SECTION 6

Hydraulic Evaluation

This section summarizes the results of a hydraulic evaluation conducted for the Town of Cary system for the defined planning periods of existing, 2010, 2015, 2025, and build-out. For each planning year, the following demand conditions were analyzed: maximum day demand, maximum day demand plus fire flow, and peak hour demand.

Utilizing the steady state and extended period simulation functionality of the Town’s hydraulic model, deficiencies were identified based on the established design criteria shown in Table 5-1. Proposed pipes, tanks, and pumps were evaluated in different combinations until an optimum design was established to eliminate simulated deficiencies. The hydraulic evaluation of the Town’s system is described in this section and includes:

• Existing System
• Future System – Pressure Zone Boundaries
• Future System – Transmission Mains
• Future System – High Service Pump Station
• Future System – Piping, Storage Tanks, and Control Valves

6.1 Existing System

The existing system hydraulic evaluation was conducted using projected 2009 demands derived by interpolating between the 2007 production and 2010 projected demands. The 2009 demands were used for existing conditions in order to provide a model that is as accurate as possible to evaluate the Town’s current system performance. The 2009 demands were linearly interpolated between the 2007 and 2010 demands and are shown in Table 2-15 for both ADD and MDD. The MDD was determined by using the peaking factor of 1.64 as described in Section 2.

For the existing system 2009 MDD evaluation, it was assumed that none of the programmed 2009 capital projects would be on-line by the summer peak demand period. Figures F1, F2, F3, F4 and F5 in Appendix F provide simulated tank level and pump flow trends from the EPS modeling analysis. Figure 6-1A displays map results showing simulated peak hour pressures and pipe velocities with the Davis Drive PRV closed. Figure 6-1B displays map results showing simulated peak hour pressures and pipe velocities with the Davis Drive PRV open. Figure 6-2 displays map results showing simulated available fire flow at 20 psi residual pressure for all hydrant nodes in the Town of Cary system.

6.1.1 Western Pressure Zone (Year 2009 No Improvements)

6.1.1.1 Extended Period Simulation (EPS) Results

As shown in Figure F1 (Appendix F), one WPZ pump at the HSPS was on-line in the model for the entire simulation while a second pump was utilized for approximately 6 hours from
4:00-11:00 A.M. The Davis Drive PRV was closed during this simulation, and the Carpenter Elevated Tank level varied from 540-ft to 528-ft msl (within acceptable limits). However, as shown in Figure 6-1A pressures over most of the eastern part of the zone along the Davis Drive corridor including portions of Research Triangle Park dropped below the 30 psi peak hour pressure criteria because the Davis Drive PRV was closed. The 16-inch along Morrisville Carpenter Road which supplies the entire eastern part of the zone was stressed with a peak hour velocity of 10 fps as indicated in Figure 6-1A. By opening the Davis Drive PRV in the model, pressure increased to over 50 psi in this same area as shown in Figure 6-1B. Only a few small areas in the vicinity of High House Road, Carpenter Upchurch Road, and Louis Stevens Road were within the 40-50 psi range. A very small area along High House Road was within acceptable limits of 30-40 psi. In order to strengthen this high elevation area without the Davis Drive PRV being required, the Town has programmed several 12-inch water main projects along High House Road, Carpenter Upchurch Road, and Louis Stevens Road as described further in Sections 6.5 and 7.1.5.

As shown in Figure 6-1B, the majority of the WPZ maintains pressure greater than 50 psi during peak hour conditions with only a few low elevation areas at the western part of the zone over 100 psi. Peak hour velocities in the WPZ are predominately below 3 fps, with a few larger mains near the Carpenter Elevated Tank, along Morrisville Carpenter Road, and downstream of the Davis Drive PRV between 3 and 5 fps, within acceptable limits.

6.1.1.2 Automated Fire Flow Simulation Results

Using the computer model, a fire flow analysis was conducted on every hydrant in the Town of Cary system under existing MDD conditions. The resulting available fire flow (AFF) at 20 psi residual pressure is shown in Figure 6-2. Commercial areas were reviewed to determine if a trunk main within the grouping of commercial parcels could achieve an AFF of 3,500 gpm which is the commercial fire flow design criteria per Table 5-1. Areas not zoned as commercial were assumed to be residential which requires an AFF of 1,000 gpm per Table 5-1. In both cases, the scope of this analysis focused on areas of fire flow adequacy and not individual parcels or facilities.

With the Davis Drive PRV off-line, a commercially zoned area along Davis Drive and High House Road resulted in an AFF between 1,000-2,500 gpm. Due to the lack of specific information on the fire flow requirements for these commercial buildings, a conclusive deficiency could not be identified. However, the AFF in a 12-inch main at a high elevation point at the intersection of High House Road and Carpenter Upchurch Road was between 700 and 1,000 gpm. As previously described, the Town has programmed a 12-inch water main along High House Road that would span the small portion of the CPZ and essentially connect the 30-inch NC-55 trunk main to the southeast quadrant of the WPZ. A specific fire flow analysis was conducted at this location with the proposed 12-inch main in service, and the simulation results indicated that the AFF would increase to approximately 3,500 gpm at the high elevation point after this project was brought on-line.

The AFF in the commercially zoned Research Triangle Park was predominately between 1,000 and 2,500 gpm as shown in Figure 6-2. As above, the fire flow requirement for specific commercial buildings was not readily available or considered as part of this analysis. However, the Town has programmed a short section of 16-inch main from Green Level-to-
Durham Road that will essentially make the RTP portion of the WPZ on a loop system and increase the AFF to the commercial design criteria of 3,500 gpm.

The AFF in the residential areas within the WPZ were predominately above 1,000 gpm with a few exceptions in the southeast quadrant of the zone which were between 700-1,000 gpm. These locations were typically isolated and on dead-end mains. With the addition of the programmed water main projects described above, the AFF will also be improved at these locations.

### 6.1.2 Central and Southern Pressure Zones (Year 2009 No Improvements)

While the CPZ and SPZ elevated tanks have very different overflow elevations (641-ft and 595-ft respectively), the two zones were analyzed together due to the operation of Kildaire Farm Road and Cary Parkway OCVs as fully open/fully closed valves. For the year 2009 MDD analysis, the control valves were kept fully open during the entire simulation to provide the maximum amount of flow to the SPZ.

It should also be noted that for the 2009 MDD simulation, the Town of Apex diurnal demand was considered similar to the hourly flows observed during the model calibration period of July 23-24, 2008. Review of the operation of the Green Level and Jenks control valves revealed that valve operation and flows were different during the same hours each day. For this reason, a composite diurnal demand for the Town of Apex was not utilized for the 2009 MDD simulation. Recommendations for further investigation of the Apex system are included in Appendix G.

