Section 6 - Hydraulic Capacity Analysis

This section discusses the process of model selection, development, calibration and application for the wastewater collection system in the Towns of Cary and Morrisville. The model was subsequently utilized to analyze the system adequacy for conveying wastewater under both existing and future scenarios in both towns' service areas and to determine a cost-effective capital improvement program to address deficiencies identified in Section 5.

6.1 Model Selection

As an integral component of this wastewater master plan, a dynamic hydraulic model was used to evaluate the hydraulic capacity of the collection system for the existing and future flow conditions. It would also help identify possible deficiencies in the system and prioritize future capital investment for the Town of Cary. Therefore, the selection of the model plays a key role in the success of the whole wastewater master planning process. Also high on the list of considerations is the stability of the numerical engine itself and its compatibility with the existing GIS system and water distribution model employed by the Town of Cary. With close collaboration and open discussion with the Town of Cary's staff, Hazen and Sawyer recommend that the InfoWorks CS™ be selected as the hydraulic software platform for this project. Two additional seats of InfoWorks CS™ Viewer were deployed on the Town of Cary's Local Area Network (LAN). Both staff from the Engineering Department and the Public Works Department can gain easy access to the model. Unique system information can be readily disseminated across the two departments. The model can also aid in capital budgeting and project scheduling decisions.

6.2 Model Development

Infoworks CS™ is a dynamic computerized model that packages a robust numerical engine to help route varying flow hydrographs through a complicated network of gravity/force main pipes, storage facilities and pumps. The accurate physical information describing key components of the Towns' sewer collection system is the most important foundation on which Infoworks CS model is based. According to the negotiated contract for this project, the hydraulic model includes all major sewer interceptors and all pump stations in the Cary system. A map of the sewer collection system can be found in Section 2-1.

The data source used in the InfoWorks CS™ model includes primarily diameter and invert data from the Town of Cary's GIS department. Additional as-built construction drawings were furnished by the Town's engineering department to supplement the GIS information. The data related to the capacity and operational levels of the pump stations currently in service were mainly gleaned from pump tests conducted internally by the Town of Cary, and by Hazen and Sawyer, P.C. staff as part of this project.

As discussed in Section 5, the year 2010 non-irrigation water demand data was used to establish the average base flow for the Infoworks CS model. As shown in Figure 6-1, each individual water customer was converted into a fixed flow input in the Infoworks CS model. In addition, each customer was linked to its closest manhole through simple GIS spatial calculation. The assumed proximity may be not 100% accurate for all the water customers involved. However, this approach allowed us to determine the broad trend of sewer service utilization at a large scale. Unlike the water billing data in the water distribution system master plan, there is no comparable household or user level data available for quantifying individual sewer service flows. The proximity assumption allows us to spatially disperse the ABF in a manner close to the actual sewer usage pattern.

As detailed in Section 5, the sewer collection system for the Towns of Cary and Morrisville as of late 2009 was selected as the base model. Since the end of 2009, additional capital projects have been implemented and others will be implemented in the near future. Through our discussion with the Town's staff, the following is a list of projects that were added to the base model to reflect the existing system configuration:

- Lower Breckenridge Pump Station switch to gravity flow
- Thomas Brooks Park PS abandonment and flow redirection

To lessen the numerical complexity of the model simulation and reduce the required simulation time, more efforts were expended to simplify the existing model network. As shown in Figure 6-2, pipes with a diameter less than 10 inches were eliminated, and all upstream manholes associated with those smaller gravity pipes were also deleted from the model. The flows, originally draining directly into the deleted manholes, were reassigned to the closest manhole in the model. An example of this exercise is shown in Figure 6-2, which demonstrates the results of applying the procedure described above to the sub-system shown in Figure 6-1.

