown to happen by the end of this Master Plan; actual timeline of service initiation is unknown and will be determined by Powhatan County

Table 5-5: Water Demand Projections - Flat Rock and Courthouse Areas - Page 2

New Residential Lot Connections

	Subdivision Area (AC)	Usable Area	Zoned (Units per Acre)	Anticipated Number of Lots	Existing Residential Lots within Subidivision	Percent Served by 2020	Lots Served by 2020	Demand by 2020 (gpd)**	Percent Served by 2025	Lots Served by 2025	Demand by 2025 (gpd)**	Percent Served by 2030	Lots Served by 2030	Demand by 2030 (gpd)**	Percent Served by 2035	Lots Served by 2035	Demand by 2035 (gpd)**
42-79 (Subdivided Zoning, 50 AC Res, 34 AC Comm)	50	75%	4	150	0	0%	0	-	20%	30	8,190	40%	60	16,380	60%	90	24,570
West of Holly Hills	182	75%	4	546	0	0%	0	-	0%	0	-	10%	55	15,015	20%	110	30,030
Stavemill Station	82	75%	8	492	6	0%	0	-	20%	99	27,027	40%	197	53,781	60%	296	80,808
Stavemill Road Industrial (assumed to be rezoned to PD at 8 units per acre)	40	75%	8	240	0	0%	0	-	20%	48	13,104	40%	96	26,208	60%	144	39,312
East of Judes Ferry Road	395	75%	4	1185	0	0%	0	-	0%	0	-	0%	0	-	0%	0	-
West of Judes Ferry Road	495	75%	4	1485	0	0%	0	-	5%	75	20,475	15%	223	60,879	25%	372	101,556
Scottville Subdivision (Partially Developed)	76	NA	R-U	140	56	NA	82	22,386	NA	82	22,386	NA	82	22,386	NA	82	22,386
Lewis Property (assumed to be rezoned to PD at 8 units per acre)*	308	75%	8	1848	0	0%	0	-	10%	185	50,450	20%	370	100,901	30%	554	151,351
Total Demand (gpd)								**22,386**			**141,632**			**295,550**			**450,013**

*Existing Scottville water demands (56 lots) are accounted for in Aqua VA existing demands

Commercial

	Subdivision Area (AC)	Usable Area	Calculated Demand per Acre (based on existing users) (gpd/AC)*	Total Demand for Developed Area (gpd)	Percent Served by 2020	Demand by 2020 (gpd)	Percent Served by 2025	Demand by 2025 (gpd)	Percent Served by 2030	Demand by 2030 (gpd)	Percent Served by 2035	Demand by 2035 (gpd)
Parcel 42-79 (Subdivided Zoning, 50 AC Res, 34 AC Comm)	34	75%	847	21,599	0%	0	50%	10,799	75%	16,199	100%	21,599
East of Oak Bridge Area	39	75%	847	24,775	0%	0	100%	24,775	100%	24,775	100%	24,775
Oak Bridge Area (Subdivided Zoning, 58 AC Indus, 40 AC Comm)	27	75%	847	17,152	0%	0	100%	17,152	100%	17,152	100%	17,152
Stavemill Commercial	30	75%	847	19,058	50%	9,529	100%	19,058	100%	19,058	100%	19,058
Luck Commercial along Luck Stone Drive	13	75%	847	8,258	25%	2,065	50%	4,129	75%	6,194	100%	8,258
General Area Including Parcels 42-6, 42-6F, 42-6D, 42-6C, 42-6B, 42-9G, 42-9 (Zoned R-C)	125	75%	847	79,406	0%	0	0%	0	50%	39,703	100%	79,406
South Creek Area [some existing lots not developed yet, 30 AC of remaining area - need to confirm inclusion in MP]	30	50%	847	12,705	25%	3,176	50%	6,353	75%	9,529	100%	12,705
Total Demand (gpd)				**182,952**		**14,770**		**82,265**		**132,609**		**182,952**

*Calculated Demand includes existing water demand rates per acre + irrigation demands per acre

Table 5-5: Water Demand Projections - Flat Rock and Courthouse Areas - Page 3

Industrial

	Subdivision Area (AC)	Usable Area	Calculated Demand per Acre (based on existing users) (gpd/AC)*	Total Demand for Developed Area (gpd)	Percent Served by 2020	Demand by 2020 (gpd)	Percent Served by 2025	Demand by 2025 (gpd)	Percent Served by 2030	Demand by 2030 (gpd)	Percent Served by 2035	Demand by 2035 (gpd)
Oak Bridge Area (Subdivided Zoning, 58 AC Indus, 40 AC Comm) [some existing lots not developed yet, 19 AC of remaining Industrial area - need to confirm inclusion in MP]	15	75%	629	7,076	25%	1,769	50%	3,538	75%	5,308	100%	7,076
South Creek Area [some exising lots not developed yet, 90 AC of remaining area - need to confirm inclusion in MP]	67	50%	629	21,072	25%	5,268	50%	10,536	75%	15,804	100%	21,072
Luck Stone Road Industrial Extension+	9	NA	NA	1,000	100%	1,000	100%	1,000	100%	1,000	100%	1,000
Total Demand (gpd)				**29,148**		**8,037**		**15,074**		**22,112**		**29,148**

*Calculated Demand includes existing water demand rates per acre + irrigation demands per acre

+WATER AND SEWER EXTENSION ALREADY APPROVED, ASSUMED WATER DEMAND SUPPLIED BY COUNTY

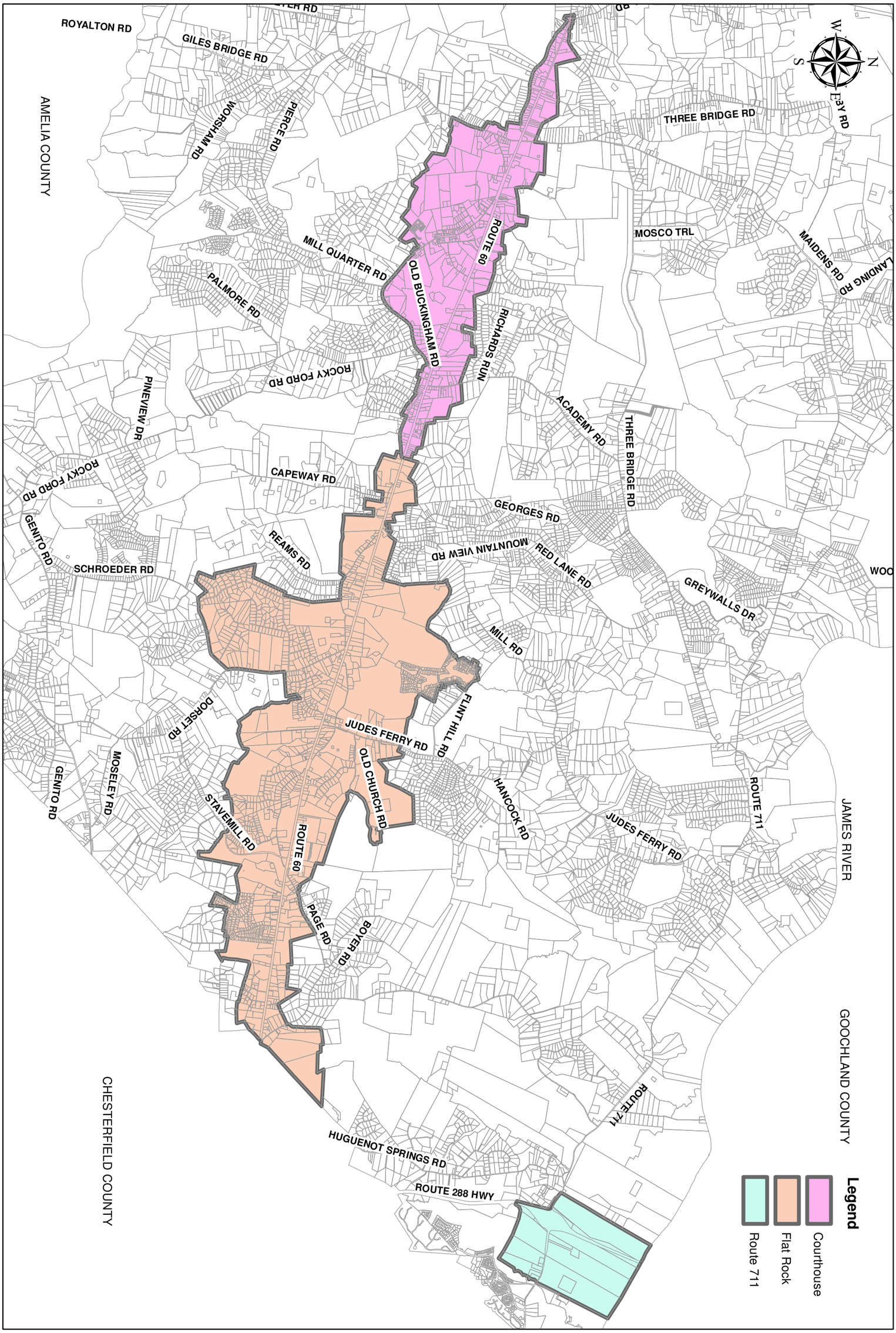
School

	Existing Demand for All Schools (gpd)	Percent Enrollment Increase by 2020	Demand by 2020 (gpd)	Percent Enrollment Increase by 2025	Demand by 2025 (gpd)	Percent Enrollment Increase by 2030	Demand by 2030 (gpd)	Percent Enrollment Increase by 2035	Demand by 2035 (gpd)
School Demand	7,827	0%	7,827	0%	7,827	7.75%	8434	7.75%	9,087
Total Demand (gpd)	**7,827**		**7,827**		**7,827**		**8,434**		**9,087**

Percentage enrollment increase is taken from "Powhatan County Public Schools School Facilities Study, Steering Committee Meeting #2" dated May 21, 2014

Table 5-6: Water Demand Projections - Route 711 Area

	Subdivision Area (AC)	Usable Area	Demand per Acre (based on Henrico Commercial Sewer Flow Rates) (gpd/AC)	Percent Served by 2020	Demand by 2020 (gpd)	Percent Served by 2025	Demand by 2025 (gpd)	Percent Served by 2030	Demand by 2030 (gpd)	Percent Served by 2035	Demand by 2035 (gpd)
East of Route 288	375	75%	1,400	10%	39,375	25%	98,438	50%	196,875	75%	295,313
West of Route 288	171	75%	1,400	0%	0	25%	44,888	50%	89,775	75%	134,663
Total					39,375		143,325		286,650		429,975



Dewberry

Dewberry Engineers Inc.

4180 INNSLAKE DRIVE
GLEN ALLEN, VIRGINIA 23060
PHONE: 804.290.7957
FAX: 804.290.7928

DATE	SCALE	TITLE	FIGURE NO.
09/2014	1 inch = 6,000 feet	WATER AND SEWER SERVICE AREAS	5-1
PROJ. NO. 50063290	PROJECT WATER AND WASTEWATER MASTER PLAN POWHATAN, VIRGINIA		

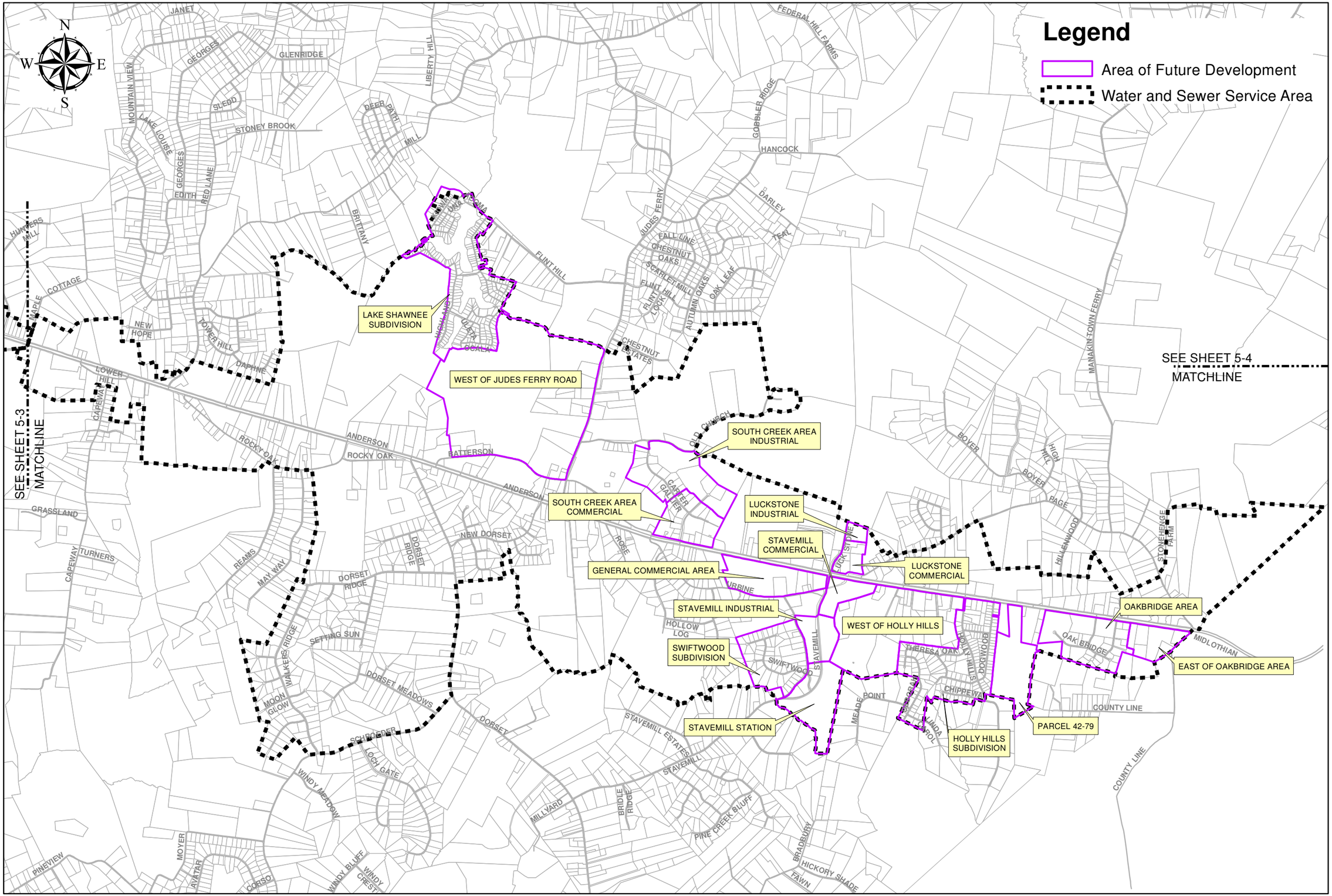


FIGURE NO. 5-2

TITLE
FLAT ROCK AREA
TARGETED GROWTH AREA

SCALE
1 inch = 3,000 feet

PROJECT
WATER AND WASTEWATER MASTER PLAN
POWHATAN COUNTY MASTER PLAN

DATE
09/2014

PROJ. NO.
50063290

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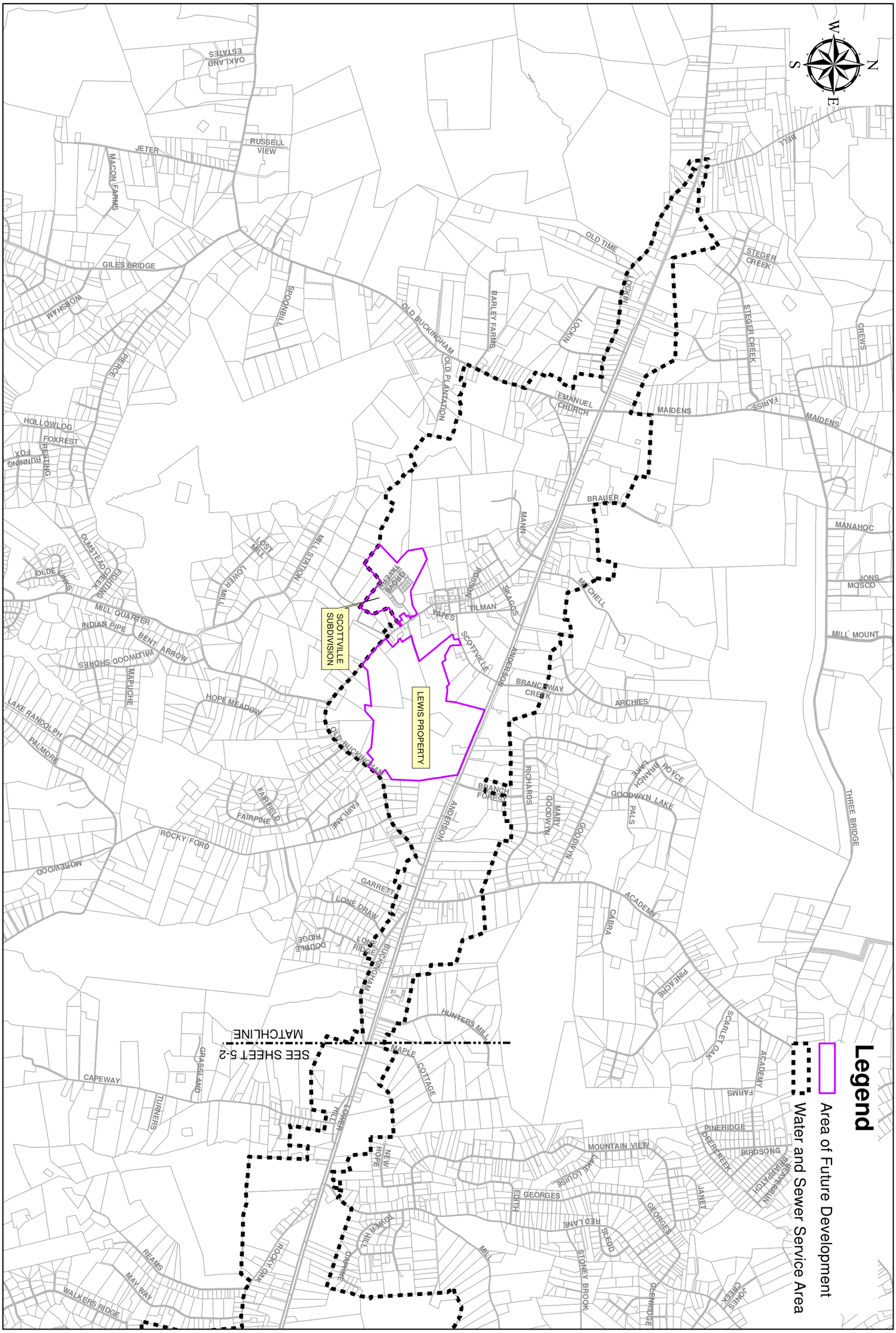