#### 6.1.2.1 Extended Period Simulation (EPS) Results

As shown in Figure F2 (Appendix F), the hourly flow conveyed to the CPZ, SPZ, and Town of Apex during the year 2009 MDD simulation varied from 22-30 mgd. The simulated head of the Harrison and Field Street Elevated Tanks varied from 641-ft to 628-ft msl. However the Maynard and Ridgeview Elevated Tanks varied from 628-ft to 618-ft msl. This 10-foot lag in the southern CPZ tanks had a pronounced effect on the SPZ. As shown in Figure F3 (Appendix F), the Plumtree Way Elevated Tank showed signs of not recovering during the EPS model run even with the Kildaire Farm Road and Cary Parkway OCVs fully open during the entire simulation. This result indicates that the transmission mains that supply water to the SPZ are nearly reaching or potentially exceeding design capacity. This was readily apparent during the July 23-24 operation of the Kildaire Farm Road and Cary Parkway OCVs which were open for 22 out of 24 hours of the day.

To remedy the potential supply deficiency to the SPZ, an alternate operational strategy was simulated which included increasing the flow from the CPZ pumps such that the Harrison and Field Street Elevated Tanks were submerged as shown in Figure F4 (Appendix F). This strategy increased operating levels in the Maynard and Ridgeview Elevated Tanks by approximately 8 feet. This in turn increased flows to the SPZ which allowed the Plumtree Way Elevated Tank to recover as shown in Figure F5 (Appendix F). While this strategy may not be acceptable for a continued long-term operation, it would allow the Town to provide the necessary flows to the SPZ if high summer demands occurred prior to completing the planned 2009 trunk main improvements described further in Section 6.3.

As shown in Figure 6-1B, peak hour pressures over much of the CPZ and SPZ are greater than 50 psi which one exception along Penny Road in the SPZ where peak hour pressures
are 30-40 psi. The remainder of the CPZ and SPZ has peak hour pressures greater than 100 psi. However, peak hour velocities in several of the CPZ trunk mains along Holt Road, Jenks Carpenter Road, Collins Road, Waldo Rood Boulevard, and Cary Parkway are between 5-7 fps. Peak hour velocities of 5-7 fps are also found along segments of 12-inch main along Maynard Road and High House Road in the vicinity of Old Apex Road and in a 6-inch pipe segment along Old Apex Road at Maynard Road. As well, peak hour velocities between 4-6 fps are found along most of Southwest Cary Parkway. While these peak hour velocities do not exceed the maximum criteria of 10 fps shown in Table 5-1, these moderately high velocities along key trunk mains in the CPZ prevent the Ridgeview and Maynard Elevated Tanks from maintaining water levels that are similar to the Harrison and Field Street Elevated Tanks.

6.1.2.2 Automated Fire Flow Simulation Results

Using the computer model, a fire flow analysis was conducted on every hydrant in the Town of Cary system under existing MDD conditions. The resulting AFF at 20 psi residual pressure is shown in Figure 6-2. Commercial areas were reviewed to determine if a trunk main within the grouping of commercial parcels could achieve an AFF of 3,500 gpm. Areas not zoned as commercial were assumed to be residential which requires an AFF of 1,000 gpm. In both cases, the scope of this analysis focused on areas of fire flow adequacy and not individual parcels or facilities.

As shown in Figure 6-2, the AFF exceeded the design criteria described in Section 5 for a majority of the CPZ and SPZ: >1,000 gpm (residential) and >3,500 gpm (commercial).

Two commercial areas in the CPZ revealed marginal AFF results. The first commercial area is located between Highway 1 and 64. The AFF along the 12-inch transmission main through this area was greater than 3,500 gpm. The AFF along Gregson Drive and Team Hendricks Way was between 1,000 and 2,500 gpm due to smaller distribution main sizing. The fire flow requirement for these particular commercial buildings was not readily available or considered part of this Master Plan analysis, and thus a conclusive deficiency could not be identified. A second commercial area with marginal AFF results is the Crossroads area located between Highway 1 and Tryon Road. However, the AFF is slightly below 3,500 gpm. Since this area is nearly built out and considerable looping is already in place, no capital projects were considered in this area.

In the SPZ, the commercial parcel located north of Optimist Farm Road resulted in an AFF lower than 3,500 gpm. However, review of the parcel information indicated that the land is owned by the Town and is the location of Middle Creek High School. No improvements are recommended in the SPZ based on the fire flow analysis.
FIGURE 6-1A
Peak Hour Pressure and Pipe Velocity Modeling Results
(Existing Conditions - Davis Drive PRV Closed)
6.1.2.3 Automated Fire Flow Simulation Results

Using the computer model, a fire flow analysis was conducted on every hydrant in the Town of Cary system under existing MDD conditions. The resulting AFF at 20 psi residual pressure is shown in Figure 6-2. Commercial areas were reviewed to determine if a trunk main within the grouping of commercial parcels could achieve an AFF of 3,500 gpm. Areas not zoned as commercial were assumed to be residential which requires an AFF of 1,000 gpm. In both cases, the scope of this analysis focused on areas of fire flow adequacy and not individual parcels or facilities.

As shown in Figure 6-2, the AFF exceeded the design criteria described in Section 5 for a majority of the CPZ and SPZ: >1,000 gpm (residential) and >3,500 gpm (commercial).

Two commercial areas in the CPZ revealed marginal AFF results. The first commercial area is located between Highway 1 and 64. The AFF along the 12-inch transmission main through this area was greater than 3,500 gpm. The AFF along Gregson Drive and Team Hendricks Way was between 1,000 and 2,500 gpm due to smaller distribution main sizing. The fire flow requirement for these particular commercial buildings was not readily available or considered part of this Master Plan analysis, and thus a conclusive deficiency could not be identified. A second commercial area with marginal AFF results is the Crossroads area located between Highway 1 and Tryon Road. However, the AFF is slightly below 3,500 gpm. Since this area is nearly built out and considerable looping is already in place, no capital projects were considered in this area.

In the SPZ, the commercial parcel located north of Optimist Farm Road resulted in an AFF lower than 3,500 gpm. However, review of the parcel information indicated that the land is owned by the Town and is the location of Middle Creek High School. No improvements are recommended in the SPZ based on the fire flow analysis.

6.2 Future System – Pressure Zone Boundaries

As described in Section 5.2.2, the pressure zone boundaries and tank overflow elevations are well established based on the highest elevations in each pressure zone. However, some areas within the Town of Morrisville operate at excessively high pressures reaching 150 psi which can lead to increased water loss and main breaks over time.