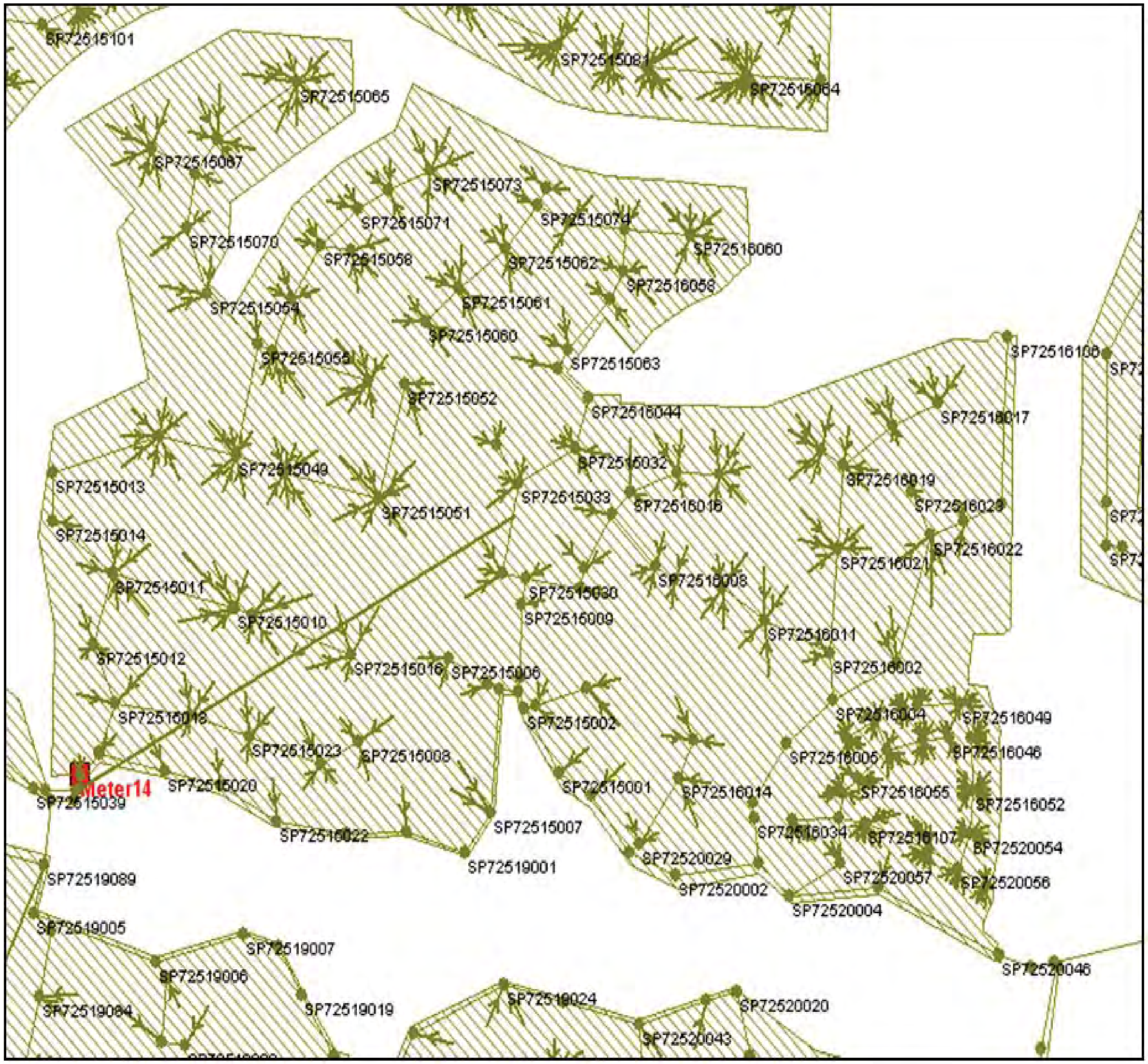


Figure 6-1: Example of Dispersed ABF Assignment Using Water Billing Data in 2010

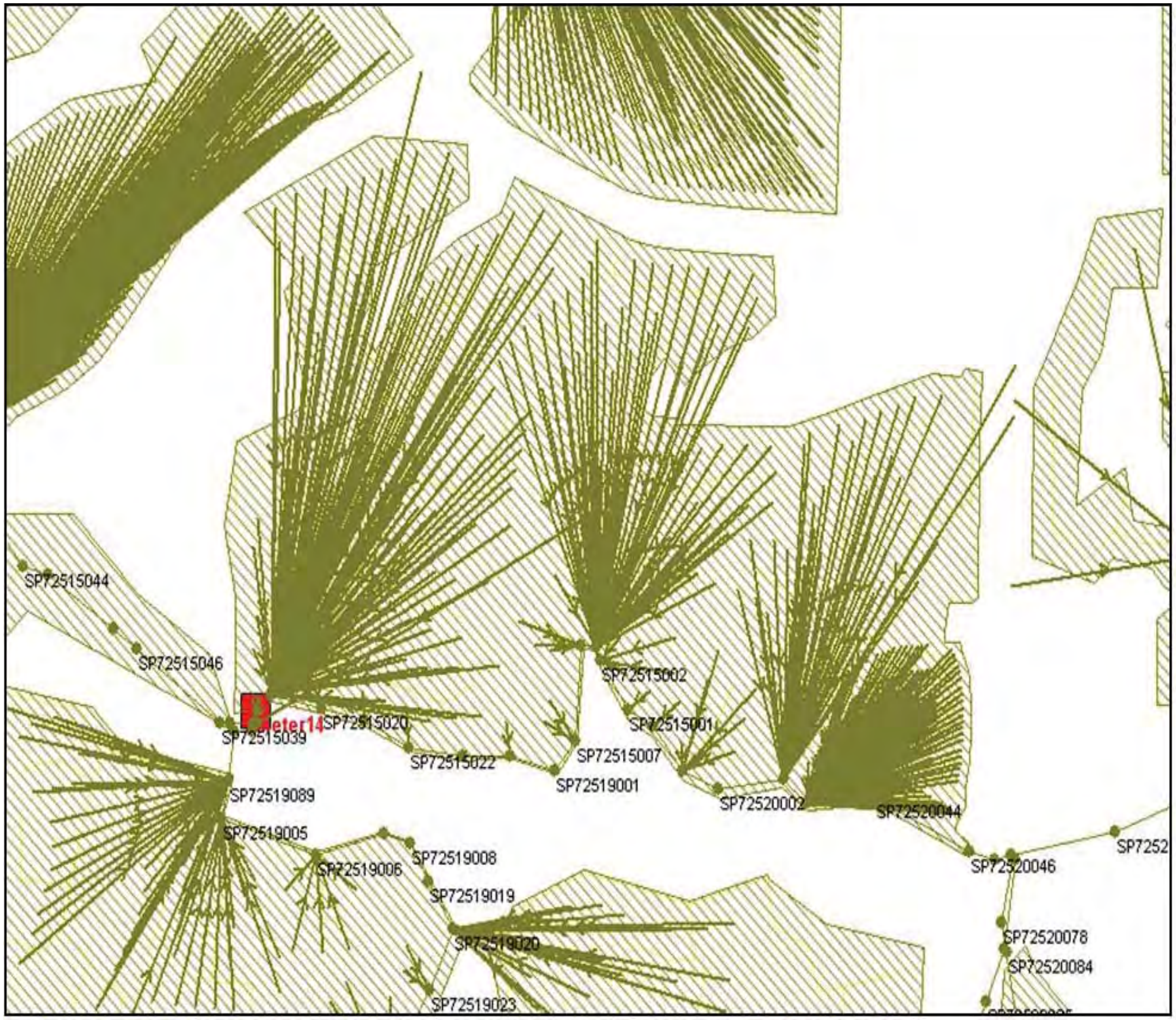


Figure 6-2: Example of Model Simplification

6.3 Wet-Weather Flow Determination

This section describes the methodology used to predict rainfall dependent wastewater flows associated with precipitation. Rainfall Dependent Inflow and Infiltration (RDI/I) is the rainfall-derived flow in a sanitary sewer system. In most systems, RDI/I is a major component of peak wastewater flows and is typically responsible for capacity-related SSOs and basement backups. RDI/I flows are generally zero before a rainfall event, increase during the rainfall event, and then decline to close to zero sometime after the rain stops. For cases with less than saturated antecedent moisture conditions, surfaces and soils may take up some of the rainfall early in the event before a response is observed and, if the event is small enough, there may not be a sanitary system response. The maximum amount of rainfall that does not produce a response in the system is termed the “initial loss”.

There are various pathways of RDI/I into sanitary sewer system. Inflow is the water that enters the sanitary sewer system directly via depressed manhole lids and frames, downspouts, sump pumps and foundation drains, and cross-connections with storm sewers. Inflow typically occurs shortly after a rainfall starts and stops quickly once it stops. Inflow is typically the major component of the RDI/I peak flow.

Infiltration refers to rainfall runoff that filters through the soil before entering a sanitary sewer system through damaged pipe sections, leaky joints or poor manhole connections. These defects can occur in both the public right-of-way portion of the sanitary sewer system or in individual service laterals on private property. Infiltration processes typically extend beyond the end of rainfall and take some time to reduce to zero after the storm event.

During model calibration, a modified unit hydrograph method (RTK method) was selected to simulate wet weather flow. This methodology has been widely adopted by the USEPA and many other municipalities in the country. This methodology is based on determining three triangular unit hydrographs for an existing event. Each of those three unit hydrographs can be determined by a group of three parameters, R, T and K, in which R stands for the percentage of rainfall descending on the service area, and both T and K are timing parameters. Each of the three unit hydrographs would have a different intensity and duration.

6.4 Model Calibration and Verification

The Infoworks CS™ model was subsequently calibrated so that it would accurately represent the flow and system hydraulics under the current operating conditions. Two separate scenarios were built to simulate dry and wet-weather flow conditions for the existing system. Both the volume and peak flow characteristics for each meter were considered. The calibration results for dry weather and wet weather flow conditions can be seen in Tables 6-1 and 6-2, respectively.

Table 6-1: Dry Weather Flow Calibration

Meter	Average Flow (MGD)			Peak Flow (MGD)			Max Depth (ft)		
	Model	Meter	% Difference	Model	Meter	% Difference	Model	Meter	% Difference
1	0.70	0.75	7%	1.12	1.10	-2%	0.37	0.41	11%
2	1.83	1.93	5%	3.55	3.69	4%	1.26	1.21	-4%
3	7.01	7.87	NA	14.43	-	NA	1.71	1.97	13%
4	1.16	1.29	10%	1.82	2.09	13%	0.45	0.50	10%
5	1.70	1.85	8%	3.23	3.26	1%	0.78	0.83	6%
6	3.93	4.35	10%	6.79	7.67	11%	0.82	1.01	19%
7	1.43	1.57	9%	2.82	2.81	0%	0.60	0.61	1%
8	0.93	1.05	11%	1.53	1.58	3%	0.48	0.52	8%
9	0.25	0.28	11%	0.44	0.47	7%	0.32	0.36	12%
10	0.55	0.65	16%	1.23	1.26	2%	0.45	0.51	12%
11	2.06	2.16	5%	3.70	3.69	0%	0.55	0.67	18%
12	2.52	2.26	-12%	4.49	4.19	-7%	0.60	0.70	14%
13	0.99	1.06	7%	1.75	1.67	-5%	0.52	0.60	13%
14	2.15	2.40	10%	4.03	4.51	11%	0.49	0.57	14%
15	8.80	8.88	1%	14.76	13.88	-6%	1.11	1.29	14%
16	4.93	5.08	3%	8.86	7.92	-12%	1.10	1.17	6%
17	1.00	1.00	0%	1.72	1.60	-7%	0.46	0.46	0%
18	1.01	0.90	-12%	1.52	1.51	-1%	0.56	0.60	7%
22	0.32	0.41	22%	0.62	0.62	0%	0.39	0.41	5%
23	1.77	1.50	-18%	2.94	2.98	1%	0.63	0.70	10%
24	0.17	0.19	11%	0.24	0.27	11%	0.22	0.19	-16%
25	1.11	-	NA	1.42	1.49	NA	1.70	1.45	-17%
26	1.91	2.38	20%	3.36	3.35	0%	0.57	0.55	-4%

