

**UTILITY MASTER
MASTER PLAN**

GOOCHLAND COUNTY, VIRGINIA



**Prepared for:
Goochland County Department of Public Utilities
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Chapter 1 Executive Summary

1.1 Purpose and Scope

The purpose of this Utility Master Plan is to provide the Goochland County Department of Public Utilities 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 Goochland Courthouse and Eastern Goochland Service Areas and identifies recommended improvements projected to be required through the Year 2045.

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 Utilities, Administration, and Planning Departments to gather information and develop concurrence regarding the methodologies used to develop the Plan.
3. Obtain information from Goochland County on proposed land use, targeted growth areas, and future population predictions.
4. Develop demand projections through 2045 and distribute the demand projections throughout the Goochland Courthouse and Eastern Goochland Service Areas in areas projected to be developed during several future time steps. Note that data from January 2013 to December 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. Model the water and wastewater systems to identify Master Plan Capital Improvement Projects (CIPs) that will address growth within the County based on these projections.
6. Develop the Utility Master Plan to summarize project activities and provide costs and recommendations for CIPs throughout the planning period.

1.2 Existing Water System

There are two existing public water systems within Goochland County, the Goochland Courthouse Water System and Eastern Goochland Water System.

1.2.1 Goochland Courthouse Water System

The Goochland Courthouse Water System (GCWS) is owned and operated by Goochland County and is currently supplied by one connection point to the Virginia Department of Correction's (DOC) water system. Goochland County currently has a permitted capacity of 200,000 gallons per day through this con-

nection point. This system consists of approximately 10 miles of waterlines, ranging in diameter from 2 to 12 inches, and is generally located within the Courthouse Village.

Storage within the GCWS is provided through the Goochland Courthouse Elevated Storage Tank, which has 300,000 gallons of total storage. This tank, along with the water supplied from DOC, provides water to meet daily peak water demands and supply water to meet fire flow demands.

For the period between January 2013 and December 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 250 residential and commercial customers as follows:

- Residential customers: 169
- Commercial customers: 81
- Total customers: 250

In 2013, water service was provided by the County to meet an annual average demand of approximately 61,000 GPD within the GCWS. This total does not account for flushing and unmetered water usage within the system.

1.2.2 Eastern Goochland Water System

The Eastern Goochland Water System (EGWS) is owned and operated by Goochland County and is currently supplied by four system interconnections to Henrico County's (Henrico) water distribution system. Through a water supply agreement, Goochland County currently has a capacity of 5.25 million gallons per day (MGD) with Henrico. This system consists of approximately 49 miles of waterlines, ranging in diameter from 2 to 24 inches, and is generally located within the Rockville Area, Centerville Village, West Creek Area, and River Road Communities.

The majority of the EGWS is served by the Tuckahoe Creek Service District (TCSD) which was established in the Eastern Goochland Service area to create the utility infrastructure to allow more intense development within the State Route 288 and easternmost Interstate 64 corridors. According to the 2008 Comprehensive plan, utility capacity was targeted toward commercial, light industrial, and office uses within the TCSD.

The EGWS is divided into four (4) pressure zones, has two elevated water storage tanks, and two booster stations to provide water supply and fire flow availability to the Eastern Goochland Service Area.

For the period between January 2013 and December 2013, the County provided water service to 1,041 residential, commercial, and irrigation customers as follows:

- Residential customers: 898
- Commercial customers: 130
- Irrigation customers: 13
- Total customers: 1,041

In 2013, water service was provided by the County to meet an annual average demand of approximately 411,000 GPD within the EGWS. This total does not account for flushing and unmetered water usage within the system.

1.3 Existing Wastewater Systems

Goochland County provides public wastewater service to the Goochland Courthouse and Eastern Goochland Service Areas.

1.3.1 Goochland Courthouse Wastewater System

The Goochland Courthouse Wastewater Collection System is owned and operated by Goochland County and wastewater treatment is currently provided by VDOC Virginia Correctional Center for Women Wastewater Treatment Plant (VCCW WWTP). Based on the current agreement, Goochland County has a maximum day capacity of 0.111 MGD at the VCCW WWTP.

This system consists of approximately 7 miles of gravity sanitary sewer, ranging in diameter from 4 to 12 inches, 0.25 miles of 4 inch force main, and two (2) wastewater pump stations.

For the period between January 2013 and December 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 92 residential, commercial, and public/municipal customers as follows:

- Residential customers: 45
- Commercial customers: 47
- Total customers: 92

In 2013, the Goochland Courthouse Wastewater Collection System collected and conveyed an average flow of 42,300 gpd to the VCCW WWTP.

1.3.2 Eastern Goochland Wastewater System

The Eastern Goochland Wastewater Collection System is owned and operated by Goochland County and wastewater treatment is currently provided by the City of Richmond and/or Henrico County. This system

consists of approximately 55 miles of gravity sanitary sewer, ranging in diameter from 6 to 42 inches, 11 miles of force main, ranging in diameter from 4 to 48 inches, and four (4) wastewater pump stations.

Wastewater treatment for the Eastern Goochland Wastewater Collection System is currently provided by Henrico County and the City of Richmond through a joint agreement. Based on this agreement, Goochland County currently has a maximum day capacity of 5 MGD for the Eastern Goochland Pump Station. Goochland County also has another agreement with Henrico County for a maximum day capacity of 0.69 MGD for the Lower Tuckahoe Pump Station.

For the period between January 2013 and December 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 778 residential and commercial customers as follows:

- Residential customers: 682
- Commercial customers: 96
- Total customers: 778

In 2013, the Eastern Goochland Wastewater Collection System collected and conveyed an average flow of approximately 400,000 gpd to Henrico County and the City of Richmond.

1.4 Future Demand Projections

Future conditions in Goochland County were evaluated to identify water and wastewater system improvements required to meet future needs. Recommended improvements within the planning period (2015-2045) were identified based on land use phasing and the development and geographic distribution of demand projections throughout the Goochland Courthouse Service Area (GCSA) and Eastern Goochland Service Area (EGSA). These projections were developed utilizing methodologies consistent with the provisions of Goochland County's 2008 Comprehensive Plan and input from the County's Public Utilities and Planning Departments.

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

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 Suite 10.0, developed by Innovyze, was used to model the water system and InfoSewer Suite 7.6, also developed by Innovyze, was used to model the wastewater system.

The models were calibrated to reflect actual conditions, and average and peak flow 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 2045.

1.6 Water System Improvements

A water system analysis was conducted to evaluate the improvements needed for the existing system as well as for future growth through the end of the planning period in 2045.

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 Existing Water Distribution System Improvements

The water model of both the Goochland Courthouse and Eastern Goochland Water Systems was utilized to evaluate system improvements required to address these three criteria: domestic pressures, fire flow availability, and water age.

1.6.1.1 Goochland Courthouse Existing Water System Improvements

Based on the existing system analysis, the Goochland Courthouse Water System required improvements to provide the County standard of a 2-hour, 1,500 gpm fire flow availability for a majority of the system. Improvements were recommended to upsize existing piping and construct loops in increase the fire flow availability.

The installation of an auto-flusher at a dead end line and the installation of a tank mixer is recommended to reduce system water age.

1.6.1.2 Eastern Goochland Existing Water System Improvements

Based on the existing system analysis, the Eastern Goochland Courthouse System has issues in some areas with inadequate domestic pressures, low fire flow availability, and high water age.

A significant amount of water main upsizing and looping is recommended to increase system capacity to meet the County standard fire flow requirement. Additionally, since the West Creek Elevated Water Storage Tank was main contributor to the low pressures, low fire flow availability, and extended water age, it was recommended that this tank be decommissioned. The Centerville Elevated Water Storage Tank has adequate storage capacity to provide the required storage for the existing system demands.

Additional improvements were also recommended to address the extended water age including the construction of a chloramine booster station, tank mixing, and auto-flusher installation. The Centerville Pressure Zone was also expanded south to increase turnover of the 24-inch main currently connecting the Centerville and West Creek pressure zones.

1.6.2 Water Supply

An evaluation of the planning period from 2015 to 2045 indicates that as the population grows within the water service areas, the County's available water supply will be sufficient to meet maximum day demands through the end of the planning period. The County has an agreement with Henrico County to provide up to a maximum day capacity of 25 MGD and an agreement with the VDOC to provide up to a maximum day capacity of 2 MGD. It is anticipated that the County will have to share the cost of expanding the water treatment plant and transmission facilities of both Henrico County and VDOC in order to have access to the maximum available capacity.

1.6.3 Water Storage and Booster Pump Capacity

Based on demand projections, the 300,000 gallon Goochland Courthouse Elevated Water Storage Tank's capacity will be exceeded by 2035. By 2035, it is recommended that a new 500,000 gallon elevated water storage tank be constructed to serve the water system through the end of the planning period. Based on future demand projections, the existing River Road West Booster Station will have to be upgraded before 2025. It is recommended that the County construct a booster station in 2025 that will meet capacity needs through the end of the planning period.

Based on the storage tank evaluation, the existing 1 million gallon Centerville Tank is sufficient to provide the required storage through 2020. In order to provide the Eastern Goochland Service Area with the future required storage, additional storage volume is required to meet the recommended storage through the end of planning period. The construction of elevated water storage tanks are recommended throughout the water system at different phases starting with a 500,000 gallon tank at Lanier Industrial Park by 2025, a 1,500,000 gallon storage tank at the intersection of Hockett Road and Patterson Avenue by 2035, and another 1,500,000 million gallon elevated storage tank north of Tuckahoe Creek Parkway along Hockett Road by 2045.

Water booster pump station upgrades will be required to provide the required water supply through the planning period. By 2025, the pumps at the Centerville Booster Pump Station will have to be upsized to meet maximum day demands. When the new 1,500,000 gallon elevated tank at the intersection of Hockett Road and Patterson Avenue is constructed in 2035, a new booster pump station will be required at the Ridgefield water supply connection to pump water into the new tank. Additionally, a 16-inch water main will be constructed connecting the River Road High Pressure Zone to the Centerville Zone to allow the River Road Booster Pump Station to be able to supply water to the new elevated tank as well. This will require the River Road booster pumps to operate at a higher flow rate than previously which will drop upstream pressures in Rivergate below 35 psi. Therefore, a new 150,000 gallon ground storage tank will be required at the River Road Booster Pump Station to buffer pressures between zones.

1.6.4 Water Distribution

The improvements recommended to serve future development within 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).

1.7 Wastewater System Improvements

A wastewater system analysis was conducted to evaluate the improvements needed for the existing system as well as for future growth through the end of the planning period in 2045.

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

1.7.1 Wastewater Discharge Capacity

An evaluation of the planning period from 2015 to 2045 indicates that as the population grows within the water service areas, the County will be required to obtain additional wastewater discharge allocations to meet peak system demands through the end of the planning period.

For the Goochland Courthouse Service Area, the County currently has an agreement in place with VDOC to discharge a maximum month average flow rate of 111,000 GPD to the wastewater treatment facilities located at the Virginia Correctional Center for Women (VCCW) on River Road West. Based on future demand projections, the VCCW WWTP will require an expansion to provide treatment and disposal of wastewater through the end of the planning period in 2045. VDOC has completed a study that estimates

the WWTP improvements totaling approximately \$4 million will be required to provide the County with a 300,000 GPD allocation. This allocation will satisfy the County's needs through until sometime in the 2020 to 2025 time period. Additional treatment capacity would still be needed to meet the projected wastewater loading in planning year 2045.

It is recommended that the County evaluate long term wastewater treatment options within the Courthouse Service Area in more detail before committing to paying VDOC to expand the VCCW WWTP.

For the Eastern Goochland Service Area, there are currently two agreements active in the Eastern Goochland Service Area concerning wastewater discharge: one with Henrico County (Henrico) and one with the City of Richmond (Richmond).

Through an agreement with the City of Richmond, dated June 1, 2002, Goochland County may convey up to the initial contracted wastewater treatment maximum month average capacity of 5 MGD with an allowable peak hour conveyance capacity of 1.33 times the maximum month average capacity (6.65 MGD). Goochland County has the option of purchasing additional wastewater treatment capacity up to a maximum month average of 8 MGD without upgrading the existing WWTP. As part of the agreement, additional wastewater treatment capacity up to a maximum month average of 15 MGD is available but will require upgrades to the Richmond's wastewater treatment plant and the renegotiation of capacity charges. The existing agreement does not allow for Goochland to exceed a maximum month average of 15 MGD and a peak hour flow of 20 MGD. Based on the loading projections, the County will need to obtain additional wastewater treatment capacity by 2045; this will require additional negotiation with the City of Richmond and Henrico County.

Henrico County is currently under contract to provide Goochland County with a maximum month average wastewater treatment capacity of up to 0.69 MGD through the Lower Tuckahoe Pump Station. Based on the future wastewater loading projections, this capacity is adequate to meet the County's need through the end of the planning period in 2045.

1.7.2 Wastewater Collection and Conveyance Capacity

The sewer model was utilized to evaluate the capacity of the existing Goochland Courthouse sewer collection system. Based on this analysis, the system has adequate capacity for the current wastewater flows, with the exception of the Valley View Pump Station, which requires both pumps to be operating simultaneously to keep up with peak sewer flows. In order to maintain full redundancy for current flows, it is recommended that the pumps be upsized. However, until the pumps are upsized, the County has an adequate contingency plan in the event a pump fails. The contingency plan includes the ownership of a spare pump and a diesel backup pump to allow for bypass pumping which reduces the priority of upsizing the pumps. In order to keep up with projected sewer loadings through the end of the planning period, an ad-

ditional upgrade will also be required by 2025 to the Valley View Pump Station, including a new 8-inch force main.

Based on the analysis of the existing Eastern Goochland wastewater collection system, the existing system has capacity for projected sewer flow rates until 2035. Anticipated improvements include the upsizing of existing interceptors to piping ranging in diameter from 27-inch to 48-inch diameter. Additionally, additional pumping capacity at the Eastern Goochland Pump Station will be required or meet the projected sewer flows. Based on future projections, the installation of additional pumps will be required to keep up with projected demands both in the 2035 and 2045 planning periods.

1.8 Implementation

Tables 1-1 and 1-2 outline the implementation plan for the water and wastewater system improvement program recommended in this Utility 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 20% construction contingency. A summary of the costs for each time step can be found below:

Water

2015-2020:	\$580,000
2020-2025:	\$18,570,000
2025-2035:	\$8,620,000
2035-2045:	\$23,340,000
2045:	\$19,400,000

Wastewater

2015-2020:	\$510,000
2020-2025:	\$480,000
2025-2035:	\$3,850,000
2035-2045:	\$14,450,000
2045:	\$20,220,000

Total

2015-2020:	\$1,090,000
2020-2025:	\$19,050,000
2025-2035:	\$12,470,000
2035-2045:	\$37,790,000
2045:	\$39,620,000

Table 1-1 Goochland Courthouse Service Area Water and Wastewater Service Area (Recommended Projects based on Growth Projections)

Water Improvement Project	Fiscal Year				
	2015-2020	2020-2025	2025-2305	2035-2045	2045
wGC-2020-0001: Northern Goochland Courthouse Fire Flow Improvements (Ex. Fire Flow Improvement)		\$ 780,000			
wGC-2020-0002: J. Sargeant Reynolds Water Main Improvements (Ex. Fire Flow Improvement)		\$ 320,000			
wGC-2020-0003: River Road Improvements (Ex. Fire Flow Improvement)		\$ 2,240,000			
wGC-2020-0004: Courthouse Elevated Water Storage Tank Mixer		\$ 110,000			
wGC-2025-0001: Sandy Hook Water Main Loop			\$ 1,020,000		
wGC-2025-0002: River Road West Booster Pump Station			\$ 2,130,000		
wGC-2035-0001: Goochland Courthouse Elevated Water Storage Tank				\$ 2,930,000	
Goochland Courthouse Water Improvements Subtotal	\$ -	\$ 3,450,000	\$ 3,150,000	\$ 2,930,000	\$ -
Wastewater Improvement Project	Fiscal Year				
	2015-2020	2020-2025	2025-2305	2035-2045	2045
sGC-2015-002: Courthouse Service Area I&I Study ²	\$ 50,000				
sGC-2020-001: Valley View Pump Station – Pump Replacement		\$ 380,000			
sGC-2025-001: Valley View Pump Station – Pump Station and Force Main Upgrade			\$ 490,000		
sGC-2025-002: Interceptor Upgrade to VCCW Wastewater Treatment Plant			\$ 650,000		
Expansion of Wastewater Capacity	TBD	TBD			
Goochland Courthouse Wastewater Improvements Subtotal	\$ 50,000	\$ 380,000	\$ 1,140,000	\$ -	\$ -
Total Goochland Courthouse Service Area Improvement Cost Estimate	\$ 50,000	\$ 3,830,000	\$ 4,290,000	\$ 2,930,000	\$ -

1. Budgetary cost estimates for water supply or wastewater disposal connections do not include potential connections fees.

2. Placeholder. Final cost to be determined based on scope.

Table 1-2 Eastern Goochland Service Area Water and Wastewater Service Area (Recommended Projects based on Growth Projections)

Water Improvement Project	Fiscal Year				
	2015-2020	2020-2025	2025-2305	2035-2045	2045
wEG-2015-0001: Centerville Elevated Water Storage Tank Mixer	\$ 110,000				
wEG-2015-0002: Chloramine Booster Station	\$ 250,000				
wEG-2015-0003: West Creek Control Valve Vault	\$ 190,000				
wEG-2015-0004: Decommission West Creek Elevated Tank	\$ 30,000				
wEG-2020-0001: Lanier Industrial Park Improvements (Ex. Fire Flow Improvement)		\$ 290,000			
wEG-2020-0002: Richmond Country Club Water Main (Ex. Fire Flow Improvement)		\$ 1,040,000			
wEG-2020-0003: Rivergate Water Main Loop (Ex. Fire Flow Improvement)		\$ 140,000			
wEG-2020-0004: West Creek-River Road Low Control Valve (Ex. Fire Flow Improvement)		\$ 130,000			
wEG-2020-0005: Lower Tuckahoe and Randolph Square Water Main Upgrades (Ex. Fire Flow Improvement)		\$ 2,110,000			
wEG-2020-0006: River Road Low Pressure Zone Water Main Upgrade (Ex. Fire Flow Improvement)		\$ 1,220,000			
wEG-2020-0007: River Road Booster Station Upgrade (Ex. Fire Flow Improvement)		\$ 1,240,000			
wEG-2020-0008: River Road High Pressure Zone Water Main Upgrade (Ex. Fire Flow Improvement)		\$ 680,000			
wEG-2020-0009: West Oak Water Main Loop (Ex. Fire Flow Improvement)		\$ 640,000			
wEG-2020-0010: Western River Road Communities Water Main Looping (Ex. Fire Flow Improvement)		\$ 800,000			
wEG-2020-0011: Lanier Industrial Park Elevated Water Storage Tank		\$ 2,830,000			
wEG-2020-0012: Parke at Saddle Creek Water Main Loop		\$ 530,000			
wEG-2020-0013: Hockett Road Water Main		\$ 3,470,000			
wEG-2025-0001: Centerville Booster Pump Station Upgrade			\$ 2,950,000		
wEG-2025-0002: Huguenot Hills Water Service			\$ 2,520,000		
wEG-2035-0001: Ashland Road Water Main Upgrade				\$ 2,030,000	
wEG-2035-0002: Ridgefield Booster Pump Station				\$ 3,970,000	
wEG-2035-0003: Patterson Avenue Water Main Extension				\$ 6,120,000	
wEG-2035-0004: River Road Water Main Extension				\$ 2,300,000	
wEG-2035-0005: River Road Booster Station Storage Tank				\$ 1,210,000	
wEG-2035-0006: Manakin Elevated Water Storage Tank				\$ 4,590,000	
wEG-2035-0007: Relocate West Creek Control Valve Vault				\$ 190,000	
wEG-2045-0001: Broad Street Water Main Upgrade					\$ 1,950,000
wEG-2045-0002: Hockett Road Elevated Water Storage Tank					\$ 4,590,000
wEG-2045-0003: Homewood Park Water Service					\$ 2,220,000
wEG-2045-0004: Ridgefield Water Main Upgrade					\$ 1,950,000
wEG-2045-0005: Manakin Village Water Service					\$ 6,710,000
wEG-2045-0006: James River Estates Water Service					\$ 1,980,000
Eastern Goochland Water Improvements Subtotal	\$ 580,000	\$ 15,120,000	\$ 5,470,000	\$ 20,410,000	\$ 19,400,000
Wastewater Improvement Project	Fiscal Year				
	2015-2020	2020-2025	2025-2305	2035-2045	2045
sEG-2015-0001: Lower Tuckahoe Sewer Service ²	\$ 460,000				
sEG-2020-0002: Eastern Goochland Service Area I&I Study ³		\$ 100,000			
sEG-2025-0001: Huguenot Hills Sewer Service			\$ 2,710,000		
sEG-2035-0001: Eastern Goochland Interceptor Upgrade				\$ 11,860,000	
sEG-2035-0002: Eastern Goochland Pump Station Upgrade				\$ 2,590,000	
sEG-2045-0001: Route 288 Interceptor Upgrade					\$ 1,660,000
sEG-2045-0002: West Creek Interceptor Upgrade					\$ 2,250,000
sEG-2045-0003: Eastern Goochland Pump Station Upgrade					\$ 2,400,000
sEG-2045-0004: Homewood Park Sewer Service					\$ 2,470,000
sEG-2045-0005: Manakin Village Sewer Service					\$ 6,570,000
sEG-2045-0006: Western River Road Communities Sewer Service					\$ 4,870,000
Eastern Goochland Wastewater Improvements Subtotal	\$ 460,000	\$ 100,000	\$ 2,710,000	\$ 14,450,000	\$ 20,220,000
Total Eastern Goochland Service Area Improvement Cost Estimate	\$1,040,000.00	\$15,220,000.00	\$8,180,000.00	\$34,860,000.00	\$39,620,000.00

1. Budgetary cost estimates for water supply or wastewater disposal connections do not include potential connections fees.

2. County share of project. The remainder of the project cost would be paid for by the residents.

3. Placeholder. Final cost to be determined based on scope.

Chapter 2 Introduction

2.1 Purpose

The Goochland County Department of Public Utilities 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 Utility 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 2045.

This Utility 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 Utilities. 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 Utility Master Plan involved extensive coordination with the Goochland County Department of Public Utilities 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 development of the Utility Master Plan also involved coordination with Henrico County Departments of Public Utilities and the Virginia Department of Corrections. This coordination was important to ensure that the Utility Master Plan incorporated the latest information available and meets the overall needs of the County.

The general approach for development of the Utility Master 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 Utilities, Administration, and Planning Departments to gather information and develop concurrence regarding the methodologies used to develop the Plan.
3. Obtain information from Goochland County on proposed land use, targeted growth areas, and population projections.
4. Develop demand projections through 2045 and distribute the demand projections throughout the Goochland Courthouse and Eastern Goochland Service Areas in areas projected to be developed during several future time steps. Note that data from January 2013 to December 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. Model the water and wastewater systems to identify Master Plan Capital Improvement Projects (CIPs) that will address existing system deficiencies as well as growth within the County.
6. Develop the Utility 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 Utility Master Plan provides an overview of Goochland County's existing water system.

3.1 Water System Overview

There are two existing public water systems within Goochland County; the Goochland Courthouse Water System (GCWS) and the Eastern Goochland Water System (EGWS). More detailed information on the County's water supply facilities, storage facilities, and pumping facilities is provided in the following sections.

3.2 Goochland Courthouse Water System

The Goochland Courthouse Water System is owned and operated by Goochland County and is currently supplied by a single connection point to Virginia Department of Correction's (VDOC) water distribution system along River Road West (State Route 6). Based on the water supply agreement, Goochland County currently has a maximum day water capacity of 200,000 gallons per day (GPD) with VDOC. This system consists of approximately 10 miles of waterlines, ranging in diameter from 2 to 12 inches, and is generally located within the Courthouse Village.

Storage within the GCWS is provided by the Goochland Courthouse Elevated Storage Tank, which has 300,000 gallons of total storage and is filled by a water booster pump station owned and operated by VDOC located along River Road West. This tank, along with the water supplied from VDOC provides water to meet maximum day water demands and supply water to meet fire flow demands.

For the period between January 2013 and December 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 250 residential and commercial customers as follows:

- Residential customers: 169
- Commercial customers: 81
- Total customers: 250

In 2013, water service was provided by the County to meet an annual average demand of approximately 61,000 GPD within the GCWS. This total does not account for flushing and unmetered water usage within the system.

A plan schematic of the existing Goochland Courthouse Water System is shown in Figure 3-1.

3.3 Eastern Goochland Water System

The Eastern Goochland Water System (EGWS) is owned and operated by Goochland County and is currently supplied by four system interconnections to Henrico County's (Henrico) water distribution system. Through a water supply agreement, Goochland County currently has a maximum day capacity of 5.25 million gallons per day (MGD) from Henrico.

The majority of the EGWS is served by the Tuckahoe Creek Service District (TCSD) which was established in the Eastern Goochland Service area to create the utility infrastructure to allow more intense development within the State Route 288 and easternmost Interstate 64 corridors. According to the Goochland County's 2008 Comprehensive Plan, utility capacity was targeted toward commercial, light industrial, and office uses within the TCSD.

The EGWS is divided into four (4) pressure zones and consists of approximately 49 miles of waterlines, ranging in diameter from 2 to 24 inches, and is generally located within the Rockville Area, Centerville Village, West Creek Area, and River Road Communities. Starting at the northern end of the system, the Centerville Pressure Zone is supplied with water at the Broad Street connection. The Centerville Booster Pump Station, located just downstream of the water supply connection, pumps water from Henrico into the Centerville Elevated Water Storage Tank.

Just south of the Centerville Pressure Zone, the West Creek Pressure Zone is supplied by two connections from Henrico at Patterson Avenue and Ridgefield Avenue. A PRV station at the Route 288 interchange and a 24-inch waterline along Route 288 connects the two pressure zones and allows a redundant water supply feed from the Centerville Pressure Zone in the event of an emergency. The West Creek Pressure Zone includes an elevated water storage tank along West Creek Parkway which is filled by the Patterson and Ridgefield connections.

The River Road area is served by two pressure zones; River Road Low and River Road High Pressure Zone. The River Road Low Pressure Zone is supplied by a Henrico water supply connection on River Road. This pressure zone does not contain a storage tank and relies on storage within Henrico County.

The River Road High Pressure Zone is connected to the West Creek Pressure Zone and includes the River Road Booster Station to increase pressures and supply water within the zone. Storage is provided by a hydro-pneumatic tank located at the River Road Booster Station.

Table 3-1 Eastern Goochland Water System Tank Summary

Tank	Capacity (Gal.)	Tank Type	Overflow Elevation/ HGL Setpoint (ft)
Centerville	1,000,000	Elevated (composite)	400
West Creek	600,000	Elevated (multi-leg)	331
River Road	10,000	Hydro-pneumatic	395 (80 psi max)

Table 3-2 Eastern Goochland Water System Booster Pump Station Summary

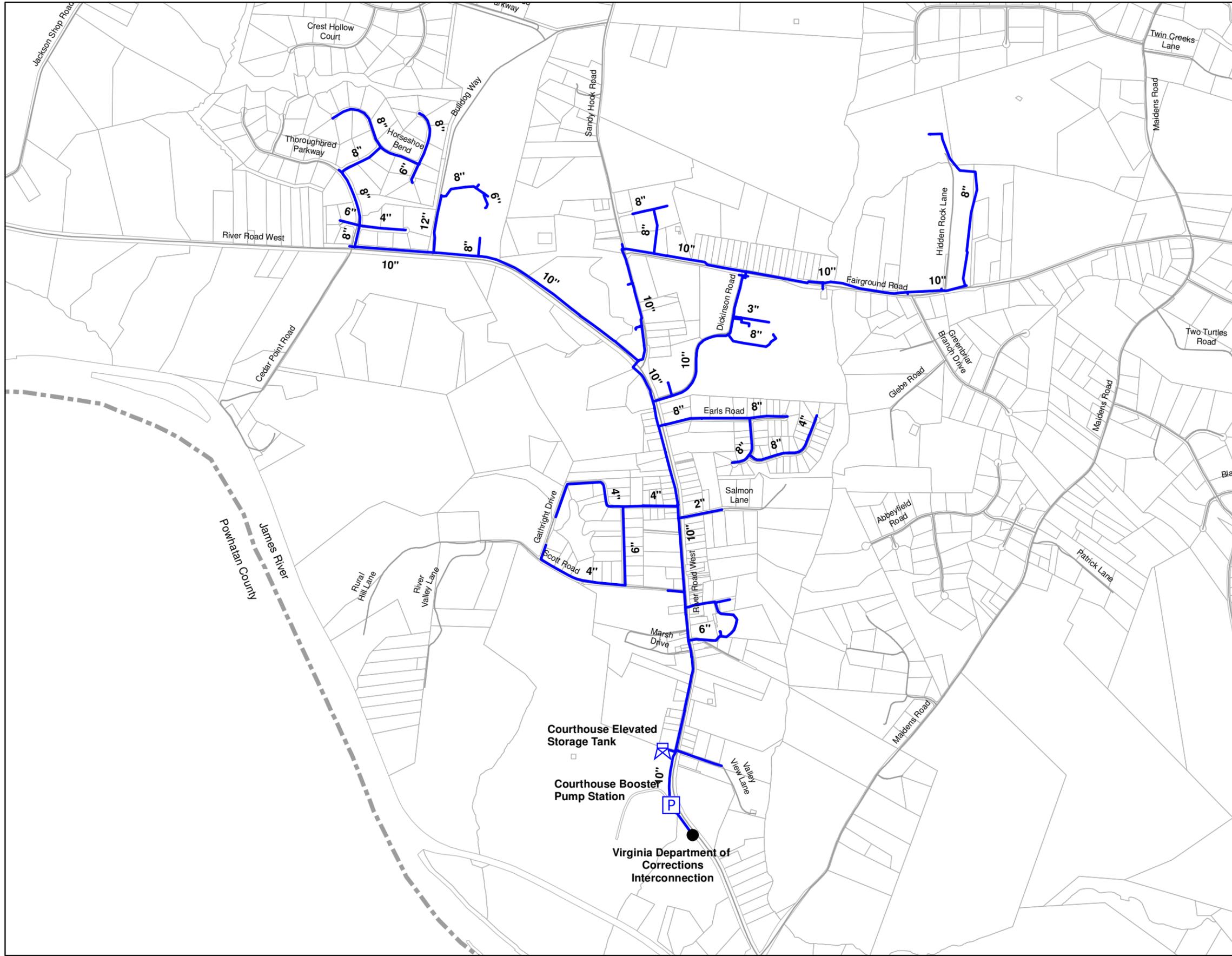
Booster Pump Station	No. of Pumps	Design Flow per Pump (gpm)	Design Head (ft)	Firm Capacity (gpm)
Centerville	3	1,300	110	2,600
River Road	3	480	90	960

For the period between January 2013 and December 2013, the County provided water service to 1,041 residential, commercial, and irrigation customers as follows:

- Residential customers: 898
- Commercial customers: 130
- Irrigation customers: 13
- Total customers: 1,041

In 2013, water service was provided by the County to meet an annual average demand of approximately 411,000 GPD within the EGWS. This total does not account for flushing and unmetered water usage within the system.

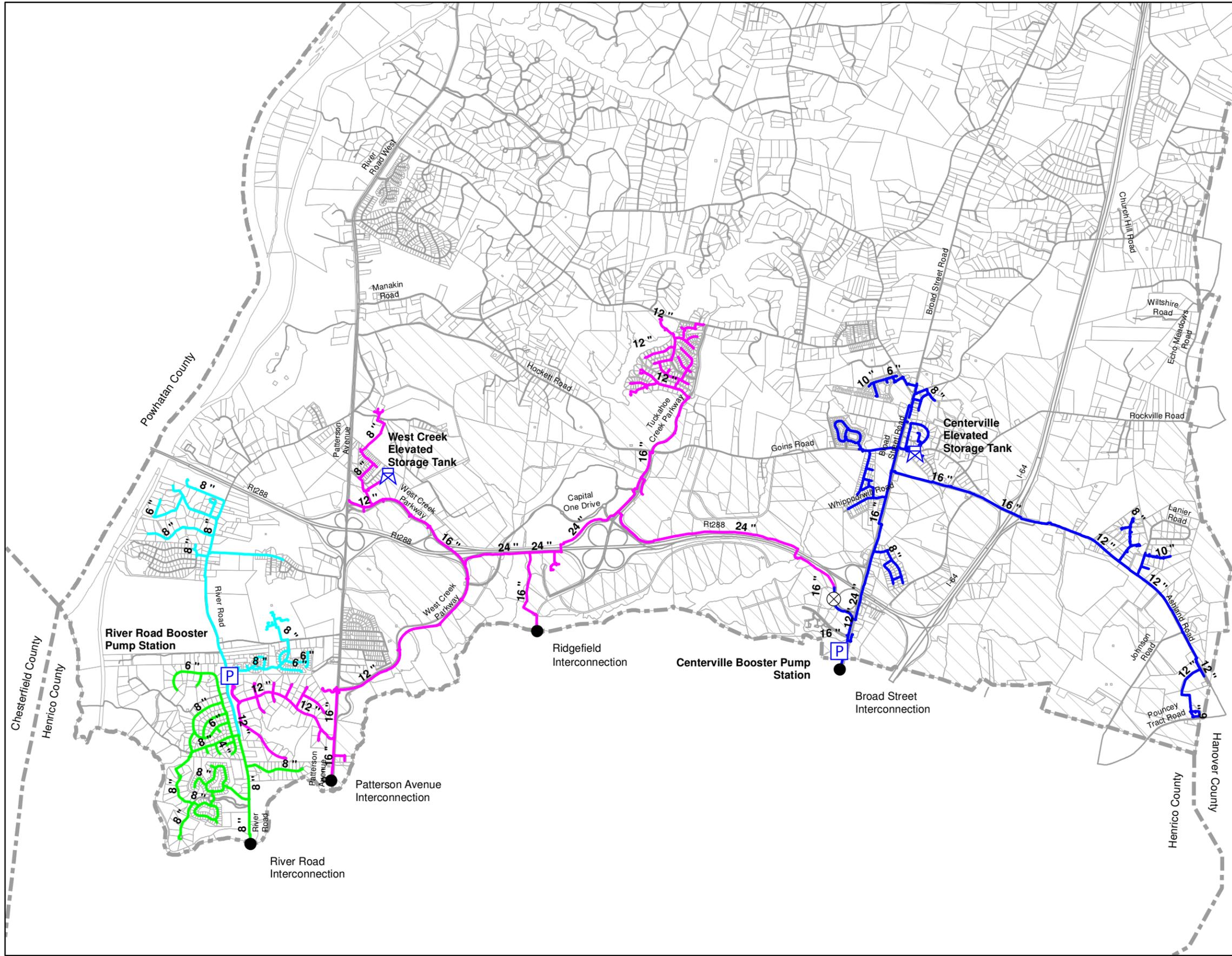
A plan schematic of the existing Eastern Goochland Water System is shown in Figure 3-2.



- Legend**
- System Interconnection
 - Ⓟ Booster Pump Station
 - ⓧ Elevated Storage Tank
 - Courthouse Waterline
 - County Boundaries

Key Plan

 Dewberry Dewberry Engineers Inc. 4805 LAKE BROOK DRIVE, SUITE 200 GLEN ALLEN, VIRGINIA 23060 PHONE: 804.290.7957 FAX: 804.290.7928	DATE 11/2014 PROJ. NO. 50061868	SCALE 1 inch = 1,500 feet PROJECT UTILITY MASTER PLAN GOOCHLAND COUNTY, VA	TITLE COURTHOUSE AREA EXISTING WATER SYSTEM	FIGURE NO. 3-1
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- Legend**
- County Boundaries
 - System Interconnection
 - ⬠ Elevated Storage Tank
 - Ⓟ Booster Pump Station
 - Waterline Pressure Zone
 - Centerville
 - River Road Low Pressure
 - River Road High Pressure
 - West Creek

Key Plan

 Dewberry Engineers Inc. 4805 LAKE BROOK DRIVE, SUITE 200 GLEN ALLEN, VIRGINIA 23060 PHONE: 804.290.7957 FAX: 804.290.7928	DATE 11/2014	SCALE 1 inch = 4,500 feet	TITLE EASTERN GOOCHLAND AREA EXISTING WATER SYSTEM	FIGURE NO. 3-2
	PROJ. NO. 50061868	PROJECT UTILITY MASTER PLAN GOOCHLAND COUNTY, VA		

Chapter 4 Existing Wastewater System

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

4.1 Wastewater System Overview

There are two existing public wastewater systems within Goochland County; the Goochland Courthouse wastewater system and the Eastern Goochland wastewater system. More detailed information on the County's wastewater collection, pumping, conveyance, and disposal facilities is provided in the following sections.

4.2 Goochland Courthouse Wastewater System

The Goochland Courthouse Wastewater Collection System is owned and operated by Goochland County and wastewater treatment is currently provided by VDOC Virginia Correctional Center for Women Wastewater Treatment Plant (VCCW WWTP). Based on the current agreement, Goochland County has a maximum month average capacity of 0.111 MGD at the VCCW WWTP.

This system consists of approximately 7 miles of gravity sanitary sewer, ranging in diameter from 4 to 12 inches, 0.25 miles of 4 inch force main, and two (2) wastewater pump stations.

4.2.1 Wastewater Pump Stations

The Goochland Courthouse Wastewater Collection System mostly consists of gravity sewer but also includes the following two pump stations.

The Administration Pump Station is a small pump station located at the County Administration Building. This pump station collects the wastewater from the Administration Building and pumps it into the 8-inch gravity sewer main along Sandy Hook Road.