Dewberry

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DATE	SCALE	TITLE	FIGURE NO.
09/2014	1 inch = 3,000 feet	COURTHOUSE AREA TARGETED GROWTH AREA	5-3
PROJ. NO. 50063290	PROJECT	WATER AND WASTEWATER MASTER PLAN POWHATAN, VIRGINIA	

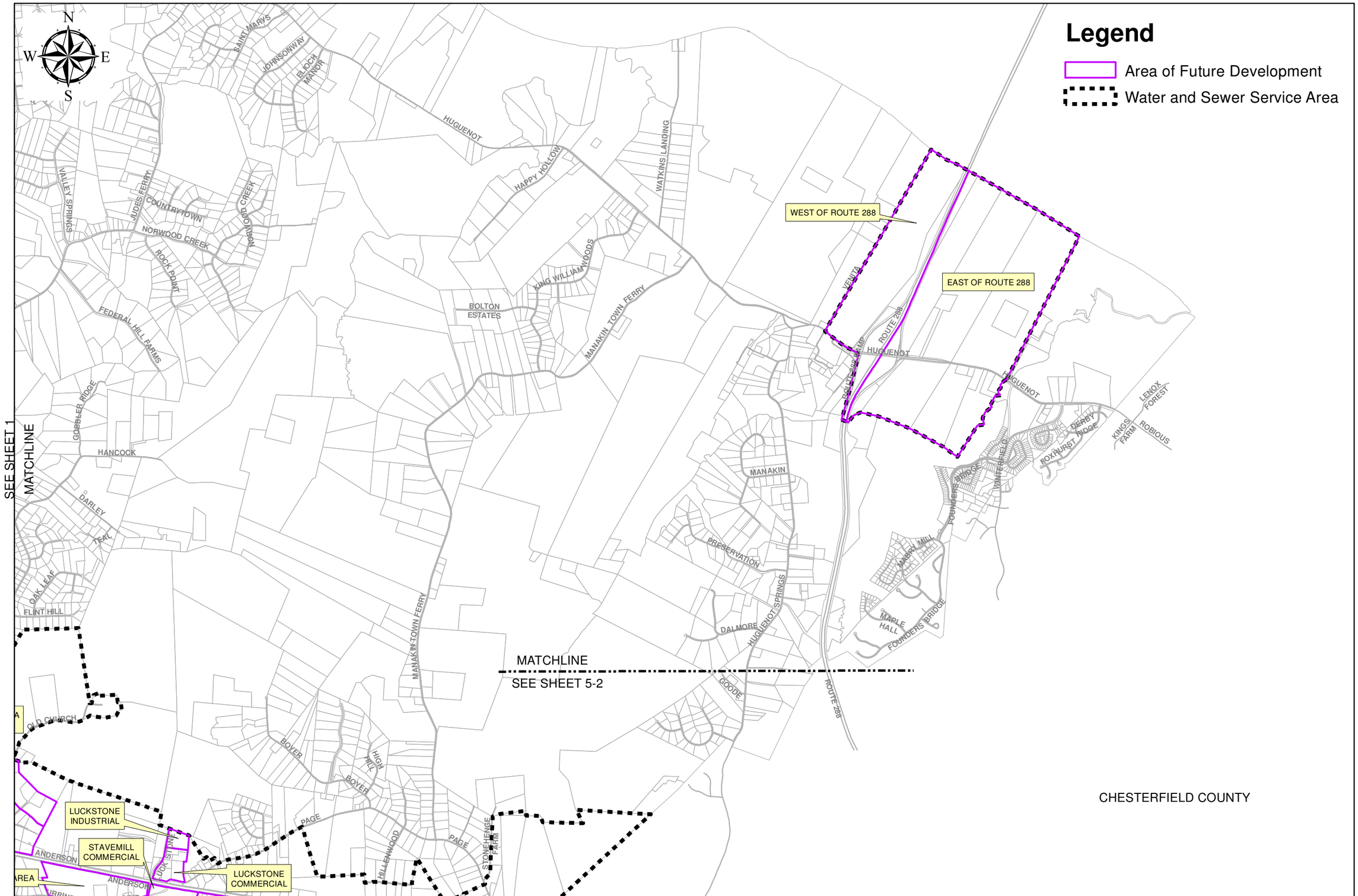

FIGURE NO. 5-4

TITLE ROUTE 711 TARGETED GROWTH AREA

SCALE 1 inch = 3,000 feet

PROJECT WATER AND WASTEWATER MASTER PLAN POWHATAN COUNTY MASTER PLAN

DATE 09/2014

PROJ. NO. 50063290

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5.6 Wastewater Demand Projections

Wastewater demand projections were developed based on metered water usage at residential connections. For commercial/industrial wastewater demand projections, metered water usage data was used, with the exception of meters that were designated "irrigation" by Powhatan County. Those meters were omitted when calculating wastewater demand, assuming that none of the water used as irrigation would enter the sewer system.

In addition to flows in the sewer collection system that result from water consumption, other sources of unaccounted sewer flow can occur within the system. One major contributor to additional flow is inflow and infiltration. Inflow results from open point sources that allow direct surface water to flow into the system, such as an open cleanout or manhole cover. Infiltration results from ground water that seeps through the sewer pipes at lose connections, poorly constructed joints or manhole connections, and old pipe.

To analyze this additional flow in the sewer system, daily logs were provided by Powhatan County that showed the daily influent flow to each wastewater treatment plant for the year 2013. From these logs, it was determined that the Dutoy Creek WWTP (Flat Rock sewer basin) had an average daily influent flow of 32,800 gpd and that the Fighting Creek WWTP (Courthouse sewer basin) had an average daily influent flow of 33,300 gpd, for a total of approximately 66,000 gpd.

The average I/I for each collection system was estimated based on comparing metered flows with the influent flows to the WWTP. The average daily flow to the Dutoy Creek WWTP based on the water meter data alone was approximately 32,653 gpd which was very close to the average influent flow to the WWTP, indicating that I/I is not a significant issue within the Dutoy Creek WWTP collection system.. The average daily flow to Fighting Creek WWTP based on the water meter data alone was approximately 23,122 gpd which was significantly lower than the average influent flow to the WWTP. This indicates that I/I is a significant issue within this collection system. It is recommended that the pipes within the Courthouse sewer basin be evaluated for I/I sources and repaired as necessary to reduce the amount of I/I in this sewer basin in the future.

For sizing of existing and future wastewater infrastructure it was necessary to apply a peak hour factor to the sewer flows in the system to account for variation of flows throughout the day. This peak factor was derived from an equation that incorporated average daily sewer flow to both treatment plants, assumed water demand per capita, and population. In order to determine what an acceptable peak hour factor would be for this system, the following equation was used:

$$k = (18 + \sqrt{P})/(4 + \sqrt{P})$$

Where,
P=Population in thousands

The equivalent population was determined by dividing the average daily flow by an assumed 100 GPD/capita, based on the Virginia Department of Environmental Quality Sewage Collection and Treatment Regulations.

5.6.1 Route 711 Area Commercial Demands

The Route 711 Area is anticipated to be developed as mainly a commercial/office building area. Due to its proximity to Henrico and Chesterfield County, it was assumed that the demands for this area would be similar to sewer demands for Henrico County. To simulate this for the Master Plan, Henrico County Commercial Sewer Flow Rates were used (1,400 gpd per acre).

5.6.2 Wastewater Demand Summary

A summary of the average wastewater system demand projections is provided in **Table 5-10.**

Table 5-7: Wastewater Demand Projections - Flat Rock and Courthouse Areas - Page 1

Total Flat Rock Area & Courthouse Area Wastewater Demands (gpd)					
	2015	**2020**	**2025**	**2030**	**2035**
Existing Residential Lot Connections	3,344	3,344	3,344	3,344	154,040
New Residential Lot Connections	-	22,386	141,632	295,550	450,013
Commercial/Industrial	26,539	38,718	81,265	107,717	134,166
Schools	16,926	16,926	16,926	18,238	19,651
Total	**46,809**	**81,374**	**243,168**	**424,849**	**757,870**
Additional Flow from I&I	19,318	19,318	19,318	19,318	19,318
Total	66,127	100,692	262,486	444,167	777,188

Flat Rock Area Wastewater Demands (gpd) [Dutoy]					
	2015	**2020**	**2025**	**2030**	**2035**
Existing Residential Lot Connections	267	267	267	267	150,963
New Residential Lot Connections	-	-	68,796	172,263	276,276
Commercial/Industrial	15,604	27,783	70,330	96,782	123,231
Schools	7,827	7,827	7,827	8,433	9,087
Subtotal	23,698	35,877	147,220	277,746	559,556
Additional Flow from I&I (Dutoy WWTP Average .0328 MGD)	9,102	9,102	9,102	9,102	9,102
Total	**32,800**	**44,979**	**156,322**	**286,848**	**568,659**

Courthouse Area Sewer Demands (gpd) [Fighting Creek]					
	2015	**2020**	**2025**	**2030**	**2035**
Existing Residential Lot Connections	3,078	3,078	3,078	3,078	3,078
New Residential Lot Connections	-	22,386	72,836	123,287	173,737
Commercial/Industrial	10,936	10,936	10,936	10,936	10,936
Schools	9,099	9,099	9,099	9,804	10,564
Subtotal	23,113	45,499	95,949	147,105	198,315
Additional Flow from I&I (Fighting Creek WWTP Average .0333 MGD)	10,216	10,216	10,216	10,216	10,216
Total	**33,329**	**55,715**	**106,165**	**157,321**	**208,531**

Notes: Anticipated growth areas and development timelines were determined by County staff during 5/5/14 and 6/13/14 meeting
Parcels that are anticipated to be rezoned to residential were assumed to have a portion of usable area and that amount of usable land will be divided into lots at the designated lot density
**Assuming 2.73 people per residential lot. Assuming 100 gpd per person demand 100 gpd per person

Existing Residential Lot Connections

	Subdivision Area (AC)	Zoned (AC per Unit)	Anticipated Number of Lots	Existing Residential Lots within Subidivision	Percent Served by 2020	Lots Served by 2020	Demand by 2020 (gpd)**	Percent Served by 2025	Lots Served by 2025	Demand by 2025 (gpd)**	Percent Served by 2030	Lots Served by 2030	Demand by 2030 (gpd)**	Percent Served by 2035	Lots Served by 2035	Demand by 2035 (gpd)**
Holly Hills	187	R-U	N/A	206	0%	0	-	0%	0	-	0%	0	-	100%	206	56,238
Swiftwood Subdivision	94	2	N/A	49	0%	0	-	0%	0	-	0%	0	-	100%	49	13,377
Lake Shawnee	220	R-U	N/A	297	0%	0	-	0%	0	-	0%	0	-	100%	297	81,081
Total Demand (gpd)[1]							-			-			-			**150,696**

1. Water and Wastewater service for existing subdivisions shown to happen by the end of this Master Plan; actual timeline of service initiation is unknown and will be determined by Powhatan County

Table 5-7: Wastewater Demand Projections - Flat Rock and Courthouse Areas - Page 2

New Residential Lot Connections

	Subdivision Area (AC)	Usable Area	Zoned (Units per Acre)	Anticipated Number of Lots	Existing Residential Lots within Subidivision	Percent Served by 2020	Lots Served by 2020	Demand by 2020 (gpd)**	Percent Served by 2025	Lots Served by 2025	Demand by 2025 (gpd)**	Percent Served by 2030	Lots Served by 2030	Demand by 2030 (gpd)**	Percent Served by 2035	Lots Served by 2035	Demand by 2035 (gpd)**
42-79 (Subdivided Zoning, 50 AC Res, 34 AC Comm)	50	75%	4	150	0	0%	0	-	20%	30	8,190	40%	60	16,380	60%	90	24,570
West of Holly Hills	182	75%	4	546	0	0%	0	-	0%	0	-	10%	55	15,015	20%	110	30,030
Stavemill Station	82	75%	8	492	6	0%	0	-	20%	99	27,027	40%	197	53,781	60%	296	80,808
Stavemill Road Industrial (assumed to be rezoned to PD at 8 units per acre)	40	75%	8	240	0	0%	0	-	20%	48	13,104	40%	96	26,208	60%	144	39,312
East of Judes Ferry Road	395	75%	4	1185	0	0%	0	-	0%	0	-	0%	0	-	0%	0	-
West of Judes Ferry Road	495	75%	4	1485	0	0%	0	-	5%	75	20,475	15%	223	60,879	25%	372	101,556
Scottville (Partially Developed)	76	NA	R-U	140	56	NA	82	22,386	NA	82	22,386	NA	82	22,386	NA	82	22,386
Lewis Property (assumed to be rezoned to PD at 8 units per acre)	308	75%	8	1848	0	0%	0	-	10%	184.8	50,450	20%	369.6	100,901	30%	554.4	151,351
Total Demand (gpd)								**22,386**			**141,632**			**295,550**			**450,013**

*Existing Scottville sewer demands (56 lots) are accounted for by existing meter data.

Commercial

	Subdivision Area (AC)	Usable Area	Calculated Demand per Acre (based on existing users) (gpd/AC)*	Total Demand for Developed Area (gpd)	Percent Served by 2020	Demand by 2020 (gpd)	Percent Served by 2025	Demand by 2025 (gpd)	Percent Served by 2030	Demand by 2030 (gpd)	Percent Served by 2035	Demand by 2035 (gpd)
42-79 (Subdivided Zoning, 50 AC Res, 34 AC Comm)	34	75%	367	12,478	0%	0	50%	6,239	75%	9,359	100%	12,478
East of Oak Bridge Area	39	75%	367	14,313	0%	0	100%	14,313	100%	14,313	100%	14,313
Oak Bridge Area (Subdivided Zoning, 58 AC Indus, 40 AC Comm)	27	75%	367	9,909	0%	0	100%	9,909	100%	9,909	100%	9,909
Stavemill Commercial	30	75%	367	11,010	50%	5,505	100%	11,010	100%	11,010	100%	11,010
Luck Commercial along Luck Stone Drive	13	75%	367	3,578	25%	895	50%	1,789	75%	2,684	100%	3,578
General Area Including Parcels 42-7, 42-7F, 42-7D, 42-7C, 42-7B, 42-9G, 42-9 (Zoned R-C)	125	75%	367	34,406	0%	0	0%	0	50%	17,203	100%	34,406
South Creek Area [some exising lots not developed yet, 30 AC of remaining area - need to confirm inclusion in MP]	30	50%	367	11,010	25%	2,753	50%	5,505	75%	8,258	100%	11,010
Total Demand (gpd)				**96,705**		**9,152**		**48,765**		**72,735**		**96,705**

*Calculated Demand includes existing water demand rates per acre

Table 5-7: Wastewater Demand Projections - Flat Rock and Courthouse Areas - Page 3

Industrial

	Subdivision Area (AC)	Usable Area	Calculated Demand per Acre (based on existing users) (gpd/AC)*	Total Demand for Developed Area (gpd)	Percent Served by 2020	Demand by 2020 (gpd)	Percent Served by 2025	Demand by 2025 (gpd)	Percent Served by 2030	Demand by 2030 (gpd)	Percent Served by 2035	Demand by 2035 (gpd)
Oak Bridge Area (Subdivided Zoning, 58 AC Indus, 40 AC Comm) [some existing lots not developed yet, 19 AC of remaining Industrial area - need to confirm inclusion in MP]	15	75%	121	1,815	0%	0	50%	908	75%	1,362	100%	1,815
South Creek Area [some exising lots not developed yet, 90 AC of remaining area - need to confirm inclusion in MP]	67	50%	121	8,107	25%	2026.75	50%	4,054	75%	6,081	100%	8,107
Luck Stone Road Industrial Extension**	9	NA	NA	1,000	100%	1,000	100%	1,000	100%	1,000	100%	1,000
Total Demand (gpd)				**10,922**		**3,027**		**5,961**		**8,443**		**10,922**

*Calculated Demand includes existing water demand rates per acre

*****WATER AND SEWER EXTENSION ALREADY APPROVED, ASSUMED WATER DEMAND SUPPLIED BY COUNTY***

School

	Existing Demand for All Schools (gpd)	PercentEnrollment Increase by 2020	Demand by 2020 (gpd)	Percent Enrollment Increase by 2025	Demand by 2025 (gpd)	Percent Enrollment Increase by 2030	Demand by 2030 (gpd)	Percent Enrollment Increase by 2035	Demand by 2035 (gpd)
School Demand	16,926	0%	16,926	0%	16,926	7.75%	18238	7.75%	19,651
Total Demand (gpd)	**16,926**		**16,926**		**16,926**		**18,238**		**19,651**

Percentage enrollment increase is taken from "Powhatan County Public Schools School Facilities Study, Steering Committee Meeting #2" dated May 21, 2014

Table 5-8: Wastewater Demand Projections - Route 711 Area

	Subdivision Area (AC)	Usable Area	Demand per Acre (based on Henrico Commercial Sewer Flow Rates) (gpd/AC)	Percent Served by 2020	Demand by 2020 (gpd)	Percent Served by 2025	Demand by 2025 (gpd)	Percent Served by 2030	Demand by 2030 (gpd)	Percent Served by 2035	Demand by 2035 (gpd)
East of Route 288	375	75%	1,400	10%	39,375	25%	98,438	50%	196,875	75%	295,313
West of Route 288	171	75%	1,400	0%	0	25%	44,888	50%	89,775	75%	134,663
Total					**39,375**		**143,325**		**286,650**		**429,975**

Table 5-9: Water Demand Projections Summary (Average Daily Demands)

Service Area	2015	2020	2025	2030	2035
Flat Rock Service Area (GPD)	180,967	203,774	347,102	508,558	821,299
Courthouse Service Area (GPD)	58,978	81,364	131,814	182,265	232,715
Route 711 Service Area (GPD)	0	39,375	143,325	286,650	429,975
Total (GPD)	**239,945**	**324,513**	**622,241**	**977,473**	**1,483,989**

Table 5-10: Wastewater Demand Projections Summary (Average Daily Demands)

Service Area	2015	2020	2025	2030	2035
Flat Rock Service Area (GPD)	32,800	44,979	156,322	286,848	568,659
Courthouse Service Area (GPD)	33,329	55,715	106,165	157,321	208,531
Route 711 Service Area (GPD)	0	39,375	143,325	286,650	429,975
Total (GPD)	**66,129**	**140,069**	**405,812**	**730,819**	**1,207,165**

Chapter 6
System Modeling

6.1 General

Powhatan County's water and wastewater systems were modeled in order to evaluate system conditions throughout the planning period and to identify improvements required to meet future needs. Computer modeling software was used to develop the system models, which were loaded with water and wastewater demand projections that were developed as described in Chapter 5 and calibrated to reflect actual conditions within the County. The models were then used to evaluate cost-effective improvement scenarios required to address future conditions.