Table 6-2: Wet Weather Calibration

Meter	Average Flow (MGD)			Peak Flow (MGD)			Max Depth (ft)		
	Model	Meter	% Difference	Model	Meter	% Difference	Model	Meter	% Difference
1	0.91	0.86	-6%	2.01	1.62	-24%	0.56	0.69	17%
2	3.72	-	NA	5.17	-	NA	2.75	-	NA
3	10.87	10.27	NA	16.32	16.32	0%	4.47	3.97	-13%
4	2.76	2.92	5%	7.63	8.20	7%	2.25	2.79	19%
5	3.53	3.72	5%	5.44	5.92	8%	5.63	5.89	4%
6	6.31	6.76	7%	8.60	8.67	1%	1.60	1.46	-10%
7	3.01	3.75	20%	3.01	3.13	4%	5.07	-	NA
8	1.34	1.42	6%	2.05	2.20	7%	0.60	0.69	13%
9	0.29	0.32	9%	0.34	0.34	0%	0.27	0.35	23%
10	0.79	0.81	2%	1.29	1.11	-16%	0.55	0.65	15%
11	3.10	2.98	-4%	4.73	4.25	-11%	0.85	0.74	-15%
12	3.15	3.11	-1%	3.96	4.10	3%	0.72	0.80	10%
13	1.60	1.65	3%	3.26	3.26	0%	0.73	0.80	9%
14	3.22	3.49	8%	3.68	3.68	0%	0.54	0.60	10%
15	13.05	12.87	-1%	17.00	17.00	0%	1.55	1.81	14%
16	7.70	7.90	3%	13.89	13.89	0%	6.06	5.80	-4%
17	1.43	1.43	0%	2.44	2.57	5%	0.67	0.53	-26%
18	1.09	1.12	3%	1.43	1.38	-4%	0.59	0.55	-7%
22	0.43	0.45	4%	0.47	0.49	4%	5.50	5.91	7%
23	2.78	3.00	7%	3.76	3.81	1%	1.49	1.71	13%
24	0.09	-	NA	0.12	-	NA	0.15	-	NA
25	1.07	-	NA	1.64	-	NA	4.02	3.85	-4%
26	2.71	2.91	7%	3.24	3.70	12%	0.72	0.68	-6%

As the result of the calibration process, the R values for the catchment basin upstream of each flow meter were determined as shown in Table 6-3. In general, higher R values can be seen as a good indicator of upstream basins with more serious inflow and infiltration problems. In the Towns of Cary and Morrisville, Meter 4 and Meter 23 have the highest R values. Upstream of Meter 4 is the Walnut Creek Pump Station service area in downtown Cary. Upstream of Meter 23 is the York Interceptor service area in downtown Morrisville. More rehabilitation efforts should be devoted to those two areas to improve the current high R values, or at least prevent the current R values from increasing.

Table 6-3: R Values for All Basins

Flow Meter	R Value (%)
1	0.3%
2	0.1%
3	0.1%
4	1.6%
5	0.1%
6	0.3%
7	1.2%
8	0.3%
9	0.2%
10	0.3%
11	0.2%
12	0.2%
13	0.6%
14	0.1%
15	0.1%
16	0.8%
17	0.8%
18	0.1%
21	0.1%
22	0.2%
23	1.6%
24	0.1%
25	0.1%
26	0.1%

6.5 Existing Capacity Analysis

After the InfoWorks CS model was fully calibrated based on the permanent flow metering data, the computer simulation for the existing dry weather flow and wet weather flow conditions was performed, as illustrated in Figures 6-3 and 6-4. The state of surcharge is defined as the ratio of peak level achieved for the duration divided by the diameter of the pipe. The result of both simulations was presented as the level of surcharge for each pipe, which was identified by color coding. If a pipe is less than 50% full, it is shown as blue. As the level of surcharge increases from 50% to 100%, the color of the pipe transitions from yellow to orange. If a pipe is more than 100% full (surcharge), the pipe is shown as red.

The number of times each meter shows surcharge from 2008 to 2010 is also included in Figures 6-3 and 6-4. This helps confirm the existing capacity of the system and identify areas that are more susceptible to surcharging and overflows.

Figure 6-3 shows that under existing dry weather flow conditions, the entire system possesses sufficient capacity, with most of gravity pipe less than 50% full. Only a few segments of particular branches, such as the York Interceptor in Morrisville, and the Lynn's Branch, Long Branch and Speight Branch Interceptors, show a capacity more than 50% full. This observation is consistent with the operating experiences in the Town of Cary, whose collection system never experiences any difficulty in handling the dry weather flow conditions.

However, under wet weather conditions (Figure 6-4), more stress in pipe capacity is exhibited in various parts of the system, including the York Interceptor; the Crabtree Creek Interceptor; the Swift Creek Interceptor; and the Lynn's Branch, Long Branch and Speight Branch Interceptors. A large portion of those segments of the system show the surcharge condition with HGL higher than the crown of the pipe. Therefore, there is no redundant capacity available in those segments. Our simulation of varying surcharge condition for different segments of the system during wet weather conditions correlates with the number of times of surcharge experienced by those segments from 2008 to 2010, based on the flow meter data collected on those segments. Please refer in details to Section 5.2.3 and Figure 5-13. Meter 22, 23 (York Interceptor), Meter 2, 4, 5 (Lynn's Branch) showed the most number of times of surcharge among all flow meters.

