STAFFORD COUNTY
MASTER REDEVELOPMENT PLAN

VOLUME X: STAFFORD COUNTY INFRASTRUCTURE

URBAN, LTD.

OCTOBER 2009 | ADOPTED MAY 17, 2011

STAFFORD County
George Washington's Boyhood Home

CMSSARCHITECTS

R11-150

BOARD OF SUPERVISORS
COUNTY OF STAFFORD
STAFFORD, VIRGINIA

RESOLUTION

At a regular meeting of the Stafford County Board of Supervisors (the Board) held in the Board Chambers, Stafford County Administration Center, Stafford, Virginia, on the 17th day of May, 2011:

MEMBERS:	VOTE:
Mark Dudenhefer, Chairman	Yes
Paul V. Milde III, Vice Chairman	No
Harry E. Crisp II	Yes
Gary F. Snellings	No
Cord A. Sterling	Yes
Susan B. Stimpson	Yes
Robert "Bob" Woodson	Yes

On motion of Mr. Sterling, seconded by Mr. Crisp, which carried by a vote of 5 to 2, the following was adopted:

A RESOLUTION TO AMEND THE STAFFORD COUNTY COMPREHENSIVE PLAN IN ACCORDANCE WITH SECTION 15.2-2229 AND SECTION 15.2-2230 OF THE CODE OF VIRGINIA (1950), AS AMENDED, BY ADOPTING THE PROPOSED AMENDMENT, AS ADVERTISED, INCLUDING A NEW ECONOMIC DEVELOPMENT ELEMENT, ENTITLED "STAFFORD COUNTY MASTER REDEVELOPMENT PLAN," DATED OCTOBER, 2009, AS REVISED BY THE PLANNING COMMISSION AT ITS MEETING ON MARCH 15, 2011

WHEREAS, under Section 15.2-2229 of the Code of Virginia (1950), as amended, the Board may amend its Comprehensive Plan; and

WHEREAS, under Section 15.2-2229 of the Code of Virginia (1950), as amended, the Planning Commission (the Commission) has been directed by the Board to prepare and consider Comprehensive Plan amendments; and

WHEREAS, under Section 15.2-2230 of the Code of Virginia (1950), as amended, the Commission can review the Stafford County Comprehensive Plan to determine whether it is advisable to amend the Comprehensive Plan; and

WHEREAS, the proposed amendment to the Comprehensive Plan would amend the Comprehensive Plan by adopting a new economic development element entitled "Stafford County Master Redevelopment Plan," dated October, 2009, with recommendations for changes to existing County ordinances, policies, and procedures to serve as a framework to guide the coordinated and harmonious development of the County's four Redevelopment Areas: Boswell's Corner, the Courthouse area, Falmouth Village, and the Southern Gateway, as revised by the Commission at its meeting on March 15, 2011; and

WHEREAS, the Commission duly advertised and held a public hearing on April 20, 2011, on the proposed Comprehensive Plan Amendment, received a recommendation of County staff supporting approval of the proposed Amendment, received public testimony, decided on a 4-3 vote to recommend approval of Volume II and decided on a 5-2 vote to recommend approval of Volumes I, III, IV, V, VI, VII, VIII, IX, and X, and has forwarded its recommendation of approval of the proposed Comprehensive Plan amendment to the Board; and

WHEREAS, the Board duly advertised and held a public hearing on the proposed Comprehensive Plan Amendment on May 17, 2011, at which time public testimony was received and the above-referenced Comprehensive Plan Amendment was considered by the Board; and

WHEREAS, the Board has carefully considered the recommendations of the Commission, the recommendations of County staff, and the public testimony at the public hearing; and

WHEREAS, the Board concludes that the adoption of the proposed Comprehensive Plan Amendment, as advertised, will guide a coordinated and harmonious development of the County's four Redevelopment Areas: Boswell's Corner, the Courthouse area, Falmouth Village, and the Southern Gateway which will, in accordance with the present and probable future needs and resources of Stafford County, best promote the health, safety, morals, order, convenience, prosperity and general welfare of the citizens of Stafford County, Virginia, including the elderly and persons with disabilities; and

WHEREAS, the Board concludes that the adoption of the proposed Comprehensive Plan Amendment, as advertised, is consistent with good planning practices.

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NOW, THEREFORE, BE IT RESOLVED by the Stafford County Board of Supervisors on this the 17th day of May 2011, hereby adopts the proposed Comprehensive Plan Amendment, as advertised, by approving a new economic development element, entitled "Stafford County Master Redevelopment Plan," dated October, 2009, as revised by the Commission at its meeting on March 15, 2011.

BE IT FURTHER RESOLVED that the maximum allowed dwelling units in the Boswell's Corner Redevelopment Area is modified to a maximum of 744 units.

A Copy, teste:

Anthony J. Romanello, ICMA-CM
County Administrator

AJR:bhj:jf

STAFFORD COUNTY MASTER REDEVELOPMENT PLAN

The efforts of the ***Phase I: Research & Program Development*** and ***Phase II: Concept Master Revelopment Plan*** have been combined into five separate volumes. In addition, three additional volumes contain the detailed Cultural Resources Report on each of the four redevelopment areas, as well as examples of Cultural Resources Legislation. Each volume, on each of the four redevelopment areas, stand alone along with the overall Stafford County General Research & Planning section. Each of the four redevelopment area's respective volume integrates the specific Phase I research and Phase II planning efforts. The volumes do not refer separately to Phase I or II efforts, since they are now combined into a book specific to the corresponding redevelopment area.

The volumes have been separated as follows:

VOLUME I

Stafford County: General Background Research & Planning Concepts

VOLUME II

Boswell's Corner

VOLUME III

Courthouse Area

VOLUME IV

Falmouth Village

VOLUME V

Southern Gateway

VOLUME VI

A. Cultural Resources Report for Falmouth Village
B. VDHR Forms for Falmouth Village

VOLUME VII

A. Cultural Resources Report for Boswell's Corner, Courthouse Area, & Southern Gateway
B. VDHR Forms for Boswell's Corner, Courthouse Area, & Southern Gateway

VOLUME VIII

Examples of Cultural Resources Legislation

VOLUME IX

Stafford County Traffic Data

VOLUME X

Stafford County Infrastructure Analysis

STAFFORD COUNTY REDEVELOPMENT MASTER PLAN

PHASE II – INITIAL MASTER PLAN ANALYSIS OF CIVIL INFRASTRUCTURE ITEMS:

Public Water Service
Public Sewer Service
Storm Water Issues

For the Following Redevelopment Areas

Boswell's Corner
Courthouse Area
Falmouth Village
Southern Gateway

PREPARED FOR:

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June 2009

ABSTRACT

Urban, Ltd. has been engaged by the Stafford County Economic Development Office through CMSS Architects to analyze the Civil Infrastructure components within the four (4) defined redevelopment planning areas. The areas include: Boswell's Corner, Courthouse Area, Falmouth Village, and Southern Gateway. The total study area consists of over 1700 parcels containing roughly 3635 acres. The infrastructure items analyzed within each planning area of this study include public water/sewer service and storm water management components. The analysis area for this Phase II study includes those areas within the redevelopment areas shown to be redeveloped according to sketches prepared by CMSS Architects as of May 19, 2009.

I. INTRODUCTION

The Stafford County Economic Development Office has initiated a study of four (4) redevelopment areas within the County: Boswell's Corner, Courthouse Area, Falmouth Village, and Southern Gateway. In an effort to determine possible obstacles to redevelopment within these sectors, the study of these areas addresses a vast amount of issues including: regional economical support, transportation, archeology, and historic resources among others. Urban's portion of this analysis focuses on the Civil Engineering components of the redevelopment process; namely, storm water management (SWM) and public water/sewer service.

The report explains the initial findings under Phase II of this study. For this Phase, Urban was given a redevelopment plan for each of the redevelopment areas by CMSS Architects. This report uses those layouts as a basis to determine the impacts to the public water/sewer systems as well as to assess what SWM measures may be necessary with redevelopment of these areas.

WATER/SEWER COMPONENTS

Resources

As a basis for preparing this report, Urban was provided with the following information which was used in our analysis:

- ***Stafford County Water/Sewer Models for use in H20Map Modeling Software***
  Stafford County uses and maintains digital models for both the public water and sewer systems. These models include all current information related to these facilities, i.e. pipe sizes, demands, geometric layout, etc. The models also use a buildout module which includes future demands and facilities based on buildout conditions under the April 2003 Land Use Plan and the May 2005 Schedule for Recommended CIP Improvements prepared by O'Brien & Gere Engineers, Inc.
- ***Stafford County Water and Sewer Master Plan Maps***
  The County's Water and Sewer Master Plan Maps graphically show those improvements considered under the Water and Sewer capital Improvements Plan. The Master Plan maps include future flow data and improvements associated with Year 2050 conditions.
- ***Stafford County Water and Sewer Capital Improvements Plan***
  The Capital Improvements Plan details in a narrative fashion the individual improvements shown on the Water and Sewer Master Plan Maps. The technical memoranda contained in the report also set forth the analytical methods used a foundation to compute the water and sewer demands.
- ***CMSS Architects Draft Master Plan Layout***
  CMSS Architects has generated layouts for each of the redevelopment areas. These layouts represent the basis of our analysis. Our analysis is based on layouts provided by CMSS Architects as of June 26, 2009. They are primarily used to determine the change in land use within each of the redevelopment areas. Changes in future land use when compared to the 2003 Land Use plan, which was the basis for the Water and Sewer Master Plan, result in changes to future water and sewer demands within the County.

METHODOLOGY

After careful review of the Water and Sewer Master Plan, Urban has decided to continue with the approach set forth by O'Brien & Gere in the May 2005 Water and Sewer Master Plan. Key components of the prior analysis include:

- ***Service Areas***
  Under the present Water and Sewer plan, the entire County was assumed to have access to public water service at buildout conditions. Public Sewer service, however, was limited to only those areas within the Urban Service District (USD). We note that while the USD was assumed to represent a "wall" – by which service from outside the wall was prohibited – both the current Master Plan as well as the one under present consideration by Stafford County include a phasing of the USD line by which future areas could be added to the USD limits.
- ***Service Demands***
  The prior study prepared by O'Brien & Gere assigned water duties to each type of Land Use on the 2003 Land Use Map. Urban began our analysis using these same water duties. However, it became apparent that these values were not indicative of this type of development. Table I.1 lists the water duties which used in the Stafford County Master Plan.

Table I.1 – Stafford County Water Duties per Land Use

Reference	*Stafford County Water Duty (Master Plan Criteria, gpd/ac)*
Suburban Residential (SRE)	500
Urban Residential (URE)	1,300
Rural Residential (RRE)	80
Agricultural (AGR)	40
Commercial (UCM, SCM, RCM)/ Neighborhood Center (NCT)	750
Office (OFF)	500
Light Industrial (LIN)/	
Business (BUS)	500
Heavy Industrial (US)	2,000
Institutional (INS)	500

Urban compared these duties to similar duties used in other Northern Virginia jurisdictions. Table I.2 shows a comparison between those rates and the rates used in the Stafford County Master Plan.

Table I.2 – Average Daily Water Demand Comparison

	STAFFORD COUNTY		FAIRFAX COUNTY		LOUDOUN COUNTY		PRINCE WILLIAM COUNTY		SELECTED VALUE	
USE	RATE (GPD)	UNITS	RATE (GPD)	UNITS	RATE (GPD)	UNITS	RATE (GPD)	UNITS	RATE (GPD)	UNITS
Office	500	per ac	0.20	per sf	0.16	per sf	2,000	per ac	0.20	per sf
Retail	750	per ac	2,000	per ac	0.093	per sf	2,000	per ac	0.20	per sf
Commercial	750	per ac	2,000	per ac	0.16	per sf	2,000	per ac	0.20	per sf
Residential (Multi-Family)	1,300	per ac	300	per unit	280	per unit	250	per unit	300	per unit
Residential (Single-Family)	500	per ac	370	per unit	350	per unit	350	per unit	370	per unit
Hotel	n/a	n/a	130	per unit	n/a	n/a	n/a	n/a	150	per unit

Out of this comparison, Urban has selected values for the water demand based on a square-foot or per unit basis rather than on an acreage basis as the current Stafford County Master Plan uses. One of the main driving factors to this analysis is that the proposed redevelopment plans by CMSS architects actually breakout the proposed development uses, square-footages, and units.

The other main factor in choosing these rates is the intensity and density of development. The CMSS redevelopment plans utilize many mixed-use areas where uses are "stacked" on top of one another in multi-level buildings. If the "per-acre" demands were followed, many acres would need to be double, triple, or even quadruple counted, making the analysis hard to follow. Urban also determined that

the density of the development yields rather low flows when the present water duty approach is used when compared to calculated demands from other jurisdictions that use a square-foot and unit basis for calculating the demands.

For the overall existing demands, the Stafford County Master Plan shows average daily demands ranging from 7.5 mgd in 1999 to 30.8 mgd in 2050. In year 2010, the Plan shows an average daily demand of approximately 12 mgd. For the purposes of our modeling, we are relying on the existing demands already entered into the water model we received from Stafford County as being an accurate reflection of the existing water demands.

For the sewer demands, the prior model assumed that 80% of the water demand translated to a sewer demand. The Stafford County Master Plan shows the projected average daily sewer flows of 6.0 mgd in 2001 to 19.8 mgd in 2050. For year 2010, the Plan shows an average daily demand of approximately 10.4 mgd. As with our approach to water model, Urban is relying on the information contained with the Stafford County digital sewer model as an accurate reflection of the existing sewer demands.

STORMWATER MANAGEMENT

This initial report for Phase II includes general recommendations and considerations for stormwater management practices/locations. Where applicable, the report also addresses other important environmental issues such as floodplains and resource protection areas (RPAs).

We also note that Stafford County is in the process of implementing an inventory of existing dam impoundments in the County. Consistent with State regulations, the County will be regulating development along corridors which may be susceptible to inundation in the event of a dam failure. As this information is presently under development, we have not included it in our analysis other than to mention it here.

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II. BOSWELL'S CORNER

Boswell's Corner is largely defined by I-95 to the west, the Quantico Marine Base to the north, and Telegraph Road to the east. Jefferson Davis Highway (US Route 1) runs north south through the middle of the area. This redevelopment area generally consists of roughly 354 Parcels that contain approximately 575 acres of land area. The total land area, including streets and roads is about 601 acres, representing ±0.3% of the County's area.

WATER/SEWER ANALYSIS

Proposed Redevelopment Land Use And Demands

Urban has dissected the proposed redevelopment plan prepared by CMSS which was available to us on or before May 19, 2009. We analyzed the existing land uses on land which is proposed to be redeveloped with new proposed uses. This results in determining the "area of influence" of the master redevelopment plan. We created two tables which outline the uses within the redevelopment area and their demands. Table II.1 lists the existing demands in this area – based on the water duty approach.

Table II.1 – Water Duties per Existing Land Use to be Replaced

USE	ACREAGE	RATE (GPD/AC)	DEMAND (GPM)
Vacant	70.06	0.00	0.0000
Rural Residential	0.00	80.00	0.0000
Suburban Residential	71.20	500.00	24.7222
Urban Residential	53.72	1300.00	48.4972
Agricultural and Forestry	0.00	40.00	0.0000
Parks and Rec	0.00	40.00	0.0000
Construction Related / Site Development	7.27	500.00	2.5243
Public Facility and Land	9.30	500.00	3.2292
Commercial Retail	38.07	750.00	19.8281
Industrial and Manufacturing	3.20	500.00	1.1111
Mining and Extraction	0.00	500.00	0.0000
Transportation and Utilities	63.59	0.00	0.0000
Total:	316.41		99.9122

Table II.2 lists the proposed uses within the influence area of the redevelopment plan. The data for the proposed uses came from the redevelopment layouts prepared by CMSS Architects. With the proposed uses, we have used the square-foot and unit demands listed in Table II.2.

Table II.2 – Water Duties per Proposed Land Use

USE	TOTAL SF	TOTAL UNITS	DEMAND RATE (GPD)	DEMAND (GPD)	DEMAND (GPM)
Office	1,094572		0.20	218,914	152.024
Retail	497,203		0.20	99,441	69.056
Commercial	89,747		0.20	17,949	12.465
Residential (Multifamily)	1,394,698	1,254	300	376,200	261.250
Single Family Residential		445	370	164,650	114.340
Hotel		219	150	32,850	22.813
Total:	3,419,056	1,918			631.95

Increase In Demands

Table II.3 shows the breakout of the proposed demand, existing demand to remain, and the existing demand. For the purposes of putting the new demands into the water model, we used the proposed demand from Table II.2, added the existing demands that will remain and subtracted out the existing demand from Table II.1 to arrive at the net additional demand for this area. The net additional demand in the Boswell's Corner area is approximately 537 gpm.

Table II.3 – Net Demand Increase

USE	DEMAND (GPM)
Proposed Demand (GPM)	631.9
Existing Demand to Remain (GPM)	4.8
Existing Demand (GPM)	99.9
Demand Used for Model:	536.8

This demand does not consider unaccounted for water and additional conservation. While the Water and Sewer Master Plan states that the peaking factor is 1.5, Urban notes that the water model actually uses variable peaking factors between 1.4-1.75. For our analysis, we continue to use the peaking factors in the present model.

Taking the increase in sewer demand as 80% of the water demand means that the sewer demands will increase by approximately 430 gpm, prior to applying the peaking factor and accounting for rainfall I/I. While the Water and Sewer Master Plan states that the peaking factor is 3.5, Urban notes that the sewer model actually uses a variable peaking factor between 2.0-3.5. Lower flow rates use the high end of the peaking factor range while higher flows use the low end of the range. For our analysis, we continue to use the peaking factors in the present model.

Water Model Design Criteria

Urban has received the present water model from Stafford County and we are relying on the facilities and demands included in that model to accurately represent the present day condition in the County. The Water and Sewer Master Plan lists the following key design values as important to the water distribution system:

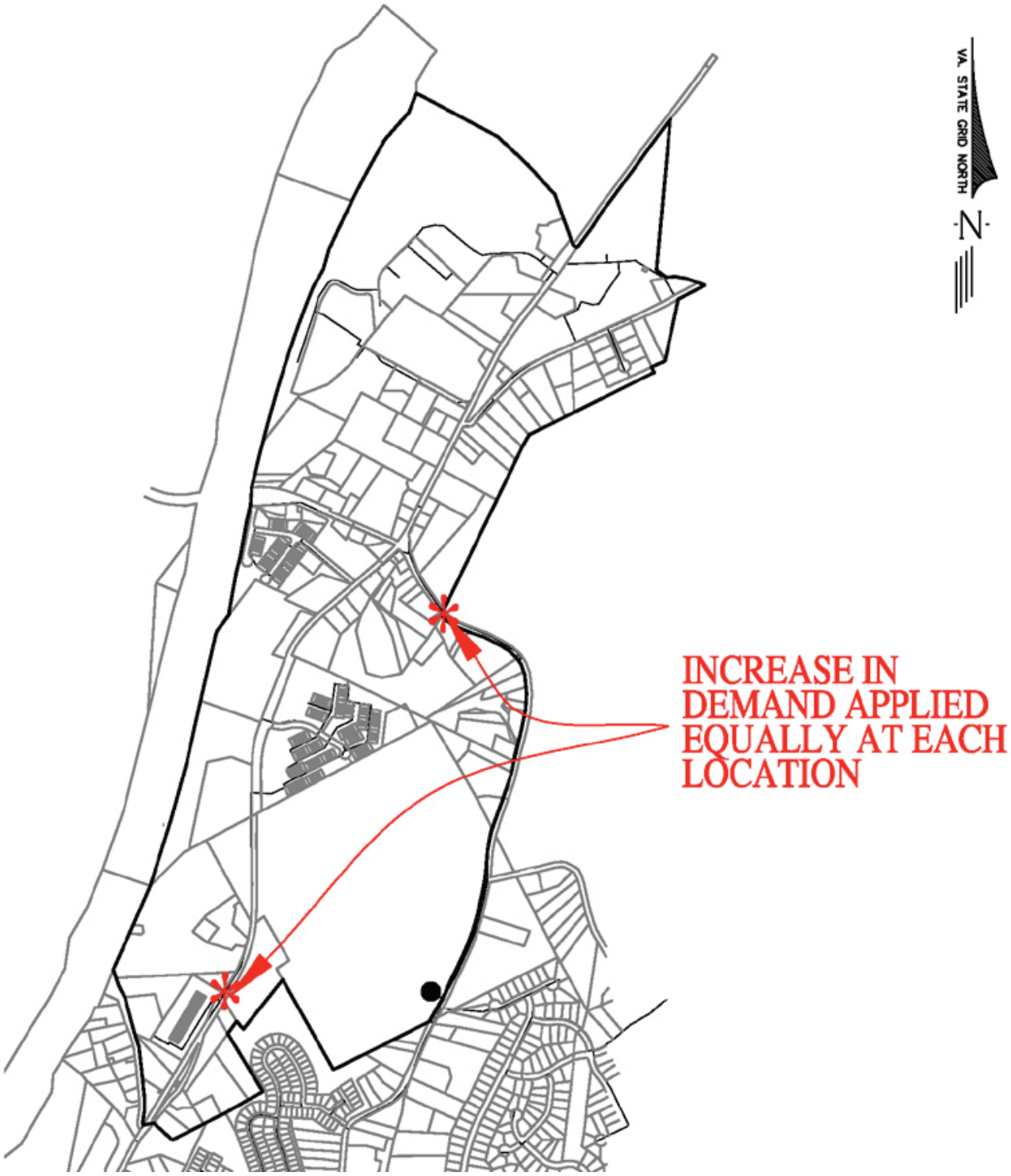
- Maximum Velocity = 5 feet per second (fps)
- Minimum/Maximum Pressure Range = 40-120 pounds per square inch (psi)
- Maximum Head Loss = 5-feet per 1000 feet of pipe

Urban has analyzed the model given to use for the present day scenario. Under present day conditions, we note that there are several instances where existing pipes fail to meet the criteria above, even under existing system demands. A list of these pipes is included in Appendix A.