Brief summaries of the water and wastewater system modeling software packages, model development activities, system loading procedures, assumptions, calibration techniques, and modeling scenarios are provided in the following sections.

6.2 Water Model

Water system modeling activities were conducted utilizing the Innovyze InfoWater Water Distribution Modeling Software. InfoWater is a water distribution system modeling package that includes a complete geographic information management system for water utilities. Its hydraulic analysis engine includes the capability to evaluate storage requirements, analyze water quality, determine fire flow requirements, and calibrate large distribution networks, making it a useful tool for water system master planning activities.

6.2.1 Model Build

For the purposes of this Master Plan, a new water system model was constructed utilizing data from the County's GIS and supplemented by available record drawing information, field verification of above ground features and survey data. Elements that were included in the water system model consisted of the following:

- Water distribution lines (with pipe roughness coefficient ranging from 100 to 150) ranging in diameter from 1" to 12"
- Water storage tanks
- Booster pump stations
- Other source water connections (Chesterfield County)
- Water meter locations

Pipe modeling information was based on a GIS geodatabase provided by the County and updated by Dewberry. The GIS data was supplemented by record drawing information as needed to fill in data gaps.

Junctions in the model were created automatically by the InfoWater at each change in pipe size, change in pipe direction, such as intersections, and any "break" in the GIS pipes, such as valves. Each junction was assigned an elevation in the model based on GIS topography contours provided by the County. These contours were converted to a raster image from which interpolated elevations were extracted and applied to each junction.

A schematic of the water lines that were included in the model are shown in **Figures 6-1, 6-2, and 6-3.**

6.2.2 Model Demand Allocation

Demands were allocated to the model in order to simulate system conditions under both average and maximum day demands. These demands were allocated in the model to the nearest node based on geo-coded service address for existing consumers or assumed connection points for future development. A detailed summary of system demands is provided in **Chapters 3 and 5**.

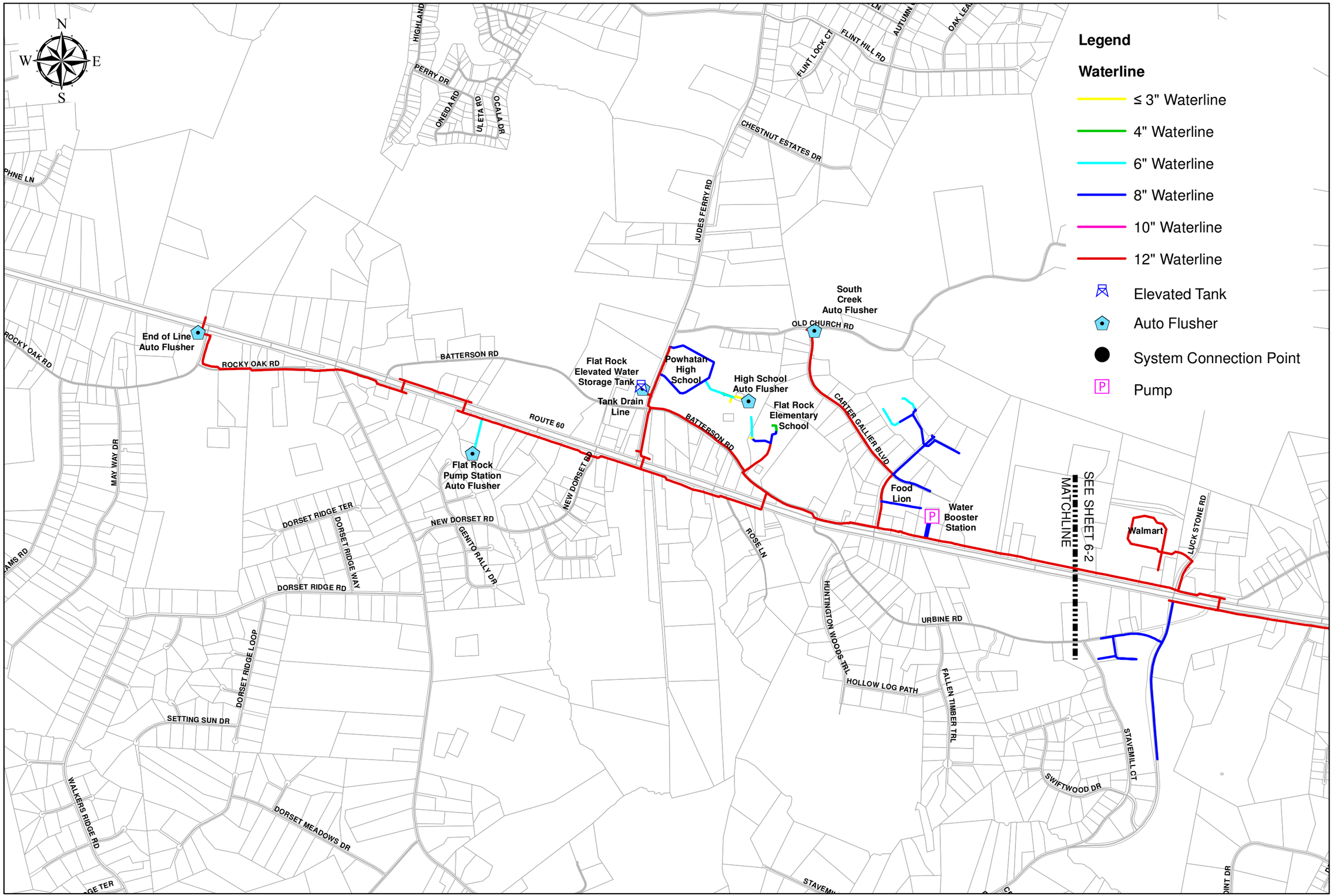

FIGURE NO. 6-1

TITLE WATERLINE MODEL SCHEMATIC WESTERN FLAT ROCK AREA

SCALE 1 inch = 1,500 feet

PROJECT WATER AND WASTEWATER MASTER PLAN POWHATAN, VIRGINIA

DATE OCT 2014

PROJ. NO. 50063290

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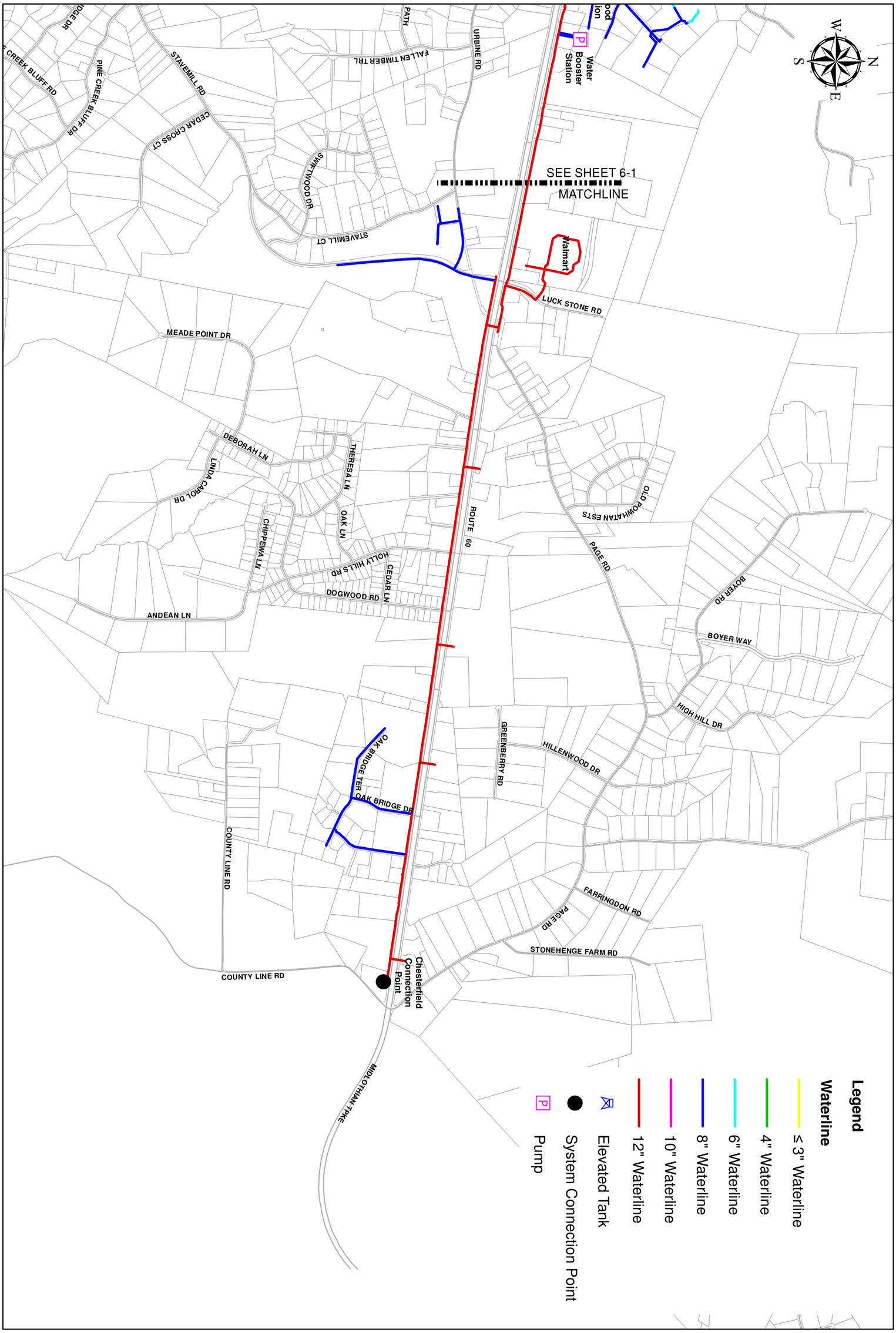

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DATE	SCALE	TITLE	FIGURE NO.
OCT 2014	1 inch = 1,500 feet	WATERLINE MODEL SCHEMATIC EASTERN FLAT ROCK AREA	6-2
PROJ. NO. 50063290	PROJECT WATER AND WASTEWATER MASTER PLAN POWHATAN, VIRGINIA		

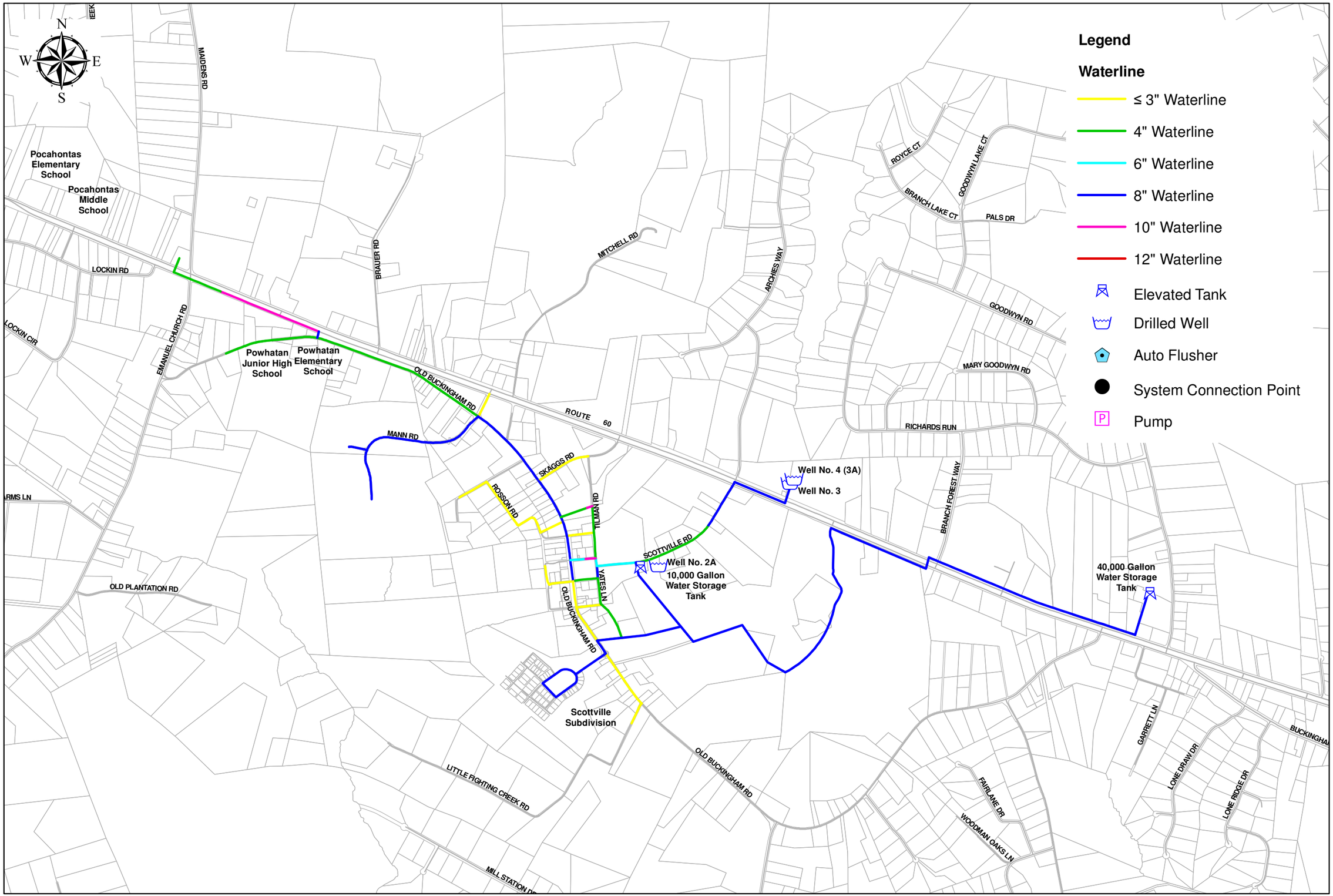

FIGURE NO. 6-3

TITLE WATERLINE MODEL SCHEMATIC COURTHOUSE AREA

SCALE 1 inch = 1,500 feet

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6.2.3 Model Calibration

The water distribution system model was calibrated to accurately represent existing function based on available meter billing data and SCADA (supervisory control and data acquisition). System operations calibrated as part of this Master Plan include demands, pipe hydraulic roughness coefficients, pump performance, and interconnections to adjacent municipalities.

Demand calibration included a detailed comparison of Powhatan County metered demand, flushing estimates, and Chesterfield meter data.

Field hydrant flow testing was completed for purposes of calibrating pipe roughness throughout the model. The pipe roughnesses were estimated by utilizing the modeling software to adjust Hazen Williams C values as needed to match field conditions during the hydrant testing.

Finally, the point of interconnection to Chesterfield County was modeled as a pumping station in order to account for upstream losses, specifically during high flow events. The pump curve was developed and calibrated based on available SCADA information from Chesterfield and Powhatan County.

6.2.4 Model Scenarios

Once the model was calibrated, extended period simulations (EPS) were run for each of the time increments (2015, 2020, 2025, 2030, and 2035) within the planning period to evaluate system improvement requirements and identify Master Plan Capital Improvement Projects (CIPs).

Steady-state fire flow analysis was first completed to access the system's ability to respond to a two (2) hour fire event during peak hour system demands while maintaining a minimum system wide pressure of 20 psi. Commercial and residential fire flows were simulated at strategic locations throughout the system to confirm system adequacy. Commercial fire flows were modeled as a 2,000 gpm for a 2-hour period and residential fire flows were modeled as 1,000 gpm for a 2-hour period.

Following the steady state fire flow analysis, extended period simulations for 60 day period using average day demands were run for each of the time increments to identify areas of high water age. The maximum water age in the system could not be determined because Chesterfield County did not provide sufficient water age information at the Chesterfield water meter.

By evaluating the adequacy of the system at each time increment through the planning period, the timing of individual CIP requirements was determined. This analysis led to the development of the water system improvement program that is described in detail in Chapter 7.

6.3 Wastewater Model

Wastewater system modeling activities were conducted utilizing the Innovyze InfoSewer Modeling Software. InfoSewer is a sanitary modeling package that provides extensive scenario and facility management functionalities that make it a useful tool for analyzing existing and proposed sewer collection systems and their growth over time.

6.3.1 Model Build

For the purposes of this Master Plan, a new sewer system model was built, utilizing data from the County's GIS, with sewer system data current as of December 2013. Included in the system model developed for this Master Plan were the following elements:

- Gravity sewer lines 6-inches in diameter or greater (trunk sewer system), as determined to be necessary for accurate modeling
- Sanitary sewer pump stations
- Force main piping

The existing model incorporated 297 pipes and 267 manholes in the entire system from GIS data in the Master Plan Model. A schematic of the trunk sewer lines that were included in the model are shown in **Figures 6-4, 6-5, and 6-6.**

Information from the GIS database was used, where possible, to provide information on pipe lengths, slopes, and ground and invert elevations and to establish continuity throughout the system. For portions of the system where available information was not included in GIS data, invert and ground elevations were taken from record drawings.

6.3.2 Model Loading Allocation

The wastewater system model was loaded through individual manholes within the distribution system. Existing residential and commercial/industrial demands were distributed to the nearest manhole in the system that was adjacent to the location of the water meter that corresponded with a residential, commercial, industrial, or school demand. A total of 66 manholes throughout the system were loaded with demands in the baseline year.

6.3.3 Model Calibration

The wastewater system model was calibrated for the baseline year of 2015 to reflect actual flows at the end points of each of the two sewer basins, the Dutoy WWTP and the Fighting Creek WWTP. Data that was used for calibration included actual measured flows within the system at treatment plants for the calendar year 2013.

Data from the water demand projections in **Table 5-1** were used to develop the initial wastewater system loadings for the baseline year, but these initial loadings were modified separately within each sewer basin to reflect actual conditions. Descriptions of the procedures that were utilized to calibrate the sewer model in each sewer basin were provided in **Section 5.6** of this Master Plan.

