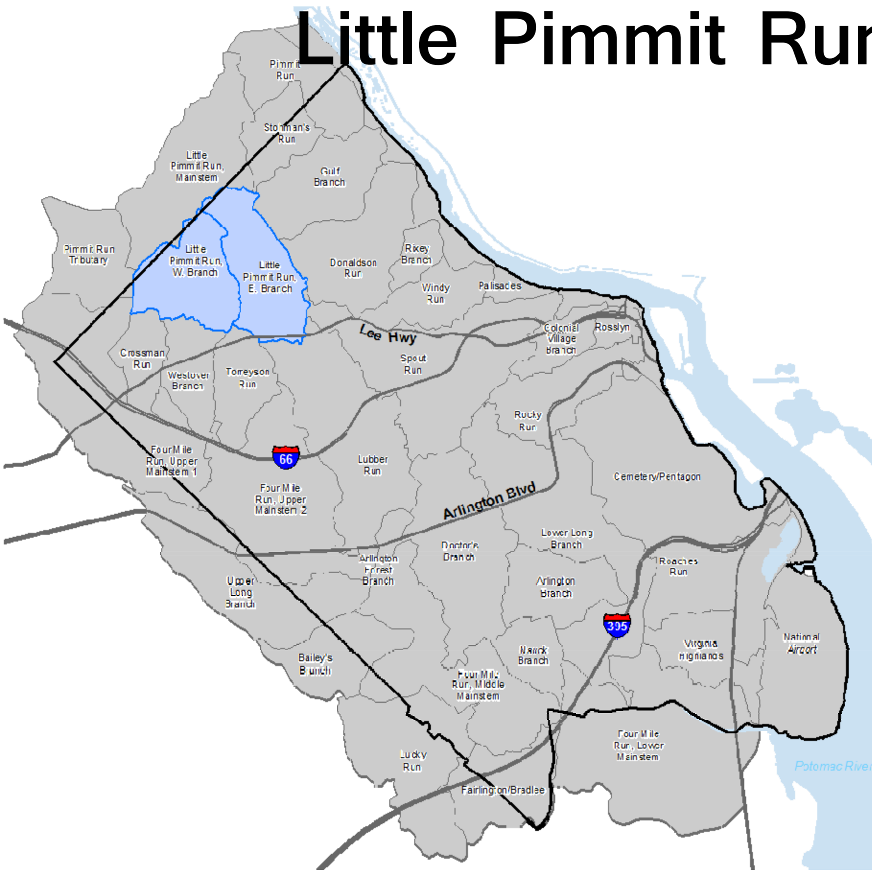
Stormwater Capacity Analysis for Little Pimmit Run Watershed



Prepared for

Arlington County, Virginia

November 28, 2012

CH2MHILL®

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Chantilly, VA 20151

Stormwater Capacity Analysis for Little Pimmit Run Watershed: Contents

This capacity analysis comprises the material below. Earlier technical memorandums—on GIS data gaps and stormwater capacity, for example—were presented as appendixes to subsequent memorandums; the outline below shows the relationship among the watershed-specific memorandums.

Design Iterations

Stormwater Capacity Analysis for Little Pimmit Run Watershed: Design Iterations, Arlington County, Virginia

PREPARED FOR: Arlington County, Virginia

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DATE: November 28, 2012

PROJECT NUMBER: 240033.T5.LP.04.01

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Executive Summary

The purpose of this project is to provide a program that will analyze storm sewer capacity issues, identify problem areas, develop and prioritize solutions, and provide support for public outreach and education. The project is being implemented in phases by watershed.

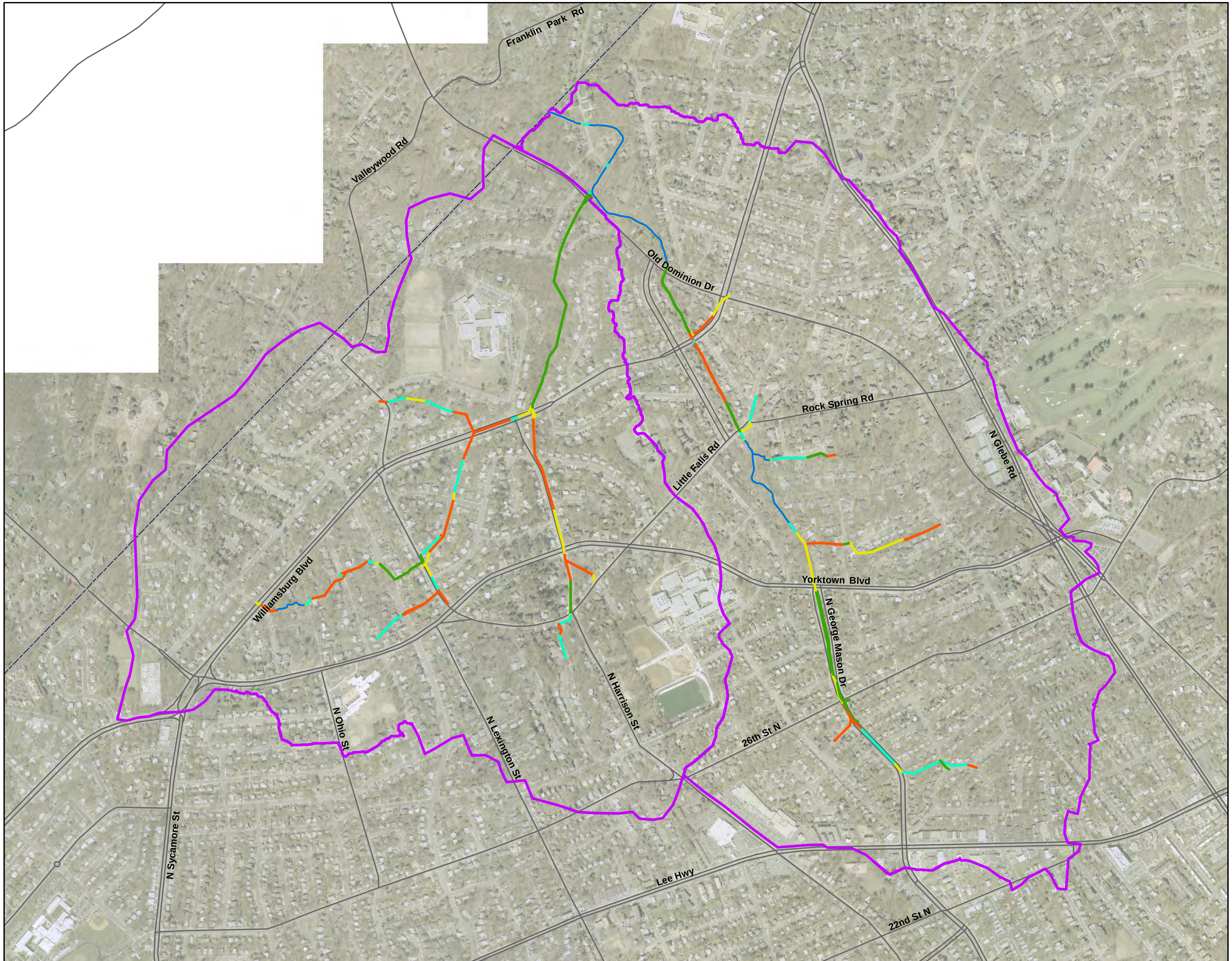
This technical memorandum (TM) focuses on the development of design solutions for the Little Pimmit Run watershed. It summarizes the County's existing storm sewer system and the hydraulic model developed in Task 2, and describes the technical approach to and results from the design iteration model runs.

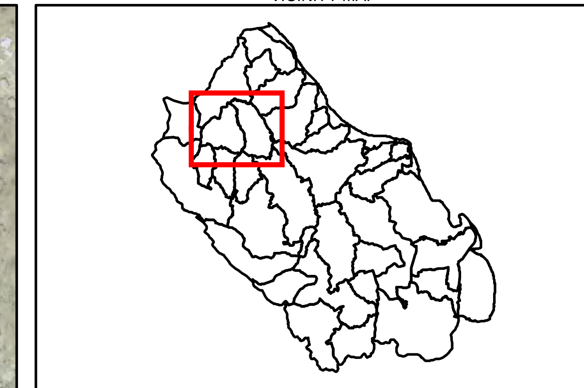
The hydraulic model developed in Task 2 of this project predicts that approximately 61 percent of the Little Pimmit Run watershed system is experiencing capacity limitations during the June 2006 storm event, and approximately 76 percent is experiencing capacity limitations during the 10-year, 24-hour (10yr-24hr) SCS Type II storm. Plan views of the conduits experiencing capacity limitations are provided in **Figure 1** and **Figure 2**.

The objective of this portion of the study is to identify design solutions to eliminate flooding in the model for these two storm events. This is accomplished by iteratively adjusting the capacity of the system as needed, including adding additional barrels of the same diameter alongside existing pipes, adding parallel pipe systems of differing sizes, increasing existing pipe diameters, and then running the hydraulic model. When a parallel pipe is added, all hydraulic parameters except for size match the existing pipe.

The solution identified to eliminate flooding during the June 2006 event requires adding additional capacity to 3,875 linear feet (LF) of pipe in Little Pimmit Run. This equates to approximately 16 percent of the modeled system. The changes required to eliminate flooding during the 10yr-24hr SCS Type II storm are more extensive. The final solution identified for the 10-yr-24hr storm requires changes to approximately 10,289 LF of pipe. These changes affect approximately 41 percent of the modeled system in Little Pimmit Run.

The hydraulic modeling results presented in this TM should be reviewed with the understanding that flooding was alleviated by adding conveyance capacity as described above (see **Figure 5** and **Figure 14**) and that the results presented are from a modeling perspective only. While flooding was eliminated from the model, practically, the risk of flooding is never completely eliminated. All of the assumptions should be verified and adjusted as necessary during the design phase. All other parameters (e.g., slope, inverts, losses, and storage nodes) were left unaltered from the hydraulic model developed in Task 2, except as described in Section 2.3.





Legend

- Flooded
- Insufficient Freeboard
- Surcharged
- Sufficient Conveyance Capacity
- Streams
- Arlington/Fairfax Boundary Line
- Roads
- Modeled (Revised) Watershed Boundary

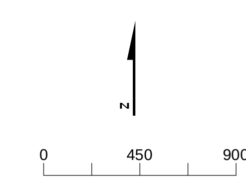


FIGURE 1
June 2006 Storm
Little Pimmit Run Watershed
Arlington County Storm Capacity Analysis

H:\ARLINGTONVACOUNTYOF\392309STORMWATERCAP\WSLITTLEPIMMITRUN\WORKINGGIS\LAYOUT\INTERNAL\DESIGN_ITERATIONS\FIGURE1_2006_STORM_EVENT_CONVEYANCE_CAPACITY.MXD FCAIN 6/21/2012 12:26:28 PM

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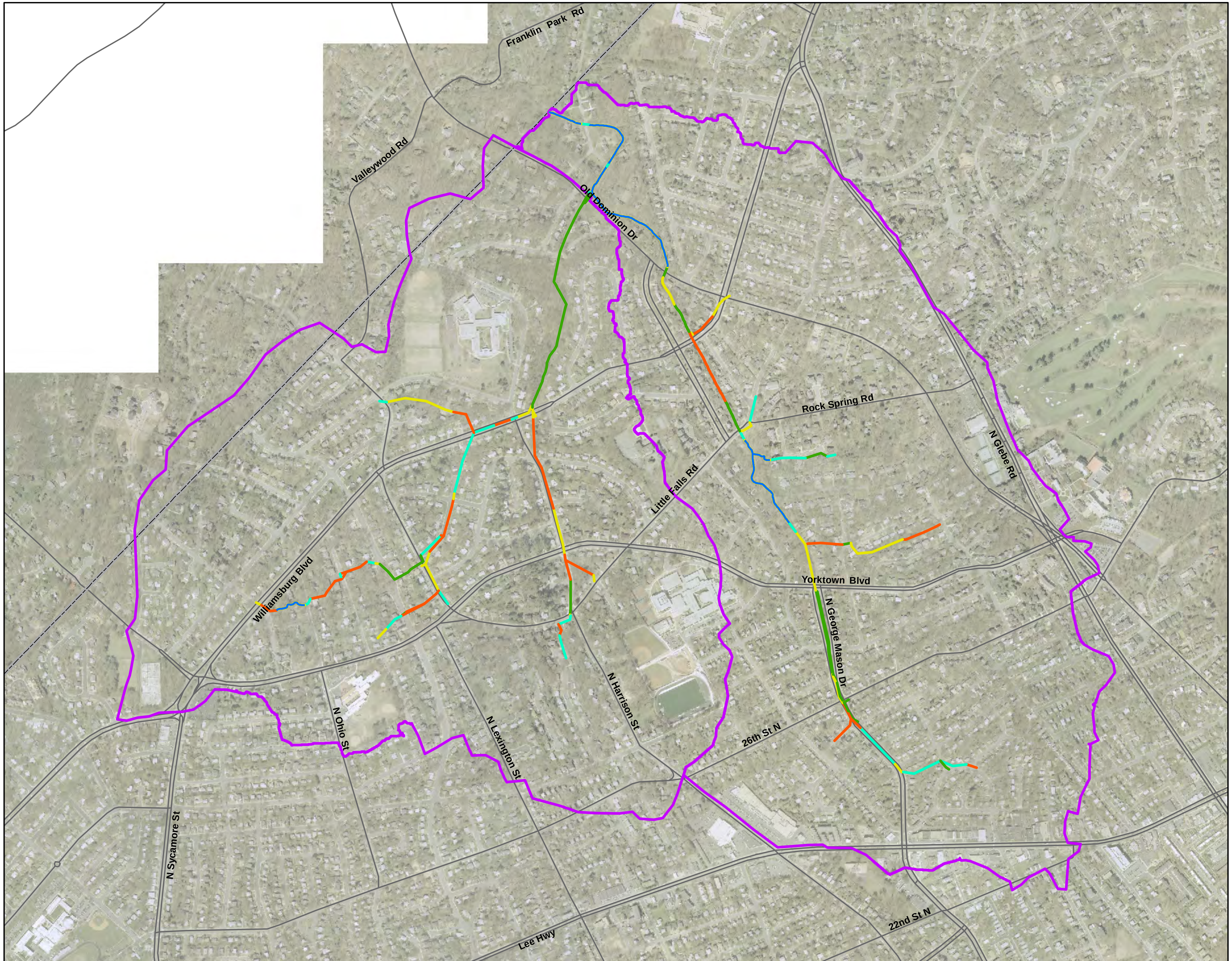
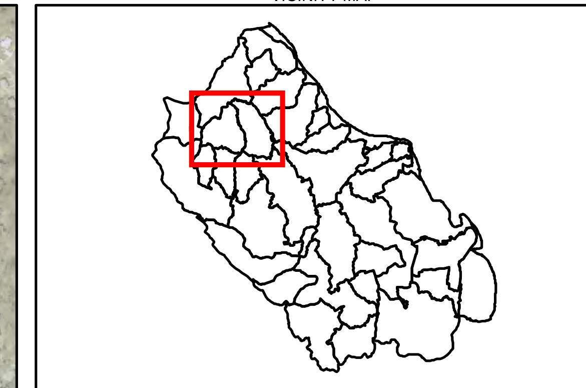


VICINITY MAP



Legend

- Flooded
- Insufficient Freeboard
- Surcharged
- Sufficient Conveyance Capacity
- Streams
- Arlington/Fairfax Boundary Line
- Roads
- Modeled (Revised) Watershed Boundary

N

0 450 900

Feet

FIGURE 2
10yr-24hr Storm
Little Pimmit Run Watershed
Arlington County Storm Capacity Analysis

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1 Introduction and Project Objectives

The work described in this TM is one of the elements of a storm sewer capacity analysis project. In discussions with representatives from Arlington County, it is understood that the County is undertaking a larger effort to update and combine the 1996 Storm Water Master Plan and the 2001 Watershed Management Plan. This TM addresses the final task (Task 4) of suggesting design solutions to the capacity problems previously identified in the modeling in Task 2 of the overall project.

2 Background

2.1 Existing System Versus Modeled System

The stormwater collection system elements include the following:

- Closed conduits, such as gravity sewers and culverts
- Stream channel segments and ditches
- Drainage inlets and junctions, such as roadside curb inlets, manholes, catchbasins, and yard and grate inlets

Elements of the ArcGIS existing stormwater collection system and the corresponding stormwater model developed for the Little Pimmit Run watershed are summarized in **Table 1**. The modeling effort includes the storm sewer network of pipes 36 inches in diameter and larger. The table reflects updated GIS information provided by the County in March 2012. This is discussed in greater detail in Section 2.2.

TABLE 1
Comparison of Existing Little Pimmit Run Stormwater System and Modeled System

Stormwater System Element	Existing	Modeled
Drainage area (acres)	1,018	972
Number of conveyance segments in stormwater system[a]	1,358	206
Total length of conveyance segments in stormwater system (linear feet)[b]	120,260	24,914
Size range (in.)[c]	4–192	36–192
Number of circular pipe segments	1,269	157
Number of noncircular pipe segments	51	25
Length of open channel segments (linear feet)	1,514	1,500
Length of stream channel segments (linear feet)	4,558	3,683
Length of ditch segment (linear feet)	406	0
Total inlets/junctions/end points (model nodes)	1,231	202
Catchbasins	565	45
Manholes	407	86
Yard inlets	70	13

TABLE 1 (CONTINUED)
Comparison of Existing Little Pimmit Run Stormwater System and Modeled System

Stormwater System Element	Existing	Modeled
Grate inlets	69	7
End walls	41	22
Junction chambers	42	29
Detention outlets	27	0
Best management practices (BMPs)	10	0
Unknown types of nodes	0	0

[a] Segments include circular pipes, box culverts, elliptical pipes, ditches, and streams.
[b] Includes streams and ditches.
[c] Modeling scope is limited to stormwater conveyance system pipes 36 inches in diameter and larger.

Figure 3 shows the existing stormwater collection system in the Little Pimmit Run watershed; **Figure 4** shows the modeled system.

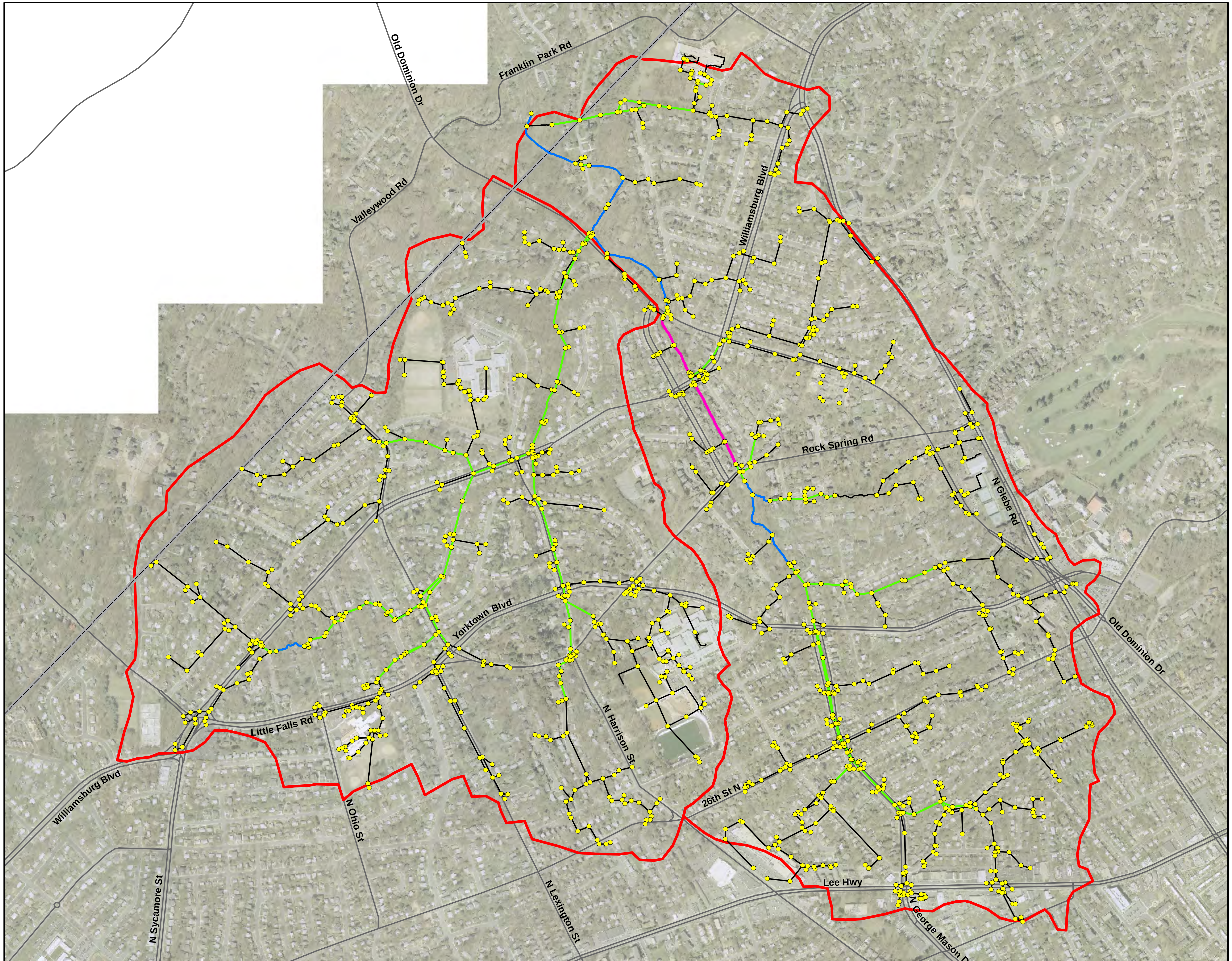
2.2 Data Sources and Review

Arlington County provided storm drainage network data in ESRI ArcGIS format, as built-drawings, and initial base layers (GIS shapefiles); the final ArcGIS PGDB (personal geodatabase) was delivered to CH2M HILL in February 2011.

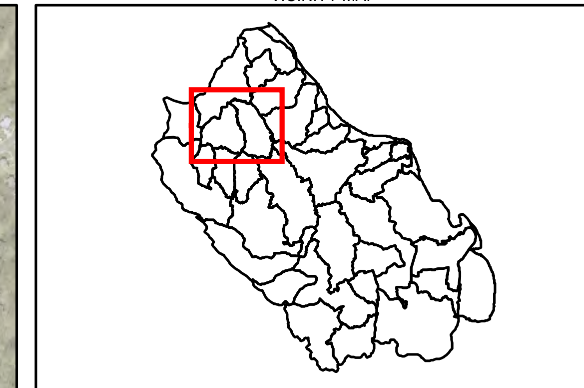
The final data for the Little Pimmit Run watershed model were evaluated for quality. CH2M HILL found 245 data gaps or anomalies. A data gaps TM detailing the suggested assumptions to fill in the gaps was prepared for the County in October 2011 and is included as an appendix to the Task 2 TM (which is itself included as **Appendix A** here). These data gaps were addressed prior to conducting the capacity analysis modeling.

Updated GIS information was provided by the County in March 2012. This information was incorporated into the design solutions modeling effort where appropriate and as documented in Appendix B. Information for new conduits less than 36 inches in diameter was used to add additional storage to storage nodes.

Updated contour data were provided by the County in September 2012. An analysis was conducted to determine the differences between the rim elevations originally used in the model and new rim elevations based on the newly provided contour data. Rim elevations that differed by more than 2 feet were reviewed and revised as appropriate. This information is documented in **Appendix B**.



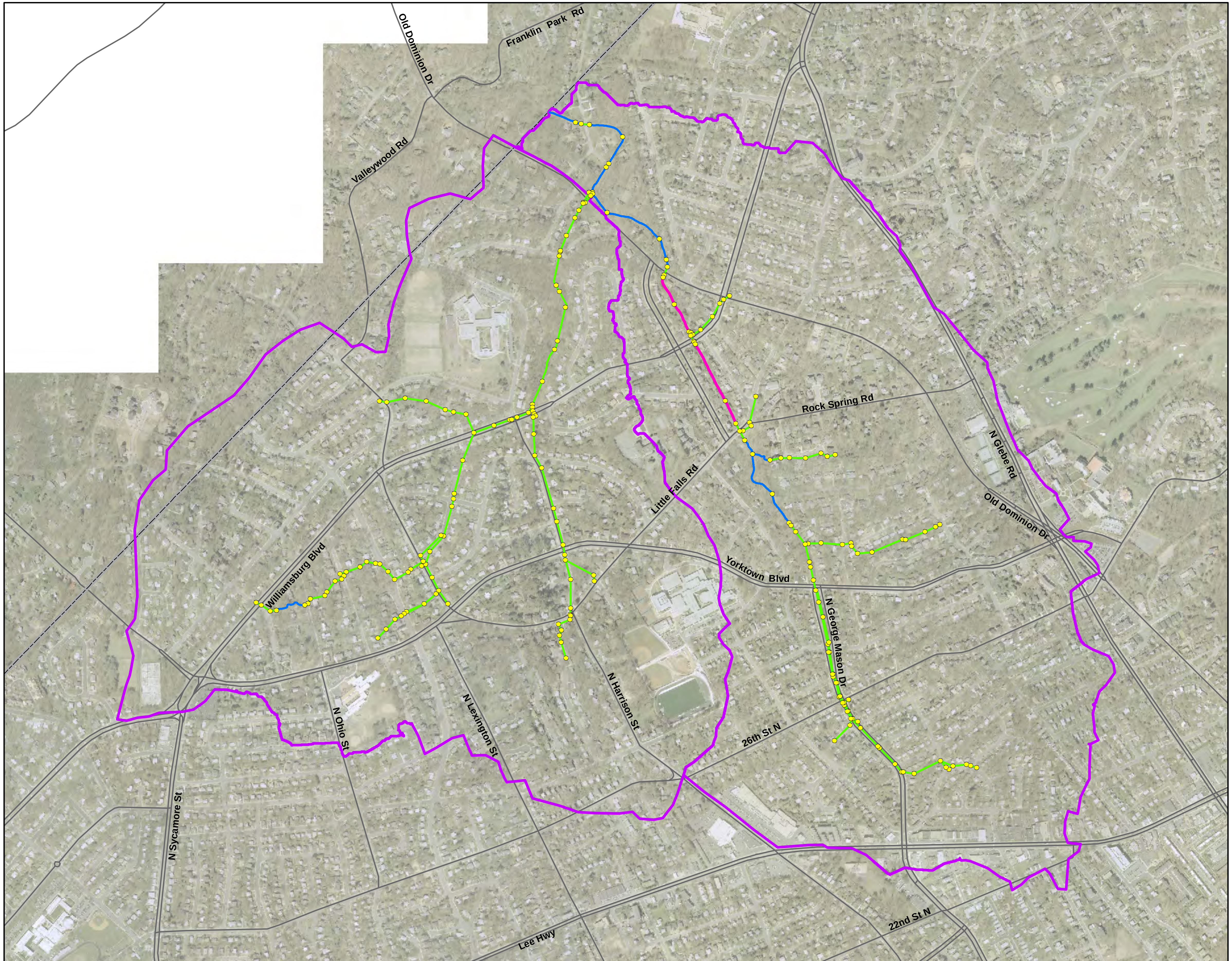
VICINITY MAP

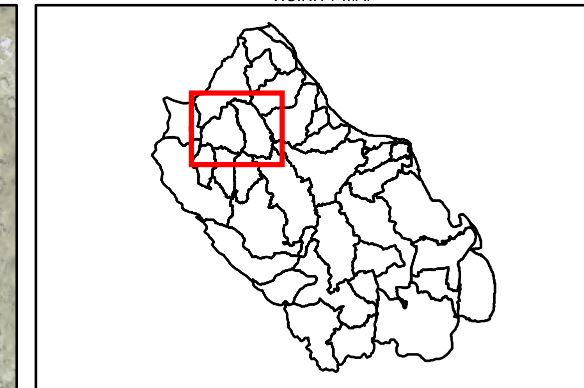


Legend

- Stormwater Junctions
- Stormwater Mains ≥ 36"
- Stormwater Mains < 36"
- Rectangular Open Channel
- Streams
- Arlington/Fairfax Boundary Line
- Roads
- Original Watershed Boundary

FIGURE 3
Existing Stormwater Collection System
Little Pimmit Run Watershed
Arlington County Storm Capacity Analysis





Legend

- Modeled Stormwater Junctions
- Modeled Stormwater Mains ≥ 36"
- Modeled Rectangular Open Channel
- Streams
- Arlington/Fairfax Boundary Line
- Roads
- Modeled (Revised) Watershed Boundary

N

0 450 900
Feet

FIGURE 4
Modeled Stormwater Collection System
Little Pimmit Run Watershed
Arlington County Storm Capacity Analysis

2.3 Hydrologic and Hydraulic Modeling

The hydrologic modeling task includes several steps: defining subwatershed boundaries, identifying hydrologic node connections, estimating hydrologic parameters for each subwatershed, and identifying rainfall distributions to analyze. ArcHydro Tools 9.2 and HEC-GeoHMS were used to delineate the subwatersheds and determine hydrologic parameters. The County chose two events for these modeling activities: the June 2006 storm event and the 10yr-24hr SCS Type II distribution.

The hydraulic modeling task includes three steps: (1) importing the stormwater network and physical data into PCSWMM version 2011, the stormwater management model selected for this project; (2) defining the boundary conditions for each hydrologic scenario; and (3) evaluating the hydraulic performance of the stormwater drainage system for the two storm event scenarios. **Figure 1** and **Figure 2** identify the areas from the Task 2 capacity analysis TM (**Appendix A**) where there was flooding in the June 2006 storm and the SCS Type II 10yr-24hr storm, respectively.

3 Technical Approach

The model developed during Task 2 using the methodology described in Section 2.3 served as the basis for the iterative design modeling described in this TM. Design iterations were run for the June 2006 and the 10yr-24hr SCS Type II storms. The goal of Task 4 is to eliminate all flooding and rim conditions in the existing conditions model, but not necessarily insufficient freeboard (less than 1 foot of separation between the ground elevation and the hydraulic grade line, or HGL) or surcharge conditions. The general objective is to strategically add additional barrels or parallel pipes to the existing system. For convention, adding an additional barrel is adding an identical conduit (identical for every parameter: size, slope, etc.); adding a parallel pipe is adding a conduit that differs from the existing system, typically by having a different size or other parameter, such as slope. The following approach was used to optimize the capacity needed to eliminate system flooding:

1. Start with the base model that includes storage in the most-upstream nodes as developed in the Task 2 capacity analysis. It is assumed that capacity issues in the minor systems will be addressed and that the flows entering the modeled system should remain as currently modeled.
2. Add pipe barrels (identical conduits). For reconstructing existing sewer systems, it is often easier to expand a system either vertically or horizontally. Arlington County has requested that we first consider horizontal expansion by adding an additional barrel or parallel pipe to increase conveyance of the existing system. Pipe barrels were added according to the following:
   - Connect additional barrels to existing manhole structures. Start with an equivalent diameter in the flooded area. Match existing inverts to ensure hydraulic continuity at the downstream end of each modified section. If multiple barrels already exist, the lowest invert should be used for any added barrels.
   - If too little or too much capacity is provided by the additional barrel, change the additional barrel to a parallel conduit and increase or decrease the diameter as

needed. Avoid altering the existing system. If the diameter of the parallel conduit required is 12 inches or smaller, then increasing the existing system diameter may be considered instead.

- Do not add additional model nodes unless absolutely necessary.

3. Begin adding pipe barrels/parallel conduits immediately downstream of a flooded node or conduit and work upstream. Try not to exceed the diameter of the most downstream conduit. Try to minimize diameter changes and work only as far upstream as needed for the flooded segment.
4. Do not be concerned about minimum cover beyond a minimum of at least 3 inches. However, do check pipe daylighting; make a round pipe rectangular as needed. As pipe size is increased, examine any downstream stream cross sections to ensure no flow is lost; if it is, consider extending the cross-section geometry based on contours.

4 Results

4.1 PCSWMM Terminology

PCSWMM displays some information on its profile graphics depending how much space is available on the profile. For example, the date and time will not always appear on longer lengths of network because there is more information that is needed to be displayed. The following list is terminology that PCSWMM uses to label the profiles seen below:

- Number displayed at the top of the figure: conduit identification number (Conduit ID)
- Number displayed at the bottom of the figure: junction identification number (Junction ID)
- Red dot at junction rim: signifies flooding at a node in the existing model.
- Number directly below pipe segments: diameter in feet followed by number of barrels in parentheses
- Vertical axis provided in feet based on NAVD88 datum
- Horizontal axis provided in feet
- Index map: blue highlighted pipe segment on index map is displayed in profile view

Sewer system profiles were generated as a result of the iterative modeling and include profiles of the existing system, the final model design solution, and in some cases a final model design parallel solution. **Table 2** and **Table 3** provide the final model flow rates. These flow rates sum the final and parallel systems.

The pipe flow depth information provided in **Table 2** and **Table 3** represents maximum flow depths reported by the model. The corresponding figures are graphical representations of approximate flow depths; therefore, refer to the tables for the most precise information.

4.2 June 2006 Event

For the June 2006 event, capacity was added to 36 conduits (3,875 LF of pipe in total). This equates to 16 percent of the modeled pipe network in Little Pimmit Run.

Changes to diameter and the existing and resulting flows are summarized in **Table 2**. A map showing the June 2006 storm upgrade locations throughout the watershed is included in **Figure 5**. Profiles showing the existing conditions and final results are shown in **Figure 6** through **Figure 13**. Profiles were displayed only for segments of the stormwater network where any of the following conditions were met:

- Pipe size was increased
- An identical barrel was added to the system
- An additional pipe was added to the system

The existing model profile depicts the peak water surface elevation with solid blue fill and peak HGL with a dark blue line. The HGL represents the sum of the pressure head and the elevation head along the profile. Flooded nodes in the existing condition model are annotated with a red dot behind the junction rim. The final profile also displays the existing system HGL with a dark green line for reference.

TABLE 2
June 2006 Storm Event: Final Iteration Results Summary

Conduit ID	Node ID		Length (ft)	Size (Diameter or H × W) (ft)		No. of Barrels		Additional Pipe		Equivalent Cross-Sectional Area (ft^2)		Existing HGL		Final HGL		Flow (cfs)	
	US	DS		Existing	Final	Existing	Final	Model ID	Diameter (ft)	Existing	Final	US (ft)	DS (ft)	US (ft)	DS (ft)	Existing	Final
West Branch																	
N. Potomac St and Williamsburg Blvd to N. Nottingham St. Parallel System																	
4526	2328	2341	53.4	3	3	1	1			7.1	7.1	2.6	1.6	2.6	1.6	50.3	50.3
4539	2341	2370	97.6	3	3	1	1			7.1	7.1	1.6	3.4	1.6	3.4	50.3	50.3
4538	2370	2359	57.3	3.5	3.5	1	1			9.6	9.6	3.4	3.2	3.4	3.2	100.8	100.9
4534	2359	2342	295.7	Stream	Stream	1	1									99.9	99.8
4527	2342	2334	34.2	3.5	3.5	1	1			9.6	9.6	5.0	4.1	4.9	3.9	88.4	89.7
4520	2334	2310	46.8	3.5	3.5	1	1			9.6	9.6	4.1	3.0	3.9	2.7	88.4	89.7
4511	2310	2294	134.4	4	4	1	1			12.6	12.6	3.0	4.6	2.7	3.3	88.4	89.7
4508	2294	2280	38.7	4	4	1	1			12.6	12.6	4.6	7.1	3.3	5.5	88.4	89.5
4500	2280	2235	123.8	4	4	1	1			12.6	12.6	7.1	5.9	5.5	4.5	88.4	89.5
4479	2235	2223	63.7	4	4	1	1			12.6	12.6	5.9	6.4	4.5	3.7	62.1	89.5
N. Nottingham St. Parallel System North (Figure 6)																	
4470	2223	2201	51.3	3	3	1	2			7.1	14.1	6.4	7.2	3.7	4.4	25.1	44.7
4459	2201	2194	59.5	2.83×4.42 [a]	2.83×4.42 [a]	1	1			9.8	9.8	7.2	7.3	4.4	4.5	25.1	45.7
N. Nottingham St. Parallel System South																	
4469	2223	2213	35.5	3.5	3.5	1	1			6.4	6.3	3.7	3.8	39.2	45.3	6.4	6.3
4465	2213	2194	42.2	3.5	3.5	1	1			6.3	7.3	3.8	4.5	36.6	45.6	6.3	7.3
N. Nottingham St. Parallel System to 33rd St. North (Figure 6; profile continues on Figure 7)																	
4455	2194	2175	134.6	3.5	3.5	1	1	LPR_C1	3	9.6	16.7	7.3	6.0	4.5	3.3	113.2	166.5
4440	2175	2151	77.1	3.5	3.5	1	1	LPR_C2	3	9.6	16.7	6.0	5.6	3.3	4.4	113.2	168.6
4432	2151	2156	79.3	3.5	3.5	1	1	LPR_C3	3	9.6	16.7	5.6	4.8	4.4	5.2	113.2	164.7
23001	2156	23146	39.0	3.5	3.5	1	1	LPR_C4	3	9.6	16.7	4.8	2.6	5.2	5.0	113.2	164.7
23002	23146	23145	102.2	3.2×5	3.2×5	1	1			16.0	16.0	2.6	2.5	5.0	4.7	113.2	164.7
23003	23145	23147	94.1	3.2×5	3.2×5	1	1			16.0	16.0	2.5	3.2	4.7	4.8	113.6	164.7
23004	23147	23148	137.7	4	4	1	1	LPR_C22	3	12.6	19.6	3.2	2.8	4.8	3.6	113.2	164.7
23005	23148	23149	36.3	4.5	4.5	1	1			15.9	15.9	2.8	3.0	3.6	3.8	113.2	164.7
23006	23149	23150	135.4	4.5	4.5	1	1			15.9	15.9	3.0	2.5	3.8	3.4	113.3	164.7
23007	23150	23151	59.7	4.83×7.58	4.83×7.58	1	1			36.7	36.7	2.5	4.0	3.4	4.7	113.6	164.7

TABLE 2 (CONTINUED)
June 2006 Storm Event: Final Iteration Results Summary

Conduit ID	Node ID		Length (ft)	Size (Diameter or H × W) (ft)		No. of Barrels		Additional Pipe		Equivalent Cross-Sectional Area (ft^2)		Existing HGL		Final HGL		Flow (cfs)	
	US	DS		Existing	Final	Existing	Final	Model ID	Diameter (ft)	Existing	Final	US (ft)	DS (ft)	US (ft)	DS (ft)	Existing	Final
23008	23151	23152	262.5	5.5	5.5	1	1			23.8	23.8	4.0	8.4	4.7	8.2	141.1	189.1
23009	23152	2024	22.1	5.5	5.5	1	1			23.8	23.8	8.4	7.6	8.2	7.2	141.1	189.2
N. Nottingham St. to John Marshall Dr. Parallel System																	
4618	2547	2494	109.1	3	3	1	1			7.1	7.1	3.3	2.0	3.3	2.0	63.3	63.3
4595	2494	2432	121.7	3	3	1	1			7.1	7.1	2.0	3.0	2.0	3.0	62.7	62.8
4566	2432	2406	65.0	3	3	1	1			7.1	7.1	3.0	1.4	3.0	1.4	62.7	62.8
John Marshall Dr. Parallel System South																	
22050	2406	2336	236.9	3	3	1	1			7.1	7.1	1.4	4.4	1.4	4.4	61.8	62.3
John Marshall Dr. Parallel System North																	
20266	2406	2384	33.2	2.2	2.2	1	1			3.8	3.8	1.4	0.0	1.4	0.0	0.7	0.4
20267	2384	2380	28.0	2.2	2.2	1	1			3.8	3.8	0.0	0.0	0.0	0.0	0.7	0.4
4543	2380	2336	177.1	2.2	2.2	1	1			3.8	3.8	0.0	4.4	0.0	4.4	0.5	0.2
John Marshall Dr. Parallel System to N. Kensington St.																	
4522	2336	2292	138.7	3	3	1	1			7.1	7.1	4.4	2.5	4.4	2.5	60.7	61.0
4506	2292	2272	38.7	3	3	1	1			7.1	7.1	2.5	3.2	2.5	3.2	60.9	61.2
N. Kensington St. and Yorktown Blvd. to 33rd St. North																	
4523	2337	2272	144.7	3.5	3.5	1	1			9.6	9.6	2.4	3.2	2.4	3.2	76.9	76.9
4496	2272	2218	134.8	4	4	1	1			12.6	12.6	3.2	2.7	3.2	2.7	148.1	148.4
4468	2218	2164	136.8	4	4	1	1			12.6	12.6	2.7	4.2	2.7	3.9	148.1	148.4
4437	2164	2102	121.9	5	5	1	1			19.6	19.6	4.2	4.3	3.9	3.7	154.6	155.4
4408	2102	2024	189.4	5	5	1	1			19.6	19.6	4.3	7.6	3.7	7.2	154.8	155.2
Stem on N. Kensington St. between 32nd St. North and 33rd St. North																	
4439	2172	2164	38.5	3.5	5	1	1			9.6	19.6	1.7	4.2	1.4	3.9	1.5	0.8
33rd St. North to Williamsburg Blvd. and N. Harrison St. (Figure 7)																	
4363	2024	1916	279.6	5	5	1	1	**LPR_C23**	**3.5**	19.6	29.3	7.6	8.1	7.2	6.0	249.4	351.2
4319	1916	1882	69.5	5	5	1	1	**LPR_C5**	**4**	19.6	32.2	8.1	7.2	6.0	5.2	244.2	339.9
4308	1882	1865	48.3	5	5	1	1	**LPR_C6**	**4**	19.6	32.2	7.2	6.3	5.2	4.2	244.2	344.8
4303	1865	1780	314.0	5.5	5.5	1	1	**LPR_C7**	**4**	23.8	36.3	6.3	16.1	4.2	7.4	236.1	369.9
4274	1780	1675	271.1	5.5	5.5	1	1	**LPR_C8**	**4**	23.8	36.3	16.1	11.0	7.4	9.6	231.5	346.9
4226	1675	1653	195.1	6.5	6.5	1	1	**LPR_C9**	**4.5**	33.2	49.1	11.0	10.7	9.6	9.3	397.1	549.8

TABLE 2 (CONTINUED)
June 2006 Storm Event: Final Iteration Results Summary

Conduit ID	Node ID		Length (ft)	Size (Diameter or H × W) (ft)		No. of Barrels		Additional Pipe		Equivalent Cross-Sectional Area (ft^2)		Existing HGL		Final HGL		Flow (cfs)	
	US	DS		Existing	Final	Existing	Final	Model ID	Diameter (ft)	Existing	Final	US (ft)	DS (ft)	US (ft)	DS (ft)	Existing	Final
4206	1653	1643	154.2	6.5	6.5	1	1	LPR_C10	4.5	33.2	49.1	10.7	9.9	9.3	9.0	397.1	549.8
23281	1643	23400	17.3	6.5	6.5	1	1	LPR_C11	4.5	33.2	49.1	9.9	8.0	9.0	7.3	370.3	549.8
23282	23400	1636	51.5	6.5	6.5	1	1	LPR_C12	4.5	33.2	49.1	8.0	6.3	7.3	5.6	370.3	549.9
20230	1636	1619	113.9	6.5	6.5	1	1	LPR_C13	4.5	33.2	49.1	6.3	7.5	5.6	7.0	365.0	549.8
20229	1619	1584	82.1	7	7	1	1	LPR_C14	5	38.5	58.1	7.5	2.1	7.0	2.7	365.1	549.8
N. Jefferson St. to N. Harrison St. and Yorktown Blvd. (Figure 8)																	
4672	SU1	2572	152.5	3	3	1	1			7.1	7.1	5.4	6.4	3.0	3.4	68.3	66.6
4625	2572	2532	64.4	3	3	1	1			7.1	7.1	6.4	5.9	3.4	3.2	68.3	66.6
4613	2532	2504	51.3	3	3	1	1			7.1	7.1	5.9	5.2	3.2	2.2	53.0	66.6
4602	2504	2463	62.6	3	3	1	2			7.1	14.1	5.2	5.4	2.2	2.7	53.0	66.6
4580	2463	2435	111.7	3	3	1	2			7.1	14.1	5.4	5.1	2.7	4.5	53.0	66.6
4568	2435	2403	37.0	3	3	1	2			7.1	14.1	5.1	3.6	4.5	4.3	53.0	66.6
4554	2403	2399	12.4	3	3	1	1			7.1	7.1	3.6	1.6	4.3	1.8	53.0	66.6
4552	2399	2350	61.2	3	3	1	1			7.1	7.1	1.6	1.3	1.8	1.5	53.0	66.6
4530	2350	2227	258.9	3.5	3.5	1	1			9.6	9.6	1.3	3.1	1.5	2.8	53.0	66.6
4474	2227	2140	184.0	3.5	3.5	1	1			9.6	9.6	3.1	5.4	2.8	4.8	54.6	66.6
Little Falls Road to N. Harrison St.																	
4477	2230	2210	52.9	3	3	1	1			7.1	7.1	2.8	1.7	2.8	1.7	63.1	63.1
4464	2210	2140	290.6	3	3	1	1			7.1	7.1	1.7	5.4	1.7	4.8	63.0	63.1
N. Harrison St. and Yorktown Blvd. to N. Harrison St. and 32nd St. North. (Figure 9; profile continues on Figure 10)																	
20243	2140	2120	47.9	4	4	1	2			12.6	25.1	5.4	4.1	4.8	4.9	137.8	173.8
20246	2120	2067	91.8	4	4	1	2			12.6	25.1	4.1	2.9	4.9	3.3	137.8	172.5
4387	2067	1964	222.2	4.5	4.5	1	1			15.9	15.9	2.9	4.1	3.3	4.7	191.7	219.0
20940	1964	1922	121.7	4.5	4.5	1	1			15.9	15.9	4.1	3.3	4.7	3.6	191.7	219.0
4323	1922	1809	386.2	5	5	1	1			19.6	19.6	3.3	7.3	3.6	6.1	190.1	218.8
4286	1809	1759	130.3	5	5	1	1			19.6	19.6	7.3	5.7	6.1	4.9	190.1	218.8

TABLE 2 (CONTINUED)
June 2006 Storm Event: Final Iteration Results Summary

Conduit ID	Node ID		Length (ft)	Size (Diameter or H × W) (ft)		No. of Barrels		Additional Pipe		Equivalent Cross-Sectional Area (ft^2)		Existing HGL		Final HGL		Flow (cfs)	
	US	DS		Existing	Final	Existing	Final	Model ID	Diameter (ft)	Existing	Final	US (ft)	DS (ft)	US (ft)	DS (ft)	Existing	Final
N. Harrison St. and 32nd St. N. to Williamsburg Blvd. Parallel System (Figure 10)																	
20234	1759	1683	193.0	5.5	5.5	1	1			23.8	23.8	5.7	5.6	4.9	3.6	248.6	281.1
20235	1683	1637	153.3	5.5	5.5	1	2			23.8	47.5	5.6	6.4	3.6	5.7	209.8	278.9
Williamsburg Blvd. Parallel System West (Figure 10)																	
20236	1637	1608	58.5	5.5	5.5	1	2			23.8	47.5	6.4	5.8	5.7	5.7	174.6	253.4
Williamsburg Blvd. Parallel System East																	
22841	1637	1630	28.0	3.5	3.5	1	1			9.6	9.6	6.4	4.6	5.7	4.1	35.3	25.5
4193	1630	1622	20.9	3.5	3.5	1	1			9.6	9.6	4.6	4.4	4.1	4.2	35.3	25.5
4188	1622	1608	31.1	3.5	3.5	1	1			9.6	9.6	4.4	5.8	4.2	5.7	35.3	25.5
Williamsburg Blvd. Parallel System to Williamsburg Blvd. (Figure 10)																	
20231	1608	1596	32.1	5.5	5.5	1	2			23.8	47.5	5.8	4.6	5.7	5.5	209.8	278.9
20232	1596	1584	26.7	5.5	5.5	1	1			23.8	23.8	4.6	2.1	5.5	2.7	209.8	278.9
30th St. North to Williamsburg Blvd. (Figure 11)																	
4161	1574	1579	66.6	3.5	3.5	1	1			9.6	9.6	2.9	2.6	2.9	2.6	76.5	76.5
4160	1579	1567	170.6	3.5	3.5	1	1			9.6	9.6	2.6	1.9	2.6	1.9	128.0	127.9
4158	1567	1575	194.0	3.5	3.5	1	1			9.6	9.6	1.9	3.6	1.9	3.2	127.6	128.0
4175	1575	1603	189.7	4	4	1	1			12.6	12.6	3.6	7.3	3.2	3.8	127.6	127.4
22665	1603	22873	78.5	4	4	1	1			12.6	12.6	7.3	8.6	3.8	4.8	127.6	126.7
22666	22873	1623	118.5	4	4	1	1			12.6	12.6	8.6	9.0	4.8	8.4	127.6	126.7
4227	1623	1675	181.4	5.5	5.5	1	1	LPR_C24	5	23.8	43.4	9.0	11.0	8.4	9.6	102.9	125.0
36th St. North to Old Dominion Dr. Culvert System																	
4166	1584	1516	229.4	6×9	6×9	2	2			108.0	108.0	2.1	2.8	2.7	3.6	700.9	946.7
22953	1516	1426	316.9	6×9	6×9	2	2			108.0	108.0	2.8	4.2	3.6	5.2	703.4	946.9
22964	1426	1397	82.8	6×9	6×9	2	2			108.0	108.0	4.2	3.4	5.2	4.1	702.9	945.8
20213	1397	1302	315.5	6×9	6×9	2	2			108.0	108.0	3.4	2.6	4.1	3.2	705.2	946.6
20211	1302	1261	158.9	6×9	6×9	2	2			108.0	108.0	2.6	3.0	3.2	3.9	704.7	946.0
24810	1261	1235	64.9	6×9	6×9	2	2			108.0	108.0	3.0	3.4	3.9	4.3	704.7	945.4
20210	1235	1154	277.3	6×9	6×9	2	2			108.0	108.0	3.4	5.0	4.3	6.1	706.0	943.9
20203	1154	1135	40.6	6×9	6×9	2	2			108.0	108.0	5.0	4.6	6.1	5.6	703.1	943.7
20205	1135	1129	10.5	6×9	6×9	2	2			108.0	108.0	4.6	4.4	5.6	5.3	703.0	943.3

TABLE 2 (CONTINUED)
June 2006 Storm Event: Final Iteration Results Summary

Conduit ID	Node ID		Length (ft)	Size (Diameter or H × W) (ft)		No. of Barrels		Additional Pipe		Equivalent Cross-Sectional Area (ft^2)		Existing HGL		Final HGL		Flow (cfs)	
	US	DS		Existing	Final	Existing	Final	Model ID	Diameter (ft)	Existing	Final	US (ft)	DS (ft)	US (ft)	DS (ft)	Existing	Final
20206	1129	1087	146.6	6×9	6×9	2	2			108.0	108.0	4.4	4.4	5.3	5.3	795.3	1025.5
20208	1087	1060	180.7	6×9	6×9	2	2			108.0	108.0	4.4	4.9	5.3	5.8	794.9	1021.0
20209	1060	1048	77.9	6×9	6×9	2	2			108.0	108.0	4.9	4.3	5.8	5.0	794.8	1021.2
6101	1048	1036	73.6	6×9	6×9	2	2			108.0	108.0	4.3	3.5	5.0	4.0	794.8	1021.2
Old Dominion Drive Culvert System North																	
6102	1036	1034	9.7	6×12	6×12	1	1			72.0	72.0	3.5	3.7	4.0	4.2	575.1	715.0
3900	1034	1018	103.8	12×12.5 [a]	12×12.5 [a]	1	1			150	150	3.7	3.3	4.2	3.9	575.1	715.1
6106	1018	1016	28.4	6×12	6×12	1	1			72.0	72.0	3.3	4.5	3.9	5.1	575.0	715.4
Old Dominion Drive Culvert System South																	
6103	1036	1035	21.7	6×12	6×12	1	1			72.0	72.0	3.5	2.7	4.0	2.8	219.8	306.4
6100	1035	1024	80.5	11×12 [a]	11×12 [a]	1	1			132	132	2.7	1.1	2.8	1.6	219.9	306.5
6104	1024	1020	24.1	6×12	6×12	1	1			72.0	72.0	1.1	5.0	1.6	5.4	219.8	306.5
East Branch																	
N. Edison St. to N. George Mason Dr. and 25th Pl. North (Figure 12; profile continues on Figure 13)																	
4963	SU2	3705	57.0	3	3	1	1			7.1	7.1	6.4	6.8	2.7	3.2	48.1	54.7
4953	3705	3695	40.5	3	3	1	1	**LPR_C15**	**2**	7.1	10.2	6.8	6.2	3.2	3.2	74.3	90.6
4956	3695	3710	124.6	3	3	1	1	**LPR_C16**	**2**	7.1	10.2	6.2	4.8	3.2	3.1	71.6	90.6
4957	3710	3643	122.0	3	3	1	1	**LPR_C17**	**2**	7.1	10.2	4.8	2.4	3.1	2.0	71.6	90.6
6413	3643	3789	267.8	3.5	3.5	1	1	**LPR_C18**	**2**	9.6	12.8	2.4	3.7	2.0	4.6	71.6	94.9
22690	3789	3770	99.3	3.5	3.5	1	1	**LPR_C19**	**2**	9.6	12.8	3.7	3.9	4.6	4.6	71.9	90.9
4983	3770	3768	16.5	3.5	3.5	1	1			9.6	9.6	3.9	3.5	4.6	4.1	72.0	90.9
4982	3768	3693	94.3	4	4	1	1			12.6	12.6	3.5	2.7	4.1	2.9	124.1	143.4
4945	3693	3503	200.1	4.5	4.5	1	1			15.9	15.9	2.7	3.7	2.9	3.8	124.3	141.9
4891	3503	3482	22.5	4.5	4.5	1	1			15.9	15.9	3.7	2.8	3.8	2.6	123.0	141.7
4884	3482	3275	232.3	4.5	4.5	1	1			15.9	15.9	2.8	7.4	2.6	4.6	123.3	141.6
4842	3275	3191	121.0	5	5	1	1	**LPR_C20**	**4**	19.6	32.2	7.4	7.8	4.6	6.3	123.3	144.0
Stem on N. Edison St. and 24th St. North																	
22942	3746	23090	34.2	3	3	1	1			7.1	7.1	0.0	0.5	0.0	0.1	0.0	0.0
22943	23090	3643	78.2	3	3	1	1			7.1	7.1	0.5	2.4	0.1	2.0	0.2	0.4

TABLE 2 (CONTINUED)
June 2006 Storm Event: Final Iteration Results Summary

Conduit ID	Node ID		Length (ft)	Size (Diameter or H × W) (ft)		No. of Barrels		Additional Pipe		Equivalent Cross-Sectional Area (ft^2)		Existing HGL		Final HGL		Flow (cfs)	
	US	DS		Existing	Final	Existing	Final	Model ID	Diameter (ft)	Existing	Final	US (ft)	DS (ft)	US (ft)	DS (ft)	Existing	Final
25th Pl. North to 26th St. North (Figure 13)																	
4867	3415	3256	201.4	3	3	1	1			7.1	7.1	5.4	5.9	2.6	5.1	78.4	81.6
4837	3256	3191	60.3	3.5	3.5	1	2			9.6	9.6	5.9	7.8	5.1	6.3	68.7	82.1
4821	3191	3122	71.5	5.5	5.5	1	1	LPR_C21	4	23.8	36.3	7.8	7.2	6.3	6.0	201.2	243.2
24852	3122	24622	62.7	5.5	5.5	1	1	LPR_C25	4	23.8	36.3	7.2	6.5	6.0	6.0	201.2	243.3
24853	24622	3054	28.5	5.5	5.5	1	1			23.8	23.8	6.5	5.5	6.0	3.9	201.2	243.3
4780	3054	2994	63.2	5.5	5.5	1	1			23.8	23.8	5.5	5.9	3.9	4.4	167.4	140.1
21736	2994	2862	130.4	5.5	5.5	1	1			23.8	23.8	5.9	6.0	4.4	4.9	225.8	203.6
24839	2862	24619	62.3	5.5	5.5	1	1			23.8	23.8	6.0	5.5	4.9	4.7	225.8	203.5
24840	24619	24618	22.4	5.5	5.5	1	1			23.8	23.8	5.5	4.1	4.7	3.6	225.8	203.5
24838	24618	24615	205.8	6	6	1	1			28.3	28.3	4.1	5.1	3.6	4.5	225.6	203.7
4658	24615	2590	71.2	6.5	6.5	1	1			33.2	33.2	5.1	4.3	4.5	3.9	225.7	203.7
4631	2590	2324	393.2	6.5	6.5	1	1			33.2	33.2	4.3	4.6	3.9	4.4	270.7	242.5
4516	2324	2270	110.2	6.5	6.5	1	1			33.2	33.2	4.6	6.0	4.4	6.3	270.3	239.9
6289	2270	2231	96.6	8	8	1	1			50.3	50.3	6.0	5.5	6.3	5.8	308.4	336.4
22797	2231	22968	123.2	8	8	1	1			50.3	50.3	5.5	6.8	5.8	7.1	307.5	334.9
22798	22968	22971	45.5	8	8	1	1			50.3	50.3	6.8	6.2	7.1	6.5	307.6	335.5
22799	22971	2063	165.9	8	8	1	1			50.3	50.3	6.2	7.7	6.5	8.0	308.3	336.9
N. George Mason Dr. and 25th Pl. North to N. George Mason Dr. and Yorktown Blvd.																	
4827	3219	3190	58.3	4	4	1	1			12.6	12.6	0.0	0.0	0.1	1.3	0.0	0.7
4820	3190	3113	77.4	4.5	4.5	1	1			15.9	15.9	0.0	0.6	1.3	1.9	0.4	2.0
4802	3113	3050	86.6	4.5	4.5	1	1			15.9	15.9	0.6	1.6	1.9	2.9	3.8	3.9
21737	3050	24621	67.1	4.5	4.5	1	1			15.9	15.9	1.6	1.5	2.9	2.8	44.2	101.2
24851	24621	24620	127.9	4.5	4.5	1	1			15.9	15.9	1.5	1.5	2.8	2.7	44.2	101.3
24844	24620	2800	85.8	4.5	4.5	1	1			15.9	15.9	1.5	1.4	2.7	2.5	44.2	101.3
21768	2800	2655	203.2	4.5	4.5	1	1			15.9	15.9	1.4	1.7	2.5	3.0	44.2	101.4
21767	2655	2573	88.6	4.5	4.5	1	1			15.9	15.9	1.7	1.5	3.0	2.5	44.1	101.3
20263	2573	2412	238.1	4.5	4.5	1	1			15.9	15.9	1.5	1.6	2.5	2.6	44.5	101.6
21733	2412	2270	253.2	4.5	4.5	1	1			15.9	15.9	1.6	6.0	2.6	6.3	44.6	101.8