Integration Of Demands In The Water Model

After determining the increase in demand within Boswell's Corner as a result of the redevelopment, Urban applied the increase in demand to the H20Map Water model. Urban used the existing conditions scenario provided by Stafford County and updated the demands in the Boswell area for the expected demand increase. Specifically, Urban applied the increase in demand at two points in the water model: at the 10" pipe at the redevelopment boundary and Jefferson Davis Highway (U.S. Route 1) and at the 10" pipe at the redevelopment boundary and Telegraph Road (Route 637). See Figure II.1 for locations. The demands were divided evenly between these two points.

Figure II.1 – Locations of Applied Increases in Demand



Capital Water Projects Considered

The present day model includes all prior completed water system Capital Improvements.

Key Findings

Prior to running the redevelopment demands, Urban ran the existing model with existing demands to assess the baseline conditions in the area. We note that the existing model is setup to model the entire County. Under the existing conditions, the model shows that there are 6 pipes which do not meet the velocity criteria, there are 20 pipes which do not meet the allowable headloss criteria, and there are 29 pipe junctions which have pressures lower than 40 psi. We note that there are an additional 143 pipe junctions with pressures greater than 120 psi.

Urban then added the additional flows for the Boswell's Corner area into the model at the locations previously described. We looked at the 7am demands as they are the highest during the day. At that time under the proposed demands, the existing County-wide system has no additional pipes which exceed the maximum velocity requirement, no additional pipes which exceed the headloss requirement, and (1) additional junction which falls below the minimum pressure requirement.

In juxtaposition with the existing model peak hour analysis, the proposed demands do affect the pipes/junctions already failing in the existing model. Of the (6) existing pipes exceeding the maximum velocity requirement, there was no appreciable change (+ 5%) for (5) pipes between the existing and proposed models, and (1) pipe that no longer fails based on the velocity criteria. Of the (20) existing pipes which exceed the headloss requirement, there was no appreciable change for (17) pipes between the existing and proposed models, (1) pipe that did show a considerable change of 12%, and (2) pipes that no longer fail based on the headloss criteria. Of the (29) existing junctions which fall below the minimum pressure requirement, there was no appreciable change for (23) junctions between the existing and proposed models, and (6) junctions that did show an appreciable change. See Appendix A for reports of the existing and proposed water analysis.

Effect on Future Capital Improvements Projects

In general, the effect on the Boswell's Corner area redevelopment on the public water system is minimal, as defined by the additional problem areas generated from the water model. Scheduled improvement 310-11, a new 10" line, will help convey domestic water flows to the northern portion of the redevelopment area.

Sewer Model Design Criteria

Urban has received the present sewer model from Stafford County and we are relying on the facilities and demands included in that model to accurately represent the present day condition in the County. The model contains information related to the gravity and force mains as well as the pump stations. As with the water model, the sewer model includes both existing and buildout scenarios. The Boswell's Corner area is included in the Aquia sewer model and the area drains to the Aquia wastewater treatment plant.

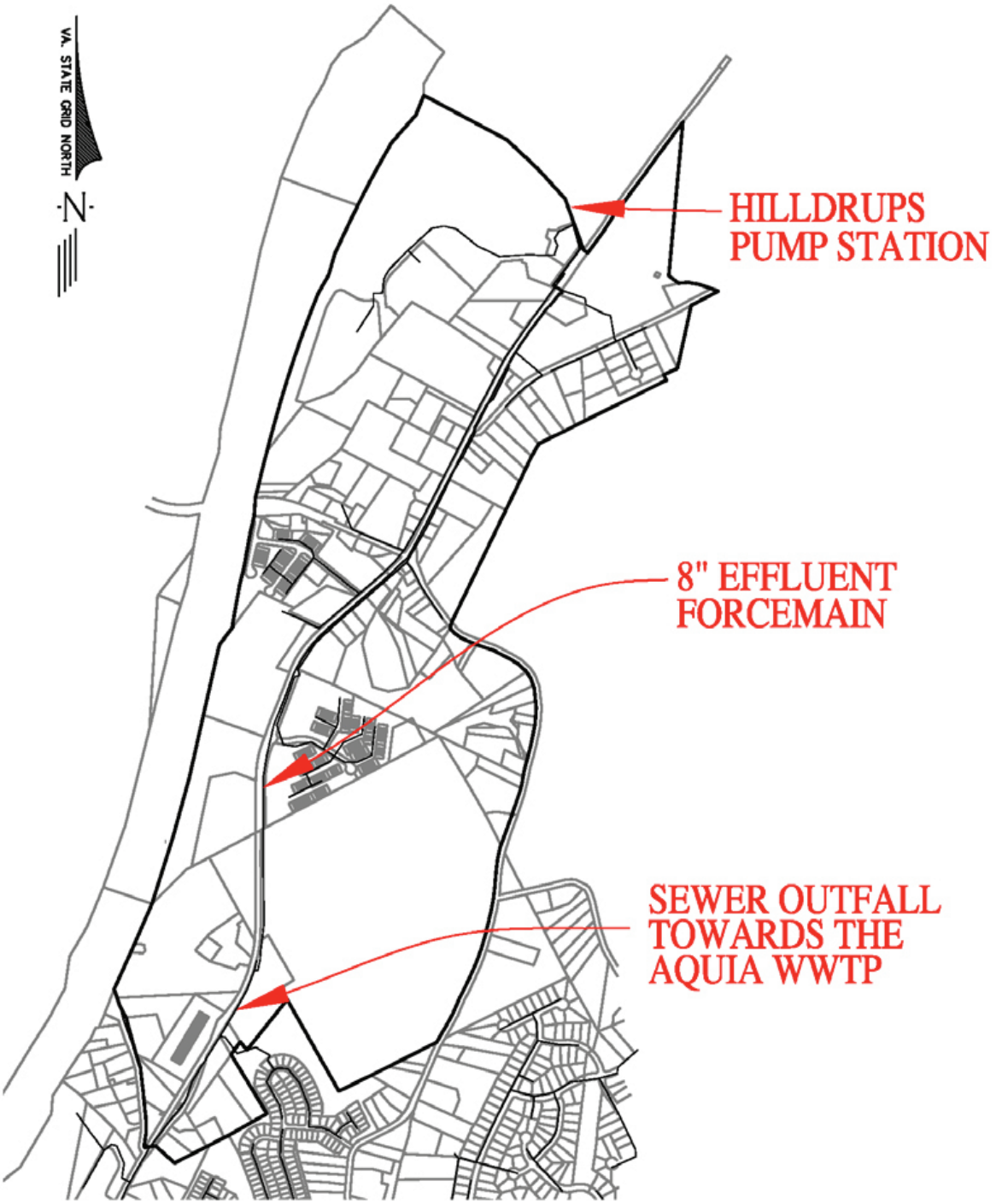
- Minimum Velocity = 2.25 feet per second (fps)
- Maximum Velocity = 15 feet per second (fps)
- q/Q Ratio* for pipes 12" in diameter or less = 0.50
- q/Q Ratio* for pipes greater than 12" in diameter = 0.85
- *q/Q is a ratio of the partial flow volume within a pipe compared to the maximum flow volume when the pipe is flowing full under gravity flow conditions.

Urban has analyzed the model given to us for the present day scenario. Under present day conditions with existing demands, we note that there are (4) gravity sewer pipes which do not meet the minimum velocity requirement and (1) gravity sewer pipe which exceeds the maximum velocity requirement. All gravity sewer pipes show adequate capacity to flow under gravity conditions.

Integration Of Demands In The Sewer Model

After determining the increase in demand within Boswell's Corner as a result of the redevelopment, Urban applied the increase in demand to the H20Map Sewer model. Urban used the existing conditions scenario provided by Stafford County and updated the demands in the Boswell area for the expected demand increase. Specifically, Urban applied the increase in demand at the Hilldrups Pump Station. With this approach, we are able to isolate three main components of the sewer system in the Boswell's Corner area: the Hilldrups Pump Station, the effluent 8" forcemain from the pump station which outfalls to the south at a gravity main in Jefferson Davis Highway (U.S. Route 1), and the outfall from that point to the Aquia wastewater treatment plant. See Figure II.2 for locations of these components.

Figure II.2 – Locations of Applied Increases in Demand



Urban has elected to reserve comment on specific sewer mains within the Boswell's Corner area until the final phase of the redevelopment plan process. This enables us to focus the analysis outside the redevelopment and on critical Capital Improvements projects within the redevelopment area now, while allowing the layout of the master plan to evolve and mature. We suspect that the 8" sewer lines that run on either side of Jefferson Davis Highway will be undersized when the full redevelopment

occurs in this area. We encourage the establishment of parallel lines to the extent practical to keep additional flows from putting these lines in a pressure flow condition.

Integration Of Demands In The Sewer Model

The present day model includes all prior completed sewer system Capital Improvements. In addition to those projects which were completed, Urban has included the following projects:

Table II.4 – Sewer Capital Improvements Projects Considered

CIP DESIGNATION	ANTICIPATED CONSTRUCTION DATE	DESCRIPTION
A-42	2010	Upgrade existing 8" line to 18" from Aquia Creek to Potomac Hills Drive
A-114	2010	Upgrade existing 8" forcemain from Aquia Pumping Station to the existing 14" forcemain near Aquia Drive
A-213	Completed	Construction the Hilldrups Pumping Station to 444 gpm

Key Findings

After running the present day scenario with the increases in demands, Urban reviewed the output from the sewer model to determine the effects to the system. Urban primarily looked for deficiencies along the outfall from the Hilldrups Pump Station to the Aquia Wastewater Treatment plant. In general, our findings show that all gravity sewer pipes now meet the minimum velocity requirement, (2) gravity sewer pipes exceed the maximum velocity requirement and (28) gravity sewer pipes exceed the capacity requirements. See Appendix B for reports of the existing and proposed sewer analysis.

The area is served by two main pumping stations: the Hilldrups PS and the Aquia Creek PS. With the additional demands in the area, the analysis shows that the Hilldrups PS needs to be upgraded again to be able to pump at least 1670 gpm. The Hilldrups PS was just recently updated to provide a pumping rate of up to 444 gpm.

There are also 4 force mains which carry flow in the sewer outfall. Each will be subject to increases in velocity and headloss in order to convey the increased sewer flows. With appropriate upgrades to the pumps, the force mains appear adequate for the future growth.

Effect On Future Capital Improvements Projects

The most notable impact on the sewer system in this area is to the Hilldrups Pumping Station. We see a need to increase the capacity of the pumping station well beyond what has already been done to accommodate the increase in flows. Likewise, the outfall from the Hilldrups Pumping Station also will need upgrades. The soon to be completed A-42 CIP project to construct an 18" sewer trunk may need further improvements and/or adjustments as several pipes will now be flowing at greater than 80% of capacity. The un-modeled 12" line shown on the CIP map is the biggest non-scheduled improvement which will need to occur. We anticipate that a portion of this line may need to be constructed larger than 12" to adequately convey the anticipated flows. Specific alignments for future CIP improvements should be coordinated with CMSS development plans since grid street realignment is often proposed.

STORMWATER COMPONENTS

Floodplain

The most problematic issue we've encountered in the Boswell's Corner area is the 100-yr floodplain which follows a tributary to the Chopawamsic Creek as it flows northward within the area. The floodplain starts on the west side of Jefferson Davis Highway (US-1) in the vicinity of Telegraph Road (VA-637) and crosses over to the east side of Jefferson Davis Highway (US-1) approximately 2,100 feet downstream. Portions of the redevelopment plan encroach on the 100-year floodplain. It should be noted that FEMA requires a Letter of Map Revision (LOMR) whenever development encroaches within the 100-yearr floodplain. A Floodplain Map is included in Appendix C.

Resource Protection Areas

There are no mapped CBPA's within the Boswell's Corner redevelopment area. However, we advise that care must be taken when developing around the existing FEMA 100-yr floodplain areas outlined above. The current redevelopment plan envisions a linear stream valley park along most of this area; a significant amenity upgrade from the existing condition of this area. The County may wish to consider additional protections, such as a CBPA, along this floodplain area. This would help by establishing additional standards for development in this area with the goal of best preventing erosion and pollutants from traveling downstream to the Chopawamsic Creek. A CRPA Map (none shown) is included in Appendix C.

SWM/BMP

Regional SWM opportunities exist within this area, however, because of the narrow and linear layout of the roads, properties, and tributaries to the Chopawamsic Creek, the areas controlled by any potential facilities will likely be small in nature and may not be economical to implement as regional facilities. Typically, each development upgrade provides its own storm water management and water quality measures on-site. However, taking a regional approach in select areas would benefit the redevelopment area by consolidating both development and storm water facilities. Ideally, the regional facilities could be implemented by the County and the developers within the area would have the option of using these facilities as controls for their projects.

Regional facilities may be designed as redundant facilities, proposed by the County, for added water quality benefits and to achieve a reduction in runoff within the Chopawamsic Creek watershed. They may also be primary facilities proposed by multiple landowners in a coordinated effort to consolidate their development and focus the storm water needs in a specific area or areas. Other added benefits of regional facilities are they can be more efficient to maintain than several smaller facilities. They may also become nice amenities to the development if planned, designed and incorporated with that in mind.

While it may prove difficult for any individual property owner to implement a regional SWM facility due to timing and cooperation of adjacent developers whose land would drain to a proposed facility, it is in the County's interest to help facilitate this approach. The County may establish a mechanism by which the County can implement a regional approach to SWM. Other jurisdictions have instituted a "pro-rata share" fee which is paid by the land owners or developers for increases in impervious area within a watershed. The proceeds would be used to construct new SWM facilities in the watershed or improvements along the tributary. Another option is for the County to create incentives, reimbursements and/or additional concessions to land owners who elect to implement a regional storm water management design which takes into consideration the future development potential of the upstream drainage area.

Ideal locations for regional SWM facilities would be in an area downstream of the proposed redevelopment and upstream of the Chopawamsic Creek territory. A Map of possible SWM locations is included in Appendix C.

III. COURTHOUSE AREA

The heart of the Courthouse Redevelopment Area is generally defined as the crossroads of Jefferson Davis Highway (US Route 1) and Courthouse Road (State Route 630). This redevelopment area generally consists of roughly 840 Parcels that contain approximately 1,743 acres of land area. The total land area, including streets and roads, is about 1,900 acres, representing ±1.1% of the County's area.

WATER/SEWER ANALYSIS

Proposed Redevelopment Land Use And Demands

Urban has dissected the proposed redevelopment plan prepared by CMSS which was available to us on or before May 19, 2009. We analyzed the existing land uses on land which is proposed to be redeveloped with new proposed uses. This results in determining the "area of influence" of the master redevelopment plan. We created two tables which outline the uses within the redevelopment area and their demands. Table III.1 lists the existing demands in this area – based on the water duty approach.

Table III.1 – Water Duties per Existing Land Use to be Replaced

USE	ACREAGE	RATE (GPD/AC)	DEMAND (GPM)
Vacant	40.95	0.00	0.0000
Rural Residential	0.00	80.00	0.0000
Suburban Residential	49.07	500.00	17.0382
Urban Residential	13.53	1300.00	12.2146
Agricultural and Forestry	0.00	40.00	0.0000
Parks and Rec	0.00	40.00	0.0000
Construction Related / Site Development	0.00	500.00	0.0000
Public Facility and Land	98.39	500.00	34.1632
Commercial Retail	23.69	750.00	12.3385
Industrial and Manufacturing	5.31	500.00	1.8438
Mining and Extraction	0.00	500.00	0.0000
Transportation and Utilities	19.96	0.00	0.0000
Total:	250.90		77.5983

Table III.2 lists the proposed uses within the influence area of the redevelopment plan. The data for the proposed uses came from the redevelopment layouts prepared by CMSS Architects. With the proposed uses, we have used the square-foot and unit demands listed in Table III.2.

Table III.2 – Water Duties per Proposed Land Use

USE	TOTAL SF	TOTAL UNITS	DEMAND RATE (GPD)	DEMAND (GPD)	DEMAND (GPM)
Office	512,261		0.20	102,452	71.1
Retail	350,381		0.20	70,076	48.7
Civic	322,658		0.20	64,532	44.8
Cultural	58,044		0.20	11,609	8.1
Church	39,416		0.20	7,883	5.4
Residential Multifamily	1,113,968	1,117	300	335,100	232.7
Single Family Residential		330	370	122,100	84.8
Hotel		67	150	10,050	7.0
Total:	2,441,278	1,514		723,802	502.6

Increase In Demands

Table III.3 shows the breakout of the proposed demand, existing demand to remain, and the existing demand. For the purposes of putting the new demands into the water model, we used the proposed demand from Table III.2, added the existing demands that will remain and subtracted out the existing demand from Table III.1 to arrive at the net additional demand for this area. The net additional demand in the Courthouse area is approximately 435 gpm.

Table III.3 – Net Demand Increase

USE	DEMAND (GPM)
Proposed Demand (GPM)	502.6
Existing Demand to Remain (GPM)	10.3
Existing Demand (GPM)	77.6
Demand Used for Model:	435.3

This demand does not consider unaccounted for water and additional conservation. While the Water and Sewer Master Plan states that the peaking factor is 1.5, Urban notes that the water model actually uses variable peaking factors between 1.4-1.75. For our analysis, we continue to use the peaking factors in the present model.

Taking the increase in sewer demand as 80% of the water demand means that the sewer demands will increase by approximately 348 gpm, prior to applying the peaking factor and accounting for rainfall I/I. While the Water and Sewer Master Plan states that the peaking factor is 3.5, Urban notes that the sewer model actually uses a variable peaking factor between 2.0-3.5. Lower flow rates use the high end of the peaking factor range while higher flows use the low end of the range. For our analysis, we continue to use the peaking factors in the present model.

Water Model Design Criteria

Urban has received the present water model from Stafford County and we are relying on the facilities and demands included in that model to accurately represent the present day condition in the County. The Water and Sewer Master Plan lists the following key design values as important to the water distribution system:

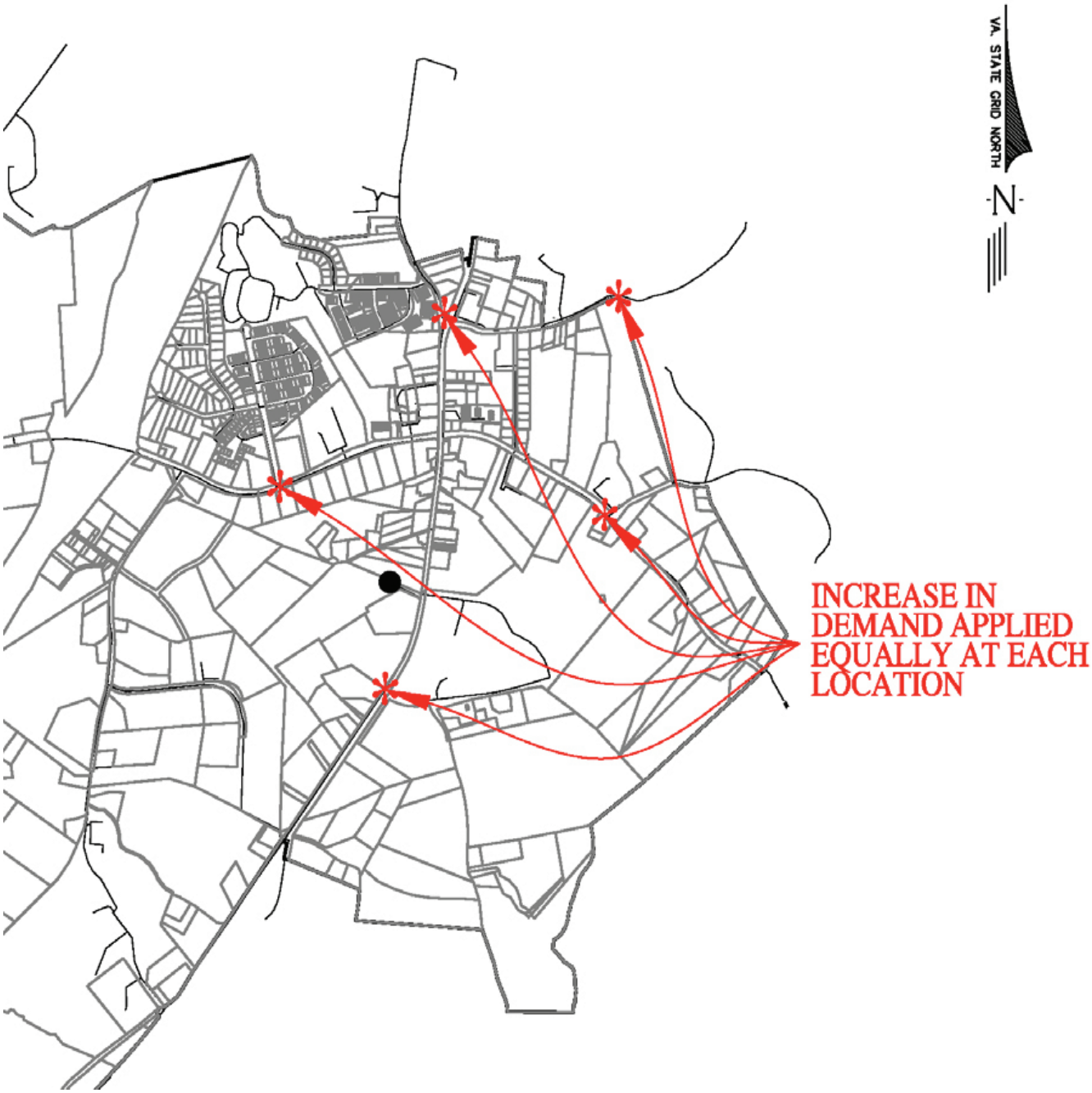
- Maximum Velocity = 5 feet per second (fps)
- Minimum/Maximum Pressure Range = 40-120 pounds per square inch (psi)
- Maximum Head Loss = 5-feet per 1000 feet of pipe

Urban has analyzed the model given to use for the present day scenario. Under present day conditions, we note that there are several instances where existing pipes fail to meet the criteria above, even under existing system demands. A list of these pipes is included in Appendix A.