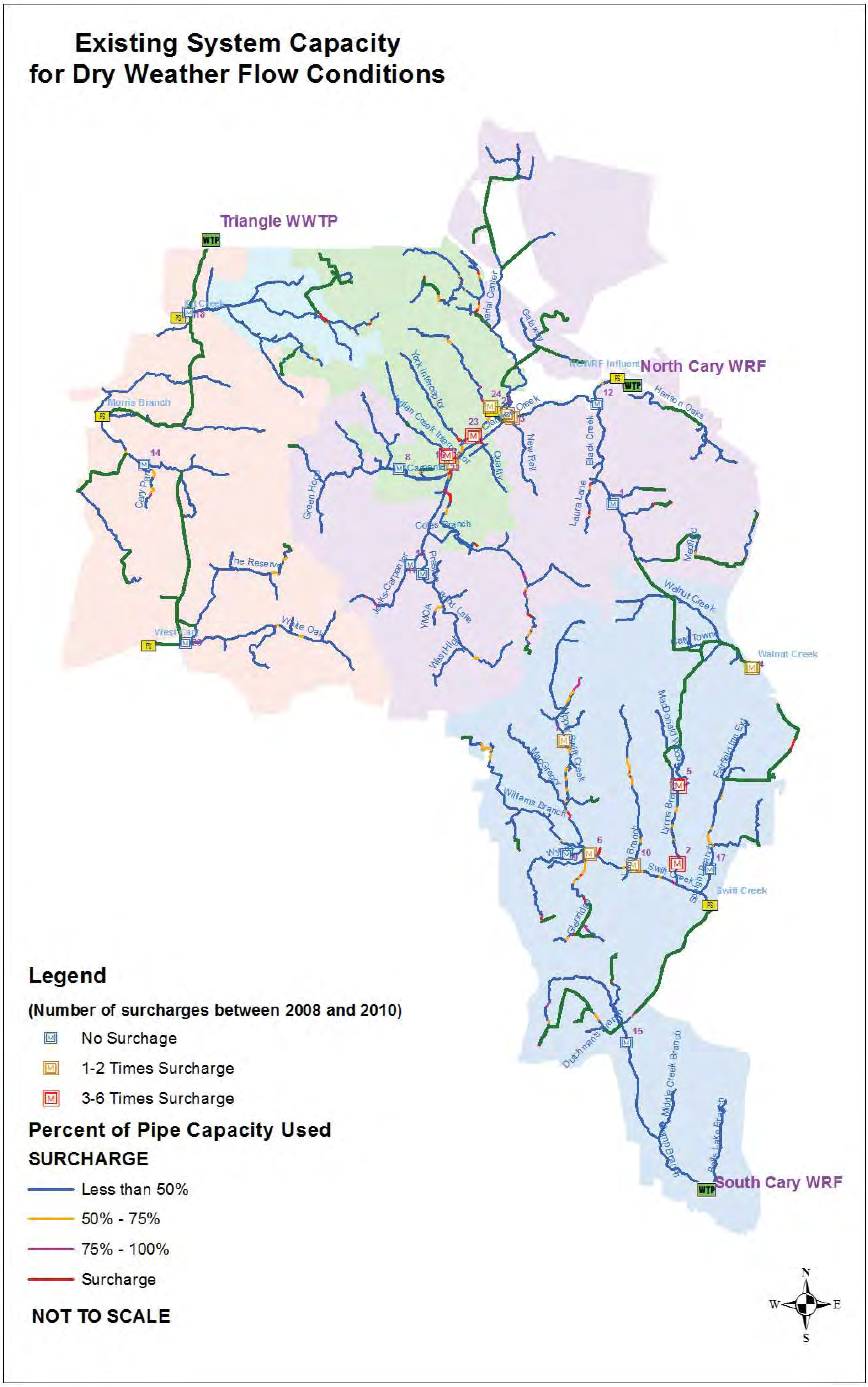


Figure 6-3: Existing Dry Weather System Capacity

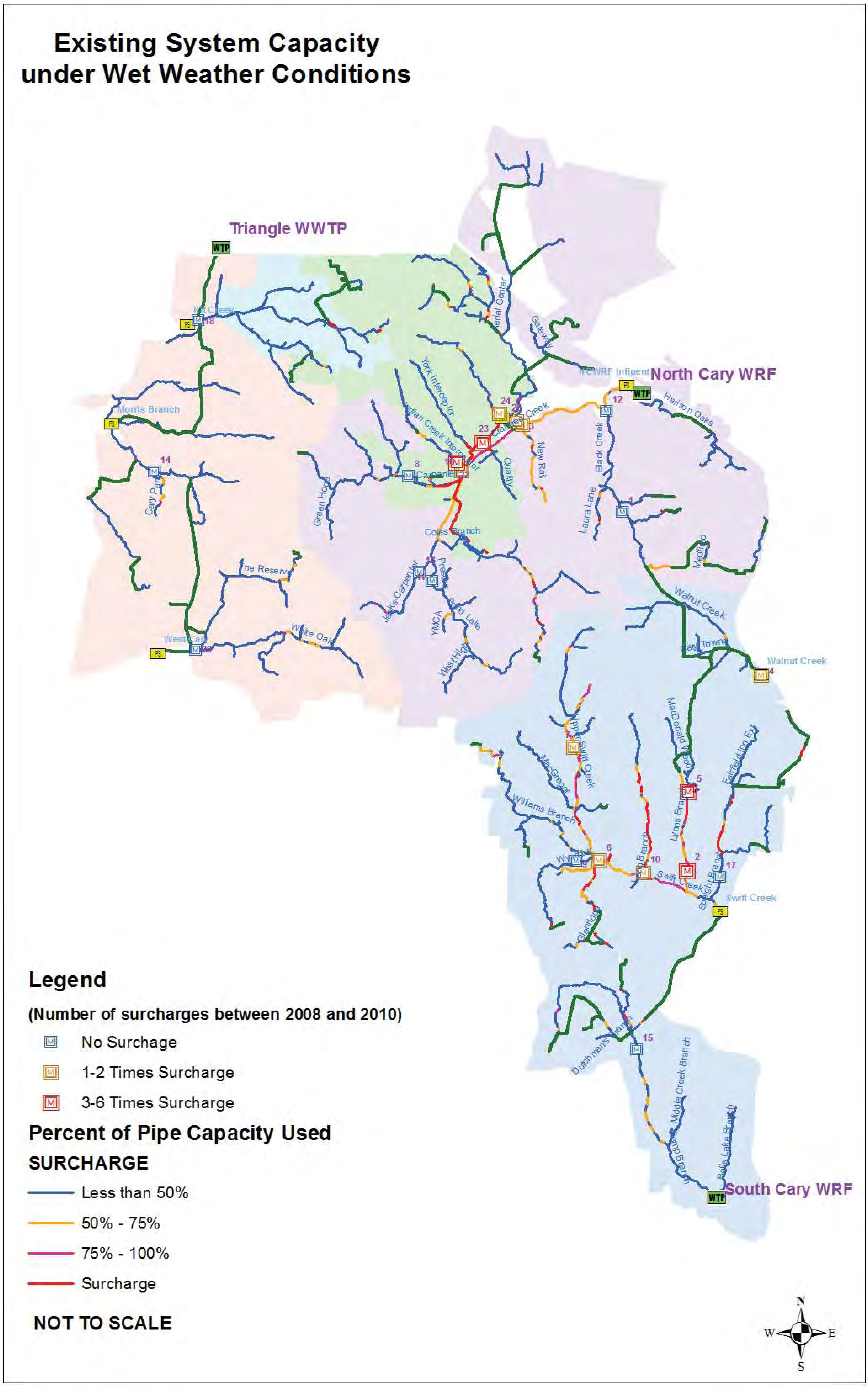


Figure 6-4: Existing Wet Weather System Capacity

6.6 Methodology in Simulating Future System

Based on discussion with the Town staff, it is recommended that, similar to the last master plan project, the peaking factor method be used to calculate the peak wet weather flow for which each pipe is adequately sized. In the last master plan, a single peaking factor of 3.1 was used throughout the system. As clearly demonstrated in Section 5, the peaking factor, a surrogate of system condition in terms of inflow and infiltration, varied markedly from basin to basin. Hence, a minor alteration was introduced to account for this spatially variability. As shown in Table 6-4, the average base flow and the peak wet weather flow for each flow meter during 2010 were determined, and this data was used to calculate the peaking factor for each flow meter. Based on current state regulations, the peaking factor cannot be lower than 2.5. In addition, the Town would prefer to limit peaking factors to 5 or less. The peaking factor for the West Service Area sub-basins were adjusted to 3.1 in accordance to Northwest Cary Force Main memo as attached in Appendix A. Therefore, the originally calculated peaking factors were adjusted to reflect those preferences. In this way, existing and future flows for each basin upstream of a flow meter were multiplied by a peaking factor assigned for this flow meter to yield a peak wet weather flow.