TABLE 2 (CONTINUED)
June 2006 Storm Event: Final Iteration Results Summary

Conduit ID	Node ID		Length (ft)	Size (Diameter or H × W) (ft)		No. of Barrels		Additional Pipe		Equivalent Cross-Sectional Area (ft^2)		Existing HGL		Final HGL		Flow (cfs)	
	US	DS		Existing	Final	Existing	Final	Model ID	Diameter (ft)	Existing	Final	US (ft)	DS (ft)	US (ft)	DS (ft)	Existing	Final
Cross Connection from Junction 3054 on Figure 13 to Junction 3050 on the section N. George Mason Dr. and 25th Pl. North to N. George Mason Dr. and Yorktown Blvd.																	
4779	3050	3054	12.9	3	**4.5**	1	**2**			7.1	31.8	1.6	5.5	2.9	3.9	44.8	103.9
Stem on N. George Mason Dr. and 26th St. North																	
4778	3024	3050	48.3	3	3	1	1			7.1	7.1	0.0	1.6	1.0	2.9	0.0	0.8
N. Brandywine St. to N. George Mason Dr.																	
4345	1976	1985	45.1	3	3	1	1			7.1	7.1	2.3	2.1	2.3	2.1	83.1	83.1
4358	1985	2010	106.3	3	3	1	1			7.1	7.1	2.1	2.3	2.1	2.3	83.6	83.4
4366	2010	2033	190.3	3	3	1	1			7.1	7.1	2.3	4.0	2.3	4.1	80.5	81.6
4367	2033	2032	27.3	3	3	1	1			7.1	7.1	4.0	1.7	4.1	1.7	80.5	81.6
4411	2032	2106	301.7	3	3	1	1			7.1	7.1	1.7	3.9	1.7	3.9	80.2	81.6
4415	2106	2115	132.8	4	4	1	1			12.6	12.6	3.9	4.2	3.9	4.2	80.3	81.6
4416	2115	2076	85.8	4	4	1	1			12.6	12.6	4.2	3.7	4.2	3.7	80.3	81.7
4392	2076	2056	28.8	4	4	1	1			12.6	12.6	3.7	3.0	3.7	3.0	80.1	81.6
4383	2056	2064	78.0	4	4	1	1			12.6	12.6	3.0	1.8	3.0	1.8	80.1	81.5
4385	2064	2054	194.7	4	4	1	1			12.6	12.6	1.8	4.3	1.8	4.5	80.1	81.6
4379	2054	2060	118.6	5	5	1	1			19.6	19.6	4.3	5.6	4.5	5.8	77.6	79.2
4381	2060	2063	26.8	5	5	1	1			19.6	19.6	5.6	7.7	5.8	8.0	77.6	77.8
N. Dickerson St. to N. George Mason Dr.																	
23519	1742	23586	72.8	4	4	1	1			12.6	12.6	2.9	2.8	2.9	2.8	76.1	76.1
23521	23586	23587	63.3	4	4	1	1			12.6	12.6	2.8	2.4	2.8	2.4	76.1	76.1
23522	23587	23594	149.2	4	4	1	1			12.6	12.6	2.4	2.7	2.4	2.7	76.0	76.0
23529	23594	1769	148.5	4	4	1	1			12.6	12.6	2.7	3.5	2.7	3.5	75.8	75.8
4270	1769	1772	76.0	4	4	1	1			12.6	12.6	3.5	4.2	3.5	4.2	75.5	75.4
4273	1772	1779	101.4	4	4	1	1			12.6	12.6	4.2	0.9	4.2	0.9	75.5	75.5
6278	1779	1753	189.3	Stream	Stream	1	1									75.3	75.2
N. George Mason Dr. to Williamsburg Blvd.																	
4382	2063	2007	145.8	8	8	1	1			50.3	50.3	7.7	7.8	8.0	7.9	482.4	504.6
22800	2007	22972	68.5	8	8	1	1			50.3	50.3	7.8	7.3	7.9	7.5	482.3	504.6
22801	22972	1971	31.4	8	8	1	1			50.3	50.3	7.3	5.0	7.5	5.0	482.3	504.5
20944	1971	1868	310.6	Stream	Stream	1	1									500.8	521.9

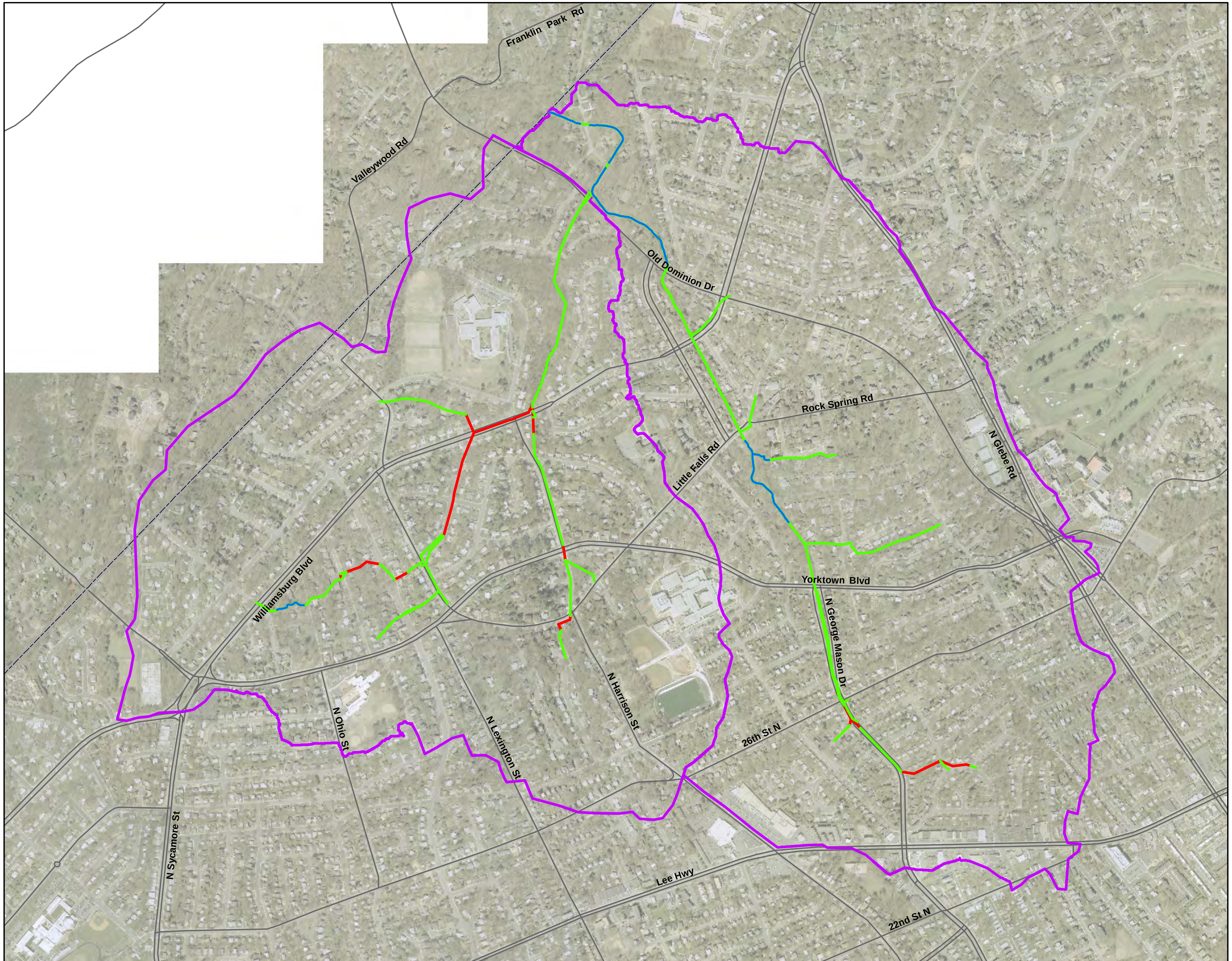
TABLE 2 (CONTINUED)
June 2006 Storm Event: Final Iteration Results Summary

Conduit ID	Node ID		Length (ft)	Size (Diameter or H × W) (ft)		No. of Barrels		Additional Pipe		Equivalent Cross-Sectional Area (ft^2)		Existing HGL		Final HGL		Flow (cfs)	
	US	DS		Existing	Final	Existing	Final	Model ID	Diameter (ft)	Existing	Final	US (ft)	DS (ft)	US (ft)	DS (ft)	Existing	Final
6287	1868	1753	475.9	Stream	Stream	1	1									497.3	518.6
6280	1753	1706	149.1	Stream	Stream	1	1									690.8	679.9
4241	1706	1670	94.9	8	8	1	1			50.3	50.3	7.2	6.7	7.3	6.7	605.4	620.7
4221	1670	1651	76.5	8	8	1	1			50.3	50.3	6.7	2.7	6.7	2.7	655.5	670.7
6279	1651	1573	229.9	6×12	6×12	1	1			72.0	72.0	2.7	2.6	2.7	2.4	658.2	671.8
6281	1573	1417	584.4	6×12	6×12	1	1			72.0	72.0	2.6	9.9	2.4	7.6	653.7	670.3
24834	1417	24606	20.2	8×16 [a]	8×16 [a]	1	1			119	119	9.9	9.3	7.6	7.8	651.4	668.2
24835	24606	24607	10.0	8×16 [a]	8×16 [a]	1	1			119	119	9.3	9.3	7.8	7.8	651.4	668.1
24836	24607	1383	58.6	8×16 [a]	8×16 [a]	1	1			119	119	9.3	11.3	7.8	11.3	710.1	728.3
20225	1383	1365	40.0	6×12	6×12	1	1			72.0	72.0	11.3	3.7	11.3	3.9	710.1	728.3
Old Dominion Dr. to Williamsburg Blvd.																	
22693	22896	1279	63.9	3	3	1	1			7.1	7.1	1.9	2.8	1.9	2.8	62.9	62.9
20223	1279	1291	50.0	3.5	3.5	1	1			9.6	9.6	2.8	2.2	2.8	2.2	92.9	92.9
20222	1291	1326	136.7	4	4	1	1			12.6	12.6	2.2	2.9	2.2	2.9	92.9	92.9
4060	1326	1359	162.4	4	4	1	1			12.6	12.6	2.9	2.7	2.9	2.6	92.6	92.7
4071	1359	1377	85.7	4	4	1	1			12.6	12.6	2.7	4.2	2.6	4.3	92.5	92.7
4072	1377	1365	22.8	4	4	1	1			12.6	12.6	4.2	3.7	4.3	3.9	92.6	92.7
Williamsburg Blvd. to Old Dominion Dr.																	
6263	1365	1295	285.3	6×12	6×12	1	1			72.0	72.0	3.7	3.1	3.9	3.5	801.5	813.7
6264	1295	1213	276.7	6×12	6×12	1	1			72.0	72.0	3.1	5.2	3.5	5.5	803.0	814.9
3990	1213	1207	22.6	8×16 [a]	8×16 [a]	1	1			119	119	5.2	4.3	5.5	4.5	802.5	813.2
3986	1207	1192	79.8	8×16 [a]	8×16 [a]	1	1			119	119	4.3	3.3	4.5	3.5	802.6	813.4
6268	1192	1169	71.2	Stream	Stream	1	1									802.8	813.3
6269	1169	1097	200.7	Stream	Stream	1	1									885.1	896.3
22151	1097	22412	550.5	Stream	Stream	1	1									884.3	896.1
22152	22412	1020	215.4	Stream	Stream	1	1									874.0	886.8
6105	1020	1016	16.7	Stream	Stream	1	1									1185.4	1280.1

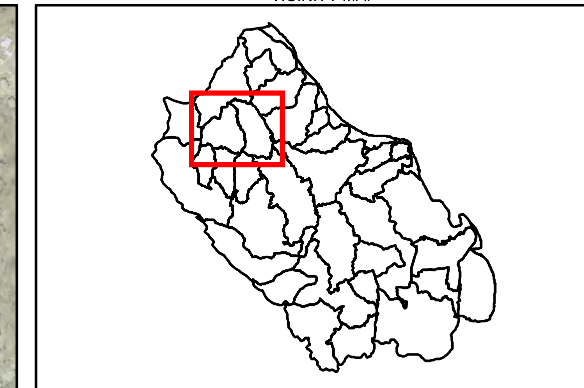
TABLE 2 (CONTINUED)
June 2006 Storm Event: Final Iteration Results Summary

Conduit ID	Node ID		Length (ft)	Size (Diameter or H × W) (ft)		No. of Barrels		Additional Pipe		Equivalent Cross-Sectional Area (ft^2)		Existing HGL		Final HGL		Flow (cfs)	
	US	DS		Existing	Final	Existing	Final	Model ID	Diameter (ft)	Existing	Final	US (ft)	DS (ft)	US (ft)	DS (ft)	Existing	Final
Little Falls Rd. and Wine St. to Williamsburg Blvd. and N. George Mason Dr.																	
4204	SU4	1649	245.4	3	3	1	1			7.1	7.1	3.8	4.1	3.8	4.1	43.4	43.9
4210	1649	1655	33.3	3	3	1	1			7.1	7.1	4.1	3.4	4.1	3.4	43.4	43.9
4218	1655	1668	85.9	3	3	1	1			7.1	7.1	3.4	2.5	3.4	2.5	43.4	43.9
4220	1668	1670	28.5	3	3	1	1			7.1	7.1	2.5	6.7	2.5	6.7	43.4	43.9
Main Branch																	
Old Dominion Dr. to County Line																	
22443	1016	22716	265.4	Stream	Stream	1	1									1758.3	1990.8
22441	22716	22715	41.5	7×10.79 [a]	7×10.79 [a]	2	2			60	60	7.7	4.9	8.4	5.2	1757.8	1990.8
22444	22715	949	281.0	Stream	Stream	1	1									1756.0	1990.0
20189	949	932	346.2	Stream	Stream	1	1									1757.0	1987.7
6091	932	930	75.0	7×10.79 [a]	7×10.79 [a]	2	2			60	60	8.7	6.6	9.8	7.5	1756.8	1976.9
20183	930	928	51.7	Stream	Stream	1	1									1756.8	1976.9
20184	928	J1	263.5	Stream	Stream	1	1									1757.4	1977.0

US, upstream; DS, downstream. Note that cross-sectional area and HGL are not calculated for natural stream sections. The existing and final HGL data represent maximum node depths.
[a] Irregularly shaped pipe, such as arch, elliptical.



VICINITY MAP



Legend

- Modeled Stormwater Mains with Recommended Additional Capacity
- Modeled Stormwater Mains with Sufficient Existing Capacity
- Streams
- Arlington/Fairfax Boundary Line
- Roads
- Modeled (Revised) Watershed Boundary

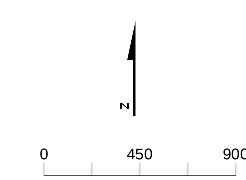


FIGURE 5
Recommended Additional Capacity for the 2006 Storm
Little Pimmit Run Watershed
Arlington County Storm Capacity Analysis

CH2MHILL

FIGURE 6 - Little Pimmit Run

N. Nottingham St. Parallel System to 33rd St. North for the June 2006 Storm Event

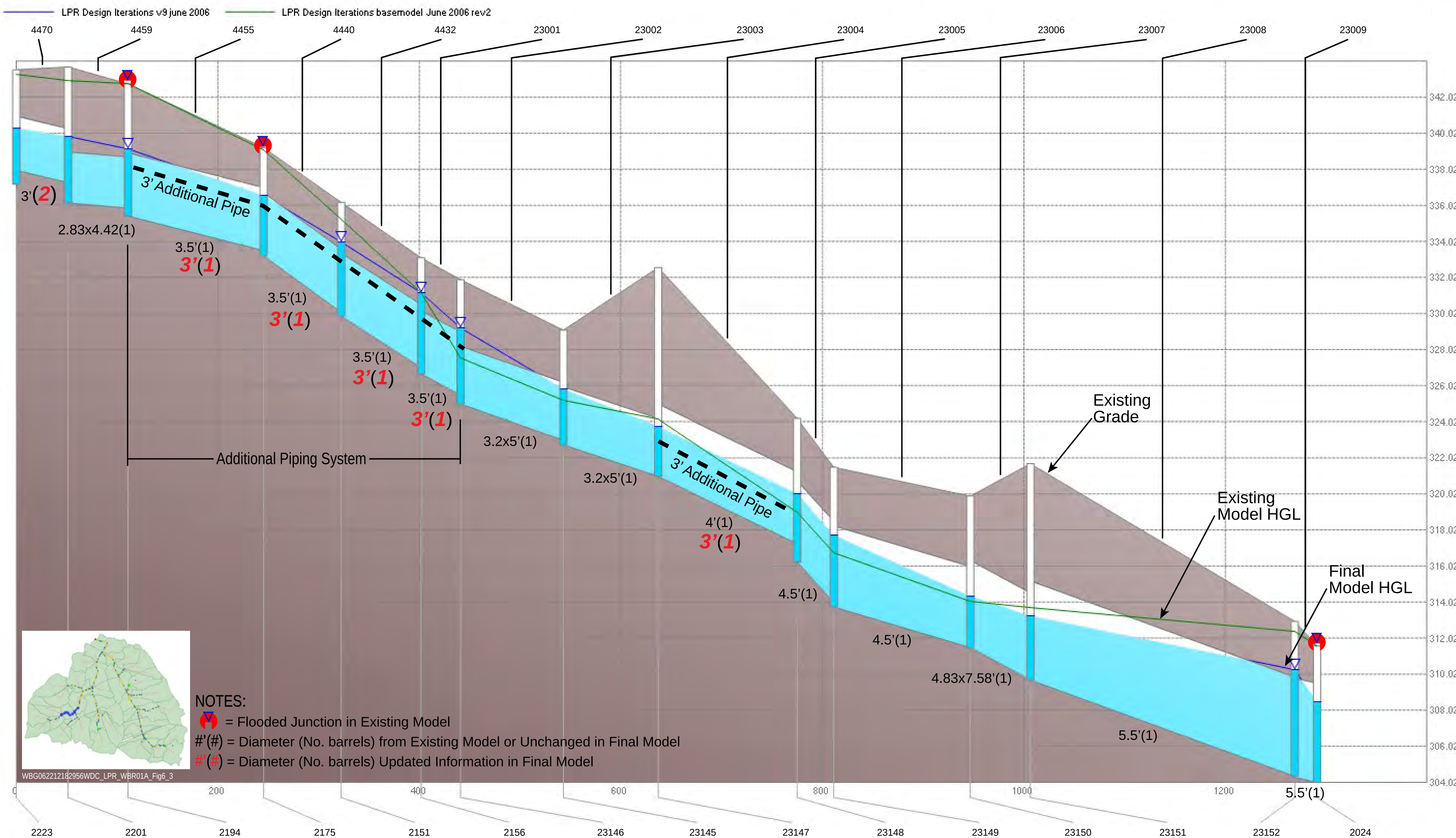


FIGURE 7 - Little Pimmit Run

33rd St. North to WIlliamsburg Blvd. and N. Harrison St. for the June 2006 Storm Event

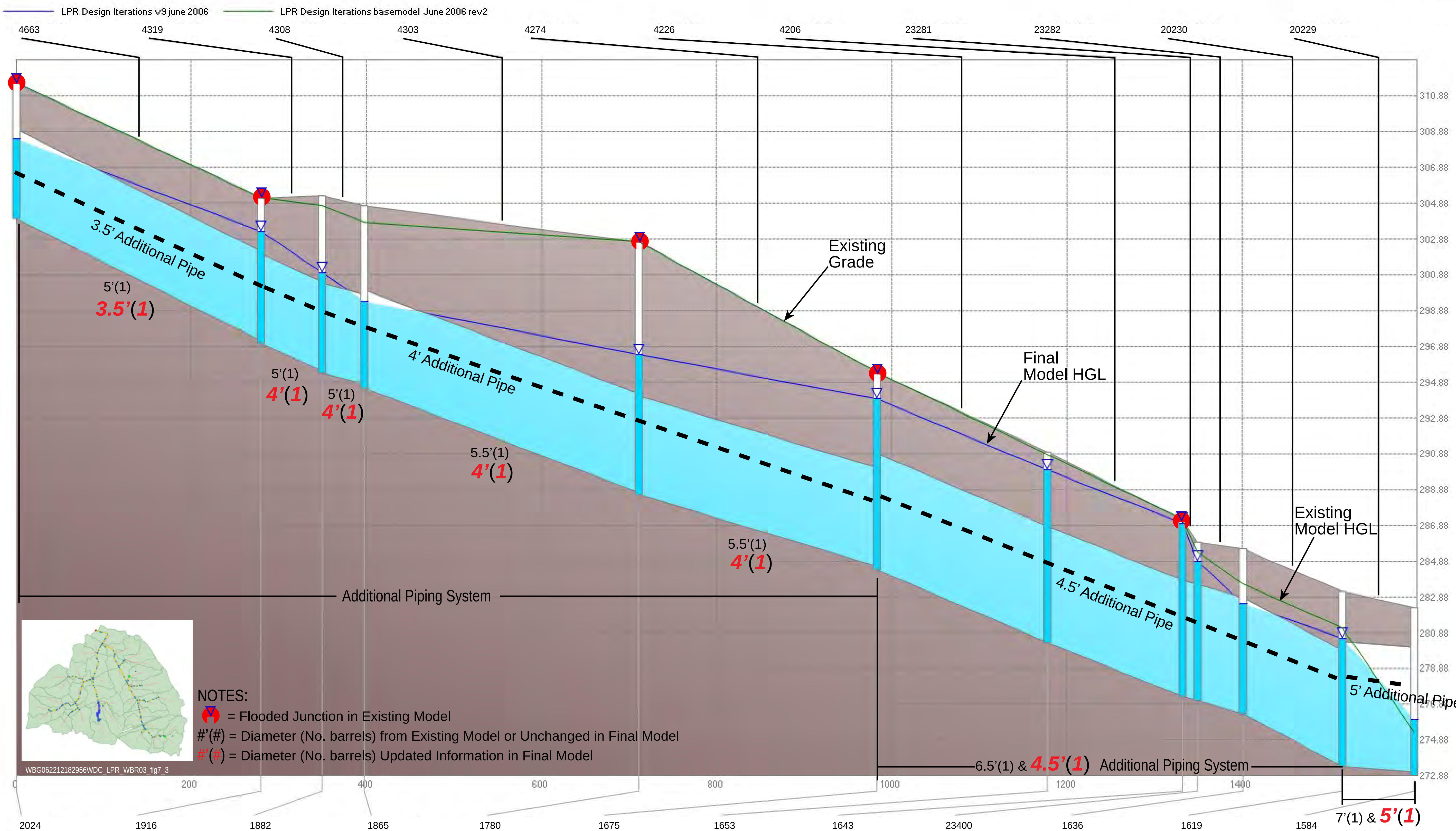


FIGURE 8 - Little Pimmit Run
N. Jefferson St. to N. Harrison St. and Yorktown Blvd. for the June 2006 Storm Event

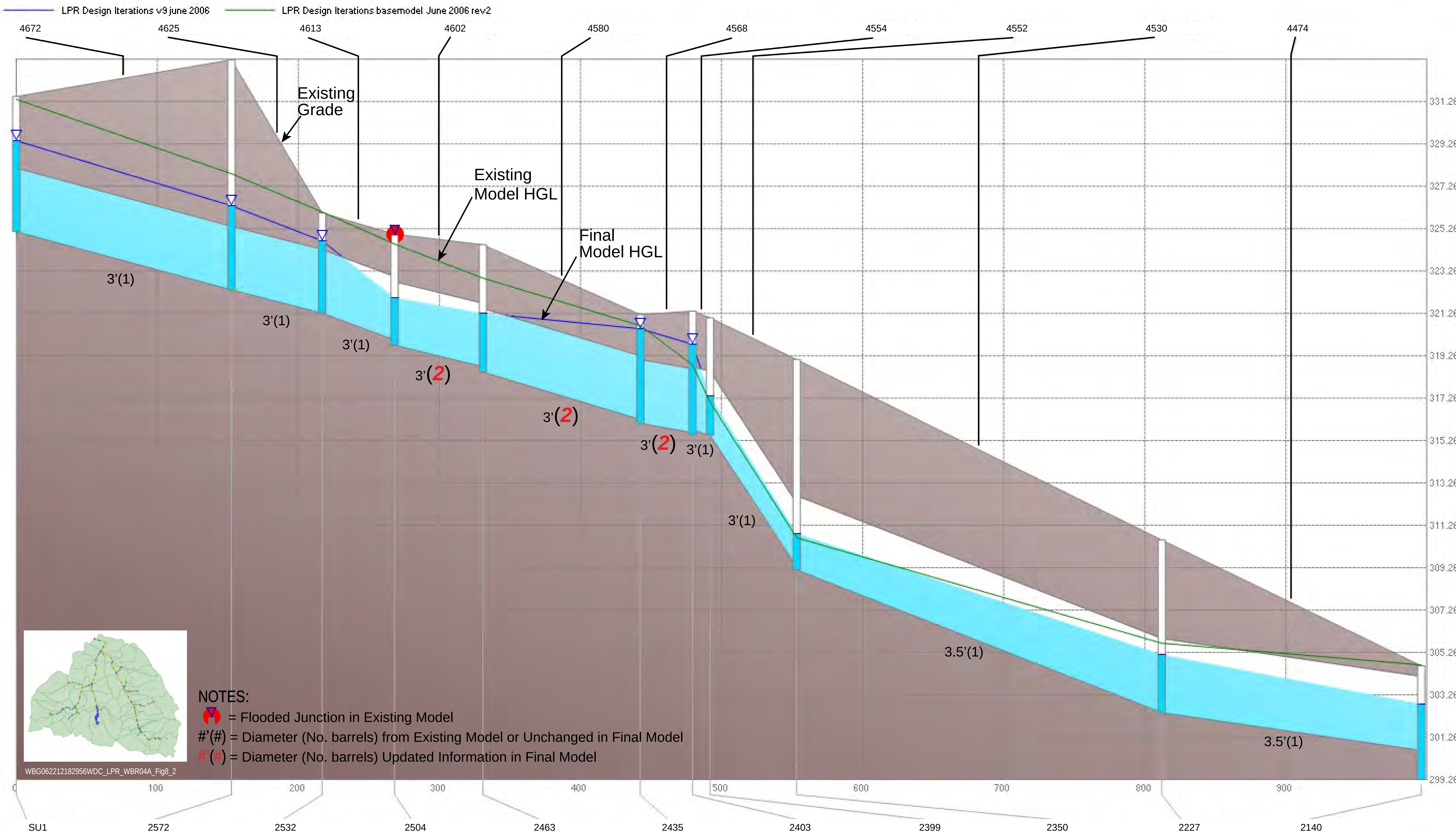


FIGURE 9 - Little Pimmit Run

N. Harrison St. and Yorktown Blvd. to N. Harrison St. and 32nd St. North for the June 2006 Storm Event

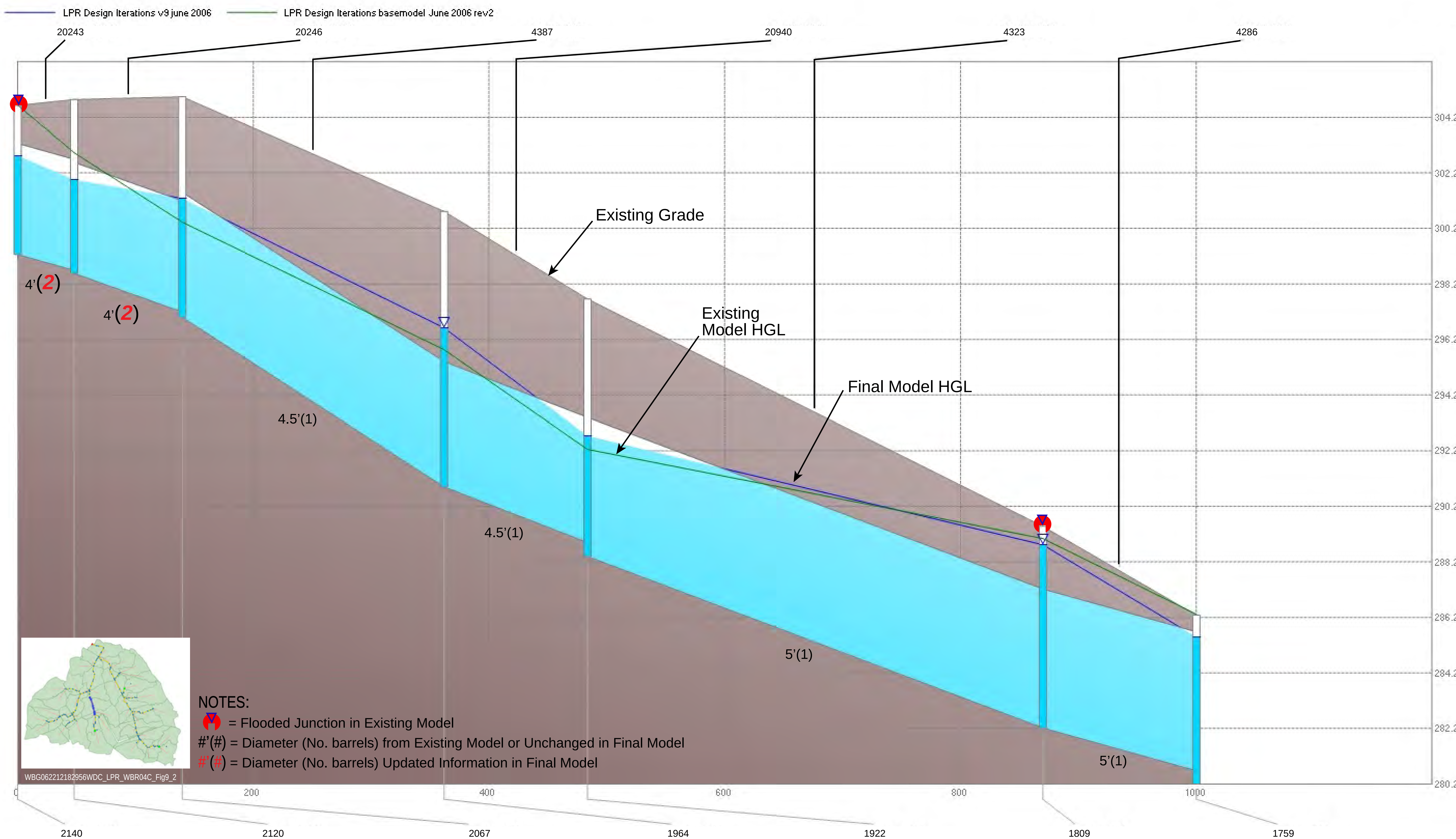


FIGURE 10 - Little Pimmit Run

N. Harrison St. and 32nd St. North to Williamsburg Blvd. for the June 2006 Storm Event

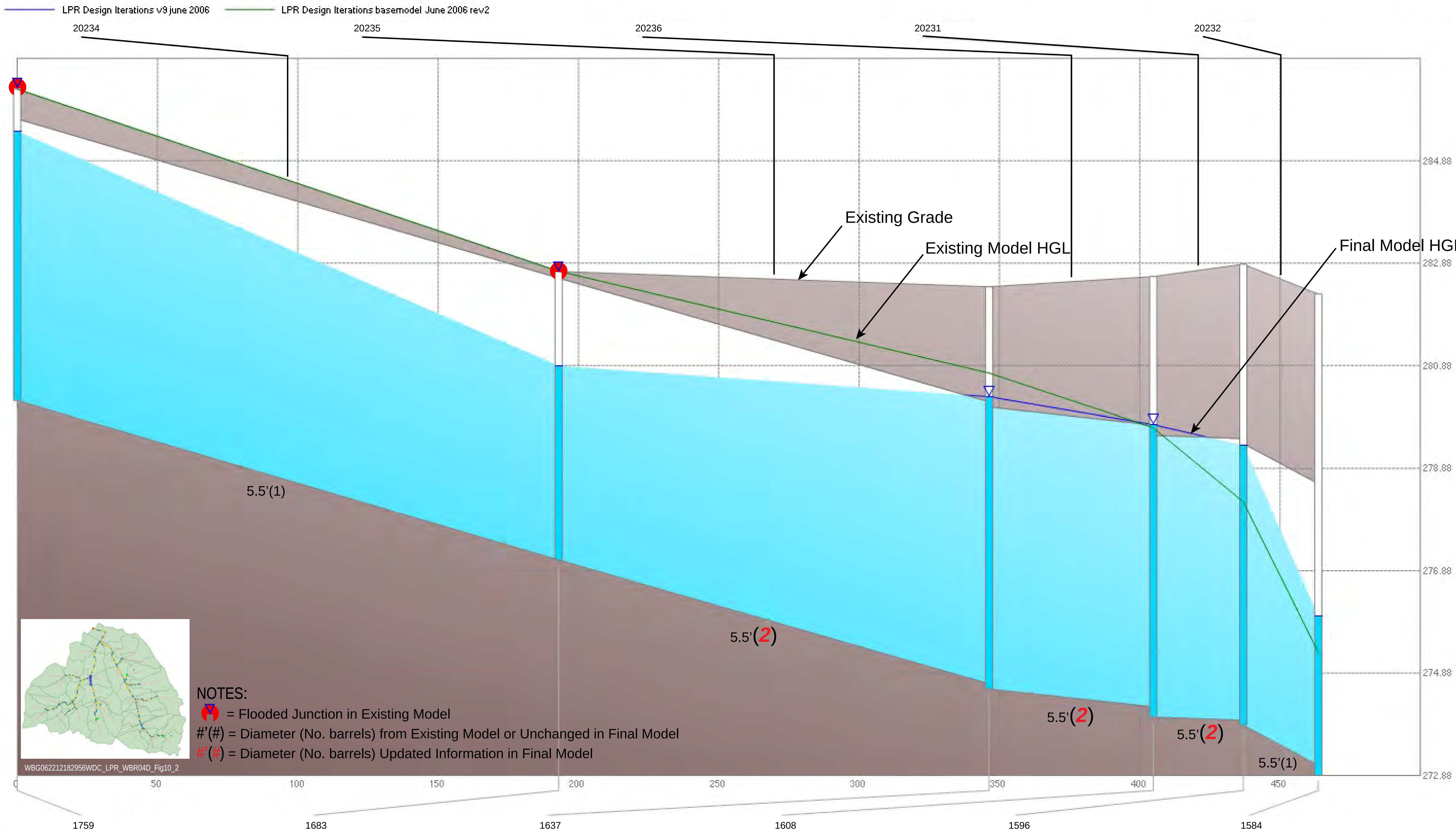


FIGURE 11 - Little Pimmit Run

30th St. North to Williamsburg Blvd. for the June 2006 Storm Event

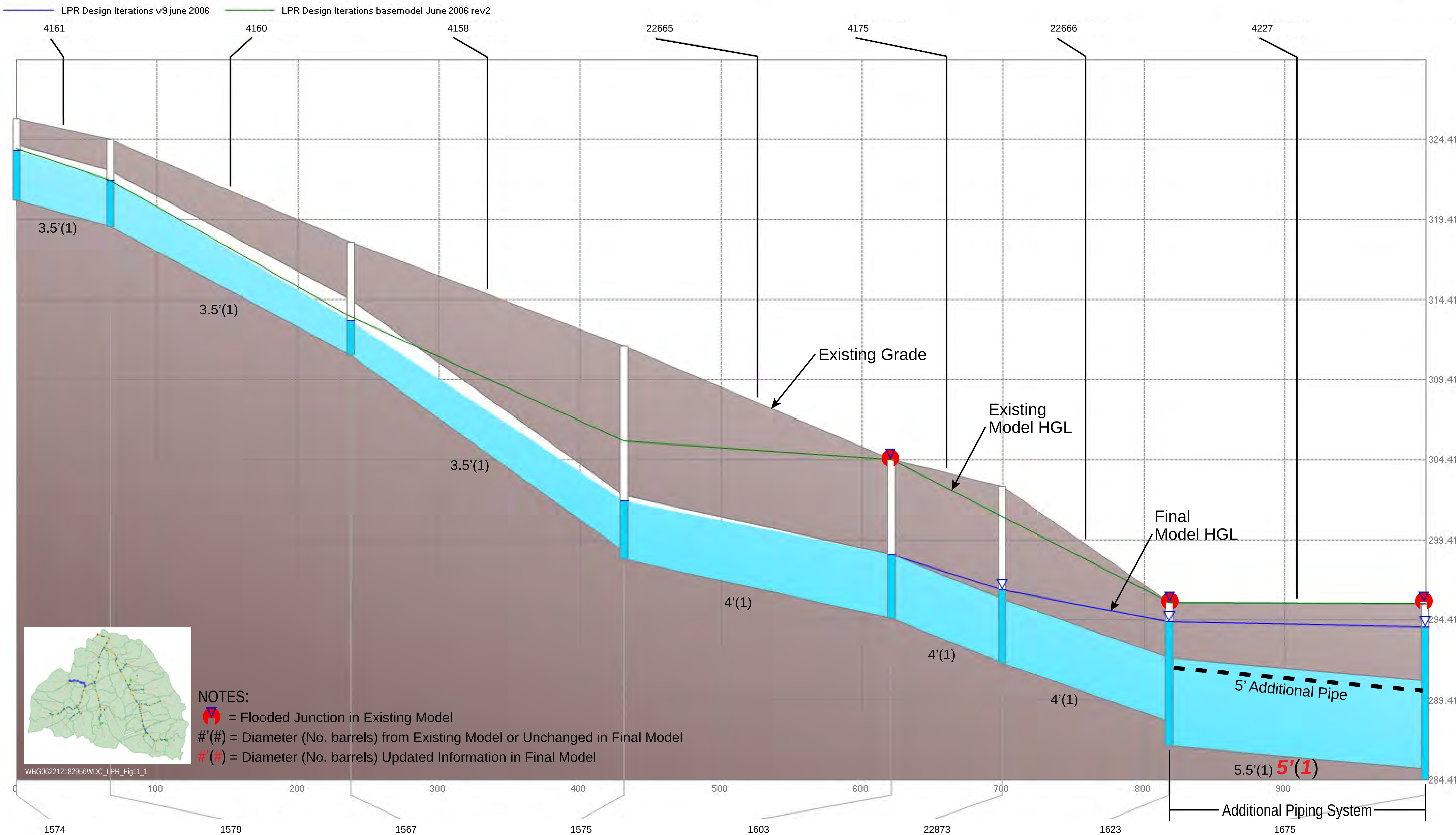


FIGURE 12 - Little Pimmit Run

N. Edison St. to N. George Mason Dr. and 25th Pl. North for the June 2006 Storm Event

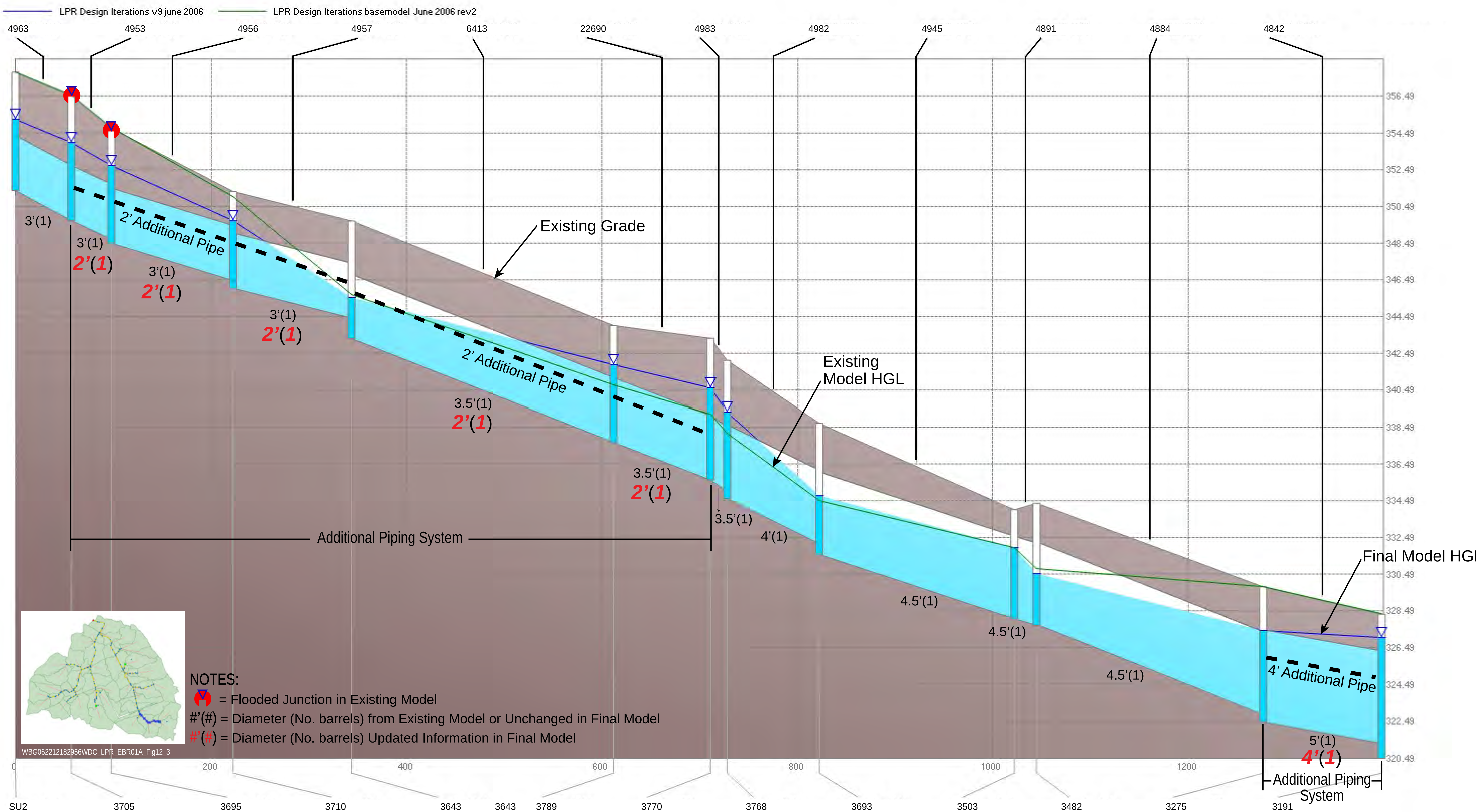
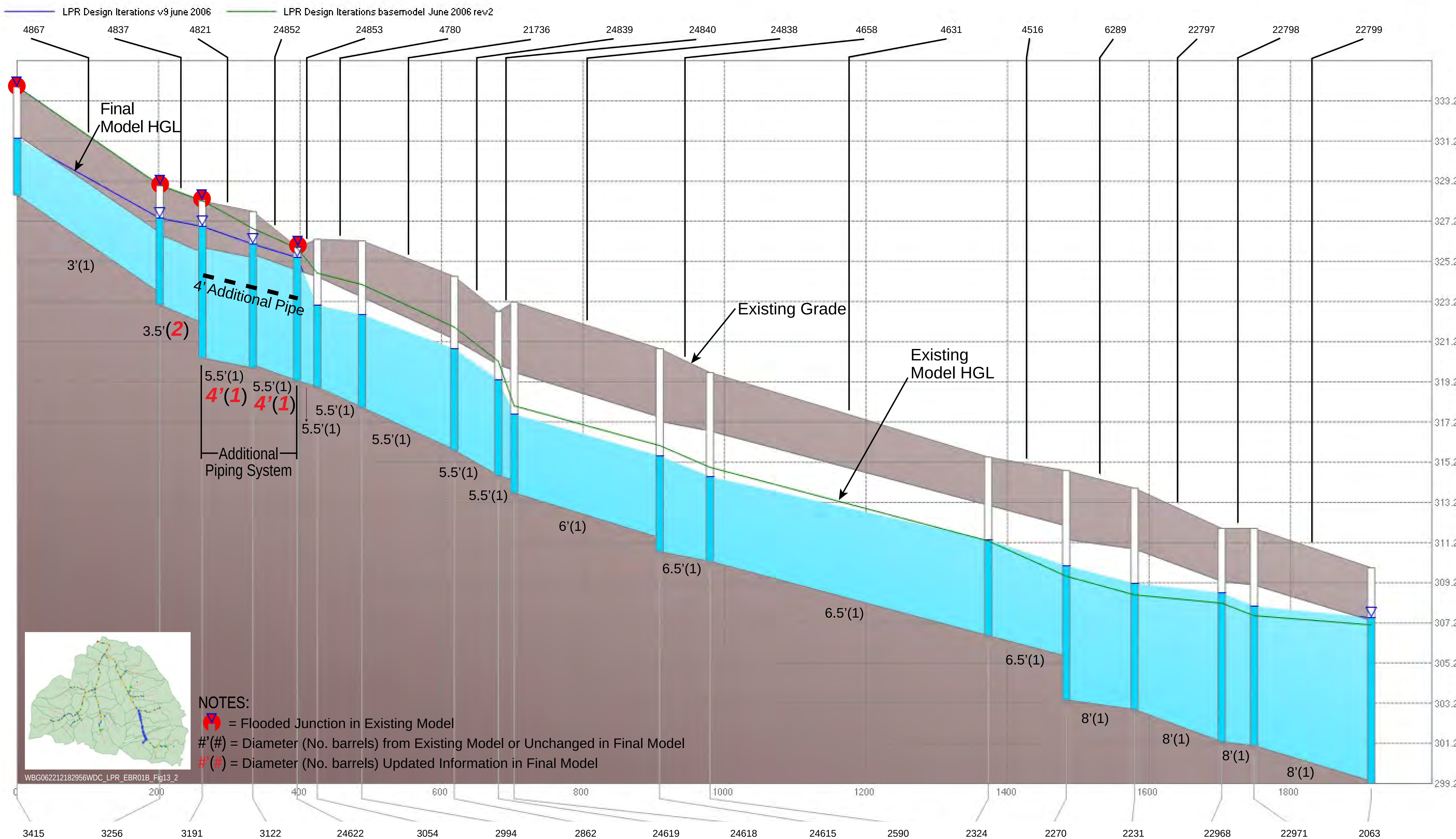


FIGURE 13 - Little Pimmit Run

25th Pl. North to 26th St. North for the June 2006 Storm Event



4.3 10yr-24hr SCS Type II Storm

For the 10yr-24hr SCS Type II storm, capacity was added to 96 conduits (10,289 LF of pipe in total). This equates to 41 percent of the modeled pipe network in Little Pimmit Run.

A summary of the changes to diameter and the existing and resulting flows are presented in **Table 3**. A map showing the 10yr-24hr storm upgrade locations throughout the watershed is included in **Figure 14**. Profiles showing the existing conditions and final results are shown in **Figure 15** through **Figure 31**. Profiles were displayed only for segments of the stormwater network where any of the following conditions were met:

- Pipe size was increased
- An identical barrel was added to the system
- An additional pipe was added to the system

The existing model profile depicts the peak water surface elevation with solid blue fill and peak HGL with a dark blue line. The HGL represents the sum of the pressure head and the elevation head along the profile. Flooded nodes in the existing conditions model are annotated with a red dot behind the junction rim. The final profile displays the existing system HGL with a dark green line for reference.