6.3.4 Model Scenarios

Utilizing loading and model inputs from the calibrated model and **Table 5-7**, average and peak hourly flow analyses were run for each of the time increments (2015, 2020, 2025, 2030, and 2035) within the planning period to evaluate system improvement requirements and identify Master Plan Capital Improvement Projects (CIPs). By evaluating modeled system flows at each of the time increments, the timing of individual CIP requirements was determined. This analysis led to the development of the wastewater system improvement program that is described in detail in Chapter 8.

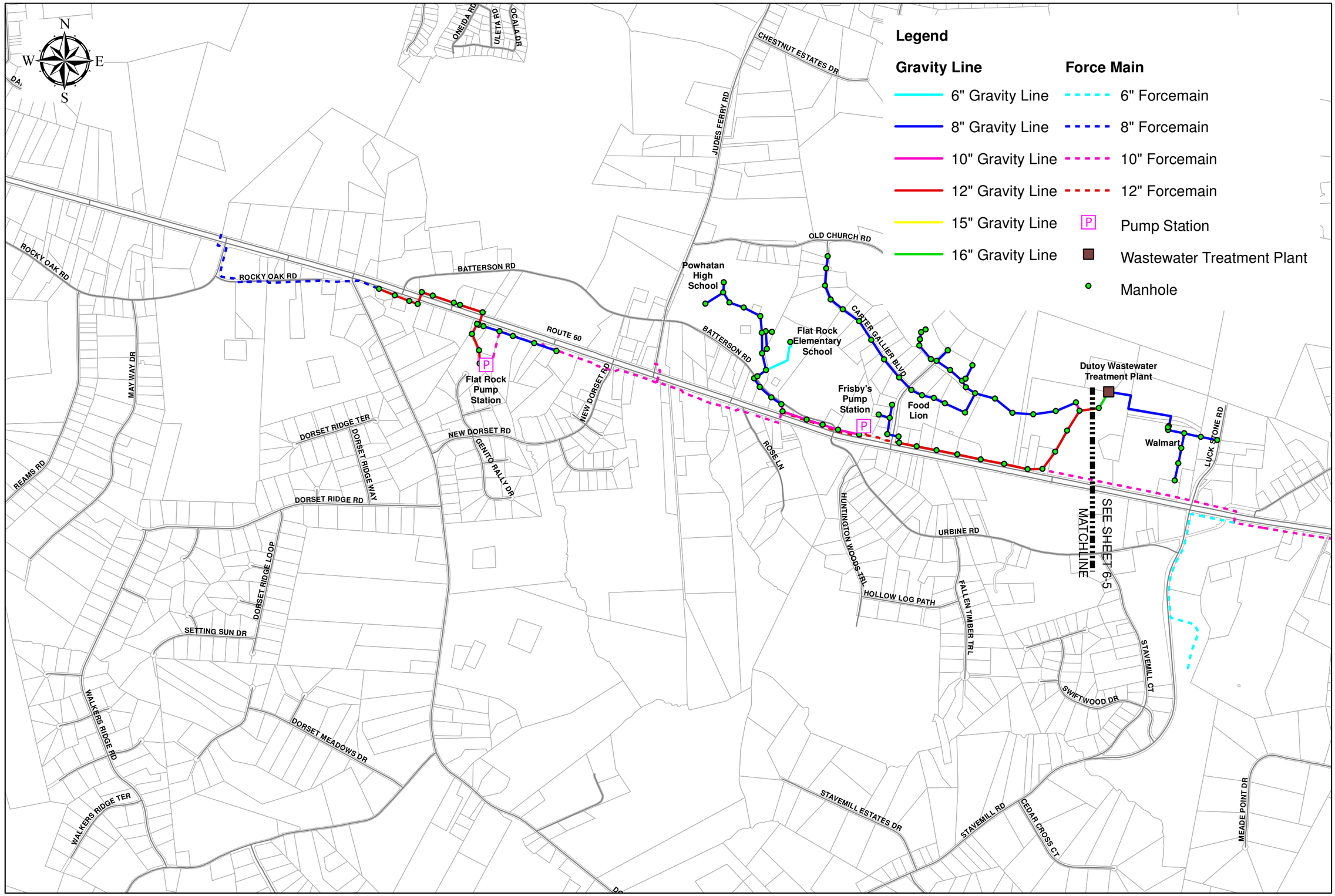

FIGURE NO. 6-4

TITLE WASTEWATER MODEL SCHEMATIC WESTERN FLAT ROCK

SCALE 1 inch = 1,500 feet

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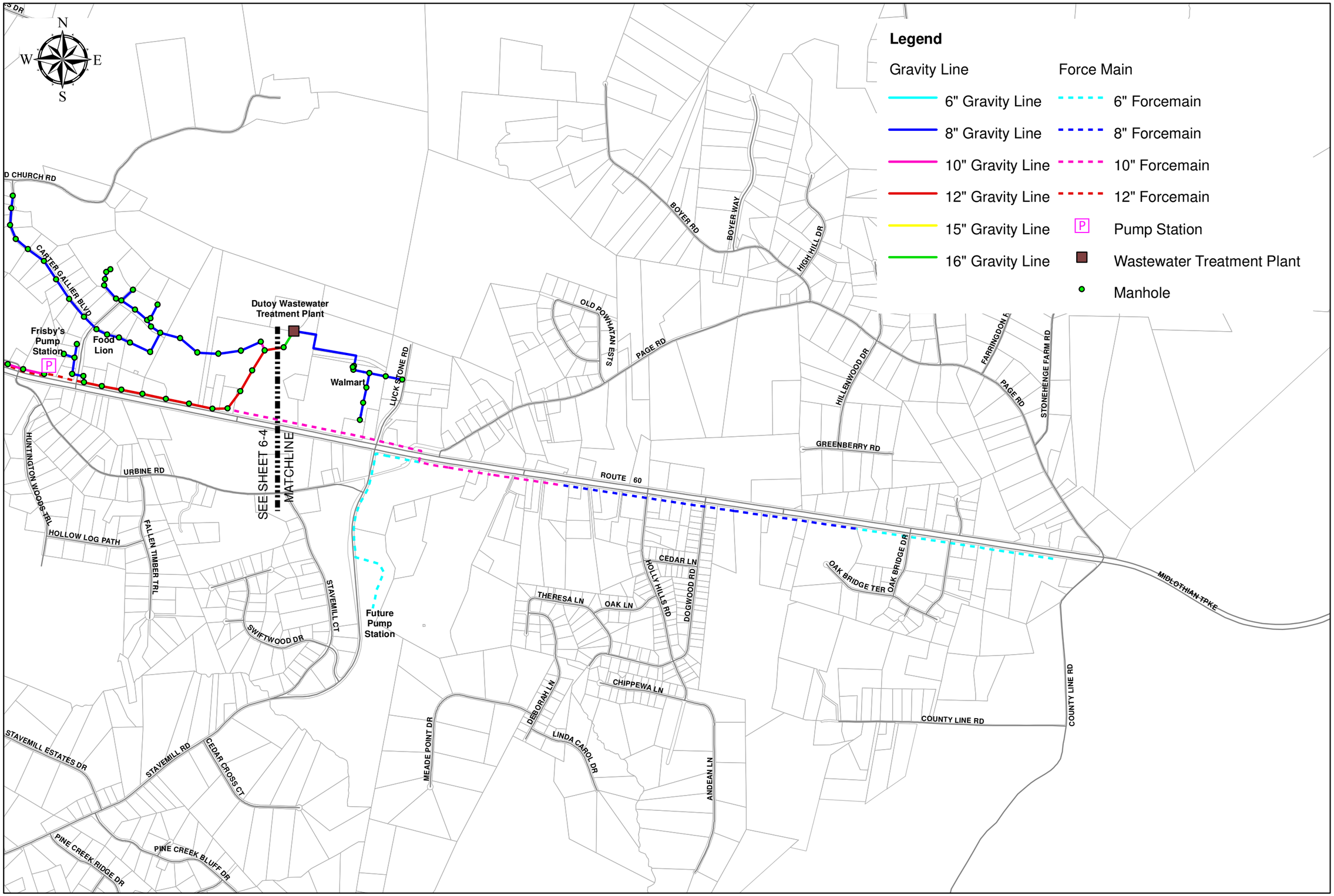

FIGURE NO. 6-5

TITLE WASTEWATER MODEL SCHEMATIC EASTERN FLAT ROCK AREA

SCALE 1 inch = 1,500 feet

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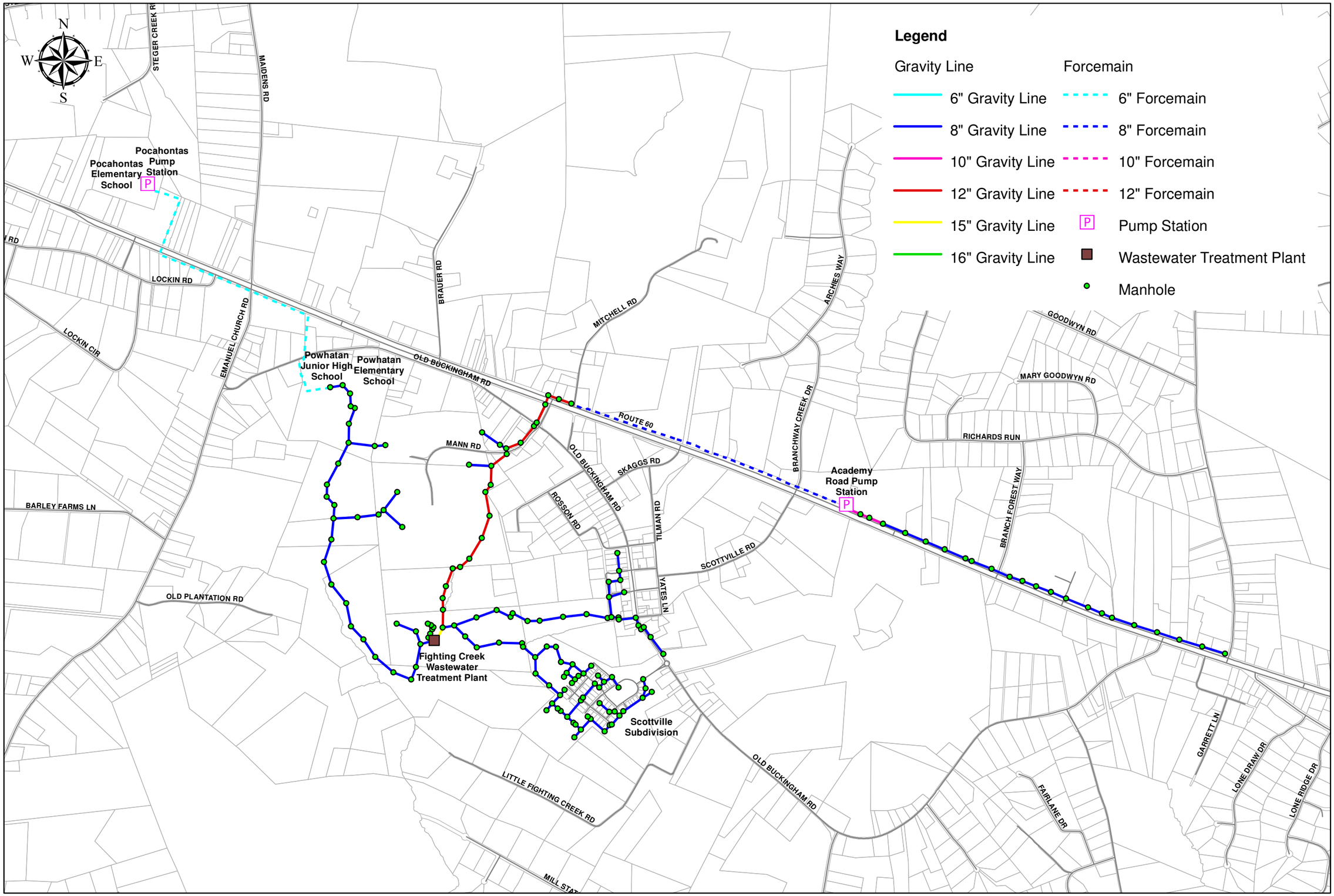

FIGURE NO. 6-6

TITLE WASTEWATER MODEL SCHEMATIC COURTHOUSE AREA

SCALE 1 inch = 1,500 feet

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Chapter 7
Water System Improvements

7.1 General

This chapter of the Master Plan presents an overview of system improvements that are proposed to provide water service within the County's Water and Sewer Service Area through the Year 2035. In general, the County constructs projects required to provide an adequate water supply to an area, and the private sector constructs projects required to provide water service to a specific area. Both VDH and County requirements were considered when developing this plan.

The Proposed Water Improvements map, included in **Appendix A** of this report, provides a graphical presentation of the recommended water system improvements. Improvements shown on this plate are color coded by the year that the improvement is needed and corresponds to the water system cost estimates for cross-referencing.

In addition, there are some developer-driven improvements identified that are planned to be constructed and paid for by private development. Other currently unidentified developer-driven improvements may be necessary as development occurs through the planning period.

In general, the water system improvements program involves improvements to water supply, water storage, and water distribution to ensure adequate supply and pressures throughout the planning period.

It should be noted that these improvements do not address operational or maintenance improvements, which are funded by user fees.

A brief overview of improvements is provided in the following sections and are shown in **Figures 7-1 through 7-5**. More detailed descriptions of individual CIPs are provided at the end of this chapter.

7.2 Water Supply Capacity

An evaluation of the planning period from 2015 to 2035 indicates that as the population grows within the water service areas, the County's available water supply will not be sufficient to meet peak system demands towards the end of the planning period. Table 7-1 provides a summary of the existing water supply sources for the County's water service areas and Table 7-2 shows the projected maximum day water demands through the end of the planning period in 2035.

Table 7-1: Existing Water Supply Sources

Supply Source	Service Area	Maximum Day Capacity
Chesterfield County (Route 60)	Flat Rock	572,000 GPD
Aqua Virginia[1]	Courthouse	118,400 GPD (Expandable to 134,400 GPD)

1. Privately owned water system.

Table 7-2: Water Demand Projections (Maximum Day Demands)

	2015	2020	2025	2030	2035
Flat Rock Service Area (GPD)	542,900	560,377	867,754	1,144,254	1,642,598
Courthouse Service Area (GPD)[1]	117,956	162,728	263,629	364,530	465,430
Route 711 Service Area (GPD)	0	108,281	358,313	644,963	859,950
Total (GPD)	**660,856**	**831,386**	**1,489,696**	**2,153,747**	**2,967,978**

1. The Courthouse Service Area is currently served by a private water system owned by Aqua Virginia.

A new water supply will need to be provided to ensure reliable water service to County residents in order to meet projected peak demands.

In order to provide additional water supply, Powhatan County signed a Memorandum of Understanding (MOU) with the Virginia Department of Corrections (VDOC) and Goochland County. The MOU allows for Powhatan to receive up to 10 million gallons per day (MGD) of treated water from the DOC water treatment plant (WTP). A revised water withdrawal permit issued by the State would be required for additional water withdrawal and treatment. The WTP currently holds a permit for 2 MGD. In 2013 the WTP produced on average of 0.66 MGD and a maximum day of 0.89 MGD with a capacity to treat up to 3 MGD. DOC will continue to own and maintain the WTP and hold the permit.

The Cobbs Creek Reservoir, located in Cumberland County, is currently in the design and land acquisition phase. Henrico County is the permit holder and has a signed MOU with Cumberland County. The reservoir will augment the James River during periods of low flows, discharging water back into the river from the reservoir. During times of higher flows water will be pumped out of the James River for storage. The permit for the reservoir accounts for future water needs of Henrico, Cumberland, and Powhatan Counties. Goochland County will indirectly benefit as it purchases water from Henrico County for use on its eastern boundary. A 10 MGD water withdrawal allocation for Powhatan County was accounted for in the Cobbs Creek permit. A signed MOU between Powhatan County and Henrico County will be necessary for Powhatan County to utilize water benefits from the reservoir in a future water withdrawal at the DOC water treatment plant. To utilize this supply, Powhatan County will be required to construct a booster station and finished water transmission main along Route 522 to transfer the water to the Powhatan County water service areas.

7.2.1 Route 711 Service Area

To serve the proposed water demand in this area by 2020, the development of a new water supply source will be required. Three (3) options were evaluated for providing a water supply for this service area. Budgetary cost estimates were included in this section to assist in the evaluation of each option.

1. *Water Supply from Chesterfield County*
   This option would include the construction of a 12-inch water transmission main along Route 711 from the Chesterfield County line to a new 500,000 gallon elevated tank. Available water pressure and flow information were not provided by Chesterfield County; however it is anticipated that supply pressures from Chesterfield would be low, therefore it was assumed that a booster station would be required at the county line to provide sufficient water supply to the service area. An agreement would have to be signed with Chesterfield County to provide water supply. The budgetary level cost estimate for this option is $5,400,000.

2. *Water Supply from Goochland County*
   This option would include the construction of a 12-inch transmission main under the James River to connect to the Goochland County water system along River Road. The transmission main would be routed to a new 500,000 gallon elevated tank in the Route 711 Service Area. It is not anticipated that a booster station will be required for this option since sufficient flows and pressures are available at the proposed connection point. An agreement would have to be signed with Goochland County to provide water supply. The budgetary level cost estimate for this option is $5,620,000.

3. *Water Supply from Flat Rock Water System*
   This option would include the construction of a 12-inch transmission main from the Route 60 water supply from Chesterfield County to a new 500,000 gallon elevated water tank in the Route 711 Service Area. It is not anticipated that a booster station will be required for this option since sufficient flows and pressures are available at the proposed connection point. The budgetary level cost estimate for this option is $7,450,000.

If an agreement with Chesterfield County could be successfully negotiated, the Chesterfield Connection at Route 711 is recommended since it would result in the lowest capital cost. However, since Chesterfield County has indicated that they do not have the capacity to provide water supply to Powhatan County at Route 711, the Goochland County connection is recommended because it would provide for a lower capital cost than the Flat Rock connection. Additionally, maintaining the current 572,000 gpd water supply allocation from Chesterfield County at the Flat Rock water system would reduce the amount of water that would have to be supplied from the Route 522 water supply.

As an interim option to providing initial water supply to the Route 711 Service Area, the County could investigate the yield and quality of groundwater within the service area. It is not anticipated that groundwater alone would be able to supply the required maximum day water supply needed through the end of the planning period; however, this could be a less expensive option to initially provide water service to the area. If the groundwater supply is found to be sufficient to provide initial water service, the County could put off the cost of the more expensive water supply infrastructure until development has been started within the service area.

Refer to **Figure 7-5** for an exhibit showing the three water supply options for the Route 711 Service Area.