Integration Of Demands In The Water Model

After determining the increase in demand within the Courthouse Area as a result of the redevelopment, Urban applied the increase in demand to the H20Map Water model. Urban used the existing conditions scenario provided by Stafford County and updated the demands in the Courthouse area for the expected demand increase. Specifically, Urban applied the increase in demand at five points in the water model: at the 12" pipe at the northern redevelopment boundary and Jefferson Davis Highway (U.S. Route 1), at the 8" pipe at the eastern redevelopment boundary and Hope Road, at the 12" pipe at the eastern redevelopment boundary and Courthouse Road (State Road 630), at the 12" pipe at the southern redevelopment boundary and Jefferson Davis Highway (U.S. Route 1), and at the 8" pipe at the western redevelopment boundary and Courthouse Road (State Road 630). See Figure III.1 for locations. The demands were divided evenly between these five points.

Figure III.1 – Locations of Applied Increases in Demand



Capital Water Projects Considered

The present day model includes all prior completed water system Capital Improvements.

Key Findings

Prior to running the redevelopment demands, Urban ran the existing model with existing demands to assess the baseline conditions in the area. We note that the existing model is setup to model the entire County. Under the existing conditions, the model shows that there are 6 pipes which do not meet the velocity criteria, there are 20 pipes which do not meet the allowable headloss criteria, and there are 29 pipe junctions which have pressures lower than 40 psi. We note that there are an additional 143 pipe junctions with pressures greater than 120 psi.

Urban then added the additional flows for the Courthouse area into the model at the locations previously described. We looked at the 7am demands as they are the highest during the day. At that time under the proposed demands, the existing County-wide system has no additional pipes which exceed the maximum velocity requirement, no additional pipes which exceed the headloss requirement, and (5) additional junctions which fall below the minimum pressure requirement.

In juxtaposition with the existing model peak hour analysis, the proposed demands do affect the pipes/junctions already failing in the existing model. There was no appreciable change (+ 5%) for all (6) pipes exceeding the maximum velocity criteria between the existing and proposed models. Of the (20) existing pipes which exceed the headloss requirement, there was no appreciable change for (17) pipes between the existing and proposed models, and (3) pipes that did show a considerable change of + 25%. Of the (29) existing junctions which fall below the minimum pressure requirement, there was no appreciable change for (16) junctions between the existing and proposed models, and (13) junctions that did show an appreciable change. See Appendix A for reports of the existing and proposed water analysis.

Effect On Future Capital Improvements Projects

In general, the effect on the Courthouse area redevelopment on the public water system is minimal, as defined by the additional problem areas generated from the water model. Scheduled improvement 370N-100, a new 1.0 MG elevated tank, will ameliorate the effects of increased demand. Scheduled improvement 370N-04, a new 12” gravity main, will assist in conveying domestic water flows from Courthouse Road to Jefferson Davis Highway.

Sewer Model Design Criteria

Urban has received the present sewer model from Stafford County and we are relying on the facilities and demands included in that model to accurately represent the present day condition in the County. The model contains information related to the gravity and force mains as well as the pump stations. As with the water model, the sewer model includes both existing and buildout scenarios. The Courthouse area is included in the Austin Run sewer model and the area drains to the Aquia wastewater treatment plant.

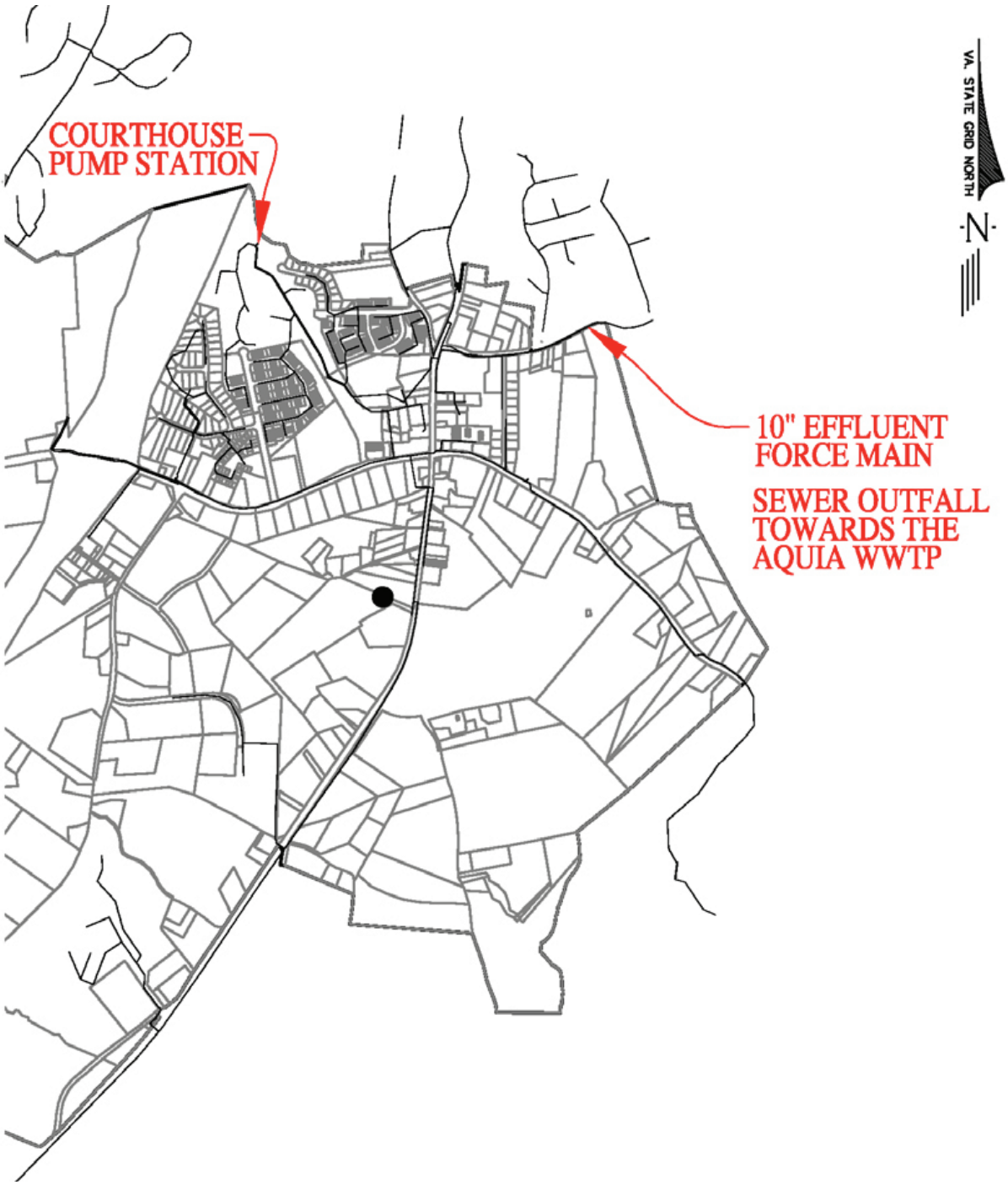
- Minimum Velocity = 2.25 feet per second (fps)
- Maximum Velocity = 15 feet per second (fps)
- q/Q Ratio* for pipes 12" in diameter or less = 0.50
- q/Q Ratio* for pipes greater than 12" in diameter = 0.85
- *q/Q is a ratio of the partial flow volume within a pipe compared to the maximum flow volume when the pipe is flowing full under gravity flow conditions.

Urban has analyzed the model given to us for the present day scenario. Under present day conditions with existing demands, we note that there are (0) gravity sewer pipes which do not meet the minimum velocity requirement and (0) gravity sewer pipes which exceeds the maximum velocity requirement. (2) downstream gravity sewer pipes do not have adequate capacity to flow under gravity conditions.

Integration Of Demands In The Sewer Model

After determining the increase in demand within Courthouse as a result of the redevelopment, Urban applied the increase in demand to the H20Map Sewer model. Urban used the existing conditions scenario provided by Stafford County and updated the demands in the Courthouse area for the expected demand increase. Specifically, Urban applied the increase in demand at the Courthouse Pump Station. With this approach, we are able to isolate five main components of the sewer system serving the Courthouse area: the Courthouse Pump Station, the effluent 10" forcemain from the pump station which outfalls to the east, the downstream gravity main which carries flows to the Austin Run Pump Station, the Austin Run Pump Station and the effluent 4" force main which outfalls at the Aquia wastewater treatment plant. See Figure III.2 for the locations of these components which fall within the redevelopment area.

Figure III.2 – Locations of Applied Increases in Demand



Urban has elected to reserve comment on specific sewer mains within the Courthouse area until the final phase of the redevelopment plan process. This enables us to focus the analysis outside the redevelopment and on critical Capital Improvements projects within the redevelopment area now, while allowing the layout of the master plan to evolve and mature. We strongly suspect that the 8" and 12" sewer lines upstream of the Courthouse PS will be undersized when the full redevelopment occurs in

this area. We encourage the establishment of parallel lines to the extent practical to keep additional flows from putting these lines in a pressure flow condition.

Integration Of Demands In The Sewer Model

The present day model includes all prior completed sewer system Capital Improvements. In addition to those projects which were completed, Urban has included the following projects:

Table III.4 – Sewer Capital Improvements Projects Considered

CIP DESIGNATION	ANTICIPATED CONSTRUCTION DATE	DESCRIPTION
A-14	2010	Replace 8" and 10" with 18" gravity sewer along Jefferson Davis from Carnaby Street to Austin Run Pump Station
A-30	2010	Construct 18" gravity main along unnamed tributary from Olde Concord Rd. to interceptor along Jefferson Davis Hwy. near Carnaby Street

Key Findings

After running the present day scenario with the increases in demands, Urban reviewed the output from the sewer model to determine the effects to the system. Urban primarily looked for deficiencies along the outfall from the Courthouse Pump Station to the Aquia Wastewater Treatment plant. In general, our findings show that (0) pipes fail to meet the minimum velocity requirements, (0) gravity sewer pipes exceed the maximum velocity requirement and (3) gravity sewer pipes exceed the capacity requirements. (2) of these (3) gravity sewer pipes were failing in the existing scenario. See Appendix B for reports of the existing and proposed sewer analysis.

The area is served by two main pumping stations: the Courthouse PS and the downstream Austin Run PS. With the additional demands in the area, the analysis shows that the Courthouse PS needs to be upgraded beyond the planned 2014 CIP upgrade, and needs to be able to handle at least 1678 gpm. The model provided to Urban by Stafford County already shows the Courthouse PS upgraded beyond the projected 2014 capacity, but the PS still fails based on the increase in demand.

Per the Capital Improvements Plan: the Austin Run Pump Station (P-40) has undergone an improvement that is not reflected in the model provided by Stafford County. CIP Improvement A-210 states that the Austin Run Pump Station will be expanded from 5.8 mgd (4027.78 gpm) to 20 mgd (13888.89 gpm) by 2006-2007. The model currently reflects a capacity of 2.89 mgd (2006.94 gpm). Based on the 20 mgd expansion: the pump station is adequately sized for the proposed increase in flow. It should be noted that the pump station fails under the non-improved scenario, and the presence of the proposed improvement should be verified. See Appendix B for full pump station analysis.

The force mains downstream of each pump station will be subject to increases in velocity and headloss in order to convey the increased sewer flows. With appropriate upgrades to the pumps, the force mains appear adequate for the future growth.

Effect On Future Capital Improvements Projects

The most notable impact on the sewer system in this area is to the Courthouse Pumping Station. We see a need to increase the capacity of the pumping station well beyond what has already been planned for 2014 to accommodate the increase in flows (A-217). The soon to be completed A-30 CIP project to construct an 18" sewer trunk was treated as existing for the modeling, since the anticipated date was 2010. This improvement is critical in carrying flows between the Courthouse Pump Station and the Austin Run Pump Station. In addition: (3) downstream pipe runs totaling 268 feet of pipe will be operating under pressure flow conditions, and will need to be upgraded. It is noted that (2) of the (3) failing downstream pipes are shown to fail in the existing scenario. Currently, no proposed CIP improvement addresses this. Specific alignments for future CIP improvements should be coordinated with CMSS development plans since grid street realignment is often proposed.

STORMWATER COMPONENTS

Floodplain

The Courthouse area has two (2) portions of floodplain inside the redevelopment boundary. The larger portion is the area of floodplain along Accokeek Creek in the southern reaches of the redevelopment area. The floodplain area affects around 10 parcels or less. The current redevelopment plans by CMSS do not encroach near either of the floodplain areas. A Floodplain Map is included in Appendix C.

Resource Protection Areas

The Courthouse redevelopment area is slightly affected by the presence of three small Critical Resource Protection Areas locations within its boundary. The first is along I-95 in the northern section. The second crosses Jefferson Davis Highway (US Route 1) along the southern section. The third is along the southeast corner boundary. The current redevelopment plans by CMSS do not propose any impacts to these areas. A CRPA Map is included in Appendix C.

SWM/BMP

The Courthouse area falls partially within the Austin Run regional detention basin map within the Stormwater component of the Comprehensive Plan. In general, the area of the north of Courthouse Road (State Route 630) slopes and drains northward to Austin Run. The P-5 facility is within the redevelopment area and it is included as one of the possible regional facility locations on the SWM map. The P-6 stormwater facility is located just outside the redevelopment area. To the south, the parcels slope generally to the south and into Accokeek Creek. Here, regional stormwater facility opportunities are available on the southern and southeastern project edges. A Map of Possible SWM locations is included in Appendix C.

IV. FALMOUTH VILLAGE

The heart of the Falmouth Village Redevelopment Area is generally defined as the crossroads of Warrenton Road (US Route 17) and Cambridge Street (US Route 1). This redevelopment area generally consists of roughly 200 Parcels that contain approximately 120 acres of land area. The total land area, including street and road right-of-way is about 138 acres, representing ±0.08% of the County's area. The southern boundary of this area is the Rappahannock River.

WATER/SEWER ANALYSIS

Proposed Redevelopment Land Use And Demands

Urban has dissected the proposed redevelopment plan prepared by CMSS which was available to us on or before May 19, 2009. We analyzed the existing land uses on land which is proposed to be redeveloped with new proposed uses. This results in determining the "area of influence" of the master redevelopment plan. We created two tables which outline the uses within the redevelopment area and their demands. Table IV.1 lists the existing demands in this area – based on the water duty approach.

Table IV.1 – Water Duties per Existing Land Use to be Replaced

USE	ACREAGE	RATE (GPD/AC)	DEMAND (GPM)
Vacant	10.22	0.00	0.0000
Rural Residential	0.00	80.00	0.0000
Suburban Residential	50.09	500.00	17.3924
Urban Residential	2.18	1300.00	1.9681
Agricultural and Forestry	0.00	40.00	0.0000
Parks and Rec	5.01	40.00	0.1392
Construction Related / Site Development	0.00	500.00	0.0000
Public Facility and Land	10.32	500.00	3.5833
Commercial Retail	9.58	750.00	4.9896
Industrial and Manufacturing	0.00	500.00	0.0000
Mining and Extraction	0.00	500.00	0.0000
Transportation and Utilities	11.18	0.00	0.0000
Total:	98.58		28.0725

Table IV.2 lists the proposed uses within the influence area of the redevelopment plan. The data for the proposed uses came from the redevelopment layouts prepared by CMSS Architects. With the proposed uses, we have used the square-foot and unit demands listed in Table IV.2.

Table IV.2 – Water Duties per Proposed Land Use

USE	TOTAL SF	TOTAL UNITS	DEMAND RATE (GPD)	DEMAND (GPD)	DEMAND (GPM)
Civic	5,200		0.20	1,040	0.722
Office	55,000		0.20	11,000	7.639
Retail	72,000		0.20	14,400	10.000
Residential (Multifamily)	224,000	201	300	60,300	41.875
Single Family Residential		223	370	82,510	57.299
Total:	356,200	424			117.535

Increase In Demands

Table IV.3 shows the breakout of the proposed demand, existing demand to remain, and the existing demand. For the purposes of putting the new demands into the water model, we used the proposed demand from Table IV.2, added the existing demands that will remain and subtracted out the existing demand from Table II.1 to arrive at the net additional demand for this area. The net additional demand in the Falmouth area is approximately 91 gpm.

Table IV.3 – Net Demand Increase

USE	DEMAND (GPM)
Proposed Demand (GPM)	117.5
Existing Demand to Remain (GPM)	1.9
Existing Demand (GPM)	28.1
Demand Used for Model:	91.3

This demand does not consider unaccounted for water and additional conservation. While the Water and Sewer Master Plan states that the peaking factor is 1.5, Urban notes that the water model actually uses variable peaking factors between 1.4-1.75. For our analysis, we continue to use the peaking factors in the present model.

Taking the increase in sewer demand as 80% of the water demand means that the sewer demands will increase by approximately 73 gpm, prior to applying the peaking factor and accounting for rainfall I/I. While the Water and Sewer Master Plan states that the peaking factor is 3.5, Urban notes that the sewer model actually uses a variable peaking factor between 2.0-3.5. Lower flow rates use the high end of the peaking factor range while higher flows use the low end of the range. For our analysis, we continue to use the peaking factors in the present model.

Water Model Design Criteria

Urban has received the present water model from Stafford County and we are relying on the facilities and demands included in that model to accurately represent the present day condition in the County. The Water and Sewer Master Plan lists the following key design values as important to the water distribution system:

- Maximum Velocity = 5 feet per second (fps)
- Minimum/Maximum Pressure Range = 40-120 pounds per square inch (psi)
- Maximum Head Loss = 5-feet per 1000 feet of pipe

Urban has analyzed the model given to use for the present day scenario. Under present day conditions, we note that there are several instances where existing pipes fail to meet the criteria above even under existing system demands. A list of these pipes is included in Appendix A.

Integration Of Demands In The Water Model

After determining the increase in demand within Falmouth as a result of the redevelopment, Urban applied the increase in demand to the H20Map Water model. Urban used the existing conditions scenario provided by Stafford County and updated the demands in the Falmouth area for the expected demand increase. Specifically, Urban applied the increase in demand at five points in the water model: at the 12" pipe at the redevelopment boundary and Cambridge Street (US-1), the 12" pipe at the redevelopment boundary and Warrenton Road (US-17), the 8" pipe at the redevelopment boundary and the intersection of Washington Street and Ingleside Drive, the 8" pipe at the redevelopment boundary and Forbes Street, and the 8" pipe at the redevelopment boundary and Butler Road (US-212). See Figure IV.1 for locations. The demands were divided evenly between these five points.

Figure IV.1 – Locations of Applied Increases in Demand

Capital Water Projects Considered

The present day model includes all prior completed water system Capital Improvements.

Key Findings

Prior to running the redevelopment demands, Urban ran the existing model with existing demands to assess the baseline conditions in the area. We note that the existing model is setup to model the entire County. Under the existing conditions, the model shows that there are 6 pipes which do not meet the velocity criteria, there are 20 pipes which do not meet the allowable headloss criteria, and there are 29 pipe junctions which have pressures lower than 40 psi. We note that there are an additional 143 pipe junctions with pressures greater than 120 psi.

Urban then added the additional flows for the Falmouth area into the model at the locations previously described. We looked at the 7am demands as they are the highest during the day. At that time under the proposed demands, the existing County-wide system has no additional pipes which exceed the maximum velocity requirement, no additional pipes which exceed the headloss requirement, and (1) additional junction which falls below the minimum pressure requirement.

In juxtaposition with the existing model peak hour analysis, there was no appreciable change (+ 5%) for the existing pipes/junctions that do not meet the velocity, headloss and pressure criteria. See Appendix A for reports of the existing and proposed water analysis.

Effect On Future Capital Improvements Projects

In general, the effect on the Falmouth area redevelopment on the public water system is minimal, as defined by the additional problem areas generated from the water model. Scheduled improvement 342-102, a 1.0 MG elevated tank, will ameliorate the effects of increased demand beyond 2025. In addition, scheduled improvements 342-01, 342-04, 342-07 and 342-10 will help convey domestic water throughout the Falmouth redevelopment area in the future condition. Specific alignments for future CIP improvements should be coordinated with CMSS development plans since grid street realignment is often proposed.

Sewer Model Design Criteria

Urban has received the present sewer model from Stafford County and we are relying on the facilities and demands included in that model to accurately represent the present day condition in the County. The model contains information related to the gravity and force mains as well as the pump stations. As with the water model, the sewer model includes both existing and buildout scenarios. The Falmouth area is included in the Falmouth-east sewer model and the area drains to the Little Falls Run wastewater treatment plant.

