

8.0 WATER DISTRIBUTION/TREATMENT SYSTEM ALTERNATIVES

8.1 Finished Water Storage & Distribution Alternatives

The volume of required finished water storage within Spotsylvania County and City of Fredericksburg water distribution systems was determined using several design criteria as described in Section 7. Storage volume was calculated by individual pressure zone, to assure its uniform placement throughout an entire service area. Finished water storage facilities were sized and located based on desired minimum zone operating pressure, ground elevations, hydraulic connectivity, water quality, availability of land, and cost. Distribution alternatives were developed and located based on several different criteria, such as velocity, pressure, fire flow, and demand, as discussed in Section 7. The discussion below summarizes future water storage and distribution project alternatives within each of Spotsylvania County's five pressure zones.

8.1.1 Thornburg Development District

Based on the Spotsylvania County 2000 Comprehensive Plan, the area along Route 1, south of the primary settlement area, was defined as the Thornburg Development District. This area is currently served by approximately 25,200 feet of 12-inch water main and a 250,000 gallon elevated storage tank. Water demand in this area has been projected to expand from 0.11 mgd (1999) to over 5.75 mgd average day demand under build-out conditions. Included in the build-out condition is an undesignated 3-mgd industrial demand. This demand, included in water and wastewater projections, would allow Spotsylvania County to actively recruit large commercial or industrial enterprises. The current distribution system does not have adequate capacity to meet these demands. Four alternatives were developed and analyzed to meet the hydraulic conditions of the build-out demand. The alternatives used a phased development approach, Phase 1 being at the start of the project and Phase 2 and 3 in the future to meet future demand needs. All of the options were predicated on the construction of transmission mains to provide water to the intersection of Route 608 (Massaponax Church Road) and Route 1.

Alternative 1 – Phase 1 includes construction of a 36-inch main along the Route 1 corridor (from Route 608 to the existing Thornburg storage tank on Mudd Tavern Road), and a 1-mg Thornburg industrial elevated storage tank (sited according to demands). Phase 2 includes an additional 1-mg Thornburg storage tank (sited according to demands) to be built in approximately 30 years.

Alternative 2 – All Phase 1 including construction of a 36-inch main along the Route 1 corridor (from Route 608 to the existing Thornburg storage tank on Mudd Tavern Road), and a 2-mg Thornburg storage tank (sited according to demands).

Alternative 3 – All Phase 1 including construction of a 36-inch main along the Route 1 corridor (from Route 608 to the existing Thornburg storage tank on Mudd Tavern Road), a 1-mg Thornburg industrial elevated storage tank (sited according to demands), and an additional 1-mg Thornburg storage tank (sited according to demands).

Alternative 4 – Phase 1 includes construction of a 24-inch main along the Route 1 corridor (from Route 608 to the existing Thornburg storage tank on Mudd Tavern Road), a 1-mg Thornburg

industrial elevated storage tank (sited according to demands). Phase 2 includes an additional 1-mg Thornburg storage tank (sited according to demands) to be built in approximately 30 years, and Phase 3 includes a 6.5 mgd pump station (located at the intersection of Route 608 and Route 1) to be built in approximately 40 years.

The costs for the four alternatives, as shown in Table 8.1, were developed based on a 60-year life-cycle, with the construction of a 1-mg storage tank in approximately 2030 for alternatives 1 and 4, and construction of a 6.5-mgd pump station in approximately 2040 in alternative 4. Capital costs were established for the tanks, pipelines, and pump station in each alternative, and all future projects used the current capital cost with a 4% inflation rate and an 8% interest rate. For operating and maintenance costs, it was assumed that the tanks would be painted every 15 years, and that the pump station would have electrical costs over a period of 20 years. All costs are in 2000 dollars, and include 40% O&P, 15% contingency, and 10% engineering. All options are predicated on the construction of a transmission main to deliver water to the intersection of Route 608 (Massaponax Church Road) and Route 1.

Table 8.1 – Capital Costs For Thornburg Development District Water Distribution Alternatives

Alternative	Capital Cost
1	\$14,660,000
2	\$15,340,000
3	\$16,500,000
4	\$10,440,000

As shown in the table, Alternative 4 is most cost effective, and accordingly the following recommended capital improvement projects were developed based on this alternative. Projects 1 through 4 are located in the Thornburg Development District, which is within the Battlefield Zone. Refer to Figure 7.

Project 1: Thornburg Industrial 1-MG Tank

Construct a 1-mg Thornburg industrial elevated storage tank to meet the operational and fire flow requirements of the undesignated 3-mgd industrial demand, which represents a large commercial or industrial enterprise. The tank site location is dependent on the location of the industrial demands, and the availability of real estate. For modeling purposes, the tank was located near the existing Thornburg storage tank (Mudd Tavern Road). Estimated capital cost for this project is \$2,370,000.

Figure 7 - Battlefield Zone

Project 2: 24-Inch Main Thornburg

Construct approximately 25,200 feet of 24-inch water main to parallel the existing 12-inch main along the Highway 1 corridor from Route 608 (Massaponax Church Road) south to the existing Thornburg storage tank off Mudd Tavern Road. Estimated capital cost for this project is approximately \$7,030,000.

Project 3: Thornburg 1-MG Tank

Construct a 1-mg elevated water storage tank in response to the growth in commercial and residential demands in the Thornburg Development District before build-out conditions are reached. This tank should be sited based on demand needs, but for modeling purposes, the tank was located near the existing Thornburg tank at the end of the Thornburg main extension. Upon completion of Project 3 (the second Thornburg water storage tank), the existing 250,000-gallon facility can be considered for decommissioning. Estimated capital cost for this project is \$1,670,000. Estimated construction date is 2030.

Project 4: Thornburg Pump Station

Construct a 6.5 mgd water booster pump station located at the intersection of Route 608 (Massaponax Church Road) and Route 1. This pump station is needed before build-out conditions are reached to supply water and keep a consistent grade line in the Thornburg area. Estimated capital cost for this project is \$860,000. Estimated construction date is 2040.

8.1.2 American Central and Five Mile Fork Pressure Zones

The Five Mile Fork pressure zone is currently served by a single 0.1-mg elevated storage tank, and the high service pump stations for both the Ni and Motts Run WTP. In the past, the American Central pressure zone had been included as part of the Five Mile Fork zone, but because of the necessary booster pump station along the 12-inch American Central water line, the Fawn Lake area is hydraulically distinct. The following table summarizes the storage requirements for both pressure zones under all demand conditions.

Table 8.2 – American Central and Five Mile Fork Pressure Zones
Finished Water Storage Requirements

Criterion	Five Mile Fork 1999	Five Mile Fork Build-out	American Central 1999	American Central Build-out
Average Day Demand (mgd)	1.66	2.96	0.04	0.59
Required Storage (mgd)	0.83	1.68	0.02	0.20
Current Effective Storage (mgd)	0.10	0.10	0	0
Deficit/Surplus (mgd)	-0.73	-1.58	-0.02	-0.20

Equipping the Gordon Road Pumps with pressure control capability may reduce the storage needs but a larger storage volume in this area is beneficial to the operation of the Motts Run Water Treatment Plant pumps.