The Valley View Pump Station is located near the southeastern end of the Goochland Courthouse service area along Valley View Lane and serves to pump all the wastewater collected within the Goochland Courthouse service area to the VCCW WWTP. This pump station consists of two (2) submersible pumps designed to pump approximately 100 gallons per minute at 130 feet of head. The pumps lift wastewater out of a 5-foot diameter wetwell and discharge flow through approximately 2,400 linear feet of 4-inch force main to an 8-inch gravity sewer located near the intersection of West River Road West and Valley View Lane.

4.2.2 Flow Summary

For the period between January 2013 and December 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 92 residential, commercial, and public/municipal customers as follows:

- Residential customers: 45
- Commercial customers: 47
- Total customers: 92

In 2013, the Goochland Courthouse Wastewater Collection System collected and conveyed an average flow of 42,300 gpd to the VCCW WWTP.

A plan schematic of the existing Goochland Courthouse Wastewater System is shown in Figure 4-1.

4.3 Eastern Goochland Wastewater System

The Eastern Goochland Wastewater Collection System is owned and operated by Goochland County and wastewater treatment is currently provided by the City of Richmond and Henrico County. This system consists of approximately 55 miles of gravity sanitary sewer, ranging in diameter from 6 to 48 inches, 11 miles of force main, ranging in diameter from 4 to 48 inches, and four (4) wastewater pump stations.

Wastewater treatment for the Eastern Goochland Wastewater Collection System is currently provided by Henrico County and the City of Richmond through a joint agreement. Based on this agreement, Goochland County currently has a maximum month average capacity of 5 MGD for the Eastern Goochland Pump Station. Goochland County also has another agreement with Henrico County for a maximum month average capacity of 0.69 MGD for the Lower Tuckahoe Pump Station.

4.3.1 Wastewater Pump Stations

The Eastern Goochland Wastewater Collection System mostly consists of gravity sewer but also includes five (5) pump stations.

The Eastern Goochland Pump Station (EGPS) is located at the eastern end of the Eastern Goochland Service Area along Patterson Avenue. This facility receives wastewater from the Tuckahoe Creek Service District, River Road Communities, and Henrico County. The pump station currently consists of three (3) dry-pit submersible pumps that operate at approximately 4,583 gallons per minute at 210 feet of head for a total installed capacity of approximately 13 MGD. The pump station has room to add an additional three (3) pumps for a total of six (6) and an ultimate firm capacity of approximately 33 MGD. The pump station includes a two influent grinder channels and a two compartment wetwell. The pumps lift wastewater out of the wetwell and pump flow through approximately 46,300 linear feet of 48-inch force main to the Maple Avenue Meter Vault, where motorized valves allow the discharge of wastewater to either the City of Richmond or Henrico County collection systems.

The Route 623 Pump Station is located southwest of the intersection of Lanier Road and Ashland Road and serves The Lanier Industrial Park. This pump station consists of two (2) submersible pumps that operate at approximately 700 gallons per minute at 28 feet of head. The pumps lift wastewater from a 6½ foot diameter wetwell and discharge flow through approximately 4,900 linear feet of 8-inch force main, routed under Interstate 64, to gravity sewer located southwest of the intersection of Interstate 64 and Ashland Road.

The West Oak Pump Station is located off of Woodfern Road, which connects to West Oak Drive, and serves the western end of the River Road Communities. This pump station consists of two (2) submersible pumps that operate at approximately 250 gallons per minute at 75 feet of head. The pumps lift wastewater out of an 8-foot diameter wetwell and discharge flow through approximately 1,040 feet of 6-inch force main to gravity sewer located on Kellington Lane.

Lower Tuckahoe Pump Station is located off of Hillpoint Road and serves the southern end of the River Road Communities. This pump station consists of two submersible pumps that operate at approximately 250 gallons per minute at 82 feet of head. The pumps lift wastewater out of an 8-foot diameter wetwell and discharge flow through approximately 3,110 feet of 6-inch force main and connect into the 30-inch force main for Henrico County's River Road Pump Station.

The Rivergate Pump Station is located just south of Patterson Avenue in the Rivergate Subdivision and serves the West Oak, Wickham, and Rivergate neighborhoods. This pump station consists of two submersible grinder pumps that operate at approximately 90 gallons per minute at 110 feet of head. The pumps lift wastewater out of a 6-foot diameter wetwell and discharge flow through approximately 4,800 feet of 4-inch force main to the Lower Tuckahoe Pump Station sewer basin. Due to ongoing operational issues at the Rivergate Pump Station a project is currently underway to take the pump station offline and construct approximately 2,600 linear feet of 12-inch gravity piping routed north to connect upstream of the Eastern Goochland Pump Station. Project completion is expected in 2015.

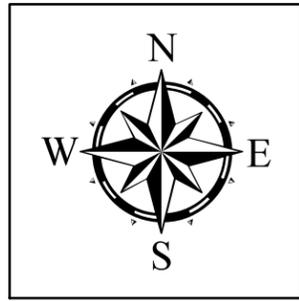
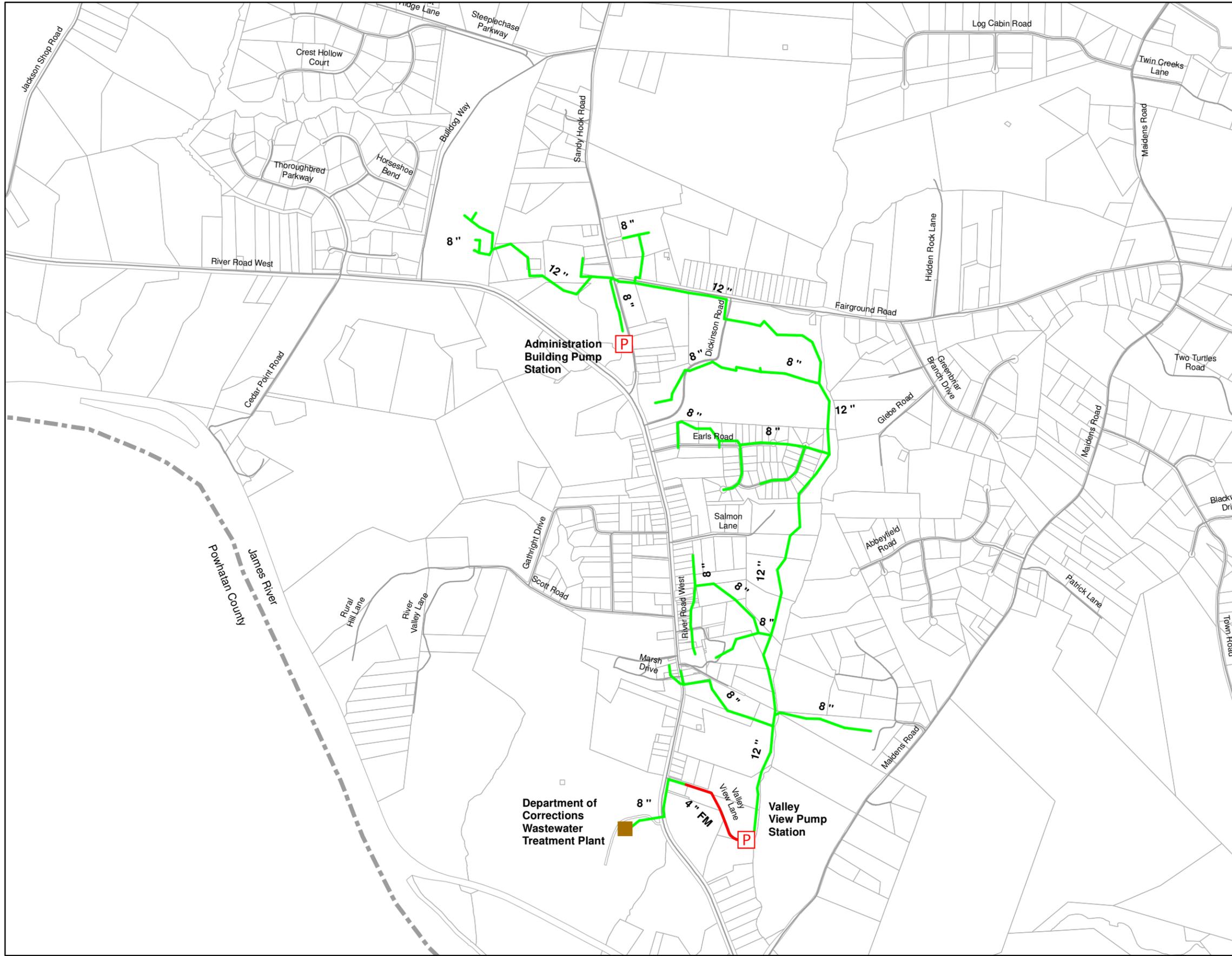
4.3.2 Flow Summary

For the period between January 2013 and December 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 778 residential and commercial customers as follows:

- Residential customers: 682
- Commercial customers: 96
- Total customers: 778

In 2013, the Eastern Goochland Wastewater Collection System collected and conveyed an average flow of approximately 400,000 gpd to Henrico County and the City of Richmond.

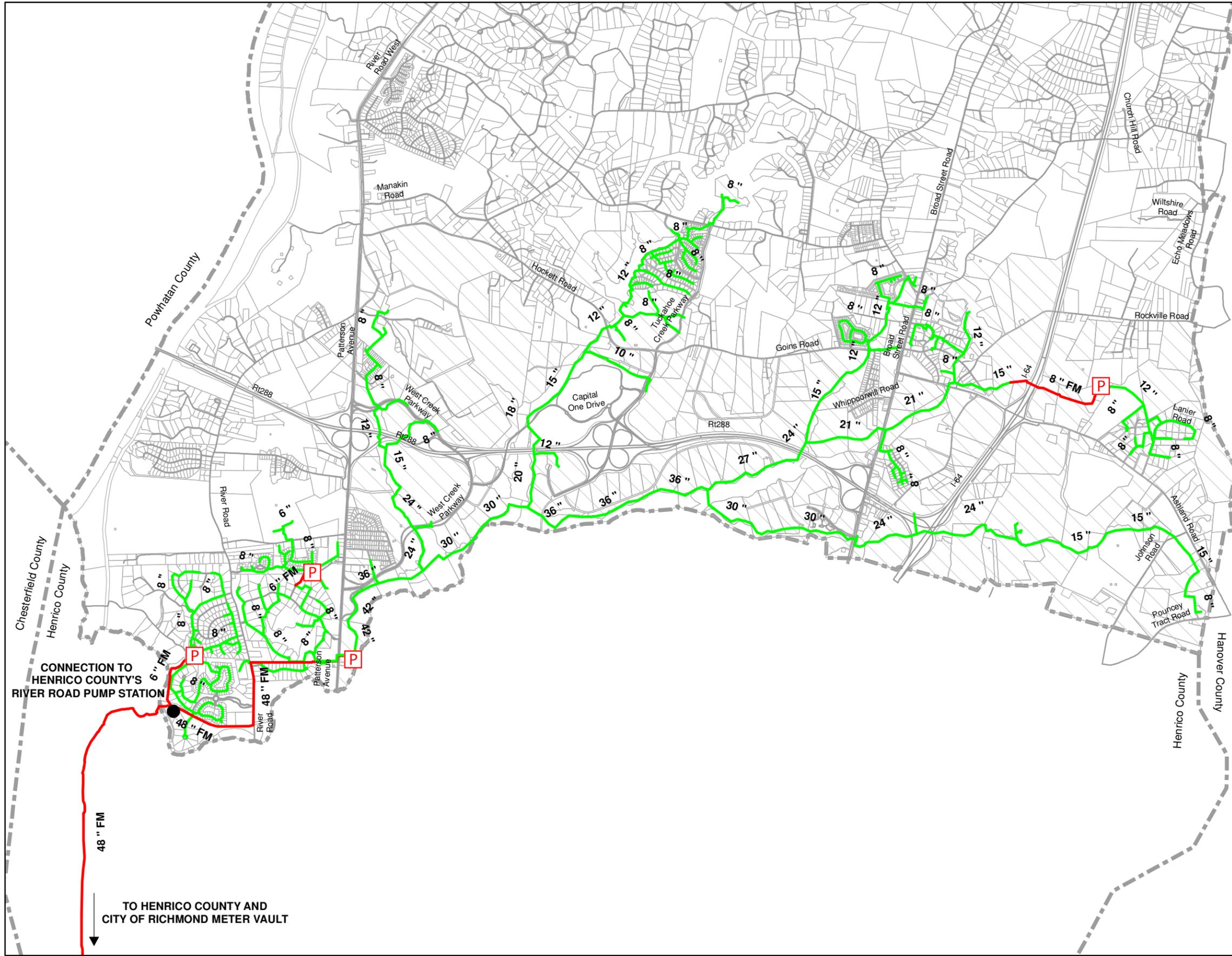
A plan schematic of the existing Eastern Goochland Wastewater System is shown in Figures 4-2.



- Legend**
- P Pump Station
 - VCCW WWTP
 - Force Main
 - Gravity Main
 - County Boundaries

Key Plan

 Dewberry Engineers Inc. 4805 LAKE BROOK DRIVE, SUITE 200 GLEN ALLEN, VIRGINIA 23060 PHONE: 804.290.7957 FAX: 804.290.7928	DATE 11/2014 PROJ. NO. 50061868	SCALE 1 inch = 1,500 feet PROJECT	TITLE COURTHOUSE AREA EXISTING WASTEWATER SYSTEM	FIGURE NO. 4-1
	UTILITY MASTER PLAN GOOCHLAND COUNTY, VA			



- Legend**
- P Pump Station
 - Force Main
 - Gravity Main
 - Existing TCSD
 - County Boundaries

Key Plan

CONNECTION TO
HENRICO COUNTY'S
RIVER ROAD PUMP STATION

48" FM

TO HENRICO COUNTY AND
CITY OF RICHMOND METER VAULT

FIGURE NO.

TITLE EASTERN GOOCHLAND AREA
EXISTING WASTEWATER SYSTEM

SCALE 1 inch = 4,500 feet

DATE 01/2015

PROJECT UTILITY MASTER PLAN
GOOCHLAND COUNTY, VA

PROJ. NO. 50061868

4-2

Dewberry
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Chapter 5 Future Demand Projections

5.1 General

Future conditions in Goochland County were evaluated to identify water and wastewater system improvements required to meet future needs associated with the projected growth of population within the Goochland Courthouse Service Area (GCSA) and Eastern Goochland Service Area (EGSA).

This Master Plan addresses future conditions and identifies required water and wastewater system improvements based on the development and geographic distribution of population and demand projections throughout the GCSA and EGSA for the planning period, which is defined as the Years 2015 through 2045. Note that data from January 2013 to December 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 GCSA and EGSA. This is particularly true of any project more than 3 years in the future.

5.2 Existing Water Demands and Sewer Loadings

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, and commercial/industrial developments. Another source of system demand includes manual flushing, which is conducted by the County periodically to improve water quality at dead end lines.

5.2.1 Existing Water Demands

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 and billing data from 2013 was provided by Goochland County for all of the water customers. The average daily water use at each meter was totaled and equaled approximately 61,200 gpd (including rented meters) in GCSA and approximately 411,400 gpd in EGSA.

These demands were compared with monthly billing data from VDOC and Henrico County at the master meters. During this same period, the monthly billing data indicated an average water supply by VDOC of approximately 75,500 gpd, which indicates that approximately 14,200 gpd or 19% of the water entering the GCSA is unaccounted for. The daily meter and monthly billing records provided by Henrico showed

an average water usage of approximately 483,300 gpd, which indicates that approximately 72,900 gpd or 15% of the water entering the EGSA is unaccounted for. It should be noted that some of the unaccounted for water includes activities such as unmetered routine flushing. Refer to **Table 5-1** for a summary of unaccounted for water usage in each pressure zone.

Table 5-1 Comparison of Goochland and Henrico County Water Meter and Billing Data

Existing Pressure Zone	Goochland County Billing Data (GPD)	Henrico County Billing Data (GPD)	Unaccounted Water Usage (GPD)	Unaccounted Water Usage (%)
Centerville	88,128	125,691	37,563	30%
West Creek and River Road High	237,010	261,347	24,338	9%
River Road Low	86,270	96,236	9,965	10%
Total Eastern Goochland	411,408	483,274	71,866	15%

It is recommended that Goochland County conduct a water system accountability study in both the Goochland Courthouse and Eastern Goochland Service Areas to determine the sources of unaccounted for water. In 2014, GCDPU found and repaired several leaks on the water system which would account for some of the unaccounted for water lost. In addition to the water accountability study, it is recommended that the County perform a billing comparison at the beginning of every year to gauge how much water is lost every year. This will allow the County to gauge whether the unaccounted for water is increasing or decreasing on a yearly basis.

5.2.2 Existing Sewer Loadings

A similar analysis was conducted for wastewater flow rates. Sewer billing data from 2013 was provided by Goochland County for all of the sewer customers. The average daily sewer loading for each consumer was totaled and equaled approximately 36,000 gpd in GCSA. In EGSA, average daily sewer loading within the Lower Tuckahoe Pump Station drainage area were estimated at 52,500 gpd. The Eastern Goochland Pump Station was estimated to receive an average daily sewer loading of 216,900 gpd.

These loadings were compared with monthly billing data from VDOC and Henrico County. During this same period, the monthly billing data indicated an average wastewater flowrate to the VDOC VCCW WWTP of approximately 42,300 gpd, which indicates that approximately 6,300 gpd or 15% of the water entering the GCSA is unaccounted for loading.

Henrico’s monthly billing data showed an average daily wastewater flowrate of 100,000 gpd from the Lower Tuckahoe Pump Station, which indicates that approximately 47,500 gpd or 48% of the wastewater entering the Lower Tuckahoe Pumping Station tributary is unaccounted for flow. This data may not be accurate because the Lower Tuckahoe meter was damaged for most of the year and as a result, Henrico County charged Goochland County based on historical use. It is recommended that the County perform a billing comparison study at the beginning of each year to compare data from the previous year.

The Eastern Goochland Pump Station received flow from both Goochland and Henrico Counties. Goochland and Henrico have an agreement in place that states Henrico will divert a minimum average daily flow rate of 1 MGD to the EGPS; however, Goochland does not have a way to measure wastewater flow into the Eastern Goochland Pump Station before the wastewater from Goochland County mixes with wastewater from Henrico County. Based on an agreement with Henrico County, it is assumed that 300,000 GPD of the flow entering the Eastern Goochland Pump Station is from Goochland County. Since there is no way to meter Goochland flow into the Eastern Goochland Pump Station, the unaccounted for flow to this pump station is unknown.

It is recommended that Goochland County install a flow measurement device to record influent flow from Goochland County to the Eastern Goochland Pump Station. This will allow the County to have a better understanding of how its system functions and can then quantify the amount of inflow and infiltration that enters the system during rain events.

It is recommended that Goochland County conduct an inflow and infiltration study in both the Goochland Courthouse and Eastern Goochland Service Areas to determine the sources of unaccounted for flow.

5.3 Development of Future Water Demands

Several workshops were held with Goochland 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 Goochland 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 are throughout the east end of the County and service to these neighborhoods have been included in this Master Plan and the future water demand projections.

It should be noted that all future development proposed in the EGSA was assumed to be incorporated into the TCSD, per the request of the County. Future water and sewer demands, recommended improvements, and CIP projects have been organized based on these targeted growth areas and county delineated village boundaries.

5.3.1 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 (2008). For each anticipated development, an assumed percentage of developable area applied to account for 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 between 1.5 and 8 units per acre based feedback from County staff, or the existing number of units in the subdivision if the area was already a developed neighborhood. The Comprehensive Plan (2008) used an assumed capita rate of 2.51 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.

5.3.2 Commercial/Industrial Water Demands

Future commercial and industrial demands were calculated based on assumed demands for planning used by Henrico County. It was assumed that future growth in these sectors would be similar to companies that are currently customers of the Henrico County water system as the observed growth trends appear to indicate the West End of Henrico County is expanding into Goochland County's East End, and therefore, their water usage would be expected to be similar.

Similarly to determining the residential water demand, for each anticipated commercial/industrial growth area, it was assumed that percent of the area would actually be developable based on the 2008 Comprehensive Plan, and this is due to various features throughout the county, such as streams, ponds, extreme elevation changes, etc.

Using the size of each growth area, a percentage of developable land within the area, and the demand per acre based on Henrico County's assumed planning demands, 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.

5.3.3 Other Water Demands

In addition to Goochland County demands, Powhatan County has approached Goochland County about the possibility of providing water service to their Route 711 Service Area, starting in 2020. The projected demands from the Powhatan County Route 711 Service Area have been included in the future demand projections.

5.3.4 Water Demand Factors

Maximum day demand projections were estimated based on reviewing supply data from Goochland and Henrico Counties for the Eastern Goochland water system. Based on this data, the maximum day factor was estimated to be between 2.5 times the average daily demand for the overall system. It was assumed that the maximum day factor would be reduced into a factor of 2 by the first planning period in 2020. A maximum day factor of 2 was assumed for existing demands and planning purposes for the Goochland Courthouse 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 maximum day demands. These peak hour factors varied between 0.5 and 2.5 for existing demands. Standard diurnal patterns from the American Water Works Association (AWWA) were utilized for future projected demands based on classification. These peak hour factors ranged between 0.16 and 3.0, with different patterns for residential, commercial, and industrial users.

5.3.5 Demand Calibration

To calibrate the projected water demands, it is essential to understand the anticipated growth within the County and within the GCSA and EGSA. Goochland County provided county-wide population census data was known for 2000, estimated population data from the Virginia Employment Commission (VEC) in 2010, and County projections for the years 2020 and 2030 with an assumed average growth rate of 2.25% as part of the 2008 Comprehensive Plan. Since some of the time steps for this Master Plan fell in between and beyond the years of predicted populations, populations for odd years (2015 and 2025) and future phases (2035 and 2045) were predicted by interpolation between years with predicted populations.

The future projected population growth was compared with population growth estimates developed during the future demand projection planning. This was accomplished by taking the increase in new residential demand between each time step and dividing that by 100 gpd per capita. This resulted in an anticipated increase in number of people within the service area for each time step.

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

Table 5-1 County-Wide Population Projections

Year	County-Wide Population
2010	22,078
2015	24,676
2020	27,580
2025	30,825
2035	38,507
2045	48,103

The population increase for each time step is given below:

Table 5-2 County-Wide Population Increase

Time Step	County-Wide Population Increase	Assumed Population Increase within the Water and Wastewater Service Areas (Based on Demand Projections)
2015 – 2020	3,978	4,514
2020 – 2025	3,246	3,898
2025 – 2035	7,682	6,926
2035 – 2045	9,596	9,750

As shown in **Table 5-2**, the projected population increase based on demand projections was higher than the predicted County-wide population increase projection in 3 out of 4 planning time steps. This was discussed with County staff and it was decided that the demand projections developed as part of this Utility Master Plan were more accurate than the previous county-wide population projections; therefore, no additional changes were made to the demand projections.

5.4 Wastewater Demand Projections

Wastewater demand projections were developed by assuming that 100% of the projected water usage at residential connections would enter the sewer collection system. For commercial/industrial wastewater demand projections, it was also assumed that 100% of projected water usage would enter the sewer collection system, with the exception of meters that were designated “irrigation” or “hydrant” by Goochland

County. Those meters were ignored when calculating wastewater demand, assuming that none of the water used as irrigation would enter the sewer system.

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 the James River Estates, Huguenot Hills, Lower Tuckahoe, and Homewood Park developments. Service to these neighborhoods has been included in this Master Plan and the future demand projections.

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 loose connections, poorly constructed joints or manhole connections, and old pipe.

Similar to water demand projections, it is necessary to apply a peak hour factor to the sewer flows in the system to account for variation of flows throughout the day for sizing of existing and future wastewater infrastructure. 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 (*k*) 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.

Henrico County and Goochland County have an agreement to provide Henrico County with up to 13 MGD peak hour flow at the Eastern Goochland Pump Station. This peak hour flow was added in each time step at even increments with the full 13 MGD peak hour flow being added at the end of the planning period in 2045.

Powhatan County has approached Goochland County about the possibility of providing wastewater service to their Route 711 Service Area, starting in 2020. The projected demands from the Powhatan County Route 711 Service Area have been included in the future demand projections.

5.5 Demand Projections Summary

A summary of the system demand projections for the Goochland Courthouse Service Area is shown on **Tables 5-3**. Refer to **Appendix A** for a detailed breakdown of demands.

Table 5-3 Courthouse Area Water Demands and Sewer Loadings (gpd)

Demand Category	2013	2020	2025	2035	2045
Existing Residential Demands	24,336	24,336	24,336	24,336	24,336
Existing Commercial Demands	33,451	33,451	33,451	33,451	33,451
Existing Hydrant Demands	3,370	3,370	3,370	3,370	3,370
Proposed Residential Demands	-	0	102,535	207,101	312,585
Proposed Commercial Demands	-	26,250	51,250	87,347	117,972
Total	61,157	87,407	214,942	355,605	491,714

A summary of the system demand projections for the Goochland Courthouse Service Area is shown on **Tables 5-4**. Refer to **Appendix A** for a detailed breakdown of demands.

Table 5-4 Eastern Goochland Area Average Water Demands and Sewer Loadings (gpd)

Demand Category	2013	2020	2025	2035	2045
Existing Residential Demands	211,666	211,666	211,666	211,666	211,666
Existing Commercial Demands	159,552	159,552	159,552	159,552	159,552
Existing Irrigation Demands	30,082	30,082	30,082	30,082	30,082
Existing Hydrant Demands	10,109	10,109	10,109	10,109	10,109
Existing Waterloss	69,826	69,826	69,826	69,826	69,826
Proposed Residential Demands	-	452,672	789,912	1,341,614	2,524,979
Proposed Commercial Demands	-	228,210	1,566,087	2,715,606	4,475,673
Proposed Powhatan Route 711 Demands	-	39,375	143,325	429,975	573,300
Total	481,234	1,201,491	2,980,557	4,968,429	8,055,187

Chapter 6 System Modeling

6.1 General

Goochland County's water and wastewater systems were modeled in order to evaluate system conditions throughout the planning period and to identify improvements required to existing systems and 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.

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 Utility 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 ranging in diameter from 2" to 24"
- Water storage tanks
- Booster pump stations
- Other source water connections (Henrico County and VDOC)
- Water meter locations (based on address)

Pipe modeling information was based on the updated GIS geodatabase provided by Goochland and updated by Dewberry. The GIS data provided by Goochland included lengths and diameters for the majority of the water pipes, and pipe material and year of installation for a minority of the pipes. Additionally, Dewberry updated a majority of the GIS data to reflect record drawing information provided by Goochland and field survey where record drawings were not available.

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 4-foot GIS topography contours provided by Goochland. These contours were converted to a raster image from which interpolated elevations were extracted and applied to each junction.

6.2.2 Model Demand Allocation

Two (2) sets of steady state 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**.

A diurnal demand pattern was developed for each pressure zone and incorporated into the model to simulate the hourly fluctuations of water usage throughout an average day and maximum day. These demand patterns were developed by using SCADA data for tank levels, pump run times, and pump suction and discharge pressures to create a system mass balance to determine hourly demand factors.

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 Goochland metered demand and Henrico SCADA and billing data. Differences in metered demands on an average basis was assumed to be a result of unmetered water usage such as manual flushing by DPU to maintain adequate water quality and/or water loss within the system. Unmetered demands were added uniformly throughout the system to more closely reflect flow entering each system at interconnections.

To ensure that a hydraulic model accurately calculates system headloss due to friction, the Hazen Williams pipe roughness coefficients must be estimated for each pipe to account for pipe roughness or friction loss. To aid in model calibration, the piping network was divided into roughness groups based on location, pipe diameter, approximate installation date, and available pipe material information. Each roughness group was assigned an initial pipe roughness coefficient based on best engineering judgment, with the final pipe roughness coefficients being determined during the automated calibration process. InfoWater utilizes an iterative algorithm to adjust the pipe roughness coefficients of the roughness groups to best fit the hydrant test data given the system features and demand inputs.

Once calibrated demand and pipe roughness coefficients were incorporated in to model, simulated pump station performance was compared to available SCADA information to ensure accuracy. Typical minor losses and roughness values modified as necessary at each pump station to ensure proper simulation of each pump station.

Finally, the points of interconnection to adjacent municipalities (Ridgefield, Patterson, and River Road) were modeled as pumping stations in order to account for upstream losses, specifically during high flow events. The pump curves were developed and calibrated based on available SCADA from Henrico and Goochland.

6.2.4 Model Scenarios

Once the model was calibrated, steady-state and extended period simulations (EPS) were run for each of the time increments (2015, 2020, 2025, 2035, and 2045) within the planning period to evaluate system improvement requirements and identify Utility Master Plan Capital Improvement Projects (CIPs).

Steady-state fire flow analysis was first completed to assess 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. Based on direction by the County, fire flows were modeled as a 1,500 gpm for a 2-hour period.

Following the steady state fire flow analysis, extended period simulations for a 60 day period using average day demands were run for each of the time increments to evaluate water age.

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. Included in the system model developed for this Master Plan were the following elements:

- Gravity sewer lines 8-inches in diameter or greater (trunk sewer system), as determined to be necessary for accurate modeling
- Sanitary sewer pump stations
- Force main piping

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 or field surveyed.

6.3.2 Model Loading

Peak hour loadings were allocated to the model in order to assess system capacity. These loadings were allocated in the model to the nearest manhole 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 4 and 5**.

6.3.3 Model Calibration

The wastewater collection and conveyance system model was calibrated to accurately represent existing function based on available billing data provided by Goochland. Loading calibration included a detailed comparison of Goochland, Henrico, and DOC billing data. Differences in loadings on an average basis were assumed to be a result of inflow and infiltration. Adjustments were not made to sewer loading data as part of this Utility Master Plan. A separate memorandum was prepared to guide the County in identifying and addressing sources of inflow and infiltration.

6.3.4 Model Scenarios

Analyses were run for each of the time increments (2015, 2020, 2025, 2035, and 2045) within the planning period to evaluate system improvement requirements and identify Master Plan Capital Improvement Projects (CIPs).

The peak hour steady state analysis was used to evaluate system capacity during a peak hour event. Peaking factors for each sub-drainage basin were determined based on average day loading conditions and equivalent population data.

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**.

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 areas through the Year 2045. 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.

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 analysis results and improvements is provided in the following sections and are shown in **Figures 7-1 through 7-18**. More detailed descriptions of individual improvement are provided at the end of this chapter.

7.2 Existing Water Distribution System Evaluation

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: domestic pressures, fire flow availability, and water age. Steady-State Simulations were utilized at each time step to analyze fire flow availability during peak hour demands. Extended Period Simulations (EPS) were performed using projected average day demands and maximum day demands. The results of these EPS simulations identified areas with low or high pressure and extended water ages.

7.2.1 Goochland Courthouse Service Area

The water model was utilized to evaluate existing system conditions and proposed improvements to address any identified system deficiencies.

7.2.1.1 Goochland Courthouse Existing Water System Conditions

For the maximum day scenario, the operation of the VDOC booster pump station was simulated based on a timer filling the elevated storage tank at 7:00 am and 3:00 pm daily. The minimum tank level observed during maximum day demands with these simulated controls was 23 feet above the bottom of the bowl or approximately 75% full. As shown on **Figure 7-1**, minimum domestic pressures under these conditions were estimated to be approximately 45 psi, which is above the minimum County standard of 35 psi.

A 2 hour, 1,500 gpm fire event was simulated in the Courthouse pressure zone at nodes nearest each fire hydrant location, based on GIS data provided by the County. The VDOC booster pump station was assumed to be off during a fire event because there is no emergency generator to provide power in an emergency situation. As indicated on **Figure 7-2**, the results of the analysis indicate that a significant portion of the Goochland Courthouse Water System does not meet the minimum County fire flow requirements.

In order to evaluate water age within the water distribution system, an extended period simulation was performed under average day demand condition. The results of this analysis, shown on **Figure 7-3**, indicate that the water age in the system is within a reasonable water age with the exception of the waterline along Hidden Rock Lane and the fire line at J. Sergeant Reynolds campus.

As discussed in **Chapter 3**, based on a comparison of the County's billing data, approximately 19% of the water supplied by VDOC is unaccounted for in the County's water metering system. Differences in metered demands on an average basis were assumed to be a result of unmetered water usage such as manual flushing by the County to maintain adequate water quality and/or water loss within the system. It will be important for Goochland 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. Consequently, it is recommended that the County conduct a water system audit to determine to sources of unaccounted for water in the distribution system.

7.2.1.2 Goochland Courthouse Existing Water System Improvements

The water model was utilized to model proposed improvements to address the identified issues. In order to supply the existing distribution system with the required fire flows, a significant portion of the water lines would require upsizing along with the addition of new water lines to create more looping in the system. The following improvements were identified in order to increase available fire flow in areas where minimum standards are not attained:

1. Upsize existing waterline along River Road West from elevated water storage tank to the intersection of River Road West and Sandy Hook Road from 10-inch to 16-inch or install a parallel waterline with a combined equivalent hydraulic capacity
2. Install 8-inch waterline to complete loop at Goochland High School and Goochland Middle School campus
3. Upsize existing waterline at J. Sergeant Reynolds campus from 4-inch to 10-inch
4. Install 12-inch waterline to close loop between the Goochland High School and Goochland Middle School campus and Holland Hills
5. Install 8-inch waterline to close loop in Holland Hills along Thoroughbred Parkway and Incline Court

With these improvements incorporated into the model, it was projected that the existing water distribution system would be able to provide the minimum required fire flow of 1,500 gpm for 2 hours at all existing hydrants with the exception of the hydrant located near the Goochland County Fairgrounds. It is estimated that the proposed improvements would increase available fire flow at that hydrant from approximately 975 gpm to 1,200 gpm; however, the construction of a water line loop of approximately 1 ½ miles in length would be required to increase fire flow capacity to 1,500 gpm. Based on future projections, it is anticipated that residential development will occur where the loop would be required; therefore, if approved by the fire marshal, it is recommended that the County put off this project until it is funded as part of the future development.

In order to address water age issues, the following improvements are recommended:

1. Modify VDOC booster station controls to automatically cycle based on the Goochland Courthouse Elevated Tank level. This would allow for the optimal cycling of the tank level to minimize water age.
2. Install a mixer within the existing tank to minimize stratification.
3. Install auto-flusher at the Goochland County Fairgrounds
4. Install back flow preventer on the fire suppression line at J. Sergeant Reynolds campus

It is recommended that the County conduct a tank mixing evaluation prior to installing an automated mixing system in the elevated storage tank. It is anticipated that tank mixing is poor based on the inlet and outlet piping configuration of the existing elevated water tank. If stratification is confirmed, a mixer should be installed to ensure complete mixing which will reduce water age within the tank; thereby, reducing flushing requirements.

Refer to **Figure 7-7** for an exhibit showing the recommended improvements to the existing Goochland Courthouse Water System.

7.2.2 Eastern Goochland Service Area

The water model was utilized to evaluate existing system conditions and proposed improvements to address any identified system deficiencies. The water system discussion is divided by pressure zone. Refer to **Figures 7-4 through 7-6** for additional information on estimates for the existing system domestic pressures, fire flow availability, and water age.

7.2.2.1 Eastern Goochland Existing Water System Conditions

The existing system was analyzed for minimum domestic pressures, fire flow availability, and water age. Minimum domestic pressures and fire flow availability were evaluated under a maximum day demand scenario and water age was evaluated under an average day demand scenario.

Centerville Pressure Zone

The Centerville Pressure Zone is supplied with water through the Centerville Booster Pump Station located at the Broad Street connection. The Centerville Booster Pump Station is currently controlled by water level relative to the bottom of the bowl in the Centerville Elevated Storage tank. The lead pump is initialized when the water level drops to 9-feet. The lag pump is activated if the water level continues to fall below 7-feet. The operation of both lead and lag pumps is terminated when the water level exceeds 12-feet.

Based on existing operation, minimum domestic pressures during maximum day demand conditions is 30 psi which is below the County standard of 35 psi. The existing hydrants within the pressure zone were simulated to exceed the County fire flow requirements with the exception of hydrants at Lanier Industrial Park and north along Ashland Road towards Aw Shucks Country Store. Extended water ages were predicted to occur at Aw Shucks and Manakin Road near the Parke at Saddlecreek, which corresponds to known water odor complaints that the County has received. Additionally, the 24-inch waterline along Route 288 up to the Route 288 PRV Vault does not get turned over because it is only open in the event of an extreme low pressure event in the West Creek Pressure Zone.

West Creek Pressure Zone

The West Creek Elevated storage is currently filled by the operation of control valves at the Ridgefield Parkway and Patterson Avenue interconnections to Henrico County's water distribution system. Control valve operations are based on tank water level, opening at 24.5 feet and closing at 36 feet. The interconnection to the Centerville pressure zone along the Route 288 alignment is available in case of emergencies to supplement flow and pressure during high demand events; however, this interconnect is infrequently utilized, contributing to extended water ages.

Based on existing operation, minimum domestic pressures during maximum day demand conditions is 30 psi, which is below the County standard of 35 psi. Fire flow capacity below County standards was simulated in Kinloch, River Gate and west of West Creek Parkway towards the Richmond Country Club. Extended water ages were also observed throughout the West Creek pressure zone including the Tuckahoe Creek Parkway, West Creek Parkway, and Route 288 corridors.

River Road Low Pressure Zone

The River Road Low Pressure Zone is served by an interconnection to Henrico County along River Road. There are no storage facilities owned by the County in this pressure zone, therefore, all fire protection is currently provided by Henrico County. Based on existing operation, minimum domestic pressures during maximum day demand conditions are estimated at 45 psi. Due to a single supply source and small pipe

diameters, the pressure zone could not provide the County required fire flow. There were no areas within the pressure zone that had extended water ages.

River Road High Pressure Zone

The River Road High Pressure Zone is supplied with water through the River Road Booster Pump Station which pumps from the West Creek Pressure Zone. The River Road Booster Pump station consists of three booster pumps and a 10,000 gallon hydro-pneumatic tank. Based on existing operation, minimum domestic pressures during maximum day demand conditions are approximately 40 psi. Therefore, no improvements are required to improve domestic pressures.