As shown in Figure 6-3, one of the lowest elevation areas is located at the intersection of Church Street, Chapel Hill Road, and Aviation Parkway and is operated at reduced pressure. This Low Pressure Zone is supplied by the CPZ through one pressure reducing valve; however, information on the exact location was not available at the time of this report. The hydraulic gradient of the Low Pressure Zone is also unknown.

The Town recently conducted a study of the WPZ and CPZ boundaries as part of a Morrisville merger study1. This study evaluated the impact of lowering pressures in the Morrisville area and the corresponding impact to existing sprinkler systems. During the

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1 Future Pressure Zone Hydraulic Modeling, Hazen and Sawyer, 2006.
2006 merger study, the modeling analysis focused primarily on the resulting static pressure and the impact to existing sprinkler systems.

During this Master Plan study, the Town chose to evaluate the Morrisville pressure zone boundary issue from a different perspective. The primary goal of this analysis was to develop pressure zone boundary alternatives which focused more on providing industry standard capacity and pressure to the Morrisville area rather than satisfying existing sprinkler system design rates. With this approach adopted, the following three pressure zone boundary alternatives were developed for the WPZ and CPZ in the Morrisville and RDU Airport areas as shown in Figure 6-3:

- Alternative 1 – Small Expansion of Western 540 PZ
- Alternative 2 – Medium Expansion of Western 540 PZ
- Alternative 3 – Large Expansion of Western 540 PZ Plus New Airport 605 PZ

The three alternatives represent varying scales of expansion of the WPZ into the Morrisville and Raleigh-Durham (RDU) Airport areas. A description of Alternatives 1, 2, and 3 is provided in Sections 6.2.2-6.2.4. Modeling analysis was conducted for Alternative 3 only as it represented the largest and potentially most difficult boundary modification to implement.

The three alternatives were developed after reviewing the 2006 pressure zone boundary study and incorporating more recent information gathered during this Master Plan evaluation. A review of the 2006 study is provided in Section 6.2.1.
6.2.1 Summary of 2006 Pressure Zone Boundary Study

During the 2006 pressure zone boundary study by Hazen and Sawyer, three different pressure zone boundary alternatives were developed:

- Alternative A – Large expansion of WPZ into Morrisville corporate limits
- Alternative B – Creating an intermediate North Pressure Zone (NPZ) for Morrisville and RDU Airport
- Alternative C – Small expansion of WPZ into low elevations of Morrisville

Pressure Zone Boundary Alternatives Maps Courtesy of 2006 Hazen and Sawyer Study

Alternative A considered that the WPZ would be expanded to encompass the entire corporate limit of Morrisville. The modeling analysis indicated that 69% of sprinkler system would fail (151 of 219 total) due to lowering the system head by approximately 100 feet. Under this boundary configuration, the RDU Airport area was cut-off from the CPZ. For this reason, a 12-inch transmission main was proposed from Evans Road along Aviation Boulevard to the Lake Crabtree Master Meter location. However, this 12-inch transmission main would be the only supply to the RDU Airport. Considering the number of simulated sprinkler failures and the single supply to the RDU Airport, this alternative was not recommended.

Alternative B considered that a new intermediate 590 PZ would be created to encompass the entire corporate limit of Morrisville and the RDU Airport. This new intermediate zone would be supplied by the CPZ through PRVs at the Highway 54, Evans, and Weston Master Meters. The modeling analysis indicated that 16% of sprinkler systems would fail (35 of 219 total) due to lowering the system head by approximately 50 feet. While this alternative reduced the number of sprinkler system failures, the loss of energy through the proposed PRV stations is considerable over time. In addition, this alternative reduced the head available at the RDU Airport, an impact which was not considered during the 2006 study.
Alternative C considered a smaller expansion of the WPZ into the lowest elevations in Morrisville. The 2006 model simulation indicated that 16% of sprinkler systems would fail (36 of 219 total). Under this PZ boundary configuration, a new 16-inch transmission main was proposed from Evans Road along Aviation Boulevard to the Lake Crabtree Master Meter location as well as other small piping and PRV recommendations.

Alternative C was recommended during the 2006 study as the preferred alternative since it reduced pressures in the lowest elevations of Morrisville and it only negatively impacts a small number sprinkler systems. It should be noted that 13 of the simulated sprinkler failures were located in the CPZ part of Morrisville, which indicates that the modeling analysis conducted in 2006 may have lacked precision in some areas. For this reason it was estimated that approximately 23 sprinkler systems (36-13=23) would fail under the Alternative C boundary modification. Approximately 21 of the simulated sprinkler system failures occurred along Aviation Boulevard in the vicinity of Southport and Dominion Drive in a pocket of commercial facilities. If the Alternative C boundary were modified to exclude the commercial area at Southport and Dominion Drive, potentially only two sprinkler systems along Morrisville Carpenter Road at Morrisville Square Way would be compromised under a modified Alternative C boundary. The development of this modified pressure zone boundary is described further in Section 6.2.2.

6.2.2 Alternative 1 – Small Expansion of Western 540 PZ

Alternative 1 consists of relatively small expansion of the WPZ into the lowest elevations of Morrisville. The proposed expansion would encompass the existing low pressure zone as shown in Figure 6-3 but would be slightly smaller than the Alternative C boundary developed by Hazen and Sawyer during the 2006 study.

The WPZ expansion would include portions of Morrisville Carpenter Road, Morrisville Parkway, Town Hall Drive, Church Street, Chapel Hill Road, Aviation Boulevard, Green Drive, and Clements Drive. While the pressure zone boundary for Alternative 1 appears to encompass key 16-inch transmission mains along Aviation Boulevard and Chapel Hill Road, these mains can be configured to remain on the CPZ.

Due to the lack of specific information in GIS on the location of the PRVs, boundary valves, and connectivity of key CPZ transmission mains in the Low Pressure Zone area, a detailed investigation is recommended. At that time, the required boundary valves and necessary pipe jumpers could be identified. It is anticipated that the existing PRVs in this area will remain active and potentially be adjusted to open only during fire flow events. This would provide additional redundancy of supply from the CPZ to the expanded WPZ area. At the existing WPZ and CPZ boundary at Davis Drive, it is anticipated that two short piping connections would be required between the two existing 16-inch mains at Morrisville Carpenter Road and Morrisville Parkway. Potentially, the Morrisville Parkway water line project (WT1124) scheduled for 2009 could incorporate one of these two connections.

Elevations in the expanded area of Alternative 1 range from approximately 285-355 feet msl. On the CPZ at a gradient of 630-ft this equates to a pressure range of 150-120 psi. On the WPZ at a gradient of 530-ft, this equates to a more suitable pressure range of 105-75 psi. A specific hydraulic modeling analysis under the Alternative 1 boundaries was not conducted during this study. Based on the estimated static pressures and potential utilization of
existing PRVs which would allow the CPZ to supply this area, fire flow capacity is not a concern under Alternative 1.