Table 6-4: Determination of Peaking Factor

Meter	Average Base Flow (MGD)	Peak Wet Weather Flow (MGD)	Peaking Factor	PF Selected
1	0.408	1.86	4.55	4.55
2	1.296	4.98	3.84	3.84
3	3.82	12.23	3.20	3.20
4	0.617	4.21	6.83	5.00
5	1.271	4.44	3.49	3.49
6	2.345	7.97	3.40	3.40
7	0.844	3.70	4.39	5.00
8	0.697	2.99	4.40	4.40
9	0.144	0.53	3.70	3.70
10	0.351	1.41	4.01	4.01

Table 6-4: Determination of Peaking Factor (Continued)

Meter	Average Base Flow (MGD)	Peak Wet Weather Flow (MGD)	Peaking Factor	PF Selected
11	1.237	3.65	2.95	2.95
12	1.265	3.70	2.92	2.92
13	0.214	0.80	3.72	3.72
14	1.553	3.41	2.20	3.1
15	4.864	12.19	2.51	3.1
16	2.684	8.75	3.26	3.26
17	0.545	2.33	4.27	4.27
18	0.623	1.60	2.58	2.58
22	0.164	0.72	4.37	3.40
23	0.725	2.96	4.08	5.00
24	0.03	0.28	9.18	3.40
25	1.142	4.17	3.65	3.65
26	1.496	3.28	2.19	3.1

6.7 Model Results and System Improvement

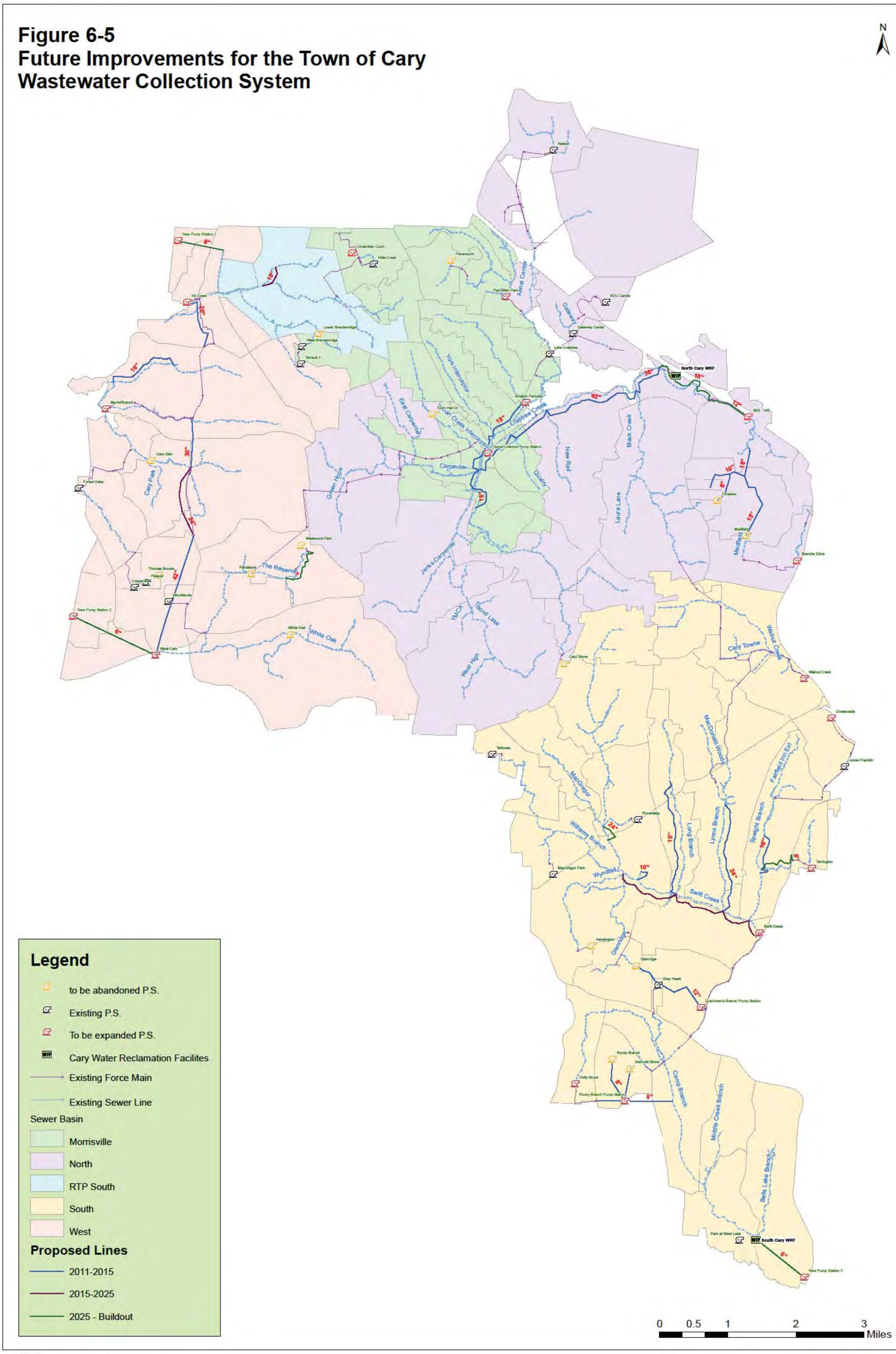
Based on the results of the hydraulic models and input from Town of Cary staff, three alternatives were developed for system improvements to meet the projected wastewater flows in the year 2015, 2025 and build-out.

First, those improvements necessary to convey projected wastewater flows through build-out conditions based on the projected service area boundaries shown in Figure 2-1 were determined. Existing interceptors that flow more than 2/3 full would be targeted for paralleling or other flow diversion schemes. All projects accompanying the inception of the WWRWRF were prioritized for completion by mid 2014. The other theme was the continuing streamlining of the existing system by abandoning small pump stations and consolidating them into regional pump stations such as the new Reedy Creek Pump Station. The ultimate routing and pipe size for future gravity sewer pipes and force mains and the sizing of future pump stations were determined based on the build-out scenario.

Second, additional simulations were conducted to investigate the system conditions in the year 2015 and year 2025 planning horizons. The purpose of this step was to determine the phasing and timing of each previously determined project. Again, the actual trigger point for each proposed project should be examined in the context of future development needs of the Town. For example, if the further expansion of the SAS campus proceeds as planned, the development of Reedy Creek Regional Pump Station and its associated gravity sewer improvement projects should proceed accordingly. The same situation may also apply to the Dutchman's Branch Pump Station and the replacement of the Rocky Branch Pump Station.

The results of those simulations are summarized in Figure 6-5, in which the timing of each proposed project is color coded. The near term projects (2011-2015) are denoted in the color blue. The middle term projects (2015-2025) are represented in the color brown and the more long-term needs of the Town (build-out) in the color green. Further details of the recommended improvements, such as scope, size and costs can be found in Section 7.

Table 6-5 summarizes the anticipated peak wet weather flows for each pump station in each planning period in conjunction with the firm capacity of each pump station as determined in Section 3. When the anticipated flow exceeds the firm capacity of each pump station, it is shown as a pink cell.