Based on the results of the analysis, due to limited firm capacity of the River Road Booster Pump Station, none of the hydrants within the pressure zone could supply the County required fire flow.

Due to long dead-end lines with minimal demand, extended water ages exceeding 14 days were simulated near the Benedictine College Preparatory.

7.2.2.2 Eastern Goochland Existing Water System Improvements

The water model was utilized to model proposed improvements to address the identified issues. In general, before evaluating capital upgrades, water system operational optimization was evaluated first to minimize the need for infrastructure upgrades. The recommended improvements to the existing water distribution system are divided by pressure zone.

Centerville Pressure Zone Improvements

In order to increase domestic pressures to meet the County's minimum requirements of 35 psi, the Centerville Tank and Booster Pump Station operation will need to be modified to maintain a minimum tank water level of 18-feet. Increasing the minimum water level of this pressure zone to maintain a minimum domestic pressure of 35 psi would also improve fire flow availability and would exceed the County's minimum requirement for fire storage.

To improve available fire flow in the Lanier Industrial Park to above 1,500 gpm, it is recommended that two dead end lines in the industrial park be closed with a loop. This would require the construction of a 12-inch water line linking the existing waterlines on Lanier Road and Commerce Center Drive.

The most significant challenge in reducing water age in the Centerville Pressure Zone is to increase turnover in the 24-inch main along Route 288. In order to increase flow through this water main, it is recommended that the Centerville pressure zone be expanded south to include the Kinloch Development and the West Creek Emergency Center. A new control valve vault would be required at the new interconnection

point between the modified Centerville and West Creek pressure zones to provide limited flow through the interconnection to maintain adequate turnover and prevent extended water ages at the interconnection. This control valve would also be configured to allow flow from the Centerville Elevated Water Storage Tank and Centerville Booster Pump Station to supplement fire flows in the West Creek, River Road Low, and River Road High pressure zones, as required for redundancy.

The water model was used to optimize pump controls to reduce water age within the Centerville Tank by increasing the operating range to maintain an average theoretical residence time of 3 days. Based on this analysis, the pump off control set point is recommended to be set at 27 feet and pump on level is recommended at 18 feet. Optimizing the pump controls and tank operation will reduce the amount of flushing required to reduce water age and maintain higher disinfectant residuals. Additionally, in order to minimize stratification in the tank, the installation of a mixer is recommended.

Improvements will also be required to address the extended water ages at the Parke at Saddle Creek Development and Aw Shucks Country Store. Both locations are at the extremities of the pressure zone and at dead ends; therefore, the installation of auto-flushers at both locations is recommended. The County has received numerous water quality complaints in these areas which are thought to be due to low total chlorine residual. Although flushing would increase the total chlorine concentration in these areas, the County does not currently have control of the total chlorine residual entering the system at the Broad Street connection. Based on monitoring information, the total chlorine residual concentrations at the Board Street connection are below 2 mg/L on fairly regular basis which means that by the time the water reaches the system extremities, the total chlorine residual is below 0.5 mg/L. Although installing auto-flushers will help increase the residual, it is also recommended that the County construct a chloramine booster station at the Centerville Booster Pump Station to will allow control of the total chlorine residual entering the system. The installation of the chloramine booster station would also reduce the amount of flushing required.

West Creek Pressure Zone Improvements

The West Creek Elevated Tank is the main cause of the low pressure and high water age issues within the West Creek Pressure Zone. This is due to the fact that the tank elevation is too low. When the Patterson and Ridgefield connections are open, the majority of the system pressures are sufficient; however, when these connection are closed during the normal tank fill/draw cycle, the system pressure is supplied by the tank which is too low. If the tank were operated to ensure a minimum domestic system pressure of 35 psi, the tank level could not be lower than 90% full which presents a significant water turnover issue. Even with the current set up, the model results indicate that the Patterson and Ridgefield water supply connections supply the majority of the system demand and the water in the West Creek Elevated Tank cycles back and forth the between the tank and piping along West Creek Parkway. This is due to the fact that the tank is located towards an extremity of the system with minimal demand surrounding it.

The results of the modeling indicated that if the West Creek Tank provided approximately 30 feet of additional pressure, the system would function more efficiently, resulting in better tank turnover and higher pressures. The following alternatives were analyzed to improve the West Creek Pressure Zone to meet the County's minimum system requirements:

1. *West Creek Tank Booster Pump Station*

This option would require the installation of a booster pump station at the West Creek Tank to pump out of the tank to increase the Hydraulic Grade Line (HGL) during times when the tank supplied water to the system. In order to prevent the system pressure from dropping during tank fill periods, a back pressure sustaining valve would have to be installed at the tank fill line.

2. *Increase Tank Height*

This option would require that the existing tank height be increased by approximately 30 feet. Although this may be possible, it is expected that this would cost in excess of \$500,000, which is a significant sum of money to invest in a tank that is over 25 years old. Additionally, the tank location is not ideal which would be another drawback to investing money into the tank.

3. *Decommission Tank*

Model results indicate that if the West Creek tank were taken offline, and the system floated off of the Ridgfield and Patterson connections, the minimum system pressures would increase above 35 psi and water age would be significantly reduced. Under this option, there would still be a connection to the Centerville Pressure Zone which would allow the West Creek Pressure Zone to utilize the fire storage in the Centerville Tank, if needed during a fire event. The current storage at the Centerville Tank would be sufficient to satisfy the current system storage requirements. This option would also allow the construction of a new elevated tank(s), in the future when needed, in a more ideal location and at a higher elevation.

Based on the evaluation of the above options, it is recommended that the County decommission the existing West Creek Elevated Water Storage Tank. Although this may seem counterintuitive, this is the best option as the tank is currently not needed, it is causing pressure and water age issues, this allows the construction of future elevated tanks in more optimum locations and at a higher elevation, and this is a low capital and operational and maintenance cost option. With these modifications, the only auto flusher that would be recommended in the West Creek Pressure Zone would be at the Kinloch Development, since it is at the end of the system,

Due to a few higher elevation areas being served by smaller diameter lines, two water line upgrades will be required to achieve the minimum fire flow of 1,500 gpm within the West Creek Pressure Zone. These improvements are listed below:

1. Upsize existing waterline service to the Richmond Country Club from 8-inch to 12-inch
2. Install 8-inch waterline from Barwick Lane in Rivergate to Patterson Avenue for an additional loop

With the implementation of the improvements discussed in this section, it is anticipated that the system operation will meet the minimum requirements of the County.

River Road Low Pressure Zone Improvements

As discussed in the previous section, the River Road Low Pressure Zone has sufficient domestic pressures and low water age; however, due to older and smaller diameter piping, the system does not meet the County's 1,500 gpm minimum fire flow requirement. The water model was utilized to identify improvements to increase fire flow capacity. These improvements included a combination of upsizing existing water lines, adding additional looping, and adding an emergency connection to the West Creek Pressure Zone. The improvements identified are summarized below:

1. Reconfigure system piping and valving to include the western portion of the lower Tuckahoe Subdivision in the River Road Booster High Pressure Zone
2. Open interconnection between West Creek and River Road Pressure Zone and install a control valve to ensure adequate flow from West Creek to River Road Low in order to maintain adequate turnover of the interconnection piping and additional fire flow capacity
3. Upgrade the existing water main along River Road Road to from 8-inch to 12-inch
4. Install 8-inch water line to complete loop in Randolph Square

With the implementation of the improvements discussed in this section, it is anticipated that the system operation will meet the minimum requirements of the County.

River Road High Pressure Zone Improvements

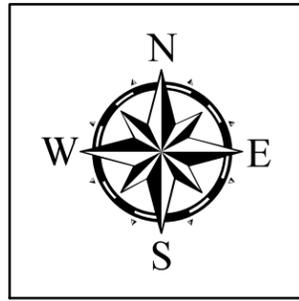
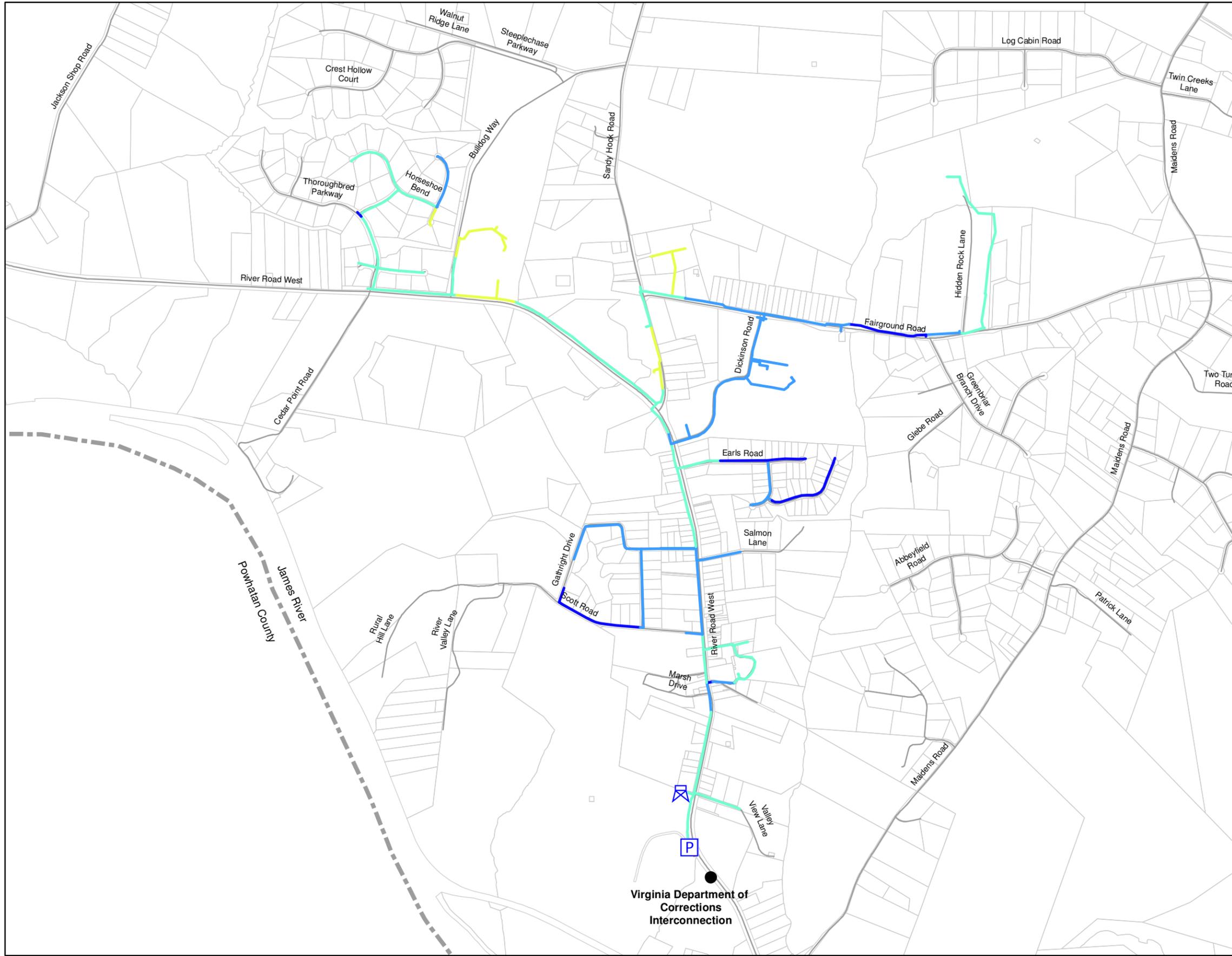
Since each existing booster pump at the River Road Booster Pump Station has a maximum capacity of approximately 600 GPM, the system is incapable of providing the required 1,500 gpm fire flow plus maximum day demand with two pumps on (firm capacity). Therefore, it is recommended that two of the pumps be replaced with higher flow pumps (~2,000 gpm each) to meet the fire flow requirement. This would also require some pipe and valve upgrades at the booster station, new VFDs, larger generator, and electrical improvements. The new pumps should be sized to allow them to be used in the future when additional water transfer capacity will be needed through the River Road Booster Pump Station.

In addition to the booster pump station upgrades, the following water line improvements would be required to provide the required fire flow within this pressure zone:

1. Install 12-inch waterline and bore under River Road to connect the Lower Tuckahoe Residential Development to the River Road High Pressure Zone
2. Upsize existing waterline in western portion of Lower Tuckahoe Residential Development from existing 6-inch and 8-inch aged cast iron to 8-inch DIP and close loops
3. Install check valves on interconnections between River Road High and Low Pressure zones to allow flow from the lower pressure system into the higher pressure system during emergency scenarios
4. Upsize existing 8-inch waterline along River Road between Pembroke Lane and Berkley Drive to 12-inch
5. Complete system looping near Benedictine College Preparatory

To reduce water age at Benedictine College Preparatory, it is recommended that an auto-flusher be installed at this location.

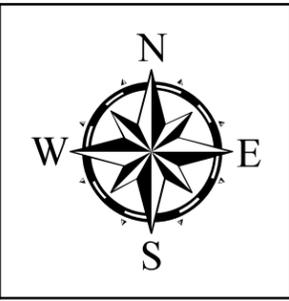
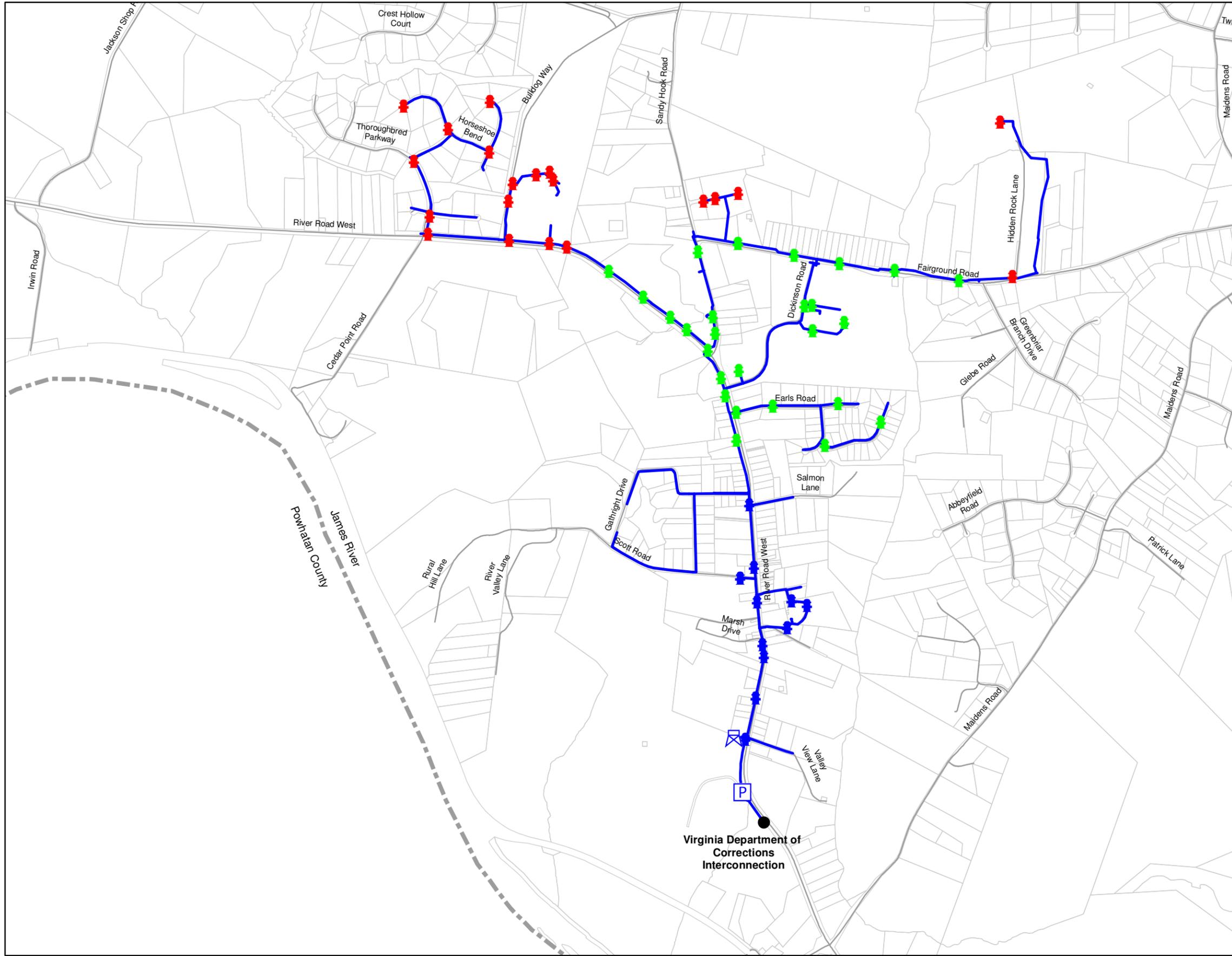
Refer to **Figures 7-8 through 7-11** for exhibits showing the recommended improvements to the existing Eastern Goochland Water System.



- Legend**
- System Interconnection
 - Minimum Pressure**
 - Less Than 35 psi
 - 35-45 psi
 - 45-55 psi
 - 55-65 psi
 - Greater Than 75 psi
 - P Booster Pump Station
 - [X] Elevated Storage Tank
 - VACountiesLine

Key Plan

 Dewberry Dewberry Engineers Inc. 4805 LAKE BROOK DRIVE, SUITE 200 GLEN ALLEN, VIRGINIA 23060 PHONE: 804.290.7957 FAX: 804.290.7928	DATE 11/2014	SCALE 1 inch = 1,500 feet	TITLE COURTHOUSE AREA MINIMUM WATER PRESSURES	FIGURE NO. 7-1
	PROJ. NO. 50061868	PROJECT UTILITY MASTER PLAN GOOCHLAND COUNTY, VA		



Legend

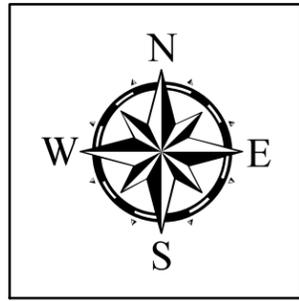
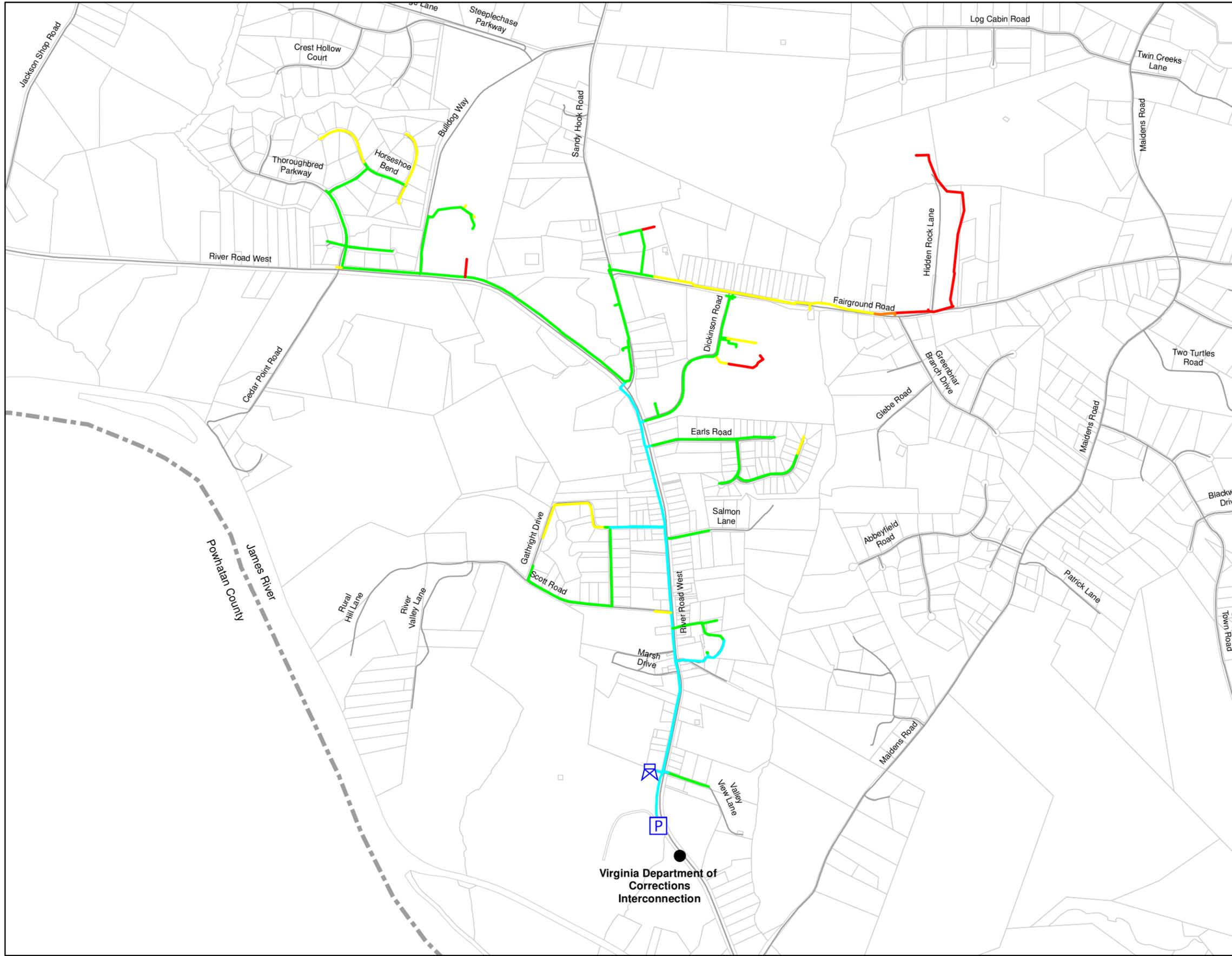
- County Boundary
- System Interconnection
- Waterline

Fire Flow Availability

- Less Than 1,000 gpm
- 1,000 gpm to 1,500 gpm
- Greater Than 1,500 gpm

Key Plan

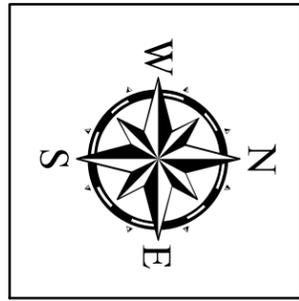
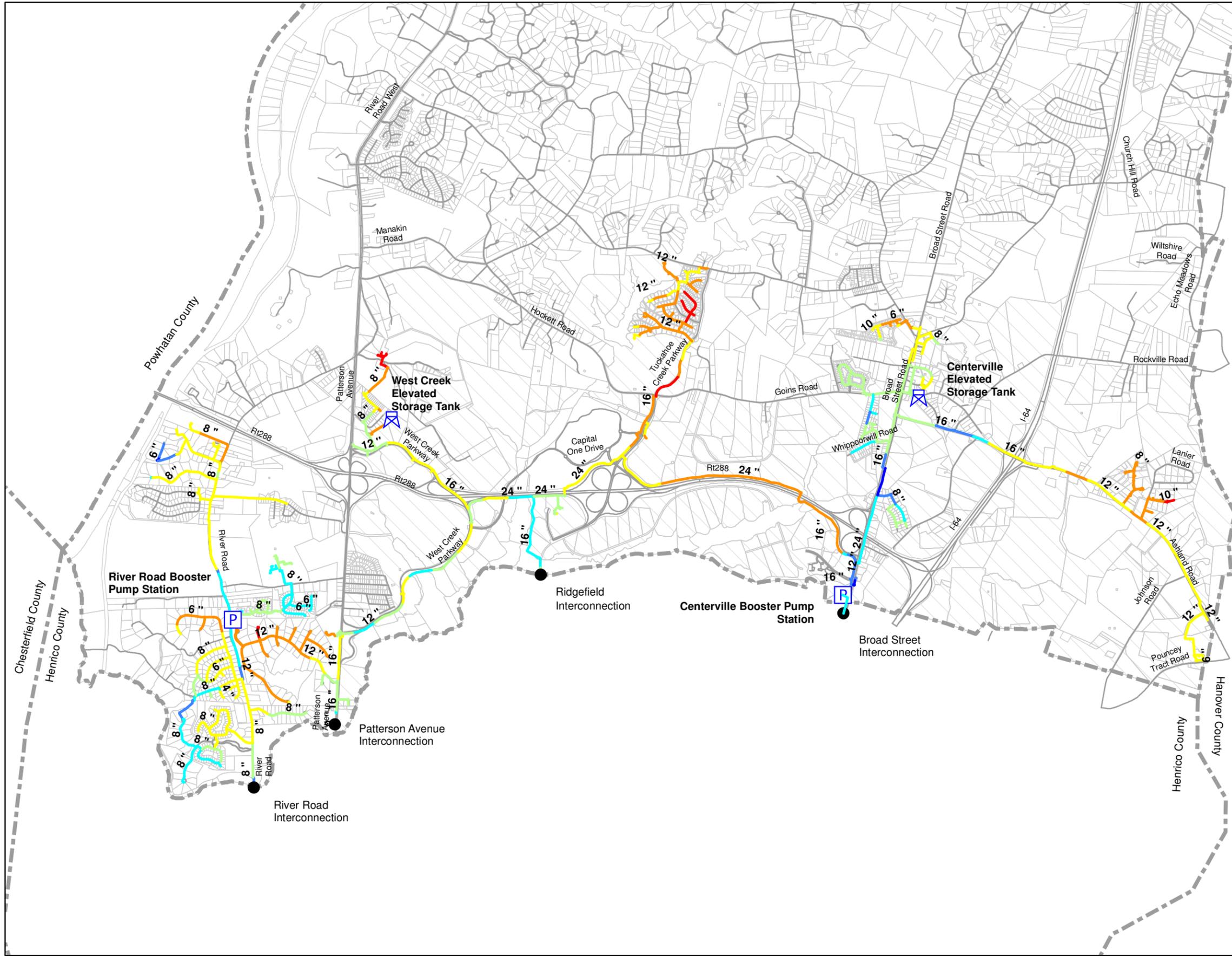
 Dewberry Dewberry Engineers Inc. 4805 LAKE BROOK DRIVE, SUITE 200 GLEN ALLEN, VIRGINIA 23060 PHONE: 804.290.7957 FAX: 804.290.7928	DATE 11/2014	SCALE 1 inch = 1,500 feet	TITLE COURTHOUSE AREA EXISTING FIRE FLOW	FIGURE NO. 7-2
	PROJ. NO. 50061868	PROJECT UTILITY MASTER PLAN GOOCHLAND COUNTY, VA		



- Legend**
- System Interconnection
 - P Booster Pump Station
 - ▲ Elevated Storage Tank
- Water Age**
- Less Than 3 Days
 - 3 Days to 7 Days
 - 7 Days to 10 Days
 - 10 Days to 14 Days
 - 14 Days to 17 Days
 - Greater Than 17 Days
 - County Boundaries

Key Plan

 Dewberry Dewberry Engineers Inc. 4805 LAKE BROOK DRIVE, SUITE 200 GLEN ALLEN, VIRGINIA 23060 PHONE: 804.290.7957 FAX: 804.290.7928	DATE 11/2014	SCALE 1 inch = 1,500 feet	TITLE COURTHOUSE AREA EXISTING WATER AGE	FIGURE NO. 7-3
	PROJ. NO. 50061868	PROJECT UTILITY MASTER PLAN GOOCHLAND COUNTY, VA		



Legend

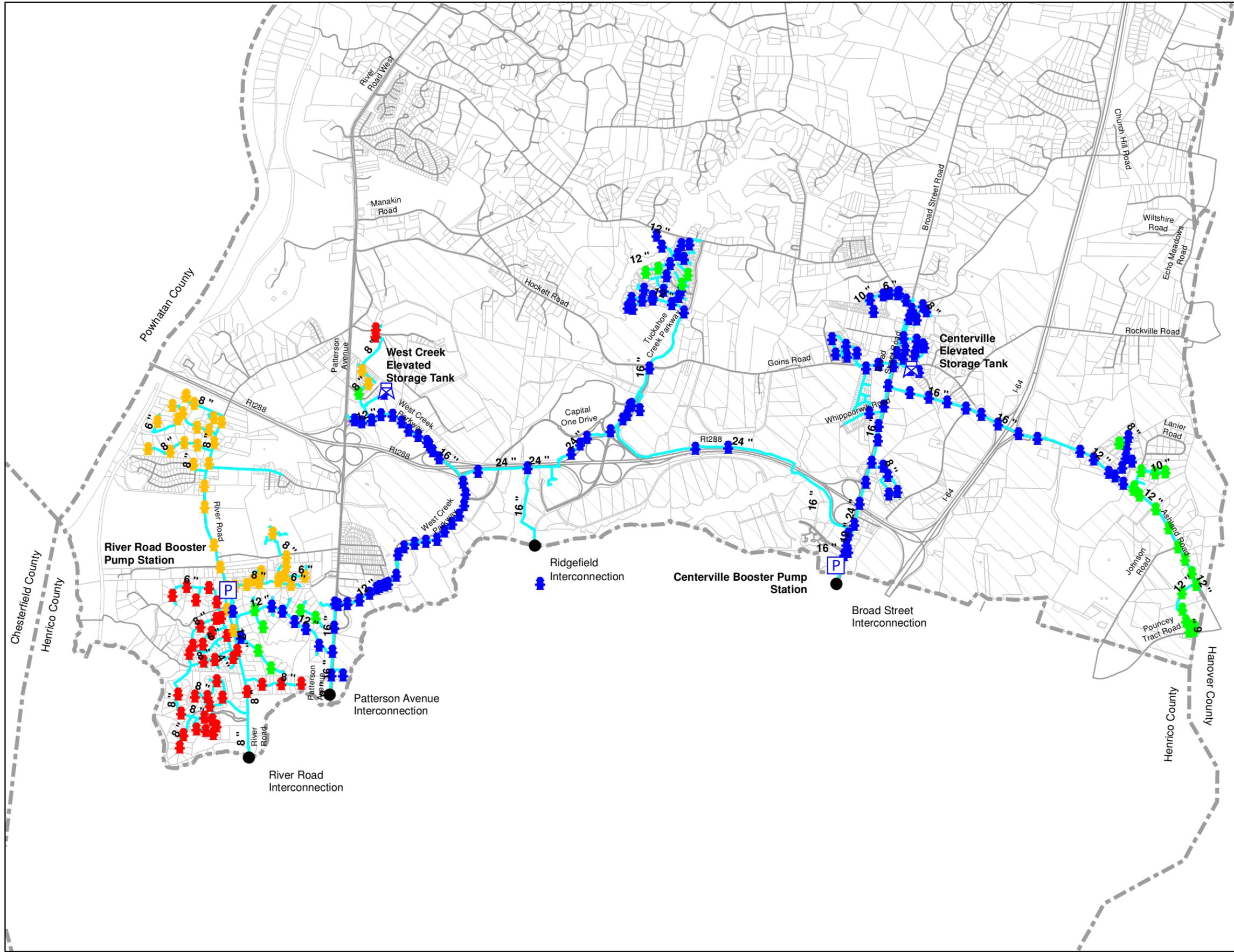
- County Boundary
- System Interconnection
- ⊠ Elevated Storage Tank
- Ⓟ Booster Pump Station

Minimum Pressure

- Red: Less Than 35 psi
- Orange: 35-45 psi
- Yellow: 45-55 psi
- Light Green: 55-65 psi
- Cyan: 65-75 psi
- Blue: 75-85 psi
- Dark Blue: Greater Than 85 psi

Key Plan

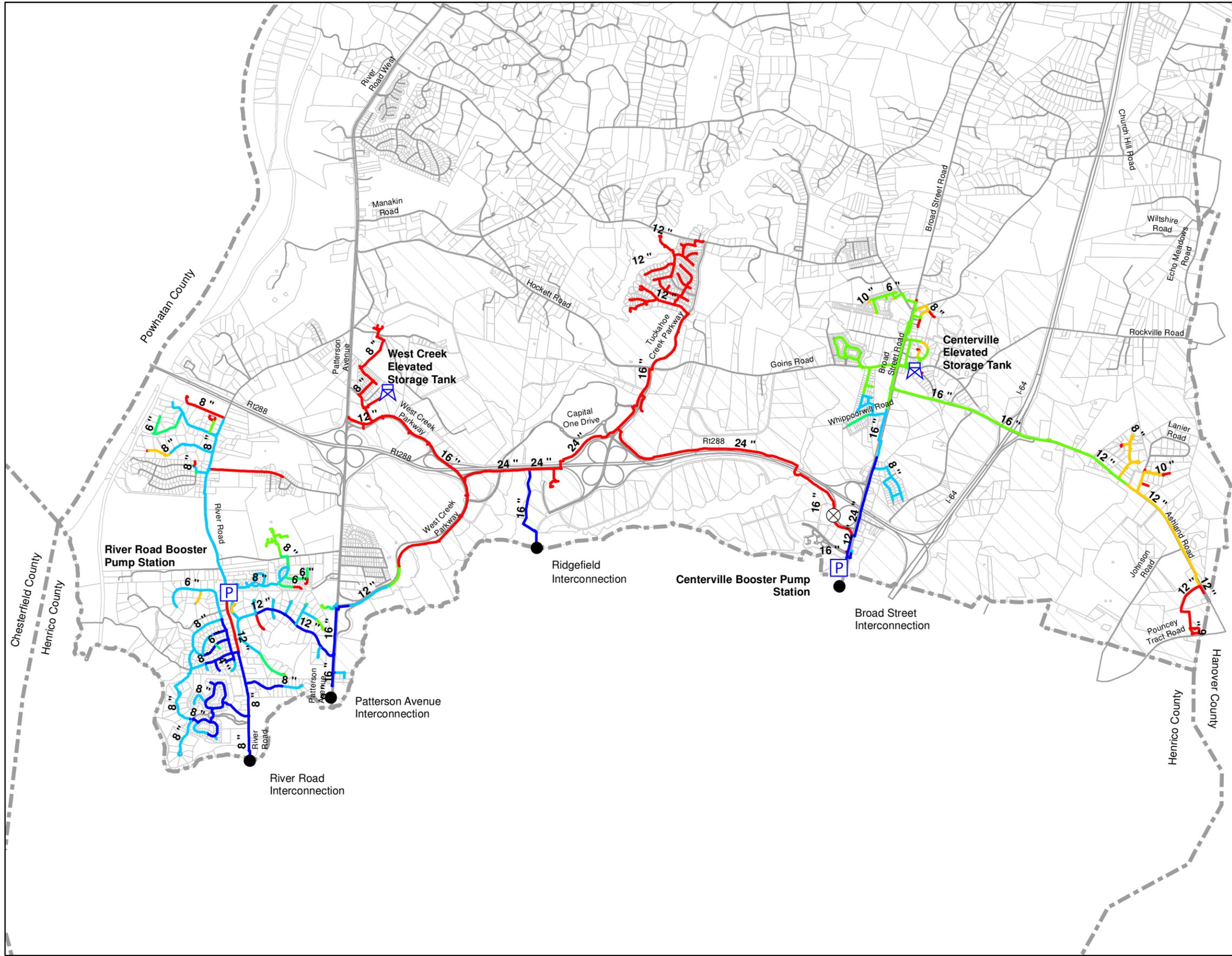
 Dewberry Dewberry Engineers Inc. 4805 LAKE BROOK DRIVE, SUITE 200 GLEN ALLEN, VIRGINIA 23060 PHONE: 804.290.7957 FAX: 804.290.7928	DATE 01/2015	SCALE 1 inch = 4,500 feet	TITLE EASTERN GOOCHLAND AREA MINIMUM WATER PRESSURES	FIGURE NO. 7-4
	PROJ. NO. 50061868	PROJECT UTILITY MASTER PLAN GOOCHLAND COUNTY, VA		



- Legend**
- System Interconnection
 - ▬ County Boundary
 - ⊠ Elevated Storage Tank
 - Ⓟ Booster Pump Station
 - Less Than 500 gpm
 - 500 gpm to 1,000 gpm
 - 1,000 gpm to 1,500 gpm
 - Greater Than 1,500 gpm