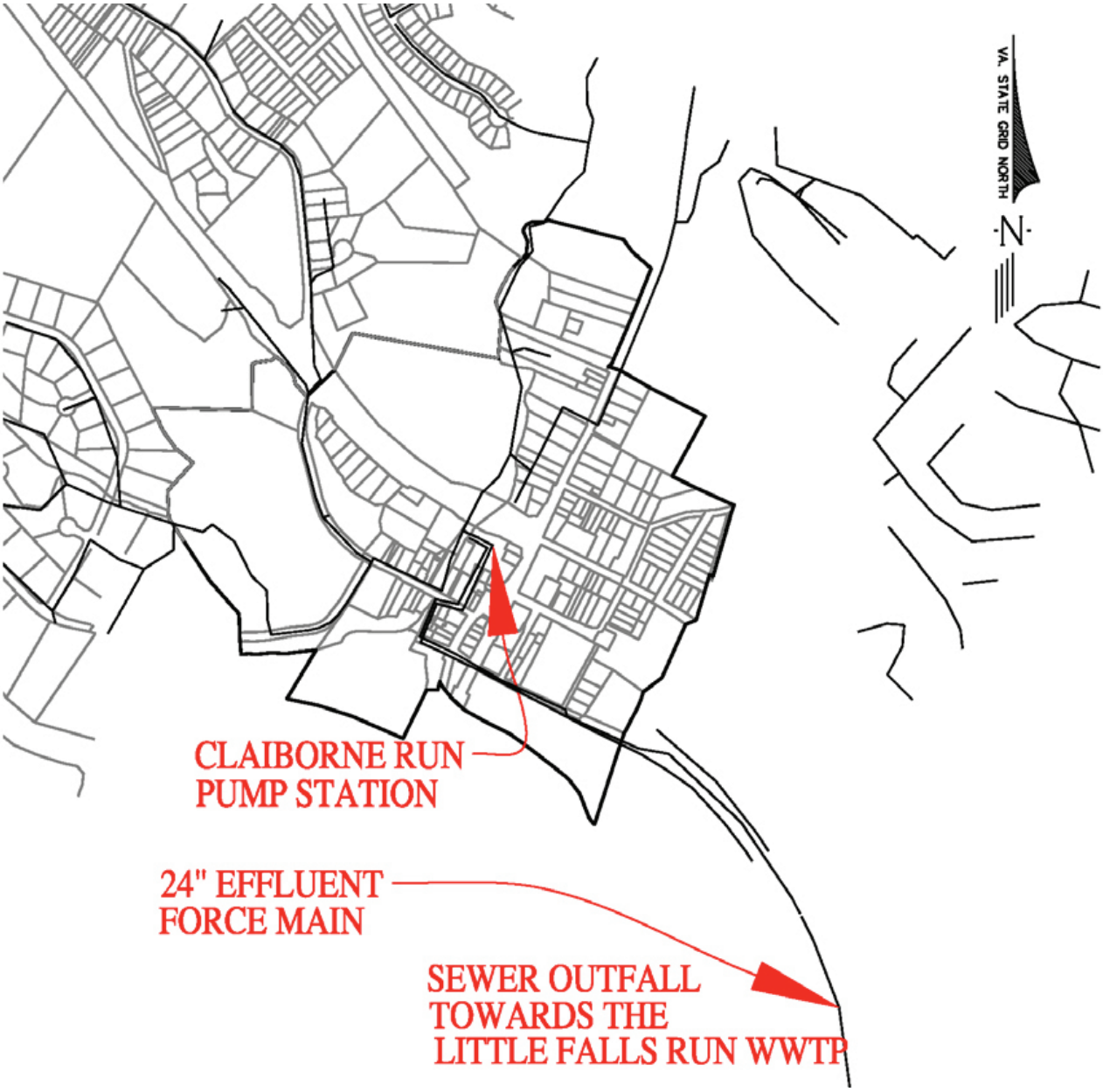
- Minimum Velocity = 2.25 feet per second (fps)
- Maximum Velocity = 15 feet per second (fps)
- q/Q Ratio* for pipes 12” in diameter or less = 0.50
- q/Q Ratio* for pipes greater than 12” in diameter = 0.85
- *q/Q is a ratio of the partial flow volume within a pipe compared to the maximum flow volume when the pipe is flowing full under gravity flow conditions.

Urban has analyzed the model given to us for the present day scenario. Under present day conditions with existing demands, we note that there are (0) gravity sewer pipes which do not meet the minimum velocity requirement and (4) gravity sewer pipes which exceeds the maximum velocity requirement. We do note (13) gravity sewer pipes that do not meet the capacity requirement to flow under gravity conditions.

Integration Of Demands In The Sewer Model

After determining the increase in demand within Falmouth as a result of the redevelopment, Urban applied the increase in demand to the H20Map Sewer model. Urban used the existing conditions scenario provided by Stafford County and updated the demands in the Falmouth area for the expected demand increase. Specifically, Urban applied the increase in demand at the Claiborne Run Pump Station. With this approach, we are able to isolate four main components of the sewer system in the Falmouth area: the Claiborne Run Pump Station, the effluent force main, downstream pump stations, and the downstream gravity sewer which eventually outfall at the Little Falls Run PS. See Figure IV.2 for the locations of these components within the Falmouth redevelopment area.

Figure IV.2 – Locations of Applied Increases in Demand



Urban has elected to reserve comment on specific sewer mains within the Falmouth area until the final phase of the redevelopment plan process. This enables us to focus the analysis outside the redevelopment and on critical Capital Improvements projects within the redevelopment area now while allowing the layout of the master plan to evolve and mature. We suspect that the smaller sewer lines that run throughout the redevelopment area will have to be horizontally added or relocated, and possibly upsized to accommodate the redevelopment. We encourage the establishment of parallel lines to the extent practical to keep additional flows from putting these lines in a pressure flow condition.

Integration Of Demands In The Sewer Model

The present day model includes all prior completed sewer system Capital Improvements. No CIP improvements are planned until 2014 for Falmouth, so no additional improvements were considered.

Table IV.4 – Sewer Capital Improvements Projects Considered

CIP DESIGNATION	ANTICIPATED CONSTRUCTION DATE	DESCRIPTION
-	-	-

Key Findings

After running the present day scenario with the increases in demands, Urban reviewed the output from the sewer model to determine the effects to the system. Urban primarily looked for deficiencies along the outfall path from the Claiborne Run Pump Station to the Little Falls Run Water Treatment plant. In general, our findings show that all gravity sewer pipes now meet the minimum velocity requirement, (4) gravity sewer pipes exceed the maximum velocity requirement and (14) gravity sewer pipes exceed the capacity requirements. It should be noted that only one additional pipe is failing for capacity compared to the existing model analysis. The (4) pipes failing for velocity are the same pipes as found in the existing model analysis. (14) of the (15) gravity sewer pipes failing for capacity were failing in the existing scenario. See Appendix B for full reports of the existing and proposed gravity sewer analysis.

The area is served by three main pumping stations: Claiborne Run PS, the Falls Run PS, and the Old Route #3 PS. Below is a summary of the Pump Station analysis, see the Appendix B for in-depth report:

- Falls Run PS: Per the Stafford County Water and Sewer master plan: the Falls Run Pump Station (P-60-M) has a capacity of 9.4 mgd (6528 gpm) (LFR – 209). The current model provided by Stafford County has the pump capacity as 4.68 mgd (3250 gpm). The planned improved capacity is adequate, but it should be verified that this improvement is really in place, since the PS fails in the unimproved scenario.
- Claiborne Run PS: Similarly, the master plan states that the Claiborne Run pump station (P-80) has undergone an improvement not reflected in the current existing sewer model. LFR-214 states that the Claiborne Run PS will be expanded from 8.1 mgd (5625 gpm) to 18 mgd by 2007-2008. The model currently reflects a capacity of 4.03 mgd (2798 gpm). The planned improved capacity is adequate, but it should be verified that this improvement is really in place, since the PS fails in the unimproved scenario.
- Old Route #3 PS: Per the capacity listed in the H20 MAP Sewer model: the Old Route #3 pumping station is not adequate to handle the proposed increase in flows and will need to be upgraded. Currently, no CIP improvement is planned to address this issue.

Effect On Future Capital Improvements Projects

The most notable impact on the sewer system in this area is to the Old Route #3 Pumping Station. We see a need to increase the capacity of the pumping station. In addition: gravity sewer lines that fail, based on capacity requirements, in the existing model will need to be improved, and should be improved to handle the proposed increase in flows. Specific alignments for future CIP improvements should be coordinated with CMSS development plans since grid street realignment is often proposed.

STORMWATER COMPONENTS

Floodplain

By our estimate, almost 50% of the parcels within the Falmouth redevelopment area are covered within floodplain limits established by both the County and the Federal Emergency Management Agency (FEMA). The 100-yr floodplain areas are concentrated along the southern parcels adjacent to the Rappahannock as well as the central core of the parcel areas where Falls Run bisects the redevelopment area. The current redevelopment plan by CMSS has for the most part avoided the floodplain. However, as previously noted: FEMA requires a Letter of Map Revision (LOMR) whenever any development encroaches within the 100-yr floodplain. A Floodplain Map is included in Appendix C.

Resource Protection Areas

The County has significant mapped CRPA's in the southern portions of the redevelopment area. The CRPA extends landward for 100-feet from any tidal or non-tidal wetlands or water bodies with perennial flow. The current redevelopment plan by CMSS has, for the most part, avoided the CRPA areas. There are a few proposed buildings that may be seriously affected by the presence of both CRPA and FEMA 100 year floodplain. A CRPA Map is included in Appendix C.

SWM/BMP

Given the floodplain and CRPA encumbrances within the Falmouth Village planning sector, as well as steep topography in some of the undeveloped areas, we anticipate that added impervious area from parcel development will be kept to a minimum. Most likely, any increases in impervious area will come from road improvements at the Route 1/17 intersection. The tight network of streets also breaks this area up into smaller planning blocks.

Given this information, we expect few opportunities to incorporate regional SWM facilities within the redevelopment area. Proposed redevelopment should focus instead on providing additional water quality measures with each development plan. The area presently has very few, if any, water quality treatment measures. The addition of these measures as development occurs will help reduce the chemical and sediment runoff to the Rappahannock River. Within the 100-yr floodplain area, we would expect to see structural type measures, such as underground filter chambers or at grade water quality inlets instead of ponds and larger bio-retention areas due to the spatial constraints of the block network created by the existing street grid.

While it may prove difficult for any individual property owner to implement a regional SWM facility due to timing and cooperation of adjacent developers whose land would drain to a proposed facility, it is in the County's interest to help facilitate this approach. The County may establish a mechanism by which the County can implement a regional approach to SWM. Other jurisdictions have instituted a "pro-rata share" fee which is paid by the land owners or developers for increases in impervious area within a watershed. The proceeds would be used to construct new SWM facilities in the watershed or improvements along the tributary. Another option is for the County to create incentives, reimbursements and/or additional concessions to land owners who elect to implement a regional storm water management design which takes into consideration the future development potential of the upstream drainage area.

The team has included a map with two (2) suggested locations where regional SWM measures may make sense. Both locations are on the west side of Cambridge Street. These locations have been selected based on their ability to serve several development parcels as well as their proximity to the major drainageways. The possible location to the north of Warrenton Road (U.S. Route 17) has the best potential and could be designed to be a significant amenity to consolidated development in this area.

The Falmouth region falls outside of the five stormwater watersheds studied within the Stafford Stormwater Management Plan. However, smaller stormwater quantity (as well as quality) management facilities and measures can still be effective and should be considered with any new development within the area. The CBPA as enabled with Section 28-62 of the Stafford County Zoning Ordinance requires a 10% reduction in non-point source pollution from redevelopment; reduction shall be based on the existing pollutant levels. The pollution calculation comes from the State Storm Water Management Handbook and is often referred to as removal of total phosphorus from runoff. Given Falmouth's very close proximity to the banks of the Rappahannock River and the perceived lack of regional SWM opportunities, the team recommends that redevelopment parcels provide an even greater reduction on the order of 20-40%.

Any proposed SWM facilities, should be kept outside of the 100-yr floodplain for maximum effectiveness. Small to medium sized facilities can likely be located in these areas. Larger facilities will be more problematic to incorporate into smaller parcels or in areas of flat topography near the river banks. The closer the location of any SWM facilities to the river the more likely the facility would be over-topped or eroded during a 100-year storm event. A Map showing the possible SWM locations discussed herein is included in Appendix C.

V. SOUTHERN GATEWAY

The Southern Gateway Redevelopment Area is generally defined as the Warrenton Road (Route 17) corridor from I-95 in the east to Celebrate Parkway in the west. This redevelopment area generally consists of roughly 309 Parcels that contain approximately 1,197 acres of land area. The total land area, including street and road right-of-way is about 1,268 acres, representing ±0.7% of the County's area.

WATER/SEWER ANALYSIS

Proposed Redevelopment Land Use And Demands

Urban has dissected the proposed redevelopment plan prepared by CMSS which was available to us on or before May 19, 2009. We analyzed the existing land uses on land which is proposed to be redeveloped with new proposed uses. This results in determining the "area of influence" of the master redevelopment plan. We created two tables which outline the uses within the redevelopment area and their demands. Table V.1 lists the existing demands in this area – based on the water duty approach.

Table V.1 – Water Duties per Existing Land Use to be Replaced

USE	ACREAGE	RATE (GPD/AC)	DEMAND (GPM)
Vacant	43.65	0.00	0.0000
Rural Residential	0.00	80.00	0.0000
Suburban Residential	39.85	500.00	13.8368
Urban Residential	0.00	1300.00	0.0000
Agricultural and Forestry	31.75	40.00	0.8819
Parks and Rec	0.00	40.00	0.0000
Construction Related / Site Development	10.69	500.00	3.7118
Public Facility and Land	0.57	500.00	0.1979
Commercial Retail	168.21	750.00	87.6094
Industrial and Manufacturing	74.29	500.00	25.7951
Mining and Extraction	1.80	500.00	0.6250
Transportation and Utilities	53.73	0.00	0.0000
Total:	424.54		132.6580

Table V.2 lists the proposed uses within the influence area of the redevelopment plan. The data for the proposed uses came from the redevelopment layouts prepared by CMSS Architects. With the proposed uses, we have used the square-foot and unit demands listed in Table V.2.

Table V.2 – Water Duties per Proposed Land Use

USE	TOTAL SF	TOTAL UNITS	DEMAND RATE (GPD)	DEMAND (GPD)	DEMAND (GPM)
Office	968,141		0.20	193,628	134.464
Retail	1,297,711		0.20	259,542	180.238
Cultural	139,404		0.20	27,881	19.362
Residential (Multifamily)	5,616,972	5,109	300	1,532,700	1,064.375
Single Family Residential		568	370	210,160	145.944
Hotel		408	150	61,200	42.500
Total:	8,502,592	6,085			1,586.883

Increase In Demands

Table V.3 shows the breakout of the proposed demand, existing demand to remain, and the existing demand. For the purposes of putting the new demands into the water model, we used the proposed demand from Table V.2, added the existing demands that will remain and subtracted out the existing demand from Table V.1 to arrive at the net additional demand for this area. The net additional demand in the Southern Gateway area is approximately 1,454 gpm.

Table V.3 – Net Demand Increase

USE	DEMAND (GPM)
Proposed Demand (GPM)	1,586.9
Existing Demand to Remain (GPM)	0.0
Existing Demand (GPM)	132.7
Demand Used for Model:	1,454.2

This demand does not consider unaccounted for water and additional conservation. While the Water and Sewer Master Plan states that the peaking factor is 1.5, Urban notes that the water model actually uses variable peaking factors between 1.4-1.75. For our analysis, we continue to use the peaking factors in the present model.

Taking the increase in sewer demand as 80% of the water demand means that the sewer demands will increase by approximately 1,163 gpm, prior to applying the peaking factor and accounting for rainfall I/I. While the Water and Sewer Master Plan states that the peaking factor is 3.5, Urban notes that the sewer model actually uses a variable peaking factor between 2.0-3.5. Lower flow rates use the high end of the peaking factor range while higher flows use the low end of the range. For our analysis, we continue to use the peaking factors in the present model.

Water Model Design Criteria

Urban has received the present water model from Stafford County and we are relying on the facilities and demands included in that model to accurately represent the present day condition in the County. The Water and Sewer Master Plan lists the following key design values as important to the water distribution system:

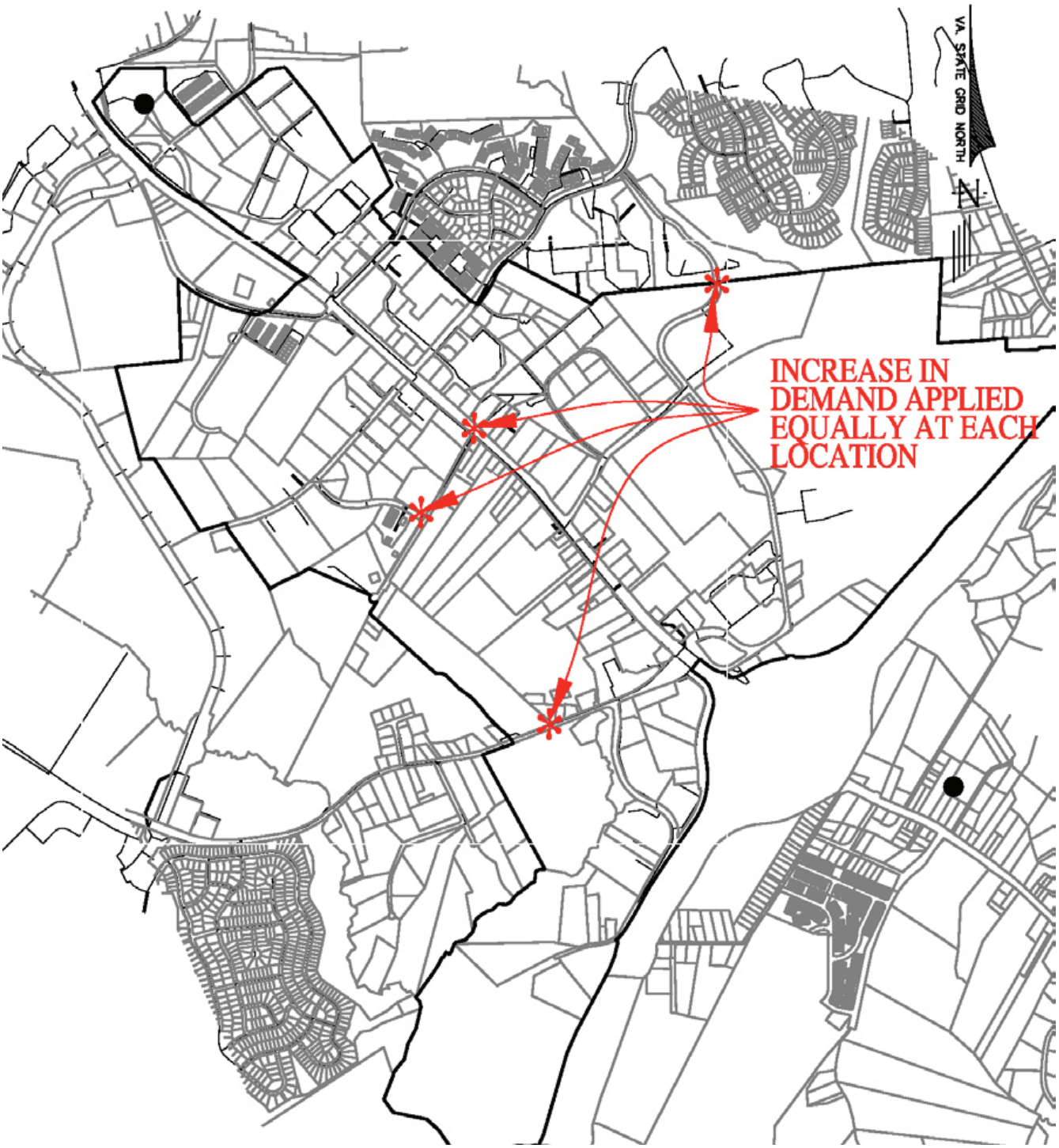
- Maximum Velocity = 5 feet per second (fps)
- Minimum/Maximum Pressure Range = 40-120 pounds per square inch (psi)
- Maximum Head Loss = 5-feet per 1000 feet of pipe

Urban has analyzed the model given to use for the present day scenario. Under present day conditions, we note that there are several instances where existing pipes fail to meet the criteria above even under existing system demands. A list of these pipes is included in Appendix A.

Integration Of Demands In The Water Model

After determining the increase in demand within Southern Gateway as a result of the redevelopment, Urban applied the increase in demand to the H20Map Water model. Urban used the existing conditions scenario provided by Stafford County and updated the demands in the Southern Gateway area for the expected demand increase. Specifically, Urban applied the increase in demand at four points in the water model: at the 12" pipe at the redevelopment boundary and Tomorrow Street, the 12" pipe at the intersection of Warrenton Road and Powell Lane, the 12" line at the end of Capital Avenue, and the 12" line at the redevelopment boundary and Sanford Drive. See Figure V.1 for locations. The demands were divided evenly between these four points.

Figure V.1 – Locations of Applied Increases in Demand



Capital Water Projects Considered

The present day model includes all prior completed water system Capital Improvements.

Key Findings

Prior to running the redevelopment demands, Urban ran the existing model with existing demands to assess the baseline conditions in the area. We note that the existing model is setup to model the entire County. Under the existing conditions, the model shows that there are 6 pipes which do not meet the velocity criteria, there are 20 pipes which do not meet the allowable headloss criteria, and there are 29 pipe junctions which have pressures lower than 40 psi. We note that there are an additional 143 pipe junctions with pressures greater than 120 psi.

Urban then added the additional flows for the Southern Gateway area into the model at the locations previously described. We looked at the 7am demands as they are the highest during the day. At that time under the proposed demands, the existing County-wide system has (2) additional pipes which exceed the maximum velocity requirement, (5) additional pipes which exceed the headloss requirement, and no additional junctions which fall below the minimum pressure requirement.

In juxtaposition with the existing model peak hour analysis, the proposed demands do affect the pipes/junctions already failing in the existing model. There was no appreciable change (+ 5%) for all (6) pipes exceeding the maximum velocity criteria, and all (20) pipes exceeding the headloss criteria between the existing and proposed models. Of the (29) existing junctions which fall below the minimum pressure requirement, there was no appreciable change for (27) junctions between the existing and proposed models, and (2) junctions that did show an appreciable change. See Appendix A for reports of the existing and proposed water analysis.