7.2.2 Courthouse Service Area

The water system within this service area is privately owned by Aqua Virginia and currently has a permitted maximum day capacity of 118,400 gallons per day (gpd). There is a draft amendment to this permit that could allow for a maximum day capacity to be increased to 134,400 gpd. However, based on the demand projections within this service area, the maximum day supply will be exceeded before 2020. It is unknown whether Aqua Virginia will be able to increase the water supply beyond 134,400 gpd with additional wells; however, it is not anticipated that Aqua Virginia will be able to increase the water supply to meet the projected maximum day demands of the Courthouse Service Area through the end of the planning period. To ensure that the Courthouse Service Area is provided with the estimated maximum day water demand by 2020, the County will be required to construct the Route 522 water supply project.

7.2.3 Flat Rock Service Area

The Flat Rock Service Area is currently provided with water supply through the Route 60 Chesterfield County water connection. Based on current maximum day water usage data, the Flat Rock water system has exceeded over 90% of the 572,000 gpd maximum day water allocation from Chesterfield County. With the current water usage patterns and projected demands, it is anticipated that the maximum day water demand will exceed the Chesterfield water allocation by approximately 2022. Since more than 70% of the water usage is due to flushing or unaccounted water, it is recommended that measures be undertaken by the County to reduce this. The actual year that additional water supply will be required will be dependent on how successfully the County can reduce unaccounted for water and optimize flushing.

It is recommended that the following steps be taken by the County to reduce water usage:

1. Water System Audit
   The purpose of this audit is to determine to sources of unaccounted for water in the distribution system.
2. Tank Mixing Evaluation
   It is anticipated that tank mixing is poor based on the inlet and outlet piping configuration of the existing elevated water tank. This should be verified and a mixer should be installed to ensure

complete mixing which will reduce water age within the tank; thereby, reducing flushing requirements.

3. Chloramine Booster Station Evaluation
   The construction of a chloramine booster station is anticipated, based on limited available information, to reduce flushing requirements because it would maintain disinfectant residual for a longer water age. Although the addition of a booster station would increase water system operational and maintenance requirements, it would be worthwhile if water supply could be conserved. It is recommended that a detailed study be conducted to evaluate the feasibility and benefits of a chloramine booster station.

It is not anticipated that Chesterfield County will increase the maximum day water allocation to Powhatan County through the Route 60 connection. As a result, the construction of the Route 522 water supply project will be required to serve the projected maximum day water demand.

7.3 Water Storage

Equalization storage is needed to meet daily peak demands and at a minimum should be equal to 20 percent of the maximum day demand over 24 hours. The increase in the storage requirement over time is a direct result of the increased equalization requirement due to the increase in system demand. Based on direction provided by the County, system storage required for fire flow is equal to 240,000 gallons, which is the volume of water needed for the County's design standard of a 2,000 gpm, 2-hour duration fire event in a non-residential area. The storage required through the end of the planning period is summarized in Table 7-3.

Table 7-3: Water Storage Requirements

	2015	2020	2025	2030	2035
Flat Rock Service Area Storage Required (gal)	348,580	352,075	413,551	468,851	568,520
Courthouse Service Area Storage Required (gal)	263,591	272,546	292,726	312,906	333,086
Route 711 Service Area Storage Required (gal)	N/A	255,750	297,330	354,660	411,990
Total Storage Required (gal)	**612,171**	**880,371**	**1,003,607**	**1,136,417**	**1,313,596**

7.3.1 Route 711 Service Area

The Route 711 Service Area has been projected by County staff to need water service by the year 2020. To meet the storage requirements through the end of the planning period, it is recommended that a 500,000 elevated storage tank be constructed near the intersection of Route 288 and Route 711.

7.3.2 Courthouse Service Area

In order to provide the Courthouse Service Area with fire protection, it is recommended that a new 500,000 gallon elevated water storage tank be constructed as part of the Route 522 Water Supply Project to provide the required storage through the end of the planning period. As discussed in the subsequent water distribution section, the construction of the new 500,000 gallon elevated tank along with a 12-inch and 16-inch loop through the Courthouse water system will allow this service area to be provided with fire protection. Also, with the Route 522 Water Supply Project, the Courthouse and Flat Rock water systems would be interconnected, which would allow the excess storage in the Courthouse system to be used for the Flat Rock system. The combined 1,000,000 gallons of storage would be sufficient for both systems through the end of the planning period.

7.3.3 Flat Rock Service Area

The Flat Rock Area is currently being served by the Flat Rock Tank, a 500,000 gallon elevated water storage tank located near the intersection of Jude's Ferry Road and Batterson Road. The existing water tank provides sufficient storage through the end of the planning period.

7.4 Water Distribution System

The improvements recommended for the water distribution system are generally required to address one or more of the following issues:

- Improvements needed to meet growing system demands in areas already served.
- Improvements desired to improve system reliability and/or service.
- Improvements needed to provide service to new areas or existing subdivisions within the Water Service Area(s).

As discussed in Chapter 6 of this report, a model of the County's water distribution system was used to evaluate system improvements required to address these three criteria. Extended Period Simulations (EPS) were performed using projected maximum day demands, and results of these EPS simulations identified storage deficiencies, low or high pressure areas, and low fire flow areas.

7.4.1 Route 711 Service Area

The Route 711 water system does not currently have existing water distribution system infrastructure. As part of a water supply project, the County will construct a transmission line, booster station (if necessary), and elevated water storage tank. It is assumed that any distribution system infrastructure would be paid for by developers.

7.4.2 Courthouse Service Area

Due to the presence of a significant amount of small diameter piping within the distribution system and limited system storage, the existing system does not supply the targeted fire flow of 2,000 gpm for a 2-hour duration for non-residential areas. This is of importance because the Courthouse Service Area includes commercial properties, several schools, and County administration buildings. Based on the limited available water supply and limited fire flow it is recommended that the County construct a 16-inch and 12-inch water main loop through the Courthouse Service Area to provide the service area with fire protection. The proposed water main loop along with the proposed 500,000 gallon elevated tank that would be included with the Route 522 Water Supply project would provide the service area with the flow and storage to serve the required 2-hour, 2,000 gpm fire event.

The Route 522 Water Supply Project to provide water service to the Courthouse Service Area will include a booster station located approximately at Route 522, south of the James River, and a 16-inch transmission main along Route 522 and Route 60. This transmission main would connect into the new 500,000 gallon elevated water tank and to the proposed 12-inch water main loop in the Courthouse Service Area.

7.4.3 Flat Rock Service Area

Based on water demand projections, the Flat Rock Service Area will require additional water supply between 2020 and 2025. This will necessitate an extension of the Route 522 Water Supply Project from the Courthouse Service Area to the Flat Rock Service Area. The extension will include a 16-inch transmission main along Route 60 with an inline booster station located approximately at the intersection of Route 60 and Branch Creek Drive. The booster station will transfer water from the proposed Courthouse Service Area 500,000 gallon elevated water tank and into the existing Flat Rock elevated tank.

No additional improvements will be necessary to the Flat Rock water distribution unless the County decides to serve any existing neighborhoods.

7.5 Water Improvement Program

A summary of the recommended water system improvements is provided on the following pages. For ease of discussion, water system improvements are broken out into a total of three small area plans. These small area plans are the Flat Rock Area, Courthouse Area, and the Route 711 Area and are shown in **Figure 1-1**. The Proposed Water Improvements **Figures 7-1 through 7-5** show these boundaries, along with water improvements by small area plan.

Descriptions of the proposed water system improvements, organized by small area plan, are provided on the following pages. The description lists the requirement for the improvement, the timing of the improvement, and a general description of the improvement. Additional details on costs associated with the water improvement program are provided in Chapter 9 of this Master Plan.

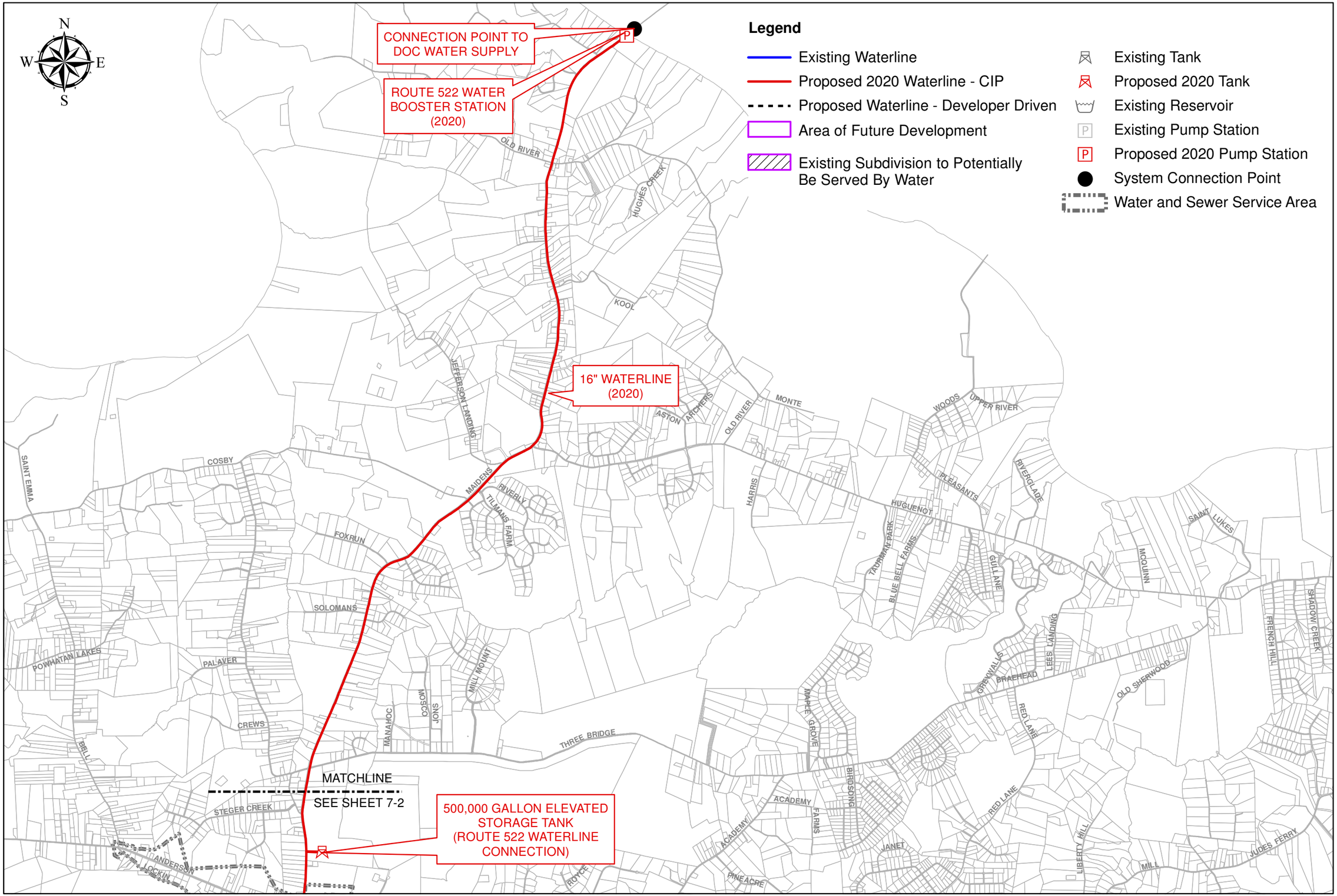

FIGURE NO. 7-1

TITLE WATER SYSTEM IMPROVEMENTS ROUTE 522 AREA

SCALE 1 inch = 4,000 feet

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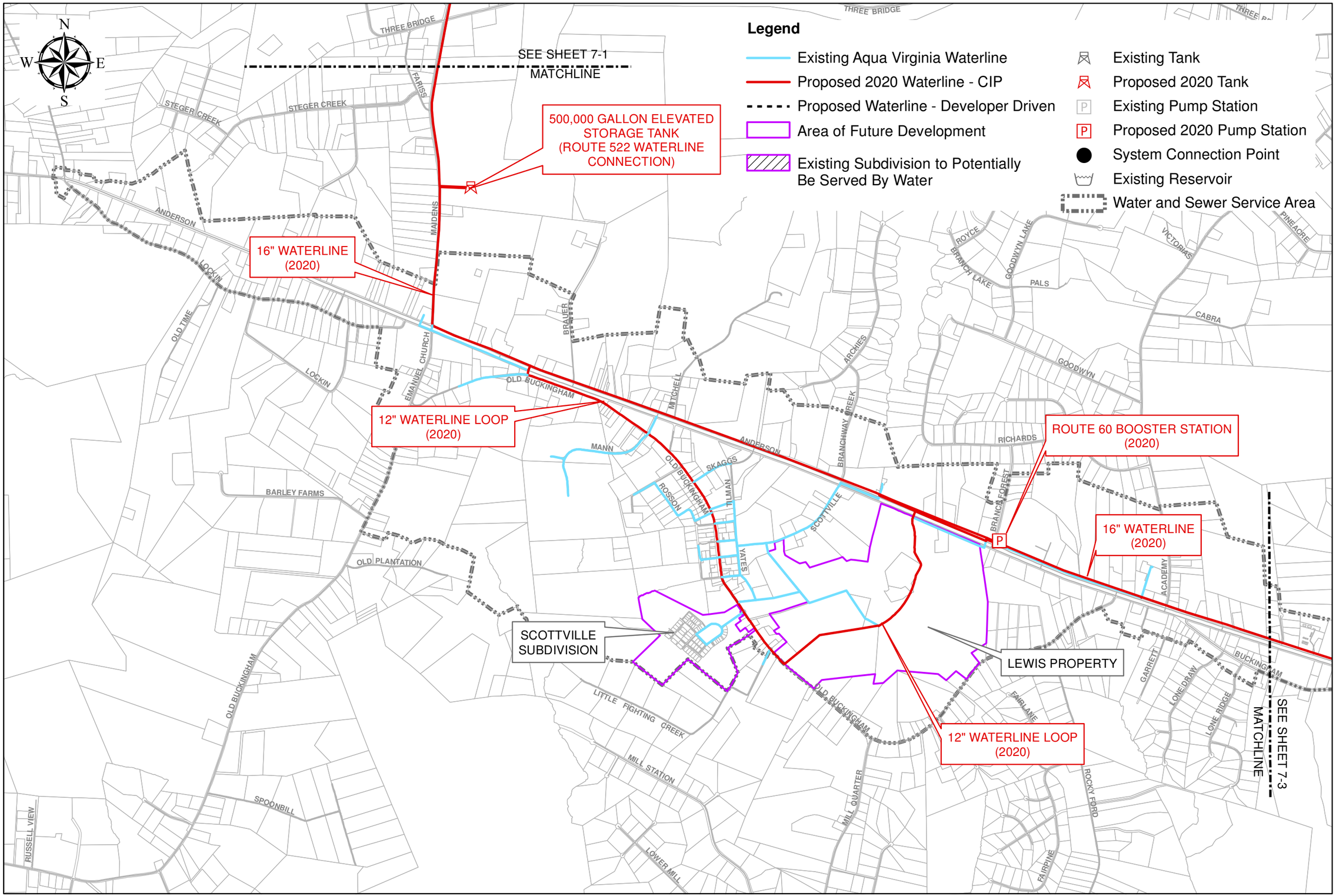

FIGURE NO. 7-2

TITLE WATER SYSTEM IMPROVEMENTS COURTHOUSE AREA

SCALE 1 inch = 2,000 feet

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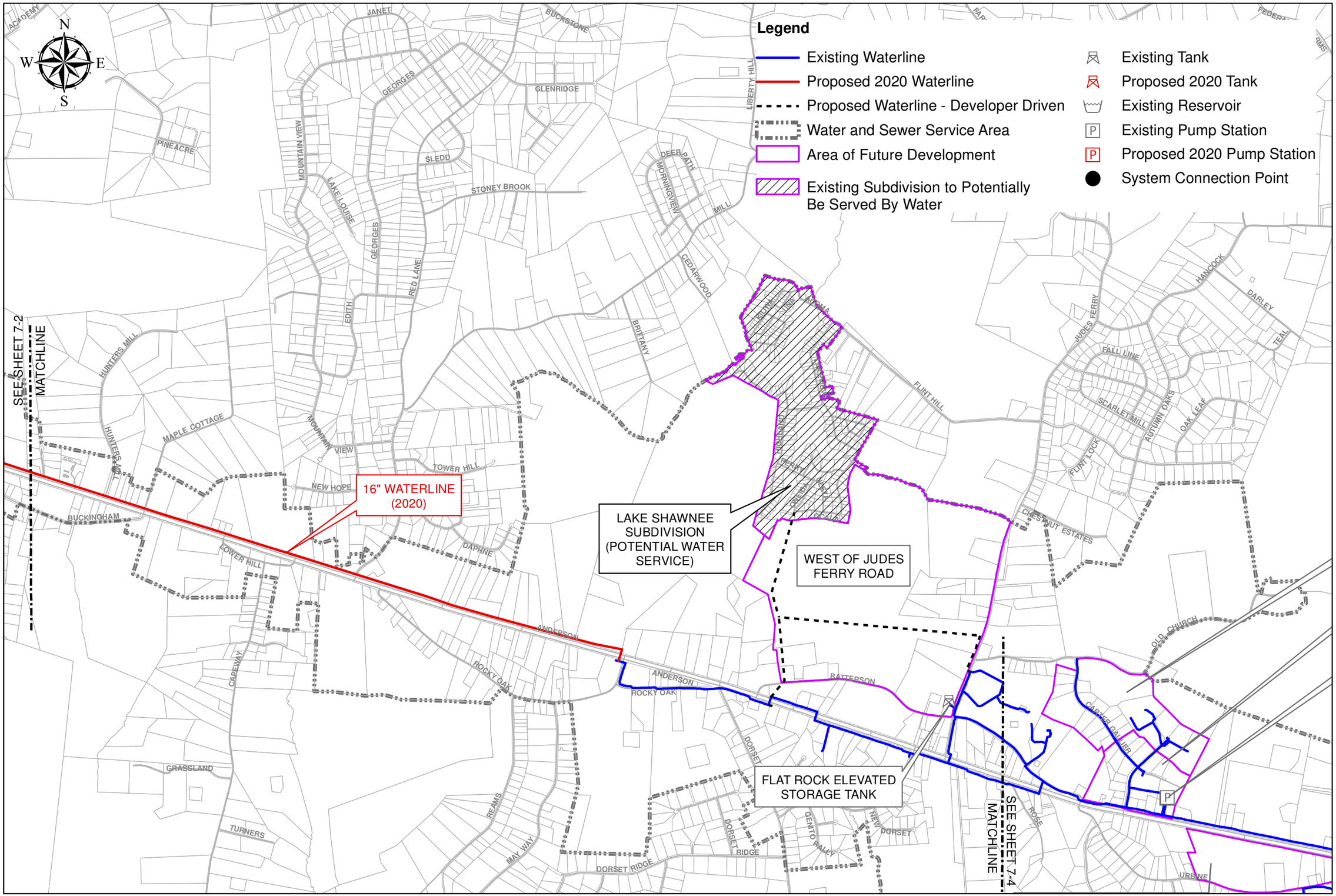