Key Plan

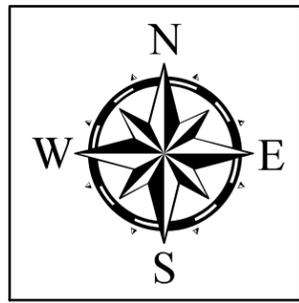
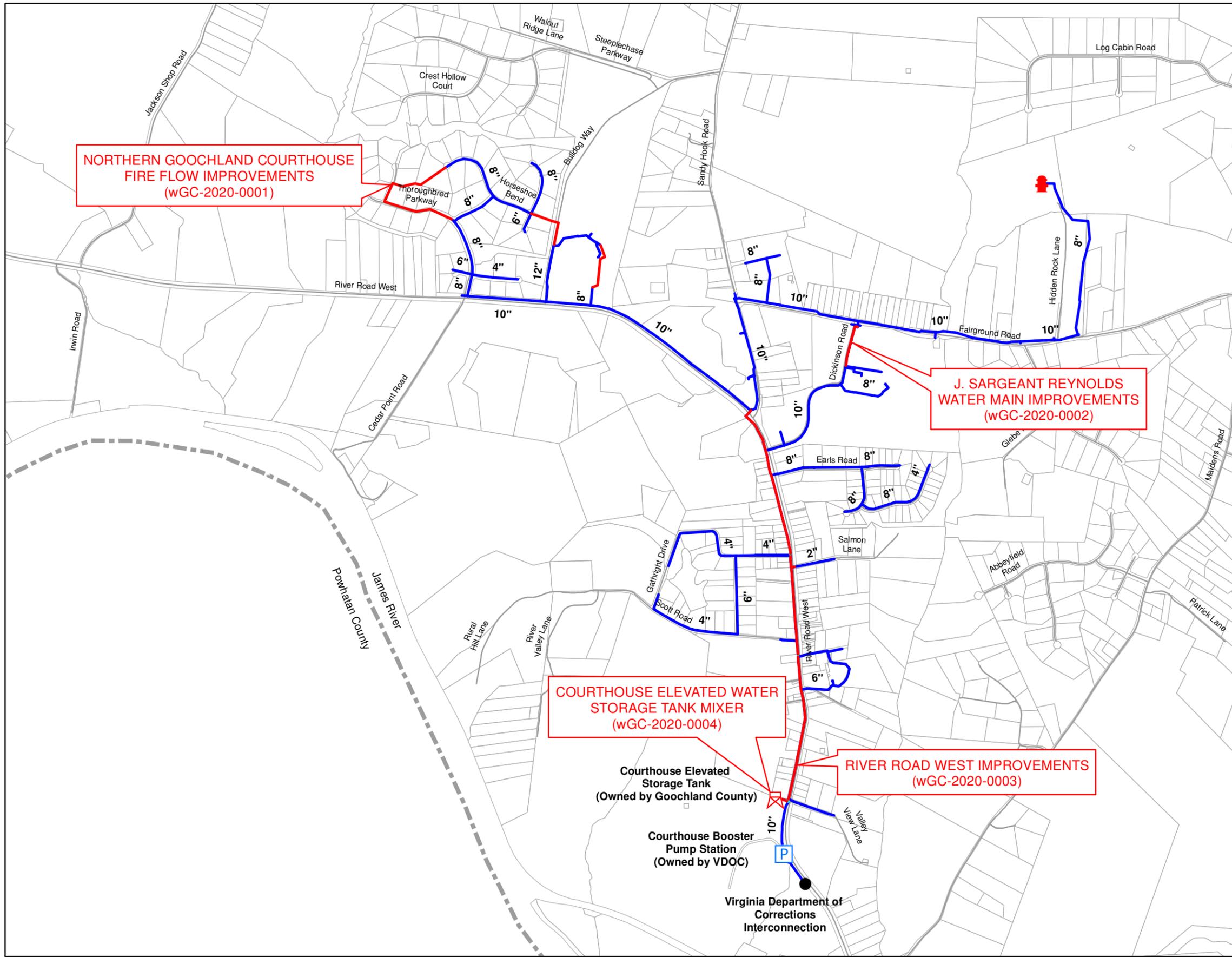
 Dewberry Dewberry Engineers Inc. 4805 LAKE BROOK DRIVE, SUITE 200 GLEN ALLEN, VIRGINIA 23060 PHONE: 804.290.7957 FAX: 804.290.7928	DATE 11/2014	SCALE 1 inch = 4,500 feet	TITLE EASTERN GOOCHLAND AREA EXISTING FIRE FLOW	FIGURE NO. 7-5
	PROJ. NO. 50061868	PROJECT UTILITY MASTER PLAN GOOCHLAND COUNTY, VA		



- Legend**
- System Interconnection
 - County Boundary
 - Max Water Age**
 - Blue line: Less Than 3 Days
 - Cyan line: 3 Days to 7 Days
 - Green line: 7 Days to 10 Days
 - Yellow-Green line: 10 Days to 14 days
 - Yellow line: 14 Days to 17 Days
 - Red line: Greater Than 17 Days
 - ⊕ Elevated Storage Tank
 - Ⓟ Booster Pump Station

Key Plan

 Dewberry Engineers Inc. 4805 LAKE BROOK DRIVE, SUITE 200 GLEN ALLEN, VIRGINIA 23060 PHONE: 804.290.7957 FAX: 804.290.7928	DATE 11/2014	SCALE 1 inch = 4,500 feet	TITLE EASTERN GOOCHLAND AREA EXISTING WATER AGE	FIGURE NO. 7-6
	PROJ. NO. 50061868	PROJECT UTILITY MASTER PLAN GOOCHLAND COUNTY, VA		

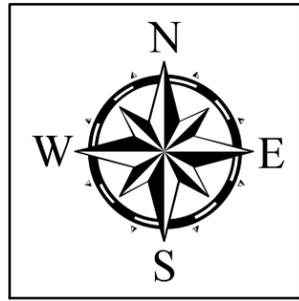
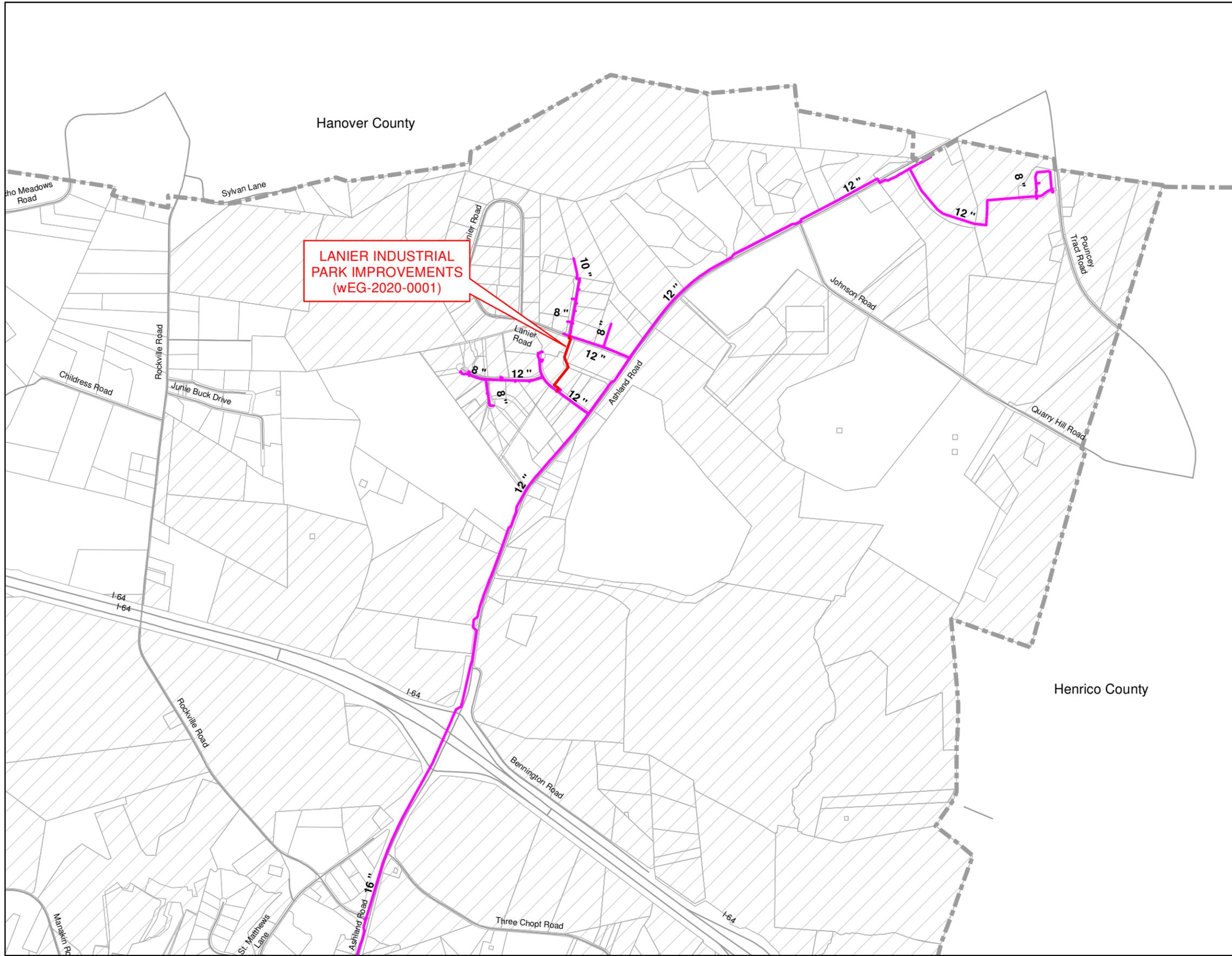


Legend

- County Boundaries
- System Interconnection
- Booster Pump Station
- Fire Improvement**
 - Check Valve
 - Control Valve
 - Gate Valve
 - Limited Fire Fire Location
- Quality Improvement**
 - Control Valve
 - Elevated Storage Tank
- Potential Improvements**
 - 2015 Improvements
 - 2020 Improvements
- Pressure Zones**
 - Centerville
 - River Road High Pres
 - River Road Low Pres
 - West Creek
 - Courthouse

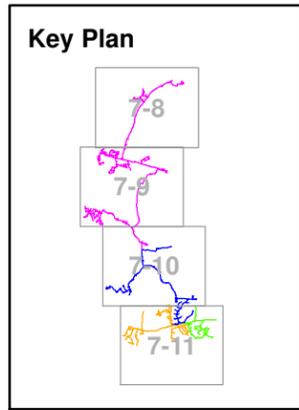
Key Plan

 Dewberry Engineers Inc. 4805 LAKE BROOK DRIVE, SUITE 200 GLEN ALLEN, VIRGINIA 23060 PHONE: 804.290.7957 FAX: 804.290.7928	DATE	01/2015	SCALE	1 inch = 1,500 feet	TITLE	COURTHOUSE AREA EXISTING IMPROVEMENTS	FIGURE NO.	7-7
	PROJ. NO.	50061868	PROJECT	UTILITY MASTER PLAN GOOCHLAND COUNTY, VA				



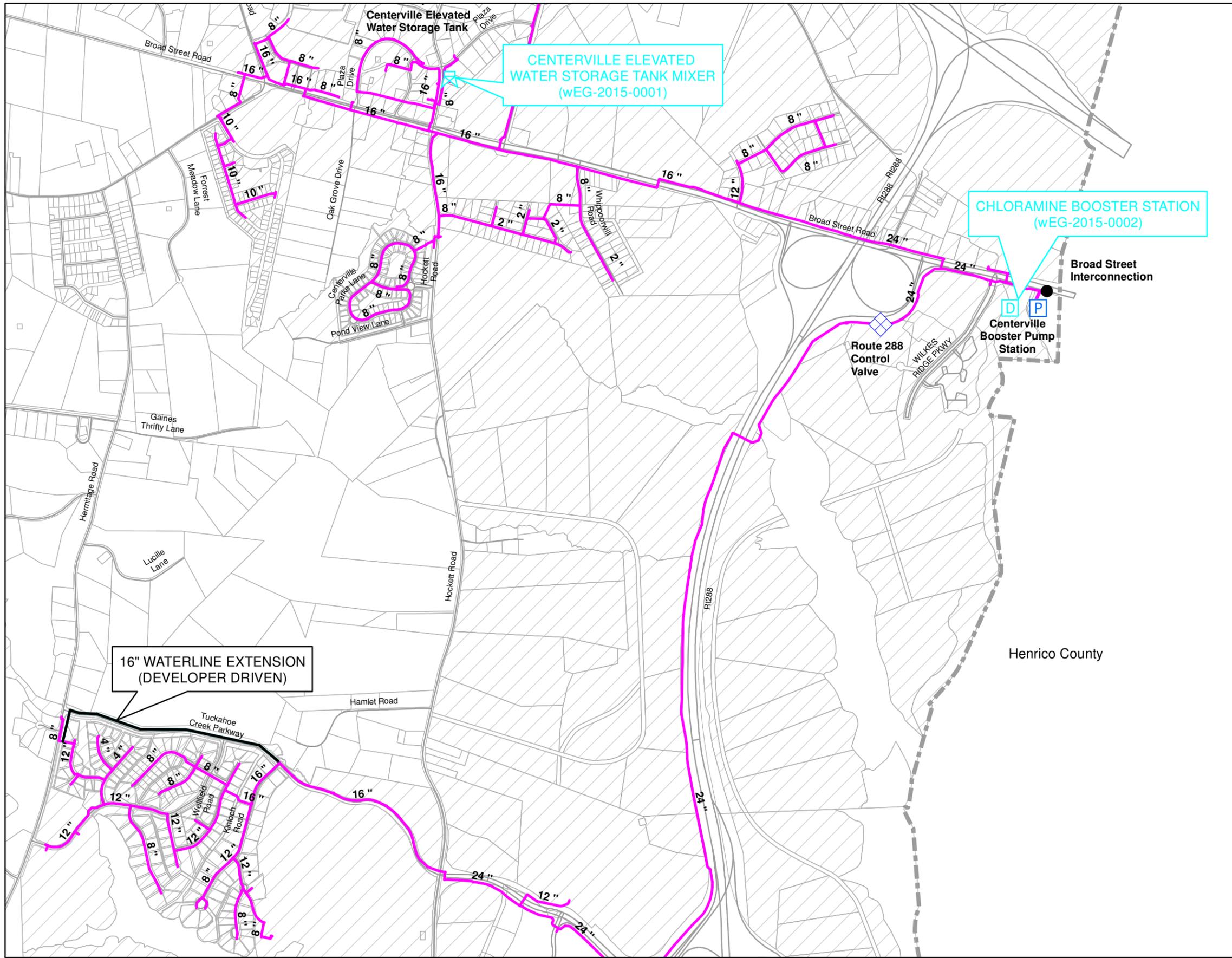
Legend

- County Boundaries
- System Interconnection
- Booster Pump Station
- Fire Improvement**
 - Check Valve
 - Control Valve
 - Gate Valve
 - Limited Fire Fire Location
- Quality Improvement**
 - Control Valve
 - Elevated Storage Tank
- Potential Improvements**
 - 2015 Improvements
 - 2020 Improvements
- Pressure Zones**
 - Centerville
 - River Road High Pres
 - River Road Low Pres
 - West Creek
 - Courthouse

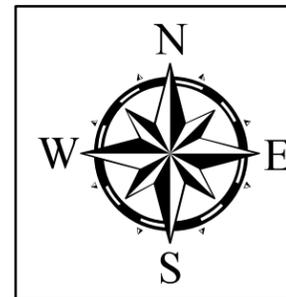


	DATE 01/2015	SCALE 1 inch = 1,500 feet	TITLE EASTERN GOOCHLAND AREA EXISTING IMPROVEMENTS	FIGURE NO. 7-8
	PROJ. NO. 50061868	PROJECT	UTILITY MASTER PLAN GOOCHLAND COUNTY, VA	

Dewberry Engineers Inc.
 4805 LAKE BROOK DRIVE, SUITE 200
 GLEN ALLEN, VIRGINIA 23060
 PHONE: 804.290.7957
 FAX: 804.290.7928

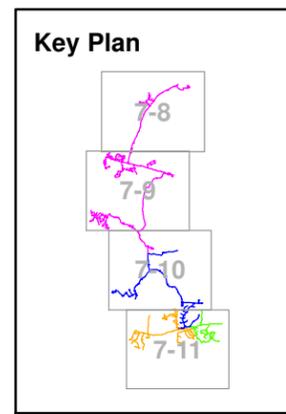


SEE FIGURE 7-10 FOR CONTINUATION



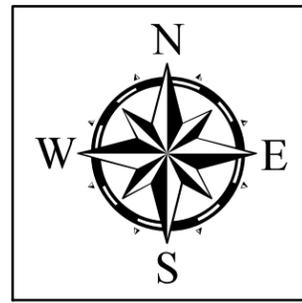
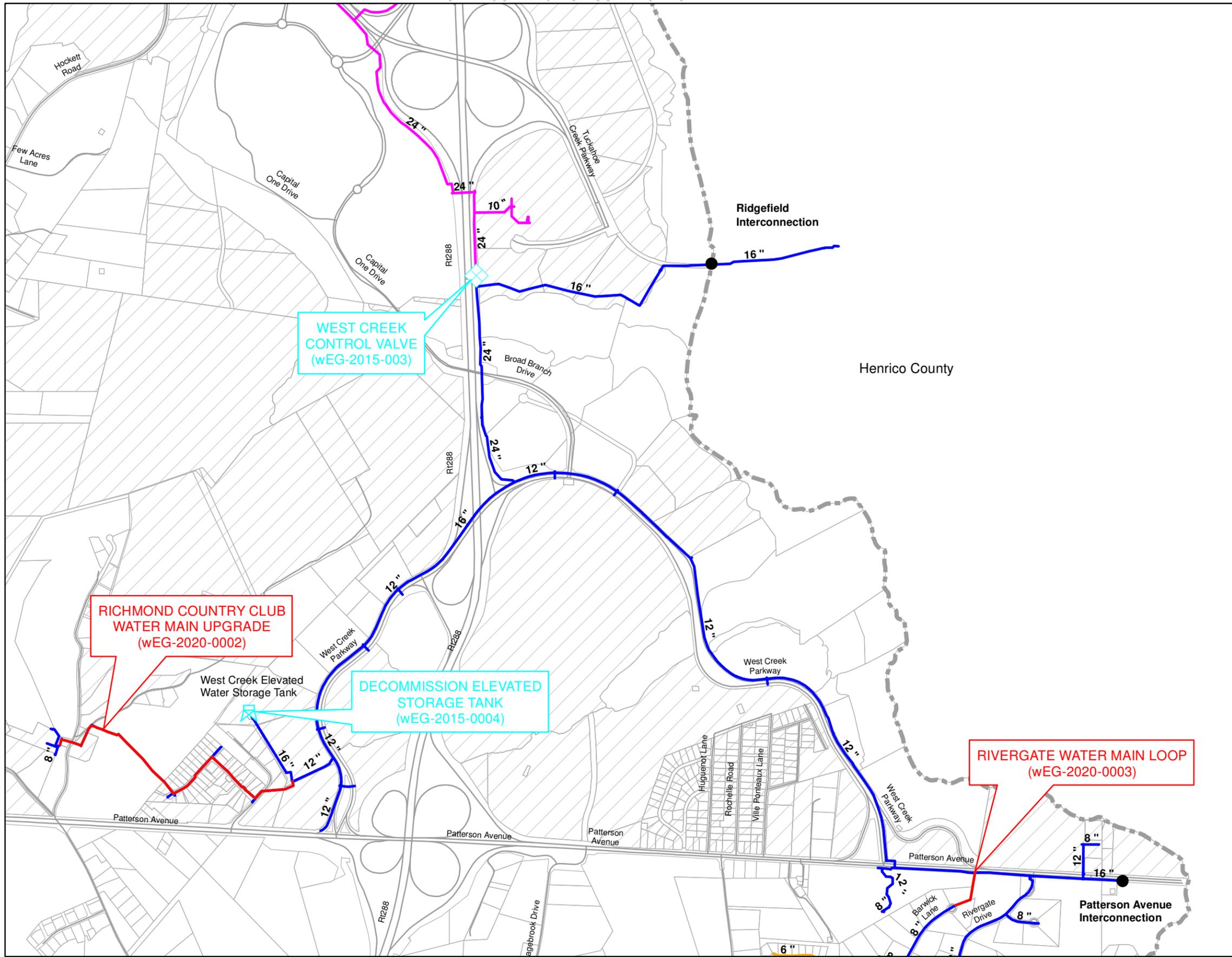
Legend

- County Boundaries
- System Interconnection
- Booster Pump Station
- Fire Improvement**
 - Check Valve
 - Control Valve
 - Gate Valve
 - Limited Fire Fire Location
- Quality Improvement**
 - Control Valve
 - Elevated Storage Tank
- Potential Improvements**
 - 2015 Improvements
 - 2020 Improvements
- Pressure Zones**
 - Centerville
 - River Road High Pres
 - River Road Low Pres
 - West Creek
 - Courthouse



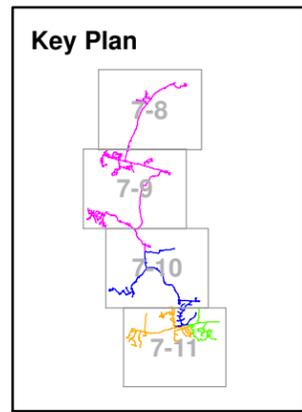
 Dewberry Engineers Inc.	DATE 01/2015	SCALE 1 inch = 1,500 feet	TITLE EASTERN GOOCHLAND AREA EXISTING IMPROVEMENTS	FIGURE NO. 7-9
	PROJ. NO. 50061868	PROJECT UTILITY MASTER PLAN GOOCHLAND COUNTY, VA		

4805 LAKE BROOK DRIVE, SUITE 200
 GLEN ALLEN, VIRGINIA 23060
 PHONE: 804.290.7957
 FAX: 804.290.7928

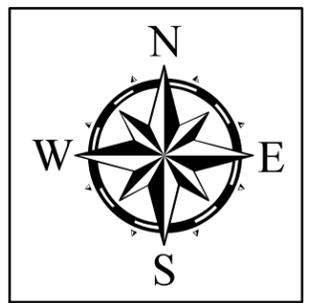
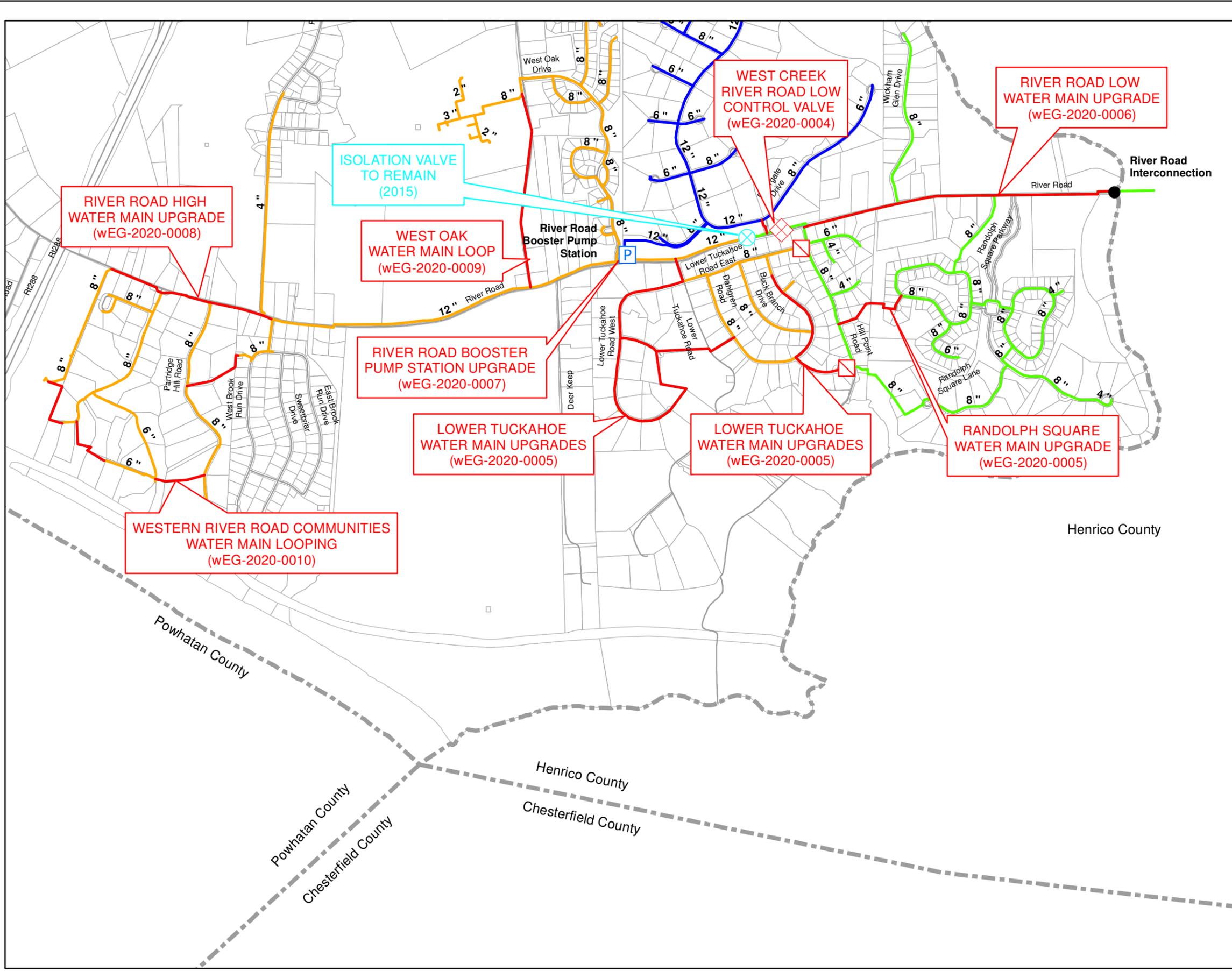


Legend

- County Boundaries
- System Interconnection
- Booster Pump Station
- Fire Improvement**
 - Check Valve
 - Control Valve
 - Gate Valve
 - Limited Fire Fire Location
- Quality Improvement**
 - Control Valve
 - Elevated Storage Tank
- Potential Improvements**
 - 2015 Improvements
 - 2020 Improvements
- Pressure Zones**
 - Centerville
 - River Road High Pres
 - River Road Low Press
 - West Creek
 - Courthouse

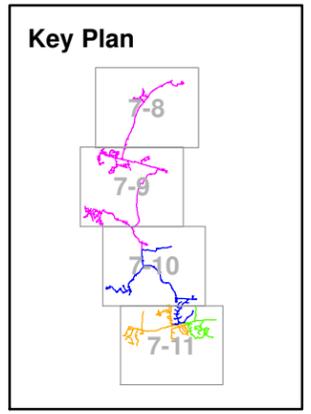


 Dewberry Engineers Inc. 4805 LAKE BROOK DRIVE, SUITE 200 GLEN ALLEN, VIRGINIA 23060 PHONE: 804.290.7957 FAX: 804.290.7928	DATE 01/2015	SCALE 1 inch = 1,500 feet	FIGURE NO. 7-10
	PROJECT 50061868	TITLE EASTERN GOOCHLAND AREA EXISTING IMPROVEMENTS	PROJECT UTILITY MASTER PLAN GOOCHLAND COUNTY, VA



Legend

- County Boundaries
- System Interconnection
- Booster Pump Station
- Fire Improvement**
 - Check Valve
 - Control Valve
 - Gate Valve
 - Limited Fire Fire Location
- Quality Improvement**
 - Control Valve
 - Elevated Storage Tank
- Potential Improvements**
 - 2015 Improvements
 - 2020 Improvements
- Pressure Zones**
 - Centerville
 - River Road High Pres
 - River Road Low Pres
 - West Creek
 - Courthouse



<p>Dewberry Engineers Inc. 4805 LAKE BROOK DRIVE, SUITE 200 GLEN ALLEN, VIRGINIA 23060 PHONE: 804.290.7957 FAX: 804.290.7928</p>	<p>DATE: 01/2015</p>	<p>SCALE: 1 inch = 1,500 feet</p>	<p>FIGURE NO. 7-11</p>
	<p>PROJECT NO. 50061868</p>	<p>TITLE: EASTERN GOOCHLAND AREA EXISTING IMPROVEMENTS</p>	<p>PROJECT: UTILITY MASTER PLAN GOOCHLAND COUNTY, VA</p>

7.3 Water Supply

An evaluation of the planning period from 2015 to 2045 indicates that as the population grows within the water service areas, the County’s available water supply will be sufficient to meet maximum day demands through 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 2045.

Table 7-1: Existing Water Supply Sources

Service Area	Supply Source	Maximum Day Capacity
Courthouse	Virginia Department of Corrections	2 MGD ¹
Eastern Goochland	Henrico County	25 MGD ²

1. The current allocation is 0.20 MGD
2. The current allocation is 5.25 MGD

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

	2015	2020	2025	2035	2045
Goochland Courthouse Service Area (MGD)	0.15	0.17	0.43	0.71	0.98
Eastern Goochland Service Area (MGD)	1.20	2.40	5.96	9.94	16.11

1. Includes projected water demand from the proposed Powhatan County connection.
2. Demand projections in MGD.

7.3.1 Goochland Courthouse Service Area

The Virginia Department of Corrections (VDOC) currently has an agreement with Goochland County to supply up to 200,000 GPD of treated water. However, based on the demand projections within this service area, the maximum day supply will be exceeded before 2025. In order to provide additional water supply required in the future, Goochland County signed a Memorandum of Understanding (MOU) with VDOC and Powhatan County. The MOU allows for Goochland to receive initially 1 MGD of treated water from VDOC’s James River Correctional Facility Water Treatment Plant (WTP) and ultimately up to 2 million gallons per day (MGD).

The James River Correctional Facility WTP currently holds a withdrawal permit for 2 MGD. In 2013 the WTP produced on average of 0.66 MGD and a maximum day of 0.89 MGD. Although the withdrawal permit limits the withdrawal at 2 MGD, the WTP and intake is designed to withdraw and treat up to 3 MGD. For Goochland County to be able to receive the 1 MGD allocation, a withdrawal permit modification would be required to allow the WTP to be able to withdraw up to 3 MGD. It is not anticipated that additional intake or WTP upgrades would be required. To expand capacity beyond 1 MGD, it is anticipated that intake, water treatment plant, and conveyance upgrades would be required. However, based on demand projections, this will not be required within the planning period.

With the current water usage patterns and projected demands, it is anticipated that the maximum day water demand will not exceed the VDOC water allocation through the end of the planning period in 2045.

7.3.2 Eastern Goochland Service Area

Through a water agreement dated June 11, 2002, Goochland County is supplied with up to 5.25 MGD of treated water from Henrico County. This agreement also includes additional future supply capacities of 11.54 MGD and 25 MGD with water treatment plant upgrades required. It is anticipated that additional payment of capacity charges will be required to increase the amount of treated water supplied by Henrico County to Goochland County. These treatment plant upgrades are contingent upon the construction of the Cobbs Creek Reservoir, located in Cumberland County. 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.

With the current water usage patterns and projected demands, it is anticipated that the maximum day water demand will not exceed the Henrico water allocation through the end of the planning period in 2045.

7.4 Water Storage and Booster Pump Station Capacity

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 180,000 gallons, which is the volume of water needed for the County’s design standard of a 1,500 gpm, 2-hour duration fire event. 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	2035	2045
Goochland Courthouse Service Area (gal)	210,897	213,566	264,626	328,116	375,307
Eastern Goochland Service Area (gal)	422,843	643,527	1,479,967	2,456,575	4,350,492

7.4.1 Goochland Courthouse Service Area

Based on the storage tank evaluation, the existing 300,000 gallon tank is sufficient to provide the required storage through 2035. By 2035, it is recommended that this tank be replaced with a new 500,000 gallon elevated water storage tank located at the Goochland High School property. This location would allow

for the tank to be located more centrally within the system which will provide improved fire flow capacity for the existing system and for the anticipated development on the western side of the service area. The high school property is also located on higher ground which will reduce the tank height requirement.

Based on future demand projections, the existing River Road West Booster Station will have to be upgraded before 2025. It is recommended that the County construct a booster station in 2025 that will meet capacity needs through the end of the planning period.

7.4.2 Eastern Goochland Service Area

Based on the storage tank evaluation, the existing 1 million gallon Centerville Tank is sufficient to provide the required storage through 2020. In order to provide the Eastern Goochland Service Area with the future required storage, additional storage volume is required to meet the recommended storage through the end of planning period. The construction of elevated water storage tanks are recommended throughout the water system at different phases starting with a 500,000 gallon tank at Lanier Industrial Park by 2025, a 1,500,000 gallon storage tank at the intersection of Hockett Road and Patterson Avenue by 2035, and another 1,500,000 million gallon elevated storage tank north of Tuckahoe Creek Parkway along Hockett Road by 2045. The location of these tanks were selected based on ground elevation, centrality to future demands, and as needed to provide adequate pressures and fire flow availability.

The addition of these tanks will satisfy the future domestic and fire storage requirements within the Eastern Goochland Service Area.

Water booster pump station upgrades will be required to provide the required water supply through the planning period. By 2025, the pumps at the Centerville Booster Pump Station will have to be upsized to meet maximum day demands. When the new 1,500,000 gallon elevated tank at the intersection of Hockett Road and Patterson Avenue is constructed in 2035, a new booster pump station will be required at the Ridgefield water supply connection to pump water into the new tank. Additionally, a water main will be constructed connecting the River Road High Pressure Zone to the Centerville Zone to allow the River Road Booster Pump Station to be able to supply water to the new elevated tank as well. This will require the River Road booster pumps to operate at a higher flow rate than previously which will drop upstream pressures in Rivergate below 35 psi. Therefore, a new 150,000 gallon ground storage tank will be required at the River Road Booster Pump Station to buffer pressures between zones.

The above described booster pump station upgrades will allow for sufficient pumping capacity for the Eastern Goochland Service Area through the end of the planning period in 2045.

7.5 Water Distribution System

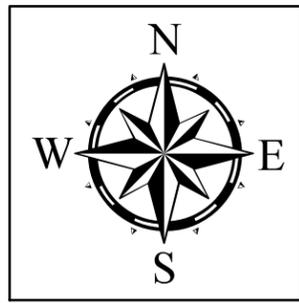
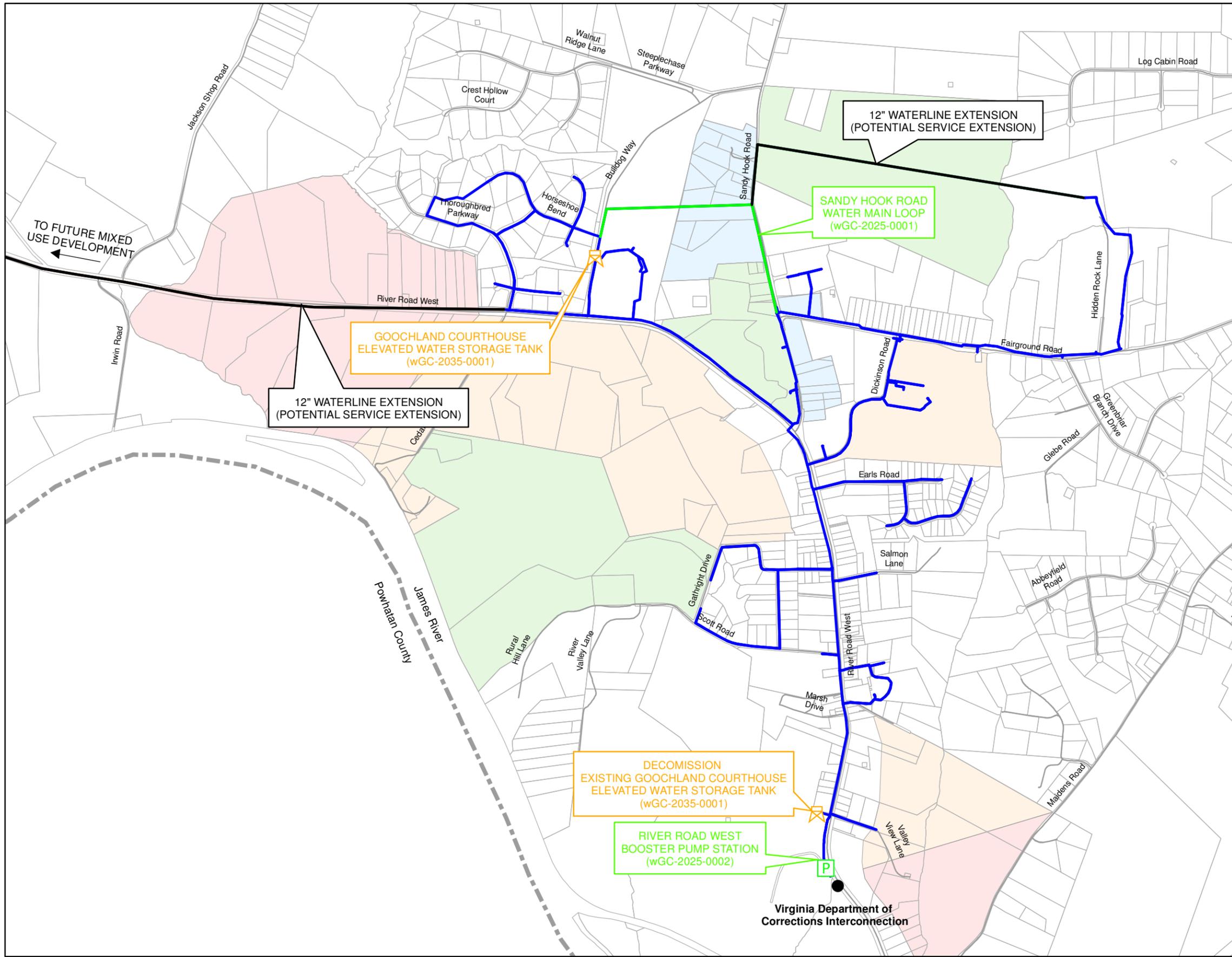
The improvements recommended to serve future development within the water distribution system are generally required to address one or more of the following issues:

- 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).

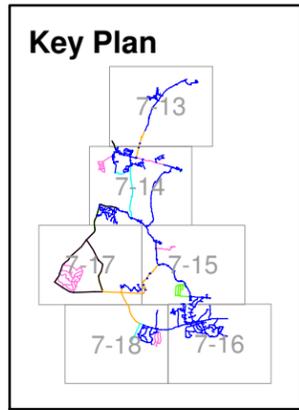
7.6 Water Improvement Program

A summary of the recommended water system improvements required for future development is provided on the following pages. The improvements are separated between the Goochland Courthouse and Eastern Goochland service areas. Refer to **Figures 7-12 through 7-18** for the location of each proposed improvement.