Effect On Future Capital Improvements Projects

In general, the effect on the Southern Gateway area redevelopment on the public water system is minimal, as defined by the additional problem areas generated from the water model. Scheduled improvement 370S-01, a 16” gravity main, will assist in conveying domestic water along Virginia Parkway.

Sewer Model Design Criteria

Urban has received the present sewer model from Stafford County and we are relying on the facilities and demands included in that model to accurately represent the present day condition in the County. The model contains information related to the gravity and force mains as well as the pump stations. As with the water model, the sewer model includes both existing and buildout scenarios. The Southern Gateway area is included in the Falmouth-west sewer model and the area drains to the Little Falls Run wastewater treatment plant; after continuing through the Falmouth east sewer model.

- Minimum Velocity = 2.25 feet per second (fps)
- Maximum Velocity = 15 feet per second (fps)
- q/Q Ratio* for pipes 12” in diameter or less = 0.50
- q/Q Ratio* for pipes greater than 12” in diameter = 0.85
- *q/Q is a ratio of the partial flow volume within a pipe compared to the maximum flow volume when the pipe is flowing full under gravity flow conditions.

Urban has analyzed the model given to us for the present day scenario. Under present day conditions with existing demands, we note that there are (3) gravity sewer pipes which do not meet the minimum velocity requirement and (7) gravity sewer pipes which exceeds the maximum velocity requirement. We do note (77) gravity sewer pipes that do not meet the capacity requirements.

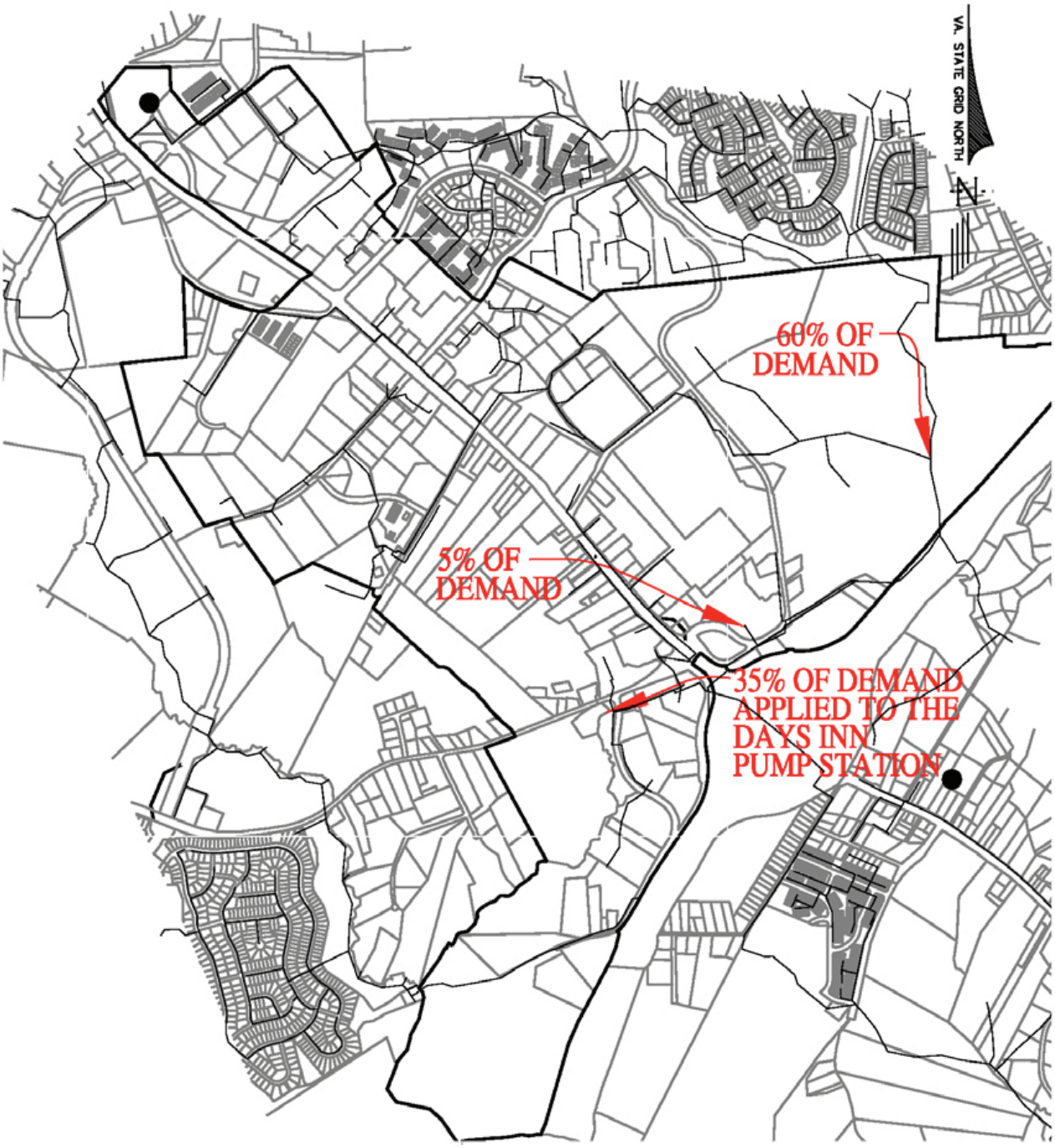
Integration Of Demands In The Sewer Model

After determining the increase in demand within Southern Gateway as a result of the redevelopment, Urban applied the increase in demand to the H20Map Sewer model. Urban used the existing conditions scenario provided by Stafford County and updated the demands in the Southern Gateway area for the expected demand increase. Specifically, Urban applied the increase in demand in the three areas where flows exited the area of influence. 35% of the total demand (407.18 GPM) was added to the Days Inn Pump Station, 5% of the total demand (58.17 GPM) was added to the gravity sewer in the vicinity of Stanstead Road and I-95, and 60% of the total demand (698.03 GPM) was added to the gravity sewer at the intersection of Auction Drive and Falls Run Drive.

With this approach, we were able to isolate seventeen primary components of the sewer system in the Southern Gateway/Falmouth area: The Days Inn Pump Station, the effluent 8" forcemain from the pump station which outfalls east across I-95 to a gravity main near Musselman Road, and the Ingleside Pump Station and then to the corresponding 6" forcemain which outfalls to the northeast to a gravity main that leads to the Falls Run Pump Station. The other two demands that were added to the gravity sewer in Southern Gateway (58.17 GPM and 698.03 GPM) ultimately converge with the demand added at the Days Inn Pump Station and the additional proposed Falmouth demand at the Falls Run Pump Station via gravity sewer. Downstream of the Falls Run Pump Station is the corresponding effluent 8" forcemain which outfalls to the southeast to a gravity main that leads to the Old Route 3 Pump Station and the downstream effluent 10" forcemain. This force main outfalls to gravity sewer the southeast which leads to the Claiborne Run Pump Station. Downstream of this point, the flow reaches the Little Falls Run Wastewater Treatment Plant via an effluent 24" forcemain. See Figure V.2 for locations of the components within the redevelopment boundary.

It is noteworthy that this system joins the Falmouth system down stream en route to the Little Falls Run wastewater treatment plant. Proposed Falmouth flows were also incorporated into this model to determine a worst-case scenario.

Figure V.2 – Locations of Applied Increases in Demand



Urban has elected to reserve comment on specific sewer mains within the Southern Gateway area until the final phase of the redevelopment plan process. This enables us to focus the analysis outside the redevelopment and on critical Capital Improvements projects within the redevelopment area now while allowing the layout of the master plan to evolve and mature. We suspect that many of the 8" and 12" sewer lines inside the areas of proposed redevelopment will have to be horizontally relocated as well as upsized.

Integration Of Demands In The Sewer Model

The present day model includes all prior completed sewer system Capital Improvements. In addition to those projects which were completed, Urban has included the following projects:

Table V.4 – Sewer Capital Improvements Projects Considered

CIP DESIGNATION	ANTICIPATED CONSTRUCTION DATE	DESCRIPTION
LFR – 103	2007	Construct 12" force main from England Run PS to proposed 24" main connected to Falls Run interceptor
LFR – 28	2007	Construct 8" gravity main along England Run from vicinity of Trotter Lane to vicinity of Warrenton Road
LFR – 29	2005	Construct 15" gravity main along England Run from England Run PS to 8" main along England Run near Trotter Lane
LFR – 204	2007	Construct England Run PS at 3.23 mgd

Key Findings

After running the present day scenario with the increases in demands, Urban reviewed the output from the sewer model to determine the effects to the system. Urban primarily looked for deficiencies along the outfall from the Southern Gateway redevelopment area all the way downstream to the Little Falls Run Water Treatment plant. In general, our findings show that the same (3) gravity sewer pipes still don't meet minimum velocity requirement, the same (7) gravity sewer pipes exceed the maximum velocity requirement, and (95) gravity sewer pipes exceed the capacity requirements. Note: (77) of these (95) gravity sewer pipes were failing in the existing scenario. See Appendix B for reports of the existing and proposed sewer analysis.

The redevelopment area's flow path to the Little Falls Run wastewater treatment plant is served by five main pumping stations: The Days Inn Pumping Station, the Ingleside Pumping Station, the Falls Run Pumping Station, the Old Rte. 3 Pumping Station and the Claiborne Run Pump Station. Below is a summary of the Pump Station analysis, see the Appendix B for in-depth report:

- The Days Inn PS: Adequate to handle the proposed increase in flow per the H20 Map model provided by Stafford County.
- Ingleside PS: Not Adequate to handle the proposed increase in flow per the H20 Map model provided by Stafford County. No CIP improvement planned.
- Falls Run PS: Not adequate to handle the proposed increase in flow per the H20 Map model provided by Stafford County. However, the Stafford County Master plan says this should have already been upgraded: and the upgraded capacity given is adequate. It should be verified if these improvements (LFR – 209) are indeed in place.
- Old Route #3 PS: Not Adequate to handle the proposed increase in flow per the H20 Map model provided by Stafford County. No CIP improvement planned.
- Claiborne Run PS: Not adequate to handle the proposed increase in flow per the H20 Map model provided by Stafford County. However, the Stafford County Master plan says this should

have already been upgraded: and the upgraded capacity given is adequate. It should be verified if these improvements (LFR – 214) are indeed in place.

There are also 5 force mains which carry flow in the sewer outfall. Each will be subject to increases in velocity and headloss in order to convey the increased sewer flows. With appropriate upgrades to the pumps, the force mains appear adequate for the future growth.

- Effect On Future Capital Improvements Projects

The most notable impact on the sewer system in this area is to the downstream Old Route #3 Pumping Station and the downstream Ingleside Pumping Station. There is a projected need to increase the capacity of both of these pumping stations. In addition: (77) gravity sewer lines that fail, based on capacity requirements, in the existing model. These will need to be improved, since they will now be needed handle the proposed increase in flows. An additional (18) pipes fail, totaling (95) gravity sewer pipes in the proposed scenario.

STORMWATER COMPONENTS

Floodplain

Southern Gateway does have several FEMA and County mapped 100-yr floodplains which affect the southern and northeastern parcels of redevelopment area. The proposed redevelopment plans by CMSS have, for the most part, avoided these areas. As previously noted: FEMA requires a Letter of Map Revision (LOMR) whenever any development encroaches within the 100-yr floodplain. A Floodplain Map is included in Appendix C.

Resource Protection Areas

The Southern Gateway redevelopment area has two (2) relatively minor locations of CRPA's within the area. The first location forms the southwestern limits of the area along a tributary to England Run. The second CRPA follows Falls Run and bisects the northeast corner of the redevelopment project area. Both areas are along tributaries to the Rappahannock River which lies to the South of the Southern Gateway redevelopment area. The current redevelopment plans by CMSS have no impacts on any existing CRPA areas. A CRPA Map is included in Appendix C.

SWM/BMP

Regional SWM facilities should be considered in those areas called out within the Storm Water Management element of the Comprehensive Plan. All of these occur within the Falls Run Watershed. Outside the Falls Run Watershed, i.e. the south side of Route 17, opportunities may exist to consider some regional storm water improvements on the northern side of the tributary to England Run, which meanders along the southern boundary of the redevelopment area.

While it may prove difficult for any individual property owner to implement a regional SWM facility due to timing and cooperation of adjacent developers whose land would drain to a proposed facility, it is in the County's interest to help facilitate this approach. The County may establish a mechanism by which the County can implement a regional approach to SWM. Other jurisdictions have instituted a "pro-rata share" fee which is paid by the land owners or developers for increases in impervious

area within a watershed. The proceeds would be used to construct new SWM facilities in the watershed or improvements along the tributary. Another option is for the County to create incentives, reimbursements and/or additional concessions to land owners who elect to implement a regional storm water management design which takes into consideration the future development potential of the upstream drainage area.

A map has been included with suggested locations where regional SWM measures may make sense. These locations have been selected based on their ability to serve several development parcels as well as their proximity to the major drainage ways. One of these locations adjacent to Falls Run already contains an SWM pond which also corresponds to location P-6 as shown on the Falls Run regional detention basin map from the Stormwater component of the Comprehensive Plan. Here, either a second pond or even modifications to the existing pond could be implemented. A Map of Possible SWM locations is included in Appendix C.

APPENDIX A

WATER ANALYSIS REPORTS

EXISTING MODEL ANALYSIS		
PEAK HOUR: 7AM		
PIPES ABOVE MAXIMUM VELOCITY (5 FPS)		
PIPE ID	**EXISTING MODEL VELOCITY**	**PEAK ANALYSIS VELOCITY**
10003A	8.82	-
60414A	5.88	-
20008A	5.62	-
26833	5.20	-
26830	5.20	-
20078	5.01	-
PIPES ABOVE MAXIMUM HEADLOSS (FT/KFT)		
PIPE ID	**EXISTING MODEL HEADLOSS**	**PEAK ANALYSIS HEADLOSS**
10003A	448.81	-
20078	16.34	-
60414A	15.71	-
20008A	14.45	-
26833	12.50	-
26830	12.49	-
60016A	10.31	-
60024A	10.14	-
60118	8.66	-
60116	8.60	-
60210	8.51	-
62160	7.97	-
62162	7.97	-
10658	6.60	-
20910	6.40	-
20017	6.40	-
26806	6.06	-
10614A	5.44	-
10A	5.32	-
10519	5.16	-
PIPES BELOW MINIMUM PRESSURE (PSI)		
PIPE ID	**EXISTING MODEL PRESSURE**	**PEAK ANALYSIS PRESSURE**
11062	39.84	-
29010	39.59	-
29016	39.14	-
11018	38.59	-
14570	38.52	-
29022	37.81	-
11056	37.76	-
15730	37.66	-
11052	37.32	-
14924	37.22	-
20200	36.95	-
11026	36.86	-
20106	36.45	-
14932	36.36	-

10222	36.01	-
10378	35.94	-
11054	35.94	-
20110	35.46	-
20108	34.59	-
10220	33.84	-
31044	32.23	-
60600	24.73	-
15702	24.68	-
15708	24.66	-
15704	22.95	-
70002A	16.78	-
10A	14.81	-
10854	-1.53	-
70063	-2.03	-

BOSWELL MODEL ANALYSIS		
PEAK HOUR: 7AM		
PIPES ABOVE MAXIMUM VELOCITY (5 FPS)		
PIPE ID	**EXISTING MODEL VELOCITY**	**PEAK ANALYSIS VELOCITY**
10003A	8.82	8.92
20008A	5.62	5.56
26833	5.20	5.14
26830	5.20	5.14
20078	5.01	4.96
60414A	*5.88*	*5.88*
PIPES ABOVE MAXIMUM HEADLOSS (FT/KFT)		
PIPE ID	**EXISTING MODEL HEADLOSS**	**PEAK ANALYSIS HEADLOSS**
10003A	448.81	451.26
20078	16.34	16.25
20008A	14.45	14.37
26833	12.50	12.43
26830	12.49	12.42
20017	6.40	6.36
20910	6.40	6.36
26806	6.06	6.03
10658	6.60	6.40
10A	5.32	5.35
10614A	5.44	5.26
10519	5.16	4.99
60414A	*15.71*	*15.71*
60016A	*10.31*	*10.31*
60024A	*10.14*	*10.14*
60118	*8.66*	*8.66*
60116	*8.60*	*8.60*
60210	*8.51*	*8.51*
62160	*7.97*	*7.97*
62162	*7.97*	*7.97*
JUNCTIONS BELOW MINIMUM PRESSURE (PSI)		
PIPE ID	**EXISTING MODEL PRESSURE**	**PEAK ANALYSIS PRESSURE**
11024	42.49	42.14
10854	-1.53	-2.03
10A	14.81	14.87
15704	22.95	22.82
15708	24.66	24.53
15702	24.68	24.55
10220	33.84	33.49
10222	36.01	35.66
11026	36.86	36.51
20108	34.59	34.58
11018	38.59	38.24
11054	35.94	35.82
10378	35.94	35.82
20110	35.46	35.45

14932	36.36	36.23
20106	36.45	36.44
14924	37.22	37.10
11052	37.32	37.20
20200	36.95	36.94
15730	37.66	37.53
11056	37.76	37.63
29022	37.81	37.80
14570	35.82	38.40
29016	39.14	39.14
11062	39.84	39.71
29010	39.59	39.58
31044	*32.23*	*32.23*
70063	*-2.03*	*-2.03*
70002A	*16.78*	*16.78*
60600	*24.73*	*24.73*

NO ADDITIONAL JUNCTIONS EXCEED 120 PSI

143 JUNCTIONS IN THE EXISTING MODEL; 137 JUNCTIONS IN THE BOSWELL PEAK ANALYSIS

Indicates items that did not change from existing to proposed conditions

COURTHOUSE MODEL ANALYSIS		
PEAK HOUR: 7AM		
PIPES ABOVE MAXIMUM VELOCITY (5 FPS)		
PIPE ID	**EXISTING MODEL VELOCITY**	**PEAK ANALYSIS VELOCITY**
10003A	8.82	8.84
20008A	5.62	5.60
26833	5.20	5.18
26830	5.20	5.18
60414A	*5.88*	*5.88*
20078	*5.01*	*5.01*
PIPES ABOVE MAXIMUM HEADLOSS (FT/KFT)		
PIPE ID	**EXISTING MODEL HEADLOSS**	**PEAK ANALYSIS HEADLOSS**
10003A	448.81	451.26
20078	16.34	16.23
20008A	14.45	14.36
26833	12.50	12.42
26830	12.49	12.41
60210	8.51	8.51
10658	6.60	8.18
10614A	5.44	6.79
10519	5.16	6.48
20017	6.40	6.36
20910	6.40	6.36
26806	6.06	6.02
10A	5.32	5.35
60414A	*15.71*	*15.71*
60016A	*10.31*	*10.31*
60024A	*10.14*	*10.14*
60118	*8.66*	*8.66*
60116	*8.60*	*8.60*
62160	*7.97*	*7.97*
62162	*7.97*	*7.97*
JUNCTIONS BELOW MINIMUM PRESSURE (PSI)		
PIPE ID	**EXISTING MODEL PRESSURE**	**PEAK ANALYSIS PRESSURE**
10854	-1.53	-1.99
10A	14.81	14.85
15704	22.95	20.83
15708	24.66	22.50
15702	24.68	22.57
11054	35.94	33.77
10378	35.94	33.77
10220	33.84	33.82
14932	36.36	34.18
20108	34.59	34.58
14924	37.22	35.05
11052	37.32	35.16
20110	35.46	35.45
15730	37.66	35.49

11056	37.76	35.59
10222	36.01	35.99
14570	38.52	36.35
20106	36.45	36.44
11026	36.86	36.83
20200	36.95	36.94
11062	39.84	37.66
29022	37.81	37.80
15710	40.69	38.52
11018	38.59	38.56
15714	41.12	38.96
29016	39.14	39.13
10404	41.57	39.38
29010	39.59	39.58
15550	41.99	39.81
11044	42.00	39.82
31044	*32.23*	*32.23*
60600	*24.73*	*24.73*
70002A	*16.78*	*16.78*
70063	*-2.03*	*-2.03*

NO ADDITIONAL JUNCTIONS EXCEED 120 PSI

143 JUNCTIONS IN THE EXISTING MODEL; 142 JUNCTIONS IN THE COURTHOUSE PEAK ANALYSIS

Indicates items that did not change from existing to proposed conditions

FALMOUTH MODEL ANALYSIS		
PEAK HOUR: 7AM		
PIPES ABOVE MAXIMUM VELOCITY (5 FPS)		
PIPE ID	**EXISTING MODEL VELOCITY**	**PEAK ANALYSIS VELOCITY**
60414A	5.92	5.88
10003A	*8.82*	*8.82*
20008A	*5.62*	*5.62*
26833	*5.20*	*5.20*
26830	*5.20*	*5.20*
20078	*5.01*	*5.01*
PIPES ABOVE MAXIMUM HEADLOSS (FT/KFT)		
PIPE ID	**EXISTING MODEL HEADLOSS**	**PEAK ANALYSIS HEADLOSS**
20078	16.34	16.34
60414A	15.71	15.74
60016A	10.31	10.35
60024A	10.14	10.18
60118	8.66	8.56
60116	8.60	8.50
60210	8.51	8.41
62160	7.97	7.99
62162	7.97	7.99
10519	5.16	5.16
10003A	*448.81*	*448.81*
20008A	*14.45*	*14.45*
26833	*12.50*	*12.50*
26830	*12.49*	*12.49*
10658	*6.60*	*6.60*
20910	*6.40*	*6.40*
20017	*6.40*	*6.40*
26806	*6.06*	*6.06*
10614A	*5.44*	*5.44*
10A	*5.32*	*5.32*
JUNCTIONS BELOW MINIMUM PRESSURE (PSI)		
PIPE ID	**EXISTING MODEL PRESSURE**	**PEAK ANALYSIS PRESSURE**
60600	27.73	24.63
11052	37.32	37.33
29016	39.14	39.15
67104	40.29	40.22
11062	*39.84*	*39.84*
29010	*39.59*	*39.59*
11018	*38.59*	*38.59*
14570	*38.52*	*38.52*
29022	*37.81*	*37.81*
11056	*37.76*	*37.76*
15730	*37.66*	*37.66*
14924	*37.22*	*37.22*
20200	*36.95*	*36.95*
11026	*36.86*	*36.86*