TABLE 3
10-yr, 24-hr SCS Type II Storm Event: Final Iteration Results Summary

	Node ID			Size (Diameter or H × W) (ft)		No. of Barrels		Additional Pipe		Equivalent Cross-Sectional Area (ft^2)		Existing HGL		Final HGL		Flow (cfs)	
Conduit ID	US	DS	Length (ft)	Existing	Final	Existing	Final	Model ID	Diameter (ft)	Existing	Final	US (ft)	DS (ft)	US (ft)	DS (ft)	Existing	Final
West Branch																	
N. Potomac St and Williamsburg Blvd to N. Nottingham St. Parallel System (Figure 15; profile continues on Figure 16)																	
4526	2328	2341	53.4	3	3	1	1			7.1	7.1	4.6	3.8	4.6	2.5	85.1	85.2
4539	2341	2370	97.6	3	3	1	1			7.1	7.1	3.8	5.0	2.5	3.5	85.2	85.1
4538	2370	2359	57.3	3.5	3.5	1	**2**			9.6	19.2	5.0	3.6	3.5	3.8	169.8	169.5
4534	2359	2342	295.7	Stream	Stream	1	1									168.3	168.2
4527	2342	2334	34.2	3.5	3.5	1	1			9.6	9.6	10.0	7.6	7.7	4.1	141.6	145.3
4520	2334	2310	46.8	3.5	3.5	1	**2**			9.6	19.2	7.6	4.3	4.1	4.1	114.7	145.3
4511	2310	2294	134.4	4	4	1	1			12.6	12.6	4.3	4.6	4.1	2.9	114.7	145.2
4508	2294	2280	38.7	4	4	1	**2**			12.6	25.1	4.6	7.1	2.9	5.5	114.7	145.2
4500	2280	2235	123.8	4	4	1	**2**			12.6	25.1	7.1	5.9	5.5	4.8	101.2	145.2
4479	2235	2223	63.7	4	4	1	**2**			12.6	25.1	5.9	6.4	4.8	4.7	64.7	145.2
N. Nottingham St. Parallel System North (Figure 16)																	
4470	2223	2201	51.3	3	3	1	1	**LPR_C10**	**4.5**	7.1	23.0	6.4	6.9	4.7	4.9	26.3	97.6
4459	2201	2194	59.5	2.83×4.42[a]	2.83×4.42[a]	1	1	**LPR_C11**	**4.5**	9.8	25.7	6.9	7.3	4.9	5.1	26.3	100.6
N. Nottingham St. Parallel System South																	
4469	2223	2213	35.5	3.5	3.5	1	1			9.6	9.6	6.4	6.3	4.7	4.6	40.0	56.2
4465	2213	2194	42.2	3.5	3.5	1	1			9.6	9.6	6.3	7.3	4.6	5.1	38.4	57.2
N. Nottingham St. Parallel System to 33rd St. North (Figure 16)																	
4455	2194	2175	134.6	3.5	3.5	1	1	**LPR_C12**	**4.5**	9.6	25.5	7.3	6.0	5.1	4.8	116.2	266.2
4440	2175	2151	77.1	3.5	3.5	1	1	**LPR_C13**	**4.5**	9.6	25.5	6.0	5.6	4.8	5.0	116.2	270.8
4432	2151	2156	79.3	3.5	3.5	1	1	**LPR_C14**	**4.5**	9.6	25.5	5.6	4.8	5.0	4.8	116.2	263.8
23001	2156	23146	39.0	3.5	3.5	1	1	**LPR_C15**	**4.5**	9.6	25.5	4.8	2.6	4.8	3.8	116.2	262.4
23002	23146	23145	102.2	3.2×5	3.2×5	1	1	**LPR_C16**	**3.2×3**	16.0	25.6	2.6	2.5	3.8	3.7	116.2	261.0
23003	23145	23147	94.1	3.2×5	3.2×5	1	1	**LPR_C17**	**3.2×3**	16.0	25.6	2.5	3.2	3.7	2.6	116.4	261.0
23004	23147	23148	137.7	4	4	1	**2**			12.6	25.1	3.2	2.8	2.6	4.2	116.2	261.6
23005	23148	23149	36.3	4.5	4.5	1	1	**LPR_C18**	**4**	15.9	28.5	2.8	3.1	4.2	5.3	116.2	264.9
23006	23149	23150	135.4	4.5	4.5	1	1	**LPR_C19**	**4**	15.9	28.5	3.1	3.1	5.3	5.8	116.4	261.7
23007	23150	23151	59.7	4.83×7.58	4.83×7.58	1	1			36.7	36.7	3.1	4.6	5.8	6.3	118.0	261.7

TABLE 3 (CONTINUED)
10-yr, 24-hr SCS Type II Storm Event: Final Iteration Results Summary

Conduit ID	Node ID		Length (ft)	Size (Diameter or H × W) (ft)		No. of Barrels		Additional Pipe		Equivalent Cross-Sectional Area (ft^2)		Existing HGL		Final HGL		Flow (cfs)	
	US	DS		Existing	Final	Existing	Final	Model ID	Diameter (ft)	Existing	Final	US (ft)	DS (ft)	US (ft)	DS (ft)	Existing	Final
23008	23151	23152	262.5	5.5	5.5	1	1			23.8	23.8	4.6	8.4	6.3	6.4	165.2	299.8
23009	23152	2024	22.1	5.5	5.5	1	2			23.8	47.5	8.4	7.6	6.4	5.8	165.3	299.9
N. Nottingham St. to John Marshall Dr. Parallel System (Figure 17; profile continues on Figure 18)																	
4618	2547	2494	109.1	3	3	1	1			7.1	7.1	7.7	4.7	6.5	3.1	78.4	85.6
4595	2494	2432	121.7	3	3	1	1			7.1	7.1	4.7	5.1	3.1	3.0	78.4	85.6
4566	2432	2406	65.0	3	3	1	1	LPR_C30	2	7.1	10.2	5.1	2.0	3.0	1.9	78.4	85.6
John Marshall Dr. Parallel System South (Figure 17; profile continues on Figure 18)																	
22050	2406	2336	236.9	3	3	1	1			7.1	7.1	2.0	7.2	1.9	5.3	73.8	81.8
John Marshall Dr. Parallel System North																	
20266	2406	2384	33.2	2.25	2.2	1	1			3.8	3.8	2.0	0.5	1.9	0.4	4.6	3.7
20267	2384	2380	28.0	2.25	2.2	1	1			3.8	3.8	0.5	0.9	0.4	0.8	4.6	3.7
4543	2380	2336	177.1	2.25	2.2	1	1			3.8	3.8	0.9	7.2	0.8	5.3	4.6	3.7
John Marshall Dr. Parallel System to N. Kensington St. (Figure 17; profile continues on Figure 18)																	
4522	2336	2292	138.7	3	3	1	1	LPR_C31	2	7.1	10.2	7.2	3.8	5.3	3.4	73.0	85.9
4506	2292	2272	38.7	3	3	1	1	LPR_C33	3	7.1	14.1	3.8	5.2	3.4	4.6	72.7	86.7
N. Kensington St. and Yorktown Blvd. to 33rd St. North (Figure 18;profile continues on Figure 19)																	
4523	2337	2272	144.7	3.5	3.5	1	1			9.6	9.6	4.6	5.2	4.1	4.6	101.2	107.4
4496	2272	2218	134.8	4	4	1	1	LPR_C46	3	12.6	19.6	5.2	4.2	4.6	4.1	169.8	218.7
4468	2218	2164	136.8	4	4	1	1	LPR_C47	3	12.6	19.6	4.2	5.9	4.1	6.1	169.8	215.6
4437	2164	2102	121.9	5	5	1	1			19.6	19.6	5.9	5.4	6.1	4.2	181.5	220.0
4408	2102	2024	189.4	5	5	1	1			19.6	19.6	5.4	7.6	4.2	5.8	181.5	220.9
Stem on N. Kensington St. between 32nd St. North and 33rd St. North																	
4439	2172	2164	38.5	3.5	5	1	1			9.6	9.6	3.5	5.9	3.6	6.1	3.6	3.8
33rd St. North to Williamsburg Blvd. and N. Harrison St. (Figure 19; profile continues on Figure 24)																	
4363	2024	1916	279.6	5	5	1	2			19.6	39.3	7.6	8.1	5.8	7.5	258.4	517.2
4319	1916	1882	69.5	5	5	1	1	LPR_C61	5.5	19.6	43.4	8.1	7.1	7.5	5.8	247.8	517.2
4308	1882	1865	48.3	5	5	1	1	LPR_C9	6	19.6	47.9	7.1	6.2	5.8	4.2	248.1	508.5
4303	1865	1780	314.0	5.5	5.5	1	1	LPR_C20	5.5	23.8	47.5	6.2	16.1	4.2	6.6	240.1	524.2
4274	1780	1675	271.1	5.5	5.5	1	1	LPR_C21	5.5	23.8	47.5	16.1	11.0	6.6	8.4	240.0	524.2

TABLE 3 (CONTINUED)
10-yr, 24-hr SCS Type II Storm Event: Final Iteration Results Summary

	Node ID			Size (Diameter or H × W) (ft)		No. of Barrels		Additional Pipe		Equivalent Cross-Sectional Area (ft^2)		Existing HGL		Final HGL		Flow (cfs)	
Conduit ID	US	DS	Length (ft)	Existing	Final	Existing	Final	Model ID	Diameter (ft)	Existing	Final	US (ft)	DS (ft)	US (ft)	DS (ft)	Existing	Final
4226	1675	1653	195.1	6.5	6.5	1	1	LPR_C22	7	33.2	71.7	11.0	10.7	8.4	9.0	413.9	803.4
4206	1653	1643	154.2	6.5	6.5	1	1	LPR_C23	7	33.2	71.7	10.7	9.9	9.0	9.4	413.9	803.4
23281	1643	23400	17.3	6.5	6.5	1	1	LPR_C24	7.5	33.2	77.4	9.9	8.0	9.4	7.7	374.2	803.4
23282	23400	1636	51.5	6.5	6.5	1	1	LPR_C25	7.5	33.2	77.4	8.0	6.3	7.7	6.0	374.4	803.5
20230	1636	1619	113.9	6.5	6.5	1	1	LPR_C26	7.5	33.2	77.4	6.3	7.5	6.0	7.7	369.0	803.4
20229	1619	1584	82.1	7	7	1	1	LPR_C27	7.5	38.5	82.7	7.5	2.4	7.7	4.0	369.1	803.4
N. Jefferson St. to N. Harrison St. and Yorktown Blvd. (Figure 20; profile continues on Figure 21)																	
4672	SU1	2572	152.5	3	3	1	1			7.1	7.1	6.3	6.5	5.5	5.4	71.9	73.7
4625	2572	2532	64.4	3	3	1	1			7.1	7.1	6.5	6.1	5.4	4.8	72.0	73.7
4613	2532	2504	51.3	3	3	1	1			7.1	7.1	6.1	5.2	4.8	3.7	53.9	73.7
4602	2504	2463	62.6	3	3	1	1	LPR_C48	2	7.1	10.2	5.2	5.4	3.7	3.6	53.9	73.7
4580	2463	2435	111.7	3	3	1	1	LPR_C49	3	7.1	14.1	5.4	5.1	3.6	4.2	53.9	73.7
4568	2435	2403	37.0	3	3	1	1	LPR_C50	3	7.1	14.1	5.1	3.6	4.2	3.0	53.9	73.7
4554	2403	2399	12.4	3	3	1	1	LPR_C51	3	7.1	14.1	3.6	1.6	3.0	1.3	53.9	73.7
4552	2399	2350	61.2	3	3	1	1	LPR_C52	3	7.1	14.1	1.6	1.3	1.3	1.2	53.9	73.7
4530	2350	2227	258.9	3.5	3.5	1	1	LPR_C53	3	9.6	16.7	1.3	3.0	1.2	2.8	53.9	73.7
4474	2227	2140	184.0	3.5	3.5	1	1	LPR_C54	4	9.6	22.2	3.0	5.4	2.8	5.3	56.2	74.1
Little Falls Road to N. Harrison St.																	
4477	2230	2210	52.9	3	3	1	1			7.1	7.1	5.0	2.3	5.0	2.3	85.4	85.4
4464	2210	2140	290.6	3	3	1	1			7.1	7.1	2.3	5.4	2.3	5.3	84.2	84.8
N. Harrison St. and Yorktown Blvd. to N. Harrison St. and 32nd St. North (Figure 21; profile continues on Figure 22)																	
20243	2140	2120	47.9	4	4	1	1	LPR_C55	4	12.6	25.1	5.4	4.3	5.3	4.2	142.2	233.7
20246	2120	2067	91.8	4	4	1	1	LPR_C56	4	12.6	25.1	4.3	3.8	4.2	3.5	142.2	233.3
4387	2067	1964	222.2	4.5	4.5	1	1	LPR_C57	4	15.9	28.5	3.8	5.5	3.5	5.0	214.7	324.0
20940	1964	1922	121.7	4.5	4.5	1	1	LPR_C58	3	15.9	23.0	5.5	4.3	5.0	4.0	214.7	324.0
4323	1922	1809	386.2	5	5	1	1	LPR_C59	2	19.6	26.7	4.3	7.3	4.0	4.3	212.4	328.5
4286	1809	1759	130.3	5	5	1	2			19.6	39.3	7.3	6.1	4.3	4.3	212.3	320.2

TABLE 3 (CONTINUED)
10-yr, 24-hr SCS Type II Storm Event: Final Iteration Results Summary

	Node ID		Length (ft)	Size (Diameter or H × W) (ft)		No. of Barrels		Additional Pipe		Equivalent Cross-Sectional Area (ft^2)		Existing HGL		Final HGL		Flow (cfs)	
Conduit ID	US	DS		Existing	Final	Existing	Final	Model ID	Diameter (ft)	Existing	Final	US (ft)	DS (ft)	US (ft)	DS (ft)	Existing	Final
N. Harrison St. and 32nd St. N. to Williamsburg Blvd. Parallel System (Figure 22; profile continues on Figure 24)																	
20234	1759	1683	193.0	5.5	5.5	1	2			23.8	47.5	6.1	5.6	4.3	5.5	259.5	417.7
20235	1683	1637	153.3	5.5	5.5	1	2			23.8	47.5	5.6	6.4	5.5	6.4	213.3	417.7
Williamsburg Blvd. Parallel System West (Figure 22; profile continues on Figure 24)																	
20236	1637	1608	58.5	5.5	5.5	1	2			23.8	47.5	6.4	5.8	6.4	5.8	177.6	379.6
Williamsburg Blvd. Parallel System East																	
22841	1637	1630	28.0	3.5	3.5	1	1			9.6	9.6	6.4	4.6	6.4	4.6	35.7	38.2
4193	1630	1622	20.9	3.5	3.5	1	1			9.6	9.6	4.6	4.4	4.6	4.5	35.8	38.2
4188	1622	1608	31.1	3.5	3.5	1	1			9.6	9.6	4.4	5.8	4.5	5.8	35.7	38.2
Williamsburg Blvd. Parallel System to Williamsburg Blvd. (Figure 22; profile continues on Figure 24)																	
20231	1608	1596	32.1	5.5	5.5	1	2			23.8	47.5	5.8	4.6	5.8	4.8	213.3	417.7
20232	1596	1584	26.7	5.5	5.5	1	2			23.8	47.5	4.6	2.4	4.8	4.0	213.3	417.7
30th St. North to Williamsburg Blvd. (Figure 23)																	
4161	1574	1579	66.6	3.5	3.5	1	1			9.6	9.6	5.1	4.4	5.1	4.3	99.4	100.1
4160	1579	1567	170.6	3.5	3.5	1	1			9.6	9.6	4.4	3.7	4.3	2.8	151.6	154.2
4158	1567	1575	194.0	3.5	3.5	1	1			9.6	9.6	3.7	9.5	2.8	6.7	150.3	154.3
4175	1575	1603	189.7	4	4	1	1			12.6	12.6	9.5	7.4	6.7	5.3	150.3	154.3
22665	1603	22873	78.5	4	4	1	1			12.6	12.6	7.4	9.9	5.3	4.5	150.3	154.3
22666	22873	1623	118.5	4	4	1	1			12.6	12.6	9.9	9.0	4.5	6.8	150.3	154.3
4227	1623	1675	181.4	5.5	5.5	1	2			23.8	47.5	9.0	11.0	6.8	8.4	100.9	154.4
36th St. North to Old Dominion Dr. Culvert System (Figure 24; profile continues on Figure 25)																	
4166	1584	1516	229.4	6×9	6×9	2	2			108.0	108.0	2.4	3.1	4.0	5.4	801.4	1386.0
22953	1516	1426	316.9	6×9	6×9	2	2			108.0	108.0	3.1	4.6	5.4	6.8	800.5	1382.1
22964	1426	1397	82.8	6×9	6×9	2	3			108.0	162.0	4.6	3.7	6.8	6.5	799.4	1381.3
20213	1397	1302	315.5	6×9	6×9	2	2	LPR_C62	6	108.0	136.3	3.7	2.8	6.5	5.5	799.5	1381.0
20211	1302	1261	158.9	6×9	6×9	2	2			108.0	108.0	2.8	3.4	5.5	7.6	799.1	1371.4
24810	1261	1235	64.9	6×9	6×9	2	2			108.0	108.0	3.4	3.7	7.6	8.0	798.9	1371.4
20210	1235	1154	277.3	6×9	6×9	2	2			108.0	108.0	3.7	5.7	8.0	7.8	798.7	1371.4
20203	1154	1135	40.6	6×9	6×9	2	2	LPR_C34	7.5	108.0	152.2	5.7	5.2	7.8	7.3	798.6	1372.1
20205	1135	1129	10.5	6×9	6×9	2	2	LPR_C35	7.5	108.0	152.2	5.2	5.2	7.3	7.1	798.7	1373.1

TABLE 3 (CONTINUED)
10-yr, 24-hr SCS Type II Storm Event: Final Iteration Results Summary

	Node ID			Size (Diameter or H × W) (ft)		No. of Barrels		Additional Pipe		Equivalent Cross-Sectional Area (ft^2)		Existing HGL		Final HGL		Flow (cfs)	
Conduit ID	US	DS	Length (ft)	Existing	Final	Existing	Final	Model ID	Diameter (ft)	Existing	Final	US (ft)	DS (ft)	US (ft)	DS (ft)	Existing	Final
20206	1129	1087	146.6	6×9	6×9	2	2	LPR_C36	7	108.0	146.5	5.2	5.1	7.1	6.9	957.6	1507.3
20208	1087	1060	180.7	6×9	6×9	2	2	LPR_C32	7	108.0	146.5	5.1	5.6	6.9	7.0	956.5	1503.7
20209	1060	1048	77.9	6×9	6×9	2	2	LPR_C28	6	108.0	136.3	5.6	4.9	7.0	6.3	955.9	1502.5
6101	1048	1036	73.6	6×9	6×9	2	2	LPR_C29	6	108.0	136.3	4.9	3.9	6.3	5.4	956.0	1502.1
Old Dominion Drive Culvert System North																	
6102	1036	1034	9.7	6×12	6×12	1	1			72.0	72.0	3.9	4.1	5.4	5.6	669.5	1004.0
3900	1034	1018	103.8	12×12.5 [a]	12×12.5 [a]	1	1			150	150	4.1	4.4	5.6	5.3	669.6	1004.2
6106	1018	1016	28.4	6×12	6×12	1	1			72.0	72.0	4.4	6.0	5.3	6.4	668.4	1004.2
Old Dominion Drive Culvert System South																	
6103	1036	1035	21.7	6×12	6×12	1	1			72.0	72.0	3.9	2.8	5.4	3.8	287.5	498.2
6100	1035	1024	80.5	11×12 [a]	11×12 [a]	1	1			132	132	2.8	3.7	3.8	2.8	287.7	498.4
6104	1024	1020	24.1	6×12	6×12	1	1			72.0	72.0	3.7	6.3	2.8	6.6	434.5	498.4
East Branch																	
N. Edison St. to N. George Mason Dr. and 25th Pl. North (Figure 25; profile continues on Figure 26)																	
4963	SU2	3705	57.0	3	3	1	1			7.1	7.1	6.4	6.8	5.1	5.5	51.3	65.8
4953	3705	3695	40.5	3	3	1	1	LPR_C37	2	7.1	10.2	6.8	6.2	5.5	5.2	76.2	102.1
4956	3695	3710	124.6	3	3	1	1	LPR_C38	2	7.1	10.2	6.2	4.8	5.2	4.2	73.9	102.1
4957	3710	3643	122.0	3	3	1	1	LPR_C39	2	7.1	10.2	4.8	2.8	4.2	2.4	73.9	102.1
6413	3643	3789	267.8	3.5	3.5	1	1	LPR_C40	2	9.6	12.8	2.8	6.3	2.4	5.2	76.5	106.6
22690	3789	3770	99.3	3.5	3.5	1	1	LPR_C41	2	9.6	12.8	6.3	6.0	5.2	4.7	76.6	105.9
4983	3770	3768	16.5	3.5	3.5	1	2			9.6	19.2	6.0	5.9	4.7	5.2	76.6	106.3
4982	3768	3693	94.3	4	4	1	1	LPR_C42	2	12.6	15.7	5.9	3.8	5.2	3.4	166.9	194.5
4945	3693	3503	200.1	4.5	4.5	1	1	LPR_C43	2	15.9	19.0	3.8	5.2	3.4	4.4	166.9	196.3
4891	3503	3482	22.5	4.5	4.5	1	1	LPR_C44	2	15.9	19.0	5.2	4.0	4.4	3.2	166.9	193.9
4884	3482	3275	232.3	4.5	4.5	1	1	LPR_C45	2	15.9	19.0	4.0	7.4	3.2	5.5	166.9	197.6
4842	3275	3191	121.0	5	5	1	1	LPR_C60	3	19.6	26.7	7.4	7.8	5.5	6.5	167.0	191.4
Stem on N. Edison St. and 24th St. North																	
22942	3746	23090	34.2	3	3	1	1			7.1	7.1	0.3	0.9	0.0	0.6	1.0	0.0
22943	23090	3643	78.2	3	3	1	1			7.1	7.1	0.9	2.8	0.6	2.4	2.3	0.8

TABLE 3 (CONTINUED)
10-yr, 24-hr SCS Type II Storm Event: Final Iteration Results Summary

	Node ID			Size (Diameter or H × W) (ft)		No. of Barrels		Additional Pipe		Equivalent Cross-Sectional Area (ft^2)		Existing HGL		Final HGL		Flow (cfs)	
Conduit ID	US	DS	Length (ft)	Existing	Final	Existing	Final	Model ID	Diameter (ft)	Existing	Final	US (ft)	DS (ft)	US (ft)	DS (ft)	Existing	Final
25th Pl. North to 26th St. North (Figure 26; profile continues on Figure 29)																	
4867	3415	3256	201.4	3	3	1	1			7.1	7.1	6.4	5.9	5.1	5.8	82.4	98.9
4837	3256	3191	60.3	3.5	3.5	1	2			9.6	19.2	5.9	7.8	5.8	6.5	73.0	99.6
4821	3191	3122	71.5	5.5	5.5	1	2			23.8	47.5	7.8	7.2	6.5	6.2	205.1	325.7
24852	3122	24622	62.7	5.5	5.5	1	2			23.8	47.5	7.2	6.7	6.2	6.2	205.1	324.8
24853	24622	3054	28.5	5.5	5.5	1	2			23.8	47.5	6.7	5.9	6.2	5.7	205.1	324.8
4780	3054	2994	63.2	5.5	5.5	1	2			23.8	47.5	5.9	6.6	5.7	6.6	169.9	219.4
21736	2994	2862	130.4	5.5	5.5	1	2			23.8	47.5	6.6	6.5	6.6	8.0	240.2	312.4
24839	2862	24619	62.3	5.5	5.5	1	2			23.8	47.5	6.5	5.9	8.0	6.8	240.2	304.0
24840	24619	24618	22.4	5.5	5.5	1	2			23.8	47.5	5.9	4.4	6.8	4.9	240.2	303.2
24838	24618	24615	205.8	6	6	1	1			28.3	28.3	4.4	5.6	4.9	6.5	239.9	303.7
4658	24615	2590	71.2	6.5	6.5	1	1			33.2	33.2	5.6	5.1	6.5	6.0	239.5	304.9
4631	2590	2324	393.2	6.5	6.5	1	1			33.2	33.2	5.1	6.3	6.0	7.2	316.6	378.1
4516	2324	2270	110.2	6.5	6.5	1	1			33.2	33.2	6.3	8.1	7.2	9.0	316.5	378.3
6289	2270	2231	96.6	8	8	1	1			50.3	50.3	8.1	7.9	9.0	8.3	366.1	489.7
22797	2231	22968	123.2	8	8	1	1			50.3	50.3	7.9	8.8	8.3	8.6	366.3	489.7
22798	22968	22971	45.5	8	8	1	1			50.3	50.3	8.8	8.3	8.6	7.6	366.3	489.7
22799	22971	2063	165.9	8	8	1	1			50.3	50.3	8.3	9.5	7.6	8.3	366.3	492.2
N. George Mason Dr. and 25th Pl. North to N. George Mason Dr. and Yorktown Blvd. (Figure 27; profile continues on Figure 26)																	
4827	3219	3190	58.3	4	4	1	1			12.6	12.6	0.0	0.2	1.9	3.1	0.0	1.7
4820	3190	3113	77.4	4.5	4.5	1	1			15.9	15.9	0.2	0.8	3.1	3.7	0.6	4.6
4802	3113	3050	86.6	4.5	4.5	1	1			15.9	15.9	0.8	1.8	3.7	4.7	3.9	8.7
21737	3050	24621	67.1	4.5	4.5	1	1			15.9	15.9	1.8	1.7	4.7	4.4	51.4	133.8
24851	24621	24620	127.9	4.5	4.5	1	1			15.9	15.9	1.7	1.6	4.4	3.9	51.4	133.7
24844	24620	2800	85.8	4.5	4.5	1	1			15.9	15.9	1.6	1.5	3.9	3.7	51.4	133.6
21768	2800	2655	203.2	4.5	4.5	1	1			15.9	15.9	1.5	1.9	3.7	4.5	51.4	133.4
21767	2655	2573	88.6	4.5	4.5	1	1			15.9	15.9	1.9	1.6	4.5	3.5	51.4	133.1
20263	2573	2412	238.1	4.5	4.5	1	1			15.9	15.9	1.6	2.4	3.5	3.6	51.6	133.4
21733	2412	2270	253.2	4.5	4.5	1	2			15.9	31.8	2.4	8.1	3.6	9.0	53.9	139.8

TABLE 3 (CONTINUED)
10-yr, 24-hr SCS Type II Storm Event: Final Iteration Results Summary

	Node ID		Length (ft)	Size (Diameter or H × W) (ft)		No. of Barrels		Additional Pipe		Equivalent Cross-Sectional Area (ft^2)		Existing HGL		Final HGL		Flow (cfs)	
Conduit ID	US	DS		Existing	Final	Existing	Final	Model ID	Diameter (ft)	Existing	Final	US (ft)	DS (ft)	US (ft)	DS (ft)	Existing	Final
Cross Connection from Junction 3054 on Figure 26 to Junction 3050 on Figure 27																	
4779	3050	3054	12.9	3	4.5	1	2			7.1	31.8	1.8	5.9	4.7	5.7	51.5	136.1
Stem on N. George Mason Dr. and 26th St. North																	
4778	3024	3050	48.3	3	3	1	1			7.1	7.1	0.0	1.8	2.8	4.7	0.0	1.4
N. Brandywine St. to N. George Mason Dr. (Figure 28)																	
4345	1976	1985	45.1	3	3	1	1			7.1	7.1	8.1	5.9	5.4	2.6	114.4	136.5
4358	1985	2010	106.3	3	3	1	2			7.1	14.1	5.9	8.3	2.6	8.0	100.6	136.1
4366	2010	2033	190.3	3	3	1	2			7.1	14.1	8.3	5.0	8.0	3.0	100.5	135.7
4367	2033	2032	27.3	3	3	1	2			7.1	14.1	5.0	2.1	3.0	1.8	92.6	135.7
4411	2032	2106	301.7	3	3	1	1	LPR_C5	2	7.1	10.2	2.1	5.6	1.8	4.6	92.5	138.8
4415	2106	2115	132.8	4	4	1	1	LPR_C1	3	12.6	19.6	5.6	5.4	4.6	4.6	92.5	134.7
4416	2115	2076	85.8	4	4	1	1	LPR_C2	3	12.6	19.6	5.4	4.4	4.6	4.0	92.6	134.7
4392	2076	2056	28.8	4	4	1	1	LPR_C3	3	12.6	19.6	4.4	3.5	4.0	3.4	92.5	134.7
4383	2056	2064	78.0	4	4	1	1	LPR_C4	3	12.6	19.6	3.5	2.2	3.4	2.8	92.7	134.5
4385	2064	2054	194.7	4	4	1	1			12.6	12.6	2.2	5.7	2.8	4.7	94.8	134.0
4379	2054	2060	118.6	5	5	1	2			19.6	39.3	5.7	7.0	4.7	6.1	94.3	133.3
4381	2060	2063	26.8	5	5	1	2			19.6	39.3	7.0	9.5	6.1	8.3	94.3	133.3
N. Dickerson St. to N. George Mason Dr.																	
23519	1742	23586	72.8	4	4	1	1			12.6	12.6	4.1	3.5	4.1	3.5	93.8	93.8
23521	23586	23587	63.3	4	4	1	1			12.6	12.6	3.5	3.5	3.5	3.5	93.8	93.8
23522	23587	23594	149.2	4	4	1	1			12.6	12.6	3.5	5.8	3.5	5.8	93.8	94.3
23529	23594	1769	148.5	4	4	1	1			12.6	12.6	5.8	6.4	5.8	6.4	93.8	97.9
4270	1769	1772	76.0	4	4	1	1			12.6	12.6	6.4	6.4	6.4	6.3	93.8	98.0
4273	1772	1779	101.4	4	4	1	1			12.6	12.6	6.4	1.1	6.3	1.9	93.8	98.0
6278	1779	1753	189.3	Stream	Stream	1	1									93.8	141.3
N. George Mason Dr. to Williamsburg Blvd. (Figure 29)																	
4382	2063	2007	145.8	8	8	1	1	LPR_C6	6	50.3	78.5	9.5	9.0	8.3	8.3	550.9	765.0
22800	2007	22972	68.5	8	8	1	1	LPR_C7	6	50.3	78.5	9.0	8.3	8.3	7.9	550.9	765.1
22801	22972	1971	31.4	8	8	1	1	LPR_C8	6	50.3	78.5	8.3	5.5	7.9	6.1	550.9	721.6
20944	1971	1868	310.6	Stream	Stream	1	1									589.6	799.3

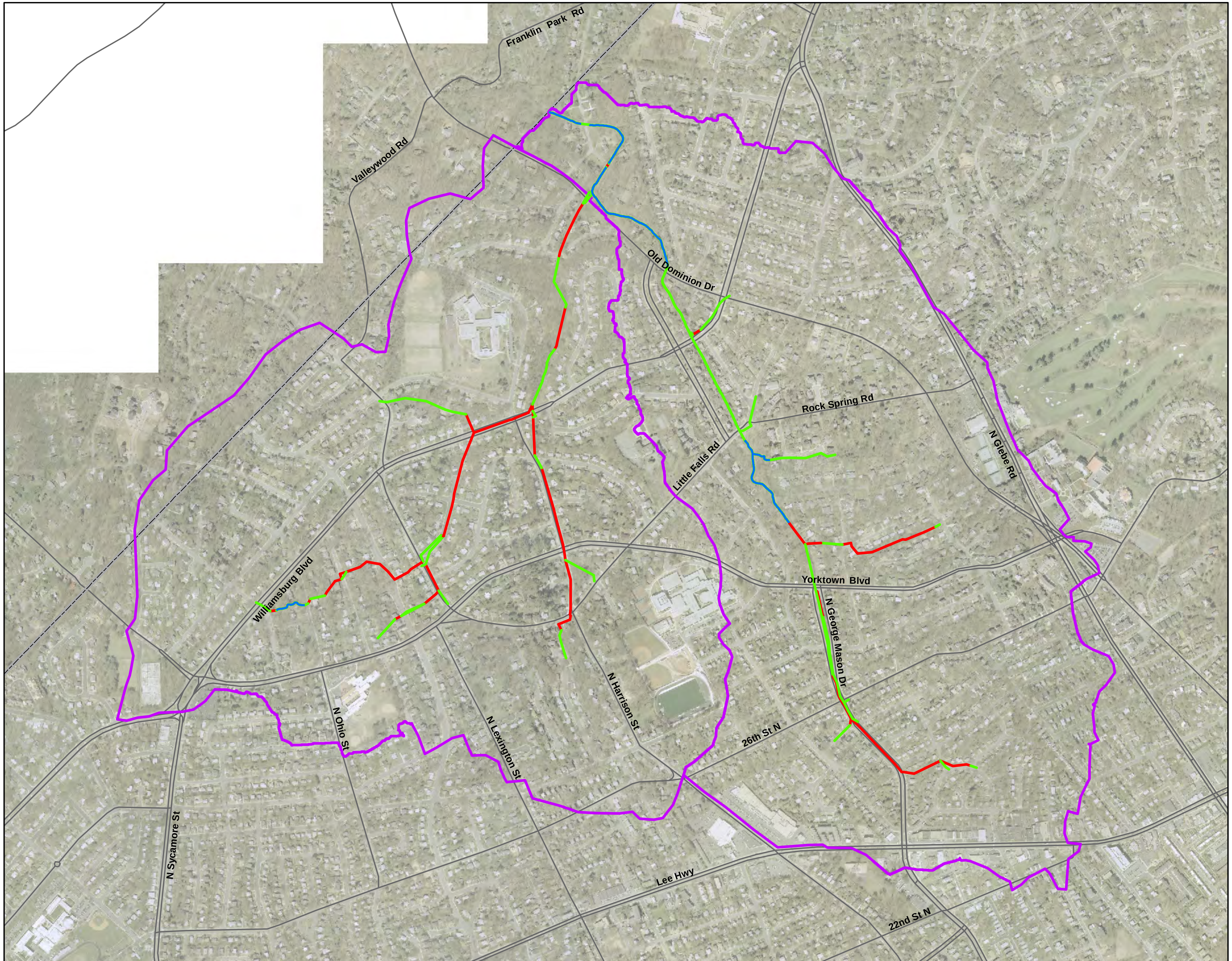
TABLE 3 (CONTINUED)
10-yr, 24-hr SCS Type II Storm Event: Final Iteration Results Summary

	Node ID			Size (Diameter or H × W) (ft)		No. of Barrels		Additional Pipe		Equivalent Cross-Sectional Area (ft^2)		Existing HGL		Final HGL		Flow (cfs)	
Conduit ID	US	DS	Length (ft)	Existing	Final	Existing	Final	Model ID	Diameter (ft)	Existing	Final	US (ft)	DS (ft)	US (ft)	DS (ft)	Existing	Final
6287	1868	1753	475.9	Stream	Stream	1	1									584.6	788.1
6280	1753	1706	149.1	Stream	Stream	1	1									759.0	884.2
4241	1706	1670	94.9	8	8	1	1			50.3	50.3	8.7	7.5	9.9	8.2	688.3	753.6
4221	1670	1651	76.5	8	8	1	1			50.3	50.3	7.5	3.0	8.2	3.2	740.8	801.9
6279	1651	1573	229.9	6×12	6×12	1	1			72.0	72.0	3.0	3.0	3.2	3.2	742.5	804.2
6281	1573	1417	584.4	6×12	6×12	1	1			72.0	72.0	3.0	9.9	3.2	9.8	739.8	800.8
24834	1417	24606	20.2	8×16 [a]	8×16 [a]	1	1			119.0	119.0	9.9	9.3	9.8	8.7	739.1	800.6
24835	24606	24607	10.0	8×16 [a]	8×16 [a]	1	1			119.0	119.0	9.3	9.3	8.7	8.0	739.2	800.6
24836	24607	1383	58.6	8×16 [a]	8×16 [a]	1	1			119.0	119.0	9.3	11.3	8.0	7.9	818.1	858.4
20225	1383	1365	40.0	6×12	6×12	1	1			72.0	72.0	11.3	4.1	7.9	4.1	818.3	858.7
Old Dominion Dr. to Williamsburg Blvd. (Figure 30)																	
22693	22896	1279	63.9	3	3	1	1			7.1	7.1	4.1	9.5	4.1	7.7	97.9	98.0
20223	1279	1291	50.0	3.5	3.5	1	1			9.6	9.6	9.5	8.3	7.7	6.2	144.2	144.3
20222	1291	1326	136.7	4	4	1	1			12.6	12.6	8.3	8.6	6.2	6.5	144.2	144.3
4060	1326	1359	162.4	4	4	1	1			12.6	12.6	8.6	6.2	6.5	4.7	144.2	144.3
4071	1359	1377	85.7	4	4	1	**2**			12.6	25.1	6.2	6.4	4.7	6.7	138.1	144.3
4072	1377	1365	22.8	4	4	1	1			12.6	12.6	6.4	4.1	6.7	4.1	138.1	144.3
Williamsburg Blvd. to Old Dominion Dr.																	
6263	1365	1295	285.3	6×12	6×12	1	1			72.0	72.0	4.1	3.4	4.1	3.8	950.8	991.2
6264	1295	1213	276.7	6×12	6×12	1	1			72.0	72.0	3.4	6.1	3.8	6.3	950.8	991.3
3990	1213	1207	22.6	8×16 [a]	8×16 [a]	1	1			119.0	119.0	6.1	4.9	6.3	5.0	950.4	990.8
3986	1207	1192	79.8	8×16 [a]	8×16 [a]	1	1			119.0	119.0	4.9	3.9	5.0	4.0	950.5	991.0
6268	1192	1169	71.2	Stream	Stream	1	1									950.5	991.0
6269	1169	1097	200.7	Stream	Stream	1	1									1075.5	1109.5
22151	1097	22412	550.5	Stream	Stream	1	1									1075.4	1109.3
22152	22412	1020	215.4	Stream	Stream	1	1									1060.9	1091.1
6105	1020	1016	16.7	Stream	Stream	1	1									1622.1	1714.0

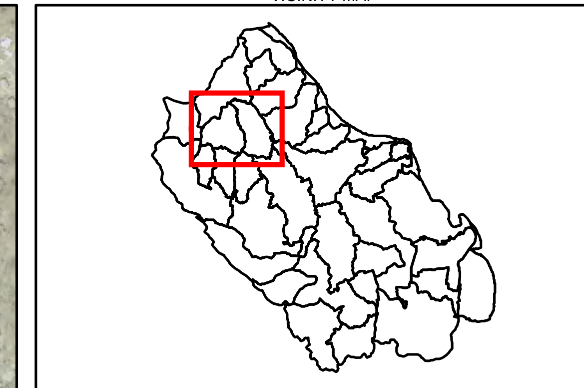
TABLE 3 (CONTINUED)
10-yr, 24-hr SCS Type II Storm Event: Final Iteration Results Summary

	Node ID			Size (Diameter or H × W) (ft)		No. of Barrels		Additional Pipe		Equivalent Cross-Sectional Area (ft^2)		Existing HGL		Final HGL		Flow (cfs)	
Conduit ID	US	DS	Length (ft)	Existing	Final	Existing	Final	Model ID	Diameter (ft)	Existing	Final	US (ft)	DS (ft)	US (ft)	DS (ft)	Existing	Final
Little Falls Rd. and Wine St. to Williamsburg Blvd. and N. George Mason Dr.																	
4204	SU4	1649	245.4	3	3	1	1			7.1	7.1	4.9	5.0	4.6	4.9	44.1	42.9
4210	1649	1655	33.3	3	3	1	1			7.1	7.1	5.0	4.2	4.9	4.2	44.1	42.9
4218	1655	1668	85.9	3	3	1	1			7.1	7.1	4.2	3.2	4.2	3.5	44.1	42.9
4220	1668	1670	28.5	3	3	1	1			7.1	7.1	3.2	7.5	3.5	8.2	44.1	42.9
Main Branch																	
Old Dominion Dr. to County Line (Figure 31)																	
22443	1016	22716	265.4	Stream	Stream	1	1									2114.1	2713.6
22441	22716	22715	41.5	7×10.79 [a]	7×10.79 [a]	2	**3**			60	60	9.7	5.9	9.1	6.2	2114.3	2713.6
22444	22715	949	281.0	Stream	Stream	1	1									2113.7	2713.0
20189	949	932	346.2	Stream	Stream	1	1									2107.4	2560.3
6091	932	930	75.0	7×10.79 [a]	7×10.79 [a]	2	2			60	60	10.8	7.7	13.2	8.4	2017.9	2483.7
20183	930	928	51.7	Stream	Stream	1	1									2017.6	2483.7
20184	928	J1	263.5	Stream	Stream	1	1									2017.0	2531.5

US, upstream; DS, downstream. Note that cross-sectional area and HGL are not calculated for natural stream sections. The existing and final HGL data represent maximum node depths.
[a] Irregularly shaped pipe, such as arch, elliptical.



VICINITY MAP



Legend

- Modeled Stormwater Mains with Recommended Additional Capacity
- Modeled Stormwater Mains with Sufficient Existing Capacity
- Streams
- Arlington/Fairfax Boundary Line
- Roads
- Modeled (Revised) Watershed Boundary

N

0 450 900
Feet

FIGURE 14
Recommended Additional Capacity for the 10-yr, 24-hr Storm
Little Pimmit Run Watershed
Arlington County Storm Capacity Analysis

CH2MHILL

FIGURE 15 - Little Pimmit Run

N. Potomac St. and Williamsburg Blvd. to N. Nottingham St. Parallel System for the 10-yr, 24-hr SCS Type II Storm Event

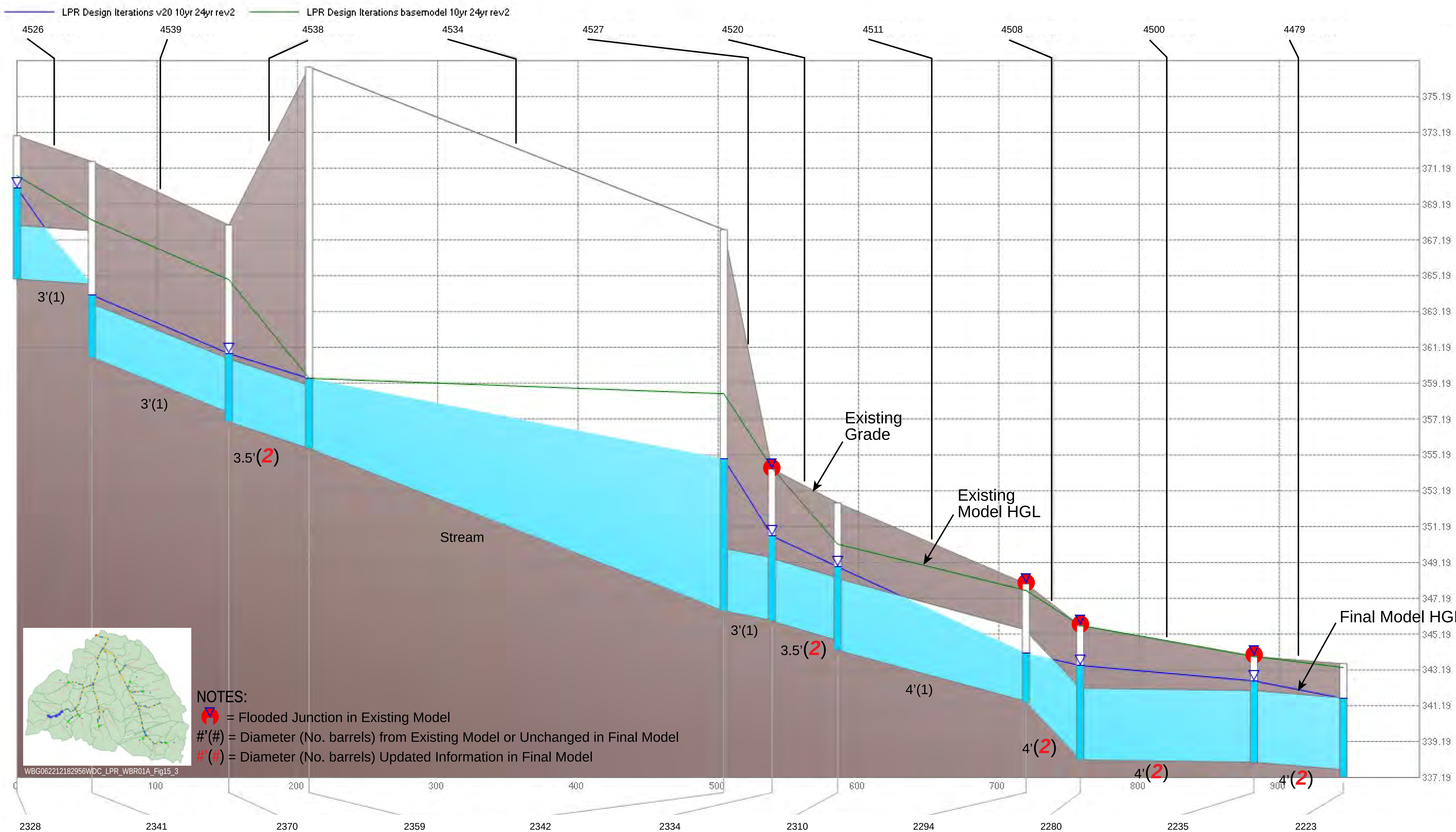


FIGURE 16 - Little Pimmit Run

N. Nottingham St. Parallel System to 33rd St. North for the 10-yr, 24-hr SCS Type II Storm Event

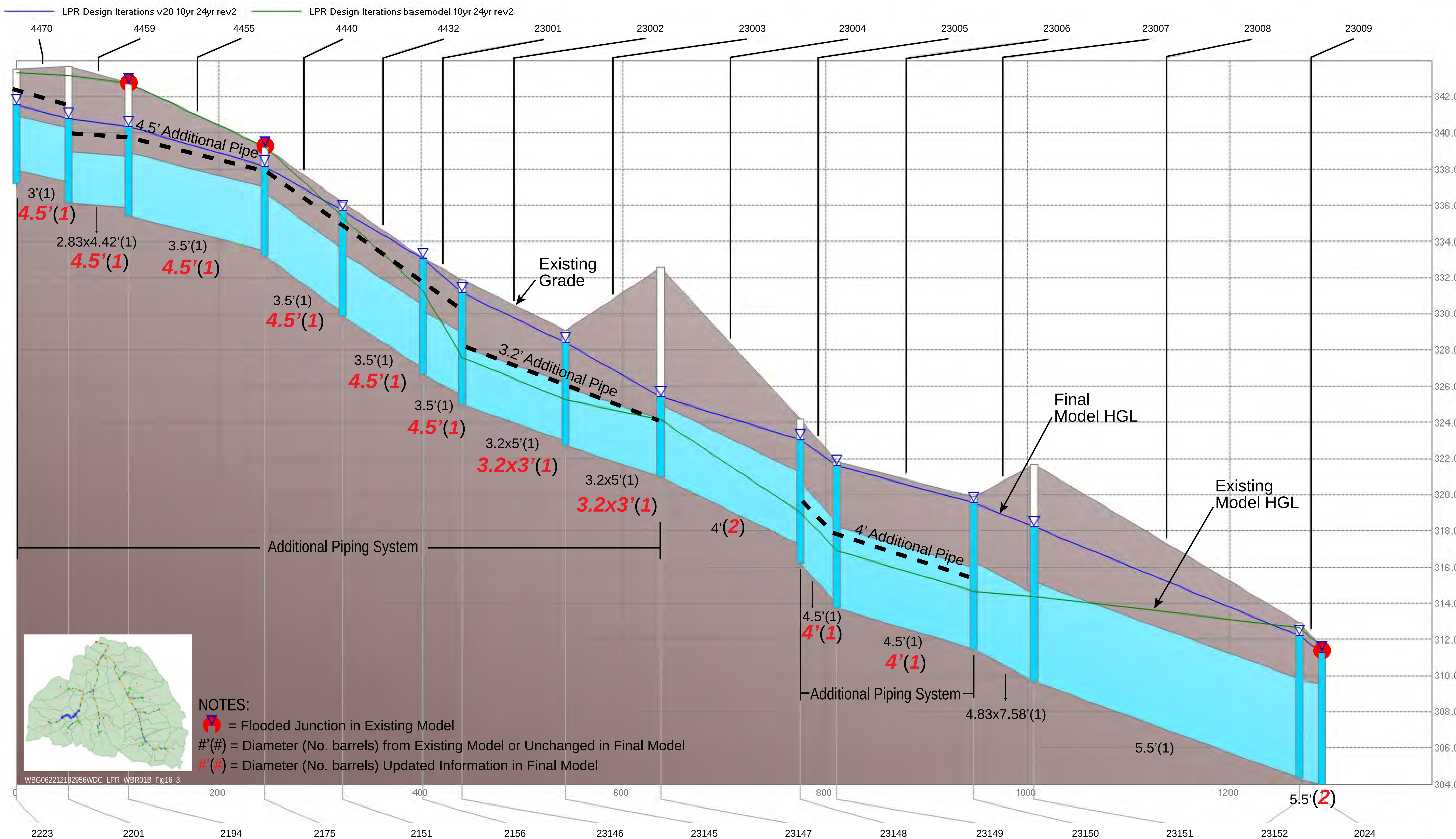


FIGURE 17 - Little Pimmit Run
N. Nottingham St. to N. Kensington St. for the 10-yr, 24-hr SCS Type II Storm Event

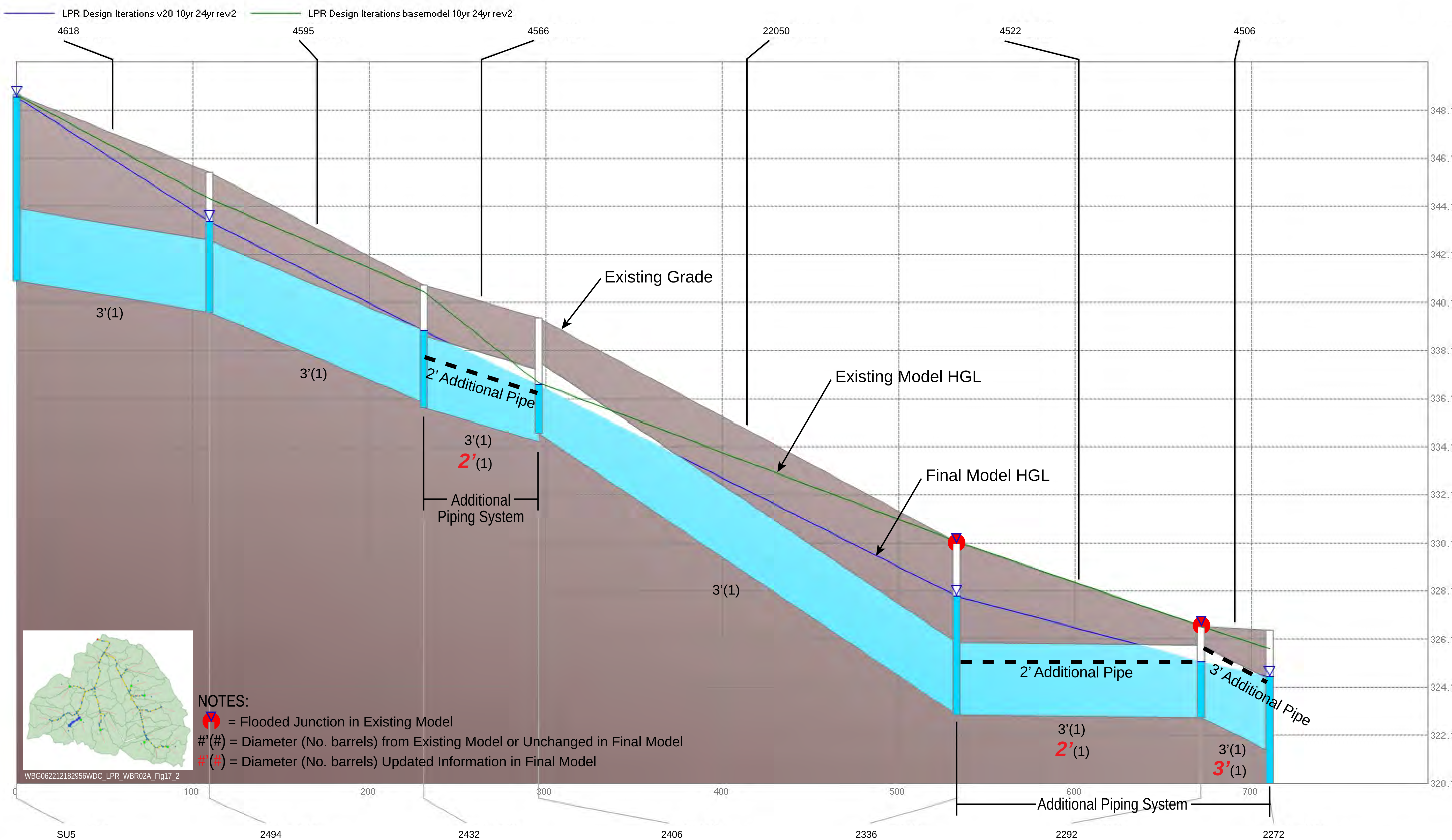


FIGURE 18 - Little Pimmit Run

N. Kensington St. and Yorktown Blvd. to 33rd St. North for the 10-yr, 24-hr SCS Type II Storm Event

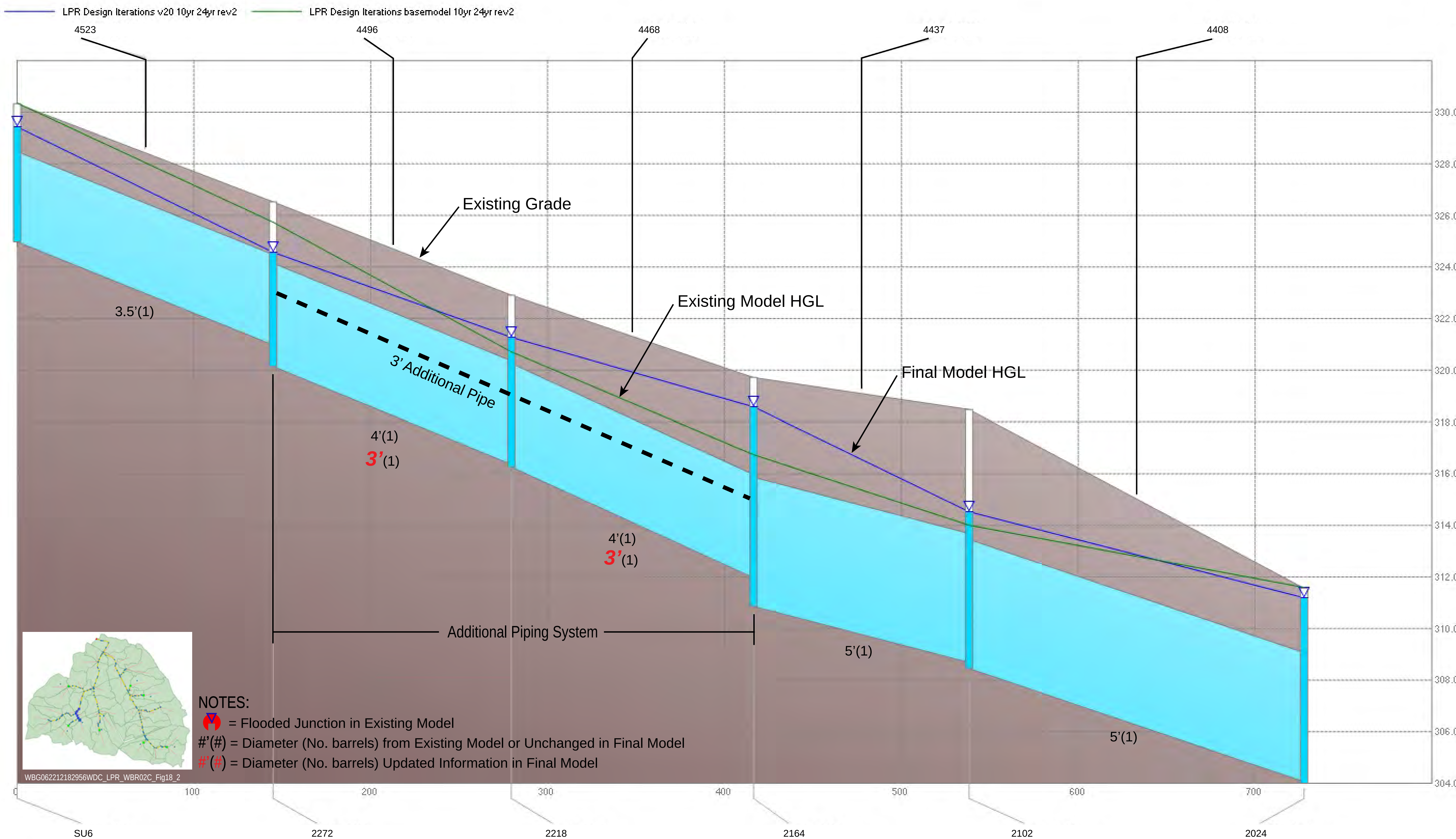


FIGURE 19 - Little Pimmit Run

33rd St. N. to Williamsburg Blvd. and N. Harrison St. for the 10-yr, 24-hr SCS Type II Storm Event