Town of Cary
North Carolina

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Figure 6-5: Recommended Capital Improvement Projects from 2010 to Build-out

Table 6-5: Pump Station Capacity

ID	Name	Firm Capacity (MGD)	Date Tested	Wet Well	2015 Force Main (in)	2015 Capacity (MGD)	2015 Flow (MGD)	2015 Velocity (fps)	2025 Downstream Force Main (in)	2025 Capacity (MGD)	2025 Flow (MGD)	2025 Velocity (fps)	BO Downstream Force Main (in)	BO Capacity (MGD)	BO Flow (MGD)	BO Velocity (fps)
1	Swift Creek*	14.71	2010	25*17	36	25.00	18.50	5.47	36	25.00	19.36	5.47	36	25.00	23.43	5.47
2	Walnut Creek	3.85	2010	12*20	16	5.50	4.01	6.10	16	5.50	4.14	6.10	16	5.50	4.99	6.10
3	Kit Creek	7.57	2010	10*18	Please see the details in Appendix A North West Cary Force Main Memo											
4	White Oak	1.63	2001	10*20	Inactive											
5	Nelson	1.46	2001	8	8	1.46	0.39	6.47	8	1.46	0.62	6.47	8	1.46	1.36	6.47
6	Crossroads	0.23	2010	8	8	0.45	0.31	1.99	8	0.45	0.33	1.99	8	0.45	0.38	1.99
7	Glenmitt Stone	0.04	2001	5	to be abandoned											
8	Fieldstone	0.79	2001	11.5*10	Inactive											
9	I-40/Reedy Creek Regional	0.80	2010	10*7	12	5.60	2.07	11.03	12	5.60	3.20	11.03	18	5.60	5.42	4.90
10	Glenridge	0.47	2010	7	to be abandoned											
11	Jones Franklin	1.05	2010	10	8	1.05	0.67	4.65	8	1.05	0.70	4.65	8	1.05	0.82	4.65
12	Medfield	1.10	2010	8	to be abandoned											
13	Blanche	0.27	2010	6	6	0.55	0.55	4.33	6	0.55	0.55	4.33	6	0.55	0.55	4.33
14	Talloway	0.20	2001	5.6	6		0.15	0.00	6	0.20	0.15	1.58	6	0.20	0.15	1.58
15	Gateway Center	0.69	2010	10	8		0.51	0.00	8	0.69	0.51	3.06	8	0.69	0.53	3.06
16	RDU Center	0.46	2010	6	6		0.37	0.00	6	0.46	0.37	3.63	6	0.46	0.37	3.63
17	MacGregor Park	0.27	2001	6	4		0.07	0.00	4	0.27	0.09	4.79	4	0.27	0.14	4.79
18	Ronaldsby	0.15	2001	7.8	4		0.03	0.00	4	0.15	0.03	2.66	4	0.15	0.04	2.66
19	Morris Branch	4.16	2010		Please see the details in Appendix A North West Cary Force Main Memo											
20	Carystone	0.25	2001	6	4	0.25	0.21	4.43	4	0.25	0.21	4.43	4	0.25	0.21	4.43
21	Thresher	0.20	2001	6	to be abandoned											
23	Town Hall	0.20		6	to be abandoned											
24	Holly Brook	0.21	2001	8	6	0.62	0.22	4.89	6	0.62	0.27	4.89	6	0.62	0.62	4.89
25	Rocky Branch	0.29	2010	6	to be abandoned											
27	Kensington	0.23	2001	6	to be abandoned											

Table 6-5: Pump Station Capacity (Continued)

ID	Name	Firm Capacity (MGD)	Date Tested	Wet Well	2015 Force Main (in)	2015 Capacity (MGD)	2015 Flow (MGD)	2015 Velocity (fps)	2025 Downstream Force Main (in)	2025 Capacity (MGD)	2025 Flow (MGD)	2025 Velocity (fps)	BO Downstream Force Main (in)	BO Capacity (MGD)	BO Flow (MGD)	BO Velocity (fps)
30	Grey Hawk	0.26	2010		4	0.26	0.06	4.61	4	0.26	0.07	4.61	4	0.26	0.17	4.61
31	Terrington	0.43			6	0.43	0.17	3.39	6	0.43	0.31	3.39	6	0.80	0.79	6.30
32	Park at West Lake	0.18			4	0.18	0.07	3.19	4	0.18	0.07	3.19	4	0.18	0.07	3.19
33	Forest Oaks	0.79	2010		8	0.79	0.33	3.50	8	0.79	0.41	3.50	8	0.79	0.56	3.50
34	Copperleaf	0.40	2010		6	0.40	0.12	3.15	6	0.40	0.14	3.15	6	0.40	0.17	3.15
35	West Cary	2.29	2010		Please see the details in Appendix A North West Cary Force Main Memo											
38	Lower Breckenridge	1.15	2010		Inactive											
39	Terrace II	0.14			8	0.14	0.04	0.60	8	0.14	0.05	0.60	8	0.14	0.08	0.60
40	West Breckenridge	0.38	2010		8	0.38	0.13	1.68	8	0.38	0.14	1.68	8	0.38	0.17	1.68
41	Woodlands	0.53	2010		6	0.53	0.12	4.18	6	0.53	0.16	4.18	6	0.53	0.16	4.18
42	Aviation Parkway	4.50	2010		16	8.00	4.87	8.87	16	8.00	5.59	8.87	16	8.00	7.89	8.87
43	Circadian Court	0.15	2010		4	0.30	0.11	5.32	4	0.30	0.27	5.32	4	0.30	0.27	5.32
44	Paramount	0.71	2010		to be abandoned											
46	Perimeter Park	3.12	NA		16	3.12	1.94	3.46	16	3.12	3.01	3.46	16	3.12	3.05	3.46
47	Lake Crabtree	0.20	2010		4	0.20	0.04	3.55	4	0.20	0.06	3.55	4	0.20	0.06	3.55
48	Kitts Creek	1.57	2010		10	1.57	0.53	4.45	10	1.57	1.18	4.45	10	1.57	1.18	4.45
	Dutchman's Branch				6	0.60	0.46	4.73	6	0.60	0.55	4.73	6	0.60	0.55	4.73
	Rocky Branch Pump Station				8	1.00	0.37	4.43	8	1.00	0.93	4.43	8	1.00	0.93	4.43
	New PF 01								3				3	0.10	0.06	3.15
	New PF 02								6				6	0.50	0.24	3.94
	New PF 03								6				6	0.50	0.47	3.94

6.8 Northwest Cary Force Main Project

As discussed in Sections 1 and 2, the Town of Cary is proceeding, along with its joint partners (Towns of Apex and Morrisville), on the Western Wake Regional Water Reclamation Facility (WWRWRF) with a start-up time frame of 2014. It is intended to provide wastewater service area in the western part of Cary and help the Town of Cary and Morrisville better comply with the State of North Carolina's Interbasin Transfer regulations. The current wastewater flow is pumped from the West Cary Regional Pump Station to the Morris Branch Pump Station and then to the Kit Creek Pump Station. Ultimately, the wastewater flows are pumped to the Durham County Triangle WWTP. A detailed technical memorandum was prepared to address key issues for the Town of Cary in switching the ultimate wastewater flow destination from the Triangle WWTP to the WWRWRF. This memorandum is included as Appendix C. The estimated cost and projected time frame for each component in this project were carried over to this master plan.

6.9 Further Consolidation of Previously Morrisville-owned System

Subsequent to the merger with the Town of Morrisville's sewer collection system, the Town of Cary staff has made substantial progress in combining the sewer asset in both towns' systems, thereby streamlining system operation, improving efficiency, and reducing costs. An additional seven sub-areas in the original Morrisville-owned system were identified in this study and included as part of its recommendations. These are graphically represented in Figures 6-6 to 6-9. The quantity of total water demand in those areas were also assigned to the middle of each area to assist the Town of Cary in determining downstream impacts of those modifications.