Although the Five Mile Fork tank is considered to be 100% effective storage, its location adjacent to the Motts Run WTP connection at Route 3 (Plank Road) and its small volume do not allow the elevated tank to absorb excess head from the Motts Run WTP high service pump station or provide significant HGL control when the WTP pumps are off. The recommended water storage alternatives are shown on Figure 8 and are as follows:

Project 5: American Central 0.2 Mgal Tank

Construct a 200,000-gallon elevated storage facility within the Fawn Lake Subdivision at the intersection of Long Street Drive and the American Central Water Line. The ground elevation at this location is 410 feet. The construction of a 200,000-gallon tank will allow for the build-out of the proposed Fawn Lake Development, and provide adequate fire storage at any residential dwelling density. In addition, the tank will serve to stabilize normal operating pressures within the subdivision. Spotsylvania County is currently conducting a Disinfection By Product (DBP) evaluation and study. Prior to the construction of an elevated storage facility in this area, the result of the DBP study should be carefully examined. Alternative construction methods such as baffles or internal water circulation may be recommended at this location to minimize detention times. Estimated capital cost for this project is \$1,110,000.

Project 6: Five Mile Fork 1-MG Tank

Construct a 1-mg elevated storage tank near the intersection of Route 674 (Chancellor Road) and Route 627 (Gordon Road). The ground elevation at this location is approximately 360 feet, among the highest locations within the pressure zone. A tank overflow elevation of 472 feet would allow for a minimum operating pressure of 45 psi throughout the zone, and would dampen the current pressure variations seen when the Ni WTP begins pumping operations. In addition, the tank will provide a consistent operating pressure of 45-65 psi, as well as expanded fire flow storage. Estimated capital cost for this project is \$2,370,000.

Project 12: Five Mile Fork 0.5-MG Tank

Construct a second 0.5 mg elevated storage tank within the Five Mile Fork pressure zone near the intersection of Route 612 (Catharpin Road) and Route 610 (Old Plank Road). During build-out conditions, the areas along the existing American Central water line and within Fawn Lake are expected to see a population growth. The tank will provide assistance with the Five Mile Fork Zone storage requirements, help augment flows to the nearby American Central Zone, and mitigate peak flows and fire flow conditions within the western portion of the Five Mile Fork Zone, as well as provide redundancy for maintenance and repair purposes. The ground elevation near the tank is approximately 340 feet, and the tank overflow elevation is 472 feet. Estimated capital cost for this project is \$1,520,000.

Figure 8 – American Central and Five Mile Fork Zones

In the Five Mile Fork Zone, the distribution alternatives with the highest priority are those that connect the northern and southeastern corridors between the Ni and Motts Run WTPs. The other projects are required to meet demand growth, and will be required prior to build-out conditions. The recommended water distribution alternatives are as follows:

Project 7: 16-Inch Main Connecting Route 3 to Route 627 Tank

Construct approximately 3,700 feet of 16-inch distribution main to connect the existing piping (or Project 8 pending sequence of construction) on Route 3 to the existing Route 627 storage tank. The main begins near the Zion Baptist Church from Route 3 heading south, crosses Route 610 (Old Plank Road) and continues south circling around Stansbury Court to the connection on Route 627 (Gordon Road). This project begins the north-south connection from the Route 3 corridor to the southern Five Mile Fork area. Estimated capital cost for this project is \$1,040,000.

Project 8: 24-Inch Main Route 3 (Salem Church Road to Harrison Road)

Construct 10,600 feet of 24-inch water distribution main along the Route 3 corridor from Route 639 (Salem Church Road) to Route 620 (Harrison Road). This project replaces existing 8-inch and 12-inch pipes on the Route 3 corridor, and provides a new interconnection to the existing piping farther west on Route 3 (near Harrison Road). The existing mains are undersized, and therefore experience high head loss, high velocity, and limit flow capacity. The proposed project will provide for greater connectivity, higher flow volumes, and greater looping throughout the Five Mile Fork distribution system. Estimated capital cost for this project is \$3,040,000.

Project 9: 16-Inch Main Route 3 (Route 620 to Route 626)

Construct approximately 4,700 feet of 16-inch main to extend the Route 3 corridor to Route 626 (Andora Drive). This project is dependent upon Project 8, which extends the Route 3 main to Route 620 (Harrison Road). This main improves flow and fire capacities within the western Five Mile Fork Zone along Route 3. With the construction of a new school and expanded commercial development along the western Route 3 corridor, increased flow capacity is needed. If growth in this area greatly exceeds currently projected values, a larger diameter main may be needed. Estimated capital cost for this project is \$1,110,000.

Project 10: 16-Inch Main Route 3 Extension

Construct approximately 7,100 feet of 16-inch water distribution main to extend the Route 3 corridor main from Route 626 (Andora Drive) to the edge of the primary settlement area. Construction of this project is dependent on Projects 8 and 9. This main helps supply water to meet demands in build-out conditions for the area in the upper northeast section of the Five Mile Fork Zone. Similar to Project 9, high demand growth beyond currently projected values may create the need for a larger diameter main. Estimated capital cost for this project is \$1,650,000.

Project 11: 16-Inch Main Gordon Rd (Route 674 to Route 627 Tank)

Construct approximately 6,000 feet of 16-inch water distribution main parallel to Route 627 (Gordon Road) from the existing Route 627 storage tank, to Route 674 (Chancellor Road). This water line will provide connectivity between the Ni and Motts Run WTPs, as well as existing and proposed Five Mile Fork water storage facilities, thereby increasing the reliability and capacity of the Five Mile Fork zone under future demand conditions. Estimated capital cost for this project is \$1,420,000.

Project 13: 12-Inch Main Old Plank Rd (Route 3 to Route 743)

Construct approximately 15,200 feet of 12-inch distribution main parallel to Route 626 (Andora Drive) from Route 3 to Route 610 (Old Plank Road), then turn and follow Route 610 (Old Plank Road) to the proposed Five Mile Fork 0.5 Mgal tank (Project 12). This main will increase supply capabilities to the western Five Mile Fork and American Central areas, which are expected to experience large demand growths in build-out conditions. The main will also aid the existing American Central Line in serving the areas located near the main, and fortify the water supply to the proposed 0.5 Mgal Five Mile Fork tank. Estimated capital cost for this project is \$2,620,000.