6.2.3 Alternative 2 – Medium Expansion of Western 540 PZ

Alternative 2 consists of a larger WPZ expansion than Alternative 1 which would essentially encompass the entire area west of Highway 54 (Chapel Hill Road) as shown in Figure 6-3. More particularly, the proposed boundary would follow the railroad west of Highway 54 from Cary Parkway to the Durham County line with the exception of an existing development on Park Place Avenue which would remain connected to the CPZ at Chapel Hill Road.

Alternative 2 strategically divides Morrisville into two zones. The west side which is primarily residential zoning would be converted to the WPZ, while the east side which is primarily commercial zoning would remain on the CPZ. This alternative would not impact the larger commercial fire sprinkler systems and would keep all the primary 16-inch trunk mains along Highway 54, Aviation Boulevard, Evans Road, and Airport Boulevard on the CPZ. In concept, the CPZ supply to the commercial area of Morrisville and RDU Airport would remain unchanged.

Elevations in the Alternative 2 boundary area range from approximately 285-402 feet msl. On the CPZ at a gradient of 630-ft this equates to a pressure range of 150-100 psi. On the WPZ at a gradient of 530-ft, this equates to a more suitable pressure range of 105-55 psi. Only a few small residential lots near the Durham County line at Kit Creek Road near Church Street have elevations as high as 400-feet msl. Therefore, a majority of the expanded WPZ would have pressures in excess of 60 psi.

While a fire flow analysis was not specifically conducted for Alternative 2, the analysis conducted for Alternative 3 indicated that fire flows in this area would meet the design criteria while operating on the WPZ. However, simulated fire flows in the subdivision near the Durham County line north of NC-540 and west of Church Street were marginal in some areas, ranging from approximately 850 gpm to 1,900 gpm across the subdivision. While a detailed analysis may show this area can sustain adequate fire flow while on the WPZ, a proposed 12 or 16-inch main along Kit Creek Road and the NC-540 off-ramp shown in Figure 6-3 will provide fire flows well in excess of design criteria and provide operational redundancy to this portion of the proposed WPZ.

6.2.4 Alternative 3 – Large Expansion of Western 540 PZ Plus New Airport 605 PZ

Alternative 3 consists of a large expansion of the WPZ to encompass all of the Morrisville and RDU Airport areas as shown in Figure 6-3. While these areas would be supplied by the Western 540 PZ, Alternative 3 considers that the RDU Airport and surrounding area would need to be on a higher PZ, established at 605-ft for the scope of this analysis.

High elevations found at the RDU Airport and at the intersection of NC-540 and Pleasant Grove Church Road would require a separate higher pressure zone to provide adequate service. Adequate service means that the existing operating hydraulic grade line of 605-ft measured near the RDU Airport area is assumed to currently be adequate for this customer and if the Town lowered this area to the 540-ft pressure zone it would likely compromise
existing sprinkler systems for the RDU Airport and those high elevation customers along Pleasant Grove Church Road. Based on the field testing described in Section 4.3.2.3, the hydraulic grade line at the RDU Airport was measured at 605-feet during the middle of May 2008. Similarly the Raleigh water system north of the RDU Airport is a 605-ft pressure zone. Review of the piping configuration in the Raleigh-Durham-Cary water distribution model and record drawings indicate that the RDU Airport may also be connected to the Raleigh 605 pressure zone. For these reason, a conceptual Western 605 PZ is proposed as part of Alternative 3 which would encompass the RDU Airport and the Pleasant Grove Church Road corridor.

The proposed Airport 605 PZ would be supplied by a booster pump station and would not include elevated storage due to the relatively small size of the zone, Federal Aviation Administration (FAA) facility height restrictions, and the potential interconnects to the Raleigh system that could serve as back-up or emergency supply to the conceptual 605 PZ. Based on a cursory review of the Raleigh-Durham-Cary water distribution model, interconnections with the Raleigh 605 PZ appear to also be located at Pleasant Grove Church Road and Globe Road. Due to the lack of elevated storage, the booster pump station would require back-up power capabilities. The booster pump station could be located adjacent to the RDU Airport Master Meter location. In order to keep the Aviation Boulevard and Airport Boulevard as a 16-inch looped system on the Western 540 PZ, a new 16-inch transmission main would be required from the booster station to Pleasant Grove Church Road as shown in Figure 6-3.

An EPS modeling analysis and automated fire flow modeling analysis was conducted on each hydrant node in the Morrisville system under Alternative 3 for build-out MDD conditions. The proposed RDU Airport 605 PZ was not specifically included in the modeling analysis as the system head could be increased as needed during detailed design to satisfy specific fire flow requirements. As shown in Figure 6-3, peak hour pressures ranged from 50 psi to 110 psi in the expanded Western 540 PZ with a large majority of the area above 60 psi. The fire flow analysis indicated that commercial and residential areas satisfy design criteria with a potential exception along Kit Creek Road as described in Section 6.2.3.

6.2.5 Pressure Zone Boundary Conclusions

While Alternative 3 satisfies peak hour pressure and fire flow design requirements for the proposed Western 540 PZ expansion area, a large number of high flow sprinkler systems could be compromised as indicated by the 2006 Hazen and Sawyer study (approximately 151 of 219). Buildings with fire sprinkler systems may require piping modifications or installation of fire pumps to satisfy required fire flows under the lower water system pressures attributed to Alternative 3.

In order to determine the relative magnitude of sprinkler system improvements that could be required under Alternative 3, the sprinkler systems that failed to meet the fire flow design requirements during the 2006 model simulations are shown in Figure 6-3 and categorized based on required fire flow in gallons per minute. Almost all of the failed sprinkler systems east of Chapel Hill Road have sprinkler design rates in excess of 150 gpm, while half in this area are greater than 800 gpm, with the high range of 1,650 gpm. Presumably, most of these commercial facilities do not have fire pumps due to the very high
system pressures that were available at the time of construction. Installing fire pumps at these sites could require significant capital expenditure for the commercial customers in this area if converted to the WPZ. In addition, the capital and operational expense of a new booster pump station at the RDU Airport is significant.

Therefore, based on this analysis, it is recommended that the Town consider implementing Alternative 1 and 2 in phases. Alternative 1 could be implemented in the near-term after conducting a detailed design study and completing several small scale capital projects. After successfully completing Alternative 1, the Town could implement Alternative 2 possibly by the 2015 time frame. This schedule would provide the Town with time to conduct the detailed design studies and to complete the necessary capital projects and address potential compromised sprinkler systems in the expanded WPZ boundary.

### 6.3 Future System – Transmission Mains

Transmission mains are defined as the key supply mains from the Cary/Apex WTP HSPS to the WPZ and CPZs.