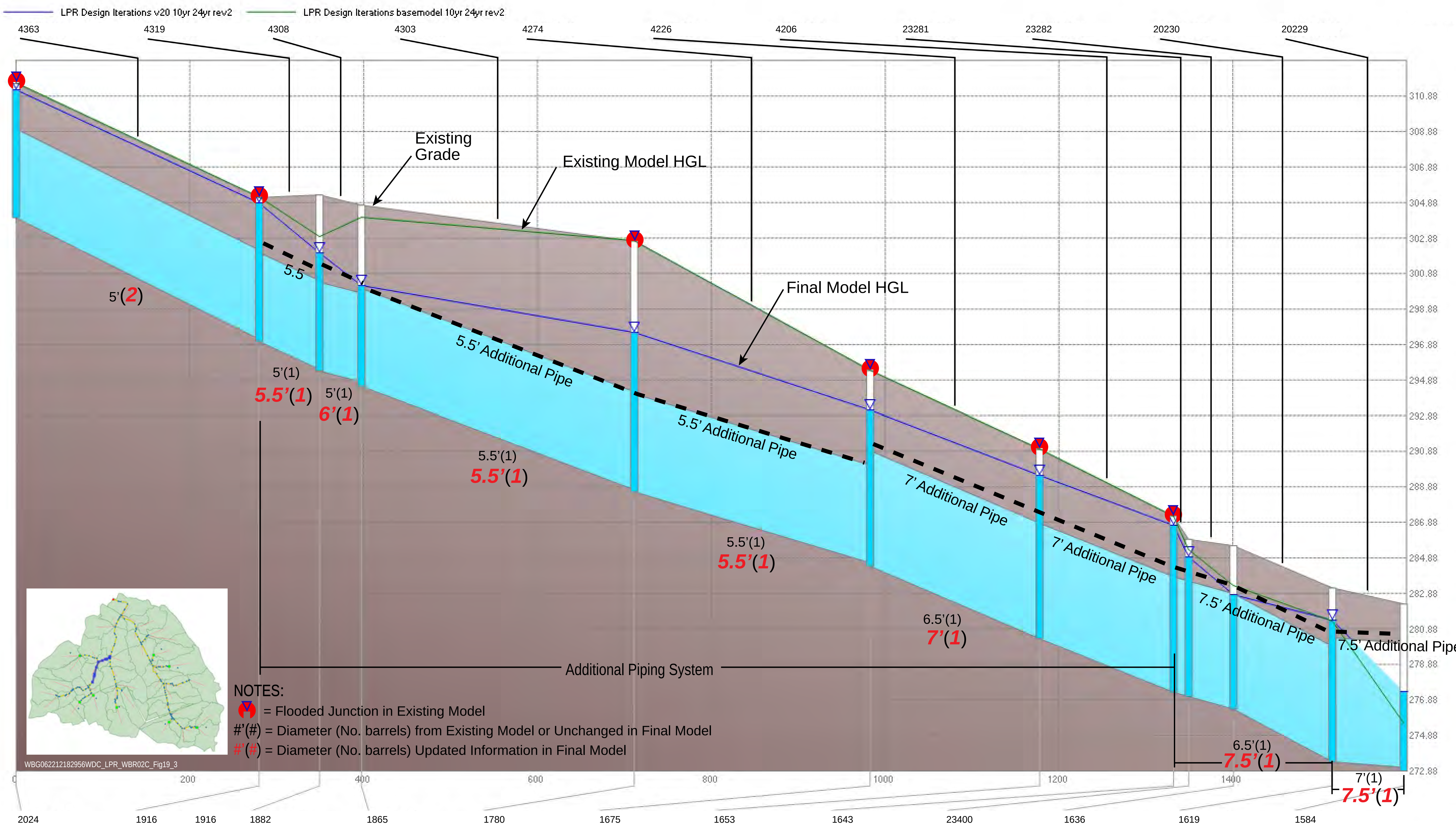


FIGURE 20 - Little Pimmit Run

N. Jefferson St. to N. Harrison St. and Yorktown Blvd. for the 10-yr, 24-hr SCS Type II Storm Event

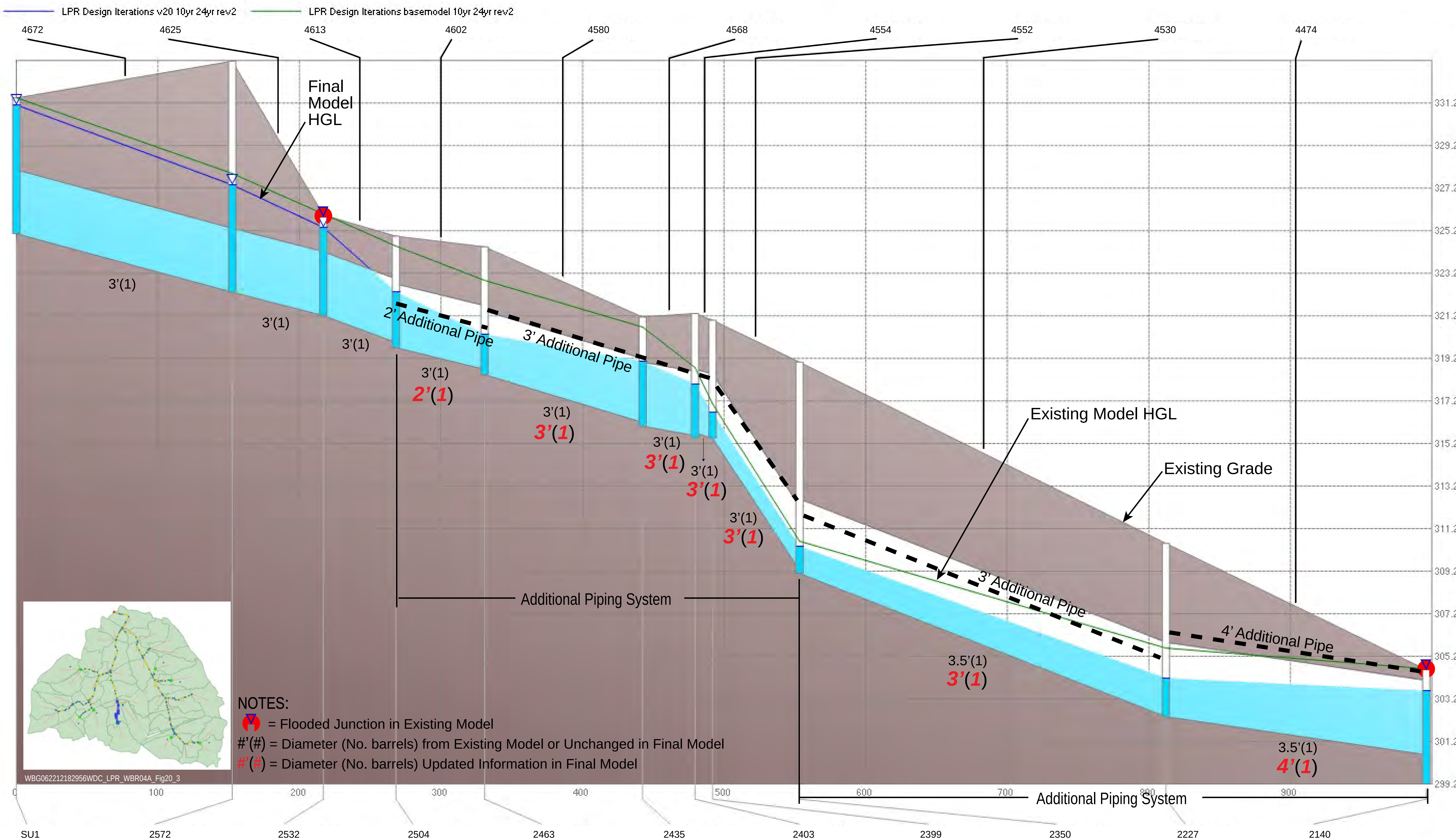


FIGURE 21 - Little Pimmit Run

N. Harrison St. and Yorktown Blvd. to N. Harrison St. and 32nd St. North for 10-yr, 24-hr SCS Type II Storm Event

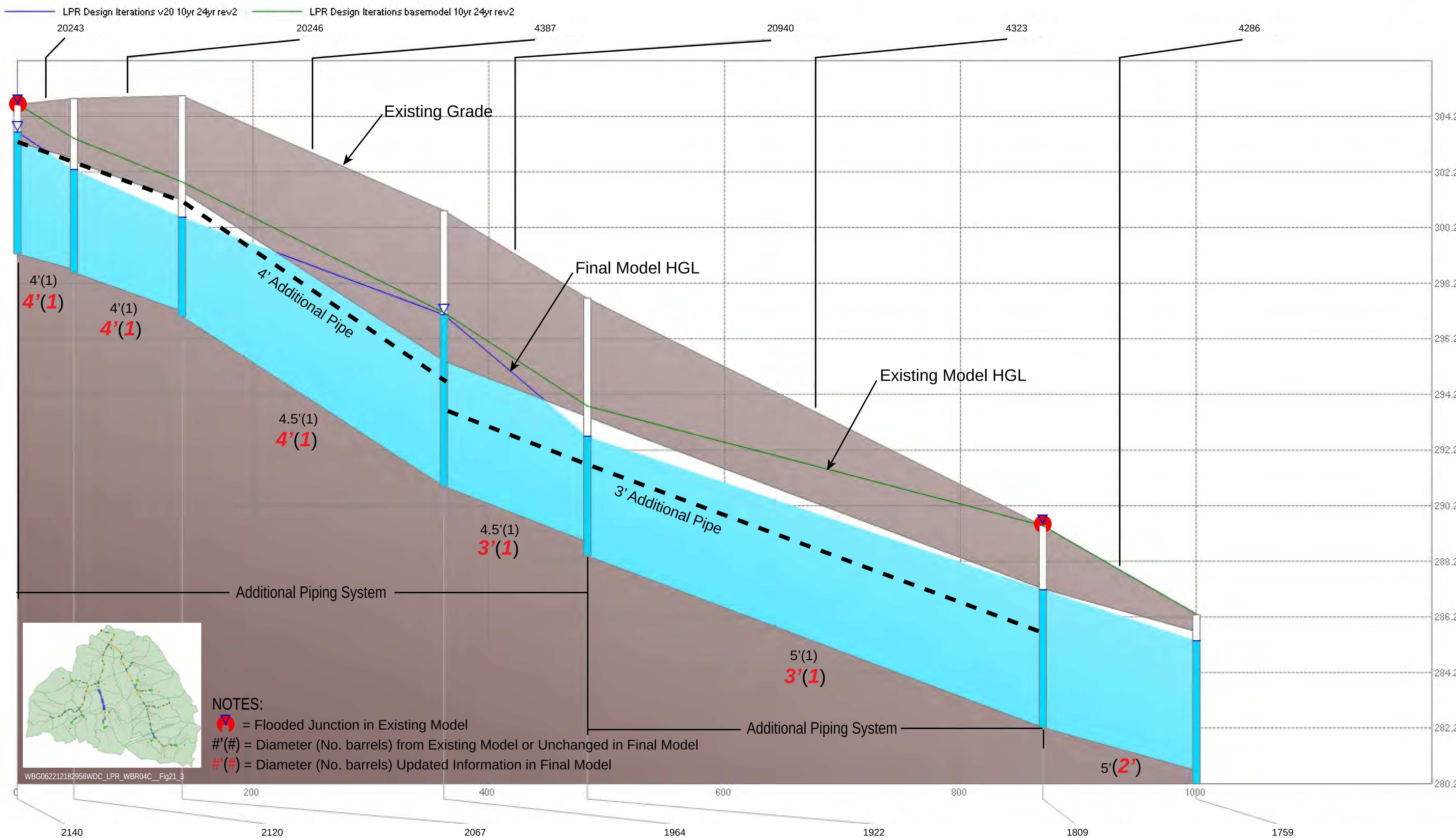


FIGURE 22 - Little Pimmit Run

N. Harrison St. and 32nd St. North to Williamsburg Blvd. for 10-yr, 24-hr SCS Type II Storm Event

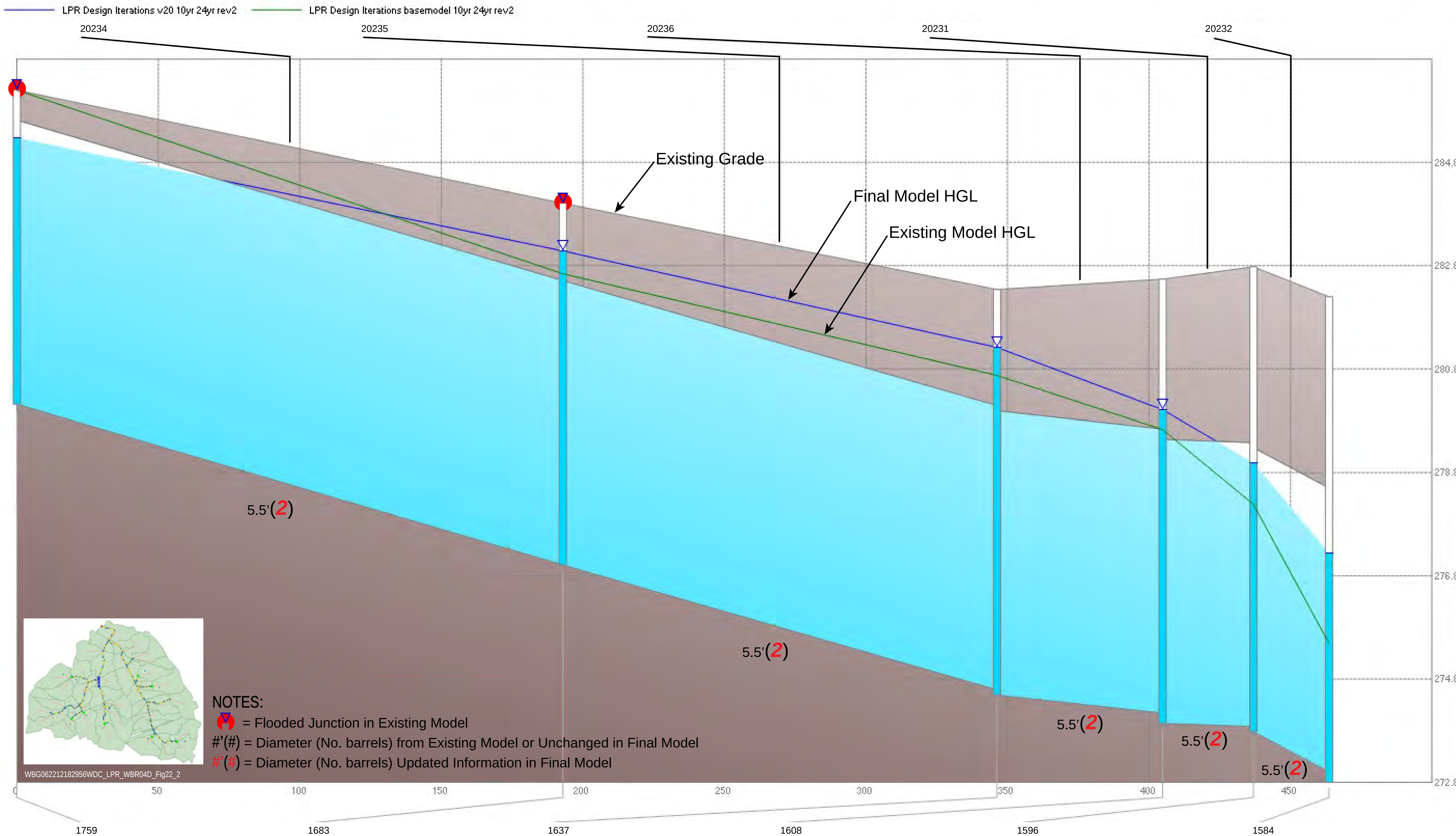


FIGURE 23 - Little Pimmit Run

30th St. North to WIlliamsburg Blvd. for 10-yr, 24-hr SCS Type II Storm Event

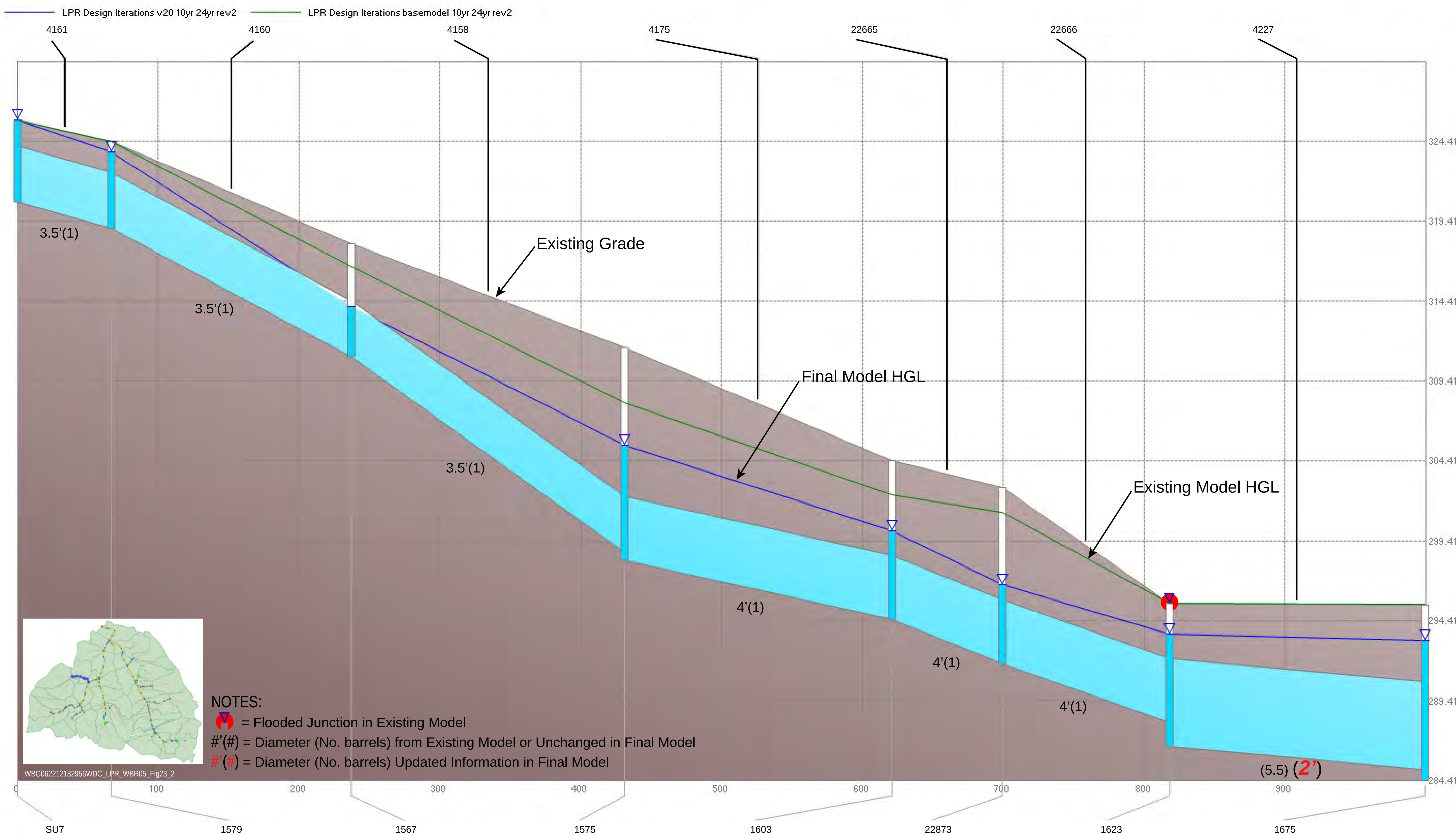


FIGURE 24 - Little Pimmit Run

36th St. North to Old Dominion Drive Culvert System for 10-yr, 24-hr SCS Type II Storm Event

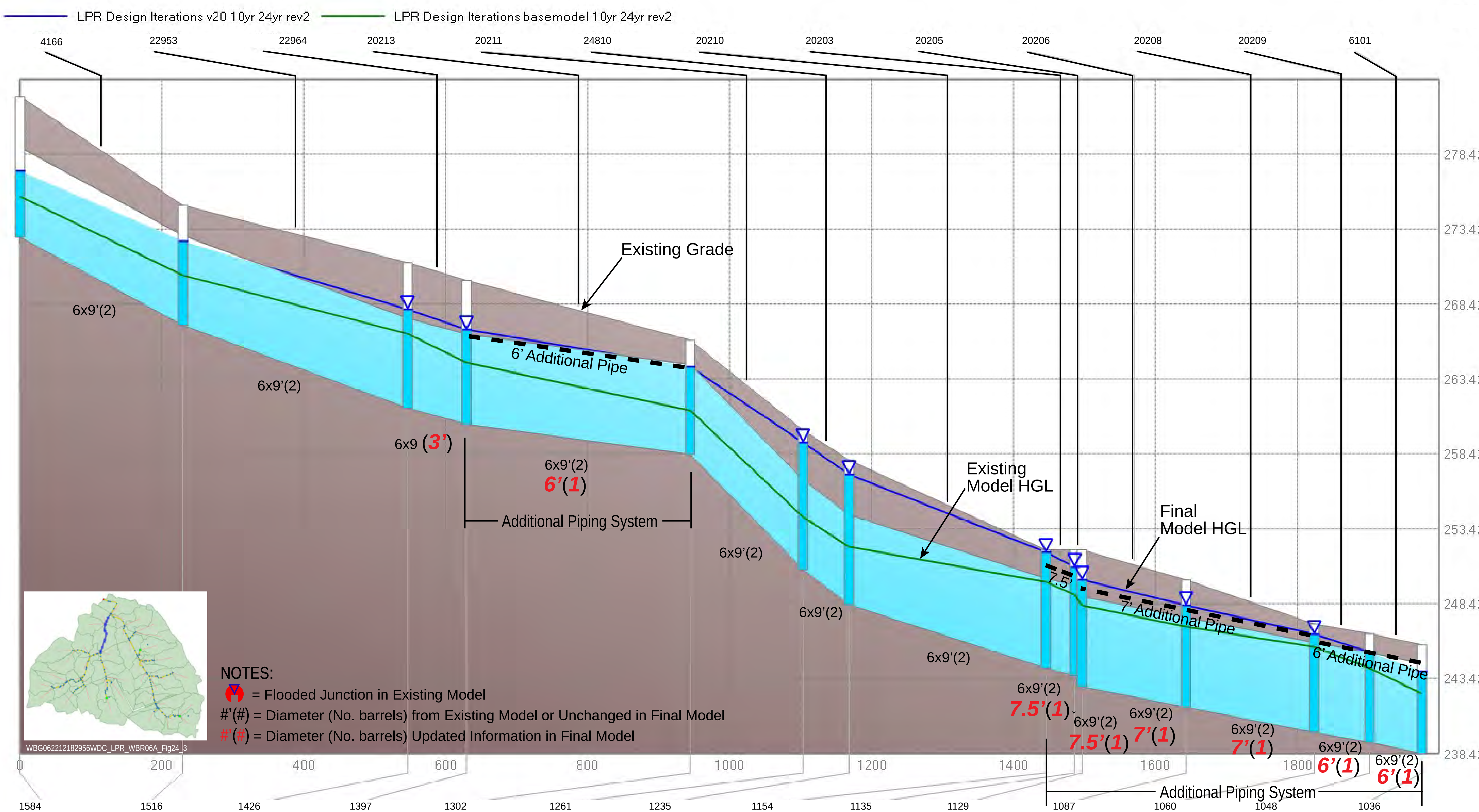


FIGURE 25 - Little Pimmit Run

N. Edison St. to N. George Mason Dr. and 25th Pl. North for 10-yr, 24-hr SCS Type II Storm Event

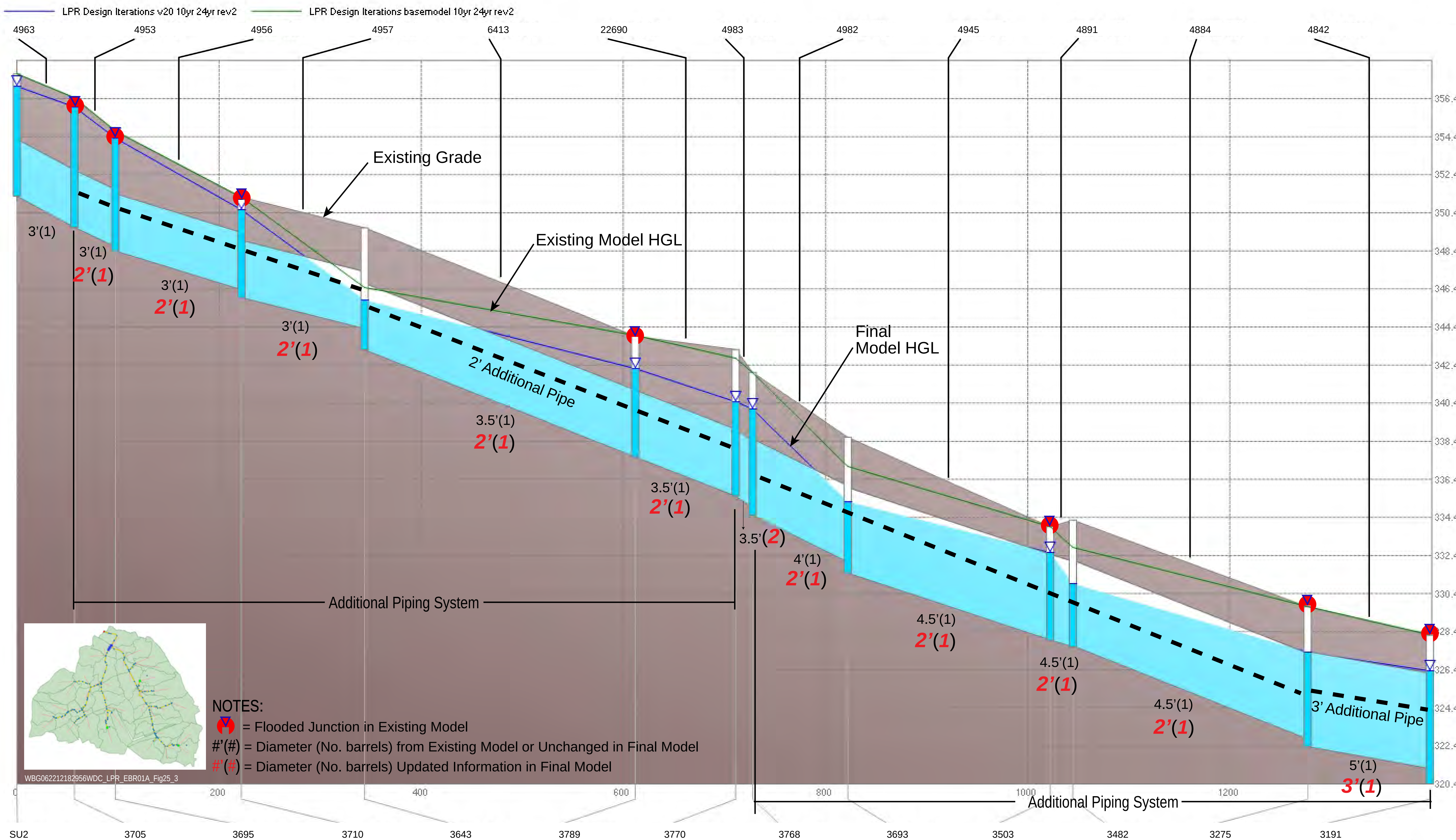


FIGURE 26 - Little Pimmit Run

25th Pl. North to 26th St. North for 10-yr, 24-hr SCS Type II Storm Event

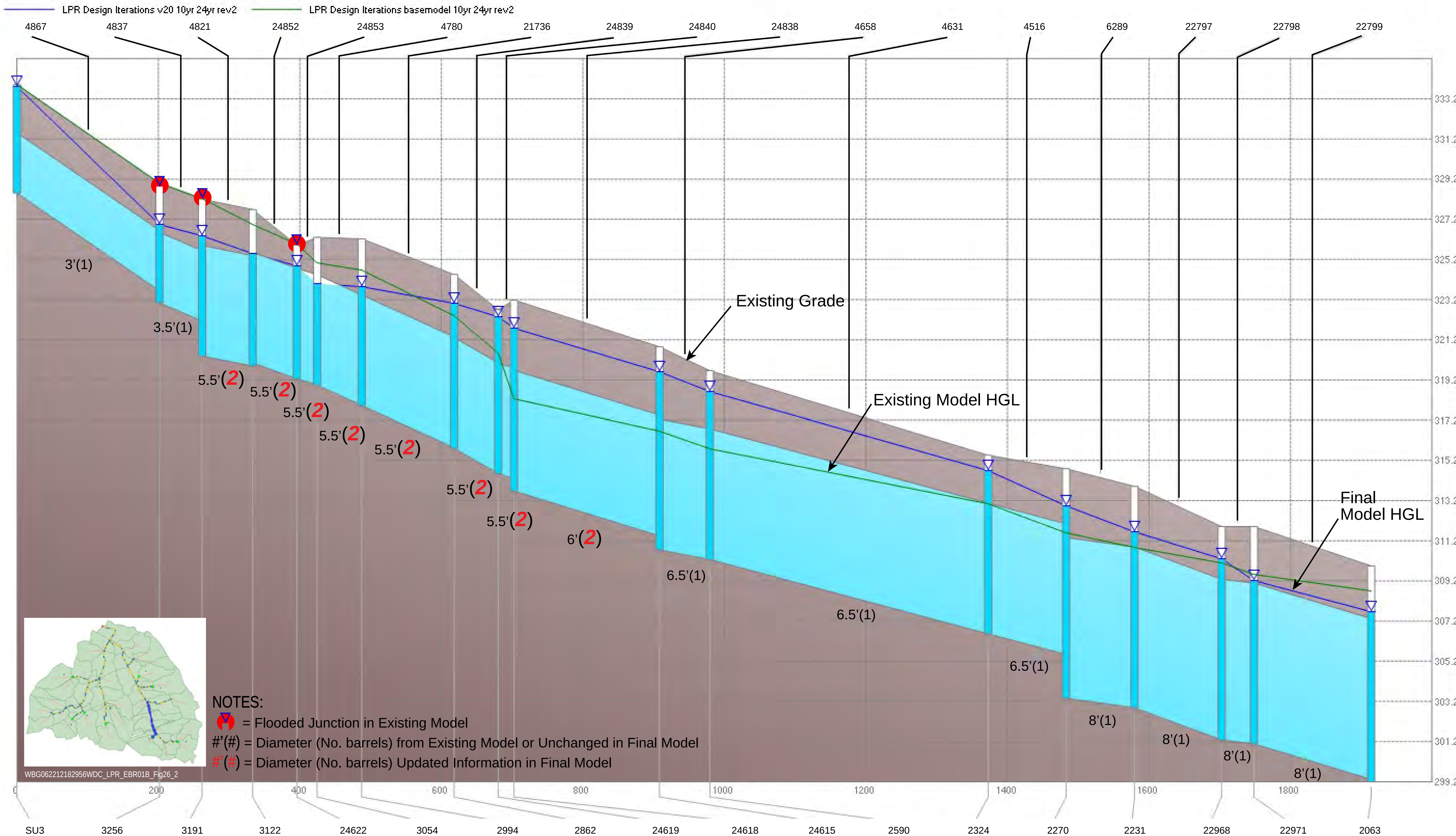


FIGURE 27 - Little Pimmit Run

N. George Mason Dr. and 25th Pl. North to N. George Mason Dr. and Yorktown Blvd. for 10-yr, 24-hr SCS Type II Storm Event

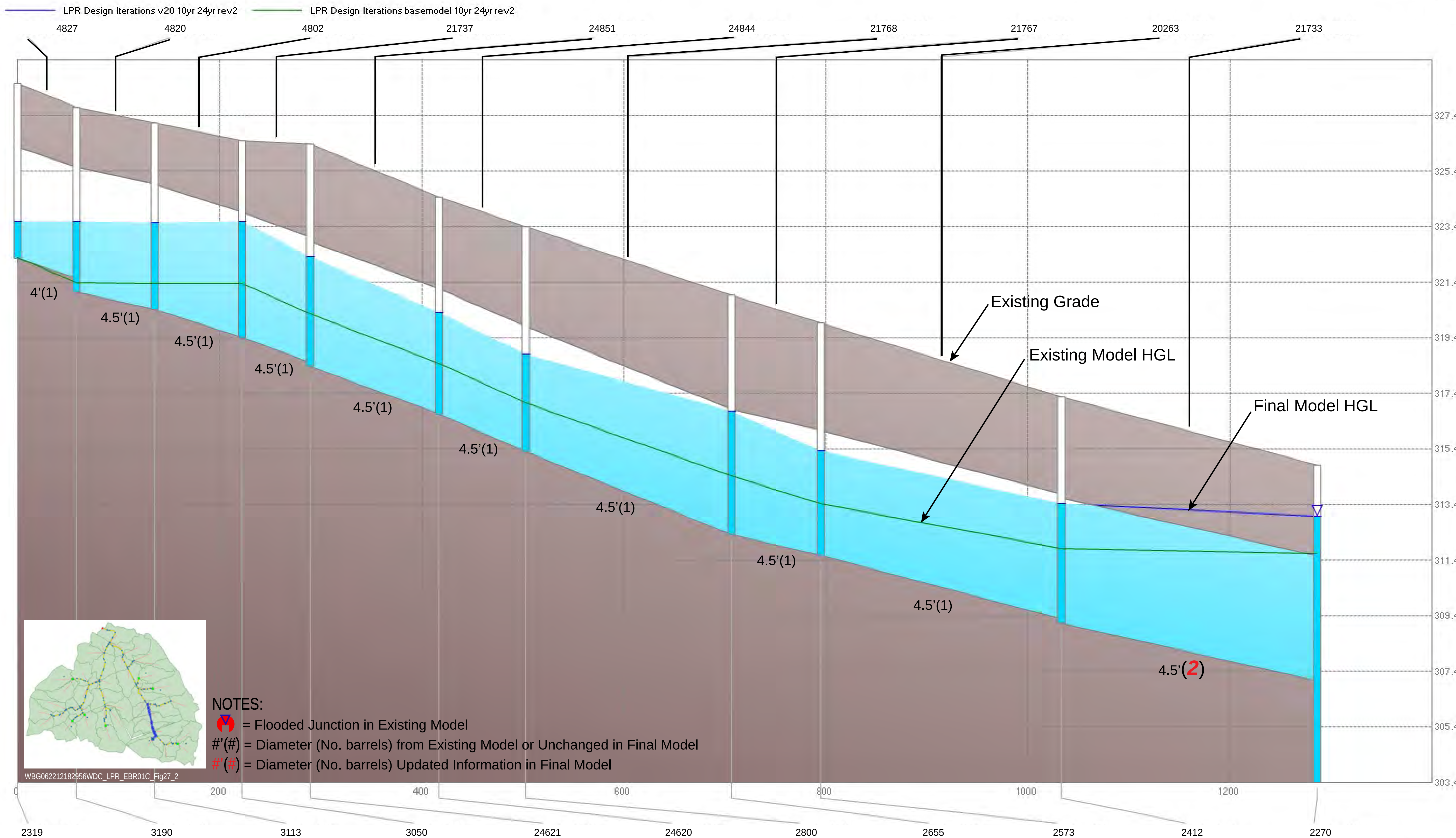


FIGURE 28 - Little Pimmit Run

N. Brandywine St. to N. George Mason Dr. for 10-yr, 24-hr SCS Type II Storm Event

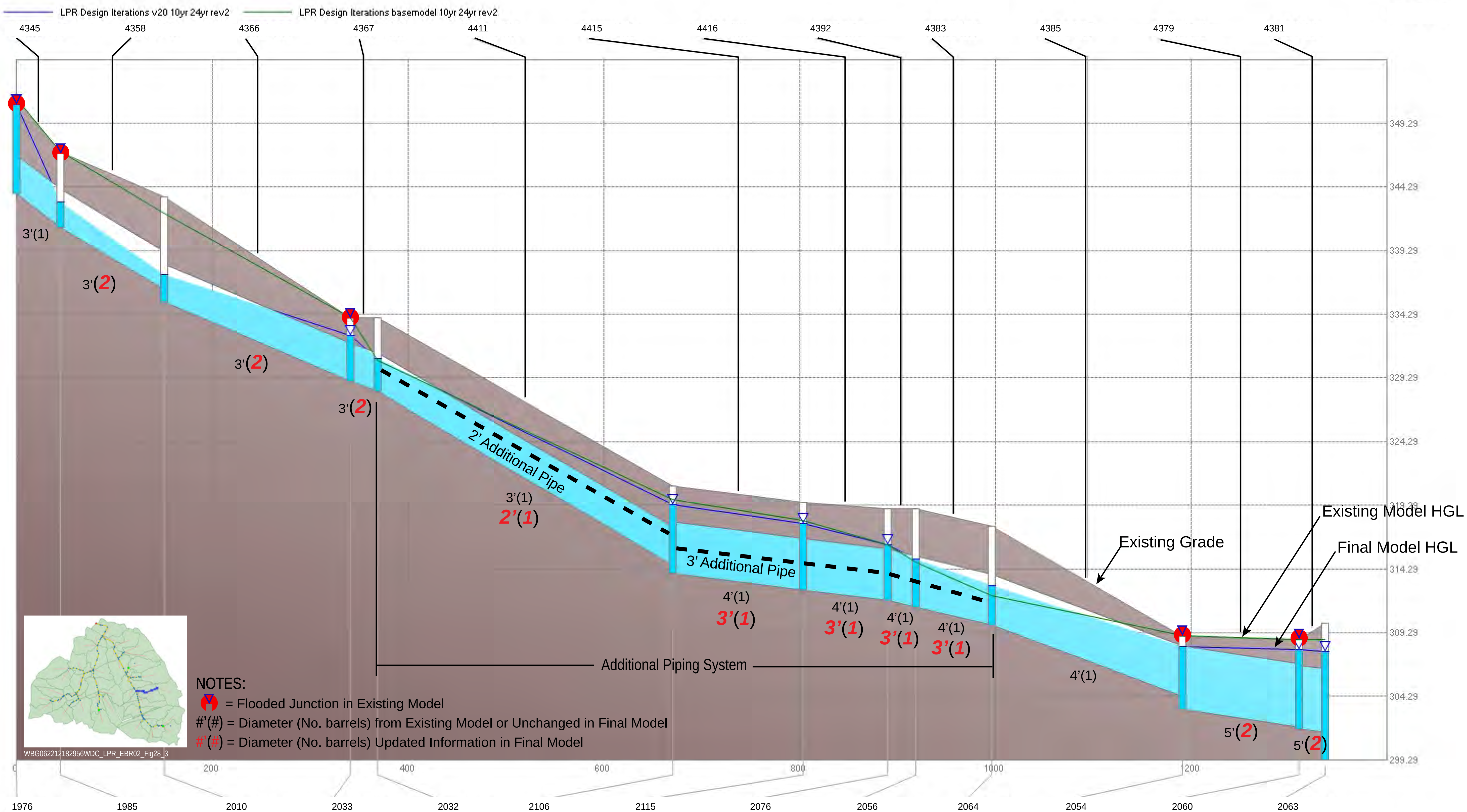


FIGURE 29 - Little Pimmit Run

N. George Mason Dr. to Williamsburg Blvd. for 10-yr, 24-hr SCS Type II Storm Event

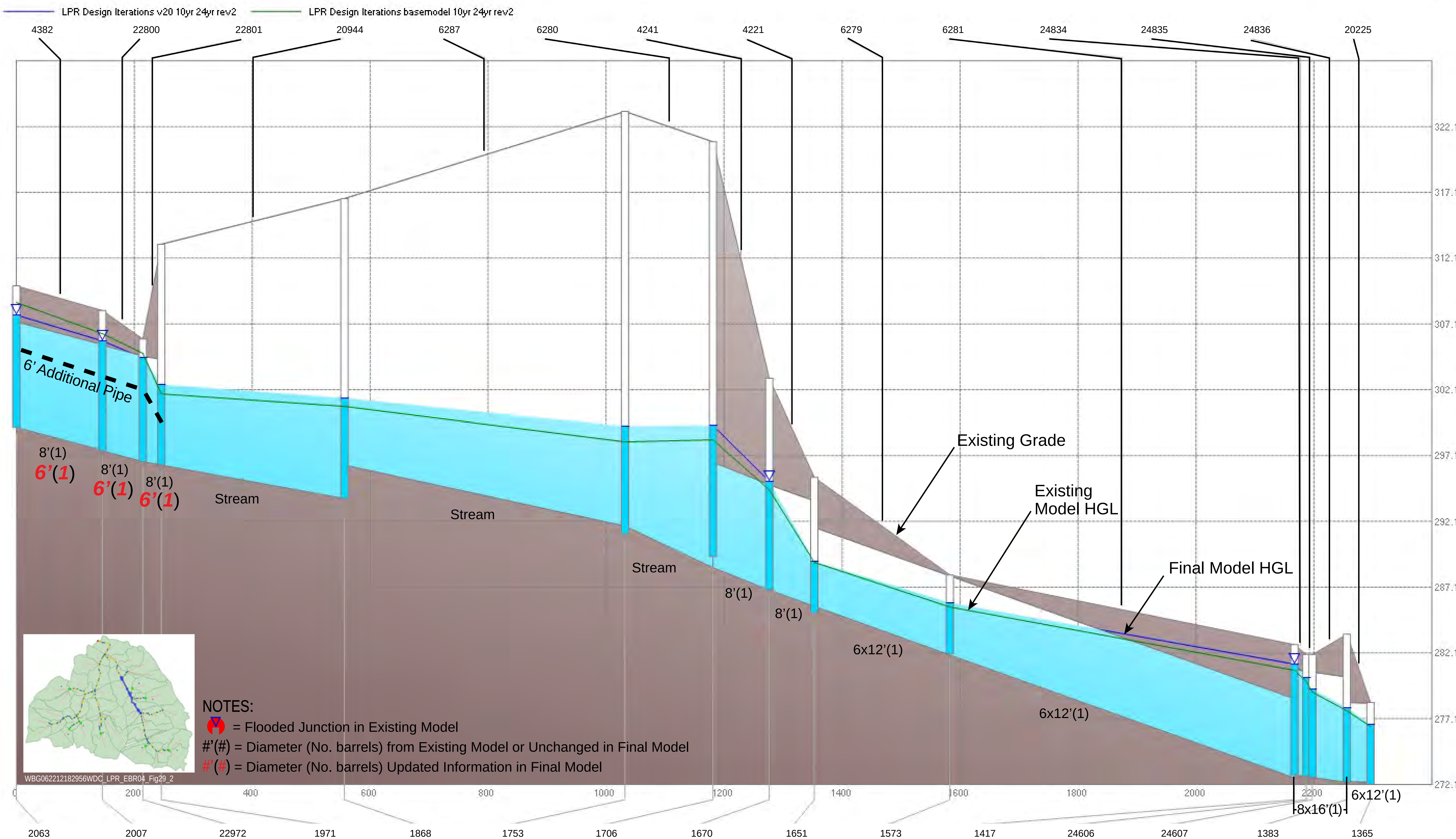


FIGURE 30 - Little Pimmit Run

Old Dominion Dr. to Williamsburg Blvd. for 10-yr, 24-hr SCS Type II Storm Event

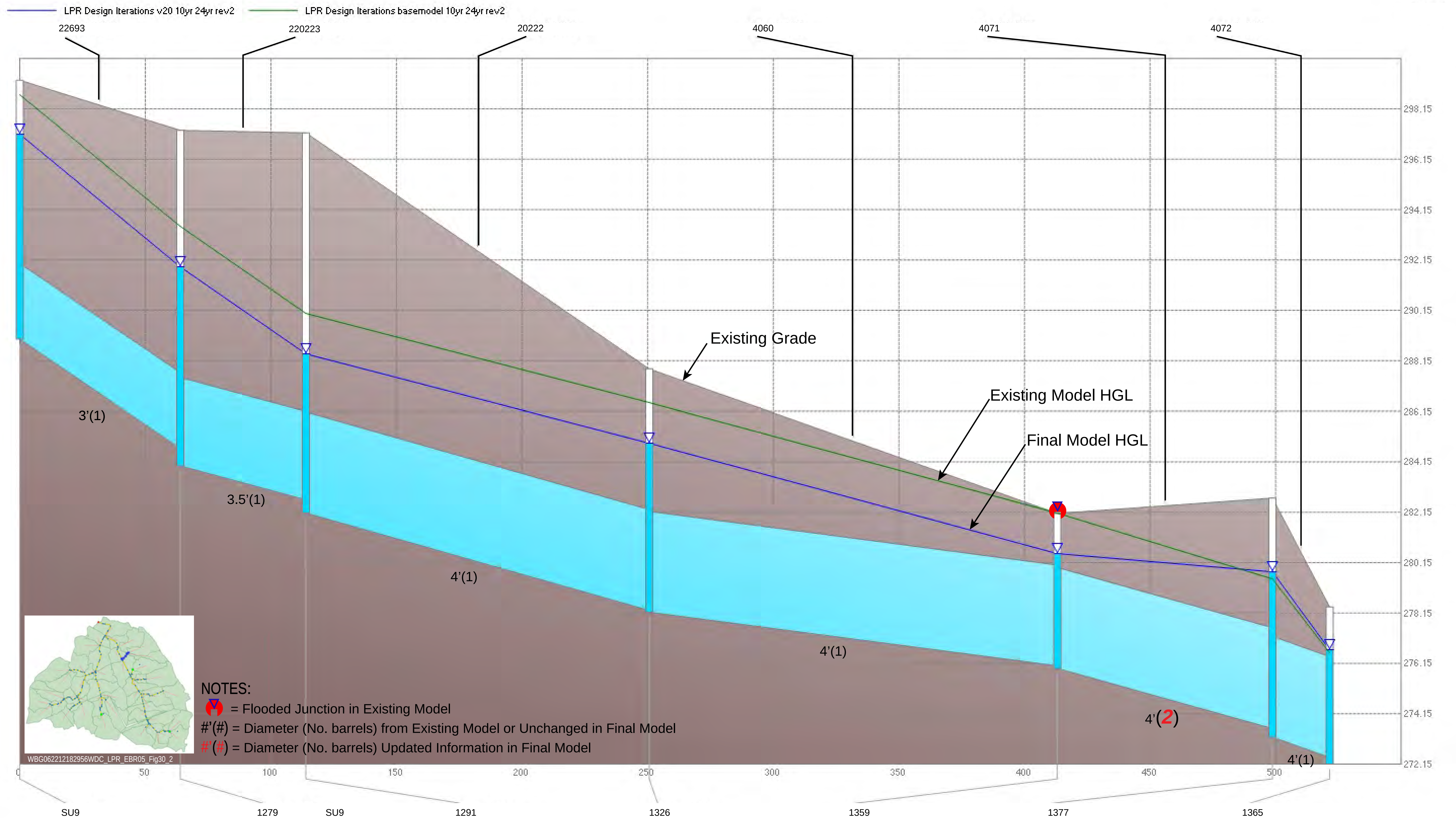
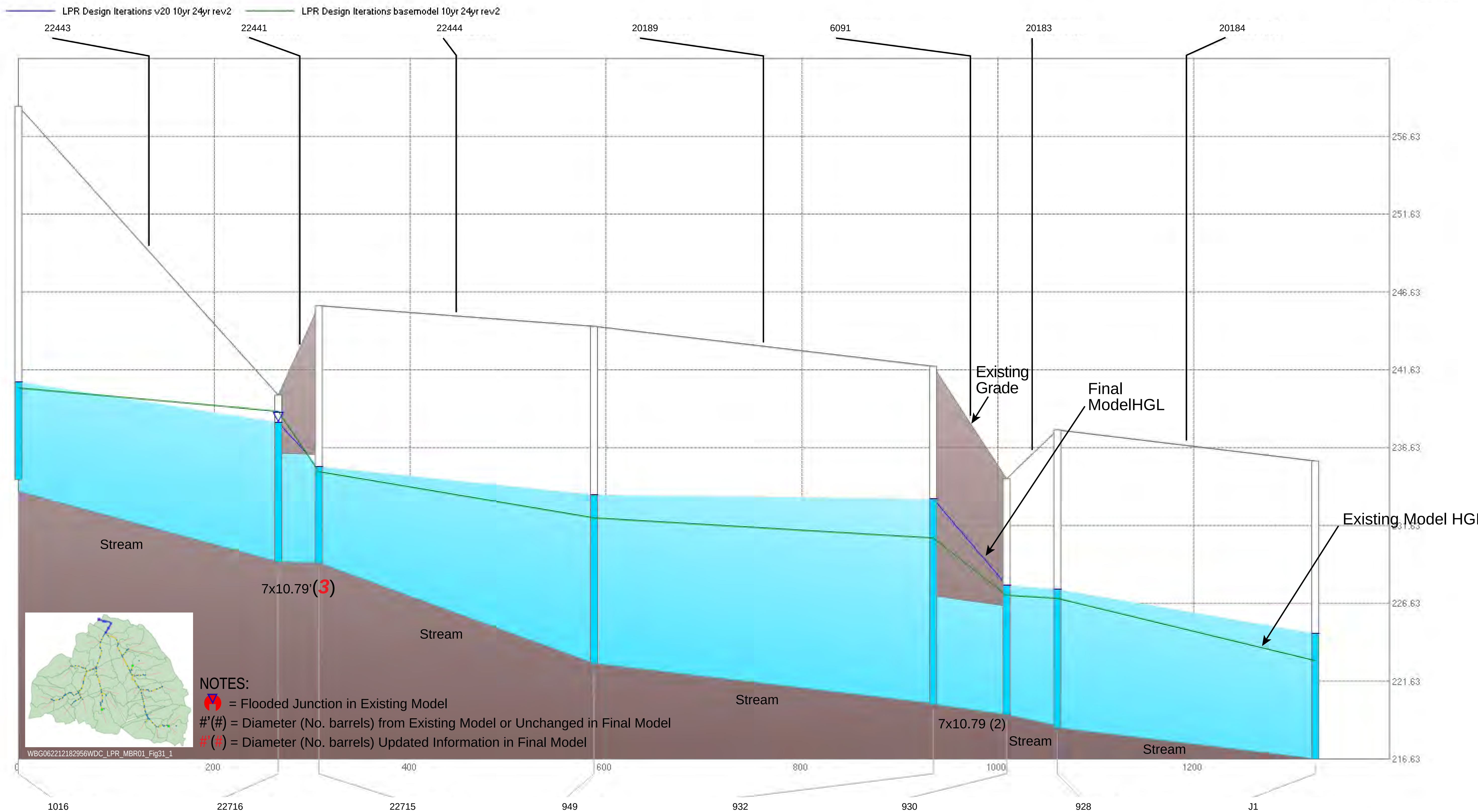


FIGURE 31 - Little Pimmit Run

Old Dominion Dr. to County Line for 10-yr, 24-hr SCS Type II Storm Event



5 Summary

The focus of this task was to develop solutions that eliminate flooding in the model during two selected storm events: the June 2006 storm event and the 10yr-24hr SCS Type II storm. Though specific model solutions were developed, the goal of the task was to understand what design capacity may be necessary to minimize the risk of flooding during similar rainfall events.

The hydraulic modeling results presented in this TM should be reviewed with the understanding that several assumptions were made to fill data gaps, primarily assumptions about pipe inverts, rim elevations, and inlet conditions. Additionally, when solutions were developed, the number of barrels and/or pipe sizes was the primary parameters adjusted. Implementation of these or similar solutions will not guarantee the elimination of flooding in the watershed.

Because of the assumptions applied to the model, it is important to note that all results are presented from a modeling perspective, not a design perspective. Assumptions should be verified and may need adjusting during the design stage of all improvement projects. Moreover, there are many factors related to scoping and implementing a project that will need to be taken into account with the model results when improvement projects are considered. Additionally, even after the completion of the improvement projects, the risk of flooding is never completely eliminated.

Results of the design iterations show that flooding in the model during the June 2006 storm event may be eliminated with additional barrels or pipes to about 16 percent of the network with a diameter of 36 inches or more. Eliminating flooding in the model during the 10yr-24hr SCS Type II storm requires changes throughout the network. The solution identified in the TM adds barrels or pipes of about 41 percent of the pipe network with a diameter of 36 inches or more.

Appendix A
Stormwater Capacity Analysis for Little Pimmit Run Watershed, Arlington County, Virginia

Stormwater Capacity Analysis for Little Pimmit Run Watershed, Arlington County, Virginia

PREPARED FOR: Arlington County, Virginia

PREPARED BY: CH2M HILL

COPIES: Tara Ajello/CH2M HILL
Rita Fordiani/CH2M HILL

DATE: August 30, 2012

PROJECT NUMBER: 240033.T3.LP.02.03

Contents

Appendixes

Tables

Figures

Executive Summary

Arlington County, Virginia, has initiated a project to analyze storm sewer capacity issues, identify problem areas, develop and prioritize solutions, and provide support for public outreach and education. The project is being implemented in phases by watershed.

The objective of this study is to identify areas in the stormwater collection system that do not have adequate capacity. Two rainfall events were modeled: (1) the June 25, 2006, storm event using rain gauge data from the Donaldson Run lift station and (2) a 10-year, 24-hour (10yr-24hr) storm based on the Soil Classification System (SCS) Type II distribution.

This technical memorandum (TM) focuses on the hydrologic and hydraulic analyses of the Little Pimmit Run watershed using the model PCSWMM 2011. It summarizes the County's existing storm sewer system in the watershed, the model development steps, data sources and gaps, and a summary of model assumptions and results.

The total rainfall for the June 2006 storm event is higher than that for the 10yr-24hr SCS Type II storm. Consequently, the results of the hydrologic analysis show that the June 2006 storm event produces more stormwater runoff (14.42 million cubic feet) than the 10yr-24hr SCS Type II storm (10.70 million cubic feet).

However, since the peak rainfall intensity for the 10yr-24hr SCS Type II storm (6.74 in./hr) is higher than the June 2006 storm event's (4.80 in./hr), the 10yr-24hr SCS Type II storm results in the watershed's having more conveyance capacity limitations. **Table 1** shows the summary of conveyance capacity limitations for each storm event.

The hydraulic modeling results presented in this TM should be reviewed with the understanding that several assumptions, primarily about pipe inverts, were made to fill data gaps. All assumptions should be verified when infrastructure is designed on the basis of this preliminary capacity modeling. This TM does not include an analysis of capacity upgrades to stormwater infrastructure designed to reduce the capacity limitations of the stormwater conveyance system.

TABLE 1
Summary of Conveyance Capacity Limitations

		HGL Flooding Ground Surface		HGL Within 1 Foot of Ground Surface		HGL Surcharging Pipe Crown		Capacity Limitations	
Scenario (with Storage)	**Modeled System[a] (Linear Feet)**	**Linear Feet**	**Percent of Modeled System**	**Linear Feet**	**Percent of Modeled System**	**Linear Feet**	**Percent of Modeled System**	**Linear Feet**	**Percent of Modeled System**
June 2006 storm event	20,859	2,926	14	4,844	23	3,402	16	11,172	54
10yr-24hr SCS Type II storm	20,859	6,491	31	4,511	22	4,022	19	15,024	72

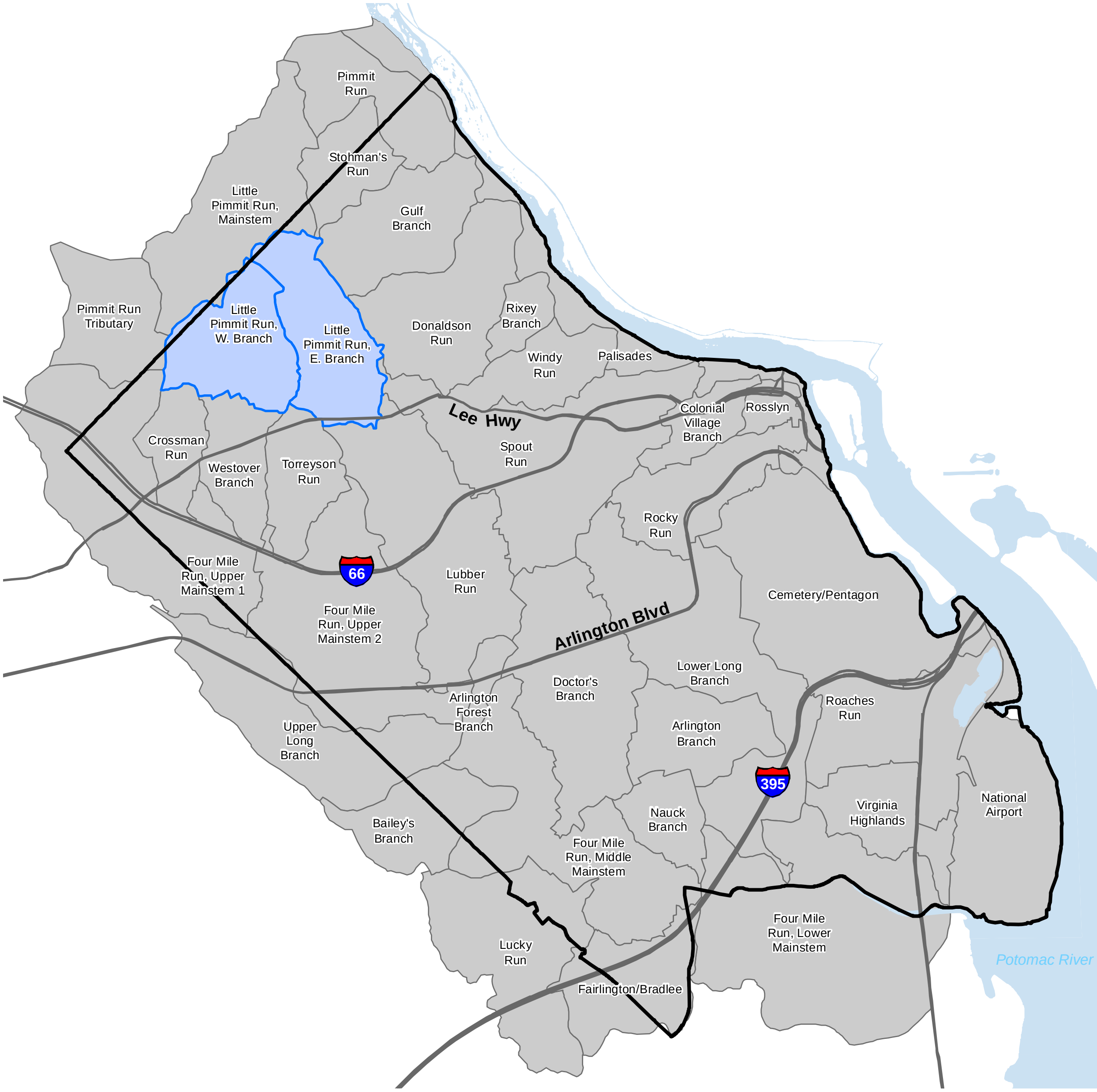
HGL, hydraulic grade line.
[a]The modeled system in this table includes the closed pipe network and rectangular open channels described in Table 2. It does not include natural stream channels.

1 Introduction and Project Objectives

The work described in this TM is one of the major elements of a storm sewer capacity analysis project. Based on discussions with Arlington County staff, it is understood that the County is undertaking a larger effort to update and combine the 1996 Stormwater Master Plan and the 2001 Watershed Management Plan. This TM is part of the project that focuses on the storm sewer capacity issues.

The purpose of this TM is to conduct a stormwater capacity analysis of the existing stormwater collection system for the Little Pimmit Run watershed and to identify areas of the stormwater collection system that may not have adequate capacity based on two storm events: the June 2006 and the 10yr-24hr SCS Type II. **Figure 1** shows the various drainage watersheds for Arlington County.

FIGURE 1
Watersheds, Arlington County, Virginia (Little Pimmit Run Highlighted)



2 Description of Existing Stormwater Collection System

2.1 Existing Versus Modeled Stormwater Collection System

The Little Pimmit Run watershed is approximately 1,018 acres and is the sixth largest watershed in Arlington County. The zoning is predominantly residential and institutional; the remaining area consists of a mix of commercial and highways.

In general, stormwater runoff is collected by storm sewers and flows in both the east and west branches and then north before joining and forming the main branch of Little Pimmit Run. The main branch continues north as a stream channel before passing into Fairfax County and eventually outletting to the Potomac River.

The stormwater collection system elements include the following:

- Closed conduits, such as gravity sewers and culverts
- Open conduits, such as concrete open channels
- Stream channel segments and ditches
- Drainage inlets and junctions, such as roadside curb inlets, manholes, catchbasins, and yard and grate inlets

Elements of the ArcGIS existing stormwater collection system and the corresponding stormwater model developed for the Little Pimmit Run watershed are summarized in **Table 2**. The modeling effort includes the storm sewer network of pipes 36 inches in diameter and larger.

TABLE 2
Comparison of Existing Little Pimmit Run Stormwater System and Modeled System

Stormwater System Element	Existing	Modeled
Drainage area (acres)	1,018	972
Number of conveyance segments in stormwater system[a]	1,348	202
Total length of conveyance segments in stormwater system (linear feet)[b]	119,800	24,542
Size range (in.) [c]	4–192	36–192
Number of circular pipe segments	1,267	155
Number of noncircular pipe segments	49	23
Length of open channel segments (linear feet)	1,514	1,500
Length of stream channel segments (linear feet)	4,558	3,683
Length of ditch segment (linear feet)	406	0
Total inlets/junctions/end points (model nodes)	1,226	197
Catchbasins	565	45
Manholes	402	81
Yard inlets	70	13

TABLE 2 (CONTINUED)
Comparison of Existing Little Pimmit Run Stormwater System and Modeled System

Stormwater System Element	Existing	Modeled
Grate inlets	69	7
End walls	41	22
Junction chambers	42	29
Detention outlets	27	0
Best management practices (BMPs)	10	0
Unknown types of nodes	0	0

[a]Segments include circular pipes, box culverts, elliptical pipes, ditches, and streams.
[b]Includes streams and ditches.
[c]Modeling scope is limited to stormwater conveyance system pipes 36 inches in diameter and larger.

Observations

- Drainage area: The modeled drainage area is smaller than the existing drainage area received initially from the County. This is because of adjustments made to the watershed boundary during this project. The modeled drainage area was reduced to eliminate one section of the system that discharges to Little Pimmit Run in Fairfax County. This was done at the direction of County staff, as discussed in Section 2.3.
- Detention outlet: The County defines a detention outlet as an element connected to a detention pipe or storage structure. These detention storage pipes are large-diameter pipes connected to downstream pipes typically having a diameter smaller (sometimes less than 36 inches) than that of the upstream pipe. In the Little Pimmit Run watershed, 27 detention outlets were identified in the ArcGIS PGDB (personal geodatabase). However, none of the detention outlets is connected to a pipe with a diameter of at least 36 inches, and thus they were not included in the model.
- BMP and unknown types of nodes: The "BMP" and "unknown types of nodes" are not modeled because they are connected to pipes with a diameter less than 36 inches.
- Though there are two systems within Little Pimmit Run (east and west), they are modeled as one complete Little Pimmit Run watershed.

Figure 2 shows the existing stormwater collection system in the Little Pimmit Run watershed; **Figure 3** shows the modeled system.

2.2 Data Sources

The storm drainage network data were provided by Arlington County in ESRI ArcGIS format for the entire County. The following documents were also provided by the County:

- As-built drawings
- HEC-RAS input files for the east branch. These files were developed for a previous flooding study related to the open channels that are present in parts of the middle and lower segments of the east branch.

Initial base layers (GIS shapefiles) were obtained from Arlington County in June 2010. CH2M HILL worked with the County to complete the storm sewer data gathering for the Little Pimmit Run watershed. The final ArcGIS PGDB was delivered to CH2M HILL in February 2011.

The final data for the Little Pimmit Run watershed model were evaluated for quality. CH2M HILL found that 88 nodes and 101 links had missing data and/or anomalies. A data gaps TM detailing the suggested assumptions to fill in the gaps was prepared for the County in September 2011. (See **Appendix A**.)

2.3 Watershed Boundary Anomalies

The Little Pimmit Run watershed boundary was provided by the County. Anomalies were identified and the boundary was adjusted as needed based on topographic data, orthophotos, and the stormwater collection system connectivity. The details of these changes are described in the data gaps TM (**Appendix A**).

3 Technical Approach

This section describes the hydraulic evaluation of the Little Pimmit Run stormwater system under various hydrologic scenarios. A dynamic stormwater model was developed as the evaluation tool using PCSWMM 2011.