20106	*36.45*	*36.45*
14932	*36.36*	*36.36*
10222	*36.01*	*36.01*
10378	*35.94*	*35.94*
11054	*35.94*	*35.94*
20110	*35.46*	*35.46*
20108	*34.59*	*34.59*
10220	*33.84*	*33.84*
31044	*32.23*	*32.23*
15702	*24.68*	*24.68*
15708	*24.66*	*24.66*
15704	*22.95*	*22.95*
70002A	*16.78*	*16.78*
10A	*14.81*	*14.81*
10854	*-1.53*	*-1.53*
70063	*-2.03*	*-2.03*

NO ADDITIONAL JUNCTIONS EXCEED 120 PSI

143 JUNCTIONS IN THE EXISTING MODEL; 139 JUNCTIONS IN THE FALMOUTH PEAK ANALYSIS

Indicates items that did not change from existing to proposed conditions

SOUTHERN GATEWAY MODEL ANALYSIS		
PEAK HOUR: 7AM		
PIPES ABOVE MAXIMUM VELOCITY (5 FPS)		
PIPE ID	**EXISTING MODEL VELOCITY**	**PEAK ANALYSIS VELOCITY**
60414A	5.88	5.88
70904B	0.00	5.71
70014	0.02	5.69
10003A	*8.82*	*8.81*
20008A	*5.62*	*5.63*
26833	*5.20*	*5.20*
26830	*5.20*	*5.20*
20078	*5.01*	*5.02*
PIPES ABOVE MAXIMUM HEADLOSS (FT/KFT)		
PIPE ID	**EXISTING MODEL HEADLOSS**	**PEAK ANALYSIS HEADLOSS**
10003A	448.81	448.61
20078	16.34	16.35
60414A	15.71	15.71
20008A	14.45	14.46
60016A	10.31	10.31
60024A	10.14	10.14
70904B	0.00	9.25
70014	0.00	9.19
60118	8.66	8.66
60116	8.60	8.60
60210	8.51	8.51
62160	7.97	7.97
62162	7.97	7.97
78002	0.03	7.24
10658	6.60	6.62
20910	6.40	6.40
20017	6.40	6.40
70430A	0.69	6.17
70434A	0.64	6.05
10614A	5.44	5.45
10519	5.16	5.16
26833	*12.50*	*12.51*
26830	*12.49*	*12.50*
26806	*6.06*	*6.07*
10A	*5.32*	*5.32*
JUNCTIONS BELOW MINIMUM PRESSURE (PSI)		
PIPE ID	**EXISTING MODEL PRESSURE**	**PEAK ANALYSIS PRESSURE**
70063	-2.03	-2.90
10854	-1.53	-1.50
70002A	16.78	16.78
60600	24.73	24.72
15702	24.68	24.70
20108	34.59	34.57
20110	35.46	35.43

20106	36.45	36.43
14924	37.22	37.24
11052	37.32	37.34
29022	37.81	37.79
29016	39.14	39.12
29010	39.59	39.57
11062	*39.84*	*39.85*
11018	*38.59*	*38.60*
14570	*38.52*	*38.54*
11056	*37.76*	*37.77*
15730	*37.66*	*37.67*
20200	*36.95*	*36.92*
11026	*36.86*	*36.86*
14932	*36.36*	*36.37*
10222	*36.01*	*36.01*
10378	*35.94*	*35.95*
11054	*35.94*	*35.94*
10220	*33.84*	*33.84*
31044	*32.23*	*32.23*
15708	*24.66*	*24.68*
15704	*22.95*	*22.96*
10A	*14.81*	*14.80*

10 ADDITIONAL JUNCTIONS EXCEED 120 PSI

143 JUNCTIONS IN THE EXISTING MODEL; 153 JUNCTIONS IN THE SOUTHERN GATEWAY

PEAK ANALYSIS

Indicates items that did not change from existing to proposed conditions

APPENDIX B

SEWER ANALYSIS REPORTS

BOSWELL EXISTING MODEL ANALYSIS (GRAVITY):

MINIMUM STANDARDS:

PIPE VELOCITY:

MINIMUM VELOCITY:	2.25 FT/SEC
MAXIMUM VELOCITY:	15 FT/SEC

PIPE CAPACITY:

MAXIMUM q/Q (<15”):	0.5
MAXIMUM q/Q (≥15”):	0.85

EXISTING PIPE RUNS THAT DO NOT MEET MINIMUM VELOCITY CRITERIA:

1) 30 (A-42) (1.420 FT/SEC)
2) 47 (A-42) (1.248 FT/SEC)
3) 60 (A-42) (1.549 FT/SEC)
4) 82 (A-42) (1.305 FT/SEC)

EXISTING PIPE RUNS THAT DO NOT MEET MAXIMUM VELOCITY CRITERIA:

1) 10-0103 (15.025 FT/SEC)

EXISTING PIPES THAT DO NOT MEET CAPACITY CRITERIA:

N/A

BOSWELL PROPOSED MODEL ANALYSIS (GRAVITY):

MINIMUM STANDARDS:

PIPE VELOCITY:

MINIMUM VELOCITY:	2.25 FT/SEC
MAXIMUM VELOCITY:	15 FT/SEC

PIPE CAPACITY:

MAXIMUM q/Q (<15”):	0.5
MAXIMUM q/Q (≥15”):	0.85

EXISTING PIPE RUNS THAT DO NOT MEET MINIMUM VELOCITY CRITERIA:

1) 30 (1.660 FT/SEC)
2) 60 (1.747 FT/SEC)

EXISTING PIPE RUNS THAT DO NOT MEET MAXIMUM VELOCITY CRITERIA:

1) 10-0103 (16.762 FT/SEC)
2) 12 (15.911 FT/SEC)

EXISTING PIPES THAT DO NOT MEET CAPACITY CRITERIA:

1) 10-0133 (q/Q = 0.516; D=10”)
2) 10-0133A (q/Q = 0.763; D=10”)
3) 10-0135 (q/Q = 0.630; D=10”)
4) 10-0139A (q/Q = 0.528; D=8”)
5) 10-0140 (q/Q = 0.735; D=10”)
6) 10-0142 (q/Q = 0.518; D=10”)
7) 42 (q/Q = 0.666; D=10”)

STAFFORD COUNTY
BOSWELL REDEVELOPMENT AREA
AQUIA WASTEWATER TREATMENT FACILITY SERVICE AREA

FORCEMAIN ANALYSIS

FM	EX FLOW TO FM (GPM)	PROP. FLOW TO FM (GPM)	EX. VELOCITY (FT/SEC)	PROP. VELOCITY (FT/SEC)	EX. HEADLOSS / LENGTH	PROP. HEADLOSS / LENGTH
10-FM-02	1815.795	2147.14	4.53	5.35	0.00648	0.00884
10-FM-04, 10-FM-06	1816.009	2147.35	3.79	4.48	0.00419	0.00571
10-FM-07	1817.351	2148.696	5.16	6.10	0.00889	0.01212
10-FM-05	2748.773	3080.118	3.47	3.88	0.00265	0.00328

STAFFORD COUNTY
BOSWELL REDEVELOPMENT AREA
AQUIA WASTEWATER TREATMENT FACILITY SERVICE AREA
PUMP ANALYSIS

PUMP	EX FLOW	PROP. FLOW	MAX CAPACITY	CAPACITY RATIO	
	TO PUMP (GPM)	TO PUMP (GPM)	OF PUMP (GPM)	EX	PROP
HILLDRUP	163.219	494.564	487.76	0.33	1.01
AQUIA CREEK	1815.795	2147.14	3994.75	0.45	0.54

Conclusion: The recently upgraded Hilldrup pump station is not adequate to handle the increase in flows

COURTHOUSE EXISTING MODEL ANALYSIS (GRAVITY):

MINIMUM STANDARDS:

PIPE VELOCITY:

MINIMUM VELOCITY:	2.25 FT/SEC
MAXIMUM VELOCITY:	15 FT/SEC

PIPE CAPACITY:

MAXIMUM q/Q (<15”):	0.5
MAXIMUM q/Q (≥15”):	0.85

EXISTING PIPE RUNS THAT DO NOT MEET MINIMUM VELOCITY CRITERIA:

N/A

EXISTING PIPE RUNS THAT DO NOT MEET MAXIMUM VELOCITY CRITERIA:

N/A

EXISTING PIPES THAT DO NOT MEET CAPACITY CRITERIA:

1) 40-0101 (q/Q = 1.351; D=24”)
2) 41-0001 (q/Q = 1.106; D=12”)

COURTHOUSE PROPOSED MODEL ANALYSIS (GRAVITY):

MINIMUM STANDARDS:

PIPE VELOCITY:

MINIMUM VELOCITY:	2.25 FT/SEC
MAXIMUM VELOCITY:	15 FT/SEC

PIPE CAPACITY:

MAXIMUM q/Q (<15”):	0.5
MAXIMUM q/Q (≥15”):	0.85

EXISTING PIPE RUNS THAT DO NOT MINIMUM VELOCITY CRITERIA:

N/A

EXISTING PIPE RUNS THAT DO NOT MAXIMUM VELOCITY CRITERIA:

N/A

EXISTING PIPES THAT DO NOT MEET CAPACITY CRITERIA:

1) 40-0101 (q/Q = 1.377; D=24”)
2) 40-0510 (q/Q = 0.968; D=18”)
3) 41-0001 (q/Q = 1.300; D=12”)

STAFFORD COUNTY
COURTHOUSE REDEVELOPMENT AREA
AQUIA WASTEWATER TREATMENT FACILITY SERVICE AREA

PUMP ANALYSIS

PUMP	EX FLOW	PROP. FLOW	MAX CAPACITY	CAPACITY RATIO	
	TO PUMP (GPM)	TO PUMP (GPM)	OF PUMP (GPM)	EX	PROP
COURTHOUSE (C-41)	1271.54	1494.89	1441.64	0.88	1.04
AUSTIN RUN (P-40)	9224.80	9401.32	13888.89*	0.66	0.68

*PER THE STAFFORD COUNTY WATER AND SEWER MASTER PLAN, THE AUSTIN RUN PUMP STATION (P-40), HAS UNDERGONE AN IMPROVEMENT NOT REFLECTED IN THE CURRENT "EXISTING" SEWER MODEL PROVIDED BY STAFFORD COUNTY. COUNTY IMPROVEMENT A-210 STATES THAT THE AUSTIN RUN PUMP STATION WILL BE EXPANDED FROM 5.8 MGD (4027.78 GPM) TO 20 MGD (13888.89 GPM) BY 2006-2007. THE MODEL CURRENTLY REFLECTS A CAPACITY OF 2.89 MGD (2006.94 GPM). BASED ON THE 20 MGD EXPANSION, THE PUMP STATION IS ADEQUATELY SIZED FOR THE PHASE I FLOW

Conclusion: The Courthouse Pump Station can't handle the Phase I flows.
(The model already shows the Courthouse Pump Station upgraded beyond the listed 2014 CIP improvement capacity, but it is still not adequate)

FALMOUTH EXISTING MODEL ANALYSIS (GRAVITY):

MINIMUM STANDARDS:

PIPE VELOCITY:

MINIMUM VELOCITY:	2.25 FT/SEC
MAXIMUM VELOCITY:	15 FT/SEC

PIPE CAPACITY:

MAXIMUM q/Q (<15”):	0.5
MAXIMUM q/Q (≥15”):	0.85

EXISTING PIPE RUNS THAT DO NOT MEET MINIMUM VELOCITY CRITERIA:

N/A

EXISTING PIPE RUNS THAT DO NOT MEET MAXIMUM VELOCITY CRITERIA:

1)	1700	(15.952 FT/SEC)
2)	9	(15.952 FT/SEC)
3)	P80-0800	(17.550 FT/SEC)
4)	P80-0802	(19.503 FT/SEC)

EXISTING PIPES THAT DO NOT MEET CAPACITY CRITERIA:

1)	1700	(D=8”, q/Q=9.619)
2)	9	(D=8”, q/Q=3.358)
3)	P68-0100	(D=12”, q/Q=22.332)
4)	P68-0101	(D=12”, q/Q=0.747)
5)	P68-0102	(D=12”, q/Q=0.796)
6)	P68-0103	(D=10”, q/Q=2.377)
7)	P68-0104	(D=10”, q/Q=0.833)
8)	P68-0106	(D=10”, q/Q=0.775)
9)	P80-1096	(D=15”, q/Q=0.859)
10)	P80-1097	(D=15”, q/Q=1.652)
11)	P80-1098	(D=15”, q/Q=1.977)
12)	P80-1099	(D=15”, q/Q=1.978)
13)	P80-1100	(D=15”, q/Q=0.924)

FALMOUTH PROPOSED MODEL ANALYSIS (GRAVITY):

MINIMUM STANDARDS:

PIPE VELOCITY:

MINIMUM VELOCITY:	2.25 FT/SEC
MAXIMUM VELOCITY:	15 FT/SEC

PIPE CAPACITY:

MAXIMUM q/Q (<15”):	0.5
MAXIMUM q/Q (≥15”):	0.85

EXISTING PIPE RUNS THAT DO NOT MEET MINIMUM VELOCITY CRITERIA:

N/A

EXISTING PIPE RUNS THAT DO NOT MEET MAXIMUM VELOCITY CRITERIA:

1)	1700	(16.222 FT/SEC)
2)	9	(16.222 FT/SEC)
3)	P80-0800	(17.578 FT/SEC)
4)	P80-0802	(19.600 FT/SEC)

EXISTING PIPES THAT DO NOT MEET CAPACITY CRITERIA:

1)	1700	(D=8”, q/Q=9.782)
2)	9	(D=8”, q/Q=3.415)
3)	P68-0100	(D=12”, q/Q=23.168)
4)	P68-0101	(D=12”, q/Q=0.775)
5)	P68-0102	(D=12”, q/Q=0.825)
6)	P68-0103	(D=10”, q/Q=2.472)
7)	P68-0104	(D=10”, q/Q=0.866)
8)	P68-0106	(D=10”, q/Q=0.806)
9)	P80-1096	(D=15”, q/Q=0.884)
10)	P80-1097	(D=15”, q/Q=1.681)
11)	P80-1098	(D=15”, q/Q=2.011)
12)	P80-1099	(D=15”, q/Q=2.012)
13)	P80-1100	(D=15”, q/Q=0.940)

STAFFORD COUNTY
FALMOUTH REDEVELOPMENT AREA
LITTLE FALLS RUN WASTEWATER TREATMENT FACILITY SERVICE AREA

PUMP ANALYSIS

PUMP	EX FLOW	PROP. FLOW	MAX CAPACITY	CAPACITY RATIO	
	TO PUMP (GPM)	TO PUMP (GPM)	OF PUMP (GPM)	EX	PROP
P-60-M	4496.398	4709.057	6527.78*	0.69	0.72
P-68	1132.263	1174.648	1350.901	0.84	0.87
P-80	6238.815	6281.201	12500**	0.50	0.50

*PER THE STAFFORD COUNTY WATER AND SEWER MASTER PLAN, THE FALLS RUN PUMP STATION (P-60-M), HAS A CAPACITY OF 9.4 MGD (6527.78 GPM) (LFR-209). THE CURRENT MODEL PROVIDED BY STAFFORD COUNTY HAS THIS PUMP CAPACITY AT 4.68 MGD (3250 GPM); THIS WOULD NOT BE ADEQUATE BASED ON THE ADDITIONAL FLOWS.

**PER THE STAFFORD COUNTY WATER AND SEWER MASTER PLAN, THE CLAIBORNE RUN PUMP STATION (P-80), HAS UNDERGONE AN IMPROVEMENT NOT REFLECTED IN THE CURRENT "EXISTING" SEWER MODEL PROVIDED BY STAFFORD COUNTY. COUNTY IMPROVEMENT LFR-214 STATES THAT THE CLAIBORNE RUN PUMP STATION WILL BE EXPANDED FROM 8.1 MGD (5625 GPM) TO 18 MGD (12500 GPM) BY 2007-2008. THE MODEL CURRENTLY REFLECTS A CAPACITY OF 4.03 MGD (2798.61 GPM). BASED ON THE 18 MGD EXPANSION, THE PUMP STATION IS ADEQUATELY SIZED FOR THE PROPOSED FLOW.

SOUTHERN GATEWAY EXISTING MODEL ANALYSIS (GRAVITY SEWER):

MINIMUM STANDARDS:

PIPE VELOCITY:

MINIMUM VELOCITY:	2.25 FT/SEC
MAXIMUM VELOCITY:	15 FT/SEC

PIPE CAPACITY:

MAXIMUM q/Q (D<15”):	0.5
MAXIMUM q/Q (D≥15”):	0.85

EXISTING PIPE RUNS THAT DO NOT MEET MINIMUM VELOCITY CRITERIA:

1) P60-0508 (0.817 FT/SEC)
2) P60-0509 (0.811 FT/SEC)
3) P60-0510 (0.820 FT/SEC)

EXISTING PIPE RUNS THAT DO NOT MEET MAXIMUM VELOCITY CRITERIA:

1) P60-0149 (19.081 FT/SEC)
2) P60-0172 (19.788 FT/SEC)
3) P60-0234 (22.891 FT/SEC)
4) 1700 (15.952 FT/SEC)
5) 9 (15.952 FT/SEC)
6) P80-0800 (17.550 FT/SEC)
7) P80-0802 (19.503 FT/SEC)

EXISTING PIPES THAT DO NOT MEET CAPACITY CRITERIA:

1) P60-0101 (q/Q = 0.933 ; D=18”)
2) P60-0102 (q/Q = 1.213 ; D=18”)
3) P60-0103 (q/Q = 1.234 ; D=18”)
4) P60-0104 (q/Q = 1.175 ; D=18”)
5) P60-0105 (q/Q = 1.409 ; D=18”)
6) P60-0106 (q/Q = 1.206 ; D=18”)
7) P60-0107 (q/Q = 1.223 ; D=18”)
8) P60-0108 (q/Q = 1.213 ; D=18”)
9) P60-0109 (q/Q = 1.546 ; D=18”)
10) P60-0119 (q/Q = 2.965 ; D=18”)
11) P60-0132 (q/Q = 1.119 ; D=18”)
12) P60-0134 (q/Q = 23.721 ; D=18”)
13) P60-0135 (q/Q = 1.117 ; D=18”)

14) P60-0136 (q/Q = 1.206 ; D=18”)
15) P60-0137 (q/Q = 1.255 ; D=18”)
16) P60-0138 (q/Q = 1.254 ; D=18”)
17) P60-0139 (q/Q = 1.196 ; D=18”)
18) P60-0142 (q/Q = 1.179 ; D=18”)
19) P60-0144 (q/Q = 1.251 ; D=18”)
20) P60-0145 (q/Q = 1.186 ; D=18”)
21) P60-0146 (q/Q = 1.243 ; D=18”)
22) P60-0147 (q/Q = 1.175 ; D=18”)
23) P60-0151 (q/Q = 1.202 ; D=18”)
24) P60-0152 (q/Q = 1.199 ; D=18”)
25) P60-0153 (q/Q = 1.197 ; D=18”)
26) P60-0155 (q/Q = 1.197 ; D=18”)
27) P60-0156 (q/Q = 1.136 ; D=18”)
28) P60-0157 (q/Q = 1.210 ; D=18”)
29) P60-0158 (q/Q = 1.173 ; D=18”)
30) P60-0159 (q/Q = 1.209 ; D=18”)
31) P60-0160 (q/Q = 1.212 ; D=18”)
32) P60-0161 (q/Q = 1.171 ; D=18”)
33) P60-0162 (q/Q = 1.300 ; D=18”)
34) P60-0163 (q/Q = 1.185 ; D=18”)
35) P60-0164 (q/Q = 1.226 ; D=18”)
36) P60-0165 (q/Q = 1.188 ; D=18”)
37) P60-0166 (q/Q = 1.204 ; D=18”)
38) P60-0167 (q/Q = 1.190 ; D=18”)
39) P60-0168 (q/Q = 1.162 ; D=18”)
40) P60-0169 (q/Q = 1.392 ; D=18”)
41) P60-0170 (q/Q = 1.297 ; D=18”)
42) P60-0234 (q/Q = 10.148 ; D=8”)
43) P60-0704 (q/Q = 1.563 ; D=10”)
44) P61-0119 (q/Q = 0.556 ; D=10”)
45) P61-0123 (q/Q = 0.674 ; D=10”)
46) P61-0124 (q/Q = 0.653 ; D=10”)
47) P61-0126 (q/Q = 0.645 ; D=10”)
48) P61-0127 (q/Q = 0.630 ; D=10”)
49) P61-0128 (q/Q = 0.653 ; D=10”)
50) P61-0129 (q/Q = 0.665 ; D=10”)
51) P61-0130 (q/Q = 0.611 ; D=10”)
52) P61-0131 (q/Q = 0.668 ; D=10”)
53) P61-0135 (q/Q = 0.655 ; D=10”)
54) P61-0136 (q/Q = 0.744 ; D=10”)
55) P61-0137 (q/Q = 0.632 ; D=10”)
56) P61-0138 (q/Q = 0.672 ; D=10”)
57) P61-0139 (q/Q = 0.644 ; D=10”)
58) P61-103 (q/Q = 0.509 ; D=10”)
59) P61-105 (q/Q = 0.578 ; D=10”)