FIGURE NO. 7-3

TITLE WATER SYSTEM IMPROVEMENTS COURTHOUSE/ FLAT ROCK AREA

SCALE 1 inch = 2,000 feet

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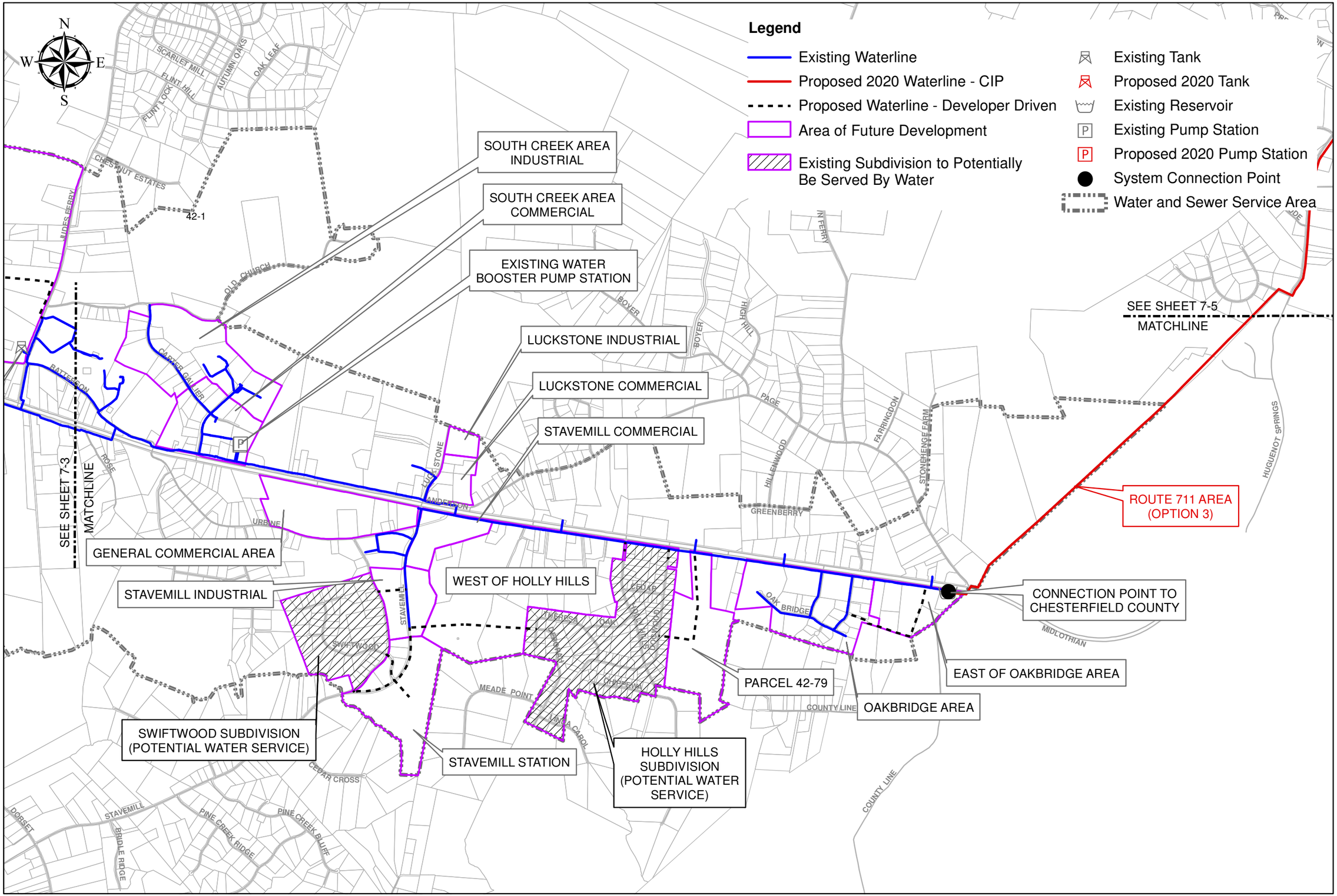

FIGURE NO. 7-4

TITLE WATER SYSTEM IMPROVEMENTS FLAT ROCK AREA

SCALE 1 inch = 2,000 feet

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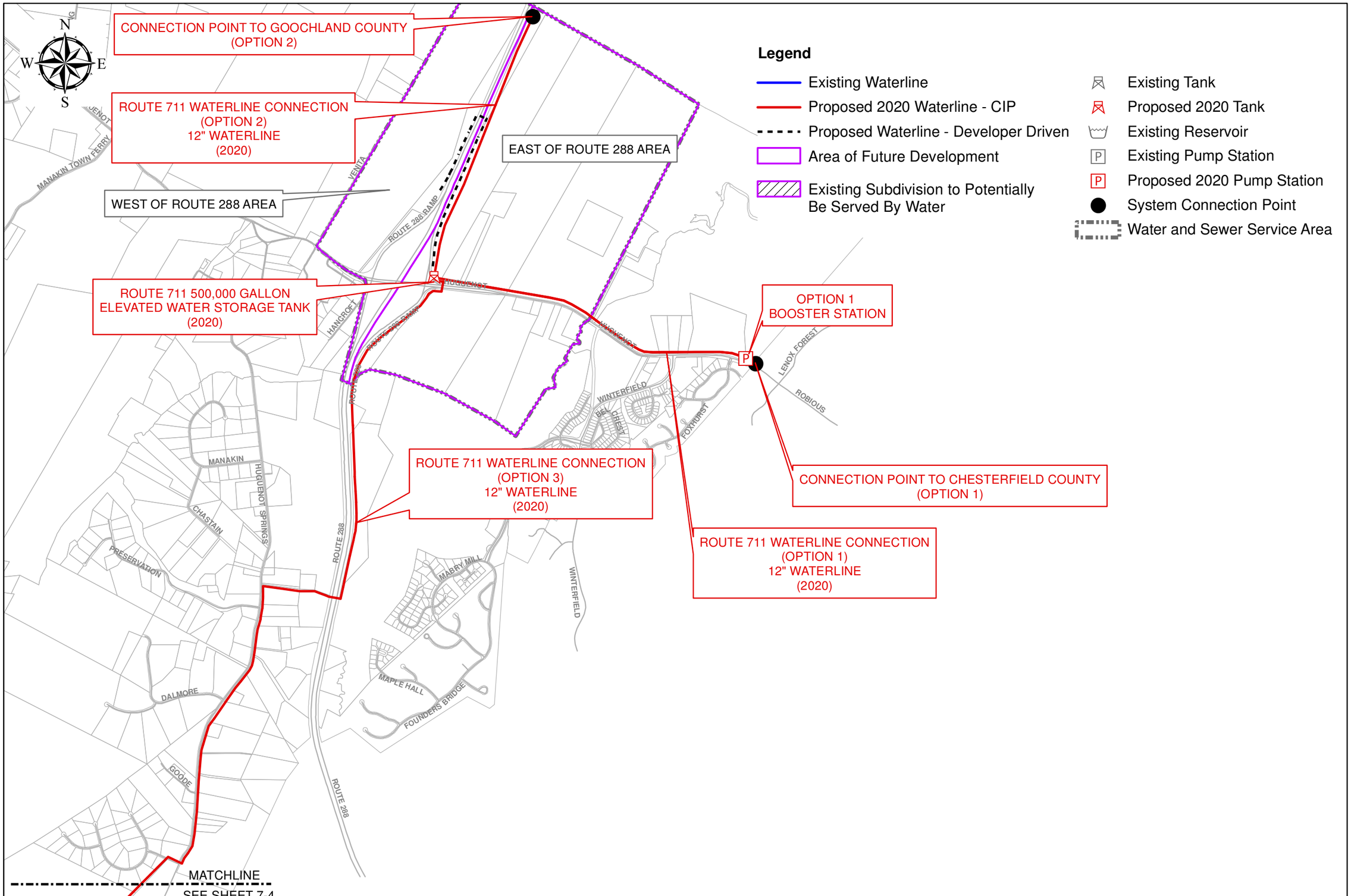

FIGURE NO. 7-5

TITLE WATER SYSTEM IMPROVEMENTS ROUTE 711 AREA

SCALE 1 inch = 2,000 feet

PROJECT WATER AND WASTEWATER MASTER PLAN POWHATAN, VIRGINIA

DATE OCT 2014

PROJ. NO. 50063290

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ROUTE 711 AREA
See Figure 7-5

Route 711 Water
500,000 gallon elevated water storage tank and 12-inch supply waterline:

- Option 1 – Connection to Chesterfield County along Route 711 to include a booster station
- Option 2 – Connection to Goochland County via a 12-inch water main directionally drilled under the James River (Approximately 10,000 LF)
- Option 3 – Connection to Route 60 waterline along eastern side of Powhatan County with 28,220 LF of 12" waterline

Project is planned for completion by 2020.

COURTHOUSE AREA
See Figure 7-1 and 7-2

Route 522 Water Supply Project to Courthouse Water System
Booster station near James River and Route 522, 59,000 LF of 16" waterline along Route 522 and Route 60, 500,000 gallon elevated water storage tank near Route 522 and Route 60, and approximately 14,800 LF of 12-inch waterline loop along Old Buckingham Road and through the Lewis Property.

Project is planned for completion between 2020 and 2025

FLAT ROCK AREA
See Figure 7-2, 7-3, and 7-4

Route 522 Water Supply Project from Courthouse Water System to Flat Rock Water System
Booster station and approximately 20,000 LF of 16-inch transmission main from the Courthouse Water System to connect into the Flat Rock water system.

Project is planned for completion between 2020 and 2025.

Chapter 8
Wastewater System Improvements

8.1 General

This chapter of the Master Plan presents an overview of system improvements that are proposed to provide wastewater service within the County's Water and Sewer Service Area through the Year 2035.

The Proposed Sewer Improvements map, included in **Appendix B** of this report, provides a graphical presentation of the recommended wastewater system improvements. Improvements shown on this plate are color coded by the year that the improvement is needed and that corresponds to the wastewater system cost estimates for cross-referencing.

In addition, there are some developer-driven improvements identified that are planned to be constructed and paid for by private development. Other currently unidentified developer-driven improvements may be necessary as development occurs through the planning period.

In general, the wastewater improvement program involves improvements to treatment capacity, pump stations and force mains, and gravity interceptor pipes. A brief overview of improvements is provided in the following subsections. More detailed descriptions of individual CIPs are provided at the end of this chapter.

8.2 Wastewater Treatment

There are three wastewater service areas within the County that will require wastewater treatment and disposal facilities. The Flat Rock and Courthouse Service Areas have existing wastewater treatment facilities while the Route 711 Service Area does not have any wastewater treatment facilities. Based on future demand projections, all three service areas will require an upgrade or addition of wastewater treatment facilities to provide treatment and disposal of wastewater through the end of the planning period in 2035.

8.2.1 Wastewater Treatment Evaluation

There are a few key issues that will need to be addressed to allow the County to expand their wastewater treatment facilities. The below sections discuss these issues in more detail.

8.2.1.1 Nutrient Removal

Powhatan County is in the Chesapeake Bay Watershed, therefore available nutrient load allocations are a limiting factor in the expansion of the existing wastewater treatment facilities to serve future demands. Current nutrient load allocations for the Powhatan County wastewater treatment facilities are based on certificate to construct (CTC) design flows that were approved by VDEQ before July 1, 2005. The nutri-

ent loads are then calculated based on the design flow and limits for phosphorus and nitrogen. If nitrogen and phosphorus limits were not included in the permits then DEQ assumes a nitrogen load allocation based on 18.7 mg/L Total Nitrogen concentration and a phosphorus allocation based on 2.5 mg/L Total Phosphorus concentration. Based on these assumptions, the WWTPs have the following nutrient load allocations:

Table 8-1: Available Nitrogen Allocations

Source	Allocation
Dutoy Creek WWTP[1] (lb/yr)	10,661
Fighting Creek WWTP[2] (lb/yr)	5,696
Total (lb/yr)	**16,357**

1. Calculated based on a 0.25 MGD CTO design flow and a total nitrogen limit of 14.0 mg/L.
2. Calculated based on a 0.10 MGD CTO design flow and a total nitrogen limit of 18.7 mg/L.

Table 8-2: Available Phosphorus Allocations

Source	Allocation
Dutoy Creek WWTP[1] (lb/yr)	1,904
Fighting Creek WWTP[2] (lb/yr)	761
Total (lb/yr)	**2,665**

1. Calculated based on a 0.25 MGD CTO design flow and a total phosphorus limit of 2.5 mg/L.
2. Calculated based on a 0.10 MGD CTO design flow and a total phosphorus limit of 2.5 mg/L.

As the wastewater treatment facilities require expansion to accommodate increasing wastewater flows, they will also require nutrient removal upgrades to not exceed the designated nitrogen and phosphorus allocations. If Limit of Technology (LOT) nutrient removal facilities were installed at the wastewater treatment plants, the existing facilities could be expanded up to a combined design flow rate of 1.79 MGD without requiring additional nutrient offsets.

Although reuse is not needed at this time to obtain additional nutrient offsets for plant expansion over the planning period, it is recommended that the County actively look for reuse opportunities with new development. This will help build up additional nutrient capacity and would reduce the potable water supply requirements.

8.2.1.2 Outfall Locations

An additional challenge for wastewater treatment facility expansion are the more stringent heavy metals limits that are in effect due to the existing outfalls' locations in low-flow receiving streams. The heavy metals limits were initially difficult to meet; however, after some modifications were made at the plants and a major source of zinc in the wastewater collection system was identified and eliminated, these limits

have been consistently achieved. Based on input from the Virginia Department of Environmental Quality (VDEQ), minimal change in permit limits (other than what is required to meet the nutrient load allocations) are expected at the current outfall locations.

For the Dutoy Creek WWTP, the effluent limits are toxicity-based limits and are expected to minimally change. Additionally, it is not anticipated that limits for CBOD, TKN, or DO will change. Similarly, for the Fighting Creek WWTP, due to the fact that there is no flow in the receiving stream, effluent limits would be applied at the end-of-pipe; therefore, toxicity-based limits would be unchanged regardless of flow. VDEQ anticipates that the CBOD, TKN, and DO limits would also remain the same.

It should be noted that the anticipated future effluent limits are estimates and VDEQ does not guarantee them. However, based on the information available, it is assumed that the existing outfall locations will continue to be used for future WWTP upgrades through end of the planning period in 2035.

8.2.2 Existing Wastewater Treatment Facility Improvements

The existing wastewater treatment plants have adequate capacity to treat the existing wastewater flow rates. Existing facility improvements are based on deficiencies of the existing facilities and not based on increasing treatment capacity.

8.2.2.1 **Fighting Creek WWTP**

The following improvements were identified for the Fighting Creek WWTP:

1. *Inadequate Influent Pump Station Capacity During I/I events and digester decant.*
   Based on information provided by the County, the existing headworks backs up significantly during I/I events and every time the digester is decanted due to undersized influent pumps. This will require the replacement of the existing pumps with larger capacity pumps with associated electrical and controls upgrades.

2. *Headworks Issues: Influent Grinder/Bypass Screen and Influent Static Screen*
   The influent grinder channel is in a deep channel upstream of the influent pump station and is difficult to access which presents maintenance and confined space entry issues. Additionally, the existing static screen at the equalization basin is ineffective and freezes during the winter. If the Fighting Creek WWTP is maintained in service, it is recommended that a new headworks with a self cleaning screen and grit collector be constructed upstream of the equalization basin.

   If the Fighting Creek WWTP is not maintained in service, it is recommended that screening be added in front of the influent pump station. This will allow the screening to still be used if the influent pump station is converted to pump to the Dutoy Creek WWTP sewer collection system.

3. *Permanent Chemical Feed and Storage Building*
   The existing chemical feed and storage building consists of a temporary structure that should be replaced with a permanent chemical feed and storage facility when the plant is expanded. This would generally consist of a precast building to house the chemical feed pumps and containment areas to house bulk chemical storage tanks.

8.2.2.2 Dutoy Creek WWTP

The following improvements were identified for the Dutoy Creek WWTP:

1. *Improved Lime Storage and Feed System*
   The existing lime feed and storage system requires manual mixing and dilution of the lime slurry. A 50 lb bag feeder is recommended to reduce operator requirements. This could be installed in the existing chemical feed building.

2. *UV Module Lifting Device*
   A manual davit crane should be installed adjacent to the existing UV system to allow for easier removal of the UV modules.

3. *New Sludge Dewatering Facility*
   Currently the County contracts the removal and land application of the existing liquid sludge from the digester tanks. A new sludge dewatering facility would include sludge feed pumps, sludge dewatering equipment with ancillary equipment such as a polymer blending and feed system, and an auger to convey dewatered sludge cake to a covered dumpster pad. The dewatering equipment would be located within a building located at the WWTP site.

   An interim option to allow both the Dutoy Creek and Fighting Creek WWTPs to dewater sludge would be for the County to purchase a trailer mounted belt press. This could put off the need to construct a dewatering building until the next required plant expansion for the Dutoy Creek WWTP.

4. *Reduce Generator Noise*
   The existing generator is located adjacent to the administration/laboratory building and produces excessive noise when it is operated. During the next plant expansion, it is recommended that the generator be relocated and/or a sound attenuating wall be built around to reduce noise.

8.2.3 Wastewater Treatment Facility Expansion

Based on projected sewer flow rates, both the Dutoy Creek and Fighting Creek WWTPs will require expansions over the planning period. In addition, the Route 711 Service Area will require a new wastewater disposal system.

8.2.3.1 Route 711 Service Area

The construction of a new wastewater treatment plant for the Route 711 Service Area is not ideal as this would add a third small plant that the County would have to operate and maintain. Based on this, the option of a new wastewater treatment plant to serve this area was not considered further. Three (3) options including the transfer of the wastewater flows generated in the Route 711 Service Area to another wastewater system were evaluated for Route 711 Service Area wastewater disposal. Budgetary cost estimates were included in this section to assist in the evaluation of each option.