3.1 Methodology

The hydrologic and hydraulic model involves the following steps:

- Hydrology
    1. Define the subwatershed boundaries
    2. Identify the hydrologic node connections
    3. Estimate the hydrologic parameters for each subwatershed
    4. Identify the rainfall distribution to analyze
- Hydraulics
    1. Import the stormwater network and physical data (inverts, ground elevation, pipe length, size, material)
    2. Define the boundary conditions for each hydrologic scenario
    3. Evaluate the hydraulic performance of the stormwater drainage system for two storm event scenarios

Arlington County provided the required data listed below:

- Arlington.mdb: geodatabase for stormwater collection system and watershed boundary shapefile
- 2009 data CD files: Arlington County's GIS data (shapefiles), such as topographic data, soil maps, cadastral data, and impervious information
- 2007 orthophotos
- 2006 rainfall event

The following sections describe the hydrologic and hydraulic modeling for the Little Pimmit Run watershed.

3.2 Hydrologic Modeling

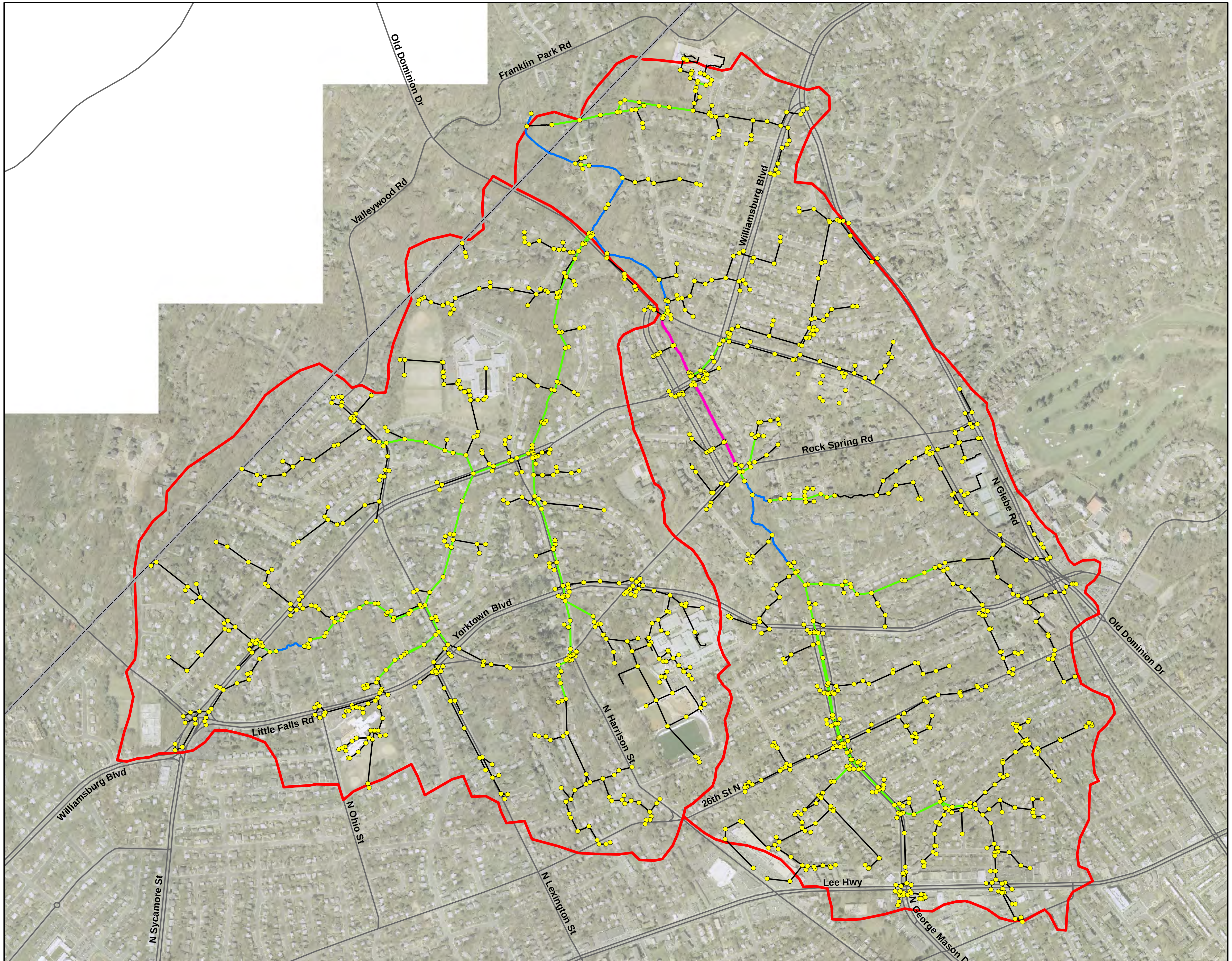
The hydrologic modeling consisted of two major components:

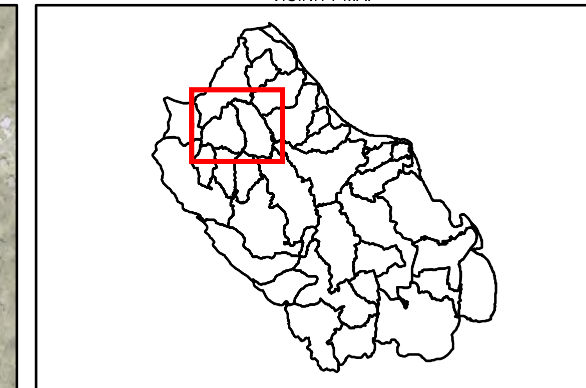
- Hydrologic parameters: delineation of subwatersheds and computation of hydrologic parameters such as drainage areas, basin slope, basin width, and percent impervious for each subwatershed
- Rainfall: modeled the June 2006 storm event and the 10yr-24hr SCS Type II storm

Most hydrologic parameters were estimated using Arc Hydro Tools 9.3 and the ArcGIS version of HEC-GeoHMS. The Arc Hydro tools are a set of public domain utilities developed jointly by the Center for Research in Water Resources (http://www.crwr.utexas.edu) of the University of Texas at Austin, and the Environmental Systems Research Institute, Inc. These tools provide functionalities for terrain processing, watershed delineation, and attribute management. They operate on top of the Arc Hydro data model in the ArcGIS environments.

HEC-GeoHMS is geospatial hydrologic modeling software developed and maintained by the Hydrologic Engineering Center (HEC) of the U.S. Army Corps of Engineers (USACE). The model allows users to visualize spatial information, perform spatial analysis, delineate subwatersheds, and estimate subwatershed hydrologic parameters. The model uses the Digital Elevation Model (DEM) for the subject watershed to compute the hydrologic parameters. The "burning in" technique allows the user to impose the drainage system on the terrain to better produce the watershed boundaries.[1]

[1] USACE, *User's Manual, Geospatial Hydrologic Modeling Extension HEC-GeoHMS,* Version 1.1. Hydrologic Engineering Center, 2003.





Legend

- Stormwater Junctions
- Stormwater Mains ≥ 36"
- Stormwater Mains < 36"
- Rectangular Open Channel
- Streams
- Arlington/Fairfax Boundary Line
- Roads
- Original Watershed Boundary

N

0 450 900
Feet

FIGURE 2
Existing Stormwater Collection System
Little Pimmit Run Watershed
Arlington County Storm Capacity Analysis

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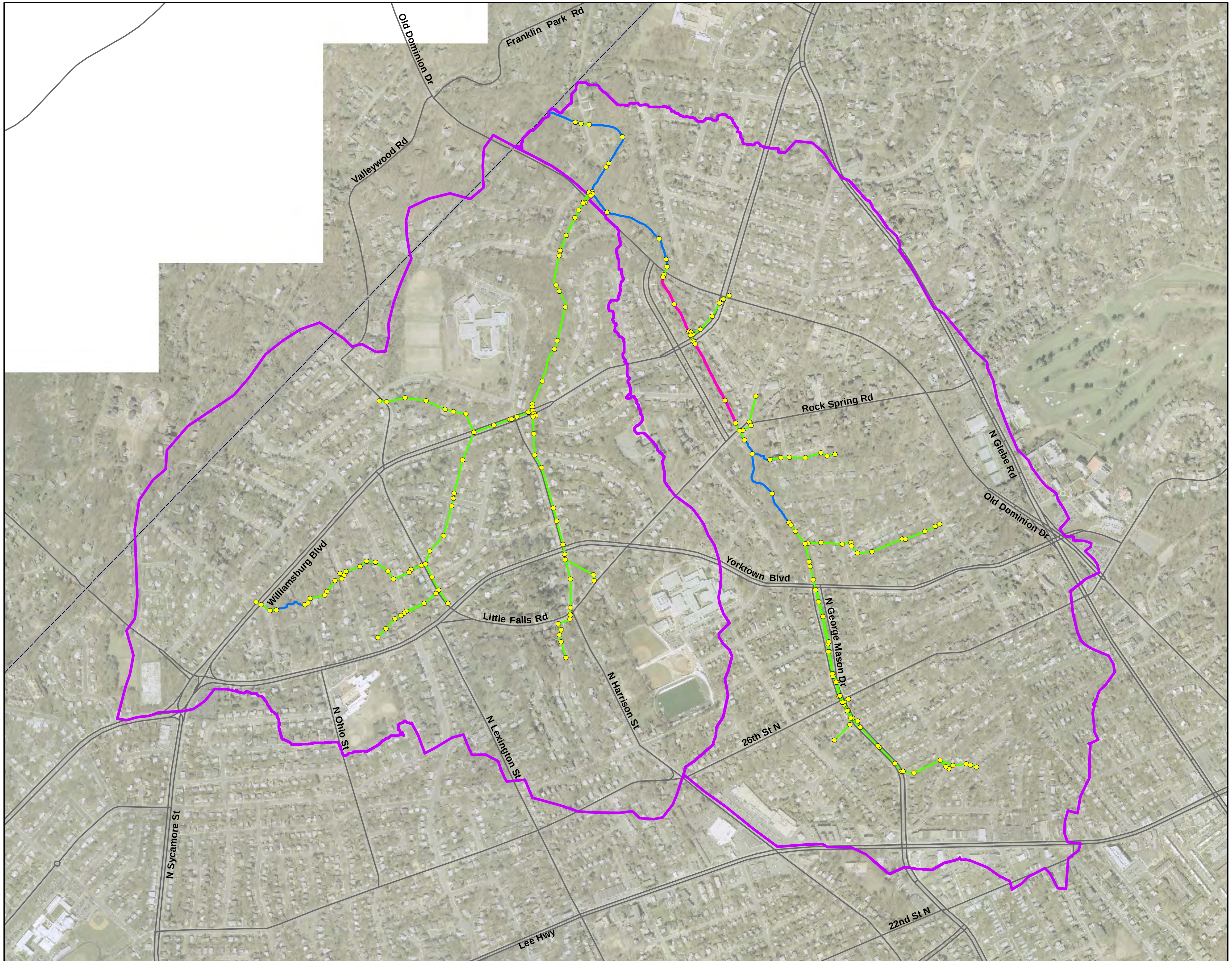

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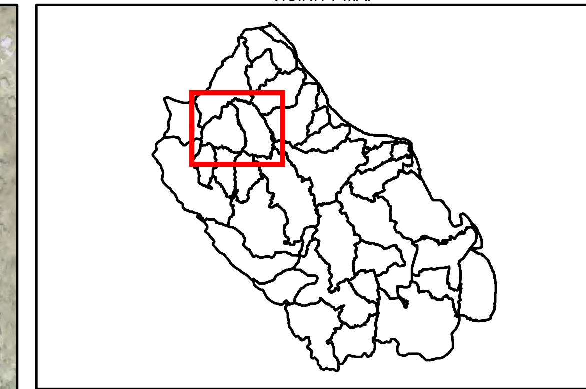

Legend

- Modeled Stormwater Junctions
- Modeled Stormwater Mains ≥ 36"
- Modeled Rectangular Open Channel
- Streams
- Arlington/Fairfax Boundary Line
- Roads
- Modeled (Revised) Watershed Boundary

N

0 450 900
Feet

FIGURE 3
Modeled Stormwater Collection System
Little Pimmit Run Watershed
Arlington County Storm Capacity Analysis

\\ORION\PROJ\ARLINGTONVACOUNTYOF\392309STORMWATERCAP\WSLITTLEPIMMITRUN\WORKINGGIS\LAYOUT\INTERNAL\STORMWATER_CAPACITY_ANALYSIS_TM\FIGURE3_MODELED_STORMWATER_COLLECTION_SYSTEM.MXD FCAIN 4/19/2012 11:24:12 AM

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3.3 Subwatersheds Delineation

The Arc Hydro tools were used to delineate the subwatersheds based on the DEM and stormwater network. Some of the automatically delineated subwatershed boundaries were adjusted before proceeding with the calculation of the hydrologic parameters. HEC-GeoHMS was used to compute the following hydrologic parameters: drainage areas, slope, and longest flow path. Width is calculated by dividing the area by the longest flow path. Additionally, the County watershed boundary between the east and west branches was adjusted near the point where the two branches join.

3.4 Imperviousness

The percent imperviousness of each subwatershed was determined by overlaying the impervious coverage information with the delineated subwatersheds in ArcGIS. The impervious coverage is represented by building and paved features (e.g., driveways, handicap ramps, paved medians, sidewalks). It was assumed the impervious coverage is 100 percent impervious. **Figure 4** shows the impervious areas used in the hydrology analysis. The shapefiles used for the impervious calculation include:

- Building_arc.shp
- Driveway_poly
- Parkinglot_poly
- Road_poly_split
- Alley_Poly
- Handicapramp_poly
- PavedMedian_poly
- Sidewalk_poly

3.5 Hydrologic Parameter Summary

The schematic of the hydrologic model for the watershed is presented in **Figure 5**. The schematic model shows the basin ID, delineated boundaries, centroidal longest flow path, and drainage inlet for each subwatershed.

The hydrologic parameters for each subwatershed are presented in **Table 3**. The following are the major drainage characteristics for the watershed:

- Total drainage area is 972 acres.
- Little Pimmit Run watershed is divided into 48 subwatersheds.
- 37.3 percent of the total drainage area is impervious (range across the subwatersheds of 21.4–80.6).
- Flows were introduced at 34 of 197 inlets (17 percent).
- Average basin area is 20 acres (range of 3–34).
- Average basin slope is 9.3 percent (range of 5.5–17.2).
- Average basin width is 929 feet (range of 288–1,480).

TABLE 3
Hydrologic Parameters

		Area				
Subwatershed	**Inlet**	**Total (Acres)**	**Impervious (Acres)**	**Percent Impervious Area**	**Slope (%)**	**Width (ft)**
W2290	2063	25	9	36.3	9.4	969
W2295	1976	32	15	47.4	8.8	1,186
W400	1020	32	8	25.3	15.4	1,270
W410	1129	18	6	34.5	17.2	1,354
W420	1020	13	4	31.4	16.4	542
W430	1169	23	10	40.7	9.4	939
W440	1129	24	7	29.8	11.9	1,070
W450	1584	28	9	30.4	14.0	1,204
W460	1169	13	5	37.4	12.4	809
W470	1377	15	5	35.2	8.0	430
W475	22896	27	11	42.0	8.9	856
W480	24607	31	11	34.6	11.9	1,214
W490	1559	25	8	31.6	7.5	881
W500	1574	33	13	38.4	8.1	1,364
W510	1675	24	5	22.4	7.1	1,131
W520	1579	24	9	38.3	6.7	827
W530	1584	8	3	35.2	8.3	669
W540	1584	18	7	38.7	10.5	909
W545	1759	28	10	36.9	8.9	1,257
W550	1670	4	1	31.6	10.0	327
W560	1675	21	8	36.3	10.1	922
W570	1753	6	2	33.7	9.6	560
W575	1742	33	11	33.1	9.7	1,353
W580	1753	21	6	28.4	10.7	878
W585	2063	9	4	45.8	10.0	591
W600	2067	20	12	58.2	7.0	650
W610	2063	25	9	35.1	7.9	758
W613	2590	18	6	35.9	7.7	1,452
W616	2994	30	13	41.3	7.6	1,136

TABLE 3 (CONTINUED)
Hydrologic Parameters

		Area				
Subwatershed	**Inlet**	**Total (Acres)**	**Impervious (Acres)**	**Percent Impervious Area**	**Slope (%)**	**Width (ft)**
W620	2140	4	2	37.8	11.3	362
W630	2140	16	6	37.2	11.7	869
W635	SU1	33	13	40.1	7.6	1,097
W640	2230	31	7	21.4	7.9	1,181
W650	2164	12	4	30.3	9.3	892
W660	2164	3	1	37.9	10.9	288
W670	2194	25	9	33.9	8.0	1,041
W680	2194	11	3	28.9	8.3	696
W710	2272	5	2	34.2	7.5	516
W715	2547	25	10	40.0	7.8	1,246
W720	2337	34	13	37.7	7.6	1,298
W730	2328	21	8	38.6	9.6	894
W740	2370	19	8	43.8	8.8	898
W750	3415	29	15	51.6	6.1	1,480
W760	3705	20	8	41.1	5.5	878
W770	3191	11	4	36.5	6.0	900
W773	3768	13	6	43.5	7.6	802
W776	3768	6	5	80.6	5.7	429
W780	3729	25	13	53.1	8.1	1,337

3.6 Infiltration Parameters

Infiltration was modeled using the Green-Ampt method. To calculate the infiltration parameters, the digital soil maps were overlaid with the subwatersheds to assign respective soils map unit symbology (MUSYM). The MUSYM was then correlated with the Arlington County soil survey to determine the soil name and characteristics. The same procedure was conducted for the Fairfax County portion of the watershed, using the Fairfax County soil survey. It was determined that approximately 90 percent of the soil in Little Pimmit Run is silty loam, 4 percent is sandy loam, and 6 percent is loam. The infiltration parameters adopted for the three types of soil are listed in **Table 4**.

TABLE 4
Soil Infiltration Parameters

Soil Texture Class	Soil Map Units	Percent of Soil	Hydraulic Conductivity (in./hr)	Suction Head (in.)	Initial Deficit (Fraction)
Loam	12, 13	6	0.13	3.50	0.23
Sandy loam	4A–4C, 9C, 11B–11D, 15D, 16B	4	0.43	4.33	0.26
Silty loam	6B–6D, 7A-7D, 10B–10D	90	0.26	6.69	0.22

Source: Rawls, Walter J., Donald L. Brakensiek, and Norman Miller, "Green-Ampt Infiltration Parameters from Soils Data," *Journal of Hydraulic Engineering*, vol. 109, no. 1, January 1983, pp. 62–70 (doi: http://dx.doi.org/10.1061/(ASCE)0733-9429(1983)109:1(62)).

The infiltration parameters of each subwatershed were determined by intersecting the soil map with the delineated subwatersheds in ArcGIS to calculate the area-weighted value. **Figure 6** shows the soil map for the Little Pimmit Run watershed. **Appendix B** provides details on soil texture class and soil map units.

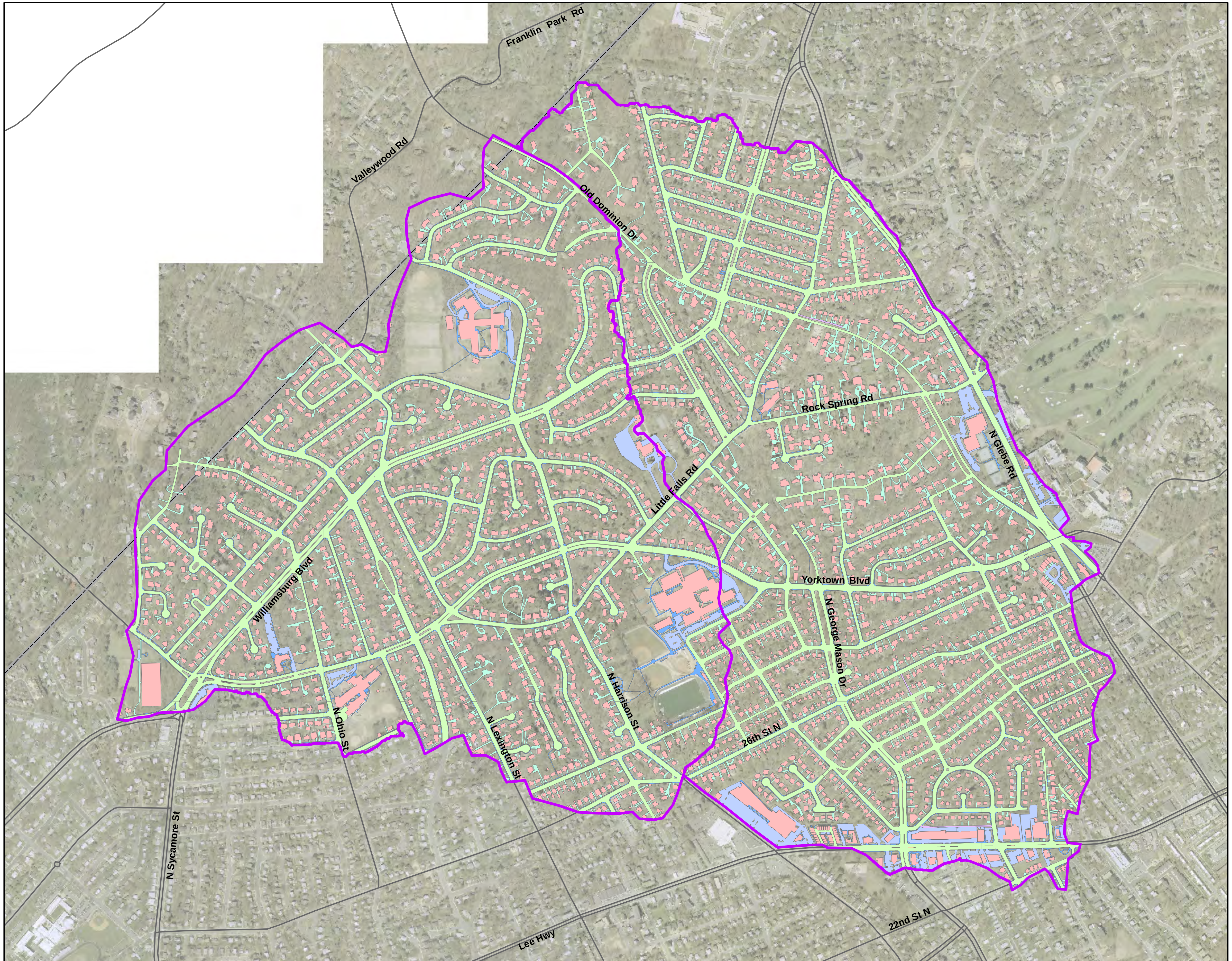
3.7 Surface Roughness and Depression Storage

Table 5 shows parameters used for pervious and impervious areas in the model. Depression storage is set at zero to reduce the time for hydrologic flow to enter the hydraulic system.

TABLE 5
Surface Roughness and Depression Storage

	Areas	
Description	Impervious	Pervious
Manning's *n*	0.014	0.3
Depression storage	0	0

Source: Source: James, W., *User's Guide to SWMM5*. 12th ed., CHI, 2008. p. 766.



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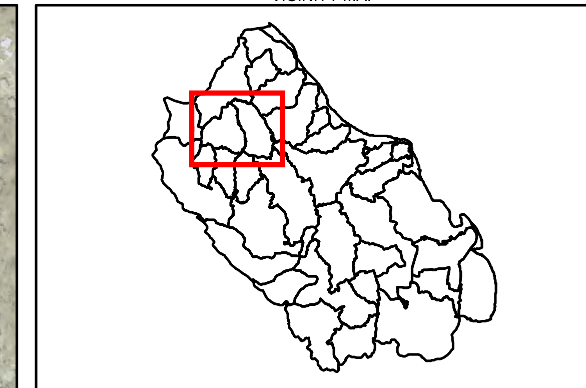


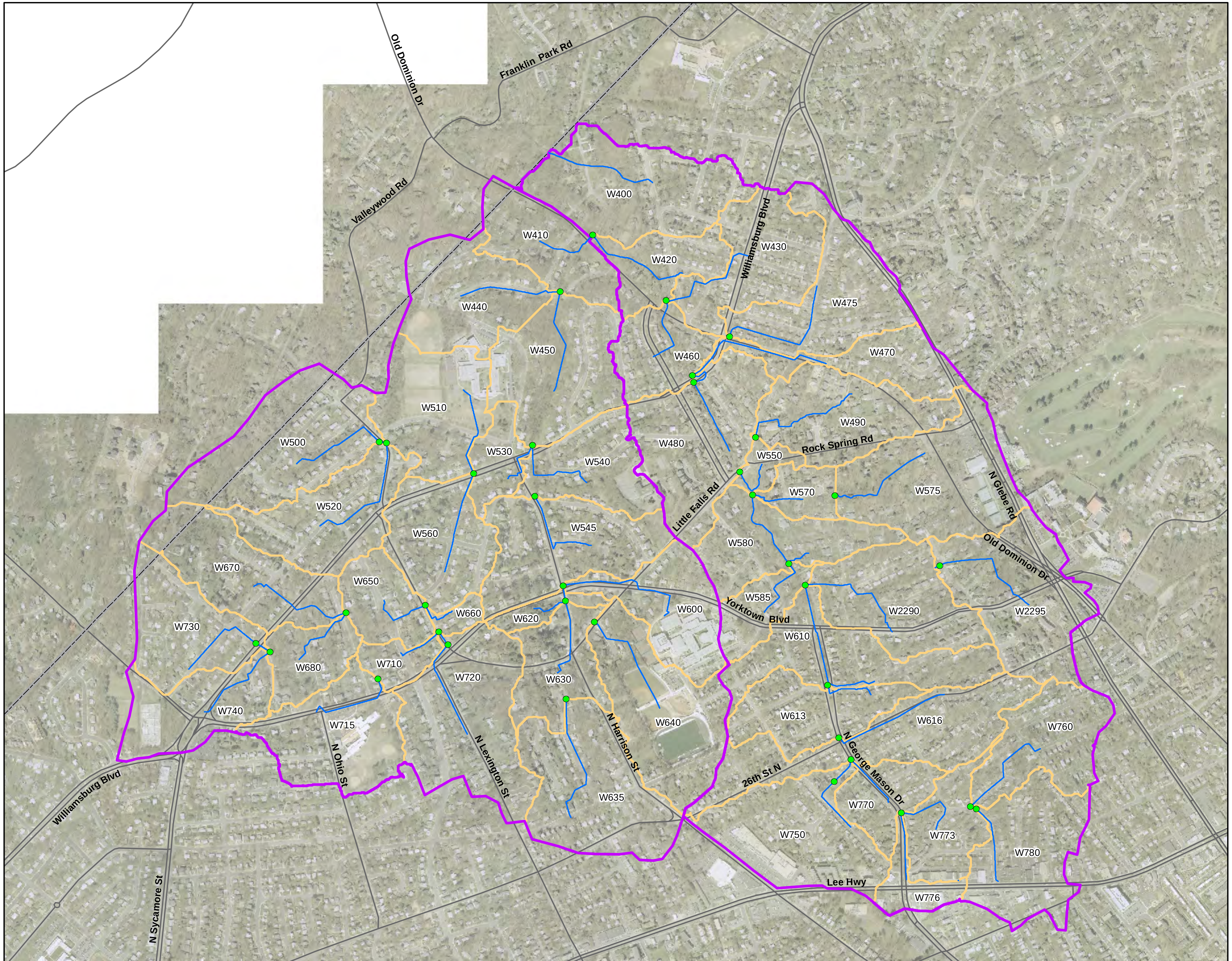
Legend

- Arlington/Fairfax Boundary Line
- Building
- Sidewalk
- Road
- Paved Median
- Parking Lot
- Handicap Ramp
- Driveway
- Alley
- Roads
- Modeled (Revised) Watershed Boundary

N

0 450 900
Feet

FIGURE 4
Impervious Areas
Little Pimmit Run Watershed
Arlington County Storm Capacity Analysis



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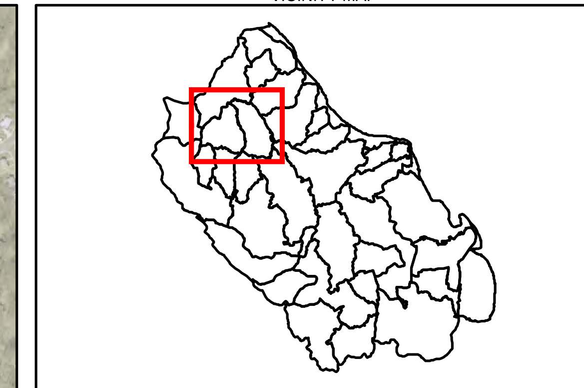

Legend

- Runoff Input Junctions
- Centroidal Longest Flow Path
- Arlington/Fairfax Boundary Line
- Subwatershed
- Roads
- Modeled (Revised) Watershed Boundary

FIGURE 5
Hydrologic Model Schematic
Little Pimmit Run Watershed
Arlington County Storm Capacity Analysis

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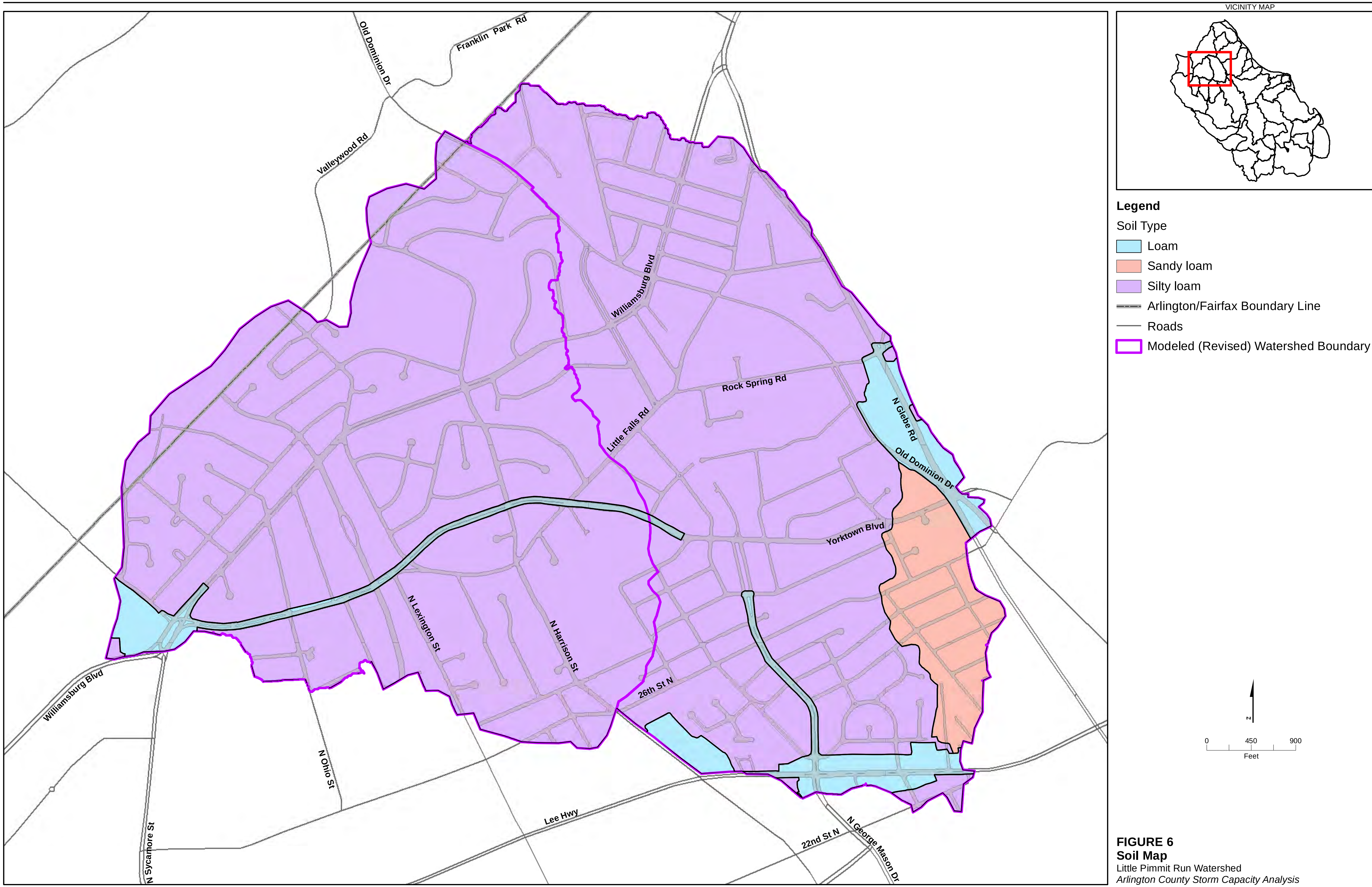


FIGURE 6
Soil Map
Little Pimmit Run Watershed
Arlington County Storm Capacity Analysis

3.8 Rainfall Distributions

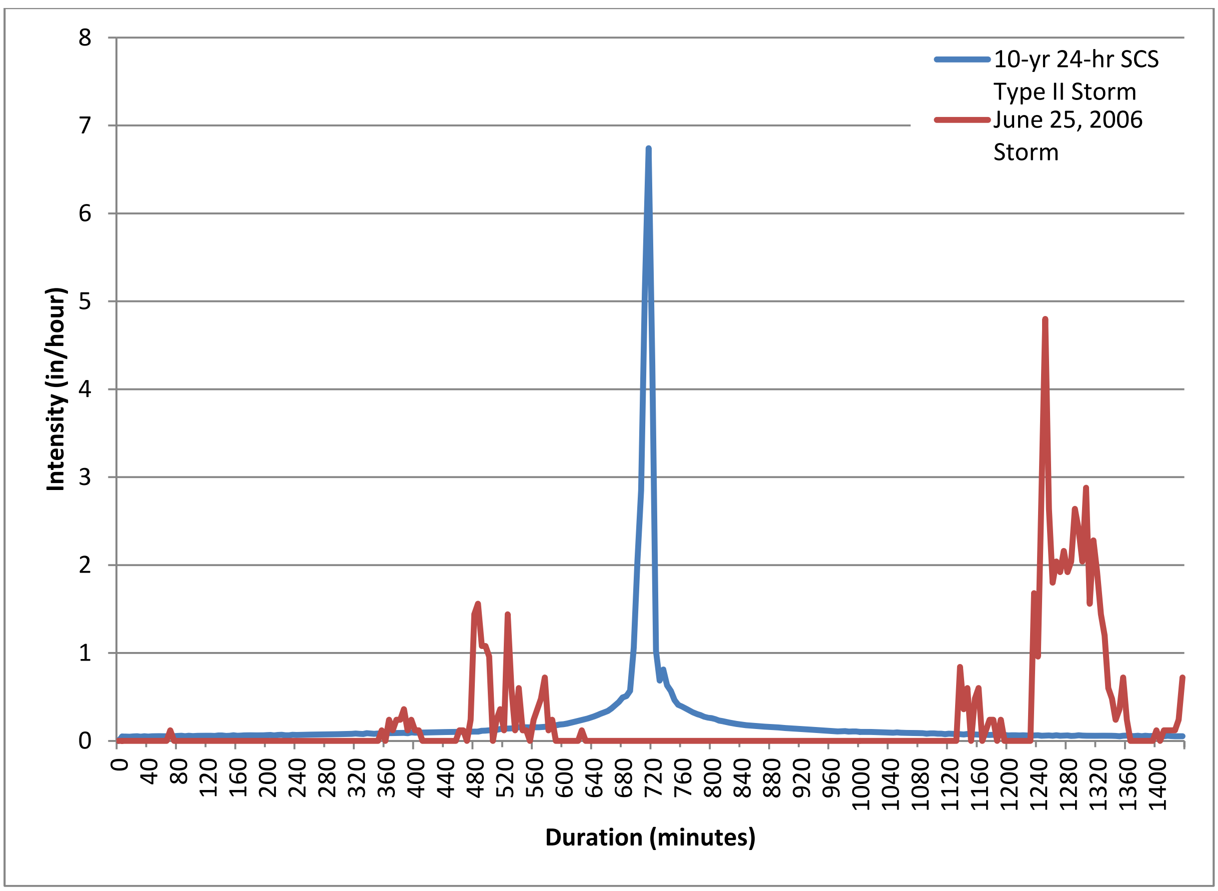
Choosing the correct rainfall distribution, as well as frequency and duration, is an important factor in the development of the hydrologic model and the results of the hydraulic model. Arlington County decided to proceed with two storms of interest:

- June 2006 storm event based on the rain gauge data at the Donaldson Run lift station; total rainfall volume of 5.84 inches
- 10yr-24 hr storm based on SCS Type II distribution: the 10yr-24 hr storm volume was obtained from VDOT's "Hydraulic Advisory 05-04.3," January 2008; total volume of 4.84 inches

The County has maintained a list and map of flooding complaints from the June 2006 storm, and this was used as anecdotal information for comparison purposes. Although not a true calibration, model results for the June 2006 storm event were compared to the flooding complaint map to see how the results align. (See Section 5.1.)

The 5-minute-duration hyetograph data for the two storms are provided in **Appendix C** and in **Figure 7**.

FIGURE 7
Storm Hyetographs



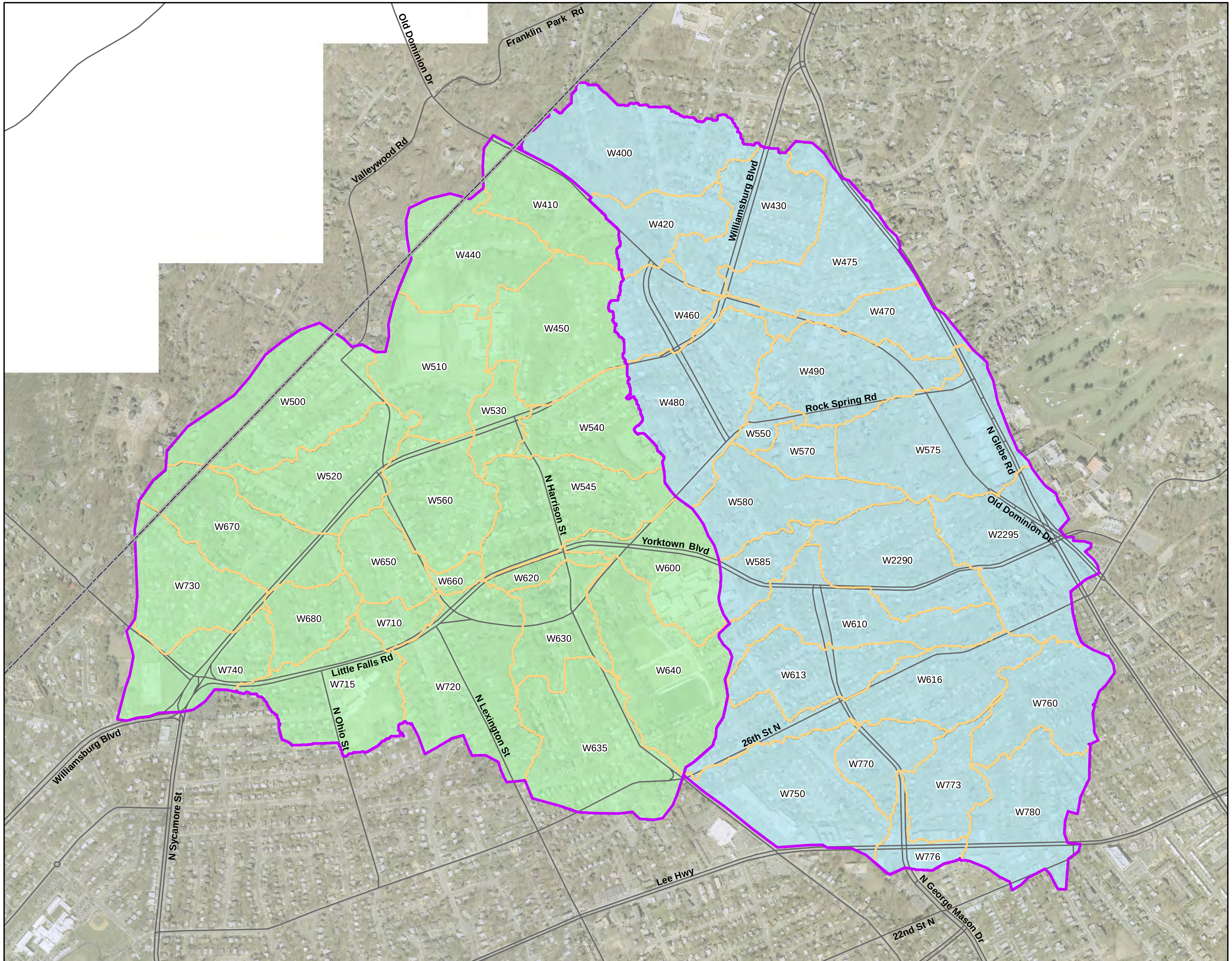
3.9 Simulation of Stormwater Runoff

The private domain software PCSWMM 2011 was used to simulate natural rainfall-runoff processes from the watershed. Hydrologic parameters such as area, slope, and width for 48 subwatersheds were estimated using Arc Hydro Tools 9.3 and the ArcGIS version of HEC-GeoHMS, as described earlier. The percent imperviousness of each subwatershed was determined by overlaying the impervious coverage information with the delineated subwatersheds in ArcGIS. These hydrologic parameters, listed in **Table 3**, were used as input to the subwatersheds. The two hyetographs were also used as input to the subwatersheds of PCSWMM 2011. The U.S. Environmental Protection Agency (EPA) SWMM Runoff Non-linear Reservoir Method was used to simulate stormwater runoff from each subwatershed in response to each of the hyetographs. Groundwater and snow pack are not included in the hydrologic analysis.

For presentation purposes, the watershed was divided into two areas (see **Figure 8**):

- Little Pimmit Run East Branch
- Little Pimmit Run West Branch

Figures 9 and **10** show the peak runoff at storm drain inlets for the two storm events. The peak runoff for the June 2006 storm is lower than the 10yr-24hr storm's, as expected. Caution should be taken when comparing the results in this figure because the runoff is related to the tributary area of each subwatershed, and the subwatersheds are not homogeneous in size.



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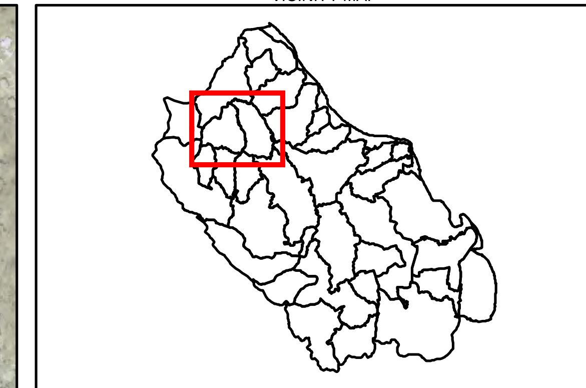

Legend

- Subwatershed
- West Branch
- East Branch
- Arlington/Fairfax Boundary Line
- Roads
- Modeled (Revised) Watershed Boundary

FIGURE 8
Subwatersheds
Little Pimmit Run Watershed
Arlington County Storm Capacity Analysis

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FIGURE 9
Peak Runoff—East Branch Subwatersheds

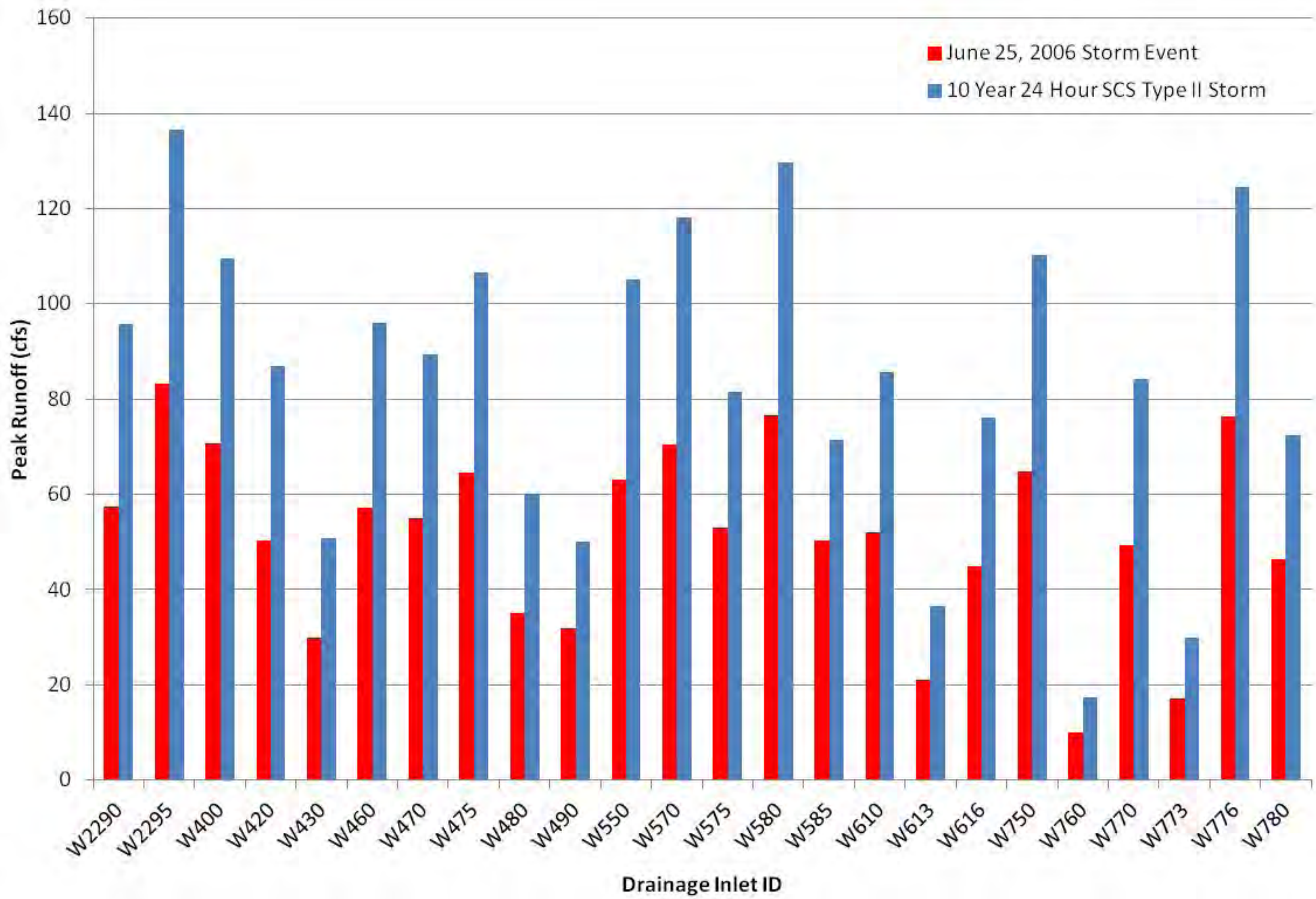
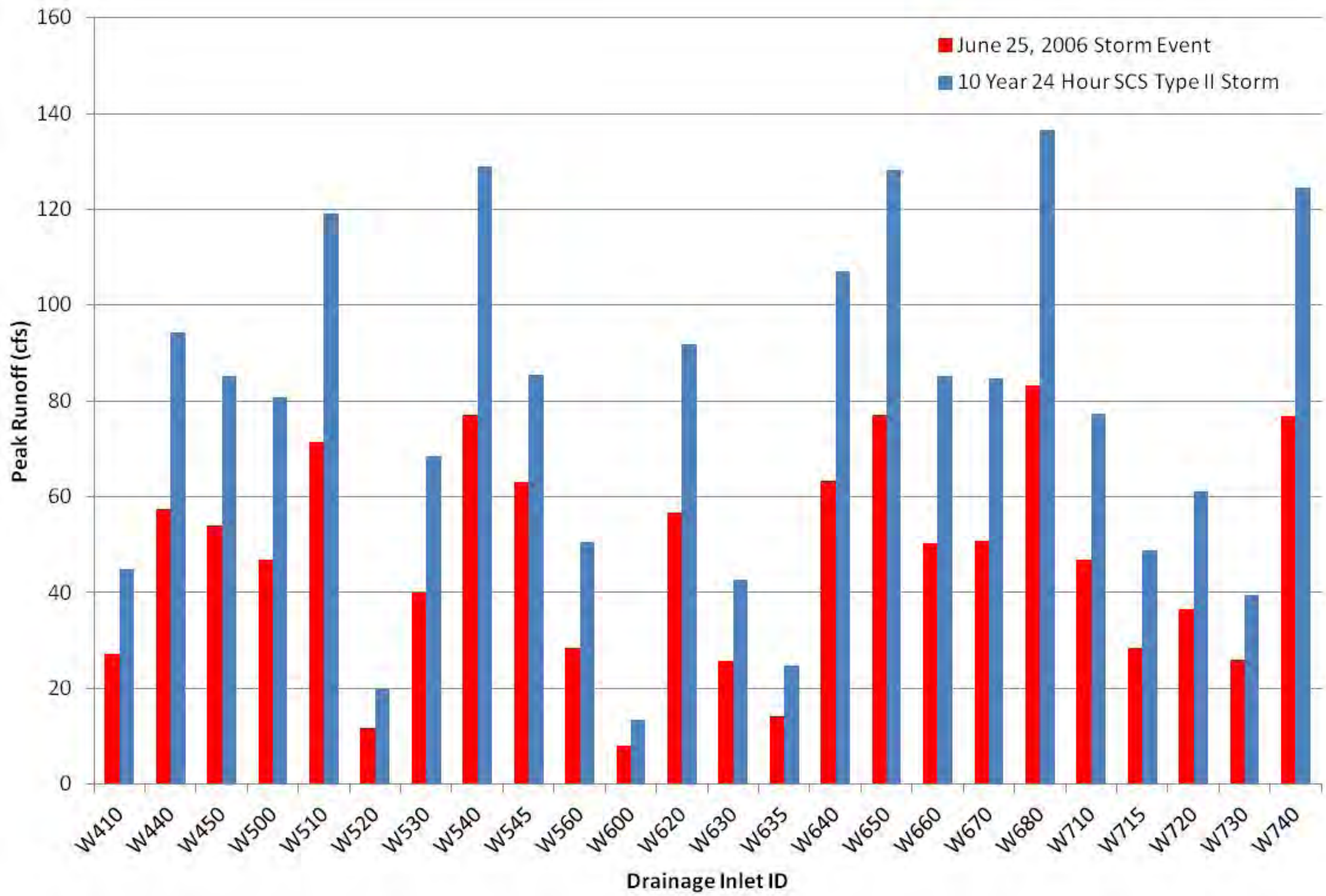


FIGURE 10
Peak Runoff—West Branch Subwatersheds



4 Hydraulic Modeling

The watershed was analyzed using the widely used and industry-accepted private domain stormwater management computer model PCSWMM 2011. The core simulation engine of this model is based on EPA's SWMM 5. PCSWMM 2011 was used to simulate the hydraulic performance of the stormwater collection system.

4.1 Simulation for Two Storm Events

Hydraulic simulations were performed for two different rainfall distributions:

- June 2006 storm event based on the rain gauge at the Donaldson Run lift station
- 10yr-24 hr storm based on SCS Type II distribution

4.2 Drainage Network

The physical data for the stormwater collection system were imported into the model primarily from the geodatabase provided by the County. This geodatabase was updated for the missing physical data listed in **Appendix A.** Model input data included the following:

- Physical data for node (catchbasin, manhole, junction, etc.), such as invert and crown elevations
- Physical data for conduits, such as invert elevations, size, shape, material, and length
- Transect data for stream segments

One area identified during the data gap analysis process as requiring added consideration when developing a modeling approach because of its unique geometry is the lower section of the west branch upstream of its confluence with the east branch. This is where a shallow open channel overlies a rectangular twin-barreled pipe. The rectangular pipe carries the majority of the flow and is the only part of the system modeled.

4.3 Stream Segments

County staff provided an HEC-RAS model for the east branch and main stem of Little Pimmit Run that included transects of stream segments indicating the following elevations: (1) centerline of stream, (2) top of bank, and (3) break lines of changes in slope. This information was incorporated in the model. The transect for the one stream segment in the west branch watershed was developed by CH2M HILL using HEC-GeoRAS and incorporated into the model.

4.4 Detention Ponds

There are no detention ponds in the modeled portion of the Little Pimmit Run watershed.

4.5 Head Losses

4.5.1 Inlet and Outlet Losses

Energy losses were assigned to represent losses encountered going from one pipe to another through an access hole. Manhole losses were applied at junctions labeled "manholes" in the

GIS, and inlet losses were applied at all other junctions (i.e., catchbasins, detention outlets, end walls, grate inlets, junctions) between pipes, between culverts, and between pipes and culverts. Inlet losses were also applied at junctions between streams and both culverts and pipes. The head loss coefficients are listed in **Table 6**.

TABLE 6
Standard Head Loss Coefficients

Structure Configuration	Loss Coefficient
Inlet—straight run	0.50
Inlet—angled through	
90°	1.50
60°	1.25
45°	1.10
22.5°	0.70
Manhole—straight run	0.15
Manhole—angled through	
90°	1.00
60°	0.85
45°	0.75
22.5°	0.45

Source: U.S. DOT, *Urban Drainage Design Manual*, 2nd ed., Hydraulic Engineering Circular No. 22, 2001.

4.5.2 Friction Head Losses

Values for roughness were set using established or previously reported values. Roughness values for the stream segment transects were provided in the HEC-RAS model data. The HEC-RAS data included roughness values for both the main channel and for the left and right overbanks. In many cases, the left and right overbank roughness values were not equal, reflecting the varied nature of the stream valley and the floodplain. **Tables 7 and 8** list standard roughness values used in the model for the different conduit types and natural streams, respectively.

TABLE 7
Standard Roughness Values for Pipes and Culverts

Element	Manning's *n*
Concrete pipe	0.014
Concrete rectangular conduit	0.015

Source: James, W., *User's Guide to SWMM5*. 12th ed., CHI, 2008. p. 766.

TABLE 8
Standard Roughness Values for Natural Streams

Element	Manning's *n*
Main channel	0.03–0.11
Overbanks	0.017–0.116

Sources: Arlington County HECRAS Model.

4.6 Boundary Conditions

The outfall boundary condition was modeled as a free outfall. Little Pimmit Run continues into Fairfax County as a natural open channel with no known outlet controls.

4.7 Storage Node

When a rainfall event is input into a model node and the flow exceeds the capacity of that node, the excess volume floods to the ground surface and is lost to the conveyance system. However, this flooding is not always representative of field conditions, and the model should be adjusted. This is often the case in models that represent a portion of the stormwater collection system. In the Little Pimmit Run watershed model, about 20 percent of the length of the piping network, albeit the largest pipes, is included in the model. Runoff can be restricted at inlet nodes and never enter the modeled system when, in fact, they are attenuated through the piping network upstream that is not included in the model and conveyed through the existing stormwater collection system. Therefore, if needed, the maximum storage capacity of the piping network upstream of the model can be calculated, and storage nodes can be added to the model.

4.8 Simulation Options

4.8.1 Routing Method

Dynamic wave was selected as the routing method for the following reasons:

- It solves the complete one-dimensional Saint Venant flow equations and therefore produces the most theoretically accurate results.
- It can account for channel storage, backwater, entrance/exit losses, and flow reversal.

4.8.2 Time Step

Generally, it is recommended that the time steps be the same for runoff computation, routing computation, and reporting. The time steps selected for the Little Pimmit Run watershed model are as follows:

- Runoff computation
  - Dry weather: 2 seconds
  - Wet weather: 2 seconds
- Routing computation: 2 seconds
- Reporting: 2 second

5 Hydraulic Model Results

5.1 Comparison of Data to Reports of Flooding

The Little Pimmit Run watershed model results were compared to the anecdotal flooding reports for the June 2006 storm event provided by the County. **Figure 11** compares the anecdotal flooding reports to the flooding generated by the model. Of the 25 anecdotal storm sewer problem call reports, several are along the modeled system and along the collection system that is smaller than 36 inches in diameter, and a few are not near the collection system. Complaints along both the west and east branches of the stormwater collection system match up well with areas that model results indicate as flooding or insufficient freeboard. Many improvements were made to the east branch stormwater collection system after 2006, and the current modeled system reflects those improvements and also indicates less flooding along the east branch.

5.2 Inlet Capacity

As mentioned in Section 4, storage will be added to the most upstream nodes if there are restrictions routing the total runoff.

Storage was initially added at three inlet nodes for the June 2006 storm event to reflect the amount of storage capacity that exists in the upstream piping network (pipes smaller than 36 inches). However, for an inlet node that still reported flooding after this initial amount of storage was added, storage volume continued to be increased incrementally until the inlet node no longer flooded. Therefore, the modeled storage volume is either equal to the system storage capacity upstream of the inlet node or the maximum storage volume required to convey the storm hyetograph. Storage was expanded to a total of eight nodes for the 10yr-24hr SCS Type II storm event.

Table 9 shows (1) the node that was restricted for the two storm events, (2) the calculated storage capacity of the piping network upstream of the inlet node (pipes smaller than 36 inches), and (3) the average and maximum storage volume used for each storm event. The average storage volume used reflects the average (zero to maximum) storage volume used over the entire storm event (24 hours). **Figure 12** shows the location of the restricted node identified in **Table 9**.