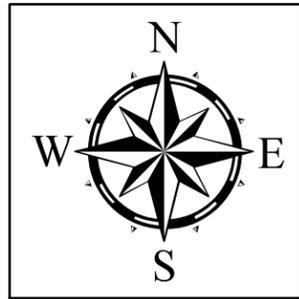
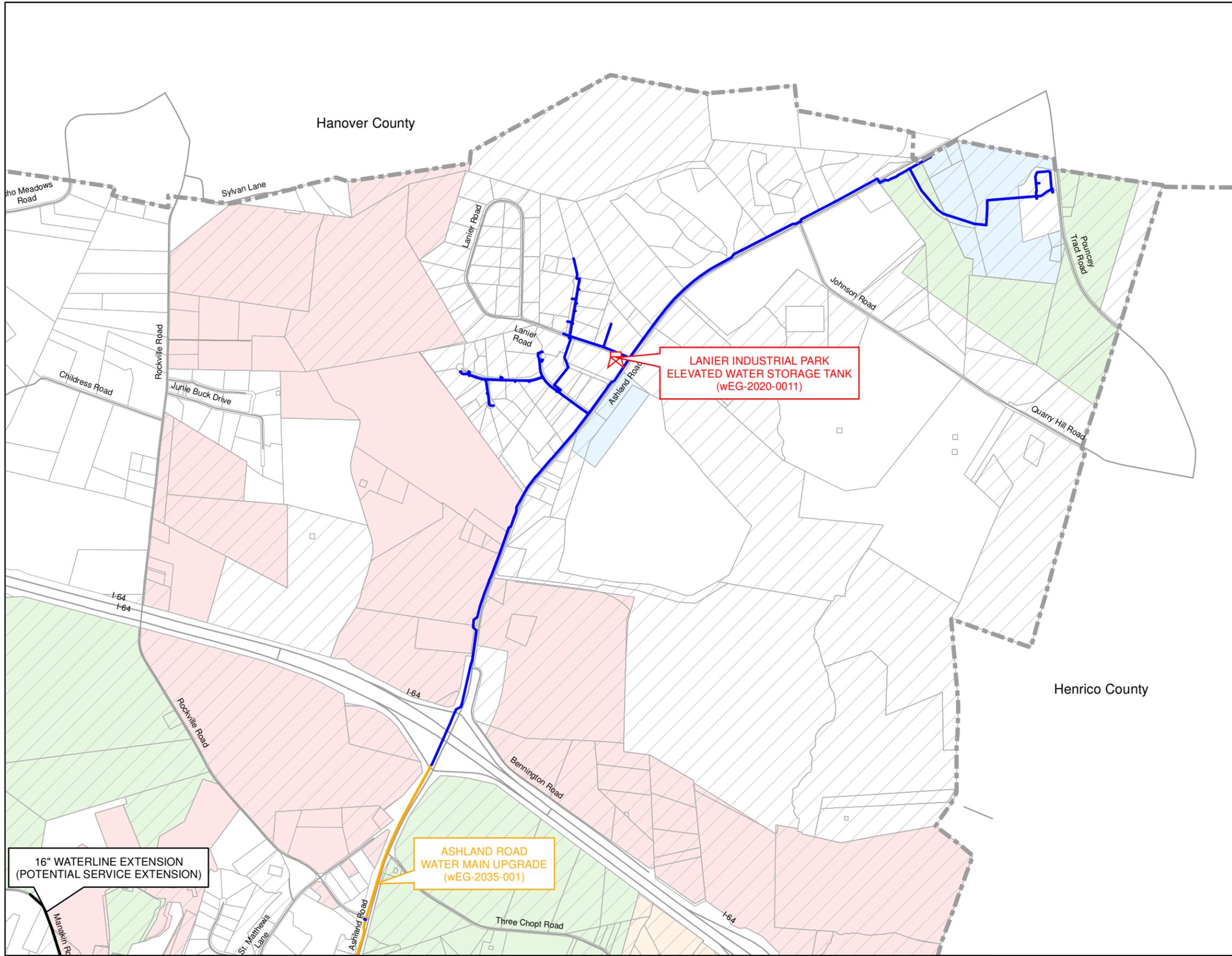
Descriptions of the proposed water system improvements, organized by area plan, are provided on the following pages. The description lists the requirement for the improvement, the timing of the improvement, and a general description of the improvement. Additional details on costs associated with the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



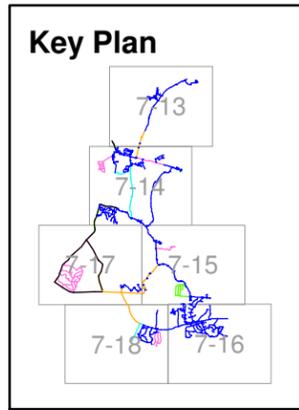
- Legend**
- System Interconnection
 - ⬆ Existing Elevated Tank
 - P Existing Pump Station
 - ▬ County Boundaries
 - ▭ Existing TSCD
 - Waterline Improvements
 - ▬ Developer Driven
 - ▬ Existing & 2015 Waterline
 - ▬ 2020 Waterline
 - ▬ 2025 Waterline
 - ▬ 2035 Waterline
 - ▬ 2045 Waterline
 - Future Development
 - 2020
 - 2025
 - 2035
 - 2045
 - ⊗ Existing to be Served



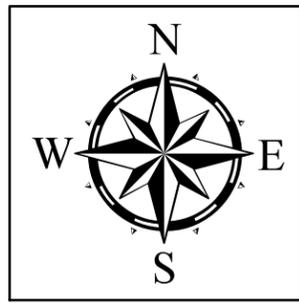
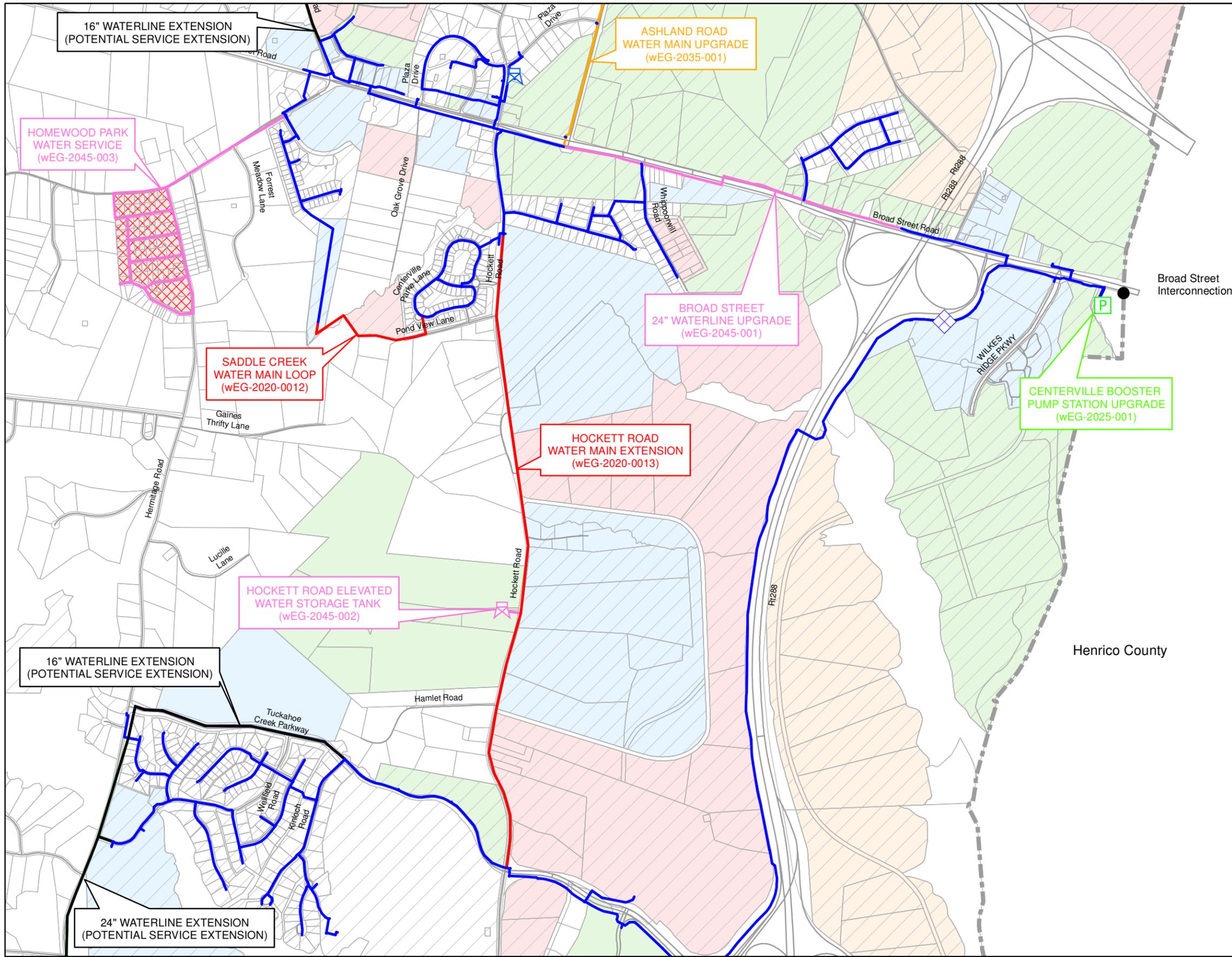
 Dewberry Engineers Inc. <small>4805 LAKE BROOK DRIVE, SUITE 200 GLEN ALLEN, VIRGINIA 23060 PHONE: 804.290.7957 FAX: 804.290.7928</small>	DATE 01/2015	SCALE 1 inch = 1,500 feet	TITLE COURTHOUSE AREA FUTURE WATER IMPROVEMENTS	FIGURE NO. 7-12
	PROJ. NO. 50061868	PROJECT UTILITY MASTER PLAN GOOCHLAND COUNTY, VA		



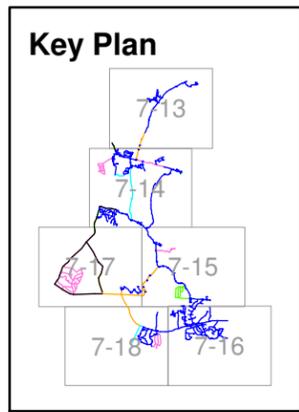
- Legend**
- System Interconnection
 - ⬮ Existing Elevated Tank
 - Ⓟ Existing Pump Station
 - County Boundaries
 - ▨ Existing TSCD
 - Waterline Improvements
 - Developer Driven
 - Existing & 2015 Waterline
 - 2020 Waterline
 - 2025 Waterline
 - 2035 Waterline
 - 2045 Waterline
 - Future Development
 - 2020
 - 2025
 - 2035
 - 2045
 - ⊠ Existing to be Served



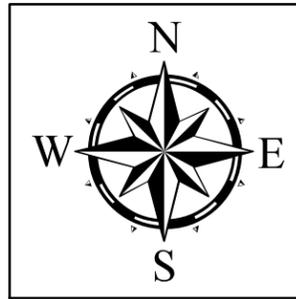
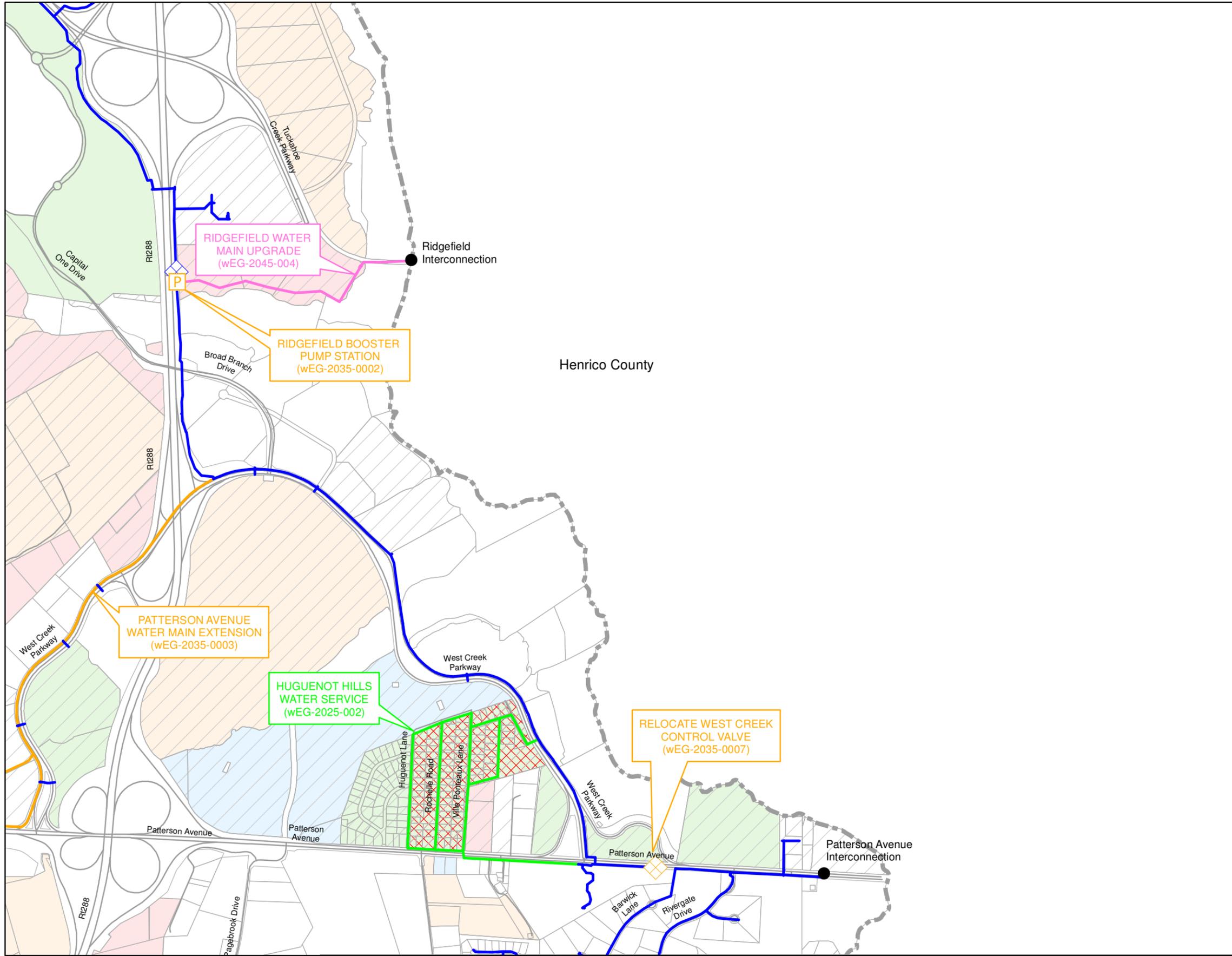
 Dewberry Engineers Inc. <small>4805 LAKE BROOK DRIVE, SUITE 200 GLEN ALLEN, VIRGINIA 23060 PHONE: 804.290.7957 FAX: 804.290.7928</small>	DATE 01/2015	SCALE 1 inch = 1,500 feet	TITLE EASTERN GOOCHLAND AREA FUTURE WATER IMPROVEMENTS	FIGURE NO. 7-13
	PROJ. NO. 50061868	PROJECT UTILITY MASTER PLAN GOOCHLAND COUNTY, VA		



- Legend**
- System Interconnection
 - ⬆ Existing Elevated Tank
 - P Existing Pump Station
 - ▭ County Boundaries
 - ▭ Existing TSCD
 - Waterline Improvements
 - Developer Driven
 - Existing & 2015 Waterline
 - 2020 Waterline
 - 2025 Waterline
 - 2035 Waterline
 - 2045 Waterline
 - Future Development
 - 2020
 - 2025
 - 2035
 - 2045
 - Existing to be Served

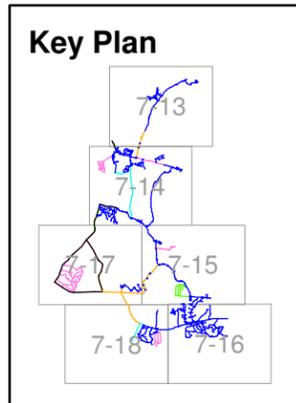


	DATE 01/2015	SCALE 1 inch = 1,500 feet	TITLE EASTERN GOOCHLAND AREA FUTURE WATER IMPROVEMENTS	FIGURE NO. 7-14
	PROJ. NO. 50061868	PROJECT UTILITY MASTER PLAN GOOCHLAND COUNTY, VA		
Dewberry Engineers Inc. 4805 LAKE BROOK DRIVE, SUITE 200 GLEN ALLEN, VIRGINIA 23060 PHONE: 804.290.7957 FAX: 804.290.7928				

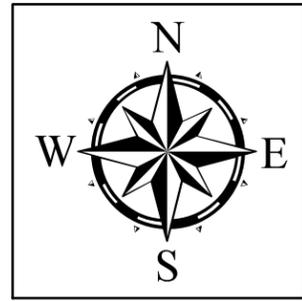
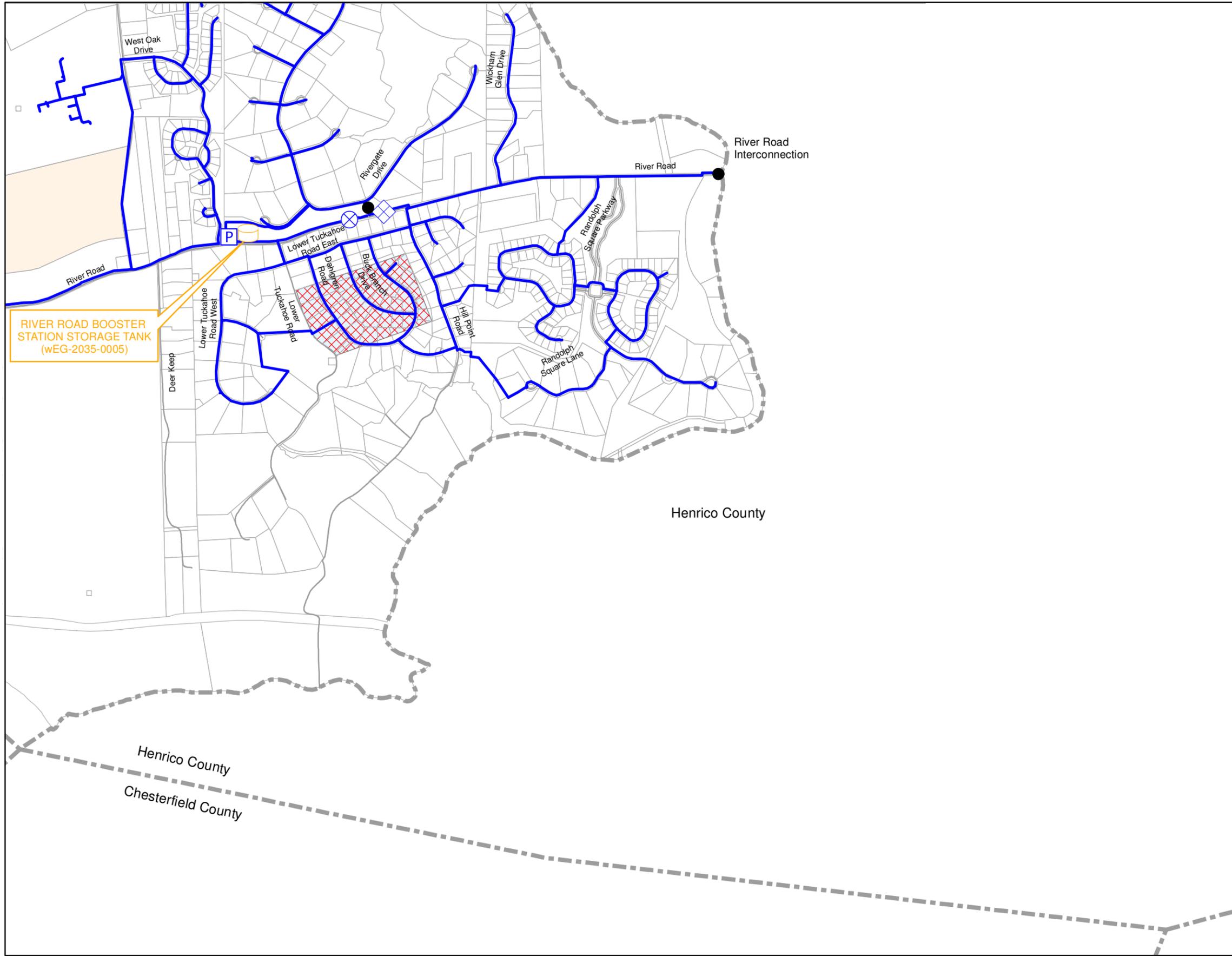


Legend

- System Interconnection
- ⬆ Existing Elevated Tank
- Ⓟ Existing Pump Station
- County Boundaries
- ▭ Existing TSCD
- Waterline Improvements
 - Developer Driven
 - Existing & 2015 Waterline
 - 2020 Waterline
 - 2025 Waterline
 - 2035 Waterline
 - 2045 Waterline
- Future Development
 - 2020
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- ⊠ Existing to be Served

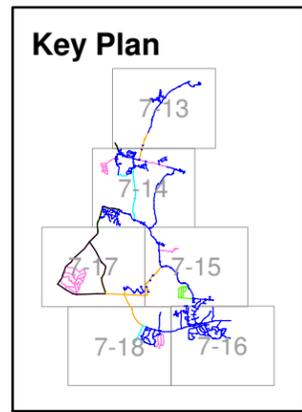


 Dewberry Engineers Inc. <small>4805 LAKE BROOK DRIVE, SUITE 200 GLEN ALLEN, VIRGINIA 23060 PHONE: 804.290.7957 FAX: 804.290.7928</small>	DATE 01/2015	SCALE 1 inch = 1,500 feet	TITLE EASTERN GOOCHLAND AREA FUTURE WATER IMPROVEMENTS	FIGURE NO. 7-15
	PROJ. NO. 50061868	PROJECT UTILITY MASTER PLAN GOOCHLAND COUNTY, VA		

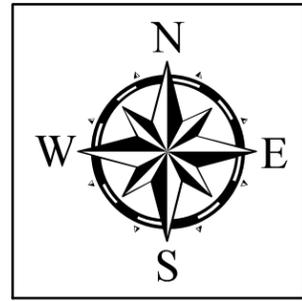
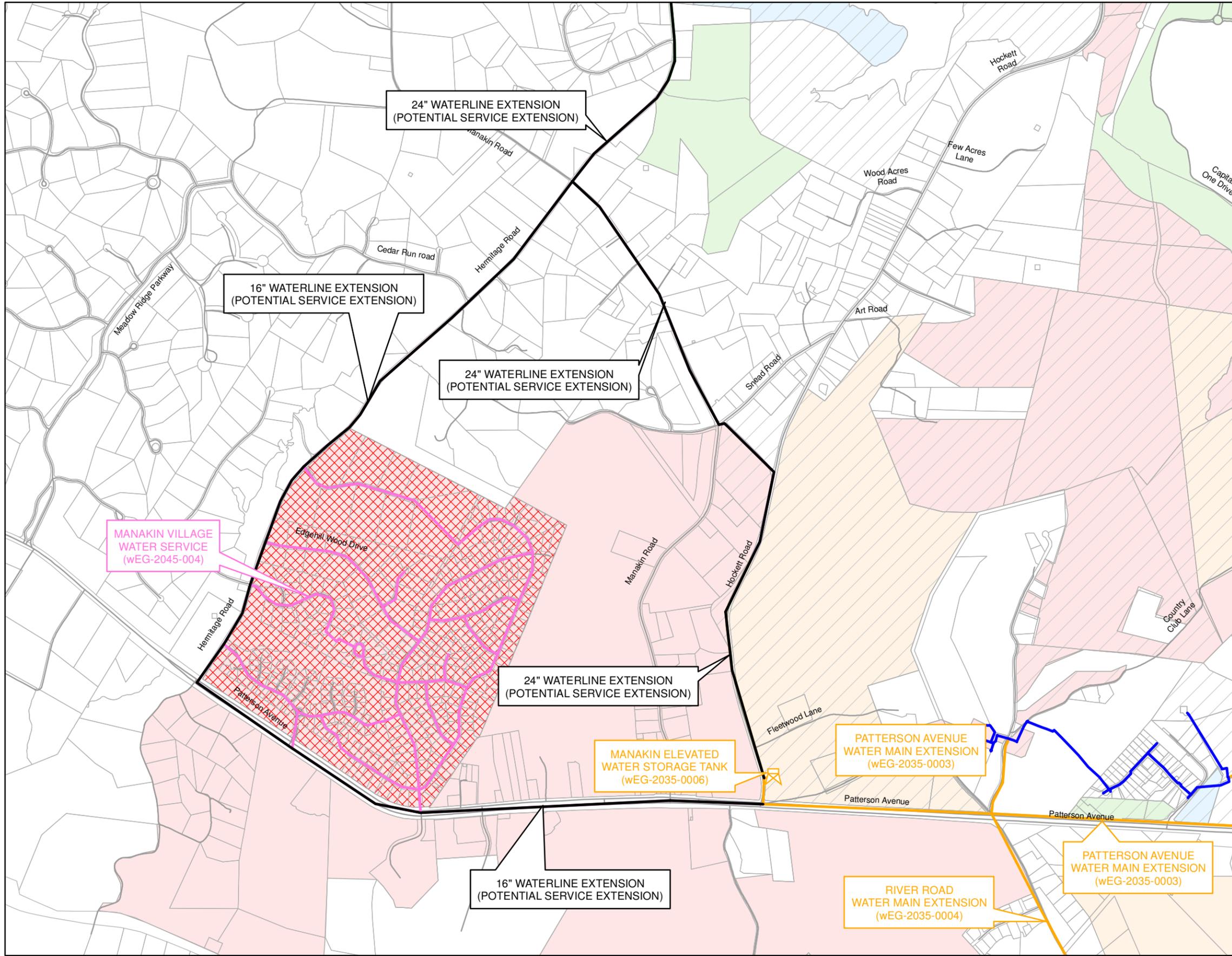


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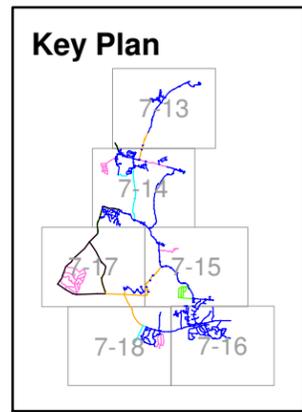
- System Interconnection
- ◊ Existing Elevated Tank
- Ⓟ Existing Pump Station
- County Boundaries
- ▨ Existing TSCD
- Waterline Improvements
 - Developer Driven
 - Existing & 2015 Waterline
 - 2020 Waterline
 - 2025 Waterline
 - 2035 Waterline
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- Future Development
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 - 2025
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 - 2045
- ▨ Existing to be Served



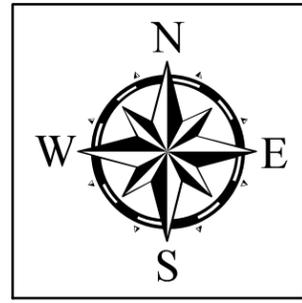
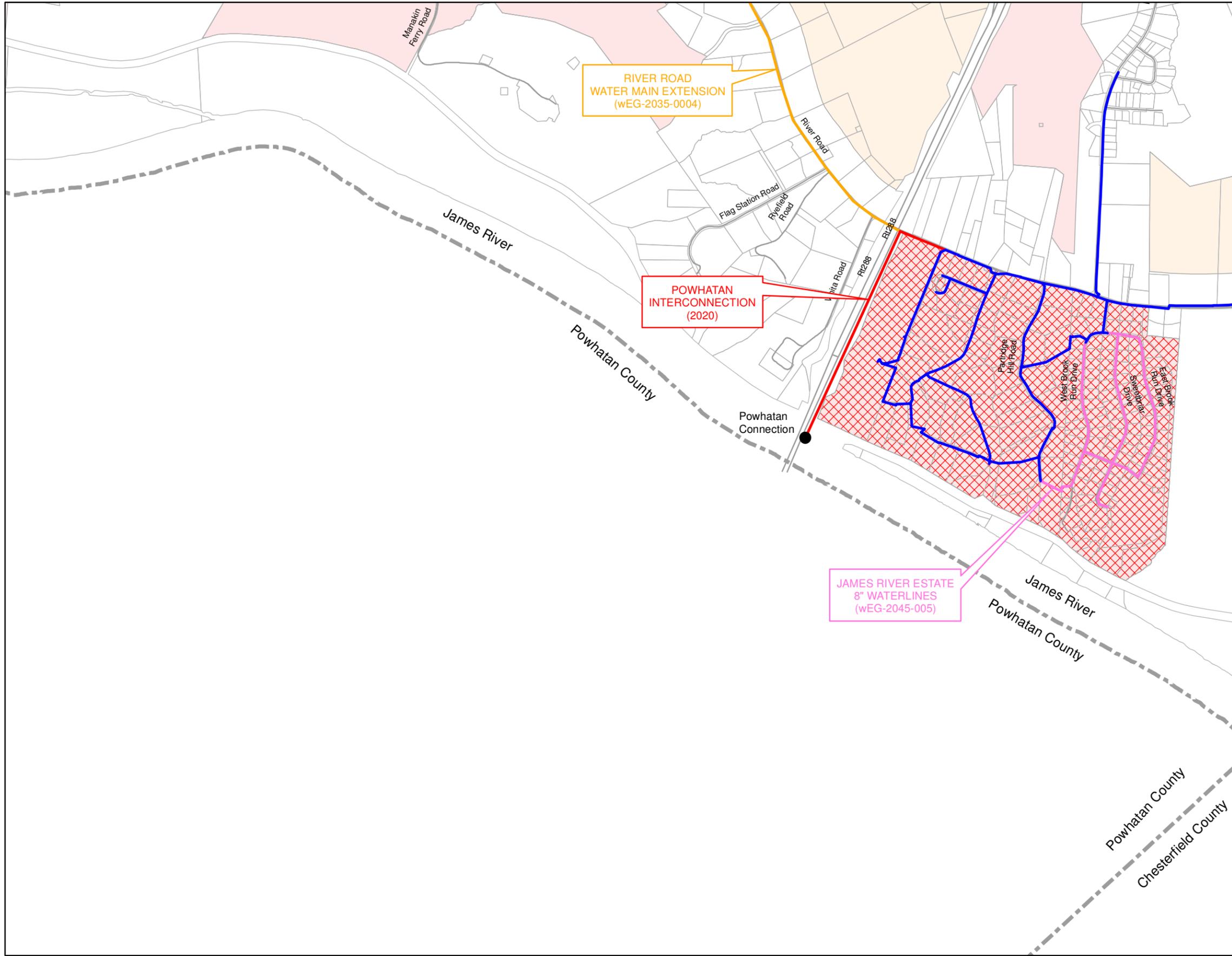
 Dewberry Dewberry Engineers Inc. 4805 LAKE BROOK DRIVE, SUITE 200 GLEN ALLEN, VIRGINIA 23060 PHONE: 804.290.7957 FAX: 804.290.7928	DATE 01/2015	SCALE 1 inch = 1,500 feet	TITLE EASTERN GOOCHLAND AREA FUTURE WATER IMPROVEMENTS	FIGURE NO. 7-16
	PROJ. NO. 50061868	PROJECT UTILITY MASTER PLAN GOOCHLAND COUNTY, VA		



- Legend**
- System Interconnection
 - ▲ Existing Elevated Tank
 - Ⓟ Existing Pump Station
 - ▬ County Boundaries
 - ▭ Existing TSCD
 - Waterline Improvements
 - ▬ Developer Driven
 - ▬ Existing & 2015 Waterline
 - ▬ 2020 Waterline
 - ▬ 2025 Waterline
 - ▬ 2035 Waterline
 - ▬ 2045 Waterline
 - Future Development
 - 2020
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 - ⊠ Existing to be Served

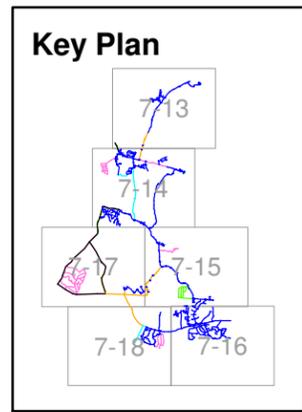


 Dewberry Engineers Inc. <small>4805 LAKE BROOK DRIVE, SUITE 200 GLEN ALLEN, VIRGINIA 23060 PHONE: 804.290.7957 FAX: 804.290.7928</small>	DATE 01/2015	SCALE 1 inch = 1,500 feet	FIGURE NO. 7-17
	PROJ. NO. 50061868	PROJECT UTILITY MASTER PLAN GOOCHLAND COUNTY, VA	TITLE EASTERN GOOCHLAND AREA FUTURE WATER IMPROVEMENTS



Legend

- System Interconnection
- ⬆ Existing Elevated Tank
- P Existing Pump Station
- County Boundaries
- ⊔ Existing TSCD
- Waterline Improvements
 - Developer Driven
 - Existing & 2015 Waterline
 - 2020 Waterline
 - 2025 Waterline
 - 2035 Waterline
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- Future Development
 - 2020
 - 2025
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- ⊗ Existing to be Served



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	PROJ. NO.	50061868	PROJECT	UTILITY MASTER PLAN GOOCHLAND COUNTY, VA				

Goochland Courthouse Service Area

See Figure 7-7 and 7-12

wGC-2020-0001: Northern Goochland Courthouse Fire Flow Improvements

This project would consist of the following improvements:

1. Install 8-inch waterline to complete loop at Goochland High School and Goochland Middle School campus – approximately 800 linear feet
2. Install 12-inch waterline to close loop between the Goochland High School and Goochland Middle School campus and Holland Hills – approximately 800 linear feet
3. Install 8-inch waterline to close loop in Holland Hills along Thoroughbred Parkway and Incline Court – approximately 2,300 linear feet

Project is planned for completion in 2020

wGC-2020-0002: J. Sargeant Reynolds Water Main Improvements

This project would consist of the following improvements:

1. Upsize existing waterline at J. Sargeant Reynolds campus from 4-inch to 10-inch – approximately 700 linear feet
2. Install backflow preventer at J. Sargeant Reynolds fire line.

Project is planned for completion in 2020

wGC-2020-0003: River Road Improvements

This project would consist of the following improvements:

1. Upsize existing waterline along River Road West from elevated water storage tank to the intersection of River Road West and Sandy Hook Road from 10-inch to 16-inch – approximately 6,400 linear feet

Project is planned for completion in 2020

wGC-2020-0004: Goochland Courthouse Elevated Water Storage Tank Mixer

This project would consist of the following improvements:

1. Installation of a tank mixer in the Centerville Elevated Storage Tank.

Project is planned for completion in 2020

wGC-2025-0001: Sandy Hook Water Main Loop

This project would consist of the following improvements:

1. New 12-inch water line looping the existing water lines along Sandy Hook Drive and Bull Dog Way – approximately 4,400 linear feet

Project is planned for completion in 2025

wGC-2025-0002: River Road West Booster Pump Station

This project would consist of the following improvements:

1. New Booster Pump Station
2. Generator and electric service to be sized for future third pump

Project is planned for completion in 2025

wGC-2035-0001: Goochland Courthouse Elevated Water Storage Tank

This project would consist of the following improvements:

1. New 500,000 gallon elevated water storage tank constructed on the Goochland High School property.
2. New water main with valves and appurtenances to connect new tank to the existing water system

Project is planned for completion in 2035

Eastern Goochland Service Area

See Figures 7-8 through 7-11 and 7-13 through 7-18

wEG-2015-0001: Centerville Elevated Water Storage Tank Mixer

This project would consist of the following improvements:

2. Installation of a tank mixer in the Centerville Elevated Storage Tank.

Project is planned for completion in 2015

wEG-2015-0002: Chloramine Booster Station

This project would consist of the following improvements:

1. Chloramine Booster Station at Centerville Booster Station site
2. New building

Project is planned for completion in 2015

wEG-2015-0003: West Creek Control Valve Vault

This project would consist of the following improvements:

1. New control valve with valve vault to control flow from the expanded Centerville Pressure Zone to the reduced West Creek Pressure Zone
2. SCADA and controls

Project is planned for completion in 2015

wEG-2015-0004: Decommission West Creek Elevated Storage Tank

This project would consist of the following improvements:

1. Work as needed to take the existing tank offline per VDH requirements.

wEG-2020-0001: Lanier Industrial Park Improvements

This project would consist of the following improvements:

1. 12-inch loop at Lanier Industrial Park – approximately 800 linear feet

Project is planned for completion in 2020

wEG-2020-0002: Richmond Country Club Water Main

This project would consist of the following improvements:

1. Replace the existing 8-inch waterline to the Richmond County Club with a new 16-inch waterline – approximately 5,100 linear feet

Project is planned for completion in 2020

wEG-2020-0003: Rivergate Water Main Loop

This project would consist of the following improvements:

1. Add a second connection between the water main on Patterson Avenue and the water mains in the Rivergate Subdivision with an 8-inch water line – approximately 500 linear feet

Project is planned for completion in 2020

wEG-2020-0004: West Creek-River Road Low Control Valve

This project would consist of the following improvements:

1. New control valve with valve vault to control flow from the West Creek Pressure Zone to the River Road Low Pressure Zone

Project is planned for completion in 2020

wEG-2020-0005: Lower Tuckahoe and Randolph Square Water Main Upgrades

This project would consist of the following improvements:

1. Water line upsizing and looping within the Lower Tuckahoe and Randolph Square Subdivision – approximately 5,700 linear feet of 12-inch piping
2. Two check valve vaults to allow for redundant fire flow connections from River Road Low to River Road High pressure zones.