60)	P61-106	(q/Q = 0.508 ; D=10”)
61)	P61-106A	(q/Q = 1.125 ; D=10”)
62)	P61-107	(q/Q = 1.024 ; D=10”)
63)	P61-110	(q/Q = 0.914 ; D=10”)
64)	P61-111	(q/Q = 0.760 ; D=10”)
65)	1700	(q/Q = 9.619 ; D=8”)
66)	9	(q/Q = 3.358 ; D=8”)
67)	P68-0100	(q/Q = 22.332 ; D=12”)
68)	P68-0101	(q/Q = 0.747 ; D=12”)
69)	P68-0102	(q/Q = 0.796 ; D=12”)
70)	P68-0103	(q/Q = 2.377 ; D=10”)
71)	P68-0104	(q/Q = 0.833 ; D=10”)
72)	P68-0106	(q/Q = 0.775 ; D=10”)
73)	P80-1096	(q/Q = 0.859 ; D=15”)
74)	P80-1097	(q/Q = 1.652 ; D=15”)
75)	P80-1098	(q/Q = 1.977 ; D=15”)
76)	P80-1099	(q/Q = 1.978 ; D=15”)
77)	P80-1100	(q/Q = 0.924 ; D=15”)

SOUTHERN GATEWAY PROPOSED MODEL ANALYSIS (GRAVITY SEWER):

MINIMUM STANDARDS:

PIPE VELOCITY:

MINIMUM VELOCITY:	2.25 FT/SEC
MAXIMUM VELOCITY:	15 FT/SEC

PIPE CAPACITY:

MAXIMUM q/Q (D<15”):	0.5
MAXIMUM q/Q (D≥15”):	0.85

PIPE RUNS THAT DO NOT MEET MINIMUM VELOCITY CRITERIA:

1) P60-0508 (1.066 FT/SEC)
2) P60-0509 (1.057 FT/SEC)
3) P60-0510 (1.069 FT/SEC)

PIPE RUNS THAT DO NOT MEET MAXIMUM VELOCITY CRITERIA:

1) P60-0149 (19.399 FT/SEC)
2) P60-0172 (20.120 FT/SEC)
3) P60-0234 (24.248 FT/SEC)
4) 1700 (18.311 FT/SEC)
5) 9 (18.311 FT/SEC)
6) P80-0800 (17.787 FT/SEC)
7) P80-0802 (20.311 FT/SEC)

PIPE RUNS THAT DO NOT MEET CAPACITY CRITERIA:

1) P60-0101 (q/Q = 1.052 ; D=18”)
2) P60-0102 (q/Q = 1.284 ; D=18”)
3) P60-0103 (q/Q = 1.307 ; D=18”)
4) P60-0104 (q/Q = 1.245 ; D=18”)
5) P60-0105 (q/Q = 1.493 ; D=18”)
6) P60-0106 (q/Q = 1.278 ; D=18”)
7) P60-0107 (q/Q = 1.296 ; D=18”)
8) P60-0108 (q/Q = 1.285 ; D=18”)
9) P60-0109 (q/Q = 1.637 ; D=18”)
10) P60-0119 (q/Q = 3.142 ; D=18”)
11) P60-0132 (q/Q = 1.186 ; D=18”)
12) P60-0134 (q/Q = 25.144 ; D=18”)
13) P60-0135 (q/Q = 1.184 ; D=18”)
14) P60-0136 (q/Q = 1.278 ; D=18”)

15) P60-0137 (q/Q = 1.330 ; D=18”)
16) P60-0138 (q/Q = 1.330 ; D=18”)
17) P60-0139 (q/Q = 1.268 ; D=18”)
18) P60-0142 (q/Q = 1.249 ; D=18”)
19) P60-0144 (q/Q = 1.326 ; D=18”)
20) P60-0145 (q/Q = 1.257 ; D=18”)
21) P60-0146 (q/Q = 1.318 ; D=18”)
22) P60-0147 (q/Q = 1.245 ; D=18”)
23) P60-0151 (q/Q = 1.274 ; D=18”)
24) P60-0152 (q/Q = 1.270 ; D=18”)
25) P60-0153 (q/Q = 1.269 ; D=18”)
26) P60-0155 (q/Q = 1.269 ; D=18”)
27) P60-0156 (q/Q = 1.204 ; D=18”)
28) P60-0157 (q/Q = 1.283 ; D=18”)
29) P60-0158 (q/Q = 1.244 ; D=18”)
30) P60-0159 (q/Q = 1.281 ; D=18”)
31) P60-0160 (q/Q = 1.285 ; D=18”)
32) P60-0161 (q/Q = 1.241 ; D=18”)
33) P60-0162 (q/Q = 1.378 ; D=18”)
34) P60-0163 (q/Q = 1.256 ; D=18”)
35) P60-0164 (q/Q = 1.300 ; D=18”)
36) P60-0165 (q/Q = 1.259 ; D=18”)
37) P60-0166 (q/Q = 1.276 ; D=18”)
38) P60-0167 (q/Q = 1.262 ; D=18”)
39) P60-0168 (q/Q = 1.232 ; D=18”)
40) P60-0169 (q/Q = 1.475 ; D=18”)
41) P60-0170 (q/Q = 1.375 ; D=18”)
42) P60-0234 (q/Q = 10.750 ; D=8”)
43) P60-0501 (q/Q = 0.503 ; D=12”)
44) P60-0704 (q/Q = 1.563 ; D=10”)
45) P61-0119 (q/Q = 0.663 ; D=10”)
46) P61-0122 (q/Q = 0.543 ; D=10”)
47) P61-0123 (q/Q = 0.804; D=10”)
48) P61-0124 (q/Q = 0.778 ; D=10”)
49) P61-0126 (q/Q = 0.775 ; D=10”)
50) P61-0127 (q/Q = 0.756 ; D=10”)
51) P61-0128 (q/Q = 0.784 ; D=10”)
52) P61-0129 (q/Q = 0.799 ; D=10”)
53) P61-0130 (q/Q = 0.734 ; D=10”)
54) P61-0131 (q/Q = 0.803 ; D=10”)
55) P61-0135 (q/Q = 0.787 ; D=10”)
56) P61-0136 (q/Q = 0.894; D=10”)
57) P61-0137 (q/Q = 0.760 ; D=10”)
58) P61-0138 (q/Q = 0.808 ; D=10”)
59) P61-0139 (q/Q = 0.774 ; D=10”)
60) P61-101 (q/Q = 0.528 ; D=10”)

61) P61-102 (q/Q = 0.527 ; D=10”)
62) P61-103 (q/Q = 0.605 ; D=10”)
63) P61-104 (q/Q = 0.512 ; D=10”)
64) P61-105 (q/Q = 0.687 ; D=10”)
65) P61-106 (q/Q = 0.604 ; D=10”)
66) P61-106A (q/Q = 1.338 ; D=10”)
67) P61-107 (q/Q = 1.219 ; D=10”)
68) P61-110 (q/Q = 1.088 ; D=10”)
69) P61-111 (q/Q = 0.905 ; D=10”)
70) P61-112 (q/Q = 0.594 ; D=10”)
71) P61-113 (q/Q = 0.504 ; D=10”)
72) P61-114 (q/Q = 0.513 ; D=10”)
73) P61-115 (q/Q = 0.542 ; D=10”)
74) 1700 (q/Q = 11.042 ; D=8”)
75) 9 (q/Q = 3.855 ; D=8”)
76) P68-0100 (q/Q = 29.622 ; D=12”)
77) P68-0101 (q/Q = 0.990 ; D=12”)
78) P68-0102 (q/Q = 1.055 ; D=12”)
79) P68-0103 (q/Q = 3.202 ; D=10”)
80) P68-0104 (q/Q = 1.122 ; D=10”)
81) P68-0105 (q/Q = 0.584 ; D=10”)
82) P68-0106 (q/Q = 1.044 ; D=10”)
83) P80-1096 (q/Q = 1.074 ; D=15”)
84) P80-1097 (q/Q = 1.903 ; D=15”)
85) P80-1098 (q/Q = 2.278 ; D=15”)
86) P80-1099 (q/Q = 2.279 ; D=15”)
87) P80-1100 (q/Q = 1.064 ; D=15”)

STAFFORD COUNTY
SOUTHERN GATEWAY REDEVELOPMENT AREA
LITTLE FALLS RUN WASTEWATER TREATMENT FACILITY SERVICE AREA
PUMP ANALYSIS

PUMP	EX FLOW	PROP. FLOW	MAX CAPACITY	CAPACITY RATIO	
	TO PUMP (GPM)	TO PUMP (GPM)	OF PUMP (GPM)	EX	PROP
PS-62 (DAYS INN)	82.84	197.36	566.41	0.15	0.35
P-61 (ingleside)	605.41	719.93	820.14	0.74	0.88
P-60-M (Falls Run)	4496.40	4709.06	6527.78*	0.69	0.72
P-68 (Old rt. 3)	1132.36	1501.86	1350.90	0.84	1.11
P-80 (Claiborne)	6238.81	6608.41	12500**	0.50	0.53

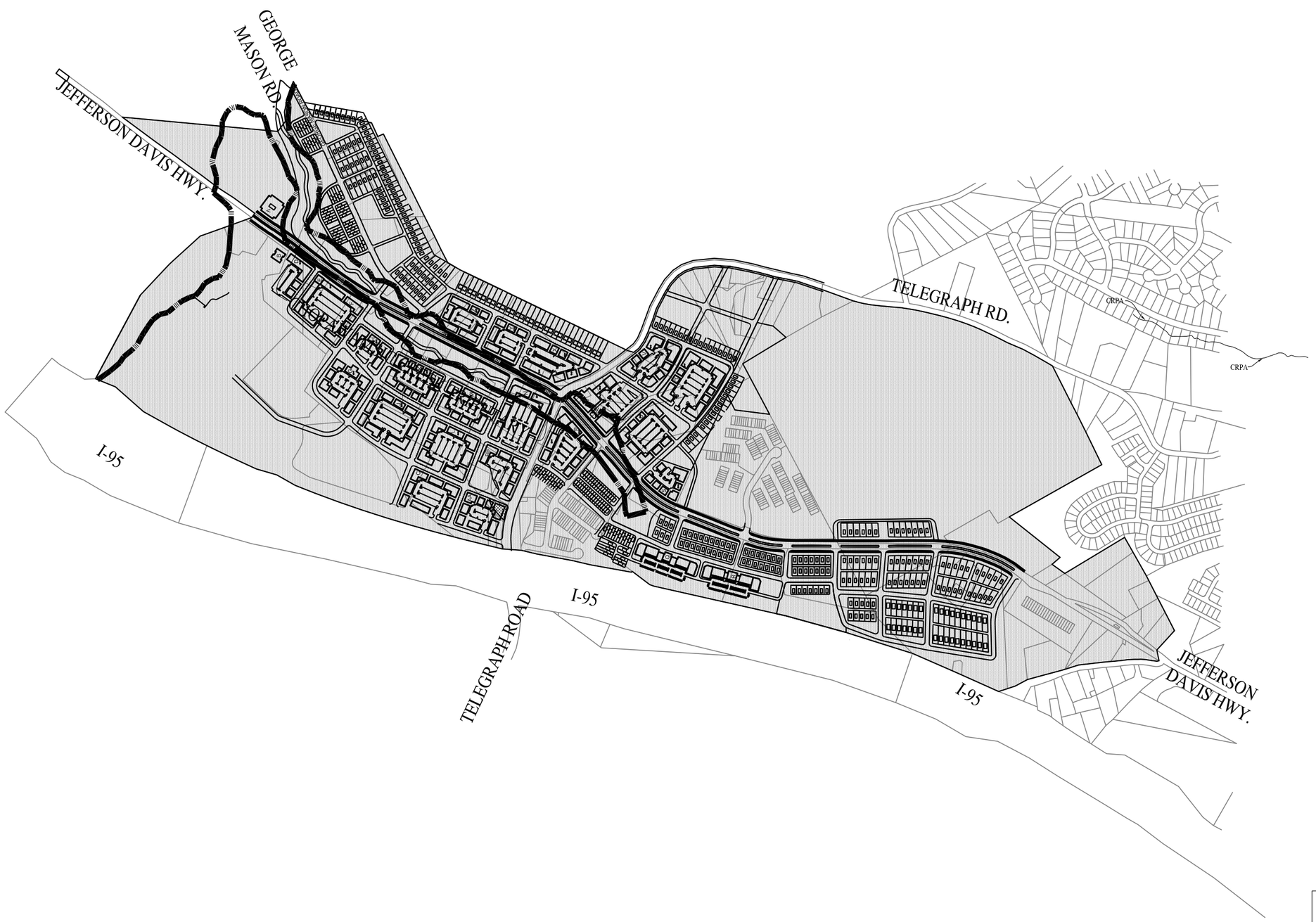
*PER THE STAFFORD COUNTY WATER AND SEWER MASTER PLAN, THE FALLS RUN PUMP STATION (P-60-M), HAS A CAPACITY OF 9.4 MGD (6527.78 GPM) (LFR-209). THE CURRENT MODEL PROVIDED BY STAFFORD COUNTY HAS THIS PUMP CAPACITY AT 4.68 MGD (3250 GPM); THIS WOULD NOT BE ADEQUATE BASED ON THE ADDITIONAL FLOWS.

**PER THE STAFFORD COUNTY WATER AND SEWER MASTER PLAN, THE CLAIBORNE RUN PUMP STATION (P-80), HAS UNDERGONE AN IMPROVEMENT NOT REFLECTED IN THE CURRENT "EXISTING" SEWER MODEL PROVIDED BY STAFFORD COUNTY. COUNTY IMPROVEMENT LFR-214 STATES THAT THE CLAIBORNE RUN PUMP STATION WILL BE EXPANDED FROM 8.1 MGD (5625 GPM) TO 18 MGD (12500 GPM) BY 2007-2008. THE MODEL CURRENTLY REFLECTS A CAPACITY OF 4.03 MGD (2798.61 GPM). BASED ON THE 18 MGD EXPANSION, THE PUMP STATION IS ADEQUATELY SIZED FOR THE PHASE I FLOW.

CONCLUSION: PUMP P-68 (OLD RT. 3) IS NOT ADEQUATE TO HANDLE THE PROPOSED PHASE I FLOW. THERE ARE NO SCHEDULED IMPROVEMENTS LISTED IN THE CIP

APPENDIX C

FLOODPLAIN, CRPA, AND SWM MAPS WITH PROPOSED REDEVELOPMENT SHOWN



GRAPHIC SCALE

1000 0 500 1000 2000 4000

(IN FEET)
1 inch = 1000 ft.

VA. STATE GRID NORTH

LEGEND

PARCEL LINES

RE-DEVELOPMENT PARCEL AREAS

FEMA 100-YR FLOODLIMITS

No.	DATE	DESCRIPTION

REVISIONS

PLAN DATE: 12-01-08

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100- YEAR FLOODPLAIN MAP

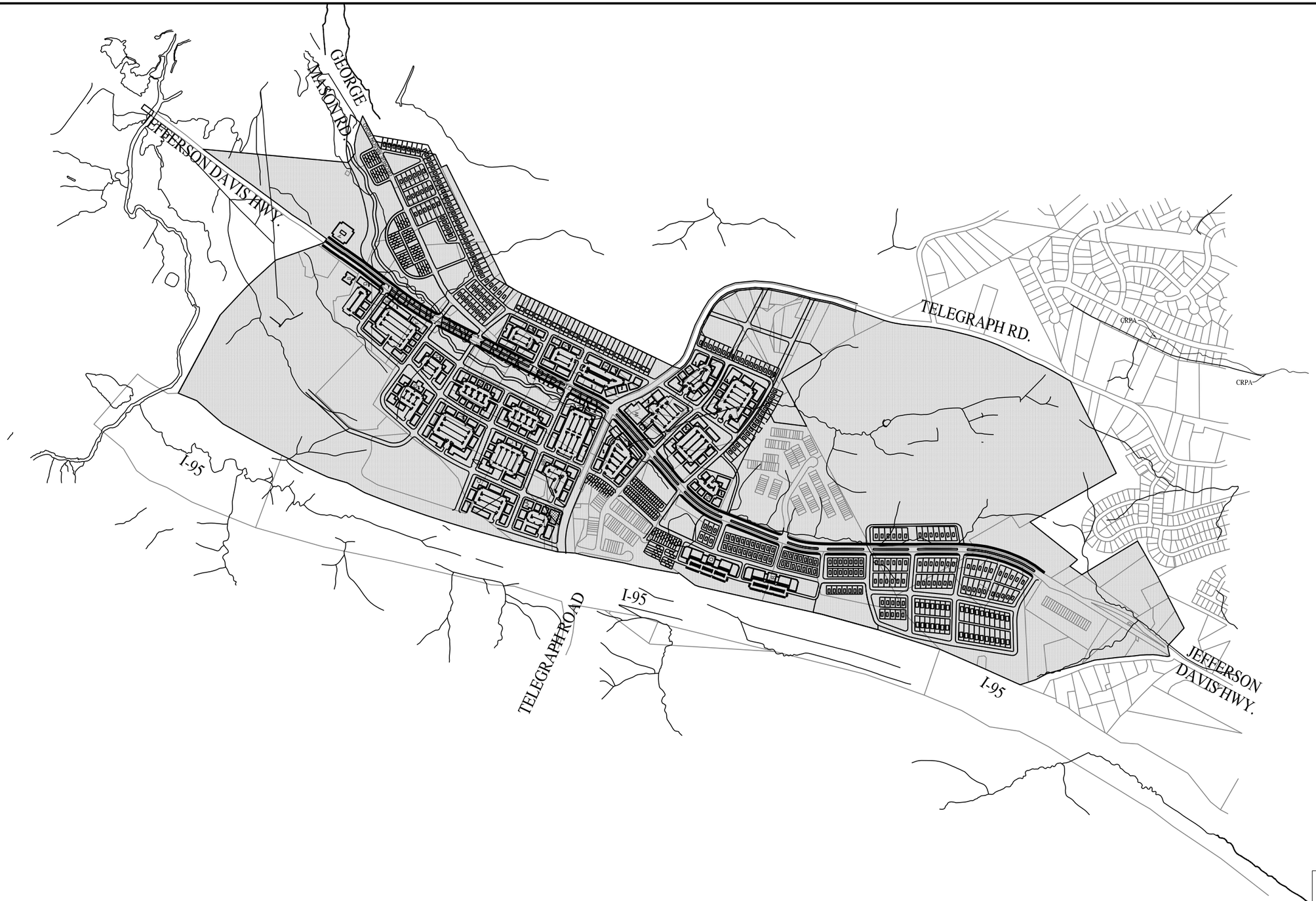
BOSWELL REDEVELOPMENT AREA

GRIFFIS-WIDEWATER ELECTION DISTRICT
STAFFORD COUNTY, VIRGINIA

SCALE: 1"=1000' C.I. 10' DATE: SEPT., 2008

SHEET 1 OF 1

FILE No. MISC-12509



GRAPHIC SCALE

1000 0 500 1000 2000 4000

(IN FEET)
1 inch = 1000 ft.

VA. STATE GRID NORTH

LEGEND

- PARCEL LINES
- RE-DEVELOPMENT PARCEL AREAS
- CRPA AREA WITHIN RE-DEV. AREAS (NONE SHOWN)

No.	DATE	DESCRIPTION

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CRPA MAP

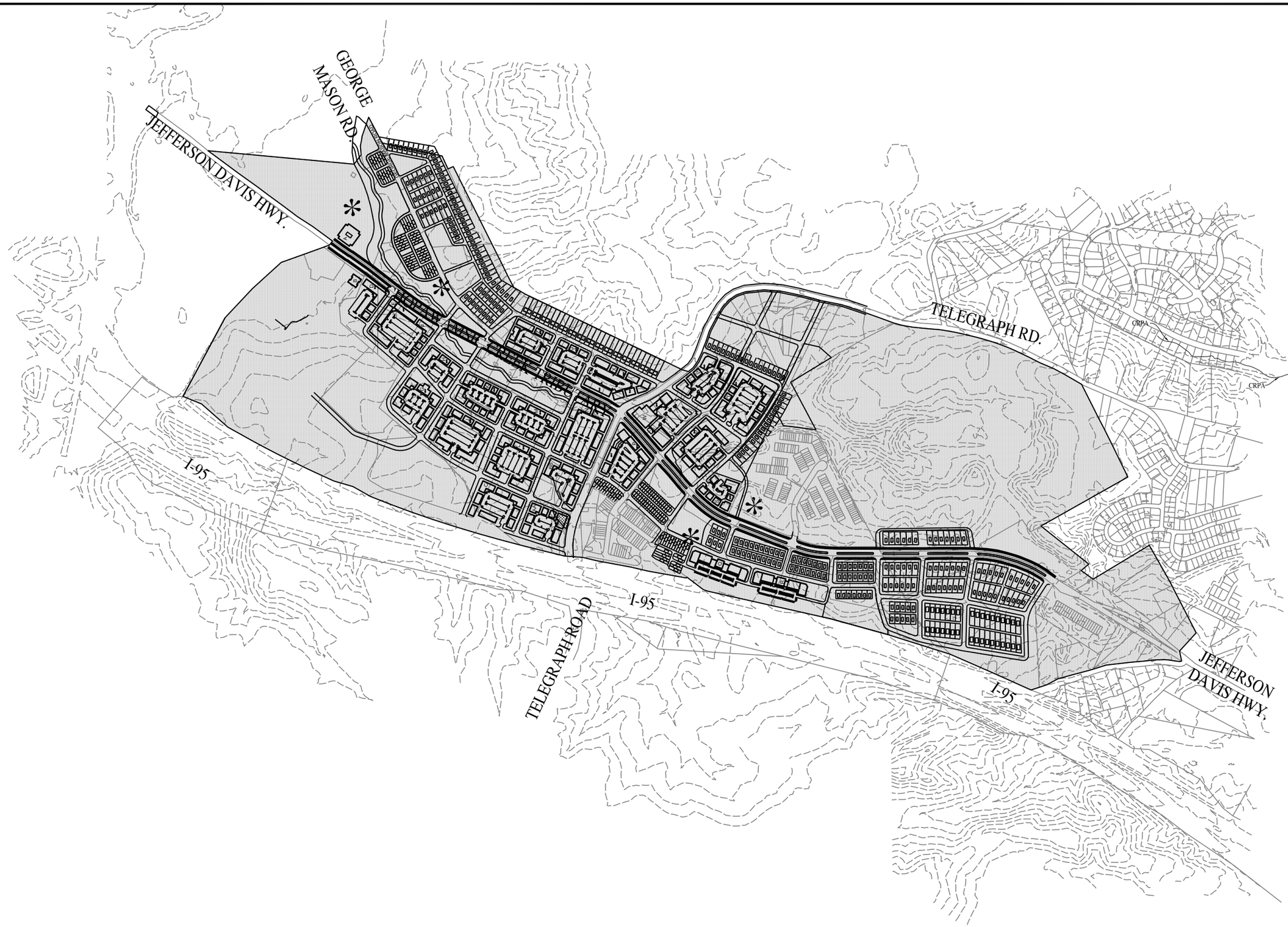
BOSWELL REDEVELOPMENT AREA

GRIFFIS-WIDEWATER ELECTION DISTRICT
STAFFORD COUNTY, VIRGINIA

SCALE: 1"=1000' C.I. 10' DATE: SEPT., 2008

SHEET 1 OF 1

FILE No. MISC-12509



GRAPHIC SCALE

1000 0 500 1000 2000 4000

(IN FEET)
1 inch = 1000 ft.