TABLE 9
Storage Node Summary

Node Id	System Storage Capacity Upstream of Inlet Node	June 2006 Storm Event			10yr-24hr SCS Type II Storm		
		Modeled Storage Capacity	Average Storage Used	Maximum Storage Used	Modeled Storage Capacity	Average Storage Used	Maximum Storage Used
2706	11,051	24,461	1,447	20,586	52,954	2,491	52,117
3729	7,629	43,335	3,190	43,310	93,090	4,597	92,377
3415	13,104	NA	NA	NA	31,860	1,252	31,844
1559	1,931	2,455	167	2,455	31,315	1,716	31,821
2547	9,440	NA	NA	NA	12,771	433	12,737
2337	7,235	NA	NA	NA	20,063	814	19,897
1574	7,304	NA	NA	NA	31,682	1,415	31,644
1742	9,554	NA	NA	NA	18,608	1,178	18,533

All values in cubic feet. NA, not applicable.

5.3 Conveyance Capacity

The conveyance capacity of the existing stormwater collection system during the storm events listed in Section 4 was evaluated based on these evaluation criteria:

- If the hydraulic grade line (HGL) rose above the ground surface, the structure was considered flooded.
- If the HGL rose to within 1 foot of the ground surface, the structure was considered to have insufficient "freeboard."
- If the HGL rose above the crown of the pipe but below the insufficient freeboard mark, the structure was considered surcharged.
- At stream-to-pipe or pipe-to-stream nodes (or connections), if the HGL rose above the pipe crown (pipe submerged), this node was also considered surcharged.

Pipes were evaluated for these conditions on the upstream and downstream ends and categorized on the basis of the least desirable condition. Results are summarized in **Table 10** for the June 2006 storm event and the 10yr-24 hr SCS Type II storm.

The hydraulic model predicts that approximately 54 percent of the Little Pimmit Run modeled stormwater collection system is experiencing capacity limitations during the June 2006 event and 72 percent is experiencing capacity limitations during the 10yr-24hr SCS Type II storm.

The details on the pipes with flooding, insufficient freeboard, and surcharged conditions are summarized in **Tables 11** and **12. Tables 13** and **14** provide details on the stream segments.

As discussed previously, cross-section information on the stream segments was provided as input to the model. All flows from both storms stayed within the cross sections and were not lost from the model. In some cases, the HGL did reach above the top of bank but still stayed within the combined stream and floodplain cross section information provided; that is, the streams fully conveyed the flow within the model.

A plan view of the watershed depicting the inlets, manholes, and other point structures experiencing these conditions is provided in **Figures 13 and 14**.

TABLE 10
Summary of Conveyance Capacity Limitations

		HGL Flooding Ground Surface		HGL Within 1 Foot of Ground Surface		HGL Surcharging Pipe Crown		Capacity Limitations	
Scenario (with Storage)	**Modeled System[a] (Linear Feet)**	**Linear Feet**	**Percent of Modeled System**	**Linear Feet**	**Percent of Modeled System**	**Linear Feet**	**Percent of Modeled System**	**Linear Feet**	**Percent of Modeled System**
June 2006 storm event	20,859	2,926	14	4,844	23	3,402	16	11,172	54
10yr-24hr SCS Type II storm	20,859	6,491	31	4,511	22	4,022	19	15,024	72

HGL, hydraulic grade line.
[a]The modeled system in this table includes the closed pipe network and rectangular open channels described in Table 2. It does not include natural stream channels.

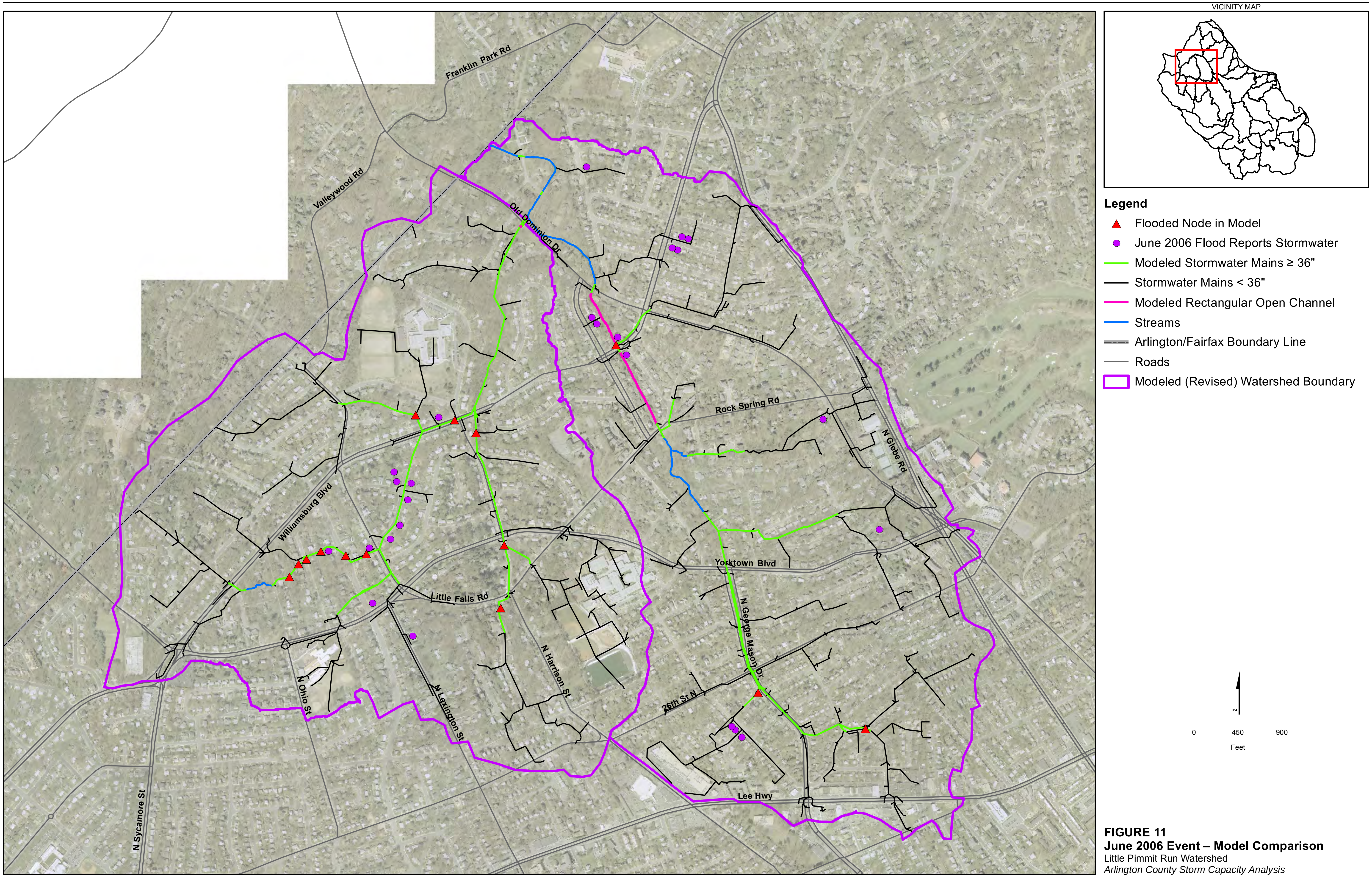


FIGURE 11
June 2006 Event – Model Comparison
Little Pimmit Run Watershed
Arlington County Storm Capacity Analysis

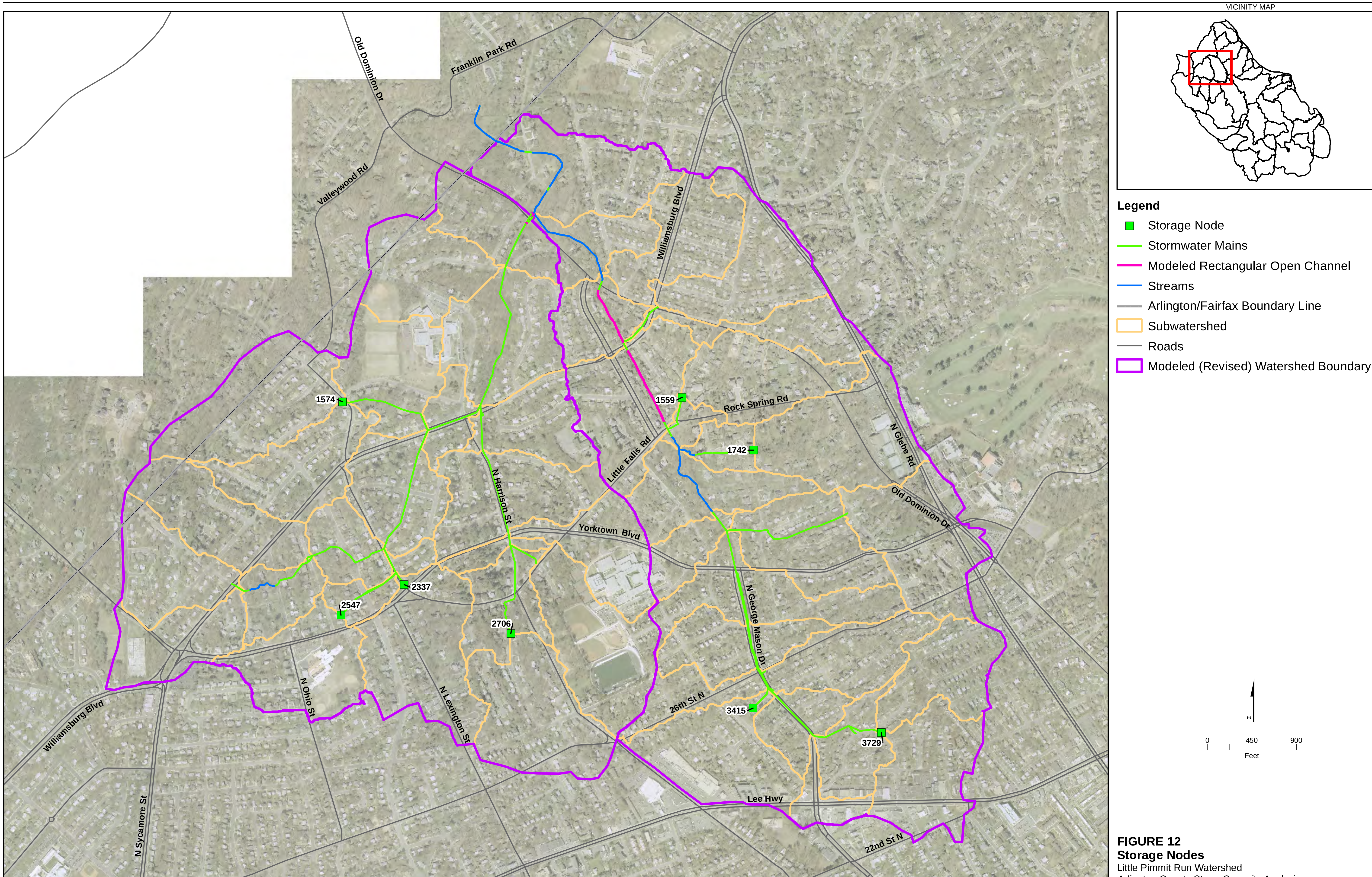


FIGURE 12
Storage Nodes
Little Pimmit Run Watershed
Arlington County Storm Capacity Analysis

CH2MHILL

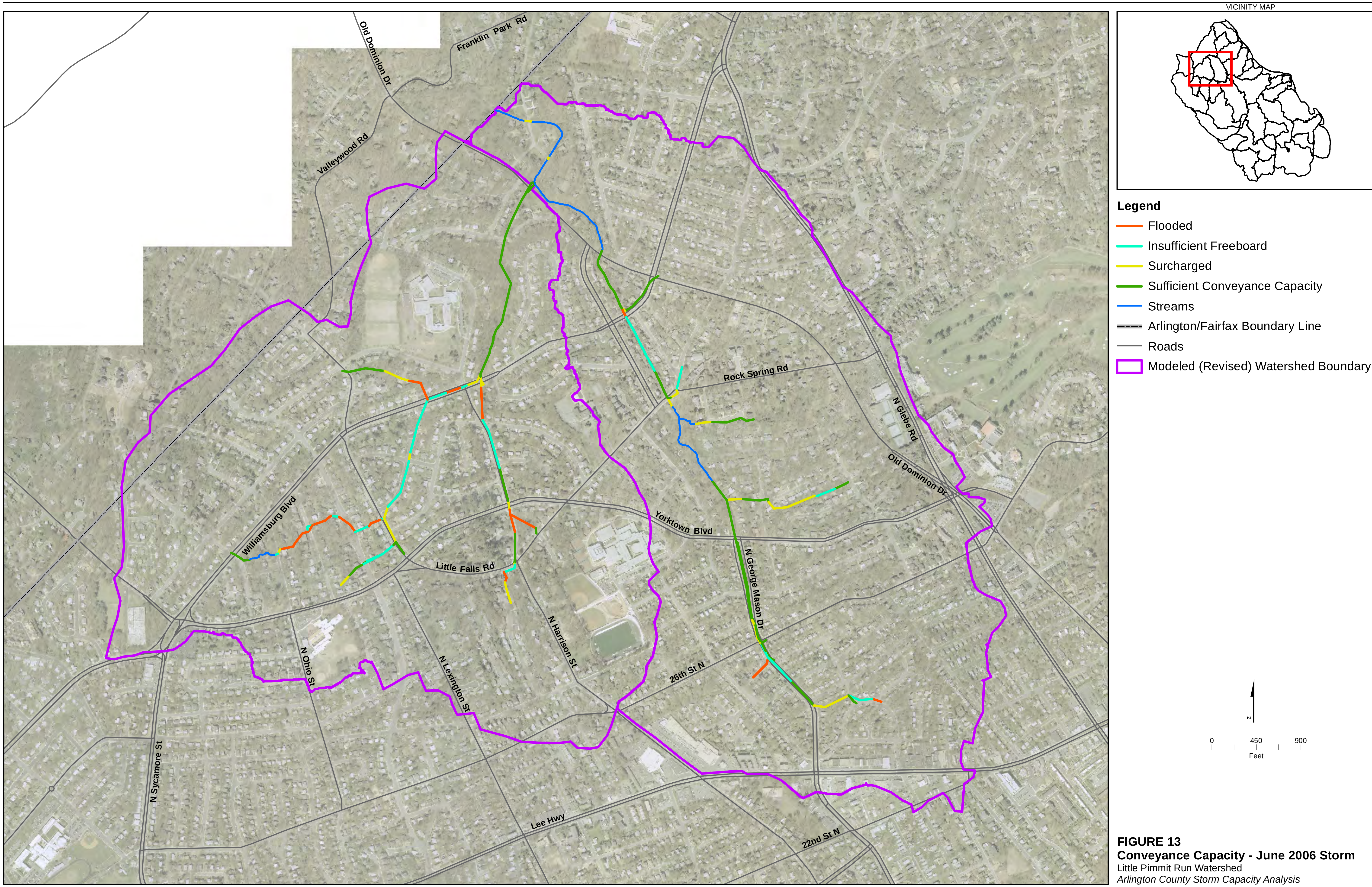


FIGURE 13
Conveyance Capacity - June 2006 Storm
Little Pimmit Run Watershed
Arlington County Storm Capacity Analysis

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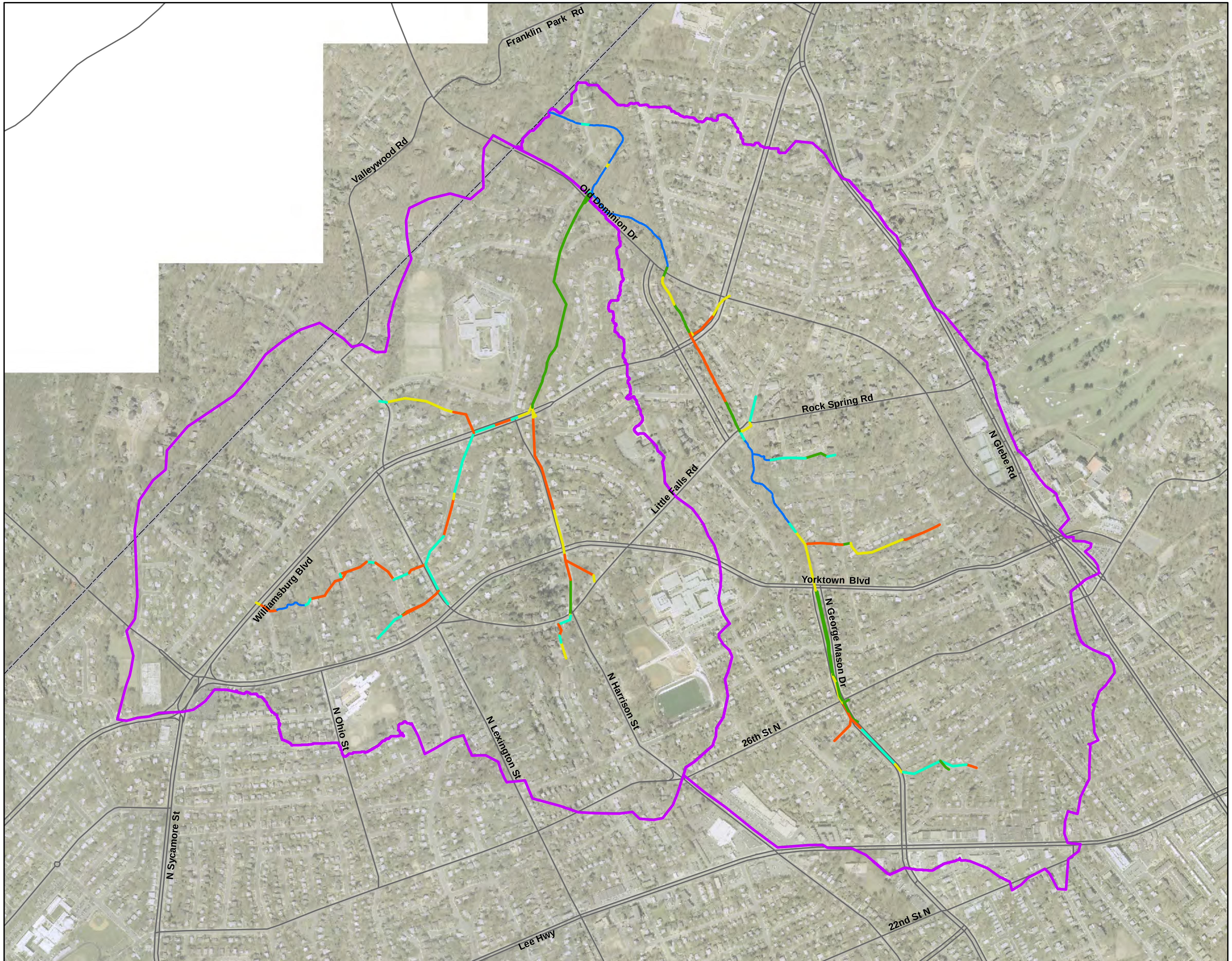
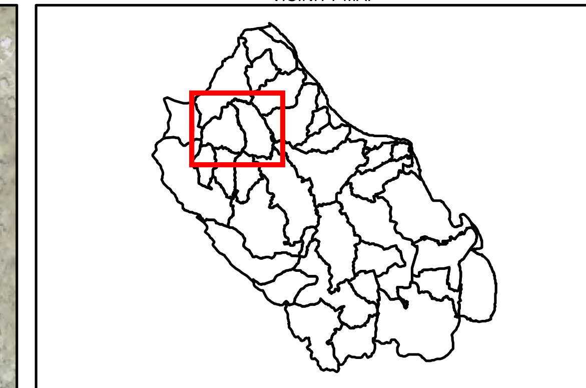


VICINITY MAP



Legend

- Flooded
- Insufficient Freeboard
- Surcharged
- Sufficient Conveyance Capacity
- Streams
- Arlington/Fairfax Boundary Line
- Roads
- Modeled (Revised) Watershed Boundary

N

0 450 900
Feet

FIGURE 14
Conveyance Capacity - 10yr-24hr Storm Event
Little Pimmit Run Watershed
Arlington County Storm Capacity Analysis

CH2MHILL

TABLE 11
Pipes Experiencing Surcharging or Higher Conditions in the 2006 Storm Event (with Storage)

Conduit ID	Node ID		Length (ft)	Diameter/Pipe Dimension (ft)	Maximum Flow (ft^3/s)	Maximum Velocity (ft/s)	Duration of Surcharge (min)		Duration of Flooding (min)		Flooding Volume (ft^3)		Insufficient Freeboard/ Depth Below Rim (ft)		Surcharge/Depth Above Crown (ft)		Summary Condition
	US	DS					US	DS	US	DS	US	DS	US	DS	US	DS	
20225	1383	1365	40	6	1,385.3	25.3	1.8	0	0.6	0	3,380	N	0.00	N	5.18	N	Flooding
20229	1619	1584	82	7	392.2	11.5	84	0	0	0	N	N	N	N	0.50	N	Surcharge
20230	1636	1619	114	6.5	392.1	11.9	0	84	0	0	N	N	N	N	N	1.00	Surcharge
20231	1608	1596	32	5.5	225.4	10.0	54.6	0	0	0	N	N	N	N	0.32	N	Surcharge
20234	1759	1683	193	5.5	269.4	11.3	3.6	48	0	45	N	61,162	0.42	0.00	0.16	0.13	Flooding
20235	1683	1637	153	5.5	225.4	9.5	48	83.4	45	0	61,162	N	0.00	N	0.13	0.75	Flooding
20236	1637	1608	59	5.5	188.2	7.9	83.4	54.6	0	0	N	N	N	N	0.85	0.12	Surcharge
20243	2140	2120	48	4	158.0	12.6	34.8	4.8	4.8	0	2,039	N	0.00	N	1.37	0.02	Flooding
20246	2120	2067	92	4	158.0	14.3	4.8	0	0	0	N	N	N	N	0.13	N	Surcharge
21736	2994	2862	130	5.5	245.3	10.3	8.4	31.2	0	0	N	N	N	N	0.35	0.45	Surcharge
22050	2406	2336	237	3	61.3	17.0	0	0	0	0	N	N	N	RIM	N	1.46	Ins. freeboard
22441	22716	22715	41	7	1,839.5	16.5	36	0	0	0	N	N	N	N	0.74	N	Surcharge
22665	1603	22873	79	4	127.8	13.8	6	42.6	0	0	N	N	N	N	3.62	4.00	Surcharge
22666	22873	1623	119	4	127.8	16.6	42.6	83.4	0	32.4	N	27,534	N	0.00	4.00	3.46	Flooding
22690	3789	3770	99	3.5	84.8	8.9	26.4	49.8	0	0	N	N	N	N	0.23	0.42	Surcharge
22841	1637	1630	28	3.5	37.2	3.9	83.4	85.2	0	0	N	N	N	N	0.70	0.91	Surcharge
23281	1643	23400	17	6.5	393.2	11.9	93	87	62.4	0	118,781	N	0.00	0.90	3.40	1.45	Flooding
23282	23400	1636	51	6.5	393.2	12.0	87	0	0	0	N	N	0.90	N	1.45	N	Ins. freeboard
24834	1417	24606	20	8	739.1	7.4	11.4	1.8	0.6	0	N	N	RIM	0.10	1.90	1.18	Ins. freeboard
24835	24606	24607	10	8	736.6	7.9	1.8	0.6	0	0	N	N	0.10	0.05	1.18	1.29	Ins. freeboard
24836	24607	1383	59	8	863.5	9.2	0.6	1.8	0	0.6	N	3,380	0.05	0.00	1.29	3.25	Flooding
24839	2862	24619	62	5.5	245.3	10.3	31.2	0	0	0	N	N	N	N	0.48	N	Surcharge
24852	3122	24622	63	5.5	217.6	9.2	45.6	46.2	0	0	N	N	0.61	0.12	1.53	1.03	Ins. freeboard
24853	24622	3054	28	5.5	217.7	9.2	46.2	0	0	0	N	N	0.12	N	1.03	N	Ins. freeboard
4072	1377	1365	23	4	97.1	10.5	0	0	0	0	N	N	N	N	0.10	N	Surcharge
4175	1575	1603	190	4	127.7	12.3	0	6	0	0	N	N	N	N	N	3.62	Surcharge
4188	1622	1608	31	3.5	37.2	3.9	85.8	54.6	0	0	N	N	N	N	0.94	1.82	Surcharge
4193	1630	1622	21	3.5	37.2	3.9	85.2	85.8	0	0	N	N	N	N	1.08	0.84	Surcharge
4204	SU4	1649	245	3	51.1	7.2	43.8	79.2	0	0	N	N	RIM	N	1.91	1.80	Ins. freeboard

TABLE 11 (CONTINUED)
Pipes Experiencing Surcharging or Higher Conditions in the 2006 Storm Event (with Storage)

Conduit ID	Node ID		Length (ft)	Diameter/Pipe Dimension (ft)	Maximum Flow (ft^3/s)	Maximum Velocity (ft/s)	Duration of Surcharge (min)		Duration of Flooding (min)		Flooding Volume (ft^3)		Insufficient Freeboard/ Depth Below Rim (ft)		Surcharge/Depth Above Crown (ft)		Summary Condition
	US	DS					US	DS	US	DS	US	DS	US	DS	US	DS	
4206	1653	1643	154	6.5	440.3	13.3	87.6	93	0	62.4	N	118,781	0.14	0.00	4.01	3.40	Flooding
4210	1649	1655	33	3	51.1	7.2	79.2	40.8	0	0	N	N	N	N	1.80	0.75	Surcharge
4218	1655	1668	86	3	51.1	7.4	40.8	0	0	0	N	N	N	N	0.85	N	Surcharge
4226	1675	1653	195	6.5	440.3	13.3	84.6	87.6	0.6	0	N	N	RIM	0.14	4.50	4.01	Ins. freeboard
4227	1623	1675	181	5.5	108.4	7.0	83.4	84.6	32.4	0.6	27,534	N	0.00	RIM	3.46	4.81	Flooding
4241	1706	1670	95	8	618.3	13.3	0	0	0	0	N	N	N	N	0.08	N	Surcharge
4270	1769	1772	76	4	75.5	6.2	0	1.8	0	0	N	N	N	N	N	0.10	Surcharge
4273	1772	1779	101	4	75.5	9.3	1.8	0	0	0	N	N	N	N	0.16	N	Surcharge
4274	1780	1675	271	5.5	257.5	11.9	72	84.6	0.6	0.6	N	N	RIM	RIM	10.64	5.31	Ins. freeboard
4286	1809	1759	130	5	206.1	10.7	39	3.6	0.6	0	N	N	RIM	0.42	2.26	0.18	Ins. freeboard
4303	1865	1780	314	5.5	257.5	15.4	1.2	72	0	0.6	N	N	N	RIM	0.08	10.52	Ins. freeboard
4308	1882	1865	48	5	257.3	14.4	47.4	1.2	0	0	N	N	N	N	1.72	0.34	Surcharge
4319	1916	1882	70	5	257.3	13.1	84	47.4	0.6	0	N	N	RIM	N	3.10	1.63	Ins. freeboard
4323	1922	1809	386	5	206.1	12.1	0	39	0	0.6	N	N	N	RIM	N	2.26	Ins. freeboard
4363	2024	1916	280	5	257.3	13.2	6.6	84	0	0.6	N	N	0.70	RIM	1.86	2.97	Ins. freeboard
4366	2010	2033	190	3	82.8	12.5	0	9.6	0	0	N	N	N	0.94	N	1.06	Ins. freeboard
4367	2033	2032	27	3	82.9	14.1	9.6	0	0	0	N	N	0.94	N	1.06	N	Ins. freeboard
4379	2054	2060	119	5	78.7	6.7	0	7.2	0	0	N	N	N	N	N	0.46	Surcharge
4381	2060	2063	27	5	78.0	7.0	7.2	0	0	0	N	N	N	N	0.60	0.56	Surcharge
4408	2102	2024	189	5	259.7	15.4	0	6.6	0	0	N	N	N	0.70	0.06	1.80	Ins. freeboard
4411	2032	2106	302	3	82.7	16.8	0	0	0	0	N	N	N	N	N	0.30	Surcharge
4415	2106	2115	133	4	81.0	6.5	0	1.8	0	0	N	N	N	N	N	0.21	Surcharge
4416	2115	2076	86	4	81.0	6.5	1.8	0	0	0	N	N	N	N	0.21	N	Surcharge
4432	2151	2156	79	3.5	114.0	13.0	88.2	88.8	0.6	0	N	N	RIM	0.10	2.81	2.50	Ins. freeboard
4437	2164	2102	122	5	261.5	13.9	82.2	0	0	0	N	N	N	N	2.64	N	Surcharge
4439	2172	2164	38	3.5	102.6	11.5	90.6	82.2	0	0	N	N	0.25	N	2.75	2.43	Ins. freeboard
4440	2175	2151	77	3.5	114.0	12.3	87	88.2	82.2	0.6	73,420	N	0.00	RIM	2.50	2.60	Flooding
4447	2188	2172	103	3.5	102.6	10.7	90	90.6	63	0	29,832	N	0.00	0.25	2.05	2.61	Flooding
4452	2156	2192	140	3.5	114.0	11.8	88.8	91.2	0	86.4	N	76,522	0.10	0.00	2.85	2.35	Flooding

TABLE 11 (CONTINUED)
Pipes Experiencing Surcharging or Higher Conditions in the 2006 Storm Event (with Storage)

Conduit ID	Node ID		Length (ft)	Diameter/Pipe Dimension (ft)	Maximum Flow (ft^3/s)	Maximum Velocity (ft/s)	Duration of Surcharge (min)		Duration of Flooding (min)		Flooding Volume (ft^3)		Insufficient Freeboard/ Depth Below Rim (ft)		Surcharge/Depth Above Crown (ft)		Summary Condition
	US	DS					US	DS	US	DS	US	DS	US	DS	US	DS	
4455	2194	2175	135	3.5	134.1	13.9	86.4	87	0.6	82.2	N	73,420	RIM	0.00	3.83	2.21	Flooding
4457	2196	2188	33	3.5	102.6	11.2	90	90	0.6	63	N	29,832	0.00	0.00	2.70	1.57	Flooding
4459	2201	2194	60	2.833	29.3	2.9	84.6	86.4	0	0.6	N	N	0.60	RIM	4.12	4.06	Ins. freeboard
4464	2210	2140	291	3	63.0	14.2	0	34.8	0	4.8	N	2,039	N	0.00	N	0.65	Flooding
4465	2213	2194	42	3.5	42.7	7.1	85.2	86.4	39	0.6	10,881	N	0.00	RIM	2.75	3.67	Flooding
4468	2218	2164	137	4	148.5	14.3	3	82.2	0	0	N	N	N	N	0.70	2.53	Surcharge
4469	2223	2213	35	3.5	42.7	6.4	83.4	85.2	0	39	N	10,881	0.23	0.00	2.62	2.65	Flooding
4470	2223	2201	51	3	29.3	6.9	83.4	84.6	0	0	N	N	0.23	0.60	2.34	2.82	Ins. freeboard
4471	2225	2196	153	3.5	102.6	11.3	88.2	90	0	0.6	N	N	N	0.00	5.56	2.35	Ins. freeboard
4472	2192	2225	88	3.5	103.5	11.2	91.2	88.2	86.4	0	76,522	N	0.00	N	2.41	5.05	Flooding
4474	2227	2140	184	3.5	61.0	9.6	0	34.8	0	4.8	N	2,039	N	0.00	N	0.50	Flooding
4479	2235	2223	64	4	72.0	7.4	83.4	83.4	62.4	0	48,126	N	0.00	0.23	1.90	1.68	Flooding
4496	2272	2218	135	4	148.6	14.9	0	3	0	0	N	N	N	N	N	0.60	Surcharge
4500	2280	2235	124	4	87.7	7.0	84	83.4	0	62.4	N	48,126	0.37	0.00	3.12	1.90	Flooding
4508	2294	2280	39	4	87.7	7.1	43.8	84	5.4	0	387	N	0.00	0.37	0.63	3.12	Flooding
4511	2310	2294	134	4	89.6	12.0	0	43.8	0	5.4	N	387	N	0.00	N	0.56	Flooding
4520	2334	2310	47	3.5	89.6	10.9	16.2	0	0	0	N	N	N	N	0.55	N	Surcharge
4522	2336	2292	139	3	62.4	9.2	0	0	0	0	N	N	RIM	N	1.46	N	Ins. freeboard
4527	2342	2334	34	3.5	89.6	9.3	0	16.2	0	0	N	N	0.78	N	1.49	0.50	Ins. freeboard
4543	2380	2336	177	2.2	1.4	0.7	0	0	0	0	N	N	N	RIM	N	2.26	Ins. freeboard
4554	2403	2399	12	3	59.2	10.2	83.4	0	0	0	N	N	N	N	0.37	N	Surcharge
4568	2435	2403	37	3	59.2	8.4	95.4	83.4	3.6	0	N	N	RIM	N	2.12	0.48	Ins. freeboard
4580	2463	2435	112	3	59.2	8.4	91.2	95.4	0	3.6	N	N	0.73	RIM	2.28	1.95	Ins. freeboard
4602	2504	2463	63	3	59.2	8.7	91.2	91.2	33	0	9,736	N	0.00	0.73	2.24	2.03	Flooding
4613	2532	2504	51	3	66.5	9.4	91.2	91.2	0	33	N	9,736	N	0.00	2.78	2.00	Flooding
4618	2547	2494	109	3	63.3	10.1	1.2	0	0	0	N	N	N	N	0.30	N	Surcharge
4625	2572	2532	64	3	66.5	9.4	90	91.2	0	0	N	N	N	N	3.66	2.78	Surcharge
4672	SU1	2572	152	3	66.5	9.5	0	90	0	0	N	N	N	N	N	3.66	Surcharge
4779	3050	3054	13	3	42.1	6.6	0	0	0	0	N	N	N	N	N	0.49	Surcharge

TABLE 11 (CONTINUED)
Pipes Experiencing Surcharging or Higher Conditions in the 2006 Storm Event (with Storage)

Conduit ID	Node ID		Length (ft)	Diameter/Pipe Dimension (ft)	Maximum Flow (ft^3/s)	Maximum Velocity (ft/s)	Duration of Surcharge (min)		Duration of Flooding (min)		Flooding Volume (ft^3)		Insufficient Freeboard/ Depth Below Rim (ft)		Surcharge/Depth Above Crown (ft)		Summary Condition
	US	DS					US	DS	US	DS	US	DS	US	DS	US	DS	
4780	3054	2994	63	5.5	181.2	8.6	0	8.4	0	0	N	N	N	N	N	0.35	Surcharge
4821	3191	3122	72	5.5	217.6	9.2	73.2	45.6	0.6	0	N	N	RIM	0.61	2.31	1.69	Ins. freeboard
4837	3256	3191	60	3.5	70.9	8.8	79.2	73.2	8.4	0.6	5,013	N	0.00	RIM	2.42	2.57	Flooding
4842	3275	3191	121	5	133.8	8.7	42.6	73.2	0.6	0.6	N	N	RIM	RIM	2.35	2.00	Ins. freeboard
4867	3415	3256	201	3	83.2	13.6	2.4	79.2	0.6	8.4	N	5,013	RIM	0.00	2.40	2.32	Flooding
4884	3482	3275	232	4.5	133.8	13.2	0	42.6	0	0.6	N	N	N	RIM	N	2.45	Ins. freeboard
4953	3705	3695	41	3	84.7	12.0	94.2	93.6	19.2	0	4,820	N	0.00	0.01	3.79	3.03	Flooding
4956	3695	3710	125	3	84.7	12.0	93.6	90	0	0	N	N	0.01	0.44	3.24	1.42	Ins. freeboard
4957	3710	3643	122	3	84.7	13.2	90	0	0	0	N	N	0.44	N	1.83	N	Ins. freeboard
4963	SU2	3705	57	3	53.6	7.6	88.8	94.2	0	19.2	N	4,820	RIM	0.00	3.42	3.79	Flooding
4983	3770	3768	17	3.5	84.8	9.7	49.8	0	0	0	N	N	N	N	0.42	N	Surcharge
6091	932	930	75	7	1,833.0	15.5	0	0	0	0	N	N	N	N	1.68	N	Surcharge
6281	1573	1417	584	6	678.7	13.3	0	11.4	0	0.6	N	N	N	RIM	N	4.13	Ins. freeboard
6413	3643	3789	268	3.5	84.8	10.4	0	26.4	0	0	N	N	N	N	N	0.23	Surcharge

US, upstream; DS, downstream; Y, yes; N, no; Ins., insufficient.

TABLE 12
Pipes Experiencing Surcharging or Higher Conditions in the 10yr-24hr SCS Type II Storm (with Storage)

Conduit ID	Node ID		Length (ft)	Diameter/ Pipe Dimension (ft)	Maximum Flow (ft^3/s)	Maximum Velocity (ft/s)	Duration of Surcharge (min)		Duration of Flooding (min)		Flooding Volume (ft^3)		Insufficient Freeboard/ Depth Below Rim (ft)		Surcharge/Depth Above Crown (ft)		Summary Condition
	US	DS					US	DS	US	DS	US	DS	US	DS	US	DS	
20222	1291	1326	137	4	155.4	12.4	4.8	9	0	0	N	N	N	N	3.67	4.22	Surcharge
20223	1279	1291	50	3.5	155.4	16.2	9	4.8	0	0	N	N	N	N	5.23	3.65	Surcharge
20225	1383	1365	40	6	1,440.5	25.4	0.6	0	0.6	0	6,318	N	0.00	N	5.18	N	Flooding
20229	1619	1584	82	7	392.2	11.5	27.6	0	0	0	N	N	N	N	0.51	N	Surcharge
20230	1636	1619	114	6.5	392.2	11.9	0	27.6	0	0	N	N	N	N	N	1.01	Surcharge
20231	1608	1596	32	5.5	225.6	10.0	21.6	0	0	0	N	N	N	N	0.31	N	Surcharge
20234	1759	1683	193	5.5	287.3	12.1	15	20.4	12	19.8	25,033	58,748	0.00	0.00	0.58	0.13	Flooding
20235	1683	1637	153	5.5	225.6	9.5	20.4	25.8	19.8	0	58,748	N	0.00	N	0.13	0.75	Flooding
20236	1637	1608	59	5.5	188.4	7.9	25.8	21.6	0	0	N	N	N	N	0.85	0.11	Surcharge
20243	2140	2120	48	4	157.9	12.6	17.4	14.4	14.4	0	39,119	N	0.00	N	1.37	0.23	Flooding
20246	2120	2067	92	4	157.9	14.4	14.4	0	0	0	N	N	N	N	0.34	N	Surcharge
20940	1964	1922	122	4.5	242.2	16.1	11.4	0	0	0	N	N	N	N	0.98	N	Surcharge
21736	2994	2862	130	5.5	256.1	10.8	16.2	19.2	0	0	N	N	N	N	1.07	1.00	Surcharge
22050	2406	2336	237	3	83.6	13.3	0	7.8	0	6	N	540	N	0.00	N	4.18	Flooding
22441	22716	22715	41	7	2,199.8	18.8	21.6	0	0	0	N	N	N	N	2.70	N	Surcharge
22665	1603	22873	79	4	169.9	13.8	18	21.6	0	0	N	N	N	N	3.35	4.27	Surcharge
22666	22873	1623	119	4	169.9	16.4	21.6	27	0	20.4	N	93,423	N	0.00	4.27	3.46	Flooding
22690	3789	3770	99	3.5	86.8	9.0	15	22.8	0.6	0	N	N	RIM	N	2.83	2.45	Ins. freeboard
22693	22896	1279	64	3	105.2	14.9	6	9	0	0	N	N	N	N	5.96	5.04	Surcharge
22797	2231	22968	123	8	383.4	8.7	0	10.8	0	0	N	N	N	N	N	0.76	Surcharge
22798	22968	22971	45	8	383.4	8.7	10.8	8.4	0	0	N	N	N	N	0.76	0.32	Surcharge
22799	22971	2063	166	8	383.5	8.2	8.4	13.8	0	0	N	N	N	N	0.32	1.33	Surcharge
22800	2007	22972	69	8	572.9	11.4	13.8	11.4	0	0	N	N	N	0.99	0.96	0.31	Ins. freeboard
22801	22972	1971	31	8	572.9	12.8	11.4	0	0	0	N	N	0.99	N	0.31	N	Ins. freeboard
22841	1637	1630	28	3.5	37.2	3.9	25.8	28.8	0	0	N	N	N	N	0.70	0.90	Surcharge
23281	1643	23400	17	6.5	393.9	11.9	39	31.8	23.4	0	64,831	N	0.00	0.90	3.40	1.45	Flooding
23282	23400	1636	51	6.5	393.9	12.0	31.8	0	0	0	N	N	0.90	N	1.45	N	Ins. freeboard
23519	SU8	23586	73	4	108.1	9.8	5.4	0	0	0	N	N	0.01	N	0.12	N	Ins. freeboard
23529	23594	1769	148	4	107.9	9.9	0	11.4	0	0	N	N	N	0.11	1.82	1.81	Ins. freeboard
24834	1417	24606	20	8	801.1	8.0	21	3	0.6	0.6	534	601	0.00	0.00	1.90	1.28	Flooding
24835	24606	24607	10	8	808.8	8.2	3	0.6	0.6	0.6	601	267	0.00	0.00	1.28	1.34	Flooding
24836	24607	1383	59	8	931.2	9.7	0.6	0.6	0.6	0.6	267	6,318	0.00	0.00	1.34	3.25	Flooding
24839	2862	24619	62	5.5	256.1	10.8	19.2	13.2	0	0	N	N	N	N	1.03	0.36	Surcharge

TABLE 12 (CONTINUED)
Pipes Experiencing Surcharging or Higher Conditions in the 10yr-24hr SCS Type II Storm (with Storage)

Conduit ID	Node ID		Length (ft)	Diameter/ Pipe Dimension (ft)	Maximum Flow (ft^3/s)	Maximum Velocity (ft/s)	Duration of Surcharge (min)		Duration of Flooding (min)		Flooding Volume (ft^3)		Insufficient Freeboard/ Depth Below Rim (ft)		Surcharge/Depth Above Crown (ft)		Summary Condition
	US	DS					US	DS	US	DS	US	DS	US	DS	US	DS	
24840	24619	24618	22	5.5	256.1	12.1	13.2	0	0	0	N	N	N	N	0.36	N	Surcharge
24852	3122	24622	63	5.5	218.5	9.2	24	24	0	11.4	N	9,127	0.65	0.00	1.49	1.15	Flooding
24853	24622	3054	28	5.5	218.5	9.2	24	13.2	11.4	0	9,127	N	0.00	N	1.15	0.44	Flooding
4060	1326	1359	162	4	155.4	12.4	9	8.4	0	1.2	N	201	N	0.00	4.29	2.05	Flooding
4071	1359	1377	86	4	152.9	12.2	8.4	11.4	1.2	0	201	N	0.00	N	2.15	2.14	Flooding
4072	1377	1365	23	4	152.9	13.3	11.4	0	0	0	N	N	N	N	2.48	0.03	Surcharge
4158	1567	1575	194	3.5	169.8	20.1	3.6	15.6	0	0	N	N	N	N	0.24	4.82	Surcharge
4160	1579	1567	171	3.5	170.3	20.0	7.8	3.6	0	0	N	N	N	N	0.88	0.24	Surcharge
4161	SU7	1579	67	3.5	110.9	11.7	12.6	7.8	0	0	N	N	0.01	N	1.60	0.88	Ins. freeboard
4175	1575	1603	190	4	169.9	13.5	15.6	18	0	0	N	N	N	N	4.82	3.35	Surcharge
4188	1622	1608	31	3.5	37.2	3.9	29.4	21.6	0	0	N	N	N	N	0.94	1.81	Surcharge
4193	1630	1622	21	3.5	37.3	3.9	28.8	29.4	0	0	N	N	N	N	1.07	0.84	Surcharge
4204	SU4	1649	245	3	49.0	6.9	27.6	39	0	0	N	N	0.01	N	1.90	1.99	Ins. freeboard
4206	1653	1643	154	6.5	449.1	13.5	32.4	39	0	23.4	N	64,831	0.21	0.00	3.94	3.40	Flooding
4210	1649	1655	33	3	49.0	6.9	39	25.8	0	0	N	N	N	N	1.99	1.05	Surcharge
4218	1655	1668	86	3	49.0	6.9	25.8	10.8	0	0	N	N	N	N	1.15	0.19	Surcharge
4220	1668	1670	28	3	49.0	8.9	10.8	0	0	0	N	N	N	N	0.19	N	Surcharge
4226	1675	1653	195	6.5	449.1	13.5	28.2	32.4	0.6	0	N	N	RIM	0.21	4.50	3.94	Ins. freeboard
4227	1623	1675	181	5.5	108.0	6.5	27	28.2	20.4	0.6	93,423	N	0.00	RIM	3.46	4.81	Flooding
4241	1706	1670	95	8	722.6	14.5	0	0	0	0	N	N	0.31	N	1.55	N	Ins. freeboard
4270	1769	1772	76	4	107.9	8.6	11.4	15	0	0	N	N	0.11	0.72	2.44	2.29	Ins. freeboard
4273	1772	1779	101	4	107.9	12.8	15	0	0	0	N	N	0.72	N	2.35	N	Ins. freeboard
4274	1780	1675	271	5.5	259.3	11.3	24	28.2	0.6	0.6	N	N	RIM	RIM	10.64	5.31	Ins. freeboard
4286	1809	1759	130	5	231.5	11.8	18.6	15	7.2	12	2,013	25,033	0.00	0.00	2.26	0.60	Flooding
4303	1865	1780	314	5.5	259.3	15.4	15.6	24	0	0.6	N	N	N	RIM	0.41	10.52	Ins. freeboard
4308	1882	1865	48	5	259.0	14.3	22.8	15.6	0	0	N	N	N	N	1.93	0.67	Surcharge
4319	1916	1882	70	5	259.0	13.2	27.6	22.8	16.8	0	9,066	N	0.00	N	3.10	1.84	Flooding
4323	1922	1809	386	5	242.2	12.7	0	18.6	0	7.2	N	2,013	N	0.00	N	2.26	Flooding
4345	1976	1985	45	3	136.5	19.3	9.6	9	0	4.2	N	2,131	N	0.00	5.14	2.87	Flooding
4358	1985	2010	106	3	119.7	19.6	9	10.2	4.2	0.6	2,131	N	0.00	RIM	2.87	4.25	Flooding
4363	2024	1916	280	5	266.7	13.6	19.2	27.6	0.6	16.8	N	9,066	RIM	0.00	2.56	2.97	Flooding
4366	2010	2033	190	3	119.7	16.9	10.2	16.8	0.6	10.2	N	10,896	RIM	0.00	5.25	2.00	Flooding
4367	2033	2032	27	3	97.2	15.5	16.8	0	10.2	0	10,896	N	0.00	N	2.00	N	Flooding

TABLE 12 (CONTINUED)
Pipes Experiencing Surcharging or Higher Conditions in the 10yr-24hr SCS Type II Storm (with Storage)

Conduit ID	Node ID		Length (ft)	Diameter/ Pipe Dimension (ft)	Maximum Flow (ft^3/s)	Maximum Velocity (ft/s)	Duration of Surcharge (min)		Duration of Flooding (min)		Flooding Volume (ft^3)		Insufficient Freeboard/ Depth Below Rim (ft)		Surcharge/Depth Above Crown (ft)		Summary Condition
	US	DS					US	DS	US	DS	US	DS	US	DS	US	DS	
4379	2054	2060	119	5	96.2	6.7	12.6	16.8	11.4	9.6	15,594	35,002	0.00	0.00	0.74	1.89	Flooding
4381	2060	2063	27	5	96.2	7.0	16.8	13.8	9.6	0	35,002	N	0.00	N	2.03	2.28	Flooding
4382	2063	2007	146	8	572.9	11.4	13.8	13.8	0	0	N	N	N	N	1.45	0.91	Surcharge
4385	2064	2054	195	4	97.2	15.5	0	12.6	0	11.4	N	15,594	N	0.00	N	0.74	Flooding
4387	2067	1964	222	4.5	242.2	15.8	0	11.4	0	0	N	N	N	N	N	0.98	Surcharge
4392	2076	2056	29	4	97.5	8.0	12	0	0	0	N	N	N	N	0.34	N	Surcharge
4408	2102	2024	189	5	266.7	15.4	16.8	19.2	0	0.6	N	N	N	RIM	1.12	2.50	Ins. freeboard
4411	2032	2106	302	3	97.5	16.6	0	13.2	0	0	N	N	N	N	N	2.02	Surcharge
4415	2106	2115	133	4	97.5	7.8	13.2	14.4	0	0	N	N	N	N	1.63	1.44	Surcharge
4416	2115	2076	86	4	97.5	7.8	14.4	12	0	0	N	N	N	N	1.44	0.34	Surcharge
4432	2151	2156	79	3.5	114.0	13.0	33	33.6	0	0	N	N	0.10	0.32	2.71	2.28	Ins. freeboard
4437	2164	2102	122	5	266.7	14.0	25.8	16.8	0	0	N	N	0.15	N	3.71	0.89	Ins. freeboard
4439	2172	2164	38	3.5	102.2	11.3	35.4	25.8	15	0	15,190	N	0.00	0.15	3.00	3.50	Flooding
4440	2175	2151	77	3.5	114.0	12.3	31.2	33	25.8	0	28,843	N	0.00	0.10	2.50	2.50	Flooding
4447	2188	2172	103	3.5	102.2	10.6	34.8	35.4	24	15	35,812	15,190	0.00	0.00	2.05	2.86	Flooding
4452	2156	2192	140	3.5	114.0	11.8	33.6	37.2	0	30.6	N	25,269	0.32	0.00	2.63	2.35	Flooding
4455	2194	2175	135	3.5	137.3	14.3	30.6	31.2	4.2	25.8	612	28,843	0.00	0.00	3.83	2.21	Flooding
4457	2196	2188	33	3.5	102.2	11.1	35.4	34.8	0.6	24	N	35,812	0.00	0.00	2.70	1.57	Flooding
4459	2201	2194	60	2.833	29.2	2.9	28.2	30.6	0	4.2	N	612	0.61	0.00	4.11	4.06	Flooding
4464	2210	2140	291	3	85.1	13.7	0	17.4	0	14.4	N	39,119	N	0.00	N	0.65	Flooding
4465	2213	2194	42	3.5	42.5	6.4	28.8	30.6	19.2	4.2	32,564	612	0.00	0.00	2.75	3.67	Flooding
4468	2218	2164	137	4	166.7	13.7	18.6	25.8	0	0	N	N	0.55	0.15	2.10	3.60	Ins. freeboard
4469	2223	2213	35	3.5	42.5	6.2	26.4	28.8	0	19.2	N	32,564	0.22	0.00	2.63	2.65	Flooding
4470	2223	2201	51	3	29.2	6.9	26.4	28.2	0	0	N	N	0.22	0.61	2.35	2.81	Ins. freeboard
4471	2225	2196	153	3.5	102.2	11.3	32.4	35.4	0	0.6	N	N	N	0.00	3.55	2.35	Ins. freeboard
4472	2192	2225	88	3.5	103.9	11.1	37.2	32.4	30.6	0	25,269	N	0.00	N	2.41	3.04	Flooding
4474	2227	2140	184	3.5	61.9	10.3	0	17.4	0	14.4	N	39,119	N	0.00	N	0.50	Flooding
4477	2230	2210	53	3	85.4	13.0	9.6	0	0	0	N	N	N	N	1.95	N	Surcharge
4479	2235	2223	64	4	71.6	7.4	26.4	26.4	23.4	0	30,082	N	0.00	0.22	1.90	1.69	Flooding
4496	2272	2218	135	4	166.7	14.9	16.8	18.6	0	0	N	N	0.40	0.55	1.98	2.00	Ins. freeboard
4500	2280	2235	124	4	87.7	7.0	27	26.4	0.6	23.4	N	30,082	RIM	0.00	3.49	1.90	Flooding
4506	2292	2272	39	3	69.1	12.4	17.4	16.8	15	0	29,149	N	0.00	0.40	0.79	1.65	Flooding
4508	2294	2280	39	4	87.7	7.0	22.8	27	19.8	0.6	30,252	N	0.00	RIM	0.63	3.49	Flooding

TABLE 12 (CONTINUED)
Pipes Experiencing Surcharging or Higher Conditions in the 10yr-24hr SCS Type II Storm (with Storage)

Conduit ID	Node ID		Length (ft)	Diameter/ Pipe Dimension (ft)	Maximum Flow (ft^3/s)	Maximum Velocity (ft/s)	Duration of Surcharge (min)		Duration of Flooding (min)		Flooding Volume (ft^3)		Insufficient Freeboard/ Depth Below Rim (ft)		Surcharge/Depth Above Crown (ft)		Summary Condition
	US	DS					US	DS	US	DS	US	DS	US	DS	US	DS	
4511	2310	2294	134	4	127.6	12.0	7.8	22.8	0	19.8	N	30,252	N	0.00	0.34	0.56	Flooding
4520	2334	2310	47	3.5	127.6	13.3	21	7.8	0	0	N	N	0.95	N	4.05	0.29	Ins. freeboard
4522	2336	2292	139	3	85.4	12.1	7.8	17.4	6	15	540	29,149	0.00	0.00	4.18	0.79	Flooding
4523	SU6	2272	145	3.5	105.9	12.6	12	16.8	0	0	N	N	0.04	0.40	1.81	1.65	Ins. freeboard
4526	2328	2341	53	3	85.2	12.2	12	0	0	0	N	N	N	N	1.57	N	Surcharge
4527	2342	2334	34	3.5	127.6	13.3	0	21	0	0	N	N	RIM	0.95	6.51	4.00	Ins. freeboard
4538	2370	2359	57	3.5	135.2	14.1	13.2	0	9	0	8,497	N	0.00	0.89	1.46	0.05	Flooding
4539	2341	2370	98	3	85.1	12.0	0	13.2	0	9	N	8,497	N	0.00	0.79	1.46	Flooding
4543	2380	2336	177	2.2	4.1	3.0	0	7.8	0	6	N	540	N	0.00	N	0.30	Flooding
4554	2403	2399	12	3	59.2	10.2	41.4	0	0	0	N	N	N	N	0.37	N	Surcharge
4566	2432	2406	65	3	87.7	13.9	15	0	0	0	N	N	0.04	N	2.06	N	Ins. freeboard
4568	2435	2403	37	3	59.2	8.4	48.6	41.4	6.6	0	N	N	RIM	N	2.12	0.48	Ins. freeboard
4580	2463	2435	112	3	59.2	8.4	43.8	48.6	0	6.6	N	N	0.66	RIM	2.35	1.95	Ins. freeboard
4595	2494	2432	122	3	87.7	12.4	10.8	15	0	0	N	N	N	0.04	1.73	1.86	Ins. freeboard
4602	2504	2463	63	3	59.2	8.7	43.8	43.8	24.6	0	11,824	N	0.00	0.66	2.24	2.10	Flooding
4613	2532	2504	51	3	71.8	10.2	43.8	43.8	0	24.6	N	11,824	0.71	0.00	3.12	2.00	Flooding
4618	SU5	2494	109	3	87.7	12.4	18	10.8	0	0	N	N	0.02	N	4.72	1.73	Ins. freeboard
4625	2572	2532	64	3	71.8	10.2	42.6	43.8	0	0	N	N	N	0.71	3.50	3.12	Ins. freeboard
4672	SU1	2572	152	3	71.8	10.2	0	42.6	0	0	N	N	N	N	N	3.50	Surcharge
4779	3050	3054	13	3	50.3	7.6	0	13.2	0	0	N	N	N	N	N	0.97	Surcharge
4780	3054	2994	63	5.5	183.7	8.6	13.2	16.2	0	0	N	N	N	N	0.44	1.07	Surcharge
4821	3191	3122	72	5.5	218.4	9.2	26.4	24	13.8	0	34,184	N	0.00	0.65	2.31	1.65	Flooding
4837	3256	3191	60	3.5	77.1	8.2	27.6	26.4	19.2	13.8	33,888	34,184	0.00	0.00	2.42	2.57	Flooding
4842	3275	3191	121	5	178.1	9.1	22.8	26.4	0.6	13.8	N	34,184	RIM	0.00	2.35	2.00	Flooding
4867	SU3	3256	201	3	102.5	14.5	16.8	27.6	0	19.2	N	33,888	RIM	0.00	2.40	2.32	Flooding
4884	3482	3275	232	4.5	178.1	13.3	0	22.8	0	0.6	N	N	N	RIM	N	2.45	Ins. freeboard
4891	3503	3482	23	4.5	178.0	11.9	8.4	0	0	0	N	N	0.74	N	0.70	N	Ins. freeboard
4945	3693	3503	200	4.5	178.0	11.6	0	8.4	0	0	N	N	N	0.74	N	0.70	Ins. freeboard
4953	3705	3695	41	3	84.7	12.0	48	46.8	8.4	0	5,152	N	0.00	0.02	3.79	3.02	Flooding
4956	3695	3710	125	3	84.7	12.0	46.8	40.8	0	0	N	N	0.02	0.44	3.23	1.42	Ins. freeboard
4957	3710	3643	122	3	84.7	13.2	40.8	0	0	0	N	N	0.44	N	1.83	N	Ins. freeboard
4963	SU2	3705	57	3	57.2	8.1	40.8	48	0	8.4	N	5,152	0.05	0.00	3.37	3.79	Flooding
4982	3768	3693	94	4	178.8	15.0	10.2	0	0	0	N	N	N	N	1.87	N	Surcharge

TABLE 12 (CONTINUED)
Pipes Experiencing Surcharging or Higher Conditions in the 10yr-24hr SCS Type II Storm (with Storage)

Conduit ID	Node ID		Length (ft)	Diameter/ Pipe Dimension (ft)	Maximum Flow (ft^3/s)	Maximum Velocity (ft/s)	Duration of Surcharge (min)		Duration of Flooding (min)		Flooding Volume (ft^3)		Insufficient Freeboard/ Depth Below Rim (ft)		Surcharge/Depth Above Crown (ft)		Summary Condition
	US	DS					US	DS	US	DS	US	DS	US	DS	US	DS	
4983	3770	3768	17	3.5	86.8	9.9	22.8	10.2	0	0	N	N	N	N	2.45	1.99	Surcharge
6091	932	930	75	7	2,165.6	18.2	0	0	0	0	N	N	N	RIM	3.82	0.74	Ins. freeboard
6106	1018	1016	28	6	698.1	15.2	0	0	0	0	N	N	N	RIM	N	0.16	Ins. freeboard
6264	1295	1213	277	6	1,014.6	18.5	0	0	0	0	N	N	N	N	N	0.05	Surcharge
6281	1573	1417	584	6	789.7	14.8	0	21	0	0.6	N	534	N	0.00	N	4.13	Flooding
6289	2270	2231	97	8	382.8	9.1	0	0	0	0	N	N	N	N	0.08	N	Surcharge
6413	3643	3789	268	3.5	86.8	10.4	0	15	0	0.6	N	N	N	RIM	N	2.83	Ins. freeboard

US, upstream; DS, downstream; Y, yes; N, no; Ins., insufficient.