Project 14: 16-Inch Ni WTP to New 1-MG Tank

Construct approximately 12,800 feet of 16-inch water main parallel to the existing 16-inch main along Route 627 (Gordon Road) from the Ni WTP to Route 674 (Chancellor Road, where the proposed 1-mg tank is located). Again, this main will help provide greater connectivity throughout the zone, as well as increase the capacity of the Ni WTP to meet demands during build-out conditions. Estimated capital cost for this project is \$2,980,000.

Project 15: 36-Inch Main Motts Run WTP to Route 3

Construct approximately 7,400 feet of 36-inch main parallel to the existing 30-inch main from the Motts Run WTP to Route 3. This main would be constructed when plant expansion to 24 mgd occurs, and would provide more treated water to the system, which will be necessary during build-out conditions. Without adding this parallel main by build-out, water at the high service pump station will see significantly higher head with the increased demand, and the water supplied to the system may have insufficient pressure to meet the required gradeline. This main is intended to primarily serve the proposed 36-inch transmission main within the Battlefield zone (Project 29). Estimated capital cost of this project is \$3,470,000.

8.1.3 Battlefield Pressure Zone

The Battlefield Pressure Zone is currently served by the 250,000-gallon Battlefield tank (overflow elevation 431.25 feet), the 100,000-gallon Courthouse tank (overflow elevation 429 feet), and the 250,000-gallon Onduline tank (overflow elevation 431.25 feet). The Mine Road booster pump station and ground storage tank can also provide water to this zone. Currently, a 6-inch connection to the City zone (at Artillery Ridge) provides approximately 700 gpm to the

Mine Road booster pump station, which subsequently pumps to the Battlefield zone. As analyzed in Section 7.2, the Thornburg tanks (discussed in Section 8.1) and a new tank are needed to meet future requirements for effective storage in Thornburg. As a result, there is one capital improvement storage tank project (besides those already included in the Thornburg Development District projects) in the Battlefield Zone as follows. Refer to Figure 7.

Project 16: Gayle Estate/Massaponax Land Company Property Subdivision Mains (A Through E)

Construct approximately 39,500 feet of 24-inch, 16-inch, and 12-inch main to support the Gayle Estate/Massaponax Land Company Property subdivision as the subdivision is developed. Main A consists of approximately 10,400 feet of 16-inch distribution main that connects to the existing main on Route 1 (and eventually also through a PRV off the 36-inch main proposed in the future), and runs west to Main B. Main B is approximately 4,400 feet of 24-inch main running north and south, connecting to Project 17 in the north, and Project 19 in the south. Mains C and E consist of approximately 16,100 feet of 12-inch main which runs from Main A to a connection with the existing main paralleling Route 1. Main D also begins at Main A and runs north to an interconnection on Pleasants Drive, and then continues east connecting to the existing Route 1 corridor (and eventually also through a PRV off the 36-inch main proposed in the future). Before the Gayle Estate/Massaponax Land Co. Property Subdivision area is fully completed, Projects 17 and 18 as listed below need to be completed to ensure an adequate water supply for the area. Estimated capital cost for this project is approximately \$8,450,000.

Project 17: 24-Inch Main Leavells Road (Battlefield Elementary School to Courthouse Road)

Construct approximately 8,400 feet of 24-inch main along Route 639 (Leavells Road) from Battlefield Elementary School to Route 208 (Courthouse Road) to parallel the existing 16-inch main. The existing 16-inch main is undersized for current demand conditions, and therefore sees high velocities and high head losses, reducing the overall capability of the system to supply water to the southern parts of the Battlefield Zone. In addition to increasing water supply capabilities, this main will help the north to south distribution system for the overall County, and through Projects 18 and 19 will provide additional water supply to Gayle Estate/Massaponax Land Co. Property subdivision, and the Thornburg Development District. The estimated capital cost of this project is approximately \$2,480,000.

Project 18: 24-Inch Main Leavells Road (Gayle Estate/Massaponax Land Company Property to Courthouse Road)

Construct approximately 11,300 feet of 24-inch main to parallel Route 639 (Leavells Road) from Route 208 (Courthouse Road) to the Gayle Estate/Massaponax Land Company Property subdivision. This main will tie into Gayle Estate/Massaponax Land Company Property area to create an adequate water supply, as well as to provide more water to the southern area of the Battlefield Zone; both of which are expected to see large increases in demand during build-out conditions. This project along with Projects 17 and 19 are of the highest priority in the Battlefield Zone, as they will provide a better north to south distribution system, which will be

needed to serve the southern portions of the County in the primary settlement area. Estimated capital cost of this project is \$3,290,000.

Project 19: 24-Inch Main Route 628 and Route 608

Construct approximately 12,100 feet of 24-inch main to parallel Route 628 (Smith Station Road, from the Gayle Estate/Massaponax Land Company Property subdivision area) and continuing on to Route 608 (Massaponax Church Road) to complete a loop from Route 3 to the Route 1 corridor. This loop will increase the capability of the system to supply adequate flows and pressures throughout the entire Battlefield Zone. In addition, this project in conjunction with Projects 16, 17, and 18 will be a direct water supply to the Onduline Tank and the Thornburg Development District (Projects 1-4). Estimated capital cost of this project is \$3,400,000.

Project 20: 12-Inch Main Route 628 (Blackstone Boulevard to Route 639)

Construct approximately 3,700 feet of 12-inch distribution main on Route 628 (Smith Station Road) from Blackstone Boulevard (where it ties in with the 16-inch Main A from the Gayle Estate/Massaponax Land Company Property subdivision) to Route 639 (Leavells Road). This main ties the southern Battlefield Zone into the Courthouse/Courtland system, increasing system looping, which will provide improved flow and pressure. Estimated capital cost for this project is \$620,000.

Project 21: 16-Inch Main Parallel on Courthouse Road

Construct approximately 3,000 feet of 16-inch main from the existing Courthouse water storage tank parallel to the existing 8-inch main along Route 208 (Courthouse Road) to Courthouse Commons Boulevard where a connection is made with the existing 16-inch main on Route 208 (Courthouse Road). This main completes a 16-inch loop on Route 208 (Courthouse Road), and in connection with Project 22 will provide a secondary means of moving water from the Ni WTP to the Battlefield zone. Estimated capital cost for this project is \$750,000.

Project 22: 16-Inch Main Route 613 (Goshen Church to Route 208)

Construct approximately 11,400 feet of 16-inch main along Route 613 (Brock Road) from the Goshen Church to Route 208 (Courthouse Road). This main provides a secondary means of moving water from the Ni WTP to the rest of the system, and in conjunction with Project 21 completes a 16-inch loop from the Ni WTP eliminating both the Goshen Church and the Courthouse area dead end mains. Estimated capital cost for this project is \$2,660,000.

Project 23: 16-Inch Massaponax Church Road Loop

Construct approximately 23,000 feet of main on Route 608 (Massaponax Church Road) from Route 1 east and north to Highway 17. This main would create a loop through the system increasing fire flow capacity, and providing a direct link to a primary Motts Run WTP connection to help serve the eastern part of the Battlefield Zone and the PRV serving the Mine Road Zone. This main also provides water supply and connectivity capabilities along the

southeastern border of the primary settlement area. Estimated capital cost for this project is \$8,360,000.