The existing WPZ 30-inch transmission main runs east from the HSPS along Wimberly Road and Jenks Road until it reaches NC-55 where it runs north until reaching NC-55/High House Road where it decreases to a 24-inch main and continues north until reaching NC-55/Green Hope School Road where it decreases to a 20-inch main and continues north to the Carpenter Elevated Tank near Morrisville Parkway and Carpenter Upchurch Road.

The existing CPZ 42-inch transmission main runs east from the HSPS along Wimberly Road and Jenks Road until it reaches NC-55 where it reduces down to a 36-inch main and continues east along Holt Road until reaching Jenks Carpenter Road where it runs north until reaching Collins Road where it runs east until reaching Davis Drive where it decreases to a 30-inch main and continues east along Waldo Rood Boulevard until reaching Cary Parkway where 20-inch mains run both north and south into the CPZ.

Future transmission mains for the WPZ and CPZ were sized and located during the 2000 Master Plan study. For this Master Plan, the previous recommendations were re-evaluated using the updated 2010, 2015, 2025, and build-out demand projections. The following three general conceptual design strategies were employed:

- Increase supply to the southern region of the CPZ (as described in Section 6.1.2, the existing transmission main system does not provide adequate flow for the Ridgeview and Maynard Elevated Tanks to recover during peak demand conditions).
- Create relatively flat system curves for the WPZ and CPZs in order to maximum capacity at the HSPS
- Provide transmission main redundancy

Strategies for increasing transmission main capacity in the WPZ and CPZs are described below. Proposed transmission main improvements are shown in Figure 6-4 and are recommended based on year 2010 and build-out MDD projections.
6.3.1 Central PZ Transmission Mains

Based on the hydraulic modeling analysis, the existing 42-inch transmission main that supplies the CPZ, SPZ and the Town of Apex is adequate to supply build-out MDD. However, modeling analysis revealed that head loss was excessive in the 36-inch main along Holt Road and Jenks Carpenter Road and the 30-inch main along Waldo Road. Rather than run parallel mains along this same route to Cary Parkway, it is recommended to construct a 24-inch main to the south along Holt Road, Howell Road, Farm Pond Road, and West High Street as shown in Figure 6-4. This alignment strategically conveys more water to the southern portion of the CPZ and SPZ where capacity is limited. In addition, the hydraulic modeling analysis revealed high head losses in an existing 20-inch main along Cary Parkway in the vicinity of Old Apex Road. For this reason, a parallel 20-inch main is recommended. Each of the above transmission main improvements is recommended to satisfy projected 2010 demand conditions and is sized based on build-out demand conditions.

6.3.2 Western PZ Transmission Mains

Based on the hydraulic modeling analysis, the existing 30-inch transmission main that supplies the WPZ is not adequate to supply build-out MDD. However, redundancy is required in the zone by the 2010 time frame due to the proposed I-540 highway construction project which will potentially isolate the western part of the WPZ as shown in Figure 6-4. During the 2000 Master Plan a second transmission main was proposed from the HSPS to the western side of the zone along Wimberly Road and Green Level West Road. Acceleration of this 24-inch transmission main by the 2010 time frame will provide redundancy in the zone to better facilitate the I-540 highway construction project and delay the need for an additional storage tank in the WPZ. At the intersection of Green Level Church Road and Green Level West Road, the 24-inch transmission main will reduce down to a 20-inch transmission main and connect to the existing 16-inch transmission main that was recently constructed on Green Level Church Road. Also, by build-out conditions it is anticipated that a new 16-inch transmission main parallel to the existing 16-inch main on Green Level Church Road will be required.
FIGURE 6-4
Proposed Transmission Main System By 2010 (WPZ and CPZ)

Legend:
Existing TM
Proposed TM
Proposed I-540 Corridor
6.4 Future System – High Service Pump Station

6.4.1 Assumptions

The hydraulic modeling analysis of the Cary/Apex WTP HSPS was conducted in conjunction with the transmission main design. A master plan for the HSPS was developed based on the following factors: projected MDD, hydraulic effects of the proposed transmission main improvements described in Section 6.3, capacity and head of existing pumps, and available empty slots at the station.

At the time of this study, it was not known whether or not flows in excess of MDD are required for the Apex system. During the future detailed design of the HSPS, this information can be determined as well as the any operational or emergency pumping criteria for the Town of Cary system which may require flows in excess of MDD.

In addition to capacity requirements described above, the proposed 2010 transmission main improvements would impact the operating point of existing and future pumps. This Master Plan analysis did not account for whether or not pumps operate at or near the best efficiency point (BEP). Detailed design efforts conducted in the future should evaluate the adequacy of existing and future pump selections based on the proposed transmission main improvements.

6.4.2 Station Pump and System Curves

The HSPS CPZ pumps provide flow to the CPZ, SPZ, and to the Town of Apex. The WPZ pumps only supply the WPZ. The HSPS currently has nine pumps in service with the following design capacities: two small CPZ pumps (4 mgd at 450 ft-Total Dynamic Head (TDH)), three large CPZ pumps (9 mgd at 450 ft-TDH), two WPZ pumps (5.5 mgd at 305 ft-TDH), and two backwash pumps (capacity unknown). There are three empty slots remaining in the station. The Cary/Apex HSPS has a total and firm estimated capacity of 41 mgd and 37 mgd, respectively, based on a modeling analysis of existing conditions. For this analysis, firm capacity was assumed to be the total flow with one large CPZ pump out of service.

Utilizing the hydraulic model, system curves were developed for both the CPZ and WPZ with and without the transmission main improvements described in Section 6.3. As shown in Figure 6-5, the simulated system curves were plotted with combined pump curves to determine the number and capacity of pumps required to satisfy projected MDD. The projected WPZ demands and the combination of CPZ, SPZ, and Town of Apex demands are represented as vertical dashed lines in Figure 6-5.

The pump combinations and corresponding total capacities represented in Figure 6-5 are slightly greater than MDD. The exact pump combinations and timing used in the EPS computer modeling analysis may differ slightly as described in Section 6.5.