TABLE 13
2006 Storm Event Stream Results

Conduit ID	Node ID		Length (ft)	Depth (ft)	Maximum Flow (ft^3/s)
	US	DS			
20183	930	928	52	5.12	1,243.7
20184	928	J1	263	4.79	1,243.7
20189	949	932	346	6.81	1,245.5
20944	1971	1868	311	3.56	578.9
22151	1097	22412	550	6.45	1,134.6
22152	22412	1020	215	5.53	1,094.7
22443	1016	22716	265	4.91	2,198.3
22444	22715	949	281	5.01	1,259.6
4534	2359	2342	296	2.65	134.8
6105	1020	1016	17	3.61	1,579.5
6268	1192	1169	71	3.69	997.7
6269	1169	1097	201	5.28	1,134.7
6278	1779	1753	189	2.26	107.8
6280	1753	1706	149	4.40	996.5
6287	1868	1753	476	3.74	577.8

TABLE 14
10yr-24hr SCS Type II Storm Event Stream Results

Conduit ID	Node ID		Length (ft)	Depth (ft)	Maximum Flow (ft^3/s)
	US	DS			
20183	930	928	52	5.86	1,441.9
20184	928	J1	263	5.33	1,441.9
20189	949	932	346	8.43	1,465.3
20944	1971	1868	311	4.20	430.0
22151	1097	22412	550	6.49	723.3
22152	22412	1020	215	6.90	724.7
22443	1016	22716	265	6.16	1,488.9
22444	22715	949	281	6.21	1,532.5
4534	2359	2342	296	3.61	86.6
6105	1020	1016	17	5.36	2,050.8
6268	1192	1169	71	4.27	665.9
6269	1169	1097	201	5.77	723.3
6278	1779	1753	189	2.82	67.8
6280	1753	1706	149	5.63	528.5
6287	1868	1753	476	4.55	427.7

Appendix A
Technical Memorandum: GIS Data Gaps in the Storm Sewer System

GIS Data Gaps and Anomalies—Little Pimmit Run

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DATE: October 6, 2011

PROJECT NUMBER: 392309

1 Introduction

This technical memorandum describes the Little Pimmit Run, East Branch, and West Branch storm sewer data obtained from the Arlington County staff and the work performed to identify and resolve the data gaps and anomalies in the storm sewer network. These data gaps and anomalies were examined in order to prepare the data for use in PC-SWMM (a hydrologic and hydraulic computer model used to simulate storm sewer systems).

For the purpose of this analysis, the major storm sewer network has been divided into 24 segments, which are shown in **Figure 1-1**. Descriptions of the 24 segments are found in **Table 1-1**. All figures are found at the end of this document.

TABLE 1-1
Little Pimmit Run Watershed—Major Storm Sewer and Stream Network Segments

Segment	Description
0	Little Pimmit Run Outfall (Stream)
1	Little Pimmit Run Outfall to N. Dickerson Street and 36th Street N.
2	N. Dickerson Street to N. Delaware Street
3	Little Pimmit Run Outfall to Old Dominion Drive and N. Edison Street (Stream)
4	Old Dominion Drive and N. Edison Street to Williamsburg Boulevard and N. Harrison Street
5	Williamsburg Boulevard from N. Harrison Street to 400’ past N. Harrison Street
6	Williamsburg Boulevard near N. Harrison Street to N. Kensington Street and 36th Street N.
7	Williamsburg Boulevard near N. Harrison Street to N. Kensington Street and 33rd Street N.
8	N. Kensington Street and 33rd Street N. to Williamsburg Boulevard and N. Potomac Street (Stream Segments)
9	N. Kensington Street and 33rd Street N. to N. Kensington Street Yorktown Boulevard
10	N. Kensington Street to N. Nottingham Street north of Yorktown Boulevard
11	Williamsburg Boulevard to Yorktown Boulevard along N. Harrison Street
12	N. Harrison Street to N. Jefferson Street south of Little Falls Road along N. Harrison Street

TABLE 1-1
Little Pimmit Run Watershed—Major Storm Sewer and Stream Network Segments

Segment	Description
13	N. Harrison Street and Yorktown Boulevard to Little Falls Road and N. Green Castle Street
14	Old Dominion Drive and N. Edison Street to N. George Mason Drive and Williamsburg Boulevard (Stream)
15	N. George Mason Drive and Williamsburg Boulevard to Old Dominion Drive and Williamsburg Boulevard
16	N. George Mason Drive and Williamsburg Boulevard to Little Falls Road between N. Columbus Street and N. George Mason Drive (Stream)
17	Little Falls Road between N. Columbus Street and N. George Mason Drive to Little Falls Road and N. Columbus Street
18	Stream from Little Falls Road to N. George Mason Drive (Stream Segments)
19	N. George Mason Drive north of Yorktown Boulevard to end of N. Dickerson Street cul-de-sac
20	N. George Mason Drive north of Yorktown Boulevard to N. Brandywine Street between 28th and 29th Street N. (Stream Segments)
21	N. George Mason Drive north of Yorktown Boulevard to 25th Place N. (Stream Segments)
22	25th Place N. between N. George Mason Drive and N. Florida Street
23	N. George Mason Drive and 25th Pl. N. to 24th Street N. and N. Edison Street
24	N. Emerson Street between 24th and 25th Street N.

Note: "Stream" indicates a segment made up wholly of natural stream; "Stream Segments" indicates a segment made up of both stream channel and closed pipe networks. The lack of qualifier indicates that the segment is made up wholly of closed pipe network.

2 Storm Data Files and Model Extent

2.1 GIS Database

Initial base layers consisting of geographic information system (GIS) shapefiles were obtained from Arlington County in June 2010. Arlington County staff exhausted the record drawings available directly through the County and completed data updates in the County's Cassworks database program. Arlington County GIS staff exported this information to an ArcGIS PGDB (personal geodatabase), which was linked with GIS shapefiles obtained in June 2010. The ArcGIS PGDB was delivered to CH2M HILL in February 2011.

2.2 Record Drawings

In addition to the ArcGIS PGDB, the County also provided the storm sewer record drawings for the Little Pimmit Run watershed in February 2011. The record drawings were used in conjunction with the ArcGIS PGDB to resolve the data gaps and anomalies.

2.3 Survey Information

The Little Pimmit Run storm system contains natural stream systems directly connected to the storm pipe network. These stream channels will also be modeled.

During a preliminary review of the ArcGIS PGDB, it was determined that there was a need to survey key stream cross sections from North Ohio Street to Williamsburg Boulevard and from the Little Pimmit Run stream channel towards North Dickerson Street. On May 20, 2011, CH2M HILL submitted one drawing suggesting two locations along the stream to be surveyed and identifying locations where invert and headwall elevations of existing culverts into those streams were required. The County has provided sufficient information.

2.4 HEC-RAS Model

Little Pimmit Run has been studied recently for a potential stream restoration design project. An existing HEC-RAS model was updated because of this potential project in 2010. Details of the study were provided in *Little Pimmit Run Stream Corridor Study Phase II Report: Hydrologic and Hydraulic Modeling Analyses* by VHB in May 2010. The HEC-RAS model includes 87 cross sections and 5 culverts and runs from the Fairfax County border (Station 1292) to approximately 1,000 feet upstream of Little Falls Road (Station 6317) along Little Pimmit Run, East Branch.

2.5 Hydraulic Model End Point

Based on the initial data review and discussion with the County, the hydraulic model will terminate in Little Pimmit Run on the downstream side of the second North Dumbarton Street crossing, as shown in **Figure 1-1**. This location is just upstream of the Arlington County–Fairfax County line and excludes several links of pipe. The contributing area to these links of pipe includes drainage predominantly from Fairfax County. The stream at this location does not experience capacity limitations according to the anecdotal flooding map of the June 2006 storm. For these reasons, we are excluding segments 0, 1, and 2 and a portion of segment 3 from the model.

2.6 Methodology

The information provided by the County was used to find solutions to the data gaps and anomalies (described in Section 3) found in the ArcGIS PGDB. The data gaps and anomalies were resolved by (in order of precedence):

1. Reviewing the information in the ArcGIS PGDB
2. Reviewing the record drawings
3. Interpolating across two or more links

If a solution could not be found, the issue was discussed with the County, or a field survey was requested from the County. The record drawings were reviewed for large structures, such as box culverts, even if no anomaly was apparent in the GIS data, because these structures are considered critical parts of the major storm sewer network.

3 Types of Data Gaps and Anomalies

3.1 Watershed Boundary Anomalies

The watershed boundary provided by the County as part of the ArcGIS PGDB was developed on the basis of contour information; as such, several minor links and nodes were not included within the boundary, and links and nodes belonging to other watersheds were included. In April 2011, CH2M HILL submitted two figures showing the locations of the boundary anomalies requiring additional input from the County before revision. After coordination with the County, CH2M HILL modified the boundary to include all of the Little Pimmit Run minor links and nodes and exclude all links and nodes pertaining to adjacent watersheds. Additional adjustments were made to other portions of the watershed on the basis of existing data in GIS. Attachment A provides documentation of all changes to the watershed boundary.

3.2 Link and Network Gaps and Anomalies

Link gaps and anomalies occur when a link has an incorrect size, type, material, or upstream and/or downstream node information. Link anomalies were resolved by reviewing the record drawings and communicating with the County.

Network anomalies included downstream links with smaller diameters than upstream links and links disconnected from the piping network. These anomalies were resolved by reviewing the record drawings and discussing them with the County. All links meeting the 36-inch size criterion that are not being modeled were approved for elimination by the County.

Table 3-1, provided at the end of this document, shows the identified link and network anomalies as well as their respective solutions.

3.3 Invert and Rim Elevation Data Gaps and Anomalies

Invert and rim elevation data gaps occur when a node is missing its invert and/or rim elevation or when a link is missing its upstream and/or downstream invert elevation. Rim elevation data gaps were resolved by interpolating from the contour information. Invert elevation data gaps were resolved by using known invert elevations from connected links or nodes, reviewing the record drawings, or interpolating between upstream and downstream nodes.

The following types of invert anomalies were identified:

- Upstream link invert was higher than the upstream node invert
- Upstream link invert was lower than upstream node invert
- Downstream link invert was lower than the downstream node invert
- Difference in invert between connected links was greater than 4 feet
- Pipe crown is above ground surface (pipe is day-lighting)
- Link has 0 percent slope

Invert anomalies were resolved by reviewing the record drawings. It should be noted that certain invert anomalies do not represent errors. For example, a downstream link invert may be lower than the downstream node invert at a flow-splitting manhole.

Tables 3-2a (links) and **3-2b** (nodes), provided at the end of this document, show the identified invert data gaps and anomalies as well as their respective solutions.

3.4 Storage Structures

Several large-diameter pipes are not connected to the major (greater than 36 inches in diameter) storm sewer and stream conveyance network. Review of the GIS data shows that the downstream node of these links is classified as a Best Management Practice (BMP) or a Detention Outlet (DO) node. CH2M HILL's review of the record drawings and discussions with the County confirmed that these pipes represent isolated storage structures that do not need to be modeled. **Figures 3-1** and **3-2** show the storage structures that were identified, and **Table 3-3** provides additional details for each storage structure.

TABLE 3-3
Storage Links

Link GID	US Node GID	DS Node GID	Link Size (in.)	Length (ft)	Link Type	Approximate Location
22876	23031	23032	36	114	Circular pipe	N. Greenbrier Court and Lee Highway
22875	23032	23033	36	138	Circular pipe	N. Greenbrier Court and Lee Highway
22985	23014	23013	48	77	Circular pipe	N. Greenbrier Court and Lee Highway
22986	23013	23128	48	92	Circular pipe	N. Greenbrier Court and Lee Highway
22763	22946	22455	48	148	Circular pipe	N. Greenbrier Street and 28th Street N.
23061	23205	22408	60	58	Circular pipe	Yorktown Boulevard and N. Nottingham Street
23057	23202	22406	60	60	Circular pipe	Yorktown Boulevard and N. Nottingham Street
22450	22718	22349	48	83.2	Circular pipe	N. Delaware Street and 37th Street N.
22652	22866	22370	60	29	Circular pipe	N. Harrison Street between 36th and 37th Street N.
22653	22869	22372	60	19	Circular pipe	N. Harrison Street between 36th and 37th Street N.
22489	22749	22375	36	209	Circular pipe	Little Falls Road near George Mason Drive
22488	22750	22749	36	67	Circular pipe	Little Falls Road near George Mason Drive
23523	23590	23592	48	62.5	Circular pipe	N. Dickerson Street near Rock Spring Road

Note: GID, unique feature ID used in GIS; US, upstream; DS, downstream.

4 Results

In total, 56 structures had network gaps or anomalies; 88 structures had node invert and/or rim gaps and anomalies; and 101 links had invert gaps or anomalies. All of the network gaps and anomalies were resolved using record drawings or the GIS data, or through discussions with the County. Of the 88 node invert and rim gaps and anomalies and 101 invert link gaps and anomalies, 66 and 79, respectively, were resolved using the GIS data or the as-built information.

Data to fill the remaining gaps and anomalies will come from the HEC-RAS model and additional discussions with the County. **Table 4-1** details outstanding questions that required guidance from the County and the resulting resolution.

In the meeting with County staff held on July 28, 2011, preliminary discussions on the modeling approach for the parallel network in the West Branch (Record Drawing ID 4620-045) took place. Those discussions will continue as the modeling progresses and will be documented in the capacity-modeling technical memorandum.

TABLE 4-1
Remaining Data Gaps and Anomalies for County Review

Segment	Link GID	US Node GID	DS Node GID	Link Size (in.)	Link Type	Data Gap/ Anomaly	Comment
8	4470	2223	2201	36	Circular pipe	US invert higher than US node	No as-built available. Cross connection exists in GIS. Confirmed with County; US node based on lowest pipe out (2223–2213)
10	4522	2336	2292	36	Circular pipe	Pipe daylighting	No US invert available on as-built; rim elevation from contours causes pipe to daylight County staff provided data to resolve issue. Result is rim = 332.5 ft, inv = 327.70 ft. Next US junction inv = 334.72 and next DS junction inv = 322.91, both of which appear to be consistent with DEM and 2-ft contours
10	22050	2406	2336	36	Circular pipe	Pipe daylighting	No DS invert or rim elevation available on as-built; DS invert from DS link and rim elevation from contours causes pipe to daylight County staff provided data to resolve issue

Note: GID, unique feature ID used in GIS; US, upstream; DS, downstream; DEM, digital elevation model.

TABLE 3-1
Network and Link Data Gaps and Anomalies

Segment	Link GID	US Node GID	DS Node GID	Link Size	Link Type	Data Gap/Anomaly	Solution	Comment
0	20181	854	825	0	Stream channel	Downstream of recommended hydraulic model end point	Link will not be modeled	—
1	20182	850	854	0	Ditch	Downstream of recommended hydraulic model end point	Link will not be modeled	—
1	20175	844	850	36	Circular pipe	Downstream of recommended hydraulic model end point	Link will not be modeled	—
1	3766	832	844	36	Circular pipe	Downstream of recommended hydraulic model end point	Link will not be modeled	—
1	24820	816	832	36	Circular pipe	Downstream of recommended hydraulic model end point	Link will not be modeled	—
1	24291	24181	816	36	Circular pipe	Downstream of recommended hydraulic model end point	Link will not be modeled	—
1	24290	811	24181	36	Circular pipe	Downstream of recommended hydraulic model end point	Link will not be modeled	—
1	3739	810	811	36	Circular pipe	Downstream of recommended hydraulic model end point	Link will not be modeled	—
1	24821	24595	810	36	Circular pipe	Downstream of recommended hydraulic model end point	Link will not be modeled	—
2	20180	797	816	36	Circular pipe	Downstream of recommended hydraulic model end point	Link will not be modeled	—
2	20177	792	797	36	Circular pipe	Downstream of recommended hydraulic model end point	Link will not be modeled	—
2	20176	796	792	36	Circular pipe	Downstream of recommended hydraulic model end point	Link will not be modeled	—
2	20186	802	796	36	Circular pipe	Downstream of recommended hydraulic model end point	Link will not be modeled	—
2	3734	803	802	36	Circular pipe	Downstream of recommended hydraulic model end point	Link will not be modeled	—
2	3742	814	803	36	Circular pipe	Downstream of recommended hydraulic model end point	Link will not be modeled	—
3	20184	928	854	0	Stream channel	Downstream of recommended hydraulic model end point	Link will not be modeled	—
3	6091	932	930	0	Box	Size missing	Obtain size data from HEC-RAS model	—
3	22444	22715	949	0	Stream channel	Length	Calculate length in GIS	—
3	22441	22716	22715	0	Box	Size and length missing	Obtain size data from HEC-RAS model; calculate length in GIS	—
3	22443	1016	22716	0	Stream channel	Length	Calculate length in GIS	—
4	6106	1018	1016	6 × 0	Open channel	Downstream of parallel network	—	Review with County to develop modeling approach of the parallel network
4	6104	1024	1020	6 × 12	Open channel	Downstream of parallel network	—	Review with County to develop modeling approach of the parallel network
4	3900	1034	1018	12 × 12.5	Arch	Downstream of parallel network	—	Review with County to develop modeling approach of the parallel network
4	6100	1035	1024	11 × 12	Arch	Downstream of parallel network	—	Review with County to develop modeling approach of the parallel network
4	6102	1036	1034	6 × 12	Open channel	Downstream of parallel network	—	Review with County to develop modeling approach of the parallel network
4	6103	1036	1035	6 × 12	Open channel	Downstream of parallel network	—	Review with County to develop modeling approach of the parallel network
4	6101	1048	1036	6 × 9	Box	Stream in parallel with buried culvert	—	Review with County to develop modeling approach of the parallel network
4	20209	1060	1048	6 × 9	Box	Stream in parallel with buried culvert	—	Review with County to develop modeling approach of the parallel network
4	20208	1087	1060	6 × 9	Box	Stream in parallel with buried culvert	—	Review with County to develop modeling approach of the parallel network

TABLE 3-1
Network and Link Data Gaps and Anomalies

Segment	Link GID	US Node GID	DS Node GID	Link Size	Link Type	Data Gap/Anomaly	Solution	Comment
4	20206	1129	1087	6 × 9	Box	Stream in parallel with buried culvert	—	Review with County to develop modeling approach of the parallel network
4	20205	1135	1129	6 × 9	Box	Stream in parallel with buried culvert	—	Review with County to develop modeling approach of the parallel network
4	20203	1154	1135	6 × 9	Box	Stream in parallel with buried culvert	—	Review with County to develop modeling approach of the parallel network
4	20210	1235	1154	6 × 9	Box	Stream in parallel with buried culvert	—	Review with County to develop modeling approach of the parallel network
4	24810	1261	1235	6 × 9	Box	Stream in parallel with buried culvert	—	Review with County to develop modeling approach of the parallel network
4	20211	1302	1261	6 × 9	Box	Stream in parallel with buried culvert	—	Review with County to develop modeling approach of the parallel network
4	20213	1397	1302	6 × 9	Box	Stream in parallel with buried culvert	—	Review with County to develop modeling approach of the parallel network
4	22964	1426	1397	6 × 9	Box	Stream in parallel with buried culvert	—	Review with County to develop modeling approach of the parallel network
4	22953	1516	1426	6 × 9	Box	Stream in parallel with buried culvert	—	Review with County to develop modeling approach of the parallel network
4	4166	1584	1516	6 × 9	Box	Stream in parallel with buried culvert	—	Review with County to develop modeling approach of the parallel network
5	23282	23400	1636	78	Circular pipe	Length missing	Calculate length in GIS	—
5	23281	1643	23400	78	Circular pipe	Length missing	Calculate length in GIS	—
6	22666	22873	1623	48	Circular pipe	Length missing	Calculate length in GIS	—
8	4459	2201	2194	34 × 53	Elliptical	Has a height and width	Change height/width from inches to feet	—
8	4534	2359	2342	0	Stream channel	—	—	County e-mail 5/26/11, 3:04 pm: 42-in. pipe under stream not constructed; no survey required given information available on plan
10	22050	2406	2336	36	Circular pipe	DS invert and length missing	Invert from DS pipe; calculate length in GIS	—
14	22152	22412	1020	0	Stream channel	Length missing	Calculate length in GIS	—
14	22151	1097	22412	0	Stream channel	Length missing	Calculate length in GIS	—
14	3990	1213	1207	108	Circular pipe	Should be an 8-by-16-ft arch culvert	Update GIS data	—
14	3986	1207	1192	108	Circular pipe	Should be an 8-by-16-ft arch culvert	Update GIS data	—
15	22605	1370	1365	0	Ditch	Length missing	Remove 18-ft-long ditch connecting 48-in. pipe to Little Pimmit Run stream from model	—
16	24836	24607	1383	54 × 78	Arch	Replaced by 8-by-16-ft arch culvert	Update GIS data based on data from Contract #08-470-SD drawings	—
16	24835	24606	24607	54 × 78	Arch	Replaced by 8-by-16-ft arch culvert	Update GIS data based on data from Contract #08-470-SD drawings	—
16	24834	1417	24606	54 × 78	Arch	Replaced by 8-by-16-ft arch culvert	Update GIS data based on data from Contract #08-470-SD drawings	—

TABLE 3-1
Network and Link Data Gaps and Anomalies

Segment	Link GID	US Node GID	DS Node GID	Link Size	Link Type	Data Gap/Anomaly	Solution	Comment
N/A	4619	2548	2522	48	Circular pipe	Downstream link has smaller diameter than upstream link	Discuss with County	Sent to County 5/17/11, 2:49 pm. County response on 5/26/11, 2:22 pm: 21-in. pipe; will not be modeled
N/A	22462	1129	22726	21	Circular pipe	Parallel pipe segment not shown in as-built	Discuss with County	Sent to County 5/17/11, 2:49 pm. County response on 6/3/11, 4:00 pm: does not exist, will not be modeled
N/A	22463	22726	1048	21	Circular pipe	Parallel pipe segment not shown in as-built	Discuss with County	Sent to County 5/17/11, 2:49 pm. County response on 6/3/11, 4:00 pm: does not exist, will not be modeled
N/A	20252	2105	2081	99	Circular pipe	Downstream link has smaller diameter than upstream link	Discuss with County	Sent to County 5/17/11, 2:49 pm. County response on 5/26/11, 3:11 pm: 15-in. pipe; will not be modeled
N/A	24075	24013	24014	54	Circular pipe	Disconnected link	Discuss with County	Sent to County 5/17/11, 2:49 pm. County response on 6/1/11: new pipe segment constructed as part of an ongoing CIP project; this pipe is not connected to system yet and will not be included in the hydraulic model

Note: GID, unique feature ID used in GIS; US, upstream; DS, downstream; HEC-RAS, modeling software.

TABLE 3-2A
Link Invert Elevation Data Gaps and Anomalies

Segment	Link GID	US Node GID	DS Node GID	Link Size (in.)	Link Type	Data Gap/Anomaly	Solution	Comment
3	20183	930	928	0	Stream channel	US and DS invert missing	Obtain invert data from HEC-RAS model; refer to Table 3-2b	—
3	6091	932	930	0	Box	US and DS invert missing	Obtain invert data from HEC-RAS model; refer to Table 3-2b	—
3	20189	949	932	0	Stream channel	US and DS invert missing	Obtain invert data from HEC-RAS model; refer to Table 3-2b	—
3	22444	22715	949	0	Stream channel	US and DS invert missing	Obtain invert data from HEC-RAS model; refer to Table 3-2b	—
3	22441	22716	22715	0	Box	US and DS invert missing	Obtain invert data from HEC-RAS model; refer to Table 3-2b	—
3	22443	1016	22716	0	Stream channel	US and DS invert missing	Obtain invert data from HEC-RAS model; refer to Table 3-2b	—
4	6101	1048	1036	6 × 9	Box	US invert missing	Refer to proposed plan 4620-045/survey data; refer to Table 3-2b	Review with County to develop modeling approach of the parallel network; US invert shown as proposed on plan
4	20209	1060	1048	6 × 9	Box	US and DS invert missing	Refer to proposed plan4620-045/survey data; refer to Table 3-2b	Review with County to develop modeling approach of the parallel network; US invert interpolated using info shown on plan
4	20208	1087	1060	6 × 9	Box	US and DS invert missing	Refer to proposed plan4620-045/survey data; refer to Table 3-2b	Review with County to develop modeling approach of the parallel network
4	20206	1129	1087	6 × 9	Box	US and DS invert missing	Refer to proposed plan 4620-045/survey data; refer to Table 3-2b	Review with County to develop modeling approach of the parallel network
4	20205	1135	1129	6 × 9	Box	US and DS invert missing	Refer to proposed plan4620-045/survey data; refer to Table 3-2b	Review with County to develop modeling approach of the parallel network
4	20203	1154	1135	6 × 9	Box	US and DS invert missing	Refer to proposed plan 4620-045/survey data; refer to Table 3-2b	Review with County to develop modeling approach of the parallel network
4	20210	1235	1154	6 × 9	Box	US and DS invert missing	Refer to proposed plan 4620-045/survey data; refer to Table 3-2b	Review with County to develop modeling approach of the parallel network
4	24810	1261	1235	6 × 9	Box	US and DS invert missing	Refer to proposed plan 4620-045/survey data; refer to Table 3-2b	Review with County to develop modeling approach of the parallel network
4	20211	1302	1261	6 × 9	Box	US and DS invert missing	Refer to proposed plan 4620-045/survey data; refer to Table 3-2b	Review with County to develop modeling approach of the parallel network
4	20213	1397	1302	6 × 9	Box	US and DS invert missing	Refer to proposed plan 4620-045/survey data; refer to Table 3-2b	Review with County to develop modeling approach of the parallel network
4	22964	1426	1397	6 × 9	Box	US and DS invert missing	Refer to proposed plan 4620-045/survey data; refer to Table 3-2b	Review with County to develop modeling approach of the parallel network
4	22953	1516	1426	6 × 9	Box	US and DS invert missing	Refer to proposed plan4620-045/survey data; refer to Table 3-2b	Review with County to develop modeling approach of the parallel network
4	4166	1584	1516	6 × 9	Box	DS invert missing	Refer to proposed plan 4620-045/survey data; refer to Table 3-2b	Review with County to develop modeling approach of the parallel network
5	23282	23400	1636	78	Circular pipe	US invert missing	Interpolate between next US/DS inverts; refer to Table 3-2b	No US invert available on as-built; blind connection of 21-in. pipe
5	23281	1643	23400	78	Circular pipe	DS invert missing	Interpolate between next US/DS inverts; refer to Table 3-2b	No DS invert available on as-built; blind connection of 21-in. pipe
6	22666	22873	1623	48	Circular pipe	US invert missing	Refer to as-built and to Table 3-2b	—
6	22665	1603	22873	48	Circular pipe	DS invert missing	Refer to as-built and to Table 3-2b	—
6	4175	1575	1603	48	Circular pipe	US invert lower than US node	Refer to as-built and to Table 3-2b	As-built shows US node invert = 298.2; US link invert correct

TABLE 3-2A
Link Invert Elevation Data Gaps and Anomalies

Segment	Link GID	US Node GID	DS Node GID	Link Size (in.)	Link Type	Data Gap/Anomaly	Solution	Comment
8	4508	2294	2280	48	Circular pipe	US invert missing	Refer to as-built and to Table 3-2b	—
8	4511	2310	2294	48	Circular pipe	DS invert missing	Refer to as-built and to Table 3-2b	—
8	4534	2359	2342	0	Stream channel	US and DS invert missing	Refer to as-built and to Table 3-2b	County e-mail 5/26, 3:04 pm: 42-in. pipe under stream not constructed; no survey required; info in plan
8	4539	2341	2370	36	Circular pipe	US invert higher than US node	Refer to as-built and to Table 3-2b	As-built shows US node invert = 360.63; US link invert correct
8	4526	2328	2341	36	Circular pipe	US invert missing; DS invert higher than DS node	Invert from US pipe; refer to as-built and to Table 3-2b	No US invert available on as-built; as-built confirms DS drop
10	4543	2380	2336	27	Circular pipe	US invert higher than US node	Refer to as-built and to Table 3-2b	As-built shows US link invert and US node invert = 335.52
10	4566	2432	2406	36	Circular pipe	DS invert lower than DS node	Refer to as-built and to Table 3-2b	As-built confirms DS invert anomaly
10	20267	2384	2380	27	Circular pipe	DS invert lower than DS node	Refer to as-built and to Table 3-2b	As-built shows US link invert = 335.64 and DS link and node invert = 335.01
10	20266	2406	2384	27	Circular pipe	US invert higher than US node	Refer to as-built and to Table 3-2b	As-built confirms US invert anomaly; as-built shows US link invert = 336.12, DS link invert = 335.64
10	4595	2494	2432	36	Circular pipe	US invert lower than US node	Refer to as-built and to Table 3-2b	US rim elevation and US invert transposed from as-built to node layer; adjustment fixes daylighting
10	4618	2547	2494	36	Circular pipe	DS invert lower than DS node; pipe daylighting	Refer to as-built and to Table 3-2b	DS rim elevation and DS invert transposed from as-built to node layer; adjustment fixes daylighting
11	4188	1622	1608	42	Circular pipe	US invert lower than US node	Refer to as-built and to Table 3-2b	Plan XWF~0017 shows US node invert = 275.60 and DS node invert = 274.52
11	20235	1683	1637	66	Circular pipe	US invert missing	Interpolate between next US/DS inverts; refer to Table 3-2b	No US invert available on as-built; blind connection of 18-in. pipe
11	4193	1630	1622	42	Circular pipe	DS invert lower than DS node	Refer to as-built and to Table 3-2b	Plan XWF~0017 shows DS node invert = 275.60
11	20234	1759	1683	66	Circular pipe	DS invert missing	Interpolate between next US/DS inverts; refer to Table 3-2b	No DS invert available on as-built; blind connection of 18-in. pipe
11	22841	1637	1630	42	Circular pipe	US invert higher than US node	Refer to as-built	Plan drawing XWF~0017 confirms US invert anomaly; US and DS invert adjusted to reflect plan
11	4286	1809	1759	60	Circular pipe	US invert lower than US node	Refer to as-built and to Table 3-2b	As-built shows US link and node invert = 282.22
11	4323	1922	1809	60	Circular pipe	DS invert lower than DS node	Refer to as-built and to Table 3-2b	As-built shows DS node invert = 282.22; DS link invert correct
11	20246	2120	2067	48	Circular pipe	US invert lower than US node	Refer to as-built and to Table 3-2b	As-built shows US link invert = 298.58; US node invert correct
12	4554	2403	2399	36	Circular pipe	US invert higher than US node	Refer to as-built and to Table 3-2b	As-built confirms US invert anomaly
12	4568	2435	2403	36	Circular pipe	DS invert lower than DS node	Refer to as-built and to Table 3-2b	—
12	4613	2532	2504	36	Circular pipe	US invert lower than US node	Refer to as-built and to Table 3-2b	No invert on as-built; raise US link invert approx. 4.5 in. to match US node invert
13	4464	2210	2140	36	Circular pipe	US invert missing	Interpolate between next US/DS inverts; refer to Table 3-2b	No US invert available on as-built
13	4477	2230	2210	36	Circular pipe	DS invert missing	Interpolate between next US/DS inverts; refer to Table 3-2b	No DS invert available on as-built
14	6105	1020	1016	6 × 0	Stream channel	US and DS invert missing	Obtain invert data from HEC-RAS model; refer to Table 3-2b	—
14	22152	22412	1020	0	Stream channel	US and DS invert missing. DS invert lower than DS node	Obtain invert data from HEC-RAS model; refer to Table 3-2b	—

TABLE 3-2A
Link Invert Elevation Data Gaps and Anomalies

Segment	Link GID	US Node GID	DS Node GID	Link Size (in.)	Link Type	Data Gap/Anomaly	Solution	Comment
14	22151	1097	22412	0	Stream channel	US and DS invert missing	Obtain invert data from HEC-RAS model; refer to Table 3-2b	—
14	6269	1169	1097	0	Stream channel	US and DS invert missing	Obtain invert data from HEC-RAS model; refer to Table 3-2b	—
14	6268	1192	1169	0	Stream channel	US and DS invert missing	Obtain invert data from HEC-RAS model; refer to Table 3-2b	—
14	3986	1207	1192	8 × 16	Arch	US invert missing	Interpolate between next US/DS inverts; refer to Table 3-2b	No US invert available on as-built; blind connection of 15-in. pipe; CON/SPAN culvert 16 ft W × 8 ft H
14	3990	1213	1207	8 × 16	Arch	DS invert missing	Interpolate between next US/DS inverts; refer to Table 3-2b	No DS invert available on as-built; blind connection of 15-in. pipe; CON/SPAN culvert 16 ft W × 8 ft H
14	6264	1295	1213	0	Open channel	US and DS invert missing	Obtain invert data from HEC-RAS model; refer to Table 3-2b	—
14	6263	1365	1295	0	Open channel	US and DS invert missing	Obtain invert data from HEC-RAS model; refer to Table 3-2b	—
15	22605	1370	1365	0	Ditch	US and DS invert missing	Remove 18-ft ditch from model; refer to Table 3-2b	Remove 18-ft ditch connecting 48–in. pipe to Little Pimmit Run Stream from model
15	4072	1377	1370	48	Circular pipe	Incorrect US invert; DS invert missing	Refer to as-built and to Table 3-2b	In stream junction at DS end; use HEC-RAS data for rim to avoid daylighting
15	22693	22896	1279	36	Circular pipe	US invert missing	Refer to as-built and to Table 3-2b	—
16	20225	1383	1365	0	Open channel	US and DS invert missing	Obtain invert data from HEC-RAS model; refer to Table 3-2b	—
16	24836	24607	1383	54 × 78	Arch	US invert missing	Interpolate between closest US/DS inverts; refer to Table 3-2b	*Note*: Double-barrel culvert; no US invert on as-built pipe; interpolate across 3 links
16	24835	24606	24607	54 × 78	Arch	US and DS invert missing	Interpolate between closest US/DS inverts; refer to Table 3-2b	*Note*: Double-barrel culvert; no US invert on as-built pipe; interpolate across 3 links
16	24834	1417	24606	54 × 78	Arch	DS invert missing	Interpolate between closest US/DS inverts; refer to Table 3-2b	*Note*: Double-barrel culvert; no US invert on as-built pipe; interpolate across 3 links
16	6281	1573	1417	0	Open channel	DS invert lower than DS node	Obtain invert data from HEC-RAS model; refer to Table 3-2b	—
16	4221	1670	1651	96	Circular pipe	DS invert missing	Obtain invert data from HEC-RAS model; refer to Table 3-2b	—
17	4220	1668	1670	36	Circular pipe	DS invert higher than DS node	Refer to as-built	As-built confirms 5.1-ft drop
17	4210	1649	1655	36	Circular pipe	US invert higher than US node	Refer to as-built and to Table 3-2b	As-built shows US link invert = 292.95; US node invert correct
18	4241	1706	1670	96	Circular pipe	US invert missing	Obtain invert data from HEC-RAS model; refer to Table 3-2b	—
18	20944	1971	1868	0	Stream channel	US and DS invert missing	Obtain invert data from HEC-RAS model; refer to Table 3-2b	In-stream junction; use HEC-RAS data for rim to avoid daylighting
18	22801	22972	1971	96	Circular pipe	US invert missing	Interpolate between next US/DS inverts; refer to Table 3-2b	Only proposed info on plan; interpolate for US invert; use HEC-RAS data for DS rim to avoid daylighting
18	22800	2007	22972	96	Circular pipe	DS invert missing	Interpolate between next US/DS inverts; refer to Table 3-2b	Only proposed info on plan; interpolate for DS invert
19	6278	1779	1753	0	Stream channel	US and DS invert missing	Obtain invert data from HEC-RAS model; refer to Table 3-2b	—
19	4270	1769	1772	48	Circular pipe	US invert higher than US node	Refer to as-built; refer to Table 3-2b	As-built shows US link invert = 298.68; US node invert correct
20	4383	2056	2064	48	Circular pipe	US invert missing	No as-built for structure. Interpolate between next US/DS inverts; refer to Table 3-2b	No US invert available on as-built
20	4392	2076	2056	48	Circular pipe	DS invert missing	No as-built for structure. Interpolate between next US/DS inverts; refer to Table 3-2b	No DS invert available on as-built

TABLE 3-2A
Link Invert Elevation Data Gaps and Anomalies

Segment	Link GID	US Node GID	DS Node GID	Link Size (in.)	Link Type	Data Gap/Anomaly	Solution	Comment
20	4366	2010	2033	36	Circular pipe	US invert lower than US node	Refer to as-built and to Table 3-2b	As-built shows US node invert = 335.25; US link invert correct
21	22799	22971	2063	96	Circular pipe	US invert missing	Refer to as-built and to Table 3-2b	—
21	22798	22968	22971	96	Circular pipe	US and DS invert missing	Refer to as-built and to Table 3-2b	—
21	22797	2231	22968	96	Circular pipe	US and DS invert missing	Refer to as-built and to Table 3-2b	—
21	6289	2270	2231	96	Circular pipe	DS invert missing	Refer to as-built and to Table 3-2b	—
21	4516	2324	2270	78	Circular pipe	US invert missing	Interpolate between next US/DS inverts; refer to Table 3-2b	No US invert available on as-built; blind connection of 24-in. pipe
21	4779	3050	3054	36	Circular pipe	US invert higher than US node	Refer to as-built	As-built confirms 0% slope and US invert anomaly
21	4631	2590	2324	78	Circular pipe	DS invert missing	Interpolate between next US/DS inverts; refer to Table 3-2b	No DS invert available on as-built; blind connection of 24-in. pipe
21	4778	3024	3050	36	Circular pipe	DS invert missing. US invert lower than US node	Refer to as-built and to Table 3-2b	As-built shows US node invert = 321.41; US link invert correct; DS pipe invert = 320.91
21	24840	24619	24618	66	Circular pipe	US invert missing	Interpolate between next US/DS inverts; refer to Table 3-2b	No US invert available on as-built; blind connection of 15-in. pipe
21	24839	2862	24619	66	Circular pipe	DS invert missing	Interpolate between next US/DS inverts; refer to Table 3-2b	No DS invert available on as-built; blind connection of 15-in. pipe
21	24853	24622	3054	66	Circular pipe	US invert missing.	Interpolate between next US/DS inverts; refer to Table 3-2B	No US invert available on as-built
21	24852	3122	24622	66	Circular pipe	DS invert missing. US invert higher than US node	Interpolate between next US/DS inverts; refer to as-built and to Table 3-2b	No DS invert on as-built; as-built shows US node invert = 319.98; US invert anomaly confirmed
21	4821	3191	3122	66	Circular pipe	DS invert lower than DS node	Refer to as-built and to Table 3-2b	As-built shows DS node invert = 319.98; DS link invert correct
23	4884	3482	3275	54	Circular pipe	US invert higher than US node	Refer to as-built and to Table 3-2b	As-built confirms US invert anomaly and shows US node invert = 327.69
23	4891	3503	3482	54	Circular pipe	US invert missing; DS invert lower than DS node	Interpolate between next US/DS inverts; refer to as-built and to Table 3-2b	No US invert available on as-built; as-built shows DS node invert = 327.69. DS link invert correct
23	4945	3693	3503	54	Circular pipe	DS invert missing	Interpolate between next US/DS inverts; refer to Table 3-2b	No DS invert available on as-built; blind connection of 18-in. pipe
23	22690	3789	3770	42	Circular pipe	US invert missing	Interpolate between next US/DS inverts; refer to Table 3-2b	No US invert available on as-built
23	6413	3643	3789	42	Circular pipe	DS invert missing	Interpolate between next US/DS inverts; refer to Table 3-2b	No DS invert available on as-built
23	4953	3705	3695	36	Circular pipe	US invert missing	Interpolate between next US/DS inverts; refer to Table 3-2b	No US invert available on as-built
23	4963	3729	3705	36	Circular pipe	DS invert missing	Interpolate between next US/DS inverts; refer to Table 3-2b	No DS invert available on as-built
24	22943	23090	3643	36	Circular pipe	US invert higher than US node	Refer to as-built and to Table 3-2b	As-built shows US link invert = 345.18; US node invert correct

Note: GID, unique feature ID used in GIS; US, upstream; DS, downstream; HEC-RAS, modeling software.

TABLE 3-2B
Node Invert and Rim Elevation Data Gaps and Anomalies

Segment	Node GID	Node Type	Data Gap/Anomaly	Solution	Comment
3	854	Junction	Missing invert and rim	Obtain invert data from HEC-RAS model; obtain top of bank elevation from HEC-RAS model for rim elevation	—
3	928	End wall	Missing invert and rim	Obtain invert data from HEC-RAS model; obtain top of bank elevation from HEC-RAS model for rim elevation	—
3	930	End wall	Missing invert and rim	Obtain invert data from HEC-RAS model; obtain top of bank elevation from HEC-RAS model for rim elevation	—
3	932	End wall	Missing invert and rim	Obtain invert data from HEC-RAS model; obtain top of bank elevation from HEC-RAS model for rim elevation	—
3	949	Junction	Missing invert and rim	Obtain invert data from HEC-RAS model; obtain top of bank elevation from HEC-RAS model for rim elevation	—
3	22715	End wall	Missing invert and rim	Obtain invert data from HEC-RAS model; obtain top of bank elevation from HEC-RAS model for rim elevation	—
3	22716	End wall	Missing invert and rim	Obtain invert data from HEC-RAS model; obtain top of bank elevation from HEC-RAS model for rim elevation	—
4	1020	Junction	Missing invert and rim	Obtain invert data from HEC-RAS model; rim elevation from contours	Review with County to develop modeling approach of the parallel network; connection of open channel to main stream
4	1018	End wall	Missing invert and rim	Refer to as-built; rim elevation from contours	Review with County to develop modeling approach of the parallel network; invert from existing info on #4620-205
4	1024	End wall	Missing invert and rim	Refer to as-built; rim elevation from contours	Review with County to develop modeling approach of the parallel network
4	1034	End wall	Missing invert and rim	Refer to as-built; rim elevation from contours	Review with County to develop modeling approach of the parallel network
4	1035	End wall	Missing invert and rim	Refer to as-built; rim elevation from contours	Review with County to develop modeling approach of the parallel network
4	1036	End wall	Missing invert and rim	Refer to as-built; rim elevation from contours	Review with County to develop modeling approach of the parallel network
4	1048	Catchbasin	Missing invert and rim	Refer to proposed plan 4620-045; rim elevation from contours	Review with County to develop modeling approach of the parallel network
4	1060	Junction	Missing invert and rim	Refer to proposed plan 4620-045 for interpolation data (no invert available at this location - interpolate); rim elevation from contours	Review with County to develop modeling approach of the parallel network; US inv (1129) = 242.87, DS inv (1048) = 239.16, arlgis_dbo = 135+83+150
4	1087	Junction	Missing invert and rim	Refer to proposed plan 4620-045 for interpolation data (no invert available at this location - interpolate); rim elevation from contours	Review with County to develop modeling approach of the parallel network; US inv (1129) = 242.87, DS inv (1048) = 239.16, arlgis_dbo = 135+83+150
4	1129	Junction	Missing invert and rim	Refer to proposed plan4620-045; rim elevation from contours	Review with County to develop modeling approach of the parallel network
4	1135	Junction	Missing invert and rim	Refer to proposed plan 4620-045 for slope data (no invert available at this location - use slope); rim elevation from contours	Review with County to develop modeling approach of the parallel network; Calc invert based on 1.661% slope shown in as-built btw GIS ID 1235 and 1139
4	1154	Junction	Missing invert and rim	Refer to proposed plan 4620-045 for slope data (no invert available at this location - use slope); rim elevation from contours	Review with County to develop modeling approach of the parallel network; Calc invert based on 1.661% slope shown in as-built btw GIS ID 1235 and 1139
4	1235	Yard Inlet	Missing invert and rim	Refer to proposed plan 4620-045 profile invert data (no invert available at this location - use profile); rim elevation from contours	Review with County to develop modeling approach of the parallel network; Invert estimated based on profile info shown in as-built
4	1261	Junction	Missing invert and rim	Refer to proposed plan 4620-045 profile invert data (no invert available at this location - use profile); rim elevation from contours	Review with County to develop modeling approach of the parallel network; Invert estimated based on profile info shown in as-built
4	1302	Junction	Missing invert and rim	Refer to proposed plan 4620-045 profile invert data (no invert available at this location - use profile); rim elevation from contours	Review with County to develop modeling approach of the parallel network; Invert estimated based on profile info shown in as-built
4	1397	Junction	Missing invert and rim	Refer to proposed plan 4620-045 profile invert data (no invert available at this location - use profile); rim elevation from contours	Review with County to develop modeling approach; Invert estimated based on profile info shown in as-built
4	1426	Catchbasin	Missing invert and rim	Refer to proposed plan4620-045; rim elevation from contours	Review with County to develop modeling approach

TABLE 3-2B
Node Invert and Rim Elevation Data Gaps and Anomalies

Segment	Node GID	Node Type	Data Gap/Anomaly	Solution	Comment
4	1516	Junction	Missing invert	Refer to proposed plan 4620-045	Review with County to develop modeling approach
5	23400	Junction	Missing invert and rim	Interpolate between next US/DS inverts; rim elevation from contours	No invert on as-built; interpolation: US inv = 277.31, DS inv = 276.36, shape_length = 17.33+51.47
6	22873	Manhole	Missing invert and rim	Refer to as-built; rim elevation from contours	Calculate invert based on 3.313% slope shown in as-built 4620-199 using arlgis_dbo from GIS ID 1603
6	1575	Grate Inlet	Link invert out lower than node invert	Refer to as-built	As-built shows node invert = 298.2; link invert correct
6	1574	Manhole	Missing rim	Rim elevation from contours	—
8	2294	Manhole	Missing invert and rim	Refer to as-built; rim elevation from contours	As-built shows invert = 341.37
8	2359	End wall	Missing invert	Refer to as-built	Invert of temporary end wall (Sta. 1+75) shown in #4620-205 per e-mail from County 5/26/11, 3:00 pm
8	2328	Manhole	Missing invert	Invert from US pipe	No invert available on as-built
8	2341	Manhole	Link invert in and out higher than node invert	Refer to as-built	As-built shows node invert = 360.63; link invert correct
10	2292	Catchbasin	Missing rim	Rim elevation from contours	—
10	2406	Catchbasin	Link invert in lower than node invert; link invert out higher than node invert	Refer to as-built	As-built confirms incoming and outgoing invert anomaly
10	2380	Catchbasin	Link invert in lower than node invert; link invert out higher than node invert	Refer to as-built	As-built shows node invert = 335.01
10	2494	Grate Inlet	Link invert in lower than node invert; pipe daylighting	Refer to as-built	Invert and rim elevation transposed from as-built in original data
11	1622	Manhole	Link invert in and out lower than node invert	Refer to plan drawing	Plan SWF~0017 shows node invert = 275.60
11	1683	Junction	Missing invert	Interpolate between next US/DS inverts	No invert on as-built; interpolation: US inv = 280.2, DS inv = 274.67, arlgis_dbo = 193+150
11	1809	Catchbasin	Link invert in and out lower than node invert	Refer to as-built	As-built shows node invert = 282.22; link invert correct
11	2120	Manhole	Link invert out lower than node invert	Refer to as-built	As-built shows outgoing link invert = 298.58; node invert correct
12	2403	Manhole	Link invert in lower than node invert; link invert out higher than node invert	Refer to as-built	As-built shows node invert = 315.52
12	2532	Manhole	Link invert out lower than node invert	Refer to as-built	No invert on as-built; raise US link invert approx. 4.5 inches to match US node invert
13	2210	Manhole	Missing invert	Interpolate between next US/DS inverts	No invert on as-built; Interpolation: US inv = 311.26, DS inv = 300.98, arlgis_dbo = 50+239
14	1016	Junction	Missing invert and rim	Obtain invert data from HEC-RAS model; rim elevation from contours	Review with County to develop modeling approach; connection of open channel to main stream
14	22412	Junction	Missing invert and rim	Obtain invert data from HEC-RAS model; obtain top of bank elevation from HEC-RAS model for rim elevation	—
14	1097	Junction	Missing invert and rim	Obtain invert data from HEC-RAS model; obtain top of bank elevation from HEC-RAS model for rim elevation	—
14	1169	Junction	Missing invert and rim	Obtain invert data from HEC-RAS model; obtain top of bank elevation from HEC-RAS model for rim elevation	—

TABLE 3-2B
Node Invert and Rim Elevation Data Gaps and Anomalies

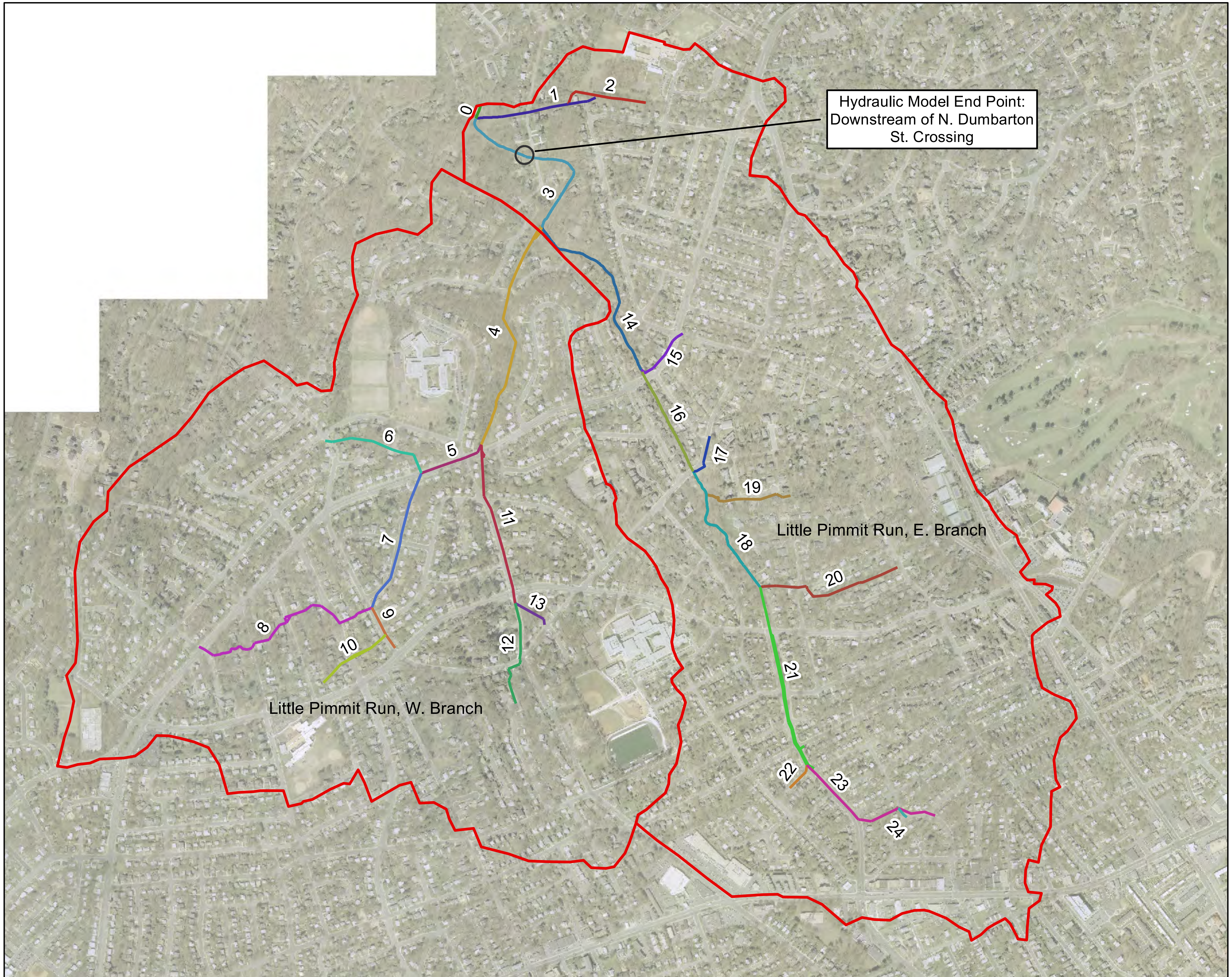
Segment	Node GID	Node Type	Data Gap/Anomaly	Solution	Comment
14	1192	End wall	Missing invert	Refer to as-built	As-built labeled as proposed; County e-mail (5/26/11, 3:40 pm) says to use proposed invert
14	1207	Junction	Missing invert and rim	Interpolate between next US/DS inverts; obtain top of bank elevation from HEC-RAS model for rim elevation	No invert on as-built; Interpolation: US inv = 264.38, DS inv = 262.4, arlgis_dbo = 20+78
14	1213	End wall	Missing invert	Refer to as-built	As-built labeled as proposed; County e-mail (5/26/11, 3:40 pm) says to use proposed invert
14	1295	Junction	Missing invert and rim	Obtain invert data from HEC-RAS model; obtain top of bank elevation from HEC-RAS model for rim elevation	—
15	1370	End wall	Missing invert and rim	Invert elevation (272.41) provided by County; obtain top of bank elevation from HEC-RAS model for rim elevation	19-ft-long ditch DS of node will not be modeled; assume node is directly connected to stream
15	1377	Manhole	Incorrect invert	Refer to as-built	—
15	22896	Manhole	Missing invert and rim	Refer to as-built; rim elevation from contours	Calculate invert based on 6.19% slope shown in as-built for adjacent 30-in. pipe using arlgis_dbo
16	1365	Junction	Missing invert and rim	Obtain invert data from HEC-RAS model; obtain top of bank elevation from HEC-RAS model for rim elevation	—
16	1383	End wall	Missing invert and rim	Per County direction update GIS data based on data from Contract #08-470-SD drawings	—
16	24607	Junction	Missing invert and rim	Per County direction update GIS data based on data from Contract #08-470-SD drawings	—
16	24606	Junction	Missing invert and rim	Per County direction update GIS data based on data from Contract #08-470-SD drawings	—
16	1417	End wall	Missing invert and rim; link invert in lower than node invert	Per County direction update GIS data based on data from Contract #08-470-SD drawings	—
16	1573	Junction	Missing invert	Obtain invert data from HEC-RAS model	—
16	1651	End wall	Missing invert	Obtain invert data from HEC-RAS model	—
17	1649	Manhole	Link invert out higher than node invert	Refer to as-built	As-built shows outgoing link invert = 292.95; node invert correct
18	1706	End wall	Missing invert	Obtain invert data from HEC-RAS model	—
18	1868	End wall	Missing invert and rim	Obtain invert data from HEC-RAS model; obtain top of bank elevation from HEC-RAS model for rim elevation	—
18	1971	End wall	Missing invert	Invert available in 'Remarks' field	—
18	22972	Catchbasin	Missing invert and rim	Interpolate between next US/DS inverts; rim elevation from contours	No as-built, only proposed info; Interpolation: US inv = 297.52, DS inv = 296.44, arlgis_dbo = 79+25
19	1753	Junction	Missing invert	Obtain invert data from HEC-RAS model	—
19	1779	End wall	Missing invert	Obtain invert data from HEC-RAS model	—
19	1769	Catchbasin	Link invert out higher than node invert	Refer to as-built	As-built shows outgoing link invert = 298.68; node invert correct
19	1742	End wall	Missing invert and rim	Refer to as-built; rim elevation from contours	As-built shows end wall invert = 309.02
20	2056	Catchbasin	Missing invert	Interpolate between next US/DS inverts	No invert available on as-built; Interpolation: US inv = 311.86, DS inv = 309.91, arlgis_dbo = 30+77
20	2010	Yard Inlet	Link invert out lower than node invert	Refer to as-built	As-built shows node invert = 335.25; link invert correct
21	22971	Junction	Missing invert and rim	Refer to as-built; rim elevation from contours	Calculate invert based on 1.04% slope shown in as-built
21	22968	Yard Inlet	Missing invert and rim	Refer to as-built; rim elevation from contours	Calculate invert based on 1.04% slope shown in as-built

TABLE 3-2B
Node Invert and Rim Elevation Data Gaps and Anomalies

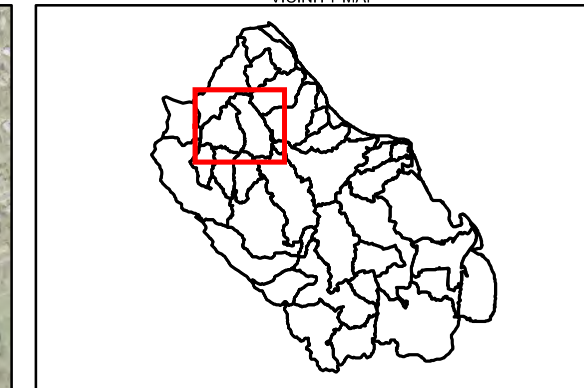
Segment	Node GID	Node Type	Data Gap/Anomaly	Solution	Comment
21	2231	Junction	Missing invert and rim	Refer to as-built; rim elevation from contours	Calculate invert based on 1.04% slope shown in as-built
21	2324	Junction	Missing invert and rim	Interpolate between next US/DS inverts; rim elevation from contours	No invert on as-built; Interpolation: US inv = 310.36, DS inv = 305.63, arlgis_dbo = 395+110.2
21	3024	Catchbasin	Missing invert and rim; link invert out lower than node invert	Refer to as-built; rim elevation from contours	As-built shows rim = 326.39 and node invert = 321.41
21	24619	Junction	Missing invert and rim	Interpolate between next US/DS inverts; rim elevation from contours	No invert on as-built; interpolation: US inv = 315.9, DS inv = 314.37, arlgis_dbo = 70+15
21	24622	Catchbasin	Missing invert and rim	Interpolate between next US/DS inverts; rim elevation from contours	No invert available on as-built; interpolation: US inv = 320.14, DS inv = 319.04, arlgis_dbo = 73+25
21	3122	Manhole	Link invert in lower than node invert; link invert out higher than node invert	Refer to as-built	As-built shows node invert = 319.98; link inverts correct
22	3415	Manhole	Missing rim	Rim elevation from contours	—
23	3482	Manhole	Link invert in lower than node invert; link invert out higher than node invert	Refer to as-built	As-built shows node invert = 327.69
23	3503	Junction	Missing invert and rim	Interpolate between next US/DS inverts; rim elevation from contours	No invert on as-built; interpolation: US inv = 331.57, DS inv = 327.69, arlgis_dbo = 192+20
23	3789	Yard inlet	Missing invert and rim	Interpolate between next US/DS inverts; rim elevation from contours	No invert on as-built; interpolation: US inv = 343.29, DS inv = 335.62, arlgis_dbo = 274+100
23	3705	Manhole	Missing invert and rim	Interpolate between next US/DS inverts; rim elevation from contours	No invert on as-built; interpolation: US inv = 351.36, DS inv = 348.7, arlgis_dbo = 62+39
24	23090	Manhole	Link invert out higher than node invert	Refer to as-built	As-built shows outgoing link invert = 345.18; node invert correct

Note: GID, unique feature ID used in GIS; US, upstream; DS, downstream; HEC-RAS, modeling software.