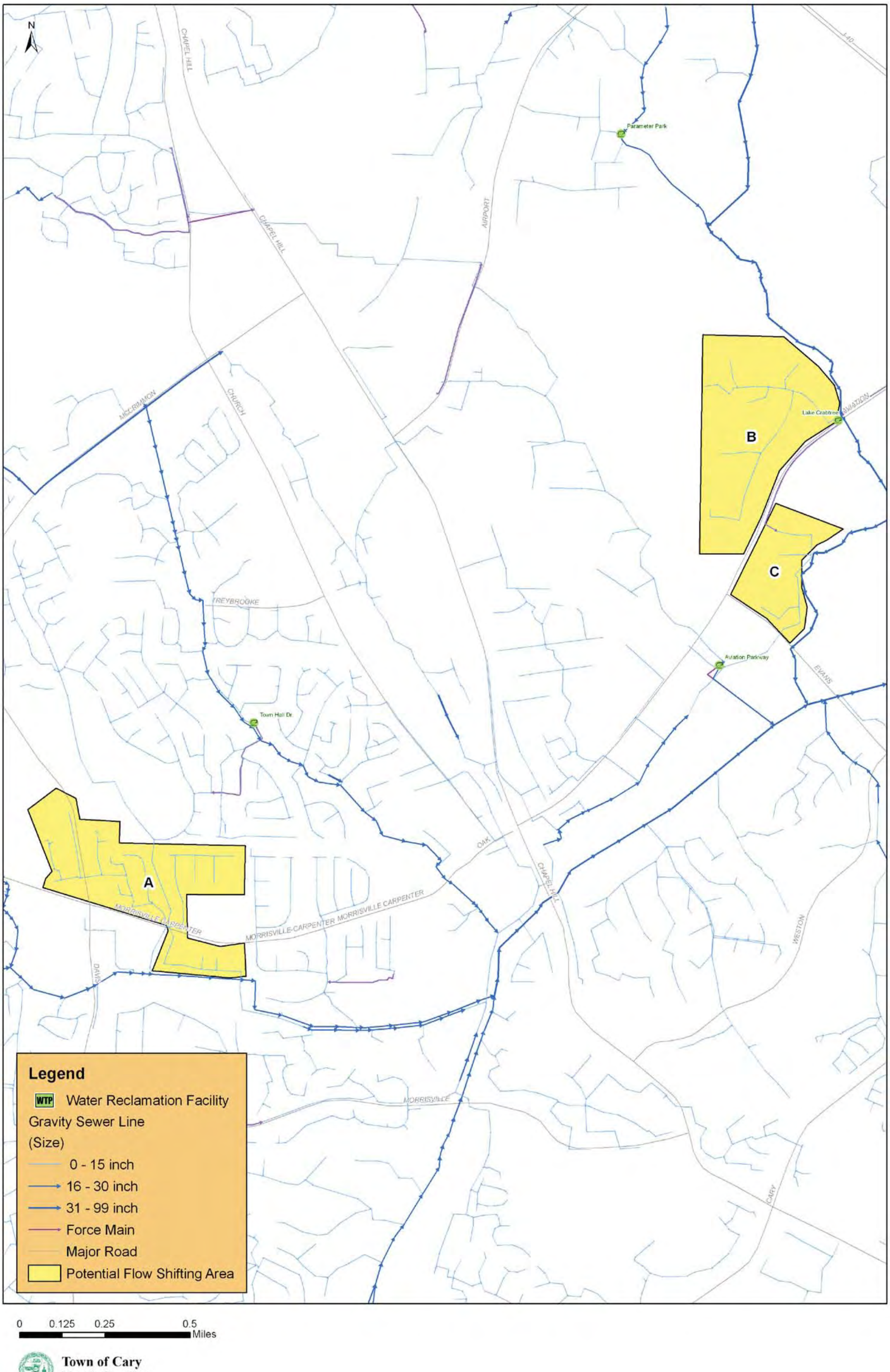

Figure 6-6: Overall View of Potential Areas to Shift from Morrisville System to Cary System

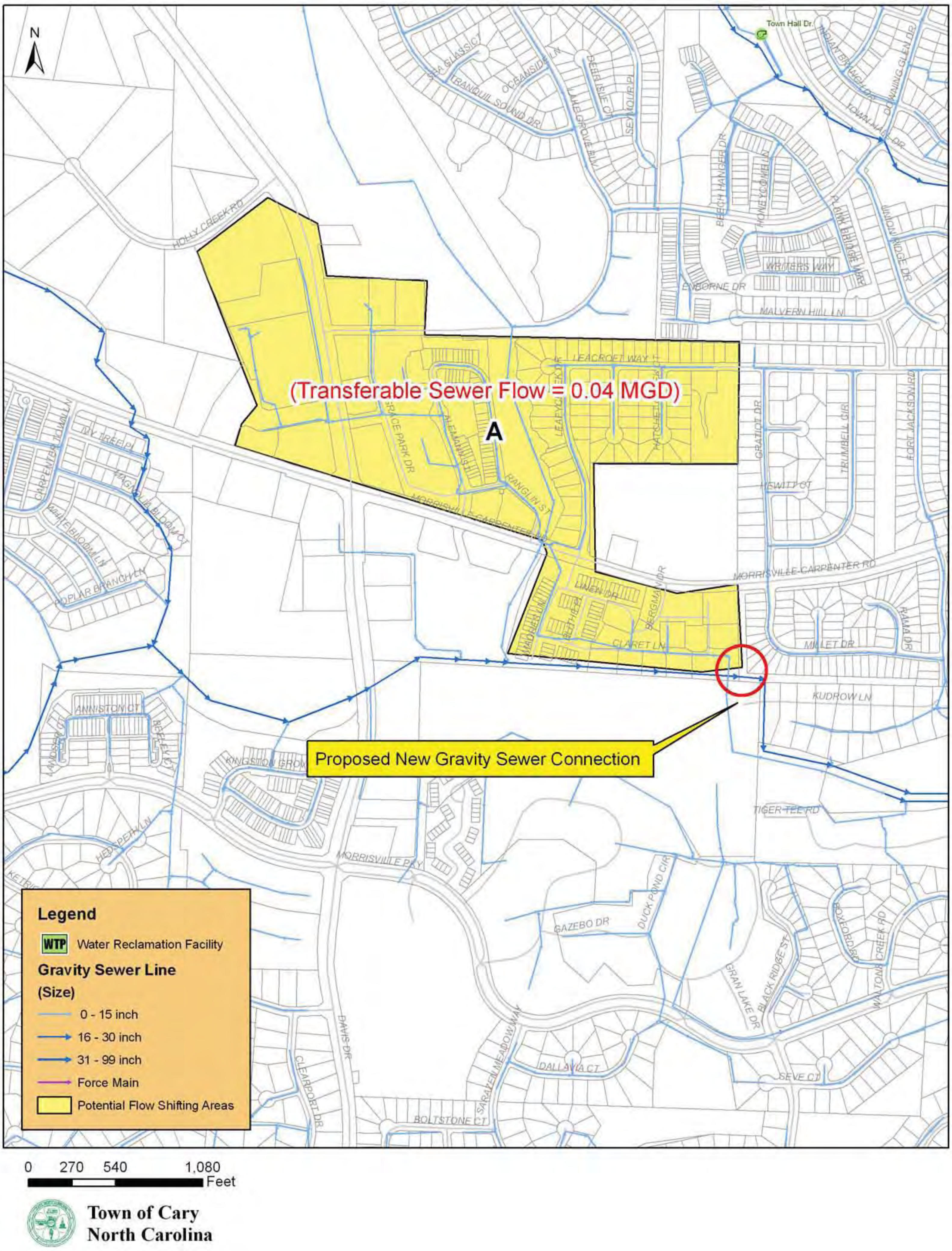

Figure 6-7: Potential Areas to Shift from Morrisville System to Cary System - Area A