1. *Pump Station and Force Main to Chesterfield County*
   This option would include the construction of a new central pump station within the Route 711 Service Area and a 12-inch force main routed to the existing gravity sewer along Route 711 at the Chesterfield County line. An agreement would have to be signed with Chesterfield County to accept the wastewater flows. The budgetary level cost estimate for this option is $2,530,000.

2. *Pump Station and Force Main to Goochland County*
   This option would include the construction of a new central pump station within the Route 711 Service Area and a 12-inch force main constructed under the James River via a directional drill and routed along Route 288 to a Goochland County gravity interceptor located north of Patterson Road. An agreement would have to be signed with Goochland County to accept the wastewater flows. The budgetary level cost estimate for this option is $4,590,000.

3. *Pump Station and Force Main to Dutoy Creek WWTP Collection System*
   This option would require that a pump station and a 12-inch force main be constructed to transfer wastewater flows south to the existing Flat Rock wastewater collection system. The force main length for this option would be significantly longer than Options 1 and 2. The budgetary level cost estimate for this option is $7,010,000.

If an agreement with Chesterfield County can be successfully negotiated, the Chesterfield Connection option is recommended since it would result in the significantly lowest capital cost. However, since Chesterfield County has indicated that they do not have the capacity to accept wastewater flows from Powhatan County at Route 711, the Goochland County connection is recommended because it would provide for a lower capital cost than the Dutoy Creek WWTP connection and would not require additional treatment plant capacity.

Refer to **Figure 8-4** for an exhibit showing the three wastewater service options for the Route 711 Service Area.

8.2.3.2 Courthouse Service Area

In order to serve the Courthouse Service Area through the end of the planning period in 2035, the Fighting Creek WWTP will require an expansion from 0.1 MGD to 0.3 MGD. Additionally, improvements to address existing deficiencies and achieve nutrient removal will be required to ensure that the plant is able to provide the required level of treatment. Two upgrade options were considered for the Fighting Creek WWTP. Budgetary cost estimates were included in this section to assist in the evaluation of each option.

1. *Expand and Upgrade for Nutrient Removal*

   The Fighting Creek WWTP expansion would occur in two phases: 0.2 MGD and 0.3 MGD. The 0.2 MGD expansion would generally require the following improvements:

   a. Influent Pump Station Upgrade
   b. New Screen and Grit Removal System
   c. New Sequencing Batch Reactor Tank
   d. Expanded Post Equalization Basin
   e. New Filters
   f. UV Disinfection System Expansion
   g. New Chemical Feed Systems

   The budgetary cost estimate for the 0.2 MGD expansion is $3,800,000.

   The 0.3 MGD expansion would generally require the following improvements:

   a. Influent Pump Station Upgrade
   b. New Sequencing Batch Reactor Tank
   c. Filter Upgrade
   d. UV Disinfection System Expansion
   e. New Aerobic Digester Tank

   The budgetary cost estimate for the 0.3 MGD expansion is $2,900,000.

   The total budget cost estimate to expanding the Fighting Creek WWTP to 0.3 MGD is $6,700,000.

2. *Take WWTP offline and Divert Flow to Dutoy Creek WWTP*

   This option would consist of taking the Fighting Creek WWTP offline and modifying the influent pump station to pump the Courthouse Service Area wastewater flows to the Flat Rock Service Area gravity sewer system to be treated by the Dutoy Creek WWTP. The modified pump station

would pump through a new 10-inch force main that would be routed north to Route 60, then east along Route 60 to the existing Flat Rock gravity sewer system.

The budgetary cost estimate for the upgraded plant pump station and force main is $5,670,000.

Based on a comparison of options, it is recommended that the Fighting Creek WWTP be taken offline and the wastewater flows from the Courthouse Service Area be re-routed to the Flat Rock Service Area. This provides significant benefit to the County as it allows the consolidation of the two County WWTPs which will reduce operations and maintenance costs. Additionally, the cost of upgrading one WWTP (Dutoy Creek WWTP) to serve both systems will be more economical.

8.2.3.3 Flat Rock Service Area

The Dutoy Creek WWTP will be expanded to serve both the Courthouse and Flat Rock Service Areas. Nutrient Loads from both the Fighting Creek and Dutoy Creek WWTPs will be aggregated to allow the use of the nutrient load allocations from Fighting Creek WWTP for the expansion of the Dutoy Creek WWTP.

Table 8-3: Dutoy Creek WWTP Expansion Timeframes

Year	**2015**	**2020**	**2025**	**2030**	**2035**
Projected Average Daily Flow Rate (GPD)[1]	66,129	100,694	262,488	444,169	777,190
Design Flow (GPD)	250,000	250,000	500,000	750,000	1,000,000

1. Combined wastewater flow rates from the Courthouse and Flat Rock Service Areas.

Table 8-4: Dutoy Creek WWTP Expansion Summary

Flow Tier	500,000 GPD	750,000 GPD	1,000,000 GPD
Upgrade Year	2025	2030	2035
General Summary of Required Upgrades	• Upgrade Influent Pump Station • Add SBR Tank • Add Post EQ Tank • Add Filter Basin • Add UV Bank • Add Alum and Caustic Feed • Add Digester Tank • Add Dewatering Building	• Upgrade Influent PS • Add SBR Tank • Add Filter Disks • Add UV Bank	• Upgrade Influent PS • Add SBR Tank • Add Filter Disks • Add UV Bank • Add Carbon Source Feed

8.3 Wastewater Collection and Conveyance

A summary of the wastewater collection system improvements is provided in a similar format to the water system improvements discussed in Chapter 7. For ease of discussion, wastewater system improvements are broken out into the same three smaller area plans that are used in the water system improvement program. These three small area plans are the Flat Rock Area, Courthouse Area, and Route 711 Area. The small area plan boundaries are shown on **Figure 1-1**. The Proposed Sewer Improvements map included in **Figures 8-1 through 8-4** also show these boundaries, along with wastewater improvements by small area plan.

8.3.1 Route 711 Service Area

The Route 711 water system does not currently have existing wastewater collection system infrastructure. As part of a wastewater disposal project, the County will construct a pump station and force main to pump the wastewater flows to another system for treatment that are generated within the proposed service area. It is assumed that any additional wastewater collection and conveyance infrastructure would be paid for by developers.

8.3.2 Courthouse Service Area

Based on an analysis of the existing wastewater collection system, the existing system has capacity for projected sewer flowrates through the end of the planning period in 2035. Based on recommendations contained in the wastewater treatment section, the Fighting Creek WWTP will be converted into a pump station and a force main will be routed to the Flat Rock wastewater collection system.

8.3.3 Flat Rock Service Area

Based on sewer flow projections and analysis of the existing system, the existing wastewater collection infrastructure will have adequate capacity to serve the Flat Rock Service Area with the exception of the main gravity sewer interceptor to the Dutoy Creek WWTP. It is anticipated that this interceptor will have to be upsized to 20-inch diameter piping by 2035.

New wastewater collection system infrastructure will be required to provide sewer service to County identified existing neighborhoods that have aging infrastructure. The neighborhoods that were included within the planning period to be provided with sewer service were the Holly Hills Subdivision, Swiftwood Subdivision, and the Lake Shawnee Subdivision.

In addition to improvements to provide additional sewer capacity, according to the County staff the two existing pump stations within the Flat Rock wastewater collection system have had issues with ragging and debris building up in the wetwells. Screening for each pump station is proposed to eliminate this issue.

Descriptions of the proposed wastewater system improvements, organized by small area plan, are provided on the following pages. The description lists the requirement for the improvement, the timing of the improvement, and a general description of the improvement. Additional details on costs associated with the wastewater improvement program are provided in Chapter 9 of this Master Plan.

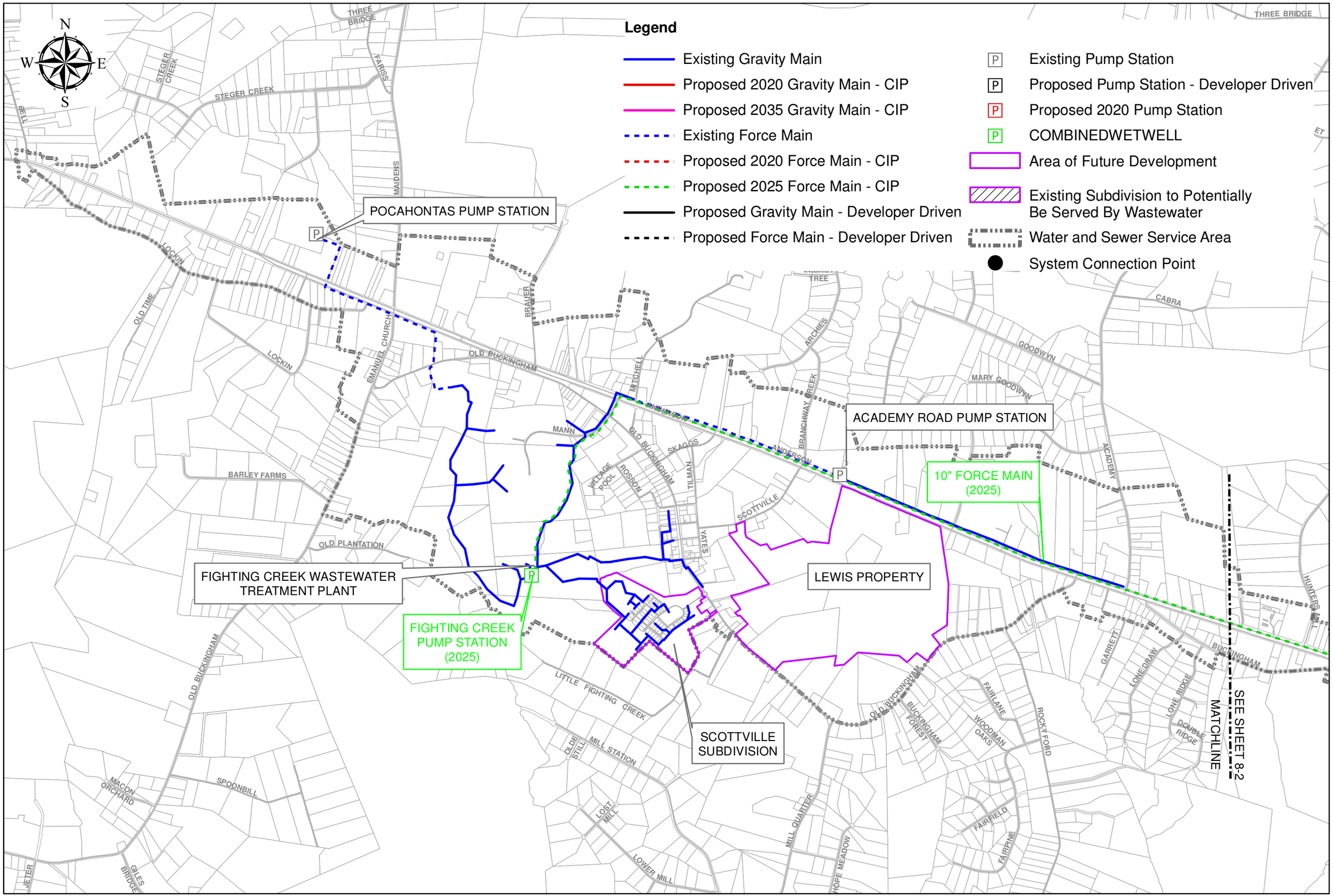

FIGURE NO. 8-1

TITLE WASTEWATER SYSTEM IMPROVEMENTS COURTHOUSE AREA

SCALE 1 inch = 2,000 feet

PROJECT WATER AND WASTEWATER MASTER PLAN POWHATAN, VIRGINIA

DATE OCT 2014

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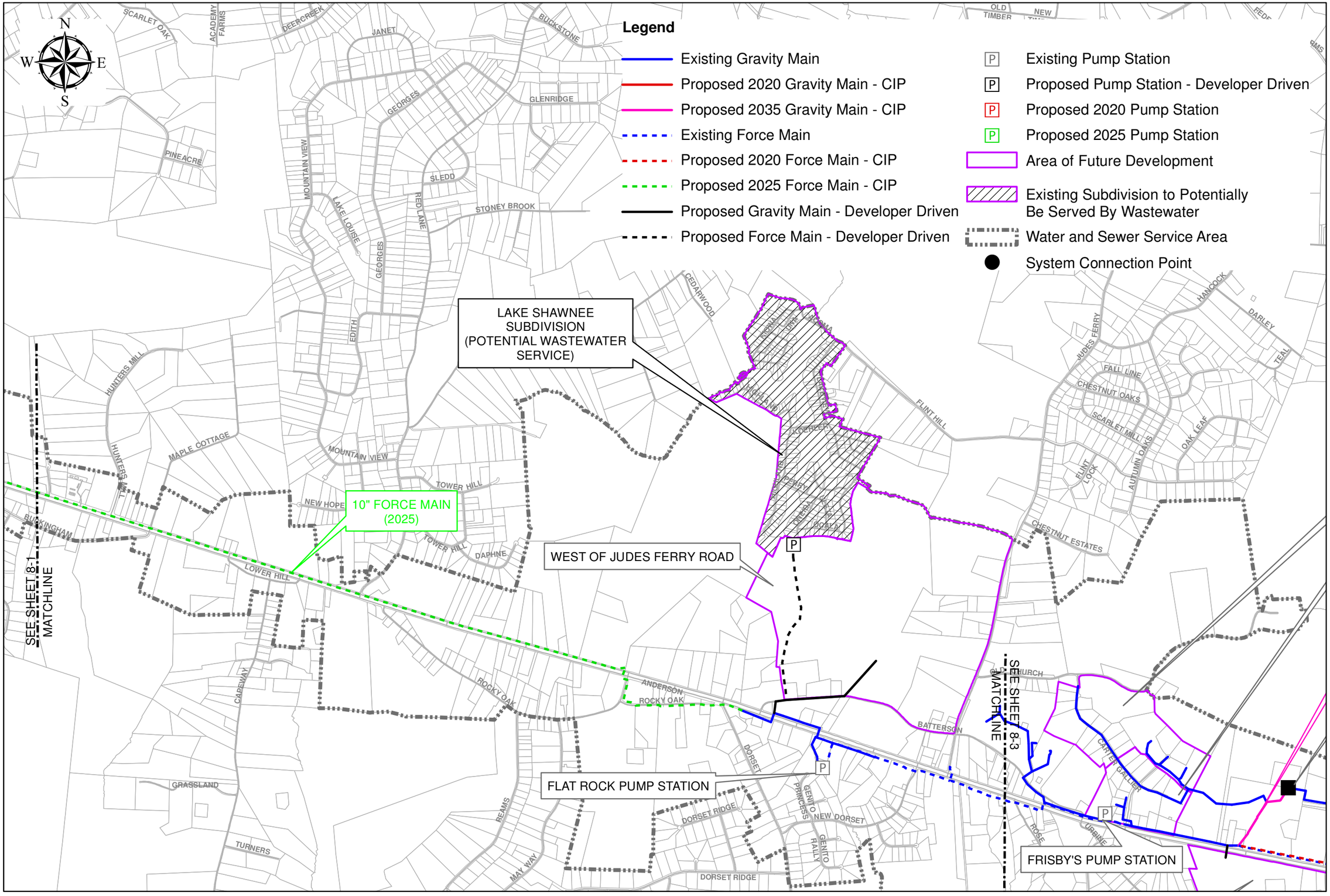

FIGURE NO. 8-2

TITLE WASTEWATER SYSTEM IMPROVEMENTS COURTHOUSE/ FLAT ROCK CONNECTION

SCALE 1 inch = 2,000 feet

PROJECT WATER AND WASTEWATER MASTER PLAN POWHATAN, VIRGINIA

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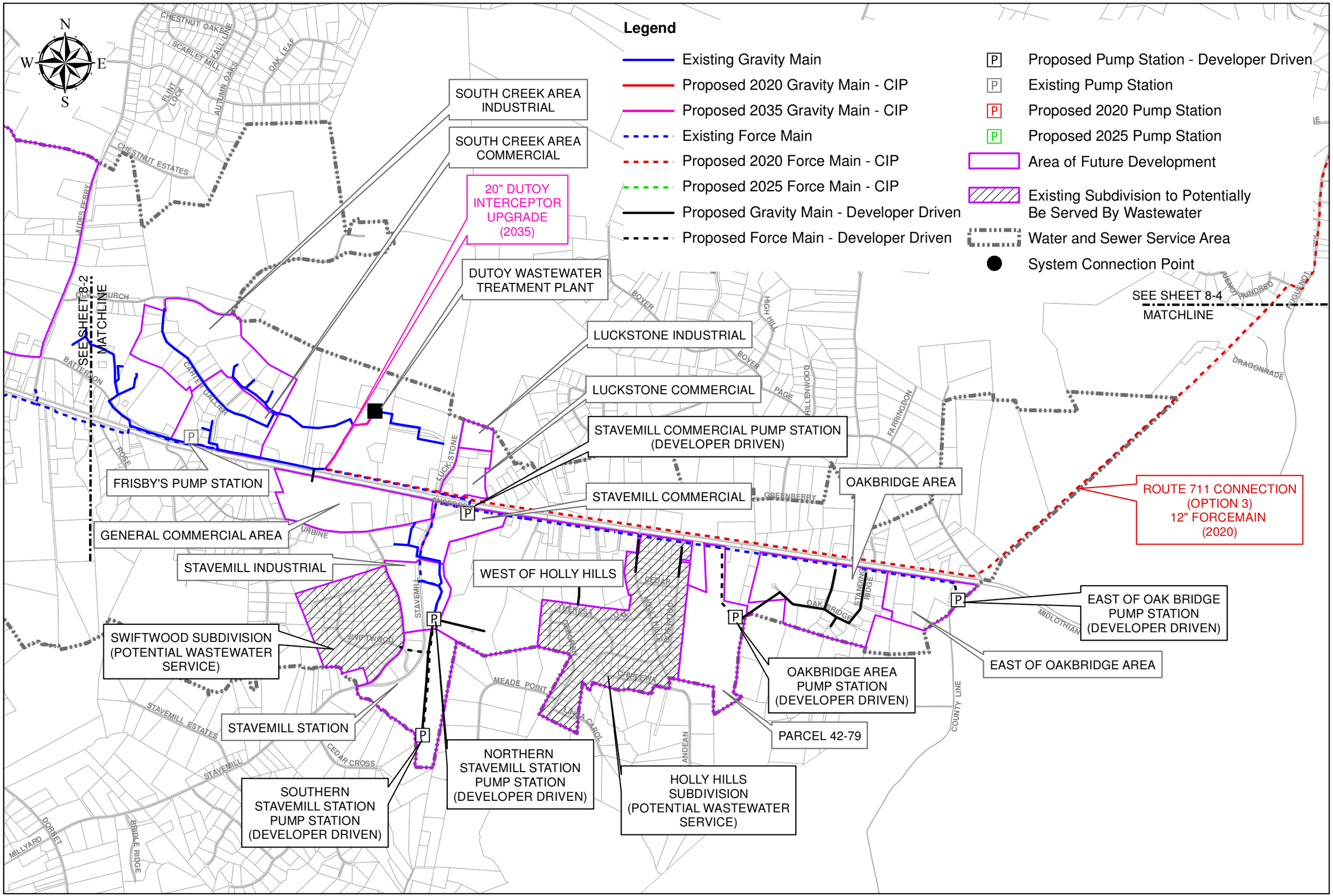