Project 24: 12-Inch Main Route 608 to Overview Drive

Construct approximately 6,800 feet of distribution main north from Route 608 (Massaponax Church Road) to an existing main on Overview Drive. This provides a loop to the industrial park area on Overview Drive, and helps to provide increased supply as needed in build-out conditions, as well as increases fire flow capacity. Estimated capital cost for this project is \$1,170,000.

Project 25: 16-Inch Main Route 1 to Lee Hill School Drive

Construct approximately 4,700 feet of 16-inch distribution main from a connection to the Route 1 corridor main east to a connection with the existing main on Lee Hill School Drive. This main would provide increased supply to an area of the Battlefield Zone, which is expected to experience significant demand growth. Estimated capital cost for this project is \$1,430,000.

Project 26: 12-Inch Lee Hill School Drive and Northeast Drive

Construct approximately 2,900 feet of 12-inch main connecting with Project 25 east on Lee Hill School Drive and then turning south to parallel an existing 8-inch main on Northeast Drive. This main provides increased water supply to the Commerce Business Park on Northeast Drive, as well as increasing fire flow capacity. Under build-out conditions, the existing 8-inch main experiences significant head losses. Estimated capital cost for this project is \$660,000.

Project 27: Lee Hill 1-MG Tank

Construct a 1-mg elevated storage tank located off Lee Hill School Drive in the Battlefield pressure zone. This tank will help meet demands in the area immediately adjacent where large growth is expected during build-out conditions, and would help improve service to the eastern-most portion of the Battlefield Zone and Mine Road Zone. Estimated capital cost of this project is approximately \$2,370,000.

This area is typically served at a hydraulic grade line (HGL) elevation of approximately 431 feet. Because of low ground elevations, the eastern section of the Battlefield zone typically experiences operating pressures much higher than the 45-60 psi goal discussed in Section 7. To mitigate the typical 80-100 psi pressures in this area, Spotsylvania County could create a new service area that would experience more typical operating pressures. Prior to developing a lower HGL pressure zone, a thorough investigation of customer impacts should be conducted.

The Battlefield pressure zone is currently supplied through three PRVs (Ni to Battlefield, Timber and Battlefield Tank) from the Five Mile Fork Zone. The zone normally operates at approximately 431 feet in the northern part of the zone, and 420 feet in the southern part of the zone because of hydraulic losses throughout the system. With the completion of the 24-inch main project along Cherry, Harrison, and Leavells Roads, the Motts Run WTP is capable of supplying water directly to the Battlefield Zone. The zone will be severely under-served in the

primary settlement areas as build-out conditions occur, and additional distribution mains will be needed. The recommended water distribution alternatives are as follows:

Project 28: 12-Inch Main Lee Hill School Drive To Lee Hill 1-MG Tank

Construct approximately 2,200 feet of 12-inch distribution main on Lee Hill School Drive to help supply water to the 1-mg Lee Hill storage tank (Project 27). Currently, the residents in the area of Lee Hill School Drive experience high pressures of 75-85 psi because of the low ground elevation. This main will help provide increased water supply to the residents in the Lee Hill School Drive area, as well as to the proposed elevated storage tank (Project 27). Estimated capital cost for this project is \$410,000.

Project 29: 36-Inch Main Route 3 to Courthouse Road

Construct approximately 25,000 feet of 36-inch main from a connection on Route 3 (Project 15) off of the Motts Run WTP south to Route 208 (Courthouse Road). This strengthens the water distribution system in the northern portions of the Battlefield Zone, and increases supply to the southern portions of the zone. In conjunction with Projects 30 and 31, this project also increases flow to the Thornburg Development District and the other areas in the southern Battlefield Zone that are projected to see large demand growths in build-out conditions. Estimated capital cost for this project is \$12,260,000.

Project 30: 36-Inch Main Route 208 to Gayle Estate/Massaponax Land Co. Property and Route 1

Construct approximately 11,600 feet of 36-inch main from the end of Project 29 to the intersection of Gayle Estate/Massaponax Land Co. Property Main A and the existing main paralleling Route 1. This main helps supply water to the areas of large growth around Route 1, and the Gayle Estate/Massaponax Land Company Property. In the future, demands within the loop area created by Projects 17, 18, and 19 will be too large to continue adequately supplying water to the Thornburg area. This project, in connection with Projects 15 and 29, will help meet the projected southern Battlefield zone demands. Estimated capital cost for this project is \$5,780,000.

Project 31: 36-Inch Main Route 1 (Gayle Estate/Massaponax Land Co. Property to Route 608)

Construct approximately 10,700 feet of 36-inch main from the end of Project 30 along the Route 1 corridor to Route 608 (Massaponax Church Road). This main, along with Projects 29 and 30, finishes the loop from the Motts Run WTP to Route 608 (Massaponax Church Road) where the proposed Thornburg Development District projects will begin. This project primarily serves to supply the Thornburg Development District under maximum day build-out conditions. Estimated capital cost for this project is \$5,140,000.

Figure 9 – Courtland, College, Mine Road, and Downtown Zones

Courthouse Area Projects

In addition to Projects 21 (Courthouse Road Main) and 22 (Goshen Church) recommended by this document, 3 additional projects were proposed in the 1999 Revision to Water/Sewer Master Plan for Courthouse Area.

Two projects will complete water system loops in the Courthouse Area. A closed loop improves fire flow pressures and provides better reliability to the system in the case of a water line break. The proposed Spotslee Connection will close the distribution system loop through the Spotslee subdivision with 1400 feet of 8-inch water main.

The second project is the proposed Massaponax Church Road loop, which connects the existing water line along Route 208 with the Fairfield Woods and Plantation Forest subdivisions by constructing a new water line along Massaponax Church Road. This project will eliminate the dead end in the water system in the Plantation Forest and Fairfield Woods subdivisions. The new water line will consist of 7000 feet of 8- and 12-inch water main and can be constructed as the Massaponax Church Road area develops within the Village Transition Area.

The final project recommended by the 1999 Revisions to the Water/Sewer Master Plan for Courthouse Area is the Courthouse Commons Loop. This water main loop is proposed to be added during the construction of the Courthouse Commons Parkway, following the roadway right-of-way. The water main loop will provide water service for development of the Village Transition Area to the east of Route 208 and on both sides of Route 608.

The Courthouse Area water lines are shown in figures from the 1999 Water/Sewer Master Plan for Courthouse Area.