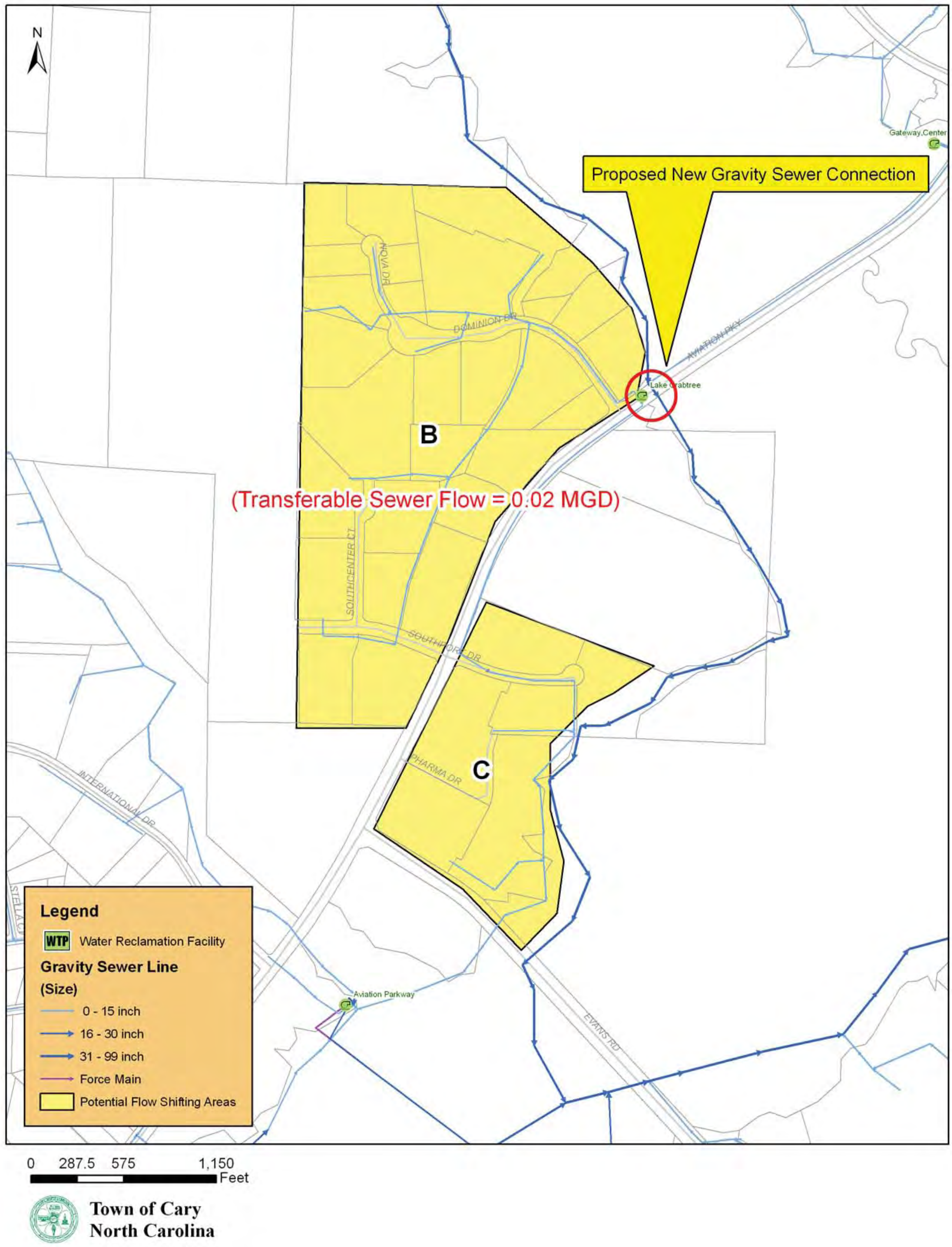

Figure 6-8: Potential Areas to Shift from Morrisville System to Cary System - Area B

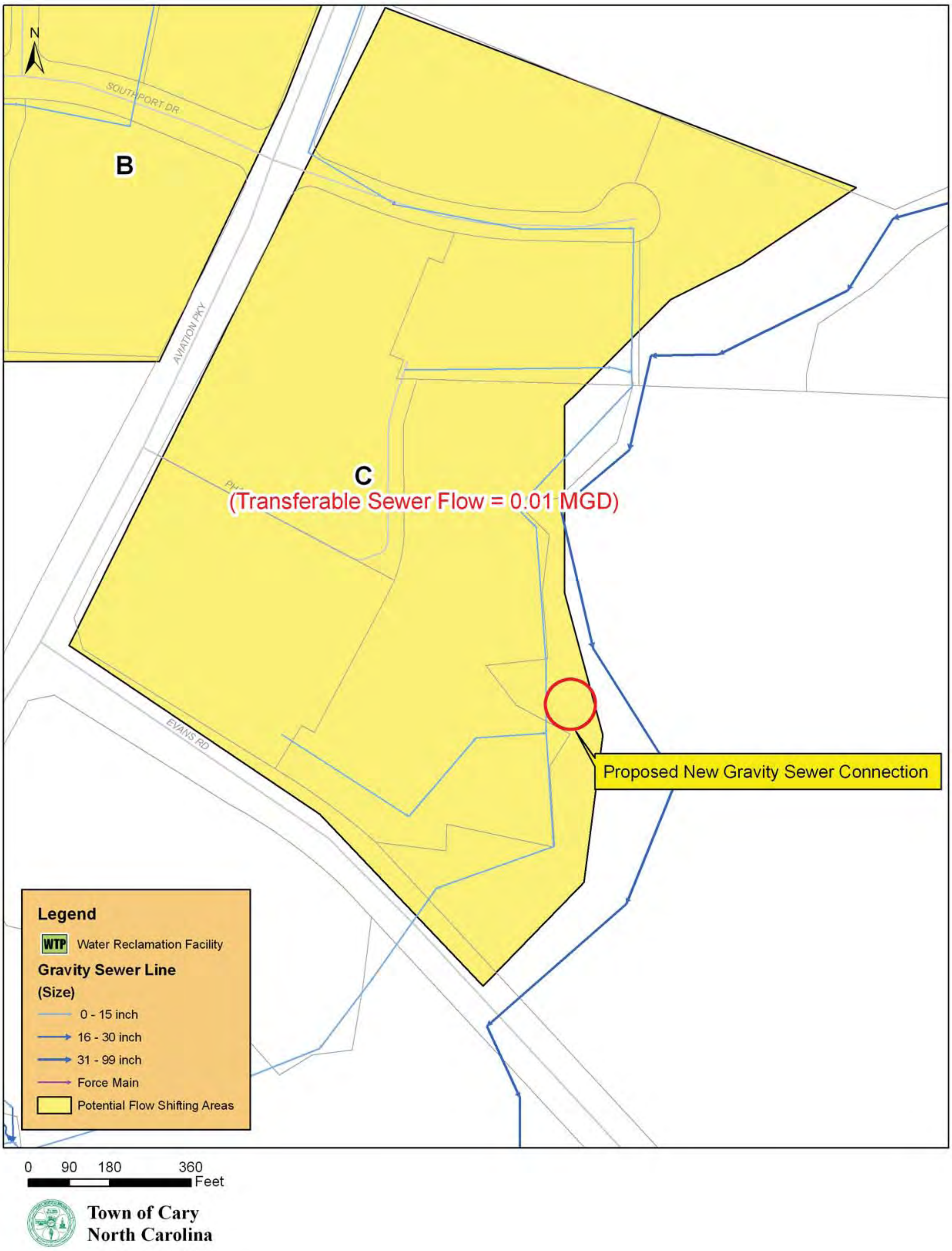

Figure 6-9: Potential Areas to Shift from Morrisville System to Cary System - Area C