Project is planned for completion in 2020

wEG-2020-0006: River Road Low Pressure Zone Water Main Upgrade

This project would consist of the following improvements:

1. Upsizing of the existing 8-inch water line to 12-inch along River Road between the Henrico connection and Hill Point Road – approximately 5,700 linear feet

Project is planned for completion in 2020

wEG-2020-0007: River Road Booster Station Upgrade

This project would consist of the following improvements:

1. Replacement of two existing pumps with two new higher capacity pumps
2. Valving and piping modifications for new pumps
3. Electrical and controls
4. New generator

Project is planned for completion in 2020

wEG-2020-0008: River Road High Pressure Zone Water Main Upgrade

This project would consist of the following improvements:

1. Upsizing of the existing 8-inch water line to 12-inch along River Road between the Berkley Drive and Partridge Hill Road – approximately 2,600 linear feet

Project is planned for completion in 2020

wEG-2020-0009: West Oak Water Main Loop

This project would consist of the following improvements:

1. Construction of an 8-inch water main loop between River Road and West Oak Drive – approximately 3,000 linear feet

Project is planned for completion in 2020

wEG-2020-0010: Western River Road Communities Water Main Looping

This project would consist of the following improvements:

1. Completion of four 8-inch water main loops within the Western River Road Communities – approximately 3,700 linear feet

Project is planned for completion in 2020

wEG-2020-0011: Lanier Industrial Park Elevated Water Storage Tank

This project would consist of the following improvements:

1. New 500,000 gallon elevated water storage tank constructed at the Lanier Industrial Park
2. New water main with valves and appurtenances to connect new tank to the existing water system

Project is planned for completion in 2020

wEG-2020-0012: Parke at Saddle Creek Water Main Loop

This project would consist of the following improvements:

1. New 8-inch water main looping the water mains at the Parke at Saddle Creek and Centerville Parke Lane – approximately 2,300 linear feet

Project is planned for completion in 2020

wEG-2020-0013: Hockett Road Water Main

This project would consist of the following improvements:

1. New 24-inch water main along Hockett Road between Tuckahoe Creek Parkway and Holly Lane – approximately 9,800 linear feet

Project is planned for completion in 2020

wEG-2025-0001: Centerville Booster Pump Station Upgrade

This project would consist of the following improvements:

1. Replacement of the three existing pumps with larger capacity pumps

2. Valving and piping modifications as needed for new pump installation
3. New control panel and VFDs
4. New generator and upsized electrical service

Project is planned for completion in 2025

wEG-2025-0002: Huguenot Hills Water Service

This project would consist of the following improvements:

1. Construction of 16-inch, 12-inch, and 8-inch water mains to serve the Huguenot Hills neighborhood with water. Approximately 2,300 linear feet of 16-inch, 900 linear feet of 12-inch, and 9,000 linear feet of 8-inch water mains.

wEG-2035-0001: Ashland Road Water Main Upgrade

This project would consist of the following improvements:

1. Replace existing 16-inch water main along Ashland Road between Broad Street and I-64 with a new 24-inch water main – approximately 5,400 linear feet

Project is planned for completion in 2035

wEG-2035-0002: Ridgefield Booster Pump Station

This project would consist of the following improvements:

1. New booster pump station located along the Ridgefield Drive water main.

Project is planned for completion in 2035

wEG-2035-0003: Patterson Avenue Water Main Extension

This project would consist of the following improvements:

1. Replace existing 16-inch water main along West Creek Parkway with a 24-inch water main and construct new water main along Patterson Avenue extending to Hockett Road and proposed elevated tank – approximately 15,300 linear feet
2. Construct 16-inch loop between the Richmond Country Club water main and proposed 24-inch water main along Patterson Avenue – approximately 1,400 linear feet

Project is planned for completion in 2035

wEG-2035-0004: River Road Water Main Extension

This project would consist of the following improvements:

1. Construct 16-inch water main starting at the existing River Road water main east of Route 288 and extending to the proposed 24-inch water main along Patterson Avenue – approximately 6,700 linear feet

Project is planned for completion in 2035

wEG-2035-0005: River Road Booster Station Storage Tank

This project would consist of the following improvements:

1. Replace the existing hydro-pneumatic tank with a new 150,000 gallon ground storage tank.
2. Piping and valving as needed for new tank.
3. Controls and electrical modifications.

Project is planned for completion in 2035

wEG-2035-0006: Manakin Elevated Water Storage Tank

This project would consist of the following improvements:

1. New 1,500,000 gallon elevated water storage tank constructed at the intersection of Hockett Road and Patterson Avenue
2. New water main with valves and appurtenances to connect new tank to the existing water system

Project is planned for completion in 2035

wEG-2045-0001: Broad Street Water Main Upgrade

This project would consist of the following improvements:

1. Replace existing 16-inch water main along Broad Street between Route 288 and Ashland Road with a new 24-inch water main – approximately 5,500 linear feet

Project is planned for completion in 2045

wEG-2045-0002: Hockett Road Elevated Water Storage Tank

This project would consist of the following improvements:

1. New 1,500,000 gallon elevated water storage tank constructed north of Tuckahoe Creek Parkway, along Hockett Road.
2. New water main with valves and appurtenances to connect new tank to the existing water system

Project is planned for completion in 2045

wEG-2045-0003: Homewood Park Water Service

This project would consist of the following improvements:

1. Construction of a 12-inch water main along Manakin Road between Camberly Court and Hermitage Road – approximately 2,100 linear feet
2. Construction of 8-inch water mains within the Homewood Park neighborhood – approximately 8,600 linear feet

Project is planned for completion in 2045

wEG-2045-0004: Ridgefield Water Main Upgrade

This project would consist of the following improvements:

1. Upsizing of the existing 16-inch Ridgefield water connection transmission main to 36-inch water main – approximately 6,400 linear feet

Project is planned for completion in 2045

wEG-2045-0005: Manakin Village Water Service

This project would consist of the following improvements:

2. Construction of a 8-inch water mains within Manakin Village neighborhood – approximately 31,500 linear feet

Project is planned for completion in 2045

wEG-2045-0006: James River Estates Water Service

This project would consist of the following improvements:

1. Construction of 8-inch water mains within the James River Estates neighborhood – approximately 9,300 linear feet

Project is planned for completion in 2045

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 Areas through the Year 2045.

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 Discharge Capacity

An evaluation of the planning period from 2015 to 2045 indicates that as the population grows within the water service areas, the County will be required to obtain additional wastewater discharge allocations to meet peak system demands through the end of the planning period. **Table 8-1** provides a summary of the existing wastewater discharge locations for the County’s wastewater service areas and **Table 8-2** shows the projected maximum month average wastewater loadings through the end of the planning period in 2045.

Table 8-1: Existing Wastewater Discharge Location

Discharge Location	Service Area	Maximum Month Average Capacity
Virginia Department of Corrections	Courthouse	0.111 MGD
City of Richmond	Eastern Goochland	15 MGD
Henrico County	Eastern Goochland Lower Tuckahoe	0.69 MGD

Table 8-2: Wastewater Loading Projections (Maximum Month Average)

Discharge Location	Service Area	2015	2020	2025	2035	2045
Virginia Department of Corrections	Courthouse	0.07	0.12	0.38	0.70	0.93
City of Richmond	Eastern Goochland ¹	0.43	1.84	5.19	8.59	15.92
Henrico County	Eastern Goochland Lower Tuckahoe	0.06	0.09	0.09	0.09	0.09

1. Includes wastewater loadings from the proposed Powhatan County connection.

2. Loading projections in MGD.

8.2.1 Goochland Courthouse Service Area

The County currently has an agreement in place with VDOC to discharge a maximum month average flow rate of 111,000 GPD to the wastewater treatment facilities located at the Virginia Correctional Center for Women (VCCW) on River Road West. Based on future demand projections, the VCCW WWTP will require an expansion to provide treatment and disposal of wastewater through the end of the planning period in 2045. VDOC has completed a study that estimates the WWTP improvements totaling approximately \$4 million will be required to provide the County with a 300,000 GPD allocation. This allocation will satisfy the County's needs through until sometime in the 2020 to 2025 timer period. Additional treatment capacity would still be needed to meet the projected wastewater loading in planning year 2045.

It is recommended that the County evaluate long term wastewater treatment options within the Courthouse Service Area in more detail before committing to paying VDOC to expand the VCCW WWTP.

8.2.2 Eastern Goochland Service Area

There are currently two agreements active in the Eastern Goochland Service Area concerning wastewater discharge: one with Henrico County (Henrico) and one with the City of Richmond (Richmond).

Through an agreement dated June 1, 2002, Goochland County may convey up to the initial contracted wastewater treatment maximum month average capacity of 5 MGD with an allowable peak hour conveyance capacity of 1.33 times the maximum month average capacity (6.65 MGD). Goochland County has the option of purchasing additional wastewater treatment capacity up to a maximum month average of 8 MGD without upgrading the existing WWTP. As part of the agreement, additional wastewater treatment capacity up to a maximum month average of 15 MGD is available but will require upgrades to the Richmond's wastewater treatment plant and the renegotiation of capacity charges. The existing agreement does not allow for Goochland to exceed a maximum month average of 15 MGD and a peak hour flow of 20 MGD. Based on the loading projections, the County will need to obtain additional wastewater treatment capacity by 2045; this will require additional negotiation with the City of Richmond and Henrico County.

Henrico County is currently under contract to provide Goochland County with a maximum month average wastewater treatment capacity of up to 0.69 MGD. Based on the future wastewater loading projections, this capacity is adequate to meet the County's need through the end of the planning period in 2045.

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 service area plans that are used in the water system improvement program. These area plans are the Goochland Courthouse Service Area and the Eastern Goochland Service Area.

8.3.1 Goochland Courthouse Service Area

The sewer model was utilized to evaluate the capacity of the existing sewer collection system. As shown in **Figure 8-1**, the system has adequate capacity for the current wastewater flows, with the exception of the Valley View Pump Station. To keep up with influent flow during high flow periods, both pumps are required to operate which exceeds the firm capacity of the pump station. If one of the pumps were out of service, the pump station could not keep up with existing peak hour flows. Based on this, it is recommended that the pumps be replaced with higher capacity pumps. It should be noted that until the pumps are upsized, the County has an adequate contingency plan in the event a pump fails. The contingency plan includes the ownership of a spare pump and a diesel backup pump to allow for bypass pumping which reduces the priority of upsizing the pumps.

Based on daily flow SCADA data provided by Goochland County, the maximum day flow rate through the Valley View Pump Station was approximately 230,000 GPD (~160 gpm). Peak hour flow data was not available but for planning purposes it is assumed that the peak hour flow rate is approximately 240 gpm. It is recommended that the peak hour flow rate be verified prior to replacing the pumps.

By 2025, a third pump will have to be installed at the Valley View Pump Station to meet projected flows. During this upgrade, the existing 4-inch force main will have to be replaced with an 8-inch force main. Assuming that Goochland County continues to send wastewater to VDOC, it is anticipated that the main interceptor along River Road West leading to the VCCW WWTP will have to be upsized to 18-inch diameter piping by 2025.

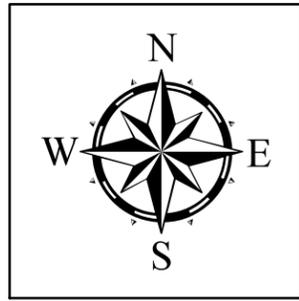
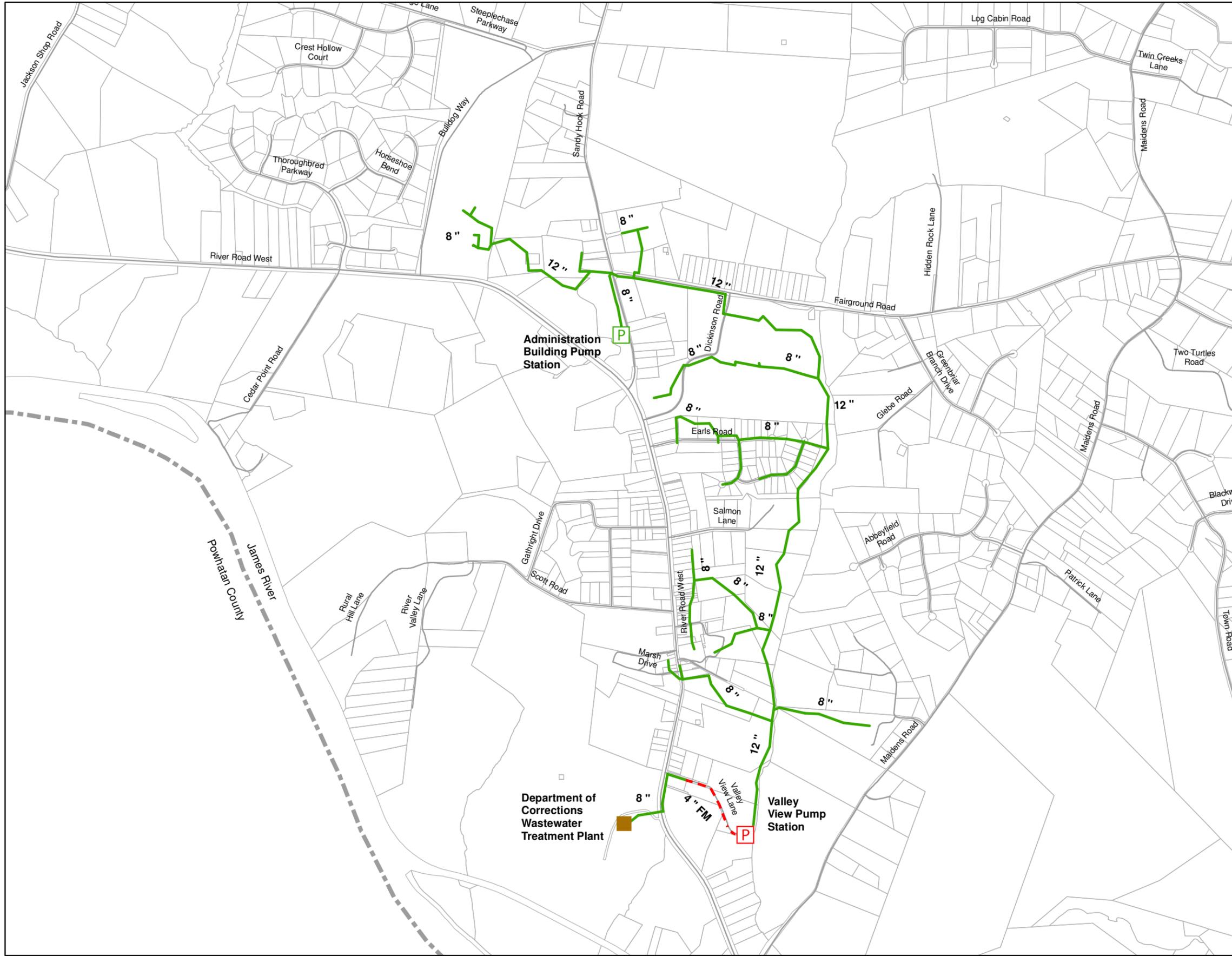
Descriptions of the proposed wastewater system improvements, organized by service area, are provided on the following pages. The description lists the requirement for the improvement, the timing of the improvement, and a general description of the improvement. Additional details on costs associated with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

8.3.2 Eastern Goochland Service Area

As shown on **Figure 8-2**, the existing system currently has adequate capacity. Based on the analysis of the existing wastewater collection system, the existing system has capacity for projected sewer flow rates until 2035. Anticipated improvements include the upsizing of existing interceptors to piping ranging in diameter from 27-inch to 48-inch diameter. Additionally, additional pumping capacity at the Eastern Goochland Pump Station will be required or meet the projected sewer flows. Based on current projections, the installation of additional pumps will be required to keep up with projected demands both in the 2035 and 2045 planning periods.

The County identified four capital improvements project where sewer infrastructure in anticipated to be construction within existing neighborhoods with aging infrastructure. These neighborhoods include Lower Tuckahoe Subdivision, James River Estates, Huguenot Hills, Lower Tuckahoe, and Homewood Park.

Descriptions of the proposed wastewater system improvements, organized by service area, 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.



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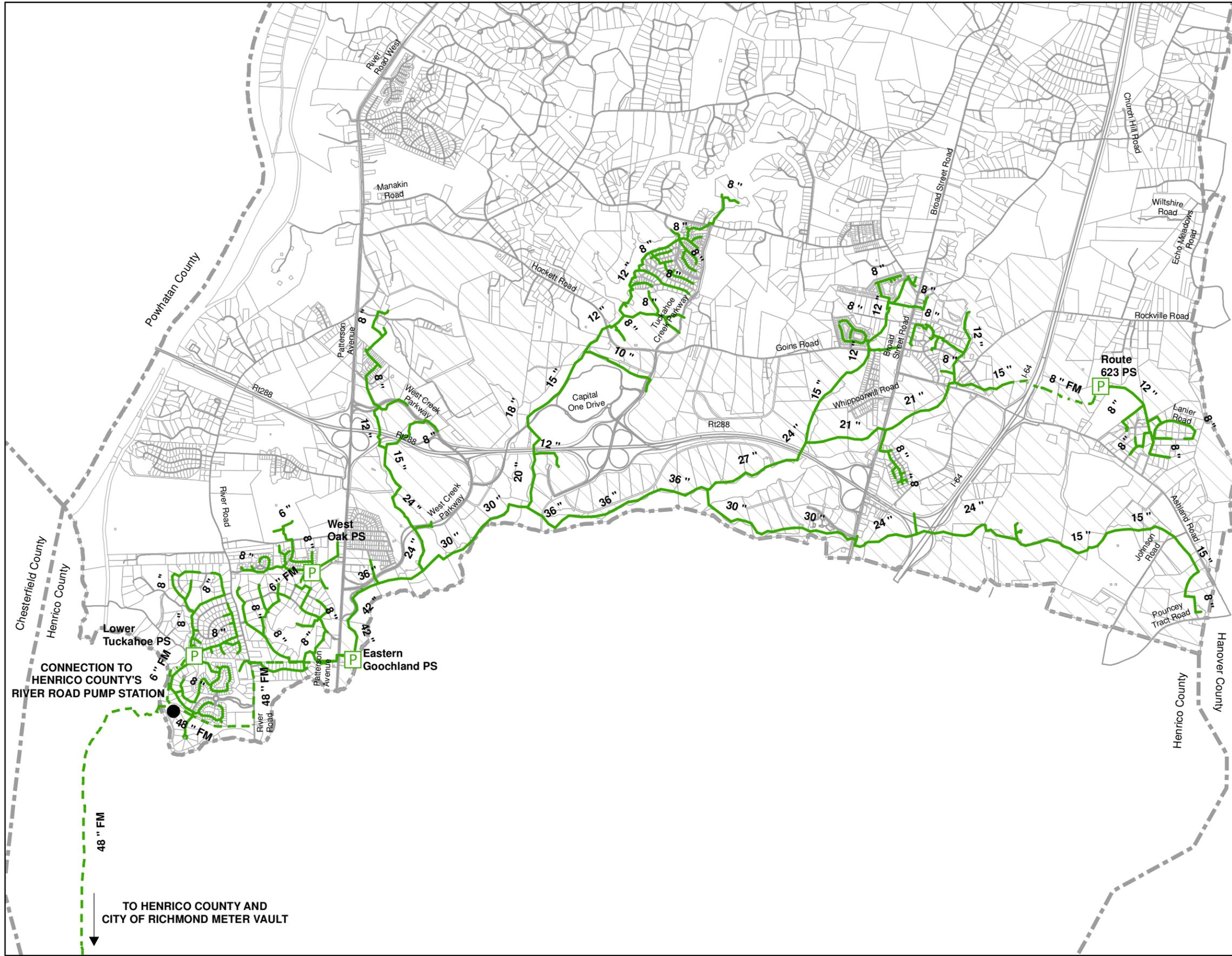
- County Boundaries
- VCCW WWTP
- P Pump Station
- Gravity Main
- - - Force Main

Capacity

- Less Than 50%
- 50% - 80%
- 80% - 100%
- Greater Than 100%

Key Plan

 Dewberry Engineers Inc. 4805 LAKE BROOK DRIVE, SUITE 200 GLEN ALLEN, VIRGINIA 23060 PHONE: 804.290.7957 FAX: 804.290.7928	DATE 11/2014 PROJ. NO. 50061868	SCALE 1 inch = 1,500 feet PROJECT	TITLE COURTHOUSE AREA EXISTING WASTEWATER ANALYSIS UTILITY MASTER PLAN GOOCHLAND COUNTY, VA	FIGURE NO. 8-1
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Legend

- Existing TCSD
- County Boundaries
- Pump Station
- Gravity main
- Force Main

Capacity

- Less Than 50%
- 50% - 80%
- 80% - 100%
- Greater Than 100%

Key Plan

FIGURE NO.

EASTERN GOOCHLAND AREA
EXISTING WASTEWATER ANALYSIS

UTILITY MASTER PLAN
GOOCHLAND COUNTY, VA

8-2

SCALE
1 inch = 4,500 feet

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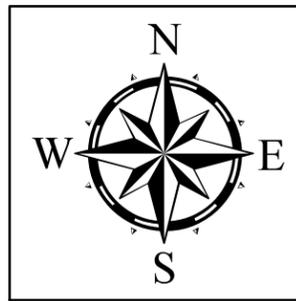
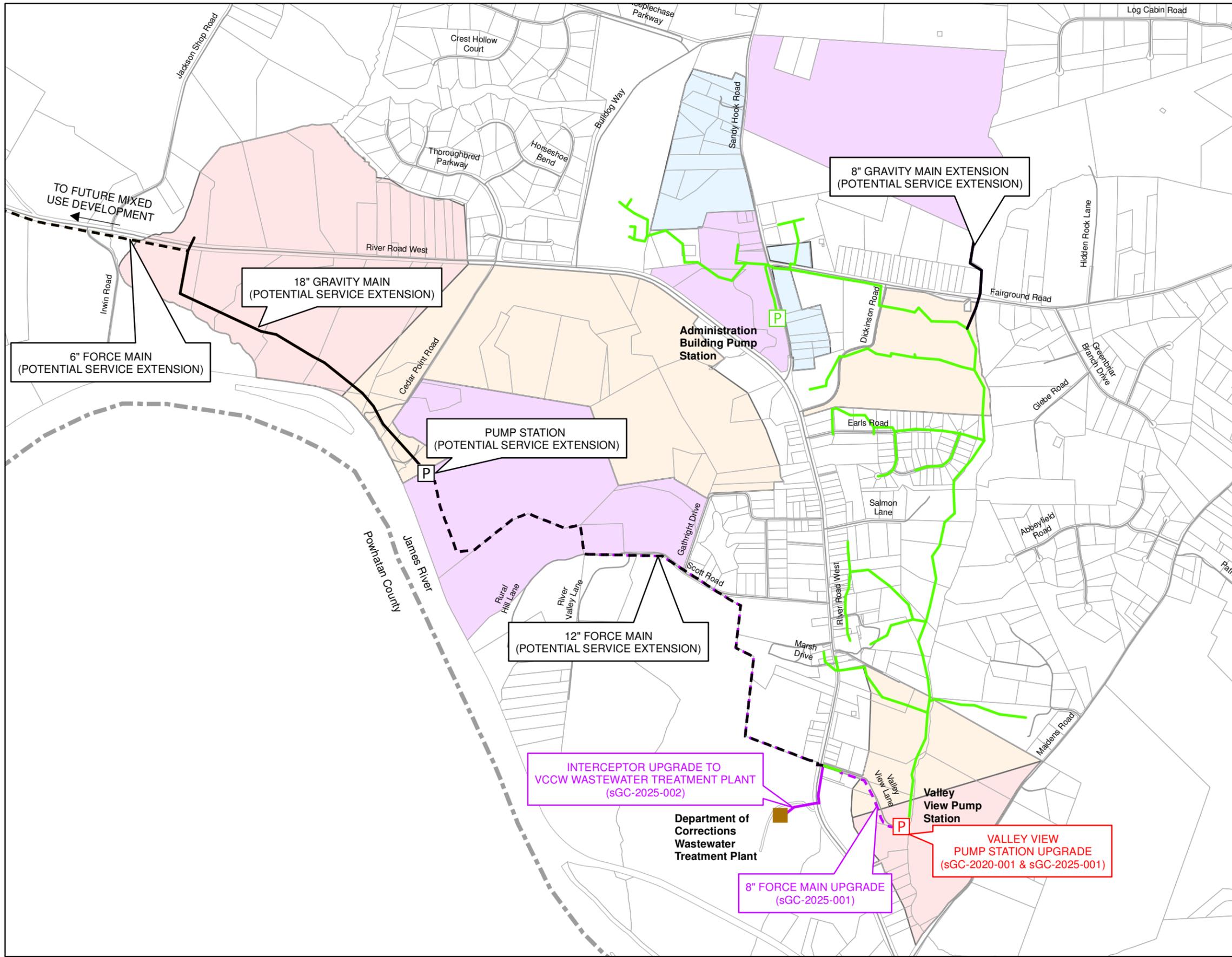
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PHONE: 804.290.7957
FAX: 804.290.7928

CONNECTION TO
HENRICO COUNTY'S
RIVER ROAD PUMP STATION

TO HENRICO COUNTY AND
CITY OF RICHMOND METER VAULT



Legend

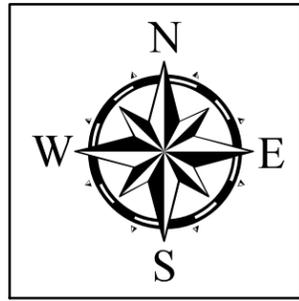
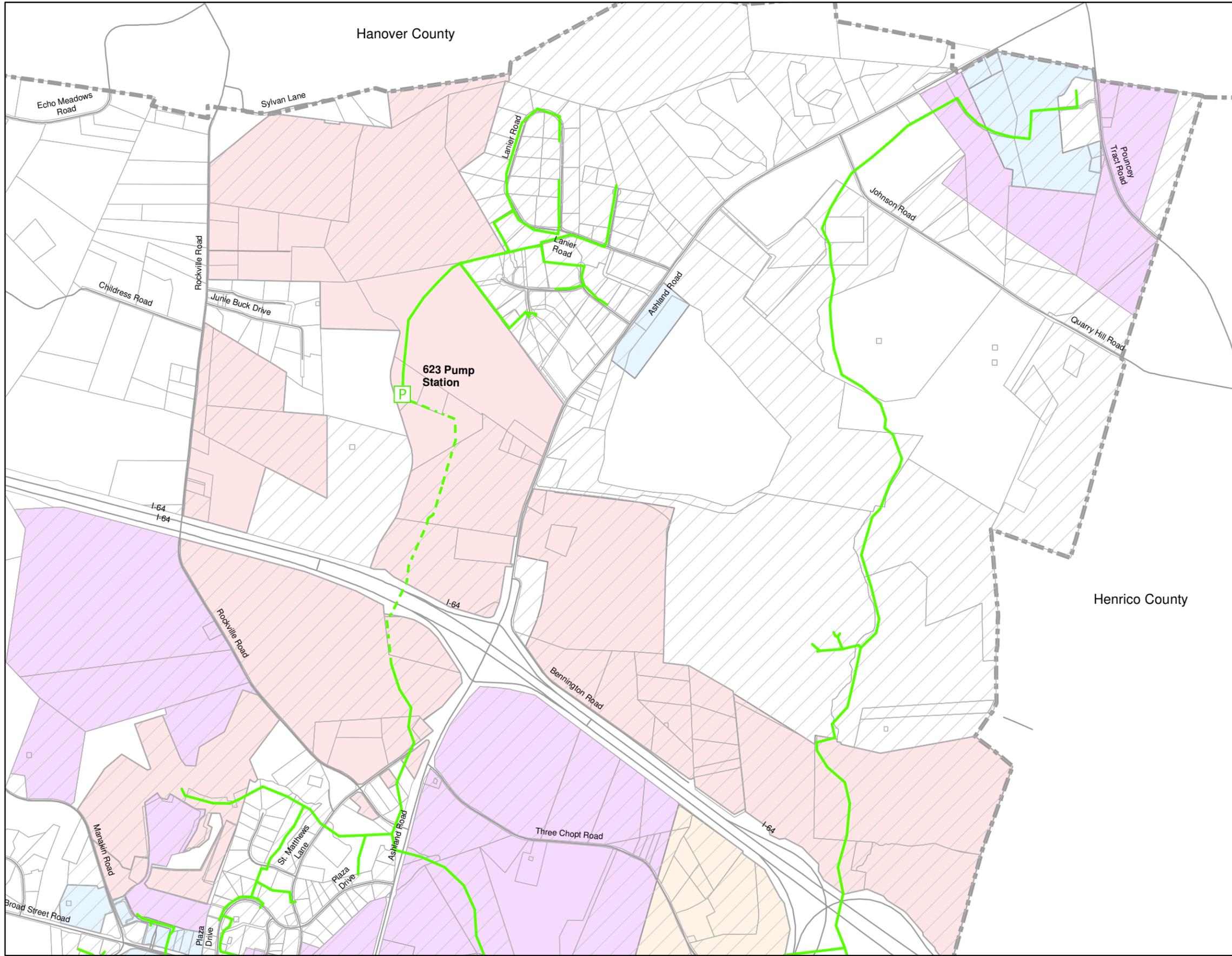
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- Existing Force Main
- Developer Driven Gravity
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- 2015 CIP Force Main
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Future Development

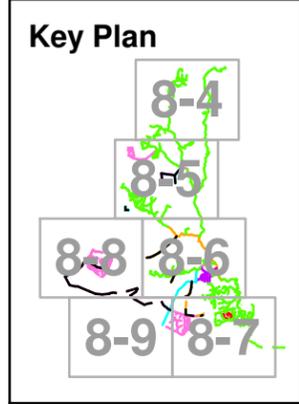
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Key Plan

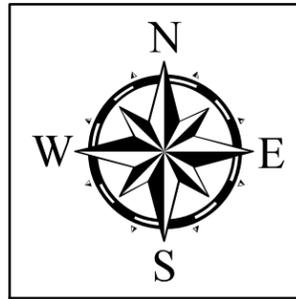
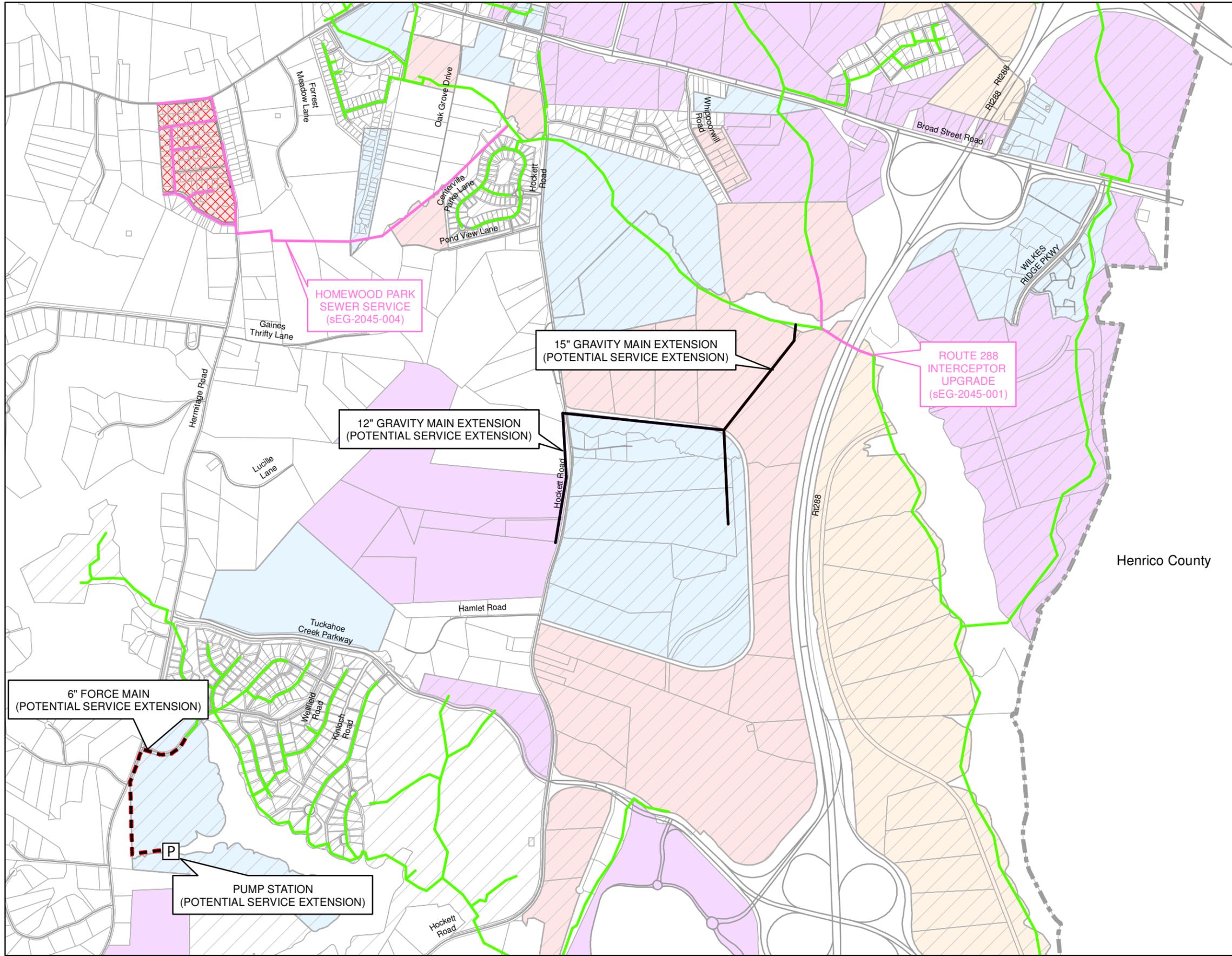
<p>Dewberry Engineers Inc. 4805 LAKE BROOK DRIVE, SUITE 200 GLEN ALLEN, VIRGINIA 23060 PHONE: 804.290.7957 FAX: 804.290.7928</p>	DATE	11/2014	SCALE	1 inch = 1,500 feet	TITLE	COURTHOUSE AREA FUTURE SEWER IMPROVEMENTS	FIGURE NO.	8-3
	PROJ. NO.	50061868	PROJECT	UTILITY MASTER PLAN GOOCHLAND COUNTY, VA				



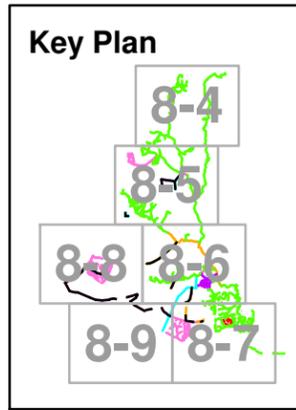
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 - Existing Gravity
 - Existing Force Main
 - Developer Driven Gravity
 - Developer Driven Force Main
 - 2015 CIP Gravity Main
 - 2015 CIP Force Main
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 - 2025 CIP Force Main
 - 2035 CIP Gravity Main
 - 2035 CIP Force Main
 - 2045 CIP Gravity Main
 - 2045 CIP Force Main
- Future Development**
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 - 2045
 - Existing to be served



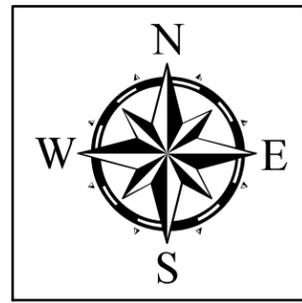
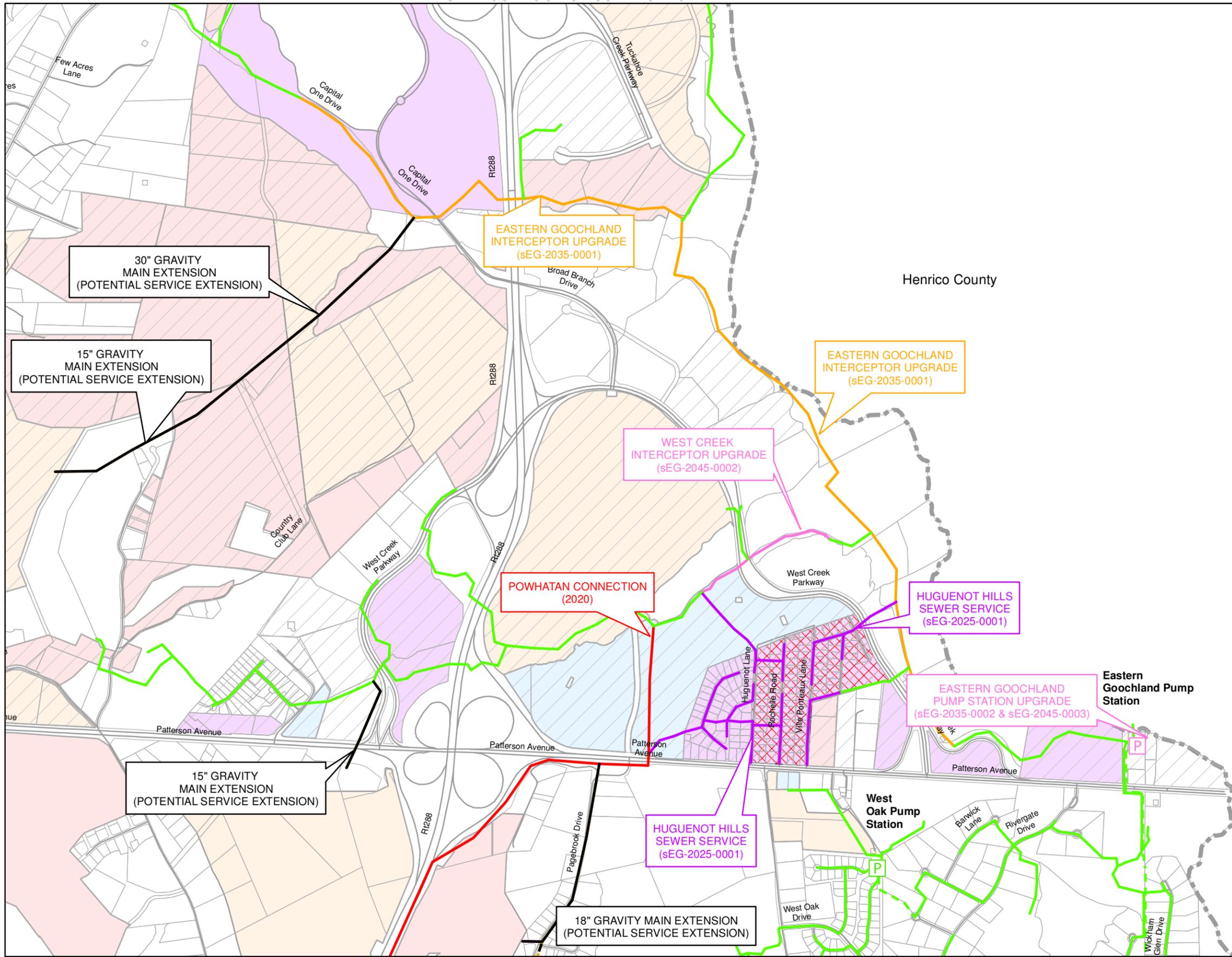
 Dewberry Engineers Inc. <small>4805 LAKE BROOK DRIVE, SUITE 200 GLEN ALLEN, VIRGINIA 23060 PHONE: 804.290.7957 FAX: 804.290.7928</small>	DATE 11/2014	SCALE 1 inch = 1,500 feet	TITLE EASTERN GOOCHLAND AREA FUTURE SEWER IMPROVEMENTS	FIGURE NO. 8-4
	PROJ. NO. 50061868	PROJECT UTILITY MASTER PLAN GOOCHLAND COUNTY, VA		