Figures



VICINITY MAP



LEGEND

Little Pimmit Run Boundary

Segment Number

- 0 (Stream)
- 1
- 2
- 3 (Stream)
- 4
- 5
- 6
- 7
- 8 (Stream Segments)
- 9
- 10
- 11
- 12
- 13
- 14 (Stream)
- 15
- 16 (Stream)
- 17
- 18 (Stream Segments)
- 19
- 20 (Stream Segments)
- 21 (Stream Segments)
- 22
- 23
- 24

Note: "Stream" indicates a segment wholly made up of natural stream, "Stream Segments" indicates a segment made up of both stream channel and closed pipe networks. The lack of qualifier indicates that the segment is wholly made up of closed pipe network.

N

0 255 510 1,020

Feet

FIGURE 1-1
Major Storm Sewer Network Segments

GIS Data Gaps and Anomalies – Little Pimmit Run

Arlington County Storm Capacity Analysis

\\ORION\PROJ\ARLINGTONVACOUNTYOF\392309STORMWATERCAP\WSLITTLEPIMMITRUN\WORKINGGIS\LAYOUT\INTERNAL\DATAGAPSTM\FIGURE1.0_NETWORK_NUMBERING.MXD FIGURE1.0.PDF KMARNEY 9/21/2011 21:10:41

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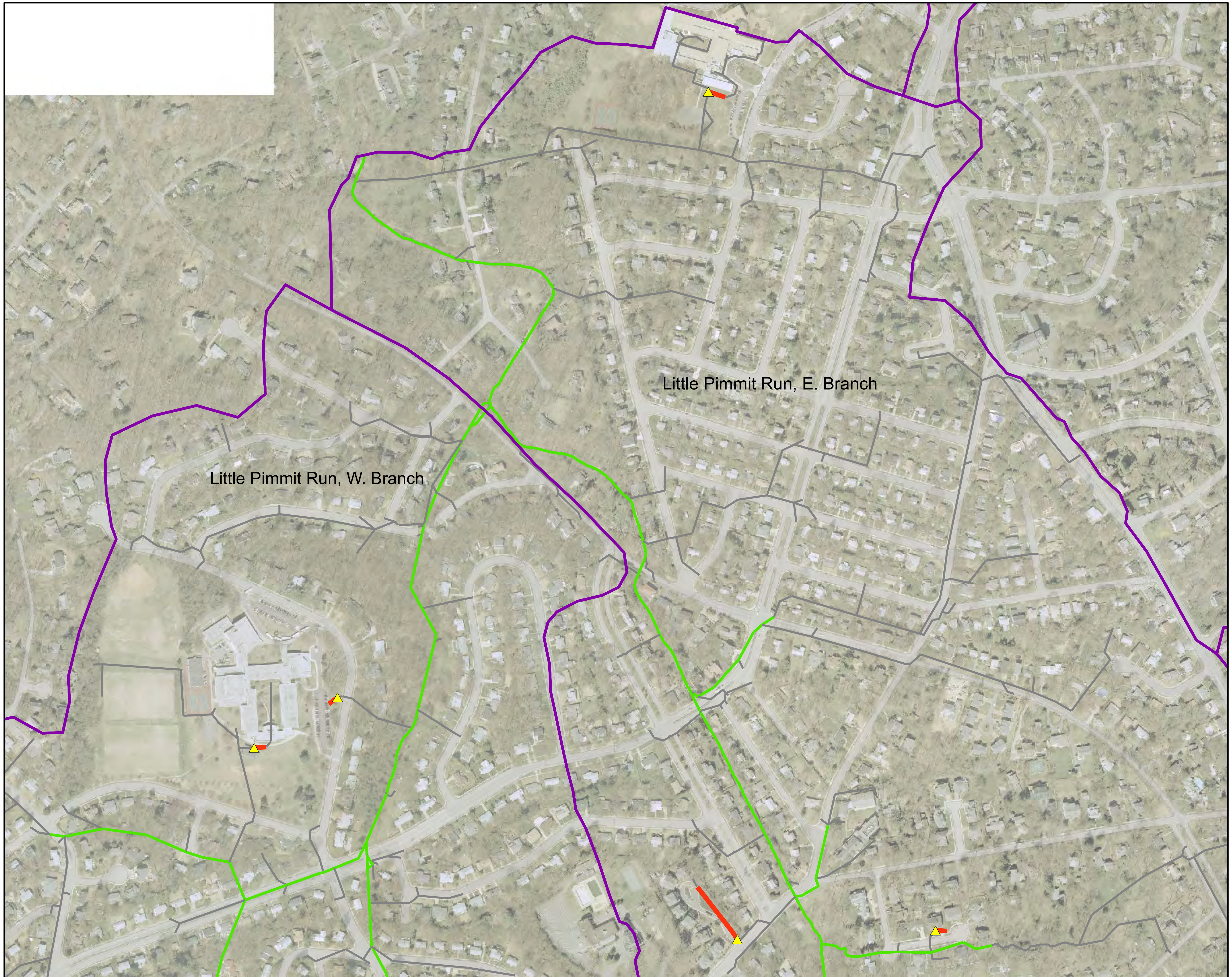
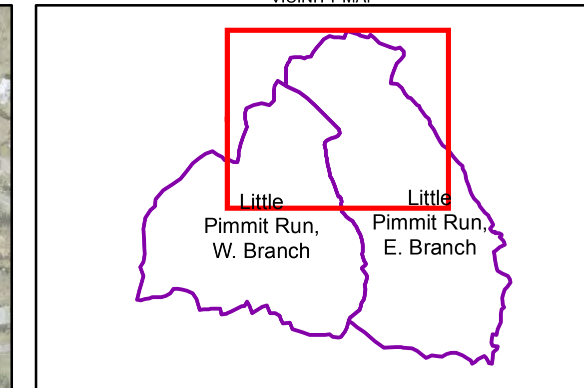




Legend

- Little Pimmit Run Boundary
- Detention Outlet
- Storage Structure
- Stormwater Mains ≥ 36"
- Stormwater Mains < 36"

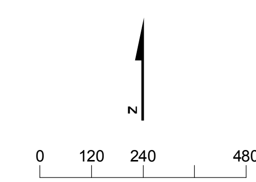


FIGURE 3-1
Little Pimmit Run Storage Structures
GIS Data Gaps and Anomalies – Little Pimmit Run
Arlington County Storm Capacity Analysis

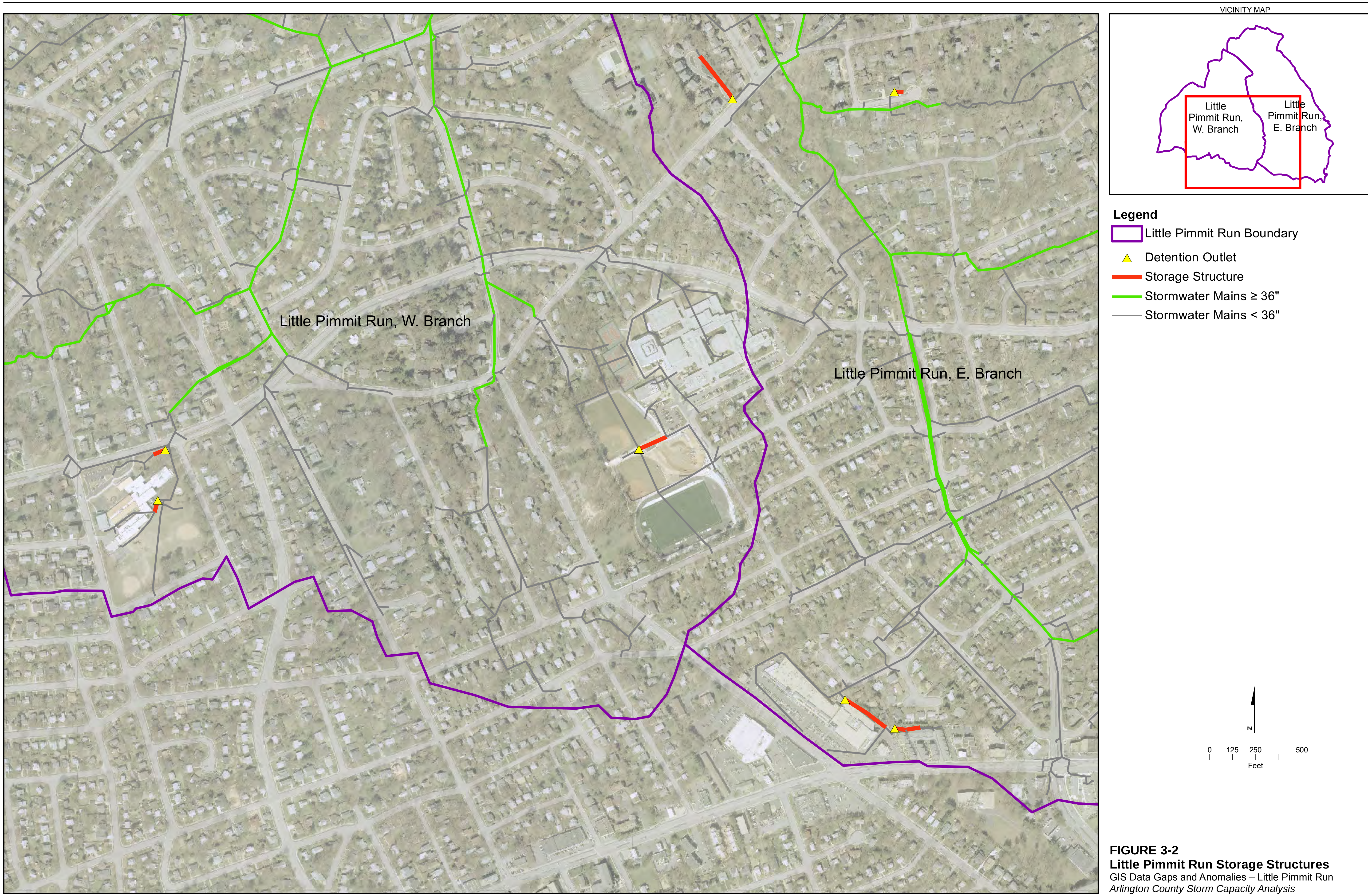
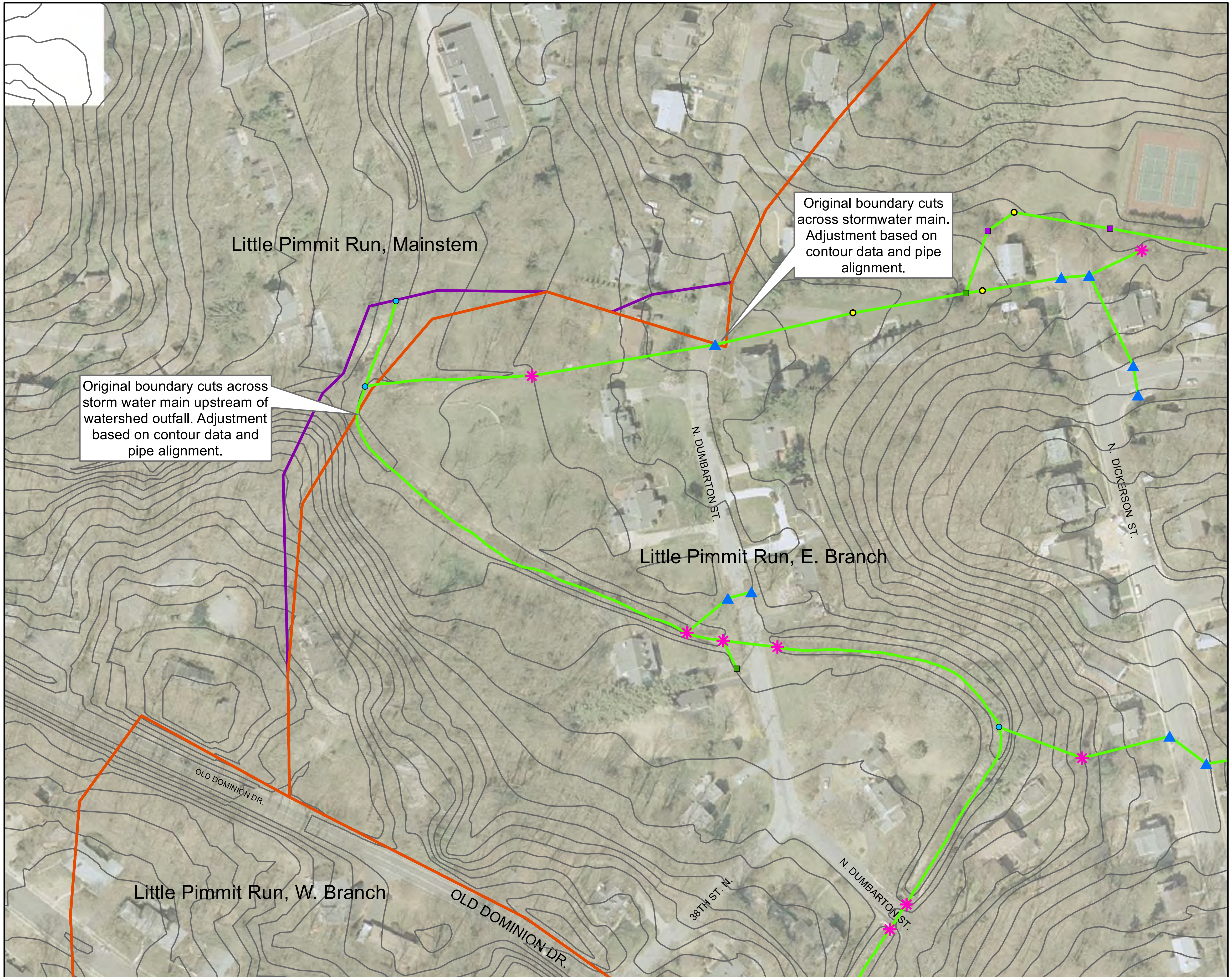


FIGURE 3-2
Little Pimmit Run Storage Structures
GIS Data Gaps and Anomalies – Little Pimmit Run
Arlington County Storm Capacity Analysis

Attachment A



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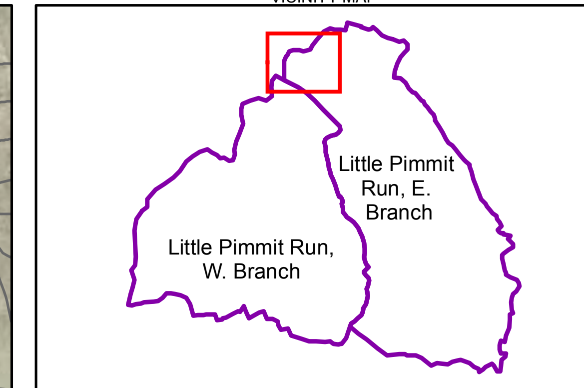


Legend

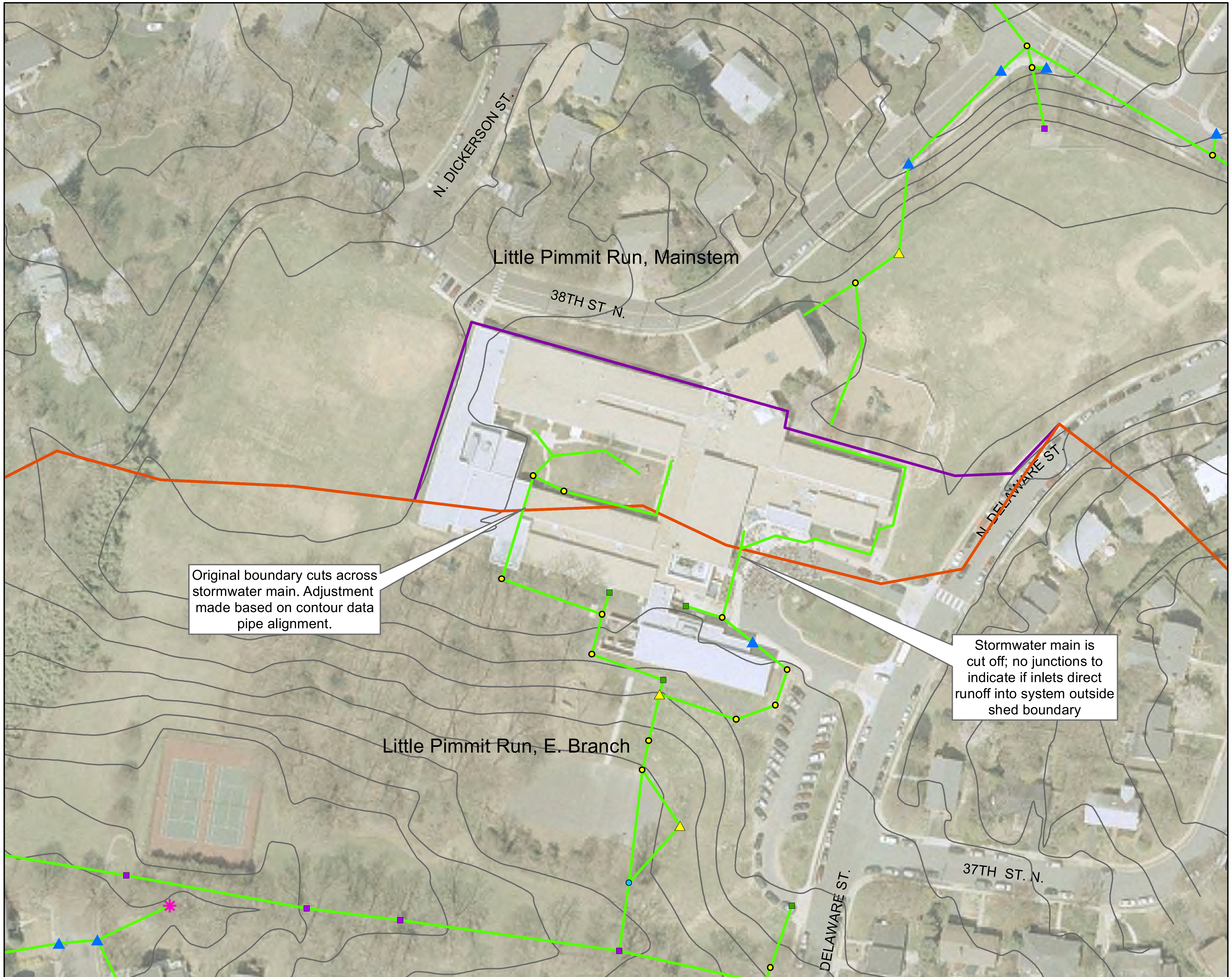
Stormwater Junctions

- BMP Structure
- Catchbasin
- Detention Outlet
- End Wall
- Grate Inlet
- Yard Inlet
- Junction
- Manhole
- Other
- Stormwater Mains
- Original Watershed Boundary
- Revised Watershed Boundary
- Fairfax Co. 5 ft Contours

N

0 25 50 100
Feet

FIGURE A1
Boundary Anomalies
GIS Data Gaps and Anomalies - Little Pimmit Run
Arlington County Storm Capacity Analysis



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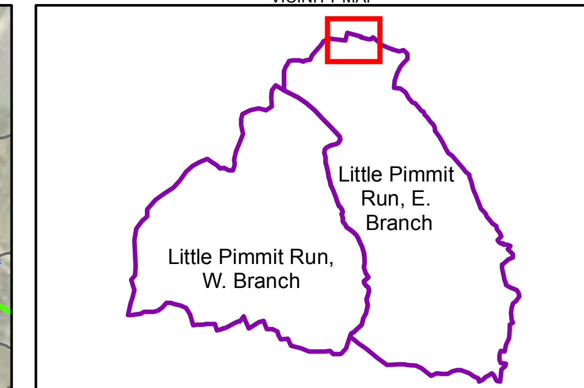

Legend

Stormwater Junctions

- BMP Structure
- Catchbasin
- Detention Outlet
- End Wall
- Grate Inlet
- Yard Inlet
- Junction
- Manhole
- Other
- Stormwater Mains
- Original Watershed Boundary
- Revised Watershed Boundary
- Fairfax Co. 5 ft Contours

N

0 25 50 100
Feet

FIGURE A2
Boundary Anomalies
GIS Data Gaps and Anomalies - Little Pimmit Run
Arlington County Storm Capacity Analysis

\\ORION\PROJ\ARLINGTONVACOUNTYOF\392309STORMWATERCAP\WSLITTLEPIMMITRUN\WORKINGGIS\LAYOUT\INTERNAL\BOUNDARYREVIEW_LITTLEPIMMIT.MXD FIGURE_A1.PDF KMARNEY 6/20/2011 11:21:52

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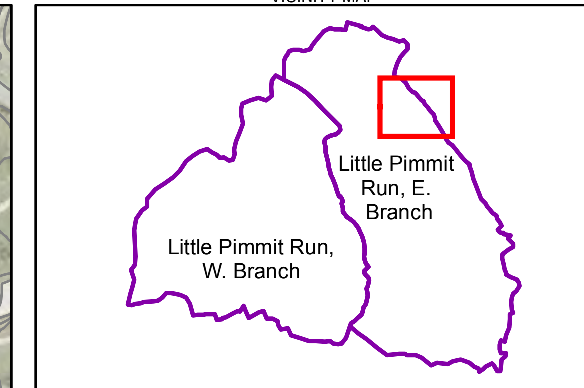
VICINITY MAP



Legend

Stormwater Junctions
- BMP Structure
- Catchbasin
- Detention Outlet
- End Wall
- Grate Inlet
- Yard Inlet
- Junction
- Manhole
- Other

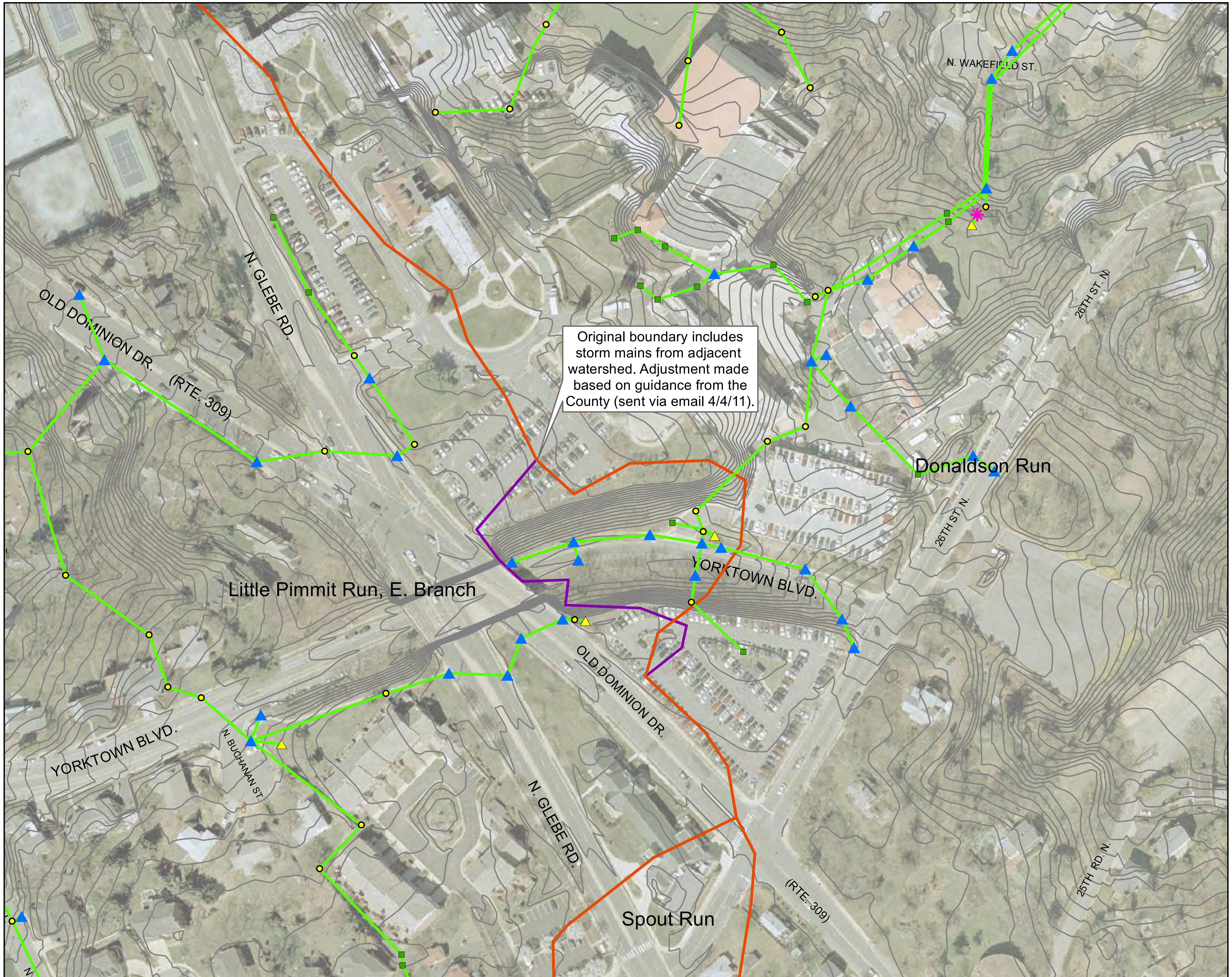
- Stormwater Mains
- Original Watershed Boundary
- Revised Watershed Boundary
- Arlington Co. 2 ft Contours

N

0 25 50 100
Feet

FIGURE A3
Boundary Anomalies
GIS Data Gaps and Anomalies - Little Pimmit Run
Arlington County Storm Capacity Analysis

CH2MHILL



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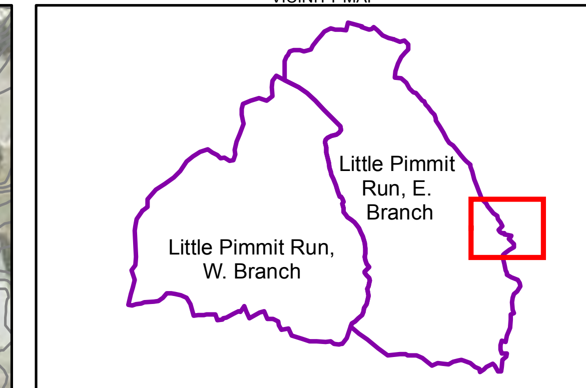

Legend

Stormwater Junctions

- BMP Structure
- Catchbasin
- Detention Outlet
- End Wall
- Grate Inlet
- Yard Inlet
- Junction
- Manhole
- Other
- Stormwater Mains
- Original Watershed Boundary
- Revised Watershed Boundary
- Arlington Co. 2 ft Contours

N

0 25 50 100
Feet

FIGURE A4
Boundary Anomalies
GIS Data Gaps and Anomalies - Little Pimmit Run
Arlington County Storm Capacity Analysis

\\ORION\PROJ\ARLINGTONVACOUNTYOF\392309STORMWATERCAP\WSLITTLEPIMMITRUN\WORKINGGIS\LAYOUT\INTERNAL\DATAGAPSTM\FIGURE_A4.MXD FIGURE_A4.PDF KMARNEY 6/20/2011 12:04:47

CH2MHILL

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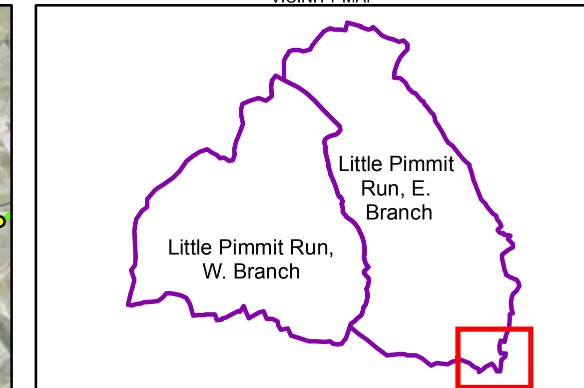

Legend

Stormwater Junctions
- BMP Structure
- Catchbasin
- Detention Outlet
- End Wall
- Grate Inlet
- Yard Inlet
- Junction
- Manhole
- Other

Stormwater Mains
Original Watershed Boundary
Revised Watershed Boundary
Arlington Co. 2 ft Contours

N

0 25 50 100
Feet

FIGURE A5
Boundary Anomalies
GIS Data Gaps and Anomalies - Little Pimmit Run
Arlington County Storm Capacity Analysis

\\ORION\PROJ\ARLINGTONVACOUNTYOF\392309STORMWATERCAP\WSLITTLEPIMMITRUN\WORKINGGIS\LAYOUT\INTERNAL\DATAGAPSTM\FIGURE_A5.MXD FIGURE_A5.PDF KMARNEY 6/20/2011 12:19:47

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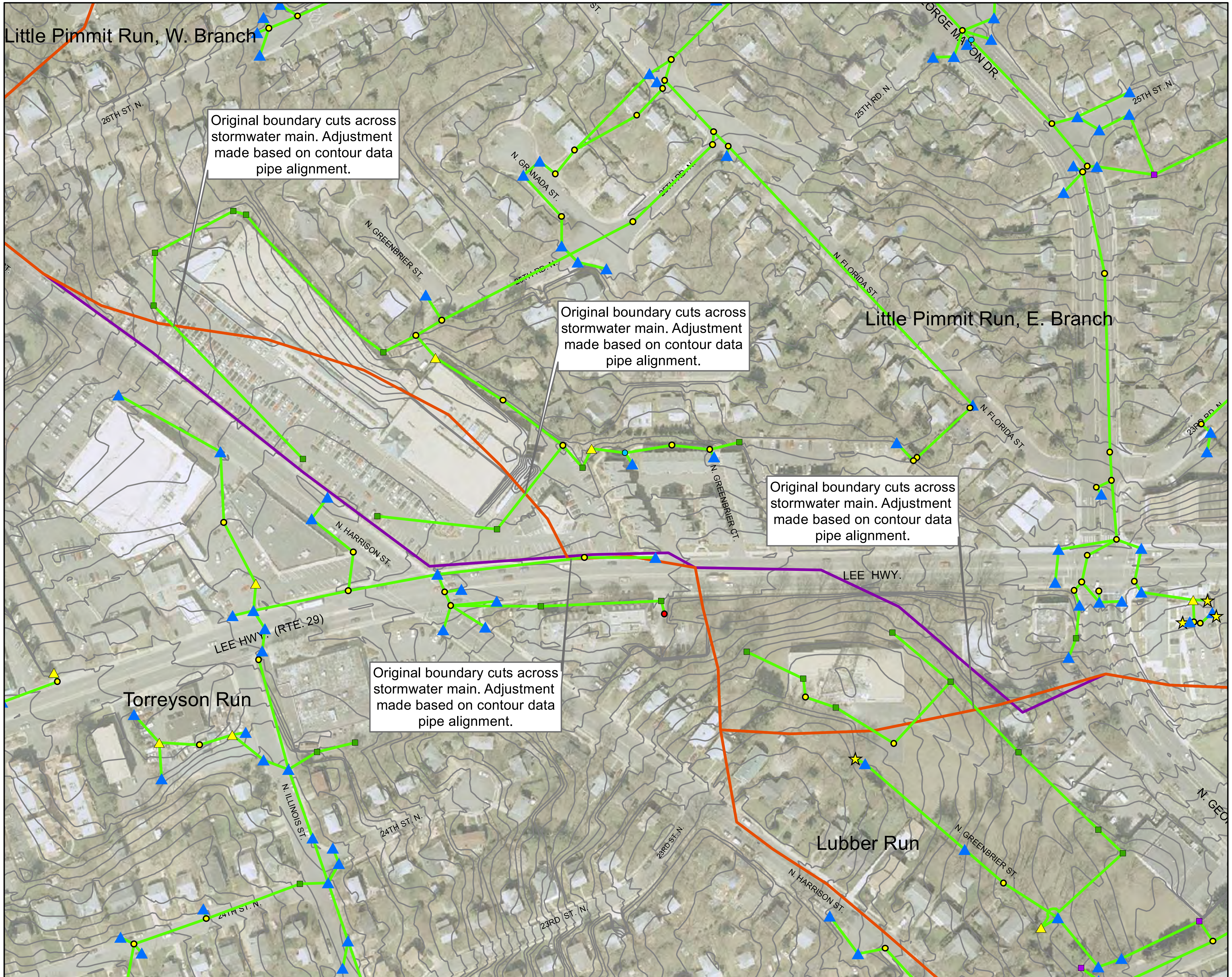

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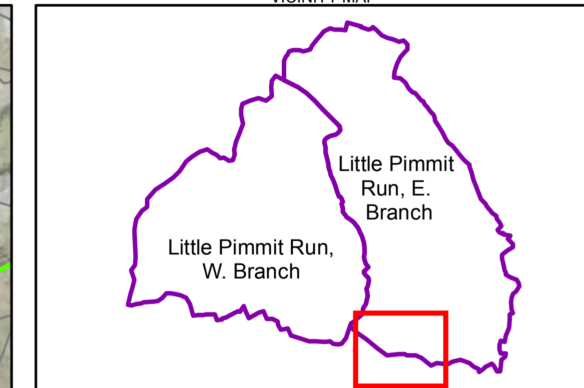


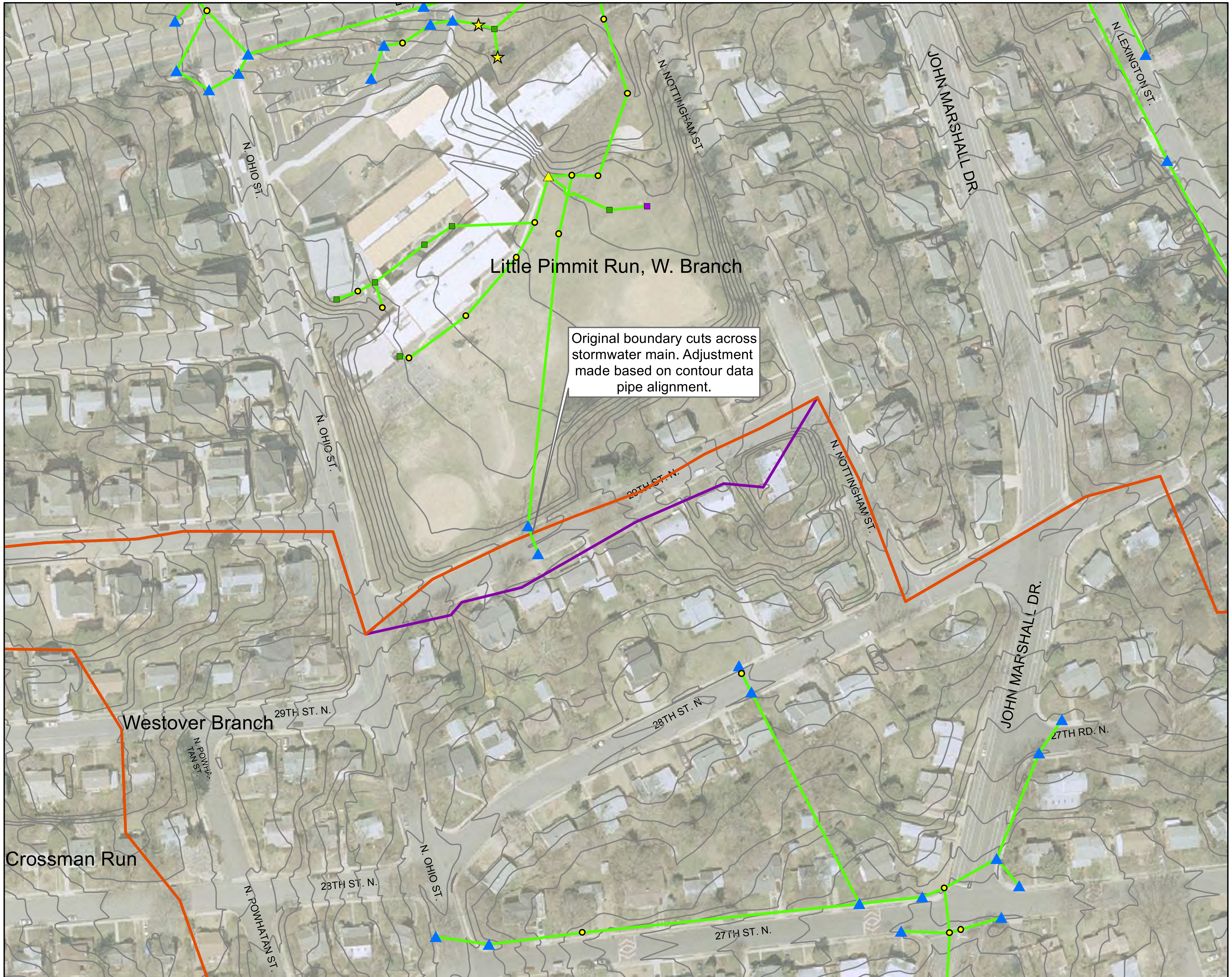
Legend

Stormwater Junctions
- BMP Structure
- Catchbasin
- Detention Outlet
- End Wall
- Grate Inlet
- Yard Inlet
- Junction
- Manhole
- Other
- Stormwater Mains
- Original Watershed Boundary
- Revised Watershed Boundary
- Arlington Co. 2 ft Contours

0 25 50 100
Feet

FIGURE A6
Boundary Anomalies
GIS Data Gaps and Anomalies - Little Pimmit Run
Arlington County Storm Capacity Analysis

CH2MHILL



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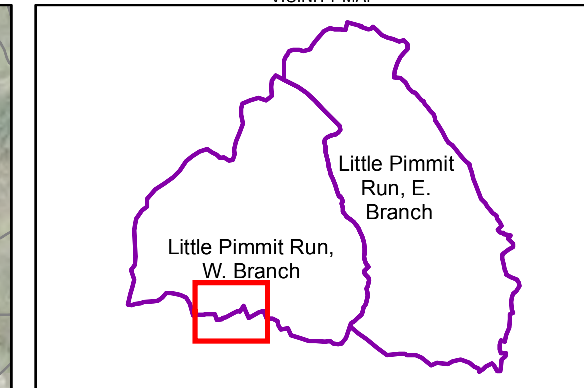

Legend

Stormwater Junctions
- BMP Structure
- Catchbasin
- Detention Outlet
- End Wall
- Grate Inlet
- Yard Inlet
- Junction
- Manhole
- Other

Stormwater Mains
Original Watershed Boundary
Revised Watershed Boundary
Arlington Co. 2 ft Contours

N

0 25 50 100
Feet

FIGURE A7
Boundary Anomalies
GIS Data Gaps and Anomalies - Little Pimmit Run
Arlington County Storm Capacity Analysis

Appendix B
Arlington County Soil Profile Assumptions Used in PCSWMM File

APPENDIX B
Arlington County Soil Profile Assumptions Used in PCSWMM Files

Soil Map Units	Composition and Profile	Assumption[a]	Selected Model Profile
4A	Sassafras 40% (0–6 inches sandy loam); urban 35%; Neabsco 15% (0–8 inches loam)	Pervious, mostly Sassafras; 0–6 inches	Sandy loam
4B	Urban 70%; Sassafras 15% (0–6 inches sandy loam); Neabsco 10% (0–8 inches loam)	Pervious, mostly Sassafras; 0–6 inches	Sandy loam
4C	Urban 70%; Sassafras 15% (0–6 inches sandy loam); Neabsco 10% (0–8 inches loam)	Pervious, mostly Sassafras; 0–6 inches	Sandy loam
6B	Glenelg 90% (0–1 inch loam; 1–6 inches silt loam)	Pervious, mostly Glenelg; 1–6 inches	Silty loam
6C	Glenelg 90% (0–1 inch loam; 1–6 inches silt loam)	Pervious, mostly Glenelg; 1–6 inches	Silty loam
6D	Glenelg 50% (0–1 inch loam; 1–6 inches silt loam); Manor 45% (0–6 inches sandy loam)	Pervious, mostly Glenelg; 1–6 inches	Silty loam
7A	Glenelg 45% (0–1 inch loam; 1–6 inches silt loam); urban 40%	Pervious, mostly Glenelg; 1–6 inches	Silty loam
7B	Glenelg 45% (0–1 inch loam; 1–6 inches silt loam); urban 40%	Pervious, mostly Glenelg; 1–6 inches	Silty loam
7C	Glenelg 45% (0–1 inch loam; 1–6 inches silt loam); urban 40%	Pervious, mostly Glenelg; 1–6 inches	Silty loam
7D	Glenelg 45% (0–1 inch loam; 1–6 inches silt loam); urban 40%	Pervious, mostly Glenelg; 1–6 inches	Silty loam
9C	Sassafras 85% (0–6 inches sandy loam)	Pervious, mostly Sassafras; 0–6 inches	Sandy loam
10B	Urban 70%; Glenelg 20% (0–1 inch loam; 1–6 inches silt loam)	Pervious, mostly Glenelg; 1–6 inches	Silty loam
10C	Urban 70%; Glenelg 20% (0–1 inch loam; 1–6 inches silt loam)	Pervious, mostly Glenelg; 1–6 inches	Silty loam

Arlington County Soil Profile Assumptions Used in PCSWMM Files

Soil Map Units	Composition and Profile	Assumption[a]	Selected Model Profile
10D	Urban 70%; Glenelg 20% (0–1 inch loam; 1–6 inches silt loam)	Pervious, mostly Glenelg; 1–6 inches	Silty loam
11B	Urban 70%; Sassafras 25% (0–6 inches sandy loam)	Pervious, mostly Sassafras; 0–6 inches	Sandy loam
11C	Urban 70%; Sassafras 15% (0–6 inches sandy loam)	Pervious, mostly Sassafras; 0–6 inches	Sandy loam
11D	Urban 70%; Sassafras 20% (0–6 inches sandy loam)	Pervious, mostly Sassafras; 0–6 inches	Sandy loam
12	Urban 85%; Udorthents 15%	Pervious Udorthents	Loam
13	Udorthents 90%	Pervious Udorthents	Loam
15D	Sassafras 45% (0–6 inches sandy loam); urban 40%	Pervious, mostly Sassafras; 0–6 inches	Sandy loam
16B	Urban 70%; Woodstown 20% (0–7 inches sandy loam)	Pervious Woodstown; assume 0–7 inches	Sandy loam

Note: Soil composition and profile information from USDA and NRCS, 2007, "Soil Survey of Arlington County, Virginia" (available at http://soildatamart.nrcs.usda.gov/Manuscripts/VA013/0/Arlington.pdf.

[a] Selected characteristics of top 6 inches of soil profile for modeling runoff.

Appendix C
Hyetograph Data

APPENDIX C
Five-Minute Hyetograph Data

Time (Minutes)	2006 Storm Event (in./hr)	10-Year, 24-Hour Storm (in./hr)
0	0.000	0.0000
5	0.000	0.0484
10	0.000	0.0486
15	0.000	0.0476
20	0.000	0.0509
25	0.000	0.0525
30	0.000	0.0482
35	0.000	0.0535
40	0.000	0.0491
45	0.000	0.0507
50	0.000	0.0540
55	0.000	0.0530
60	0.000	0.0533
65	0.000	0.0532
70	0.120	0.0534
75	0.000	0.0524
80	0.000	0.0558
85	0.000	0.0574
90	0.000	0.0530
95	0.000	0.0583
100	0.000	0.0539
105	0.000	0.0556
110	0.000	0.0589
115	0.000	0.0578
120	0.000	0.0581
125	0.000	0.0582
130	0.000	0.0573
135	0.000	0.0615
140	0.000	0.0618
145	0.000	0.0570
150	0.000	0.0584
155	0.000	0.0632
160	0.000	0.0587
165	0.000	0.0604
170	0.000	0.0637

APPENDIX C (CONTINUED)
Five-Minute Hyetograph Data

Time (Minutes)	2006 Storm Event (in./hr)	10-Year, 24-Hour Storm (in./hr)
175	0.000	0.0627
180	0.000	0.0629
185	0.000	0.0629
190	0.000	0.0631
195	0.000	0.0621
200	0.000	0.0654
205	0.000	0.0672
210	0.000	0.0626
215	0.000	0.0674
220	0.000	0.0688
225	0.000	0.0641
230	0.000	0.0643
235	0.000	0.0685
240	0.000	0.0677
245	0.000	0.0678
250	0.000	0.0672
255	0.000	0.0707
260	0.000	0.0732
265	0.000	0.0724
270	0.000	0.0726
275	0.000	0.0726
280	0.000	0.0728
285	0.000	0.0720
290	0.000	0.0745
295	0.000	0.0780
300	0.000	0.0774
305	0.000	0.0775
310	0.000	0.0769
315	0.000	0.0801
320	0.000	0.0836
325	0.000	0.0806
330	0.000	0.0775
335	0.000	0.0871
340	0.000	0.0839
345	0.000	0.0810

APPENDIX C (CONTINUED)
Five-Minute Hyetograph Data

Time (Minutes)	2006 Storm Event (in./hr)	10-Year, 24-Hour Storm (in./hr)
350	0.000	0.0844
355	0.120	0.0876
360	0.000	0.0870
365	0.240	0.0872
370	0.120	0.0866
375	0.240	0.0898
380	0.240	0.0933
385	0.360	0.0903
390	0.120	0.0871
395	0.240	0.0968
400	0.120	0.0936
405	0.120	0.0906
410	0.000	0.0941
415	0.000	0.0973
420	0.000	0.0967
425	0.000	0.0969
430	0.000	0.0962
435	0.000	0.0997
440	0.000	0.1022
445	0.000	0.1015
450	0.000	0.1017
455	0.000	0.1016
460	0.120	0.1018
465	0.120	0.1011
470	0.000	0.1035
475	0.240	0.1072
480	1.440	0.1063
485	1.560	0.1057
490	1.080	0.1146
495	1.080	0.1158
500	0.960	0.1199
505	0.000	0.1267
510	0.240	0.1259
515	0.360	0.1348
520	0.120	0.1400

APPENDIX C (CONTINUED)
Five-Minute Hyetograph Data

Time (Minutes)	2006 Storm Event (in./hr)	10-Year, 24-Hour Storm (in./hr)
525	1.440	0.1403
530	0.600	0.1413
535	0.120	0.1477
540	0.600	0.1555
545	0.120	0.1550
550	0.120	0.1548
555	0.000	0.1549
560	0.240	0.1550
565	0.360	0.1547
570	0.480	0.1550
575	0.720	0.1594
580	0.120	0.1630
585	0.240	0.1697
590	0.000	0.1788
595	0.000	0.1854
600	0.000	0.1892
605	0.000	0.1972
610	0.000	0.2096
615	0.000	0.2192
620	0.000	0.2261
625	0.120	0.2356
630	0.000	0.2481
635	0.000	0.2599
640	0.000	0.2757
645	0.000	0.2920
650	0.000	0.3083
655	0.000	0.3238
660	0.000	0.3407
665	0.000	0.3692
670	0.000	0.4054
675	0.000	0.4416
680	0.000	0.4925
685	0.000	0.5096
690	0.000	0.5696
695	0.000	1.0590

APPENDIX C (CONTINUED)
Five-Minute Hyetograph Data

Time (Minutes)	2006 Storm Event (in./hr)	10-Year, 24-Hour Storm (in./hr)
700	0.000	2.0449
705	0.000	2.8482
710	0.000	5.0925
715	0.000	6.7422
720	0.000	4.2836
725	0.000	1.0223
730	0.000	0.6866
735	0.000	0.8119
740	0.000	0.6292
745	0.000	0.5675
750	0.000	0.4643
755	0.000	0.4088
760	0.000	0.3917
765	0.000	0.3718
770	0.000	0.3449
775	0.000	0.3235
780	0.000	0.3083
785	0.000	0.2922
790	0.000	0.2750
795	0.000	0.2644
800	0.000	0.2585
805	0.000	0.2473
810	0.000	0.2308
815	0.000	0.2234
820	0.000	0.2155
825	0.000	0.2072
830	0.000	0.1994
835	0.000	0.1910
840	0.000	0.1832
845	0.000	0.1795
850	0.000	0.1755
855	0.000	0.1716
860	0.000	0.1669
865	0.000	0.1644
870	0.000	0.1645

APPENDIX C (CONTINUED)
Five-Minute Hyetograph Data

Time (Minutes)	2006 Storm Event (in./hr)	10-Year, 24-Hour Storm (in./hr)
875	0.000	0.1598
880	0.000	0.1599
885	0.000	0.1573
890	0.000	0.1528
895	0.000	0.1486
900	0.000	0.1449
905	0.000	0.1455
910	0.000	0.1418
915	0.000	0.1376
920	0.000	0.1331
925	0.000	0.1305
930	0.000	0.1306
935	0.000	0.1259
940	0.000	0.1261
945	0.000	0.1235
950	0.000	0.1190
955	0.000	0.1147
960	0.000	0.1111
965	0.000	0.1118
970	0.000	0.1067
975	0.000	0.1095
980	0.000	0.1102
985	0.000	0.1056
990	0.000	0.1066
995	0.000	0.1069
1000	0.000	0.1025
1005	0.000	0.1012
1010	0.000	0.1017
1015	0.000	0.1018
1020	0.000	0.1015
1025	0.000	0.0970
1030	0.000	0.0963
1035	0.000	0.0977
1040	0.000	0.0943
1045	0.000	0.0926

APPENDIX C (CONTINUED)
Five-Minute Hyetograph Data

Time (Minutes)	2006 Storm Event (in./hr)	10-Year, 24-Hour Storm (in./hr)
1050	0.000	0.0971
1055	0.000	0.0920
1060	0.000	0.0924
1065	0.000	0.0884
1070	0.000	0.0889
1075	0.000	0.0917
1080	0.000	0.0867
1085	0.000	0.0875
1090	0.000	0.0826
1095	0.000	0.0854
1100	0.000	0.0858
1105	0.000	0.0818
1110	0.000	0.0822
1115	0.000	0.0772
1120	0.000	0.0817
1125	0.000	0.0797
1130	0.000	0.0773
1135	0.840	0.0764
1140	0.360	0.0724
1145	0.600	0.0776
1150	0.000	0.0739
1155	0.480	0.0718
1160	0.600	0.0733
1165	0.000	0.0716
1170	0.120	0.0674
1175	0.240	0.0676
1180	0.240	0.0686
1185	0.000	0.0640
1190	0.240	0.0647
1195	0.000	0.0676
1200	0.000	0.0624
1205	0.000	0.0629
1210	0.000	0.0631
1215	0.000	0.0627
1220	0.000	0.0635

APPENDIX C (CONTINUED)
Five-Minute Hyetograph Data

Time (Minutes)	2006 Storm Event (in./hr)	10-Year, 24-Hour Storm (in./hr)
1225	0.000	0.0618
1230	0.000	0.0579
1235	1.680	0.0626
1240	0.960	0.0640
1245	2.880	0.0590
1250	4.800	0.0601
1255	2.640	0.0624
1260	1.800	0.0578
1265	2.040	0.0632
1270	1.920	0.0586
1275	2.160	0.0609
1280	1.920	0.0620
1285	2.040	0.0570
1290	2.640	0.0584
1295	2.400	0.0631
1300	2.040	0.0592
1305	2.880	0.0575
1310	1.560	0.0583
1315	2.280	0.0580
1320	1.920	0.0581
1325	1.440	0.0581
1330	1.200	0.0581
1335	0.600	0.0579
1340	0.480	0.0586
1345	0.240	0.0569
1350	0.360	0.0530
1355	0.720	0.0578
1360	0.240	0.0592
1365	0.000	0.0542
1370	0.000	0.0552
1375	0.000	0.0575
1380	0.000	0.0530
1385	0.000	0.0583
1390	0.000	0.0538
1395	0.000	0.0561

APPENDIX C (CONTINUED)
Five-Minute Hyetograph Data

Time (Minutes)	2006 Storm Event (in./hr)	10-Year, 24-Hour Storm (in./hr)
1400	0.120	0.0571
1405	0.000	0.0521
1410	0.120	0.0536
1415	0.120	0.0583
1420	0.120	0.0544
1425	0.120	0.0527
1430	0.240	0.0534
1435	0.720	0.0532

Appendix B
GIS Updates from March 2012 and Rim Updates from September 2012

GIS Updates from March 2012

ID	Asset Type	Update Description
23145	Junction	Replaced junction 2192
23146	Junction	Added new junction
23147	Junction	Added new junction
23148	Junction	Added new junction
23149	Junction	Added new junction
23150	Junction	Added new junction
23151	Junction	Added new junction
23152	Junction	Added new junction
4452	Conduit	Abandoned, deleted from model
4472	Conduit	Abandoned, deleted from model
4471	Conduit	Abandoned, deleted from model
4457	Conduit	Abandoned, deleted from model
23001	Conduit	Added new conduit
23002	Conduit	Added new conduit
23003	Conduit	Added new conduit
23004	Conduit	Added new conduit
23005	Conduit	Added new conduit
23006	Conduit	Added new conduit
23007	Conduit	Added new conduit
23008	Conduit	Added new conduit
23009	Conduit	Added new conduit
2225	Junction	Abandoned, deleted from model
2196	Junction	Abandoned, deleted from model
2188	Junction	Abandoned, deleted from model
2192	Junction	Replaced by junction 23145

Rim Elevation Updates from September 2012

Junction ID	Original Model Rim Elevation (ft)	Revised Rim Elevation (ft)
23594	313.83	310.41
2572	335.70	333.23
1976	353.50	351.18
2532	328.10	326.00
1780	304.74	302.70
2294	346.00	348.00
1630	281.95	284.00
1742	313.16	316.00
2370	362.00	368.02