8.1.4 Mine Road Pressure Zone

The New Post area, at the intersection of Route 2 and Highway 17, is expected to experience significant growth in accordance with the County's Comprehensive Plan. All of the projects within the Mine Road Zone serve the projected expansion of demand in and around the New Post area. A water storage tank was considered in the New Post area, but the ground elevation would require that the tank be over 200 feet tall, and therefore, cost prohibitive. Extremely tall tanks such as this can evoke strong public resistance. The following distribution main projects, shown on Figure 9, will increase flow in areas of the Mine Road Zone which are expected to see high demands in build-out conditions:

Project 32: 12-Inch Main Mine Road to Route 608

Construct approximately 2,800 feet of 12-inch main from the end of the existing main on Mine Road east to Route 608 (Massaponax Church Road). The main connects to the system at a dead end, and provides looping of the system, which reduces potential water quality issues, and increases fire flows. This main also connects and fortifies the distribution system connections from the Battlefield Zone to the Mine Road Zone. Estimated capital cost for this project is \$510,000.

Project 33: 12-Inch Main Route 2 to New Post

Construct approximately 4,800 feet of 12-inch main along Route 2 to extend the existing main southeast to Highway 17. This main would provide additional water supply to an area in the Mine Road Zone, near New Post, and would provide water supply along the primary roadway and development corridors. Estimated capital cost for this project is \$1,000,000.

Project 34: 12-Inch Main Tidewater Trail Loop

Construct approximately 8,700 feet of 12-inch main in two different segments. The first segment parallels Route 609 (Jim Morris Road) north beginning just north of Billy Days Road to the intersection at Route 2. The second segment parallels Highway 17 from the west side of the RF&P Industrial Park to Route 609 (Jim Morris Road). This main provides an additional loop in the Motts Run/New Post distribution system increasing fire flows, and supply capabilities. Estimated capital cost for this project is \$1,460,000.

Project 35: 12-Inch Main Highway 17 (Mine Road and Battlefield Zone Connection)

Construct approximately 3,600 feet of 12-inch transmission main east along Highway 17 from Route 608 (Massaponax Church Road) through a 12-inch PRV to Crossroads Business Park. This main expands the existing PRV connection between the Mine Road Zone and the Battlefield Zone, and ties in a primary development corridor along Highway 17. The primary connection serving the southeastern Mine Road Zone is a 12-inch main. The proposed project will help decrease the high velocities and head losses that the existing 12-inch main will experience in build-out conditions. Estimated capital cost for this project is \$690,000.

Project 36: 12-Inch Main Mills Drive Loop to New Post

Construct approximately 11,000 feet of 12-inch main south along Route 609 (Jim Morris Road) from the connection of Project 34 to Highway 17, then paralleling Highway 17 to New Post. This main would continue the Highway 17 corridor coverage, and will complete the looping of the system in the New Post area increasing fire flow capacity and supply capabilities. Estimated capital cost for this project is \$2,140,000.

8.1.5 City Pressure Zone

The Spotsylvania County City pressure zone is currently served through two interconnections to the City of Fredericksburg Courtland pressure zone. The City Zone does not have water storage facilities. The City Zone had a 1999 storage deficit of 0.18 mg and a build-out deficit of 0.57 mg. The City Zone interconnections, however, are pressure-reducing structures that provide flow directly from the adjacent Courtland Zone tanks. With the completion of the new 1.5-mg City Courtland Tank, the Courtland Zone can provide adequate storage. Should the City of Fredericksburg Courtland Zone water demands develop beyond current projections, a water storage facility within the City Zone may become necessary. Refer to Figure 9.

Project 37: 12-Inch Main (City Zone to Courtland Zone Connection)

Construct approximately 4,500 feet of 12-inch main from the intersection of Route 1 and Devonshire Drive west to Kingswood Boulevard. The proposed main has a 12-inch PRV, and will provide additional water to the City Zone, as well as be an immediate source near the City of Fredericksburg Courtland tanks. Estimated capital cost for this project is \$900,000.

All of the projects described above are shown in Table 8.3. Conceptual estimates of probable construction cost for each project are included in Exhibit E.

Table 8.3 – Capital Costs of CIP Water Project

Project Number	Title	Length (feet)	Capital Costs
1	Thornburg Industrial 1-MG Tank	---	\$2,370,000
2	24-Inch Main Thornburg	25,200	\$7,030,000
3	Thornburg 1-MG Tank	---	\$1,670,000
4	Thornburg Pump Station	---	\$860,000
5	American Central 0.2-MG Tank	---	\$1,110,000
6	Five Mile Fork 1-MG Tank	---	\$2,370,000
7	16-Inch Main Connecting Rt. 3 to Rt. 627 Tank	3,700	\$1,040,000
8	24-Inch Main Rt. 3 (Salem Church Rd. to Harrison Rd.)	10,600	\$3,040,000
9	16-Inch Rt. 3 (Rt. 620 to Rt. 626)	4,700	\$1,110,000
10	16-Inch Main Rt. 3 Extension	7,100	\$1,650,000
11	16-Inch Main Gordon Rd. (Rt. 674 to Rt. 627 Tank)	6,000	\$1,420,000
12	Five Mile Fork 0.5-MG Tank	---	\$1,520,000
13	12-Inch Main Old Plank Road (Rt. 3 to Rt. 743)	15,200	\$2,620,000
14	16-Inch Main Ni WTP to New 1-MG Tank	12,800	\$2,980,000
15	36-Inch Main Motts Run WTP to Rt. 3	7,400	\$3,470,000
16	Gayle Estate/Massaponax Land Company Property Subdivision Mains (A Through E)	39,500	\$8,450,000
17	24-Inch Main Leavells Rd. (Battlefield Elementary School to Courthouse Rd.)	8,400	\$2,480,000
18	24-Inch Main Leavells Rd. (Gayle Estate/Massaponax Land Company Property to Courthouse Rd.)	11,300	\$3,290,000

19	24-Inch Main Rt. 628 and Rt. 608	12,100	\$3,400,000
20	12-Inch Main Rt. 628 (Blackstone Blvd. to Rt. 639)	3,700	\$620,000
21	16-Inch Main Parallel on Courthouse Rd.	3,000	\$750,000
22	16-Inch Main Rt. 613 (Goshen Church to Rt. 208)	11,400	\$2,660,000
23	16-Inch Main Massaponax Church Rd. Loop	23,000	\$8,360,000
24	12-Inch Main Rt. 608 to Overview Dr.	6,800	\$1,170,000
25	16-Inch Main Rt. 1 to Lee Hill School Dr.	4,700	\$1,430,000
26	12-Inch Lee Hill School Dr. and Northeast Dr.	2,900	\$660,000
27	Lee Hill 1-MG Tank	---	\$2,370,000
28	12-Inch Main Lee Hill School Dr. to Lee Hill 1-MG Tank	2,200	\$410,000
29	36-Inch Main Rt. 3 to Courthouse Rd.	25,000	\$12,260,000
30	36-Inch Main Rt. 208 to Gayle Estate/Massaponax Land Company Property and Rt. 1	11,600	\$5,780,000
31	36-Inch Main Rt. 1 (Gayle Estate/Massaponax Land Company Property to Rt. 608)	10,700	\$5,140,000
32	12-Inch Main Mine Rd. to Rt. 608	2,800	\$510,000
33	12-Inch Main Rt. 2 to New Post	4,800	\$1,000,000
34	12-Inch Main Tidewater Trail Loop	8,700	\$1,460,000
35	12-Inch Main Highway 17 (Mine Rd. and Battlefield Zone Connection)	3,600	\$690,000
36	12-Inch Main Mills Drive Loop to New Post	11,000	\$2,140,000
37	12-Inch Main (City Zone to Courtland Zone Connection)	4,500	\$900,000
Total Capital Costs of CIP Water Project			\$100,190,000