- Legend**
- P Existing Pump Station
 - Existing Gravity
 - Existing Force Main
 - Developer Driven Gravity
 - Developer Driven Force Main
 - 2015 CIP Gravity Main
 - 2015 CIP Force Main
 - 2020 CIP Gravity Main
 - 2020 CIP Force Main
 - 2025 CIP Gravity Main
 - 2025 CIP Force Main
 - 2035 CIP Gravity Main
 - 2035 CIP Force Main
 - 2045 CIP Gravity Main
 - 2045 CIP Force Main
- Future Development**
- 2020
 - 2025
 - 2035
 - 2045
 - Existing to be served



<p>Dewberry Dewberry Engineers Inc. 4805 LAKE BROOK DRIVE, SUITE 200 GLEN ALLEN, VIRGINIA 23060 PHONE: 804.290.7957 FAX: 804.290.7928</p>	DATE 11/2014	SCALE 1 inch = 1,500 feet	TITLE EASTERN GOOCHLAND AREA FUTURE SEWER IMPROVEMENTS	FIGURE NO. 8-5
	PROJ. NO. 50061868	PROJECT UTILITY MASTER PLAN GOOCHLAND COUNTY, VA		

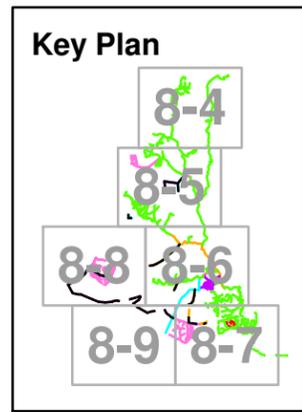


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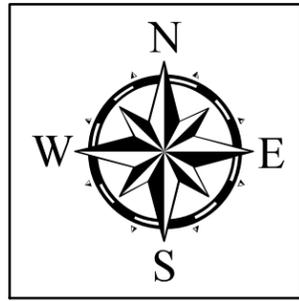
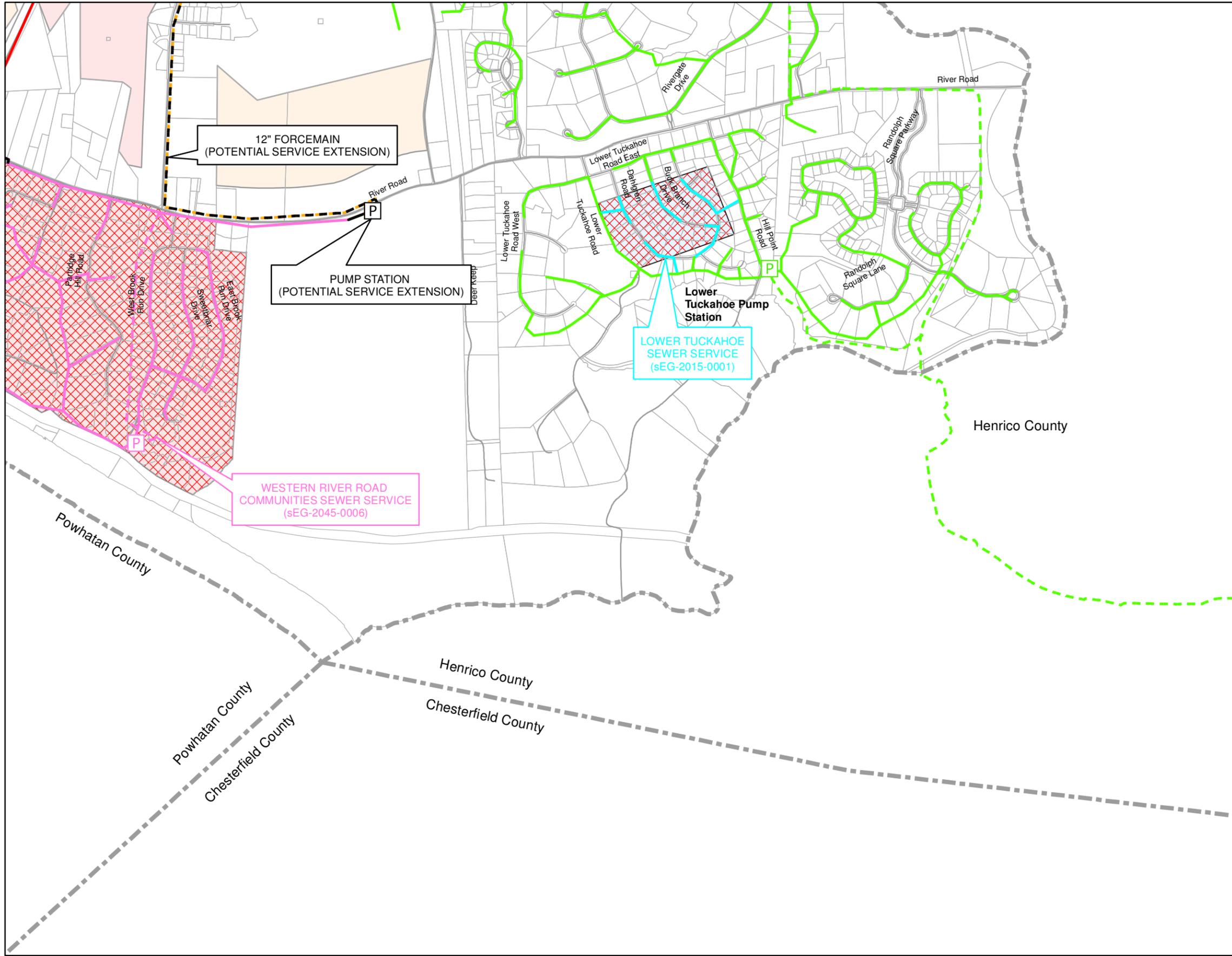
- P Existing Pump Station
- Existing Gravity
- Existing Force Main
- Developer Driven Gravity
- Developer Driven Force Main
- 2015 CIP Gravity Main
- 2015 CIP Force Main
- 2020 CIP Gravity Main
- 2020 CIP Force Main
- 2025 CIP Gravity Main
- 2025 CIP Force Main
- 2035 CIP Gravity Main
- 2035 CIP Force Main
- 2045 CIP Gravity Main
- 2045 CIP Force Main

Future Development

- 2020
- 2025
- 2035
- 2045
- Existing to be served



 Dewberry Engineers Inc. 4805 LAKE BROOK DRIVE, SUITE 200 GLEN ALLEN, VIRGINIA 23060 PHONE: 804.290.7957 FAX: 804.290.7928	DATE 11/2014	SCALE 1 inch = 1,500 feet	FIGURE NO. 8-6
	PROJ. NO. 50061868	PROJECT UTILITY MASTER PLAN GOOCHLAND COUNTY, VA	TITLE EASTERN GOOCHLAND AREA FUTURE SEWER IMPROVEMENTS

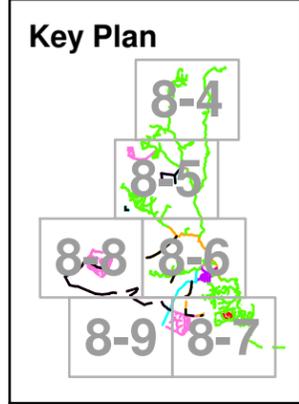


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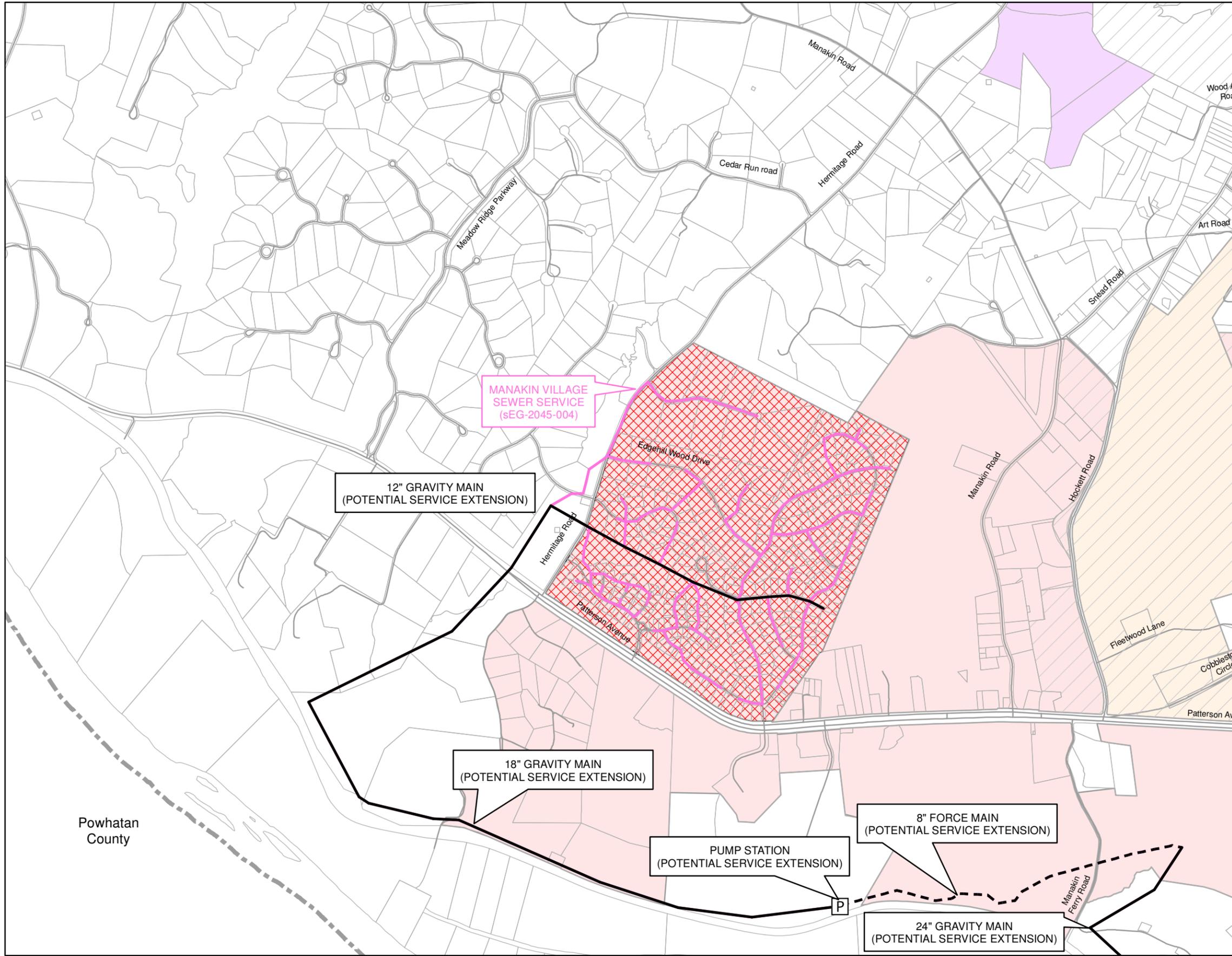
- P Existing Pump Station
- Existing Gravity
- - - Existing Force Main
- Developer Driven Gravity
- - - Developer Driven Force Main
- 2015 CIP Gravity Main
- - - 2015 CIP Force Main
- 2020 CIP Gravity Main
- - - 2020 CIP Force Main
- 2025 CIP Gravity Main
- - - 2025 CIP Force Main
- 2035 CIP Gravity Main
- - - 2035 CIP Force Main
- 2045 CIP Gravity Main
- - - 2045 CIP Force Main

Future Development

- 2020
- 2025
- 2035
- 2045
- Existing to be served



 Dewberry Engineers Inc. <small>4805 LAKE BROOK DRIVE, SUITE 200 GLEN ALLEN, VIRGINIA 23060 PHONE: 804.290.7957 FAX: 804.290.7928</small>	DATE 11/2014	SCALE 1 inch = 1,500 feet	TITLE EASTERN GOOCHLAND AREA FUTURE SEWER IMPROVEMENTS	FIGURE NO. 8-7
	PROJ. NO. 50061868	PROJECT UTILITY MASTER PLAN GOOCHLAND COUNTY, VA		



Legend

- P Existing Pump Station
- Existing Gravity
- Existing Force Main
- Developer Driven Gravity
- Developer Driven Force Main
- 2015 CIP Gravity Main
- 2015 CIP Force Main
- 2020 CIP Gravity Main
- 2020 CIP Force Main
- 2025 CIP Gravity Main
- 2025 CIP Force Main
- 2035 CIP Gravity Main
- 2035 CIP Force Main
- 2045 CIP Gravity Main
- 2045 CIP Force Main

Future Development

- 2020
- 2025
- 2035
- 2045
- Existing to be served

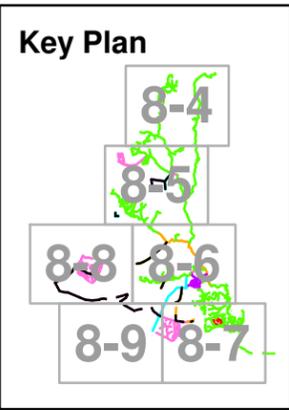


FIGURE NO.

**EASTERN GOOCHLAND AREA
FUTURE SEWER IMPROVEMENTS**

**UTILITY MASTER PLAN
GOOCHLAND COUNTY, VA**

8-8

SCALE
1 inch = 1,500 feet

PROJECT

DATE
11/2014

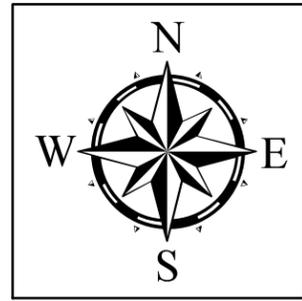
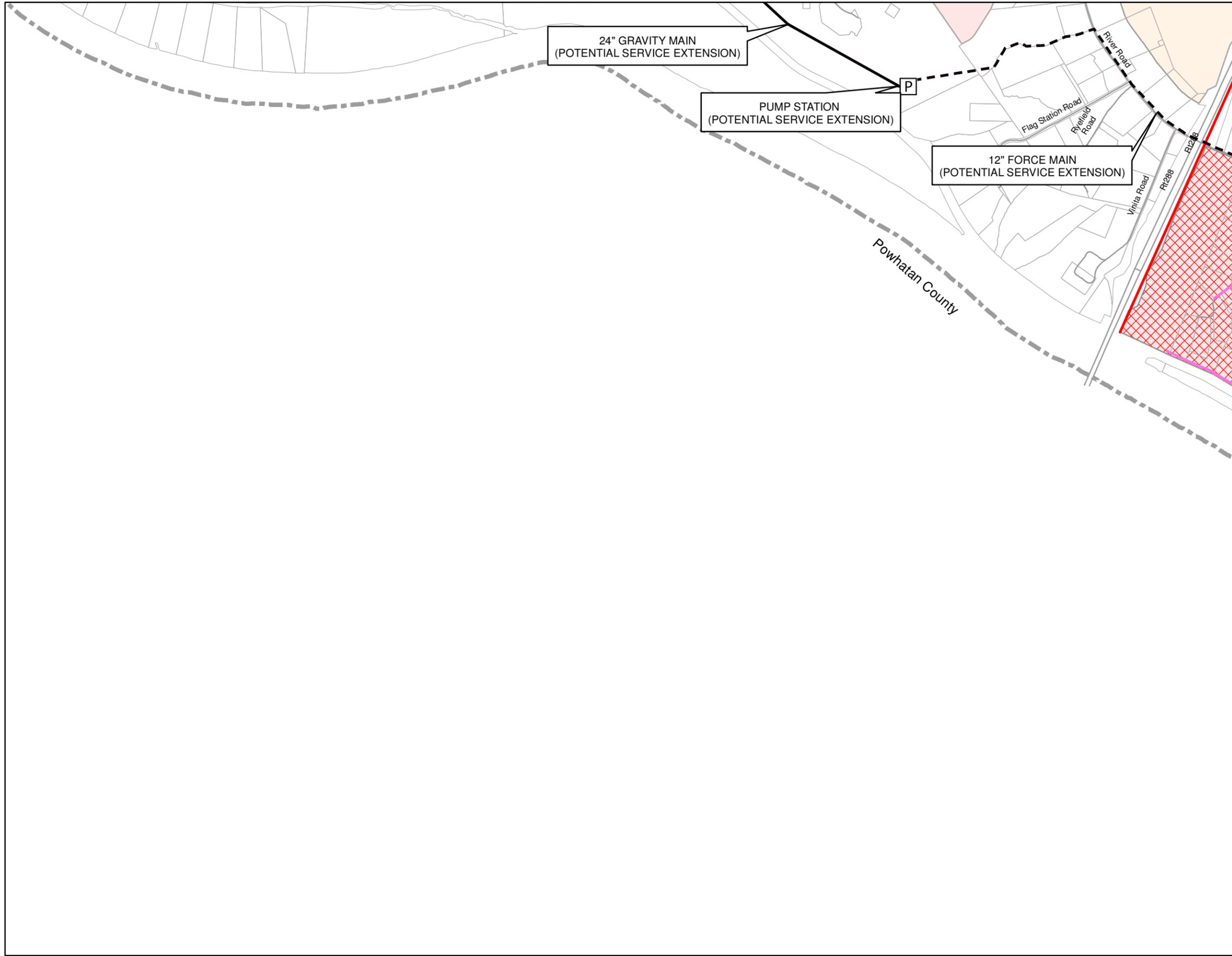
PROJ. NO.
50061868

Dewberry
Dewberry Engineers Inc.

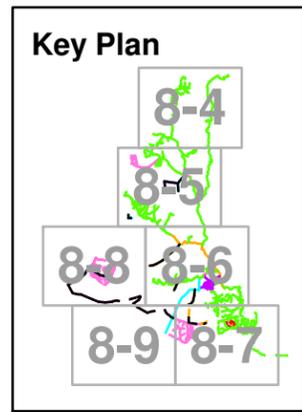
4805 LAKE BROOK DRIVE, SUITE 200
GLEN ALLEN, VIRGINIA 23060
PHONE: 804.290.7957
FAX: 804.290.7928



Powhatan County



- Legend**
- P Existing Pump Station
 - Existing Gravity
 - Existing Force Main
 - Developer Driven Gravity
 - Developer Driven Force Main
 - 2015 CIP Gravity Main
 - 2015 CIP Force Main
 - 2020 CIP Gravity Main
 - 2020 CIP Force Main
 - 2025 CIP Gravity Main
 - 2025 CIP Force Main
 - 2035 CIP Gravity Main
 - 2035 CIP Force Main
 - 2045 CIP Gravity Main
 - 2045 CIP Force Main
- Future Development**
- 2020
 - 2025
 - 2035
 - 2045
 - Existing to be served



 Dewberry Engineers Inc. <small>4805 LAKE BROOK DRIVE, SUITE 200 GLEN ALLEN, VIRGINIA 23060 PHONE: 804.290.7957 FAX: 804.290.7928</small>	DATE 11/2014	SCALE 1 inch = 1,500 feet	TITLE EASTERN GOOCHLAND AREA FUTURE SEWER IMPROVEMENTS	FIGURE NO. 8-9
	PROJ. NO. 50061868	PROJECT UTILITY MASTER PLAN GOOCHLAND COUNTY, VA		

Goochland Courthouse Service Area
See Figure 8-3

sGC-2020-001: Valley View Pump Station – Pump Replacement

This project would consist of the following improvements:

1. Replace pumps and control panel
2. Replace generator (size for future pump station)
3. Upgrade electrical service (size for future pump station)

Project is planned for completion by 2015.

sGC-2025-001: Valley View Pump Station – Pump Station and Force Main Upgrade

This project would consist of the following improvements

1. Construct new larger wetwell and valve vault
2. Add a third pump and relocate two existing pumps into new wetwell
3. Replace 1,400 LF of 4-inch existing force main with 8-inch diameter piping

Project is planned for completion by 2025.

sGC-2025-002: Interceptor Upgrade to VCCW Wastewater Treatment Plant

This project would consist of the following improvements:

1. Upsize 1,300 LF of 8-inch existing gravity main to an 18-inch gravity main

Project is planned for completion by 2025.

Eastern Goochland Service Area
See Figures 8-4 through 8-9

sEG-2015-0001: Lower Tuckahoe Sewer Service

This project would consist of the following improvements:

1. Construction of 8-inch gravity sewer within the existing Lower Tuckahoe neighborhood – approximately 1,400 linear feet

Project is planned for completion by 2015.

sEG-2025-0001: Huguenot Hills Sewer Service

This project would consist of the following improvements:

1. Construction of 8-inch gravity sewer within the existing Huguenot Hills neighborhood – approximately 12,800 linear feet

Project is planned for completion by 2025.

sEG-2035-0001: Eastern Goochland Interceptor Upgrade

This project would consist of the following improvements:

1. Upsize approximately 7,100 LF of 15-inch, 18-inch, 20-inch, and 30-inch existing pipe to 36-inch diameter pipe
2. Upsize approximately 9,800 LF of 30-inch, and 36-inch existing pipe to 42-inch diameter pipe

Project is planned for completion by 2035.

sEG-2035-0002: Eastern Goochland Pump Station Upgrade

This project would consist of the following improvements:

1. Install a 4th pump
2. Install new control panel and VFD
3. Install new generator and electric service

Project is planned for completion by 2035.

sEG-2045-0001: Route 288 Interceptor Upgrade

This project would consist of the following improvements:

1. Upsize approximately 2,100 LF of 21-inch and 24-inch existing pipe to 27-inch diameter pipe

Project is planned for completion by 2045.

sEG-2045-0002: West Creek Interceptor Upgrade

This project would consist of the following improvements:

1. Upsize approximately 2,300 LF of 24-inch existing pipe to 36-inch diameter pipe

Project is planned for completion by 2045.

sEG-2045-0003: Eastern Goochland Pump Station Upgrade

This project would consist of the following improvements:

1. Install two additional pumps for a total of 6 pumps
2. Install new VFDs

Project is planned for completion by 2045.

sEG-2045-0004: Homewood Park Sewer Service

This project would consist of the following improvements:

1. Construction of 8-inch gravity sewer within the existing Homewood Park neighborhood – approximately 11,500 linear feet

Project is planned for completion by 2045.

sEG-2045-0005: Manakin Village Sewer Service

This project would consist of the following improvements:

1. Construction of 8-inch gravity sewer within the existing Manakin Village neighborhood – approximately 30,200 linear feet

Project is planned for completion by 2045.

sEG-2045-0006: Western River Road Communities Sewer Service

This project would consist of the following improvements:

1. Construction of 8-inch gravity sewer within the existing Western River Road Communities – approximately 20,400 linear feet
2. Construction of a pump station and 4-inch force main – approximately 7,200 linear feet

Project is planned for completion by 2045.

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.

Tables 9-1 and 9-2 outline the projected water and wastewater system improvements by service area, 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 9-1 Goochland Courthouse Service Area Water and Wastewater Service Area (Recommended Projects based on Growth Projections)

Water Improvement Project	Fiscal Year				
	2015-2020	2020-2025	2025-2305	2035-2045	2045
wGC-2020-0001: Northern Goochland Courthouse Fire Flow Improvements (Ex. Fire Flow Improvement)		\$ 780,000			
wGC-2020-0002: J. Sargeant Reynolds Water Main Improvements (Ex. Fire Flow Improvement)		\$ 320,000			
wGC-2020-0003: River Road Improvements (Ex. Fire Flow Improvement)		\$ 2,240,000			
wGC-2020-0004: Courthouse Elevated Water Storage Tank Mixer		\$ 110,000			
wGC-2025-0001: Sandy Hook Water Main Loop			\$ 1,020,000		
wGC-2025-0002: River Road West Booster Pump Station			\$ 2,130,000		
wGC-2035-0001: Goochland Courthouse Elevated Water Storage Tank				\$ 2,930,000	
Goochland Courthouse Water Improvements Subtotal	\$ -	\$ 3,450,000	\$ 3,150,000	\$ 2,930,000	\$ -
Wastewater Improvement Project	Fiscal Year				
	2015-2020	2020-2025	2025-2305	2035-2045	2045
sGC-2015-002: Courthouse Service Area I&I Study ²	\$ 50,000				
sGC-2020-001: Valley View Pump Station – Pump Replacement		\$ 380,000			
sGC-2025-001: Valley View Pump Station – Pump Station and Force Main Upgrade			\$ 490,000		
sGC-2025-002: Interceptor Upgrade to VCCW Wastewater Treatment Plant			\$ 650,000		
Expansion of Wastewater Capacity	TBD	TBD			
Goochland Courthouse Wastewater Improvements Subtotal	\$ 50,000	\$ 380,000	\$ 1,140,000	\$ -	\$ -
Total Goochland Courthouse Service Area Improvement Cost Estimate	\$ 50,000	\$ 3,830,000	\$ 4,290,000	\$ 2,930,000	\$ -

1. Budgetary cost estimates for water supply or wastewater disposal connections do not include potential connections fees.

2. Placeholder. Final cost to be determined based on scope.

Table 9-2 Eastern Goochland Service Area Water and Wastewater Service Area (Recommended Projects based on Growth Projections)

Water Improvement Project	Fiscal Year				
	2015-2020	2020-2025	2025-2305	2035-2045	2045
wEG-2015-0001: Centerville Elevated Water Storage Tank Mixer	\$ 110,000				
wEG-2015-0002: Chloramine Booster Station	\$ 250,000				
wEG-2015-0003: West Creek Control Valve Vault	\$ 190,000				
wEG-2015-0004: Decommission West Creek Elevated Tank	\$ 30,000				
wEG-2020-0001: Lanier Industrial Park Improvements (Ex. Fire Flow Improvement)		\$ 290,000			
wEG-2020-0002: Richmond Country Club Water Main (Ex. Fire Flow Improvement)		\$ 1,040,000			
wEG-2020-0003: Rivergate Water Main Loop (Ex. Fire Flow Improvement)		\$ 140,000			
wEG-2020-0004: West Creek-River Road Low Control Valve (Ex. Fire Flow Improvement)		\$ 130,000			
wEG-2020-0005: Lower Tuckahoe and Randolph Square Water Main Upgrades (Ex. Fire Flow Improvement)		\$ 2,110,000			
wEG-2020-0006: River Road Low Pressure Zone Water Main Upgrade (Ex. Fire Flow Improvement)		\$ 1,220,000			
wEG-2020-0007: River Road Booster Station Upgrade (Ex. Fire Flow Improvement)		\$ 1,240,000			
wEG-2020-0008: River Road High Pressure Zone Water Main Upgrade (Ex. Fire Flow Improvement)		\$ 680,000			
wEG-2020-0009: West Oak Water Main Loop (Ex. Fire Flow Improvement)		\$ 640,000			
wEG-2020-0010: Western River Road Communities Water Main Looping (Ex. Fire Flow Improvement)		\$ 800,000			
wEG-2020-0011: Lanier Industrial Park Elevated Water Storage Tank		\$ 2,830,000			
wEG-2020-0012: Parke at Saddle Creek Water Main Loop		\$ 530,000			
wEG-2020-0013: Hockett Road Water Main		\$ 3,470,000			
wEG-2025-0001: Centerville Booster Pump Station Upgrade			\$ 2,950,000		
wEG-2025-0002: Huguenot Hills Water Service			\$ 2,520,000		
wEG-2035-0001: Ashland Road Water Main Upgrade				\$ 2,030,000	
wEG-2035-0002: Ridgefield Booster Pump Station				\$ 3,970,000	
wEG-2035-0003: Patterson Avenue Water Main Extension				\$ 6,120,000	
wEG-2035-0004: River Road Water Main Extension				\$ 2,300,000	
wEG-2035-0005: River Road Booster Station Storage Tank				\$ 1,210,000	
wEG-2035-0006: Manakin Elevated Water Storage Tank				\$ 4,590,000	
wEG-2035-0007: Relocate West Creek Control Valve Vault				\$ 190,000	
wEG-2045-0001: Broad Street Water Main Upgrade					\$ 1,950,000
wEG-2045-0002: Hockett Road Elevated Water Storage Tank					\$ 4,590,000
wEG-2045-0003: Homewood Park Water Service					\$ 2,220,000
wEG-2045-0004: Ridgefield Water Main Upgrade					\$ 1,950,000
wEG-2045-0005: Manakin Village Water Service					\$ 6,710,000
wEG-2045-0006: James River Estates Water Service					\$ 1,980,000
Eastern Goochland Water Improvements Subtotal	\$ 580,000	\$ 15,120,000	\$ 5,470,000	\$ 20,410,000	\$ 19,400,000
Wastewater Improvement Project	Fiscal Year				
	2015-2020	2020-2025	2025-2305	2035-2045	2045
sEG-2015-0001: Lower Tuckahoe Sewer Service ²	\$ 460,000				
sEG-2020-0002: Eastern Goochland Service Area I&I Study ³		\$ 100,000			
sEG-2025-0001: Huguenot Hills Sewer Service			\$ 2,710,000		
sEG-2035-0001: Eastern Goochland Interceptor Upgrade				\$ 11,860,000	
sEG-2035-0002: Eastern Goochland Pump Station Upgrade				\$ 2,590,000	
sEG-2045-0001: Route 288 Interceptor Upgrade					\$ 1,660,000
sEG-2045-0002: West Creek Interceptor Upgrade					\$ 2,250,000
sEG-2045-0003: Eastern Goochland Pump Station Upgrade					\$ 2,400,000
sEG-2045-0004: Homewood Park Sewer Service					\$ 2,470,000
sEG-2045-0005: Manakin Village Sewer Service					\$ 6,570,000
sEG-2045-0006: Western River Road Communities Sewer Service					\$ 4,870,000
Eastern Goochland Wastewater Improvements Subtotal	\$ 460,000	\$ 100,000	\$ 2,710,000	\$ 14,450,000	\$ 20,220,000
Total Eastern Goochland Service Area Improvement Cost Estimate	\$1,040,000.00	\$15,220,000.00	\$8,180,000.00	\$34,860,000.00	\$39,620,000.00

1. Budgetary cost estimates for water supply or wastewater disposal connections do not include potential connections fees.

2. County share of project. The remainder of the project cost would be paid for by the residents.

3. Placeholder. Final cost to be determined based on scope.

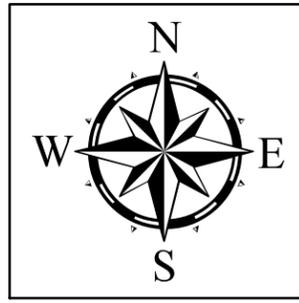
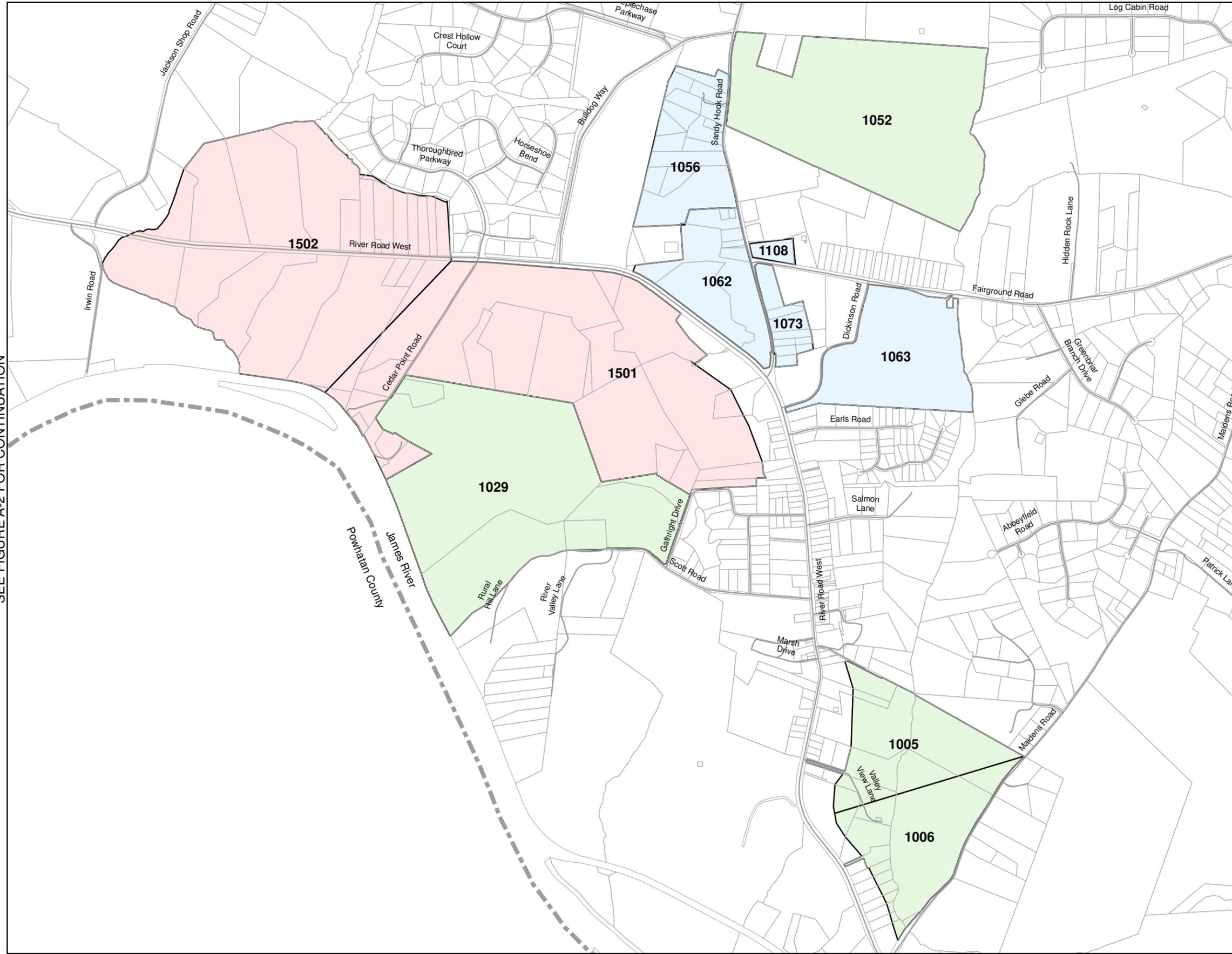
APPENDIX A
Future Demand
Projections Details



Utility Master Plan
Goochland County, Virginia



SEE FIGURE A-2 FOR CONTINUATION



Legend

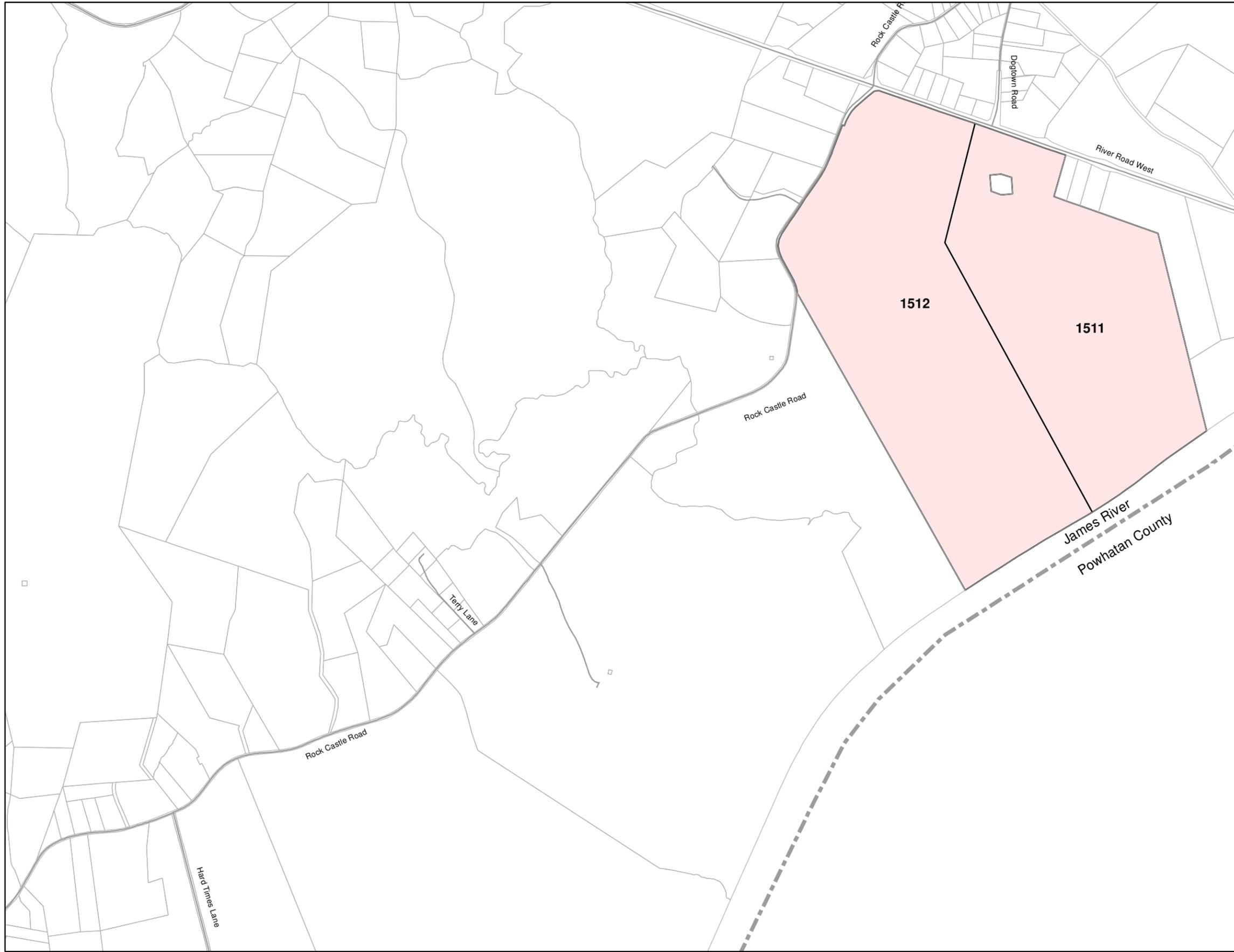
- County Boundaries
- TCSD

Future Development

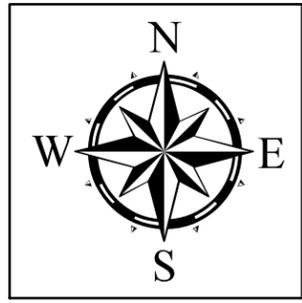
- Commercial
- Industrial
- Mixed Use
- Residential
- Existing to be Served
- Existing