The proposed combination of WPZ pumps required to satisfy planning year flow projections is as follows:

- Year 2007 MDD – 1 existing pump (5.5 mgd at 305-ft TDH)
• Year 2010 MDD – 2 existing pumps (5.5 mgd at 305-ft TDH each)
• Year 2015, 2025, and Build-Out MDD – 2 existing and 1 new pump (5.5 mgd at 305-ft TDH each)

The proposed combination of CPZ pumps required to satisfy planning year flow projections is as follows:

• Year 2007 and 2010 MDD – 3 existing large pumps (9.0 mgd at 450-ft TDH)
• Year 2015 MDD – 3 existing large and 1 existing small pump (9.0 and 5.5 mgd respectively at 450-ft TDH)
• Year 2025 MDD – 3 existing large and 2 existing small pumps (9.0 and 5.5 mgd respectively at 450-ft TDH)
• Build-Out MDD – 5 new extra-large pumps (10.0 mgd at 485-ft TDH)

**FIGURE 6-5**
Cary / Apex WTP High Service Pump Station Pump and System Curves

6.4.3 Station Configuration and Proposed Flows
The existing HSPS configuration is sufficient for build-out MDD flows. Figure 6-6 provides a matrix of pump information for each of the defined planning periods including: projected MDD, required pumped flows, and pump status which is color coded as green for “pump on”, red for “pump off”, and white for “empty slot”. As described in Section 6.3, several transmission main improvements are recommended by the 2010 time frame. Figure 6-5 accounts for these improvements by listing the required pumped flows for 2010 conditions with and without the transmission main improvements. In addition, a schematic layout is

TOWN OF CARY WATER DISTRIBUTION SYSTEM MASTER PLAN 6-19
provided as a master plan for the HSPS and is color coded as follows: small CPZ pumps (blue), large CPZ pumps (aqua), and the WPZ pumps (magenta).

The Town recently conducted a study of the HSPS which concluded that one large CPZ pump and one WPZ pump should be installed in the near term to satisfy demand projections. The “swing slot” refers to this slot originally being included for either a future WPZ or CPZ pump. As shown in Figure 6-6, the new CPZ pumps would be installed in “swing slot” #8F, and the new WPZ pump would be installed in empty slot #9F. Detailed design for these pump installations was ongoing during the course of this Master Plan study. It is anticipated that pumps #8F and 9F will be operational by 2010.

After the new CPZ pump #8F and WPZ pump #9F are operational in 2010, design modifications are not anticipated until year 2025. At that time, a fourth WPZ 5.5 mgd pump would be installed in slot #10F. At that time all empty slots would be filled. At build-out, all of the CPZ pumps would be replaced with 10.0 mgd pumps for a firm and total CPZ pump capacity of approximately 50 mgd and 60 mgd, respectively, and a firm and total WPZ pump capacity of approximately 13 mgd and 18 mgd, respectively. At that time, the HSPS would be built out and have firm capacity to satisfy build-out MDD.

**FIGURE 6-6**
Cary / Apex WTP High Service Pump Station Proposed Flows and Configuration

<table>
<thead>
<tr>
<th>Demand Projections</th>
<th>Prior to 7M Improvements</th>
<th>With Transmission Main Improvements Completed</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2007</td>
<td>2010</td>
</tr>
<tr>
<td>Apex Maximum Day Demand</td>
<td>4.8</td>
<td>5.8</td>
</tr>
<tr>
<td>CPZ Maximum Day Demand</td>
<td>15.53</td>
<td>18.13</td>
</tr>
<tr>
<td>WPZ Maximum Day Demand</td>
<td>3.39</td>
<td>3.98</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Pump #</th>
<th>Design (MGD)</th>
<th>Design (TDW)</th>
<th>Status</th>
<th>Status</th>
<th>Status</th>
<th>Status</th>
<th>Status</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>4 / 2</td>
<td>450</td>
<td>SMALL</td>
<td>SMALL</td>
<td>SMALL</td>
<td>SMALL</td>
<td>SMALL</td>
<td>SMALL</td>
</tr>
<tr>
<td>4</td>
<td>4 / 3</td>
<td>450</td>
<td>SMALL</td>
<td>SMALL</td>
<td>SMALL</td>
<td>SMALL</td>
<td>SMALL</td>
<td>SMALL</td>
</tr>
<tr>
<td>5</td>
<td>9 / 10</td>
<td>450</td>
<td>LARGE</td>
<td>LARGE</td>
<td>LARGE</td>
<td>LARGE</td>
<td>LARGE</td>
<td>LARGE</td>
</tr>
<tr>
<td>6</td>
<td>9 / 10</td>
<td>450</td>
<td>LARGE</td>
<td>LARGE</td>
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</tr>
<tr>
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<tr>
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<td>LARGE</td>
<td>LARGE</td>
</tr>
</tbody>
</table>

Operating point of on-line pumps (B):
- Additional capacity of on-line pumps (C+B-A): 2.3
- Required Flow From WPZ Pumps (D): 5.12

2 Technical Memorandum #3, Finished Water Pump Station Evaluation, HDR Engineering Inc., 2008
6.5 Future System – Piping, Storage Tanks, Control Valves

This section describes the hydraulic modeling analysis conducted for each of the planning years to illustrate that the Town of Cary system will adequately satisfy projected MDD, peak hour demand (PHD), and MDD + fire flow (FF) water demands. This section focuses primarily on the necessary piping, storage tanks, and control valves with some discussion of the proposed pumps at the HSPS described in Section 6.4.

For each of the defined planning periods (2010, 2015, 2025, and build-out), an EPS hydraulic modeling analysis was conducted for MDD and PHD. For the build-out scenario, MDD, PHD, and MDD + FF were analyzed. Simulated tank head and HSPS flow variations are provided in Figures F6 through F17 in Appendix F for each of the planning year MDD simulations.

Figure 6-7 displays a map of the existing water system showing the recommended capital improvement program (CIP) projects for each planning period. Each recommended project is described in detail in Section 7.

A map showing peak hour pipe velocities and pressures for build-out MDD conditions is provided in Figure 6-8. A map showing the available fire flow at 20 psi residual pressure for build-out MDD conditions is provided in Figure 6-9.

The existing pressure zone boundaries were utilized for completion of all modeling analyses including the build-out simulation. Due to potential pressure zone modification as described in Section 6.2, some recommended pipelines may need to be upsized or expedited based on a future detailed pressure zone study.

For the EPS simulations, the diurnal demand patterns described in Section 4 were utilized for the Town of Cary system. However, a diurnal demand pattern was not applied to the Town of Apex demand points in the model (Green Level and Jenks master meters) and the analysis was based on the assumption that the Town of Apex storage tanks can adequately provide equalization flows during MDD. Recommendations for further investigation of the Apex system are included in Appendix G.

6.5.1 Project Numbering and Categories

Each recommended project was given a tracking number (i.e. WPZ-x, CPZ-x, or SPZ-x) based on the pressure zone in which the project is located. The tracking number does not indicate the timing or priority of the project but is merely used for tracking purposes. For example, the first project in the WPZ is called “WPZ-1”. The project number may also coincide with Capital Improvement Budget “CIB” or “Assigned” project number established by the Town (i.e. WTxxxx). Both project numbers are provided in Table 7-1 in Section 7 of this report.