8.2 Water Supply Alternatives

As discussed in Sections 3 and 7, the Spotsylvania County and the City of Fredericksburg average daily build-out water demand is 24 mgd. Assuming use of the 5.8 mgd City water allocation, the safe yield of current water resources is approximately 22 mgd. Therefore, a minor additional water resource will be required for build-out conditions.

There are several alternatives for Spotsylvania County to meet future water supply demands. Eight water supply categories have been identified, and are listed below with a brief description of the alternatives. The primary source of information was the “Environmental Impact Report for the County of Spotsylvania”, by HSMM, in March of 1994.

Purchase Water From Others

In the past, Spotsylvania County purchased treated water from the City of Fredericksburg. Prior to the spring of 2000, the City operated a Rappahannock River intake that provided up to 6 mgd, of which Spotsylvania County purchased a portion for the County's use. After Motts Run WTP was established, the City's WTP and river intake were decommissioned. As a result, purchasing water from the City of Fredericksburg is no longer an option.

Currently, Stafford County is proposing to build Rocky Pen Run Reservoir located approximately ½-mile upstream from the confluence of Rocky Pen Run and the Rappahannock River in Stafford County. The reservoir is expected to have a safe yield of 14.3 mgd, and could have the potential to serve Spotsylvania County and the City of Fredericksburg. Preliminary review of the Stafford County permit request by the Corps of Engineers indicated that a reservoir in this location would not affect known endangered species, but may impact several potentially eligible historic properties. If the Rocky Pen Reservoir permit is approved, this could be a viable raw or treated water source for Spotsylvania County.

Alter Existing Sources

Several water sources currently in use by Spotsylvania County could be expanded or modified to provide expanded source water safe yield.

- Motts Run Reservoir Expansion - The Motts Run Reservoir is currently undergoing modifications and improvements, with an expected construction completion in 2002. The reservoir is located approximately 1,000 feet upstream of the confluence of Motts Run and the Rappahannock River. The water level will not be raised during these modifications, and the volume of the reservoir will remain at 1.328 billion gallons, with a safe yield of approximately 3.9 mgd. According to HSMM's March 1994 "Final Environmental Impact Report", Motts Run Reservoir could have a safe yield of 6.1 mgd by raising the normal pool elevation by 15 feet. Negative impacts of this include the loss of approximately 17.9 acres of wetlands, and the inundation of approximately 90 acres of forest and public recreational facilities.
- Ni Reservoir Embankment Raising - Raising the Ni Reservoir embankment involves increasing the dam crest elevation and the flood easement area, which would raise the normal pool elevation within the reservoir by 20 feet. The yield of the reservoir would be increased from 4 mgd to 9 mgd. Disadvantages to this alternative are that a number of residential dwellings would be inundated, and several others put within 100 feet of the normal pool; the cost of property acquisition has increased due to residential development near the reservoir; the reservoir's flood protection capabilities downstream of the dam would be eliminated; approximately 25 acres of the Fredericksburg-Spotsylvania National Military Park would be flooded; winter foraging grounds of transient bald eagles (known to utilize the reservoir) would be at least temporarily disrupted; and because of

design capabilities, the existing dam may have to be removed and rebuilt to support the additional loads associated with the larger water volume.

- Ni Reservoir Spillway Modifications - The normal pool elevation of the Ni Reservoir could be raised by 9 feet through spillway modifications. These modifications include raising the crest elevation of the existing standpipe outlet structure, paving the emergency spillway, increasing reservoir yield by approximately 1.6 mgd, and adding approximately 610 million gallons of water supply storage to the reservoir. Advantages of the spillway modifications are that the reservoir could then pass the 100-year flood level within the present flood easement (although the reservoir would no longer be able to help control flood flows downstream of the dam); the reservoir would pass the spillway design flood specified in an earlier inspection report without overtopping the dam. The additional water from the reservoir would be treated at the existing expanded Ni WTP. Disadvantages of this alternative are that approximately 196 acres of wetland would be impacted; several properties would be below the proposed 100-year flood elevation; the reservoir would no longer be able to control flood flows downstream of the dam; and approximately 5.1 acres of the Fredericksburg-Spotsylvania National Military Park would be flooded.
- Ni Reservoir Pump Storage - Another Ni Reservoir alternative includes raising the normal pool of the Ni Reservoir by 9 feet (as just examined), and augmenting the reservoir with water from the Rappahannock River, increasing the safe yield of the Ni Reservoir by 2.2 mgd (from 4 mgd to 6.2 mgd). This alternative is feasible only in conjunction with reservoir expansion through spillway modifications, and as with that alternative, it would result in the flooding of approximately 196 acres of wetland; would place several existing residential dwellings within 100 feet of the normal pool elevation; and flood 5.1 acres of the Fredericksburg-Spotsylvania National Military Park. This alternative would serve the same basic function as the Hunting Run Reservoir, which is currently under construction.
- Dredge the Ni Reservoir - Dredging of the Ni Reservoir would encompass either wholesale dredging of bottom sediments, or a phased dredging program, utilizing cofferdams or similar structures. Dredging of the reservoir could increase capacity (safe yield) by 0.7 mgd, 1.2 mgd, and 1.5 mgd for one, two and three foot increments respectively. Wholesale dredging of the Ni River Reservoir would have adverse impacts because the bottom sediments would be re-suspended in the water, resulting in high loading demands being placed on the treatment plant, possibly rendering the plant temporarily unusable. Dredging the reservoir through a phased approach will lessen the amounts of re-suspended bottom sediments, but would still have long-term effects from the concentration of dissolved solids in the water. Another disadvantage is that a phased approach could take several years to be fully implemented. Additionally, an area would have to be found for dewatering and disposing of dredge material, thus leading to significant transportation costs. Dredging the reservoir would also result in the loss of approximately 34 acres of wetlands along the shoreline of the Ni River.

Develop New Raw Water Source (Reservoir/Lake)

Creating a new reservoir or using an existing reservoir as a raw water source could have a high initial cost, but may be a long-term solution to meeting future demands.