Key Plan

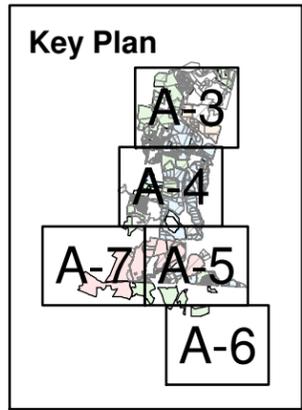
 Dewberry Dewberry Engineers Inc. 4805 LAKE BROOK DRIVE, SUITE 200 GLEN ALLEN, VIRGINIA 23060 PHONE: 804.290.7957 FAX: 804.290.7928	DATE 11/2014 PROJ. NO. 50061868	SCALE 1 inch = 1,500 feet PROJECT	TITLE COURTHOUSE AREA FUTURE DEVELOPMENT DEMANDS UTILITY MASTER PLAN GOOCHLAND COUNTY, VA	FIGURE NO. A-1
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SEE FIGURE A-1 FOR CONTINUATION



- Legend**
- County Boundaries
 - ▨ TCSD
- Future Development**
- Commercial
 - Industrial
 - Mixed Use
 - Residential
 - Existing to be Served
 - Existing



 Dewberry Dewberry Engineers Inc. 4805 LAKE BROOK DRIVE, SUITE 200 GLEN ALLEN, VIRGINIA 23060 PHONE: 804.290.7957 FAX: 804.290.7928	DATE	11/2014	SCALE	1 inch = 1,500 feet	TITLE	COURTHOUSE AREA FUTURE DEVELOPMENT DEMANDS	FIGURE NO.	A-2
	PROJ. NO.	50061868	PROJECT	UTILITY MASTER PLAN GOOCHLAND COUNTY, VA				

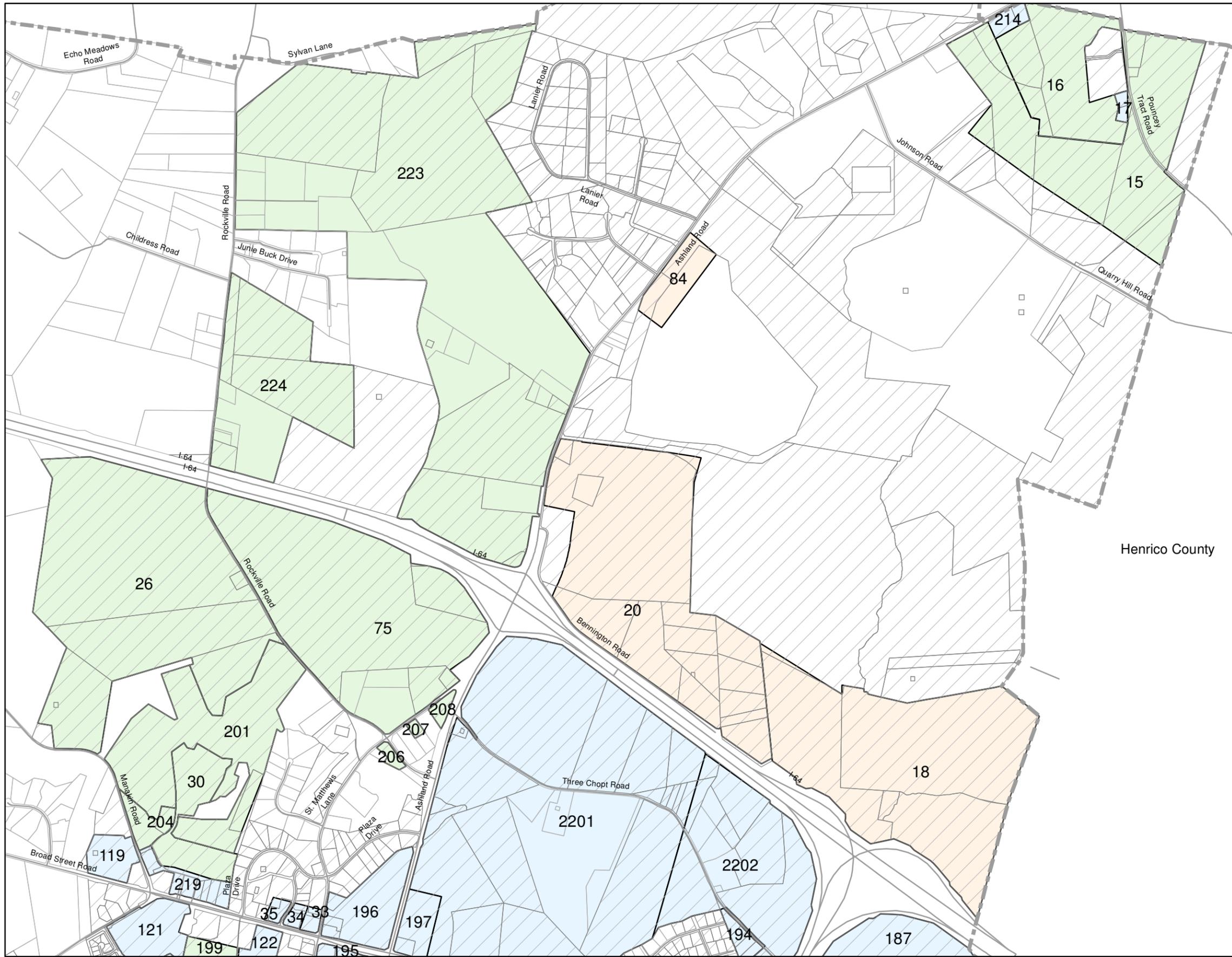
Water Demand and Sewer Loading Projections - Courthouse Service Area

Proposed Residential Demand

Map ID	Total Area (AC)	Percent Developable	Developable Area (AC)	Density	Units	Demand by 2020 (gpd)	Demand by 2025 (gpd)	Demand by 2035 (gpd)	Demand by 2045 (gpd)
1501	289.2	50.00%	144.6	Medium	145	-	-	36,301	-
1511	289.3	50.00%	144.6	Low	200	-	-	50,200	-
1502	297.0	50.00%	148.5	Medium	148	-	-	-	37,273
1512	386.6	50.00%	193.3	Low	200	-	-	-	50,200
1029	226.2	50.00%	113.1	Medium	226	-	56,764	-	-
1052	182.4	50.00%	91.2	Medium	182	-	45,771	-	-
1005	72.0	50.00%	36.0	Medium	72	-	-	18,066	-
1006	71.8	50.00%	35.9	Medium	72	-	-	-	18,011
Total Demand						0	102,535	104,566	105,484

Proposed Commercial Demand

Map ID	Total Area (AC)	Percent Developable	Developable Area (AC)	Classification	Demand by 2020 (gpd)	Demand by 2025 (gpd)	Demand by 2035 (gpd)	Demand by 2045 (gpd)
1056	58.2	50.00%	29.1	Retail	25,000	-	-	-
1073	15.8	50.00%	7.9	Retail	750	-	-	-
1108	4.6	50.00%	2.3	Retail	500	-	-	-
1062	54.5	50.00%	27.3	Retail	-	25,000	-	-
1063	76.7	50.00%	38.4	J Sargeant Expansion	-	-	5,472	-
1501	289.2	50.00%	144.6	Retail	-	-	25,000	-
1511	289.3	50.00%	144.6	Retail	-	-	5,625	-
1502	297.0	50.00%	148.5	Retail	-	-	-	25,000
1512	386.6	150.00%	193.3	Retail	-	-	-	5,625
Total Demand					26,250	25,000	36,097	30,625

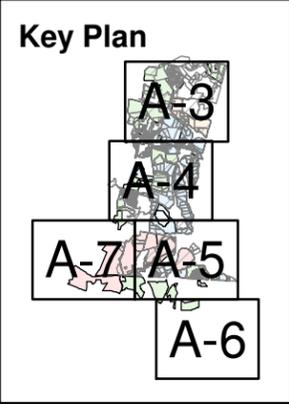


Legend

- County Boundaries
- TCSD

Future Development

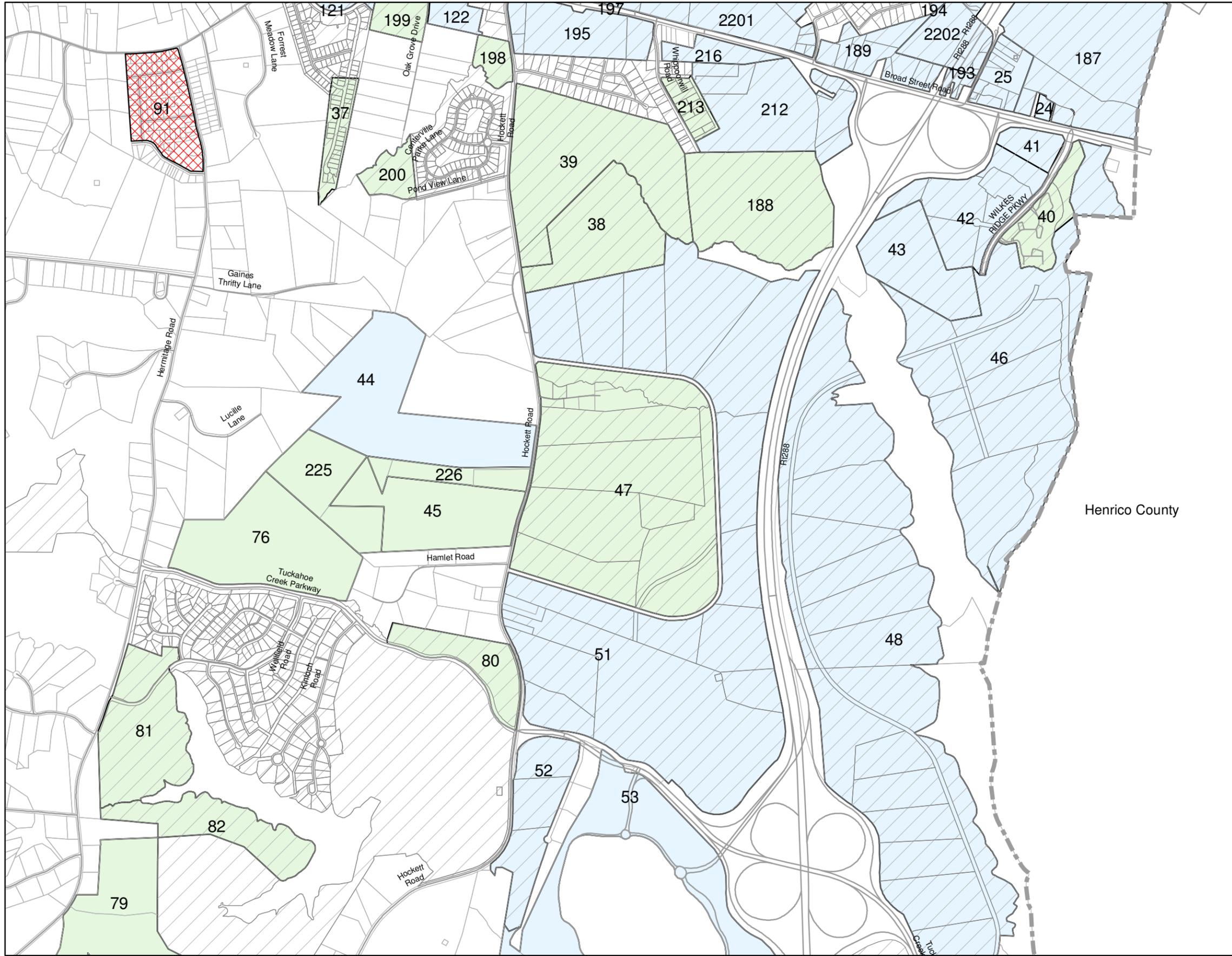
- Commercial
- Industrial
- Mixed Use
- Residential
- Existing to be Served
- Existing



SEE FIGURE A-4 FOR CONTINUATION

<p>Dewberry Dewberry Engineers Inc. 4805 LAKE BROOK DRIVE, SUITE 200 GLEN ALLEN, VIRGINIA 23060 PHONE: 804.290.7957 FAX: 804.290.7928</p>	<p>DATE</p> <p>11/2014</p>	<p>SCALE</p> <p>1 inch = 1,500 feet</p>	<p>FIGURE NO.</p> <p>A-3</p>
	<p>PROJ. NO.</p> <p>50061868</p>	<p>PROJECT</p> <p>UTILITY MASTER PLAN GOOCHLAND COUNTY, VA</p>	<p>TITLE</p> <p>EASTERN GOOCHLAND AREA FUTURE DEVELOPMENT DEMANDS</p>

SEE FIGURE A-3 FOR CONTINUATION



SEE FIGURE A-5 FOR CONTINUATION



Legend

- County Boundaries
- TCS

Future Development

- Commercial
- Industrial
- Mixed Use
- Residential
- Existing to be Served
- Existing

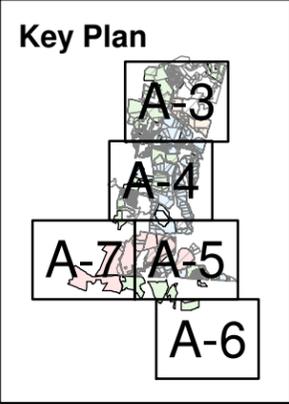


FIGURE NO.

**EASTERN GOOCHLAND AREA
FUTURE DEVELOPMENT DEMANDS**

SCALE
1 inch = 1,500 feet

DATE
11/2014

**UTILITY MASTER PLAN
GOOCHLAND COUNTY, VA**

PROJECT

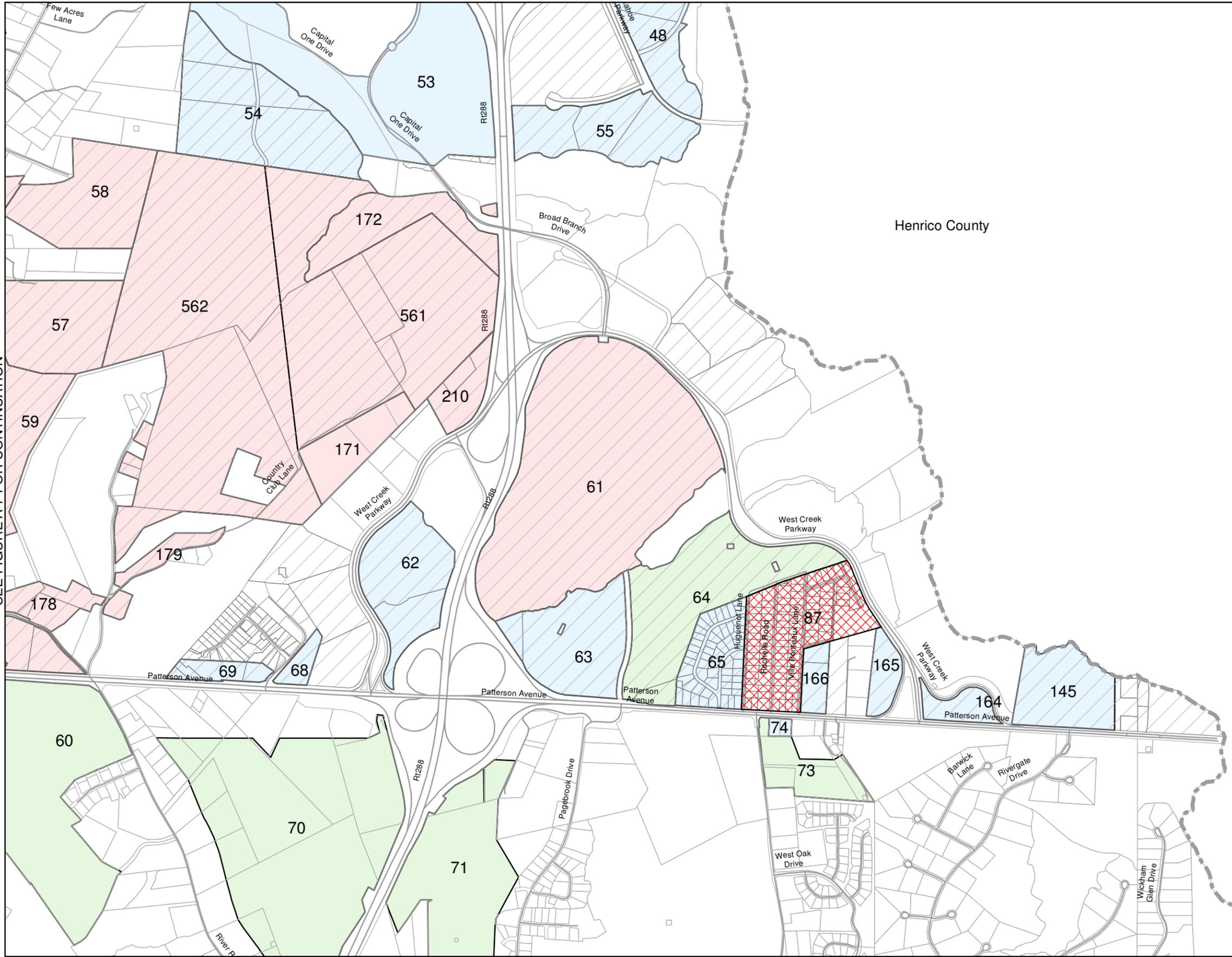
PROJ. NO.
50061868

Dewberry
Dewberry Engineers Inc.
4805 LAKE BROOK DRIVE, SUITE 200
GLEN ALLEN, VIRGINIA 23060
PHONE: 804.290.7957
FAX: 804.290.7928

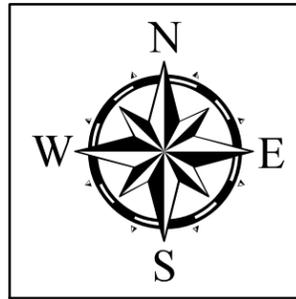


A-4

SEE FIGURE A-4 FOR CONTINUATION



SEE FIGURE A-6 FOR CONTINUATION

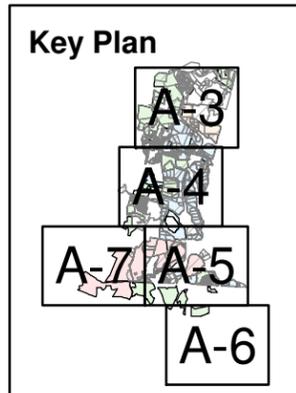


Legend

- County Boundaries
- ▨ TCSD

Future Development

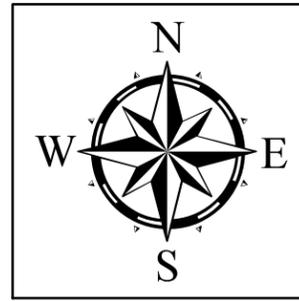
- ▨ Commercial
- ▨ Industrial
- ▨ Mixed Use
- ▨ Residential
- ▨ Existing to be Served
- ▨ Existing



SEE FIGURE A-7 FOR CONTINUATION

<p>Dewberry Engineers Inc. 4805 LAKE BROOK DRIVE, SUITE 200 GLEN ALLEN, VIRGINIA 23060 PHONE: 804.290.7957 FAX: 804.290.7928</p>	<p>DATE 11/2014</p>	<p>SCALE 1 inch = 1,500 feet</p>	<p>FIGURE NO. A-5</p>
	<p>PROJ. NO. 50061868</p>	<p>TITLE EASTERN GOOCHLAND AREA FUTURE DEVELOPMENT DEMANDS</p>	<p>PROJECT UTILITY MASTER PLAN GOOCHLAND COUNTY, VA</p>

SEE FIGURE A-5 FOR CONTINUATION



- Legend**
- County Boundaries
 - TCS
- Future Development**
- Commercial
 - Industrial
 - Mixed Use
 - Residential
 - Existing to be Served
 - Existing

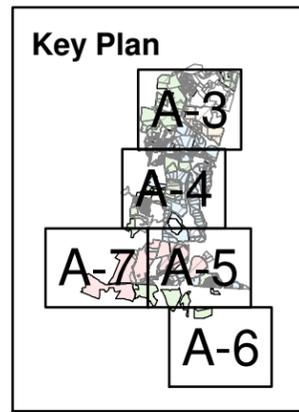


FIGURE NO.

**EASTERN GOOCHLAND AREA
FUTURE DEVELOPMENT DEMANDS**

**UTILITY MASTER PLAN
GOOCHLAND COUNTY, VA**

A-6

SCALE
1 inch = 1,500 feet

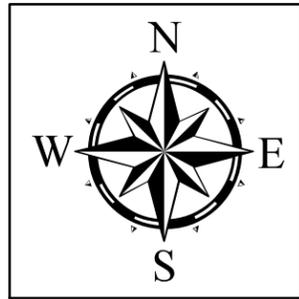
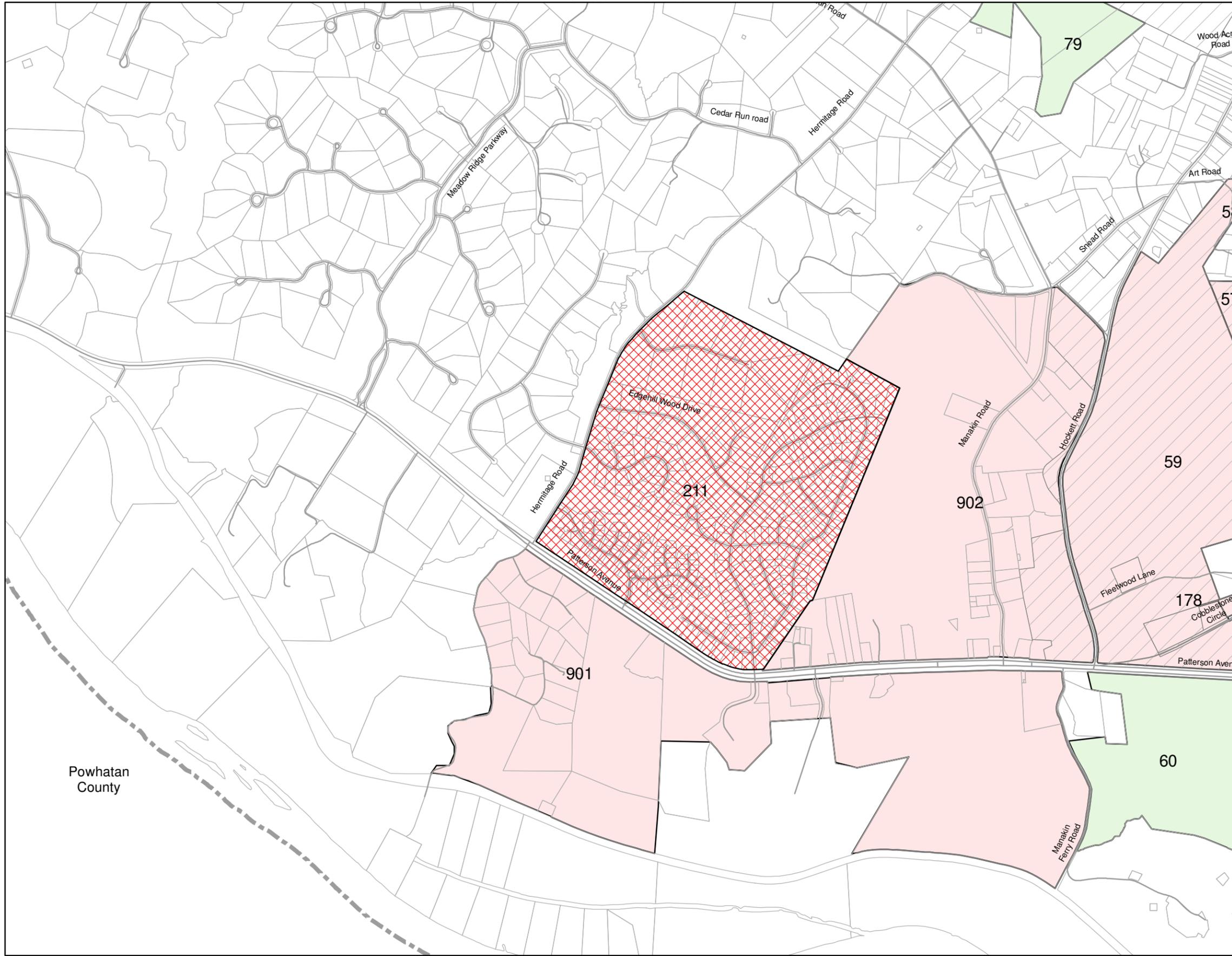
PROJECT

DATE
11/2014

PROJ. NO.
50061868

Dewberry
Dewberry Engineers Inc.
4805 LAKE BROOK DRIVE, SUITE 200
GLEN ALLEN, VIRGINIA 23060
PHONE: 804.290.7957
FAX: 804.290.7928

SEE FIGURE A-4 FOR CONTINUATION



Legend

- County Boundaries
- ▭ TCSD

Future Development

- ▭ Commercial
- ▭ Industrial
- ▭ Mixed Use
- ▭ Residential
- ▨ Existing to be Served
- ▭ Existing

SEE FIGURE A-5 FOR CONTINUATION

Key Plan

Powhatan County

<p>Dewberry Dewberry Engineers Inc. 4805 LAKE BROOK DRIVE, SUITE 200 GLEN ALLEN, VIRGINIA 23060 PHONE: 804.290.7957 FAX: 804.290.7928</p>	DATE	11/2014	PROJ. NO.	50061868
	SCALE	1 inch = 1,500 feet	PROJECT	UTILITY MASTER PLAN GOOCHLAND COUNTY, VA
TITLE	EASTERN GOOCHLAND AREA FUTURE DEVELOPMENT DEMANDS			
FIGURE NO.	A-7			

Water Demand and Sewer Loading Projections - Eastern Goochland Service Area

Proposed Residential Demands

Village	Map ID	Total Area (AC)	Percent Developable	Developable Area (AC)	Density	Units	Demand by 2020 (gpd)	Demand by 2025 (gpd)	Demand by 2035 (gpd)	Demand by 2045 (gpd)
Rockville	15	132.0	80%	105.6	High	251	-	62,955	-	-
Rockville	16	59.6	80%	47.6	High	118	29,618	-	-	-
Rockville	223	479.2	80%	383.4	Medium	728	-	-	-	182,827
Rockville	224	95.8	80%	76.7	Medium	146	-	-	-	36,566
Centerville	26	238.2	80%	190.5	High	453	-	113,585	-	-
Centerville	30	28.1	80%	22.5	Apartments	171	-	42,883	-	-
Centerville	37	13.7	80%	11.0	High	53	13,303	-	-	-
Centerville	38	54.9	80%	43.9	Medium	100	25,100	-	-	-
Centerville	39	97.0	80%	77.6	High	200	50,200	-	-	-
Centerville	40	21.6	80%	17.3	Apartments	500	125,500	-	-	-
Centerville	75	185.7	80%	148.6	High	353	-	-	-	88,580
Centerville	188	75.7	80%	60.5	Medium	115	-	-	-	28,869
Centerville	198	8.0	80%	6.4	Medium	12	-	-	-	3,068
Centerville	199	13.4	80%	10.7	Medium	20	-	-	-	5,114
Centerville	200	11.3	80%	9.1	Medium	17	-	-	-	4,327
Centerville	201	91.8	80%	73.5	High	174	-	-	-	43,791
Centerville	204	7.7	80%	6.2	High	15	-	-	-	3,680
Centerville	206	1.8	80%	1.5	High	3	-	-	-	877
Centerville	207	1.0	80%	0.8	High	2	-	-	-	482
Centerville	208	2.4	80%	1.9	High	5	-	-	-	1,138
Centerville	213	9.8	80%	7.8	High	19	-	-	-	4,674
West Creek	45	54.0	80%	43.2	High	103	-	25,764	-	-
West Creek	47	220.7	80%	176.6	Low	250	62,750	-	-	-
West Creek	57	57.3	80%	45.8	Medium	44	-	-	-	10,924
West Creek	58	57.4	80%	45.9	Medium	44	-	-	-	10,953
West Creek	59	357.2	80%	285.7	Medium	271	-	-	68,132	-
West Creek	61	224.0	80%	179.2	Medium	170	-	-	42,725	-
West Creek	64	83.8	80%	67.1	High	300	75,300	-	-	-
West Creek	68	6.3	80%	5.0	Low	5	1,255	-	-	-
West Creek	76	73.3	80%	58.7	Medium	100	25,100	-	-	-
West Creek	79	90.6	80%	72.5	Medium	138	-	34,565	-	-
West Creek	80	26.9	80%	21.5	Low	30	-	7,530	-	-
West Creek	81	59.0	80%	47.2	Medium	90	22,525	-	-	-
West Creek	82	38.0	80%	30.4	Medium	58	14,492	-	-	-
West Creek	171	26.4	80%	21.1	Medium	20	-	-	-	5,031
West Creek	172	39.3	80%	31.4	Medium	30	-	-	-	7,498
West Creek	178	20.1	80%	16.1	Medium	15	-	-	-	3,843
West Creek	179	9.1	80%	7.2	Medium	7	-	-	-	1,726
West Creek	210	16.7	80%	13.3	Medium	13	-	-	-	3,180
West Creek	225	36.0	80%	28.8	High	68	-	17,165	-	-
West Creek	226	16.1	80%	12.9	High	31	-	7,693	-	-
West Creek	561	199.9	80%	159.9	Apartments	1500	-	-	376,500	-
West Creek	562	278.8	80%	223.0	Apartments	1500	-	-	-	376,500

Water Demand and Sewer Loading Projections - Eastern Goochland Service Area

Proposed Residential Demands Continued

Village	Map ID	Total Area (AC)	Percent Developable	Developable Area (AC)	Density	Units	Demand by 2020 (gpd)	Demand by 2025 (gpd)	Demand by 2035 (gpd)	Demand by 2045 (gpd)
River Road	60	231.3	50%	115.7	Medium	231	-	-	-	58,064
River Road	70	204.4	50%	102.2	Low	153	-	-	38,486	-
River Road	71	97.3	50%	48.7	Low	100	-	-	-	25,100
River Road	72	106.1	50%	53.0	Low	80	-	-	19,965	-
River Road	73	23.5	50%	11.7	Medium	23	-	-	5,894	-
Manakin	901	506.9	50%	253.4	Low	304	-	-	-	76,338
Manakin	902	454.4	50%	227.2	Low	273	-	-	-	68,439
Total Demand							445,142	312,140	551,702	1,051,591

Water Demand and Sewer Loading Projections - Eastern Goochland Service Area

Proposed Commercial Demands

Village	Map ID	Total Area (AC)	Percent Developable	Developable Area (AC)	Classification	Demand by 2020 (gpd)	Demand by 2025 (gpd)	Demand by 2035 (gpd)	Demand by 2045 (gpd)
Rockville	17	1.7	80%	1.3	Dance Studio	1,300	-	-	-
Rockville	214	4.3	80%	3.4	Retail	1,000	-	-	-
Centerville	24	1.9	80%	1.5	Fast Food	2,500	-	-	-
Centerville	25	15.5	80%	12.4	Retail	17,335	-	-	-
Centerville	33	2.1	80%	1.7	Fast Food	2,500	-	-	-
Centerville	34	2.0	80%	1.6	Fast Food	2,500	-	-	-
Centerville	35	2.1	80%	1.7	Drug Store	-	60	-	-
Centerville	41	9.6	80%	7.7	Fast Food	5,000	-	-	-
Centerville	42	48.0	80%	38.4	Medical	60,000	-	-	-
Centerville	43	41.4	80%	33.1	Design Development	-	101,950	-	-
Centerville	46	198.6	80%	158.9	Office	-	70,000	-	-
Centerville	119	10.2	80%	8.2	Retail	11,452	-	-	-
Centerville	121	19.8	80%	15.9	Retail	22,219	-	-	-
Centerville	122	11.4	80%	9.2	Retail	12,816	-	-	-
Centerville	187	121.6	80%	97.3	Retail	-	136,219	-	-
Centerville	189	24.8	80%	19.8	Retail	-	27,723	-	-
Centerville	193	3.3	80%	2.6	Retail	-	3,675	-	-
Centerville	194	4.8	80%	3.9	Retail	-	5,411	-	-
Centerville	195	37.0	80%	29.6	Retail	-	41,423	-	-
Centerville	196	26.3	80%	21.1	Retail	-	29,492	-	-
Centerville	197	11.5	80%	9.2	Retail	-	12,828	-	-
Centerville	212	66.1	80%	52.9	Retail	-	74,068	-	-
Centerville	216	10.9	80%	8.7	Retail	12,206	-	-	-
Centerville	219	10.1	80%	8.1	Retail	11,291	-	-	-
Centerville	2201	388.0	80%	310.4	Retail	-	434,531	-	-
Centerville	2202	122.0	80%	97.6	Retail	-	-	136,586	-
West Creek	44	88.8	80%	71.0	Elementary School	-	4,000	-	-
West Creek	48	404.5	80%	323.6	High Rise Office	-	-	437,500	-
West Creek	51	416.7	80%	333.4	Office	-	-	-	466,694
West Creek	52	40.3	80%	32.3	High Rise Office	-	-	-	245,903
West Creek	53	211.6	80%	169.3	Capital One Expansion	-	209,113	-	-
West Creek	54	86.7	80%	69.4	High Rise Office	-	-	-	528,901
West Creek	55	50.0	80%	40.0	Hospital Expansion	-	-	-	764
West Creek	57	57.3	80%	45.8	Retail	-	-	-	32,069
West Creek	58	57.4	80%	45.9	Retail	-	-	-	32,154
West Creek	59	357.2	80%	285.7	Retail	-	-	200,010	-
West Creek	61	224.0	80%	179.2	Retail	-	-	125,424	-
West Creek	62	50.2	80%	40.2	Retail	-	90,000	-	-
West Creek	63	54.1	80%	43.3	Retail	62,500	-	-	-
West Creek	68	6.3	80%	5.0	Office	2,625	-	-	-
West Creek	69	9.8	80%	7.9	Office	-	34,260	-	-
West Creek	171	26.4	80%	21.1	Retail	-	-	-	14,769
West Creek	172	39.3	80%	31.4	Retail	-	-	-	22,012
West Creek	178	20.1	80%	16.1	Retail	-	-	-	11,281
West Creek	179	9.1	80%	7.2	Retail	-	-	-	5,068
West Creek	210	16.7	80%	13.3	Retail	-	-	-	9,335
West Creek	561	199.9	80%	159.9	Retail	-	-	250,000	-
West Creek	562	278.8	80%	223.0	Retail	-	-	-	250,000

Water Demand and Sewer Loading Projections - Eastern Goochland Service Area

Proposed Commercial Demands Continued

Village	Map ID	Total Area (AC)	Percent Developable	Developable Area (AC)	Classification	Demand by 2020 (gpd)	Demand by 2025 (gpd)	Demand by 2035 (gpd)	Demand by 2045 (gpd)
River Road	65	31.0	50%	15.5	Retail	-	21,704	-	-
River Road	74	2.1	50%	1.1	Self Storage	965	-	-	-
River Road	145	37.4	50%	18.7	Retail	-	26,154	-	-
River Road	164	10.8	50%	5.4	Retail	-	7,543	-	-
River Road	165	11.0	50%	5.5	Retail	-	7,723	-	-
River Road	166	9.3	50%	4.7	Retail	-	-	-	6,528
Manakin	901	506.9	50%	253.4	Retail	-	-	-	70,965
Manakin	902	454.4	50%	227.2	Retail	-	-	-	63,622
Total Demand						228,210	1,337,877	1,149,520	1,760,067

Water Demand and Sewer Loading Projections - Eastern Goochland Service Area

Proposed Industrial Demands

Village	Map ID	Total Area (AC)	Percent Developable	Developable Area (AC)	Demand by 2020 (gpd)	Demand by 2025 (gpd)	Demand by 2035 (gpd)	Demand by 2045 (gpd)
Rockville	84	16.4	80%	13.1	30,162	-	-	-
Rockville	18	197.6	80%	158.1	-	-	-	363,615
Rockville	20	196.7	80%	157.3	-	-	-	361,901
Total Demand					30,162	0	0	725,516

Existing Neighborhood (Not currently served) Demands (Both Water & Sewer Service)

Village	Map ID	Total Area (AC)	Percent Developable	Developable Area (AC)	Units	Demand by 2020 (gpd)	Demand by 2025 (gpd)	Demand by 2035 (gpd)	Demand by 2045 (gpd)
Centerville	91	34.3	80%	27.5	75	-	-	-	18,825
River Road	87	62.4	50%	31.2	100	-	25,100	-	-
River Road	89	394.3	50%	197.2	100	-	-	-	25,100
Manakin	211	426.7	50%	213.4	350	-	-	-	87,850
Total Demand						-	25,100	-	131,775

Existing Neighborhood (Not currently served) Demands (Sewer Service Only)

Village	Map ID	Total Area (AC)	Percent Developable	Developable Area (AC)	Units	Demand by 2020 (gpd)	Demand by 2025 (gpd)	Demand by 2035 (gpd)	Demand by 2045 (gpd)
River Road	86	44.2	50%	22.1	30	7,530	-	-	-
Total Demand						7,530	-	-	-