Water distribution modeling and master planning studies are typically conducted about every five to ten years. Numerous recommendations result from these studies, and over time the purpose for the recommended project can be lost or changes in demand to a local service area may negate the need for previously recommended projects or require new ones.
With this in mind, each project recommended during this study was categorized based on the purpose of the project as follows:

- **1 - Hydraulic**: This category designates that the recommended project is hydraulically necessary to satisfy varying criteria detailed in Table 5-1, such as maintaining adequate flows and pressures in the system.

- **2 - Water Quality**: This category designates that the recommended project has anticipated benefits associated with water quality, such as removal of dead-end piping by forming loops in the system. This category is not hydraulically necessary to satisfy flow and pressure criteria. For this reason, the pipe was closed in the computer model even for the build-out scenario.

- **3 - Planned or Anticipated Local Service**: This category describes those recommended projects that are in progress or anticipated to meet the water needs of new service areas, such as new subdivision and new commercial parks. This project category is not hydraulically necessary to satisfy flow and pressure criteria from a system perspective, but will be necessary for local service demands. While a pipe diameter is provided in Figure 6-7, the Town may choose to increase or decrease the diameter based on site specific flow and pressure requirements. This category piping was also closed in the computer model even for the build-out scenario.

In addition to the project categories described above, the Town tracks ongoing developer projects designated as “proposed” in the Town’s water system geodatabase. These projects were not a CIB or Assigned capital project. For this reason, these projects are shown as “developer undesignated” for the existing system, and as “not designated” for proposed projects in Figure 6-7.

### 6.5.2 Year 2010 Simulation Results

The EPS modeling results for 2010 MDD conditions (with improvements) are provided as Figures F6 through F8 (Appendix F).

#### 6.5.2.1 Western PZ (Year 2010)

As described in Section 6.4, a third WPZ pump is currently under design and will be operational by the 2010 time frame. As well, a 24-inch new transmission main is proposed from the HSPS to Green Level Church Road by the same period. As shown in Figure F6 (Appendix F), the WPZ pump flows were varied from 6.5 mgd to 12 mgd by operating one pump the entire day and bringing on the second pump as needed to refill the Carpenter Elevated Tank which varied from 539-ft to 520-ft msl. The Davis Drive PRV and BPS were off-line during the simulation.

#### 6.5.2.2 Central PZ (Year 2010)

As shown in Figure F7 (Appendix F), the CPZ pump flows were varied from 22 mgd to 30 mgd by running two large pumps the entire day and bringing a third large pump on-line as needed to maintain adequate levels in the CPZ tanks. The Old Apex BPS was not utilized during the simulation. The CPZ tank levels varied from 624-ft to 641-ft msl. The transmission main improvements described in Section 6.4 improve the levels in the Ridgeview and Maynard Elevated Tanks to better match the Harrison and Field Street
Elevated Tanks. However, levels were approximately 10 feet lower than Harrison and Field Street during the morning hours due to high peak hour demands in the SPZ but were within acceptable ranges.

### 6.5.2.3 Southern PZ (Year 2010)

At Highway 1, a proposed third connection and control valve improved supply to the SPZ such that the Plumtree Way Elevated Tank easily recovered during the MDD simulation as shown in Figure F8 (Appendix F). Levels in the tank varied from 574-ft to 595-ft msl by operating the proposed Highway 1, Kildaire Farm Road, and Cary Parkway control valves as OCVs which were closed for 6 hours each day of the simulation. Potentially, the proposed Highway 1 control valve could be designed as a flow control valve as it is the strongest of the three connections, and the Kildaire Farm Road and Cary Parkway OCVs could be used to supply peak demands in the SPZ by continuing to operate as OCVs. In addition, a third pipeline proposed within the SPZ along Holly Springs Road increased supply to the Plumtree Way Elevated Tank and provides redundancy within the zone.

No elevated tanks are recommended by the 2010 time frame.

### 6.5.3 Year 2015 Simulation Results

The EPS modeling results for 2015 MDD conditions with improvements are provided as Figures F9 through F11 (Appendix F).

#### 6.5.3.1 Western PZ (Year 2015)

As shown in Figure F9 (Appendix F), two WPZ pumps were on-line for most of the day at 12 mgd and for a few hours one pump was on-line at 6.5 mgd. In order to satisfy projected 2015 demands, a second elevated tank is recommended in the WPZ. In the hydraulic model, this 2 MG elevated tank was located north of the Carpenter Elevated Tank near the intersection of I-540 and NC-55. The Carpenter Elevated Tank and proposed I-540 Elevated Tank levels varied from 539-ft to 522-ft msl during the model simulation with the Davis Drive PRV and BPS off-line. In addition, several small transmission main projects are recommended: 12-inch along Green Level West Road (WPZ-23), 12-inch along Roberts Road (WPZ-22), short section of 12-inch along Cary-to-Durham Road (WPZ-11), and a short section of 16-inch along Carpenter Fire Station Road (WPZ-16). As described in Section 6.2, the Town may consider expanding the Western PZ into Morrisville by the 2015 time frame. This expansion may require up sizing WPZ-23 to a larger diameter to increase supply into the zone. As well, a proposed parallel 16-inch main along Green Level West Road (WPZ-19) may need to be constructed by 2015 instead of at build-out. Also, WPZ-13 (undesignated year) may need to be constructed as part of a WPZ expansion. However, as part of a future detailed WPZ expansion study, the Town may choose to rely on the Davis Drive PRV during 2015 MDD conditions, which may counteract the need to upsize and expedite capital projects WPZ-13, 19, 22, and 23. In the event that the Town does not expand the WPZ boundary by 2015, projects WPZ-22 and WPZ-23 could potentially be delayed until 2025 if the Town chooses to rely on the Davis Drive PRV during 2015 MDD conditions.
6.5.3.2 Central PZ (Year 2015)
As shown in Figure F10 (Appendix F), the CPZ pump flows were varied from 30 mgd to 32 mgd by running three large pumps for most of the day. The Old Apex BPS was utilized by filling the tank for 12-hours and pumping for 12 hours utilizing 2 MG over a 24-hour period. All of the CPZ Elevated Tanks operated at similar levels during the entire simulation from 621-ft to 640-ft msl. This is due in part to a proposed 16-inch parallel transmission main along Old Apex Road (CPZ-5), 12-inch and 16-inch transmission main segments along Maynard Road loop from High House Road to the Maynard Road Elevated Tank (CPZ-6, 16, 18), a 16-inch parallel transmission main along Kildaire Farm Road from Maynard Road to the Ridgeview Elevated Tank (CPZ-13, 16), and a 16-inch parallel transmission main along Cary Parkway from Old Apex Road to Lake Pine Drive (CPZ-12).