FIGURE NO. 8-3

TITLE WASTEWATER SYSTEM IMPROVEMENTS FLAT ROCK AREA

SCALE 1 inch = 2,000 feet

PROJECT WATER AND WASTEWATER MASTER PLAN POWHATAN, VIRGINIA

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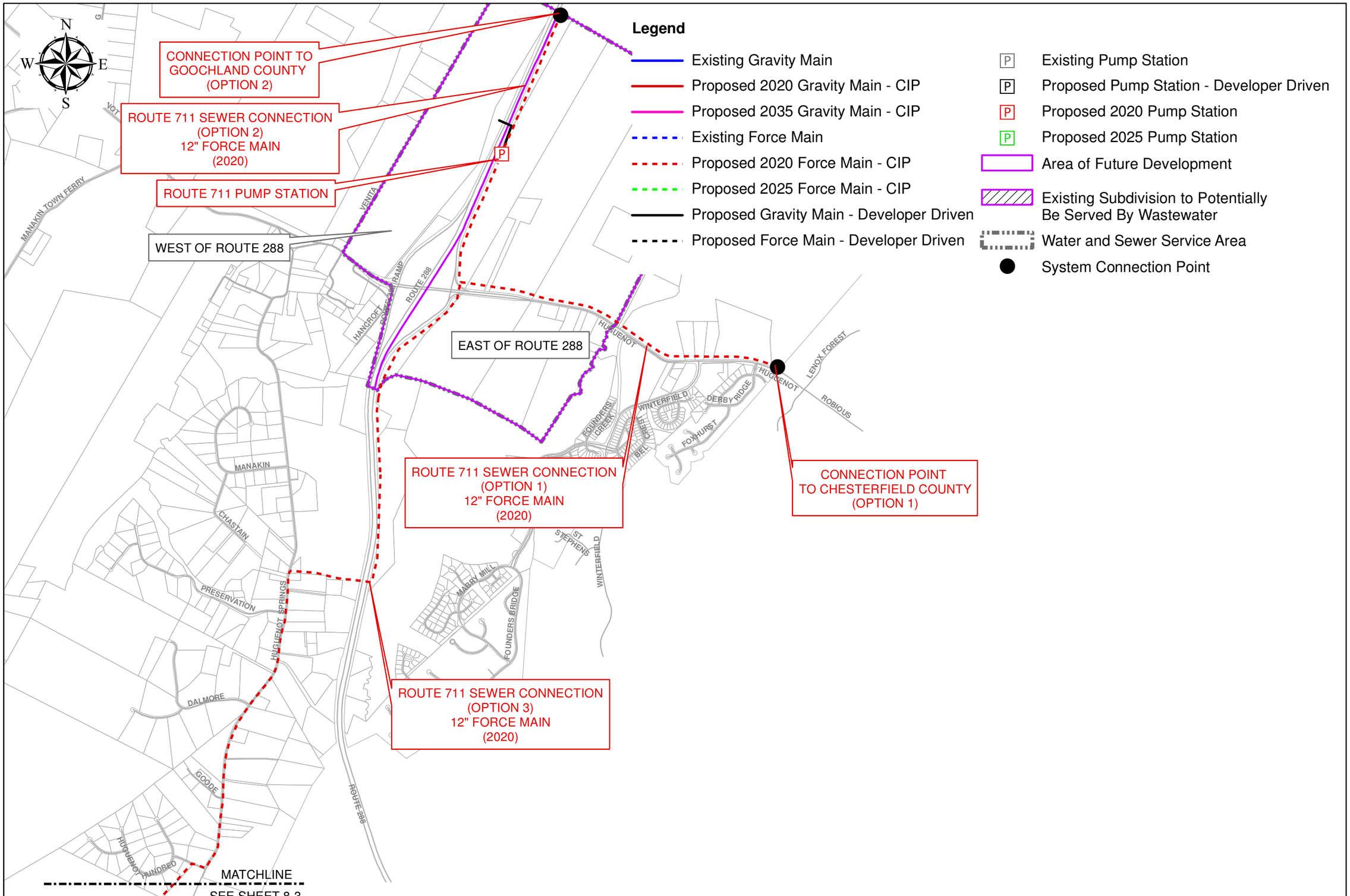

FIGURE NO. 8-4

TITLE WASTEWATER SYSTEM IMPROVEMENTS ROUTE 711 AREA

SCALE 1 inch = 2,000 feet

PROJECT WATER AND WASTEWATER MASTER PLAN POWHATAN, VIRGINIA

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ROUTE 711 AREA
See Figure 8-4

Route 711 Wastewater Disposal Facility

Pump station and force main:

- Option 1 – Connection to Chesterfield County along Route 711 with approximately 7,500 LF of 12" force main
- Option 2 – Connection to Goochland County via a 12-inch force main directionally drilled under the James River (Approximately 16,000 LF)
- Option 3 – Connection to Route 60 force main along eastern side of Powhatan County with approximately 44,000 LF of 12" force main

Project is planned for completion by 2020.

COURTHOUSE AREA
See Figure 8-1

Fighting Creek WWTP Improvements

The following improvements to the Fighting Creek WWTP were identified:

1. *Pump Upgrades:* This would consist of replacing the existing pumps with higher capacity pumps with associated electrical and controls upgrades.
2. *Headworks Issues:* This would consist of the construction of a new headworks structure upstream of the influent pump station with a self cleaning screen.
3. *Permanent Chemical Feed and Storage Building:* This would consist of a new precast concrete or CMU building to house the existing chemical feed systems. It would also include containment areas of bulk chemical storage.

Based on the assumption that the Fighting Creek WWTP will be taken offline, it is recommended that only the pump upgrades and influent screening be completed prior to 2025. The new pumps should be selected so that they can be reused for the future Fighting Creek Pump Station.

Project is planned for completion by 2015.

Connection of Fighting Creek and Dutoy Creek Wastewater Treatment Plants

Abandon the existing Fighting Creek WWTP and upgrade the influent pump station to pump wastewater flows from the Courthouse Service Area through approximately 36,200 LF of 10" force main along Route 60.

Project is planned for completion by 2025.

FLAT ROCK AREA
See Figure 8-2 and 8-3

Dutoy Creek WWTP Improvements
The following improvements to the Dutoy Creek WWTP were identified:

1. *Improved Lime Storage and Feed System:* This would include a 50 lb bag feeder installed in the existing chemical storage building.
2. *UV Module Lifting Device:* This would include the installation of a manual davit crane adjacent to the UV system.
3. *New Sludge Dewatering Facility:* This would include the construction of a new sludge dewatering building to include sludge feed pumps, sludge dewatering equipment with ancillary equipment such as a polymer blending and feed system, and an auger to convey dewatered sludge cake to a new covered dumpster pad. A portable belt press would be used by both the Dutoy Creek WWTP and Fighting Creek until the permanent dewatering building is constructed with the next expansion in 2025.

The improved Lime Storage and Feed System and UV Module Lifting Device are planned for completion by 2015.

The purchase of a portable trailer mounted belt press is planned for by 2015.

The New Sludge Dewatering Facility is planned for completion by 2025 with the Dutoy Creek WWTP expansion project.

Dutoy Creek WWTP Expansions
Multiple expansion of the Dutoy Creek WWTP to upgrade for enhanced nutrient removal and expand capacity to 0.5 MGD, 0.75 MGD, and 1.0 MGD.

Projects are planned for completion by 2025, 2030, and 2035.

Interceptor Upgrade Upstream of Dutoy Wastewater Treatment Plant
Upsize 1,808 LF of 12” and 16” existing pipe to 20” diameter pipe due to future capacity issues.

Project is planned for completion by 2035.

Chapter 9
Implementation

The implementation plan outlined in this Chapter of the Master Plan establishes the steps associated with the design and construction of water and wastewater improvements that are projected during the planning period. Timing of the proposed projects will depend on the actual rate of development.

The major capital improvement projects that will be required to sustain growth in the existing water and sewer service areas are the Route 522 Water Supply Project and WWTP upgrades. Based on current water usage and growth projections, the Route 522 Water Supply Project will have to be constructed within 5 to 7 years. It will be critical that Powhatan County determine the source of unaccounted for water and minimize non-revenue water usage because this will extend the capacity of the existing water supply. If the current water usage trend continues, it is anticipated that planning for the Route 522 Water Supply Project will have to be started in approximately 2017.

Based on current wastewater flows within the existing sewer service area, major plant expansions and modifications will be required by 2025 with planning, permitting, and engineering starting by 2020. In the meantime, it is recommended that minor improvements should be constructed at both WWTPs to optimize operations such as chemical feed improvements and the procurement of a portable belt press. Recommended improvements at the Fighting Creek WWTP, which is recommended to be taken offline in 2025, should be focused on the influent pump station because this will be able to be reused for the 2025 upgrade.

The water supply and wastewater disposal source for the Route 711 service area will have to be finalized in order for development to occur within this service area. Due to the fact that Chesterfield County has indicated that they do not have available water and sewer capacity at Route 711, it is recommended that Powhatan County begin discussions with Goochland County for water and sewer service. The planning for this should be started immediately based on Powhatan County's desire to provide water and sewer service to the Route 711 Service Area by 2020.

Table 9-1 outlines the projected water and wastewater system improvements, summarizing the following information:

- Name of system improvement.
- Budgetary cost estimate in 2014 dollars.
- Year by which project needs to be completed by to serve increased demand within the system. This means that the planning, permitting, engineering, and construction must be started at least 3 to 5 years ahead of the time of completion (actual timeframe dependant on project complexity)

Table 9-2 summarizes the projected water and wastewater system improvements by service area.

Table 9-1
Water and Wastewater Improvement Costs by Service Area

	Fiscal Year				
	2015[1]	**2020**	**2025**	**2030**	**2035**
Water Improvements					
Courthouse Area					
Route 522 Water Supply Project to Courthouse		$ 17,580,000			
Courthouse Area Subtotal	***$ -***	***$ 17,580,000***	***$ -***	***$ -***	***$ -***
Flat Rock Area					
Chloramine Booster Station		$ 250,000			
Flat Rock Elevated Tank Mixing System	$ 80,000				
Route 522 Water Supply Project Extension to Flat Rock		$ 5,580,000			
Flat Rock Area Subtotal	***$ 80,000***	***$ 5,830,000***	***$ -***	***$ -***	***$ -***
Route 711 Area					
Option 1 - Connect to Chesterfield County via Route 711		$ 5,400,000			
Option 2 - Connect to Goochland County		$ 5,620,000		$ 500,000	
Option 3 - Connect to Route 60		$ 7,450,000			
Route 711 Subtotal[2]	***$ -***	***$ 5,620,000***	***$ -***	***$ 500,000***	***$ -***
Water Improvements Subtotal	**$ 80,000**	**$ 29,030,000**	**$ -**	**$ 500,000**	**$ -**
Wastewater Improvements					
Courthouse Area					
Fighting Creek WWTP Influent Pump Station Upgrade incl. Screening	$ 730,000				
Fighting Creek WWTP Pump Station and Force Main			$ 5,670,000		
Courthouse Area Subtotal	***$ 730,000***	***$ -***	***$ 5,670,000***	***$ -***	***$ -***
Flat Rock Area					
Portable Belt Press	$ 175,000				
Dutoy Creek WWTP Improvements (Lime Feeder & Davit Crane)	$ 220,000				
Dutoy Creek WWTP 0.50 MGD Expansion (Including Dewatering Bldg)			$ 6,680,000		
Dutoy Creek WWTP 0.75 MGD Expansion				$ 2,700,000	
Dutoy Creek WWTP 1.0 MGD Expansion					$ 2,840,000
Dutoy Interceptor Upgrade					$ 510,000
Flat Rock Area Subtotal	***$ 395,000***	***$ -***	***$ 6,680,000***	***$ 2,700,000***	***$ 3,350,000***
Route 711 Area					
Option 1 - Connect to Chesterfield County via Route 711		$ 2,530,000			
Option 2 - Connect to Goochland County		$ 4,590,000			
Option 3 - Connect to Route 60		$ 7,010,000			
Route 711 Area Subtotal[2]	***$ -***	***$ 4,590,000***	***$ -***	***$ -***	***$ -***
Wastewater Improvements Total	**$ 1,125,000**	**$ 4,590,000**	**$ 12,350,000**	**$ 2,700,000**	**$ 3,350,000**
Grand Total	**$ 1,205,000**	**$ 33,620,000**	**$ 12,350,000**	**$ 3,200,000**	**$ 3,350,000**

1. 2015 Fiscal Year projects indicate existing system improvements to be implemented within the next 3 years. The remaining timesteps assume that the projects will be completed by the indicated year.
2. For planning purposes, it was asssumed that Option No. 2 would be constructed to provide water and wastewater service to the Route 711.
3. Budgetary cost estimates for water supply or wastewater disposal connections do not include potential connections fees.

The above listed capital improvement projects are based upon the population projections contained in the Water and Wastewater Master Plan

Table 9-2: Summary of Water and Wastewater Improvement Costs by Service Area

Service Area	2015	2020	2025	2030	2035
Route 60 Service Area (Includes Flat Rock and Courthouse Service Areas)	$1,205,000	$23,410,000	$12,540,000	$2,700,000	$3,350,000
Route 711 Service Area	-	$10,210,000	-	$500,000	-
Total	**$1,205,000**	**$33,620,000**	**$12,540,000**	**$3,200,000**	**$3,350,000**

The above listed capital improvement projects are based upon the population projections contained in the Water and Wastewater Master Plan

Table 9-1a
Water and Wastewater Improvement Costs by Service Area

	Fiscal Year				
	2015[1]	**2020**	**2025**	**2030**	**2035**
Water Improvements					
Courthouse Area					
Route 522 Water Supply Project to Courthouse			$ 17,580,000		
Courthouse Area Subtotal	***$ -***	***$ -***	***$ 17,580,000***	***$ -***	***$ -***
Flat Rock Area					
Chloramine Booster Station		$ 250,000			
Flat Rock Elevated Tank Mixing System	$ 80,000				
Route 522 Water Supply Project Extension to Flat Rock				$ 5,580,000	
Flat Rock Area Subtotal	***$ 80,000***	***$ 250,000***	***$ -***	***$ 5,580,000***	***$ -***
Route 711 Area					
Option 1 - Connect to Chesterfield County via Route 711		$ 5,400,000			
Option 2 - Connect to Goochland County		$ 5,620,000		$ 500,000	
Option 3 - Connect to Route 60		$ 7,450,000			
Route 711 Subtotal[2]	***$ -***	***$ 5,620,000***	***$ -***	***$ 500,000***	***$ -***
Water Improvements Subtotal	**$ 80,000**	**$ 5,870,000**	**$ 17,580,000**	**$ 6,080,000**	**$ -**
Wastewater Improvements					
Courthouse Area					
Fighting Creek WWTP Influent Pump Station Upgrade incl. Screening	$ 730,000				
Fighting Creek WWTP Pump Station and Force Main				$ 5,670,000	
Courthouse Area Subtotal	***$ 730,000***	***$ -***	***$ -***	***$ 5,670,000***	***$ -***
Flat Rock Area					
Portable Belt Press	$ 175,000				
Dutoy Creek WWTP Improvements (Lime Feeder & Davit Crane)	$ 220,000				
Dutoy Creek WWTP 0.50 MGD Expansion (Including Dewatering Bldg)			$ 6,680,000		
Dutoy Creek WWTP 0.75 MGD Expansion				$ 2,700,000	
Dutoy Creek WWTP 1.0 MGD Expansion					$ 2,840,000
Dutoy Interceptor Upgrade					$ 510,000
Flat Rock Area Subtotal	***$ 395,000***	***$ -***	***$ 6,680,000***	***$ 2,700,000***	***$ 3,350,000***
Route 711 Area					
Option 1 - Connect to Chesterfield County via Route 711		$ 2,530,000			
Option 2 - Connect to Goochland County		$ 4,590,000			
Option 3 - Connect to Route 60		$ 7,010,000			
Route 711 Area Subtotal[2]	***$ -***	***$ 4,590,000***	***$ -***	***$ -***	***$ -***
Wastewater Improvements Total	**$ 1,125,000**	**$ 4,590,000**	**$ 6,680,000**	**$ 8,370,000**	**$ 3,350,000**
Grand Total	**$ 1,205,000**	**$ 10,460,000**	**$ 24,260,000**	**$ 14,450,000**	**$ 3,350,000**

1. 2015 Fiscal Year projects indicate existing system improvements to be implemented within the next 3 years. The remaining timesteps assume that the projects will be completed by the indicated year.
2. For planning purposes, it was asssumed that Option No. 2 would be constructed to provide water and wastewater service to the Route 711.
3. Budgetary cost estimates for water supply or wastewater disposal connections do not include potential connections fees.

The above listed capital improvement projects are NOT based upon the population projections contained in the Water and Wastewater Master Plan

Table 9-2a: Summary of Water and Wastewater Improvement Costs by Service Area

Service Area	2015	2020	2025	2030	2035
Route 60 Service Area (Includes Flat Rock and Courthouse Service Areas)	$1,205,000	$250,000	$24,260,000	$13,950,000	$3,350,000
Route 711 Service Area	-	$10,210,000	-	$500,000	-
Total	**$1,205,000**	**$10,460,000**	**$24,260,000**	**$14,450,000**	**$3,350,000**

The above listed capital improvement projects are NOT based upon the population projections contained in the Water and Wastewater Master Plan