- Fawn Lake – Fawn Lake is located along the Greenfield Creek south of the Wilderness Battlefield Military Park. The average depth of the lake is more than twice the depth of the Ni River Reservoir (19 feet compared to 8.8 feet), and the reservoir would yield at least 1.4 mgd. However, use the lake as a water supply has numerous disadvantages. Fawn Lake was built to serve as a recreational lake, not as a public water supply; therefore, no measures were taken to clean the lake bottom. There is a high probability of water quality problems due to anaerobic conditions in the lower depths. Additionally, several residences in the area would be affected and, with development in the Fawn Lake area (a club house, lots for 1,200 homes, a golf course, and several other amenities), the cost to acquire land in the area has greatly escalated.
- Lake Anna – Lake Anna is a 13,000-acre man-made impoundment on the North Anna River, along the southern border of Spotsylvania County. Virginia Power created the lake in 1972 to provide cooling water for operations at the North Anna Nuclear Power Station. Accordingly, Virginia Power has stated that the lake is unable to handle fluctuations in lake depth because of the need to serve the nuclear power station, as well as maintain the recreational resources of the lake. Also, because of the wide use of the lake for recreational purposes, there could be a potential water supply contamination problem from marinas and engine-powered boats used at the lake. Currently, Virginia Power has a permit for the lake that expires in 2012. Virginia Power intends to reapply for the permit for an additional 20 years, making Lake Anna unavailable as a significant water resource for Spotsylvania County for the next 32 years. Additionally, water would need to be transported approximately 15 miles to reach the primary settlement areas in Spotsylvania County. Spotsylvania County has also expressed a desire to keep Lake Anna State Park as a resort and recreation area.
- Po Reservoir Upstream of Rt. 648 – The dam for this alternative would be located on the Po River approximately one mile upstream of Andrews Bridge (State Route 648), and would include a 5 mgd or larger reservoir. Costs for water mains would be minimal for this alternative, in comparison with several of the other alternatives. Additionally, the Po River watershed has not yet been impounded. However, construction of a 5-mgd reservoir would result in permanent flooding of approximately 14.4 acres of the Fredericksburg-Spotsylvania National Military Park and impact approximately 312 acres of wetlands.
- Po Reservoir Upstream of Rt. 208 – This alternative would include a dam and reservoir with a 7.7 mgd safe yield located approximately 2,400 feet upstream of Shells Bridge (Route 208). The dam would be 25 feet wide, 1,100 feet long, and 55 feet high with one 300 foot wide spillway. This alternative could be a significant water resource. Impacts include a reduction in the mean annual flow downstream of the proposed dam; flooding of 172 acres of wetlands; flooding of riverine habitat supporting a population of dwarf

wedge mussel (a federally-listed endangered species); flooding of a historic archaeological site; impact to nine residential dwellings; a new Route 648 bridge and causeway would be required; and encroachment of the 100-year flood plain onto 3.2 acres of Fredericksburg-Spotsylvania National Military Park. This alternative, with estimated construction costs, are discussed in HSMM's 1994 "Final Environmental Impact Report". Costs for construction of a 7.7 mgd Po River Reservoir are estimated at \$21.28 million in 2000 dollars.

- Wilderness Run Reservoir – The Wilderness Run Reservoir would be a side-stream reservoir located on the Wilderness Run River, similar to Hunting Run Reservoir. There are many disadvantages to this location for a reservoir, one of the most apparent being the inter-jurisdictional issues that could arise between Orange and Culpeper Counties. Also, the water would have to be transported considerable distance before reaching the primary settlement area in Spotsylvania County. The creation of a reservoir in this area could cause population growth outside of the primary settlement area, which is undesirable. Additionally, several other municipalities withdraw water from the Rapidan and/or Rappahannock Rivers, and the river may not be able to support additional raw water intakes.
- Pipe Dam Run Reservoir – The Pipe Dam Run Reservoir would be a water supply dam and side-stream reservoir similar to the Hunting Run Reservoir. The dam would be located on the Pipe Dam Run River, upstream of the river's confluence with the Rappahannock River. Permitting for an intake in this area could be difficult due to the amount of water already being withdrawn from the Rappahannock River. A complex safe yield study would be necessary to determine if the required minimum in-stream flow of the river could be maintained with an additional intake. Also, there are several nearby archeological areas, which would be disturbed by the location of the reservoir.

Develop New Run-Of-River Raw Water Sources

The development of river water impoundment alternatives was discussed in the previous section. The options discussed below are direct raw water intake structures within either the Rappahannock or Potomac Rivers. These options may be developed in conjunction with other supply alternatives.

- Lower Rappahannock River Intake – Under this alternative, a raw water intake for Spotsylvania County would be located on the lower Rappahannock River just below the fall line. This alternative offers relatively low construction costs and operation expenses, relatively few environmental impacts, and access to a large water supply. However, water quality in this area of the Rappahannock River has been classified as poor, presumably due to urban run-off, agricultural run-off (from further upstream), industry discharges, and sewage effluent discharges. Also, although closed down in the late 1980's, the L.A. Clarke and Sons wood-preserving factory located on Massaponax Creek had been a major discharger of toxic substances. The site has been listed for Superfund clean up. But soils, groundwater, and river sediments affected by the discharges are reported to still be contaminated.

Another potential water quality problem is the nearby upriver locations of the major highways I-95 and US Route 1. An accident on one of these roads near the river involving load transport vehicles, could release pollutants into the river, and the water source could be rendered unusable for an indeterminate amount of time. Finally, the Virginia State Health Department recommends that there be at least five miles between a sewage outflow and raw water intake for a public water supply, requiring the intake to be located five miles downstream of the Massaponax WWTP, and therefore would be located in Caroline County. Significant transmission and/or treatment facilities would be required to reach the Spotsylvania County primary settlement area, and any pipelines and/or WTP located within Caroline County would require Carolina County approval.

- Potomac River – A Potomac River raw water side-stream intake could be located on either the Aquia or Potomac Creek in Stafford County. Raw water could be piped south to an area near the City of Fredericksburg where a new/existing (based on capacity) WTP could treat the water for distribution, or a new WTP could be constructed at the intake location and finished water could then be pumped to the County’s distribution system. One drawback of using the Potomac River is that there could be several inter-jurisdictional issues with Stafford County, King George County and the City of Fredericksburg. Also, there are several other municipalities that use the Potomac River as a water supply and as a wastewater discharge receiving stream. Since the VDH recommends that there be at least five miles between a sewage outflow and raw water intake for a public water supply, additional studies on that particular area of the Potomac River would be required before a specific intake location could be chosen. Also, it has been confirmed that there is fresh water in these areas of the Potomac, but further investigations need to be done on the possibility of salt-water intrusion.