During the simulation, the Old Apex BPS operated close to pump run-out conditions due to the proposed 16-inch main. It is recommended that the Old Apex BPS be evaluated during detailed design of CPZ-5 to determine if pumps should be modified or replaced to operate on a better portion of the pump curve and to determine the “usable” volume of the ground storage tank.

6.5.3.3 Southern PZ (Year 2015)
As shown in Figure F11(Appendix F), levels in the Plumtree Way Elevated Tank varied from 595-ft to 579-ft msl by operating the proposed Highway 1, Kildaire Farm Road, and Cary Parkway OCVs in a similar manner as the 2010 simulation described above. No pipeline improvements are recommended in the SPZ for the planning year 2015.

6.5.4 Year 2025 Simulation Results
The EPS modeling results for 2025 MDD conditions with improvements are provided in Figures F12 through F14 (Appendix F).

6.5.4.1 Western PZ (Year 2025)
As shown in Figure F12 (Appendix F), two WPZ pumps were on-line for most of the day at 12 mgd and for a few hours in the morning three pumps were on-line at 17 mgd. The Davis Drive PRV and BPS were off-line during the simulation. The Carpenter and proposed I-540 Elevated Tank levels varied from 539-ft to 522-ft msl during the model simulation. The proposed I-540 Elevated Tank generally lagged Carpenter levels by 5-feet but was within acceptable limits. In order to have a firm pumping capacity of 17 mgd, a fourth and final WPZ pump is recommended by year 2025. No pipeline or tank improvements are recommended in the WPZ for the year 2025.

6.5.4.2 Central PZ (Year 2025)
As shown in Figure F13 (Appendix F), the CPZ pump flows were varied from 30 mgd to 33 mgd by running three large pumps for most of the day. The Old Apex BPS was utilized by filling the tank for 12-hours and pumping for 12 hours utilizing 2 MG over a 24-hour period. All of the CPZ Elevated Tanks operated at similar levels during the entire simulation from 641-ft to 622-ft msl. No pipeline or tank improvements are recommended in the CPZ for the year 2025.
6.5.4.3 Southern PZ (Year 2025)

As shown in Figure F11 (Appendix F), levels in the Plumtree Way Elevated Tank varied from 595-ft to 574-ft msl by operating the proposed Highway 1, Kildaire Farm Road, and Cary Parkway OCVs slightly longer than the Year 2010 and Year 2015 simulations described above. Completion of the 16-inch transmission main along Ten Ten Road is recommended (SPZ-9). A small section of 12-inch transmission main is recommended at Lockmere Drive (SPZ-8) parallel to an existing 8-inch distribution main per the Town’s GIS. If the existing 8-inch distribution main in the GIS is actually a 12-inch transmission main, SPZ-8 may not be required. No tank improvements are recommended in the SPZ for the year 2025.

6.5.5 Build-out Simulation Results

Model simulation results of peak hour pressures and pipe velocities under build-out MDD conditions (with improvements) are shown in Figure 6-9. The EPS modeling results for build-out MDD conditions with improvements are provided in Figures F15 through F17 (Appendix F).

Simulated peak hour pressures were above 50 psi for a majority of the Town of Cary system. A few high elevation areas resulted in pressures between 40-50 psi: Louis Stevens Road corridor in the WPZ, a few small areas north of Walnut Street inside the Maynard Road loop in the CPZ, and the area west of the Plumtree Way Elevated Tank in the SPZ. Two very small high elevation areas resulted in pressures of 30-40 psi slightly above the 30 psi peak hour pressure criteria: High House Road corridor in the WPZ and at Penny Road in the SPZ. As described in Section 6.2, low elevation areas in the Morrisville area result in pressures approaching 150 psi under the existing pressure zone boundaries.

Simulated peak hour pipe velocities were predominately below 3 fps for a majority of the Town’s system. A few transmission mains had velocities between 3 and 7 fps, but none exceeded the maximum criteria of 10 fps.

A fire flow analysis was conducted on every hydrant in the Town of Cary system under build-out MDD conditions (with improvements) using the computer model. The resulting AFF at 20 psi residual pressure are shown in Figure 6-9. Commercial areas were reviewed to determine if a transmission main within the grouping of commercial parcels could achieve an AFF of 3,500 gpm. Areas not zoned as commercial were assumed to be residential which requires an AFF of 1,000 gpm. In both cases, the scope of this analysis focused on areas of fire flow adequacy and not individual parcels or facilities. No global fire flow deficiencies were found, and for this reason no capital projects were recommended strictly to improve fire flow.

6.5.5.1 Western PZ (Build-out)

As shown in Figure F15 (Appendix F), three WPZ pumps were on-line for most of the day at 18 mgd, and for a few hours in the afternoon two pumps were on-line at 12 mgd. The Davis Drive BPS was off-line during the simulation, but the Davis Drive PRV was utilized for 4 hours during the morning at the current pressure setting resulting in a flow of approximately 3.5 mgd. The Carpenter and proposed I-540 Elevated Tank levels varied from 539-ft to 518-ft msl during the model simulation. The proposed I-540 Elevated Tank generally lagged Carpenter levels by 6-feet but was within acceptable limits. Several
transmission main projects are recommended: 12-inch along White Oak Church Road (WPZ-18) and a parallel 16-inch to an existing 16-inch on Green Level Church Road (WPZ-19). No tank improvements are recommended in the WPZ at build-out.

6.5.5.2 Central PZ (Build-out)

As shown in Figure F16 (Appendix F), the CPZ pump flows were set at approximately 50 mgd. To achieve this target flow, it is recommended that all of the CPZ pumps be replaced with 10.0 mgd pumps so that all the CPZ pumps are the same capacity. For the build-out simulation, the Old Apex BPS was utilized by filling the tank for 12-hours and pumping for 12 hours utilizing 2 MG over a 24-hour period. All of the CPZ Elevated Tanks operated at similar levels during the entire simulation from approximately 640-ft to 620-ft msl. No pipeline or tank improvements are recommended in the CPZ at build-out excluding the replacement of Maynard and Harrison tanks.

6.5.5.3 Southern PZ (Build-out)

A second elevated tank is recommended in the SPZ by build-out. In the hydraulic model, this 1 MG elevated tank was located at the intersection of Ten Ten Road and Holly Springs Road as proposed in the previous 2000 Water Master Plan.

As shown in Figure F17 (Appendix F), levels in the Plumtree Way Elevated Tank and the proposed Holly Springs Elevated Tank varied from 595-ft to 576-ft msl by operating the following OCVs for the entire day: proposed Highway 1, proposed Holly Springs, existing Kildaire Farm Road, and existing Cary Parkway. No pipeline or tank improvements are recommended in the SPZ at build-out.