VA. STATE GRID NORTH

LEGEND

PARCEL LINES

RE-DEVELOPMENT PARCEL AREAS

* AREAS W/ POTENTIAL FOR REGIONAL SWM/BMP FACILITIES

No.	DATE	DESCRIPTION

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SWM MAP

BOSWELL REDEVELOPMENT AREA

GRIFFIS-WIDEWATER ELECTION DISTRICT
STAFFORD COUNTY, VIRGINIA

SCALE: 1"=1000' C.I. 10' DATE: SEPT., 2008

SHEET 1 OF 1

FILE No.
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100- YEAR FLOODPLAIN MAP

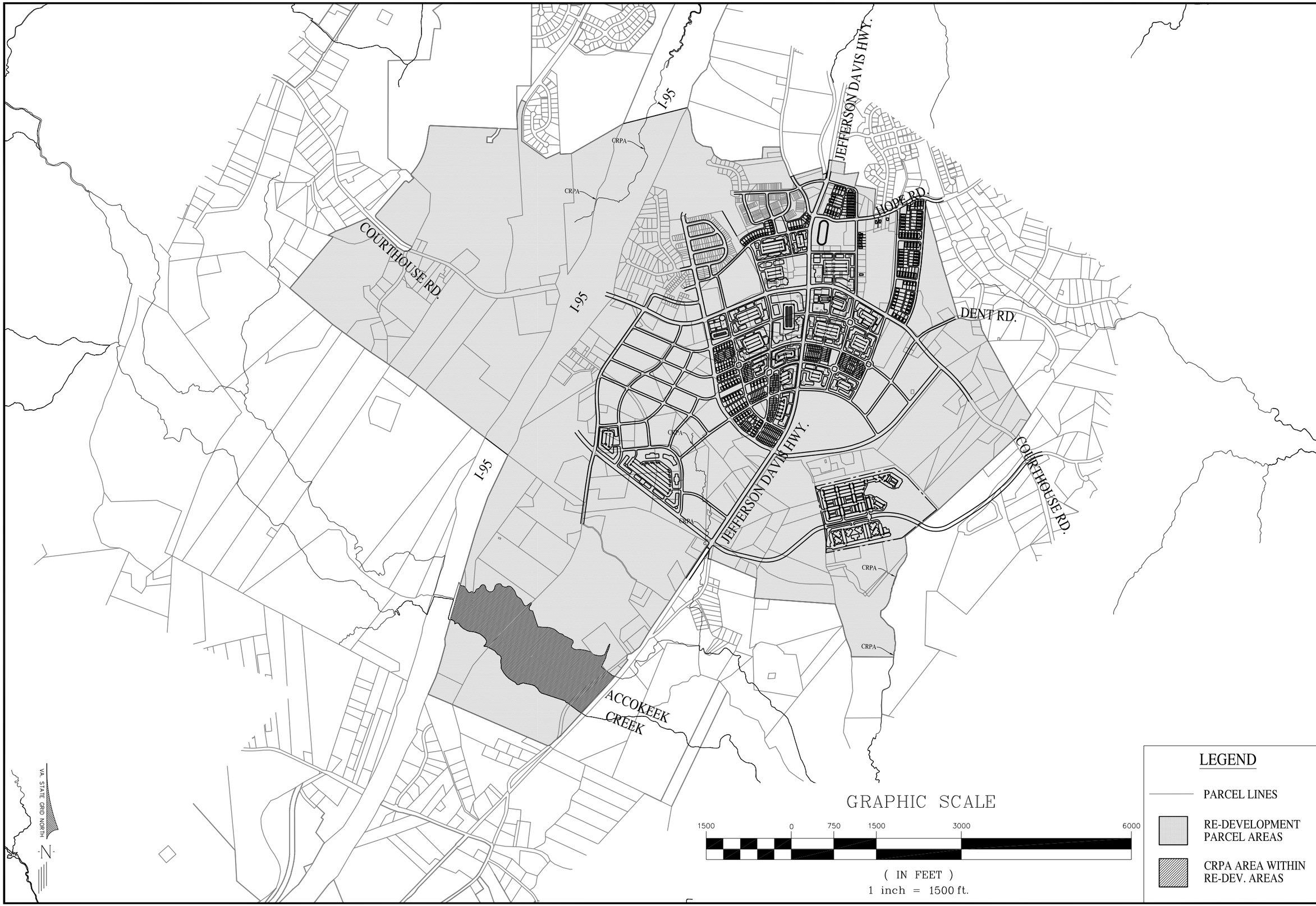
COURTHOUSE REDEVELOPMENT AREA

HARTWOOD/AQUIA ELECTION DISTRICT
STAFFORD COUNTY, VIRGINIA

SCALE: 1"=1500' C.I. = N/A DATE: SEPT., 2008

SHEET 1 OF 1

FILE No.
MISC-12509



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CRPA MAP

COURTHOUSE REDEVELOPMENT AREA

HARTWOOD/AQUIA ELECTION DISTRICT
STAFFORD COUNTY, VIRGINIA

SCALE: 1"=1500' C.I. = N/A DATE: SEPT., 2008

SHEET
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OF
1

FILE No.
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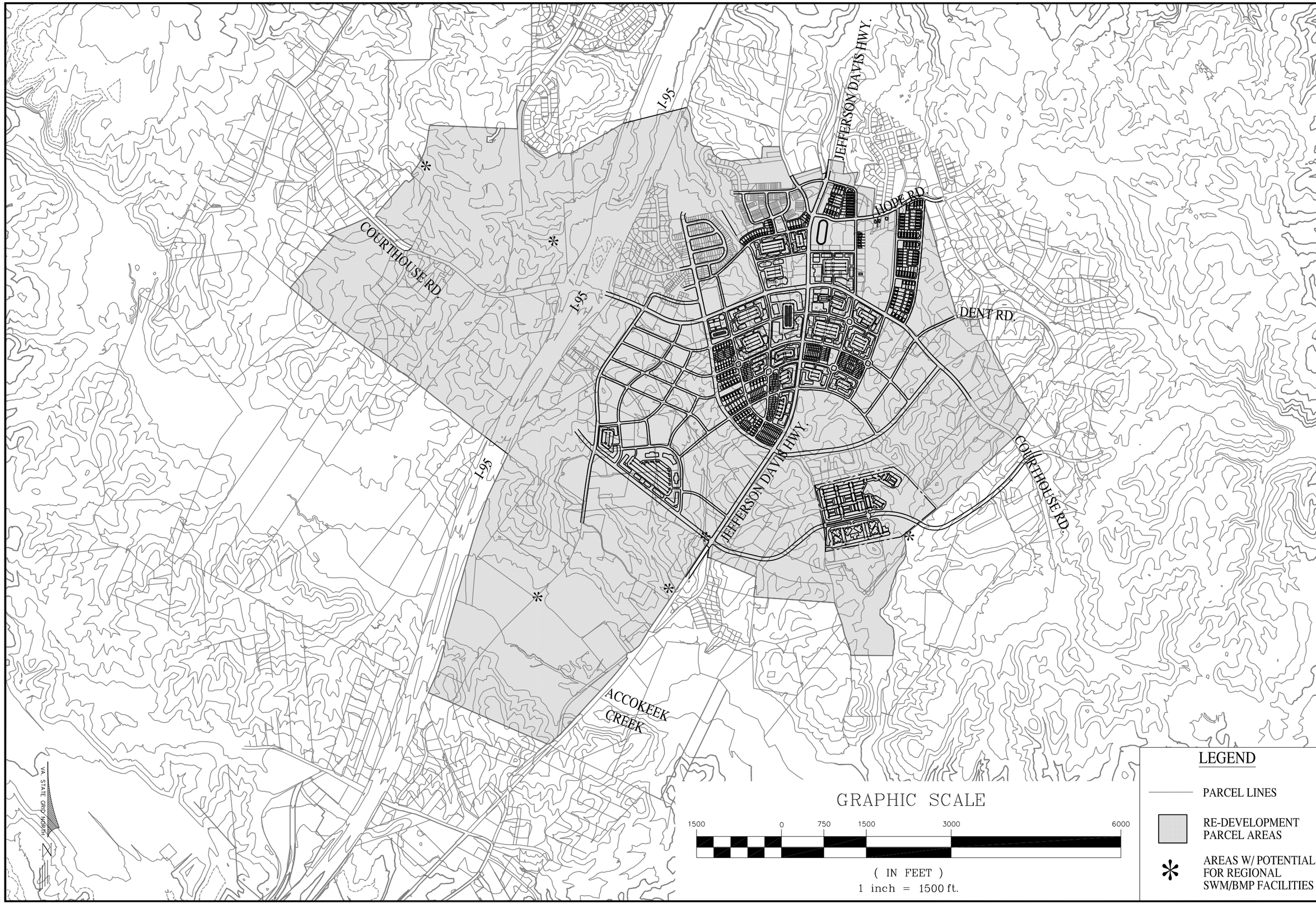

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SWM MAP

COURTHOUSE REDEVELOPMENT AREA

HARTWOOD/AQUIA ELECTION DISTRICT
STAFFORD COUNTY, VIRGINIA

SCALE: 1"=1500' C.I. = N/A DATE: SEPT., 2008

SHEET 1 OF 1

FILE No.
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WARRENTON RD

WASHINGTON ST.

INGLESIDE DR.

CAMBRIDGE ST.

FORBES ST.

BUTLER RD.

RIVER RD.

RAPPAHANNOCK RIVER

VA. STATE GRID NORTH

N

GRAPHIC SCALE

500 0 250 500 1000 2000

(IN FEET)
1 inch = 500 ft.

LEGEND

- PARCEL LINES
- RE-DEVELOPMENT PARCEL AREAS
- FEMA 100-YR FLOODLIMITS

No.	DATE	DESCRIPTION
		REVISIONS

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100- YEAR FLOODPLAIN MAP

FALMOUTH REDEVELOPMENT AREA

FALMOUTH/HARTWOOD ELECTION DISTRICT
STAFFORD COUNTY, VIRGINIA

SCALE: 1"=500' C.I. = 10' DATE: SEPT. 2008

SHEET
1
OF
1

FILE No.
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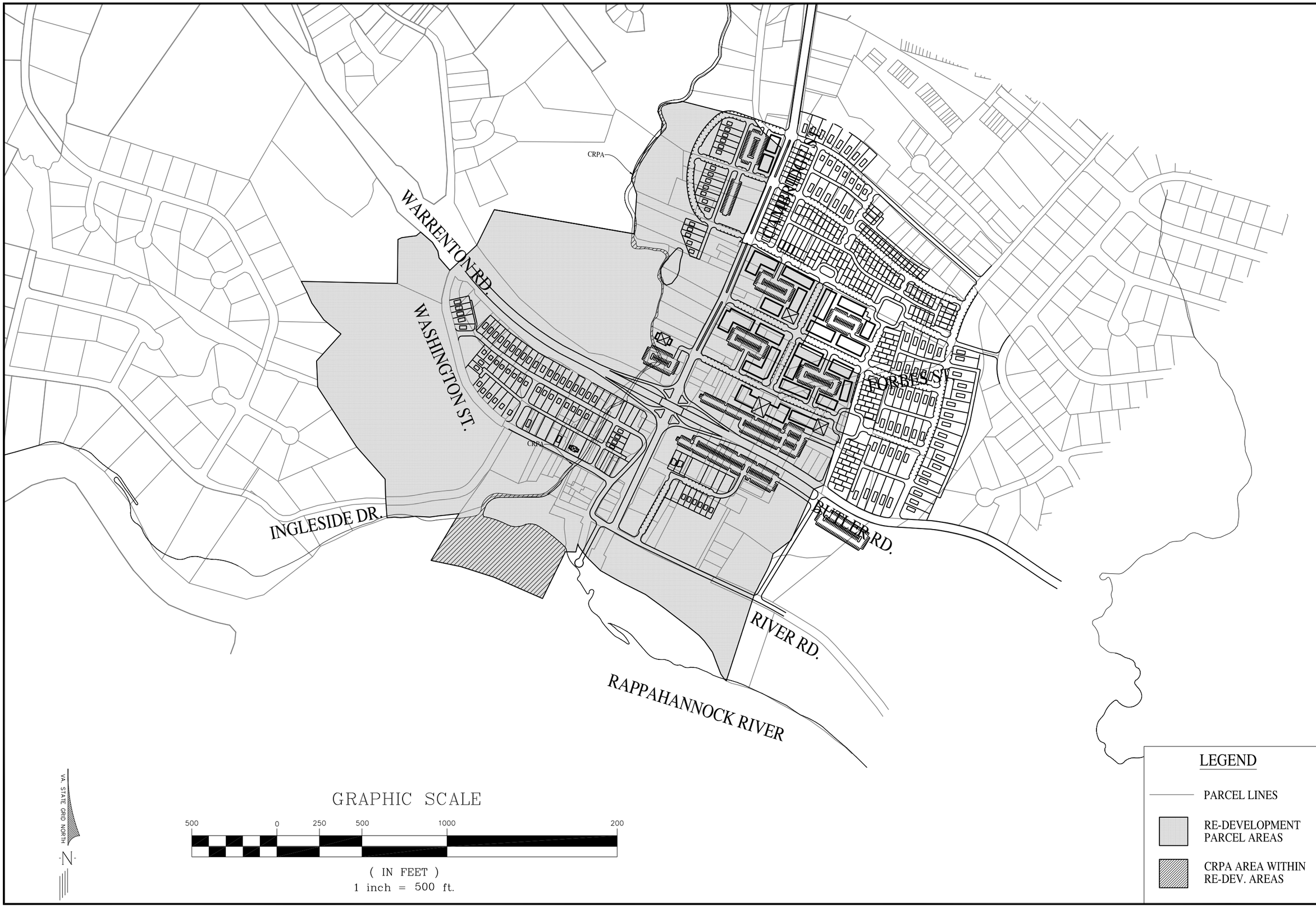

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CRPA MAP

FALMOUTH REDEVELOPMENT AREA

FALMOUTH/HARTWOOD ELECTION DISTRICT
STAFFORD COUNTY, VIRGINIA

SCALE: 1"=500'
C.I. = 10'
DATE: SEPT. 2008

SHEET
1
OF
1

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WARRENTON RD.

WASHINGTON ST.

INGLESIDE DR.

CAMBRIDGE ST.

FORBES ST.

BUTLER RD.

RIVER RD.

RAPPAHANNOCK RIVER

VA. STATE GRID NORTH

N

GRAPHIC SCALE

500 0 250 500 1000 2000

(IN FEET)
1 inch = 500 ft.

LEGEND

PARCEL LINES

RE-DEVELOPMENT PARCEL AREAS

* AREAS W/ POTENTIAL FOR REGIONAL SWM/BMP FACILITIES

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SWM MAP

FALMOUTH REDEVELOPMENT AREA

FALMOUTH/HARTWOOD ELECTION DISTRICT
STAFFORD COUNTY, VIRGINIA

SCALE: 1"=500 C.I. = 10' DATE: SEPT. 2008

SHEET 1 OF 1

FILE No.
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VA. STATE GRID NORTH

N

GRAPHIC SCALE

1500 0 750 1500 3000 6000

(IN FEET)
1 inch = 1500 ft.

LEGEND

- PARCEL LINES
- RE-DEVELOPMENT PARCEL AREAS
- FEMA 100-YR FLOODLIMITS

No.	DATE	DESCRIPTION

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100- YEAR FLOODPLAIN MAP

SOUTHERN GATEWAY REDEVELOPMENT AREA

FALMOUTH/HARTWOOD ELECTION DISTRICT
STAFFORD COUNTY, VIRGINIA

SCALE: 1"=1500' C.I. 10' DATE: SEPT., 2008

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CRPA MAP

SOUTHERN GATEWAY REDEVELOPMENT AREA

FALMOUTH/HARTWOOD ELECTION DISTRICT
STAFFORD COUNTY, VIRGINIA

SCALE: 1"=1500' C.I. 10' DATE: SEPT., 2008

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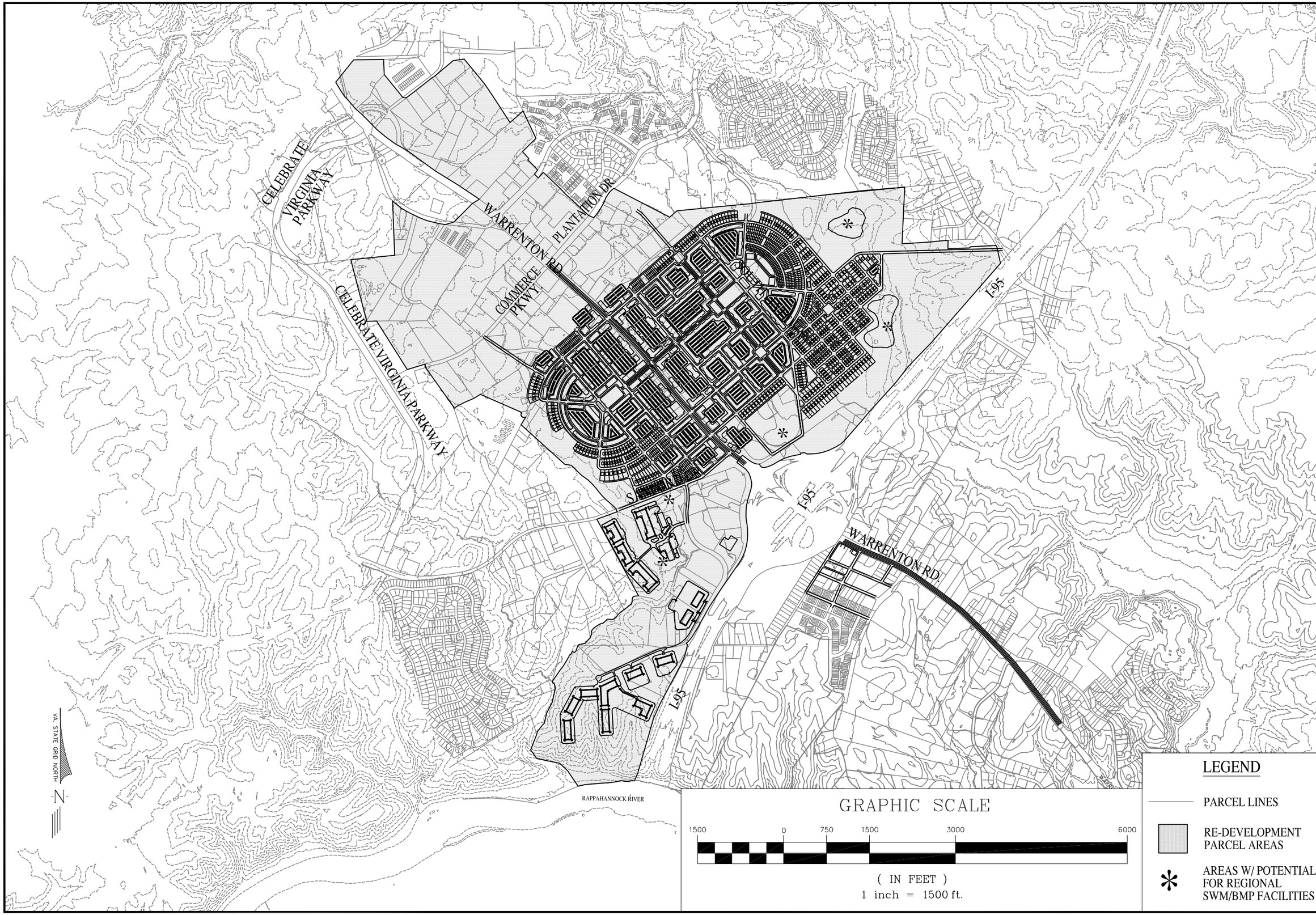

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SWM MAP

SOUTHERN GATEWAY REDEVELOPMENT AREA

FALMOUTH/HARTWOOD ELECTION DISTRICT
STAFFORD COUNTY, VIRGINIA

SCALE: 1"=1500' C.I. 10' DATE: SEPT., 2008

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