Groundwater

Currently, water is supplied to approximately one-third of Spotsylvania County residents through small private wells. Most of these wells are located within the Piedmont Physiographic Province. Piedmont aquifers are generally low yielding, and highly variable in thickness and hydrologic characteristics. Because of this, the Spotsylvania County Board of Supervisors dedicated groundwater for residential use only, and denies withdrawals for commercial and industrial purposes, indicating that groundwater is not a viable public water source for Spotsylvania County.

8.3 Water Treatment Alternatives

Spotsylvania County has several water treatment alternatives to meet future demands. The different alternatives with brief descriptions are listed below.

New Po River WTP

A new 6-mgd water treatment plant could be constructed on the Po River, built in conjunction with a 7.7-mgd safe yield reservoir (as discussed in section 8.2), and would be located

approximately 2,400 feet upstream of Route 208. The plant would have a continuous production rate of 2-mgd, 4-mgd or 6-mgd depending on County water demand. Water mains, for connection to the Spotsylvania County distribution system, would be short and inexpensive. However, the Po River watershed is similar to the Ni River watershed and water from the Po River would be expected to be comparable to the raw water currently being treated at the Ni WTP. The water quality is marginal; therefore, a new WTP on the Po River would have to be capable of treating marginal quality water and producing finished water within acceptable limits. This alternative, with estimated construction costs, was discussed in HSMM's 1994 "Final Environmental Impact Report". Costs for construction of a 6-mgd Po River WTP are estimated at \$11,930,000 in 2000 dollars.

New Potomac River WTP

A new water treatment plant could be built on the Aquia or Potomac Creeks within Stafford County, and would be built in conjunction with a Potomac River intake. Disadvantages include significant inter-jurisdictional issues between Stafford County (where both creeks, the WTP and transmission main would be located), the City of Fredericksburg, and possibly King George County (part of Potomac Creek is located in their jurisdiction). In addition, the water quality of the Potomac River at this location is unknown and may require the use of advanced treatment technologies such as membrane filtration. Alternately, raw water from the Potomac River could be pumped to a location within Spotsylvania County for treatment.

Expand Ni WTP

The Ni WTP was initially constructed in 1974 with a 1-mgd capacity; expanded in 1977 to 2-mgd; expanded again in 1981 to 4-mgd, and in 1993 underwent final expansion to its current capacity of 6 mgd. It may be possible to further expand the Ni WTP to increase treatment capacity; however, an additional raw water supply would be required. Expanding the Ni Reservoir capacity or pumping from alternative raw water sources could accomplish this. However, the WTP when treating Ni Reservoir water, may require additional process improvements to mitigate excess formation of Disinfection By Products (DBPs). The "Preliminary Engineering Report" (HSMM, February 1991) for the Ni WTP addition details significant issues concerning water quality at the Ni Reservoir. The HSMM report references a 1988 "Evaluation of Water Supply Alternatives" (Hoehn) and a 1990 "Evaluation of Treatment Alternatives for THM-Precursor Removal From the Po River and Ni River" (Mostaghimi). The "Preliminary Engineering Report" details water quality characteristics such as low turbidity, low alkalinity, and high THM Formation Potential due to algae growth. The study evaluated ozone as an alternative disinfectant, recommending that its application may not adequately remove THM Formation Potential. Additionally, the report recommended the addition of a raw water diffused aeration system, a rapid mix, granular activated carbon, and flow pacing of the coagulant feed. In addition, expansion of the Ni WTP would require new finished water transmission mains both at the plant site and within the Five Mile Fork pressure zone.

Expand Motts Run WTP

The Motts Run water treatment facility and Rappahannock River raw water pumping station were completed in the spring of 2000, as part of the Spotsylvania County water supply expansion project. The Motts Run WTP currently has a treatment capacity of 12 mgd. The plant was designed such that future upgrades would be possible. The estimated cost of expanding treatment capacity from 12 mgd to 18 mgd and 18 mgd to 24 mgd is \$2,500,000 and \$7,500,000, respectively. Current raw water supplies to the Motts Run WTP total 11.4-17.2 mgd, pending Corps of Engineers permit modifications. Future additional raw water supply at this location may necessitate expansion beyond 24 mgd.

The location of future treatment facilities will dictate the finished water entry point into the distribution system. Based on current safe yield and expansion capabilities at the Motts Run WTP, the transmission improvements described in Section 8.1 originate from this facility. Significant alterations to the distribution entry point may require modifications to several transmission main projects but, generally, will not impact storage or smaller diameter distribution main projects.

8.4 Water System Expansion Summary

The information presented in Sections 7 and 8 of this report outline the existing and proposed Spotsylvania County water storage, transmission, and distribution facilities. In addition, there is significant discussion of future water sources, safe-yield, and treatment alternatives.

The proposed storage and transmission capital improvement projects were evaluated based on 1999 and build-out demand projections for average day, maximum day, and peak hour conditions. Each project was analyzed using a combined Spotsylvania County/City of Fredericksburg Cybernet hydraulic model. The capital costs, as well as key project data (volumes, diameters, and lengths) are presented in Table 8.3. A full size map is included in the Appendix indicating the location of each project.

The future water supply alternatives presented in Section 8.2 represent a broad spectrum of options. Many of the alternatives were discussed and eliminated from consideration in HSMM's 1994 "Environmental Impact Report". The report was in favor of the Hunting Run, Motts Run, Rappahannock and Rapidan Rivers Project, which is currently under construction. As the County and City water demands continue to grow beyond the expanded supply of the Hunting Run project, additional reliable safe yield will be required. Of the alternatives discussed, the following should be considered for further detailed investigations in the following order of priority:

- Optimization of Current Rappahannock/Rapidan River Supplies
- Stafford County
- Potomac River
- Ni Reservoir Improvements
- Po River Reservoir

Future water treatment capacity for the combined Spotsylvania County and City of Fredericksburg system is discussed in reference to the available safe-yield supply. The Motts

Run WTP can be expanded from 12 mgd to 18 mgd, and again to 24 mgd, at a cost of \$2.5 million and \$7.5 million respectively. Beyond the expansion of the Motts Run facility, the site and size of a future treatment plant would be based upon the location of the source water supply. Alternatives include: further expansion of the Motts Run WTP beyond 24 mgd, expansion of the Ni WTP, construction of a new Po River WTP, construction of a wastewater effluent treatment plant for non-potable reuse, and the site selection and construction of a Potomac River WTP. Conceptual estimate of probable construction cost for 18-mgd of additional Spotsylvania County and City of Fredericksburg water treatment capacity is \$20,500,000.

The recommendations provided herein include:

- The commissioning of a County wide safe yield study to evaluate the combined total available annual raw water supply using uniform assumptions, inputs, controls, and calculation methods. This study can be used to confirm the current safe yield of the supply system, define the quantities of future supplies needed and, if beneficial, discuss modifications to current withdrawal permits to increase available yields.
- Based on defined needs, the future commissioning of a detailed source water evaluation study and the initiation of a program to secure and protect water rights and property for the selected option.