5.0 WASTEWATER COLLECTION/TREATMENT SYSTEM ALTERNATIVES

5.1 Wastewater Treatment for Thornburg Development District – New Po-Ni Wastewater Treatment Plant

Since current sewage flow to the existing Thornburg WWTP is a little greater than 0.1 mgd, initial capacity of a new Po-Ni WWTP must be limited. A new 2-mgd plant expandable to 7 mgd would meet the Spotsylvania County 2000 Comprehensive Plan development scenario. Components of the new Thornburg WWTP sewerage system would include:

1. A 2-mgd WWTP located between the Po and Ni Rivers, east of I-95 and accessible from Route 632. Utilize two trains with no primary clarifiers, anoxic and aerobic bio-reaction basins for total nitrogen reduction, final clarifiers, chemical phosphorus reduction, and effluent filtration to meet effluent limits of 10 mg/l BOD_5, 10 mg/l TSS, 3 mg/l TKN (10/10/3 limits), plus 8 mg/l total nitrogen and 1.5 mg/l total phosphorus. The process is consistent with the process proposed for the FMC and Massaponax WWTP.

   Implementation of total nitrogen reduction treatment processes as part of the Po-NI WWTP would enable Spotsylvania County to participate in the Virginia Water Quality Improvement Fund. The fund could pay up to 50% of the cost of that portion of the plant expansion related to total nitrogen and phosphorus reduction beyond that which DEQ might require at that time. State funding of the WQIF has become doubtful.

2. Future expansion of the WWTP to a final design capacity of 7 mgd.

Capital Costs

Capital cost for a 7-mgd Po-Ni WWTP has been estimated at $ 23,304,000. Component costs are itemized in the following table. Costs are in 2000 dollars and include engineering, but not property acquisition.

Table 5.1 – Capital Costs for 7-mgd Po-Ni Wastewater Treatment Plant

Component	Capital Cost
2-mgd Wastewater Treatment Plant and Outfall	$10,774,000
Wastewater Treatment Plant Expansion to 7 mgd	$12,530,000
Total Cost	$23,304,000

Personnel

The existing Thornburg WWTP has a 4-person operating staff consisting of one chief operator and three Class III shift operators. Operating budget for the Thornburg WWTP for the fiscal year from June 1999 through June 2000 is $258,410, including $197,890 for personnel

compensation and benefits. For a new 2-mgd Po-Ni WWTP, staff requirements would increase to a 7-person operating staff consisting of one chief operator, one Class II shift operator, three class III shift operators, one trainee, and one laborer. Additionally, one person would be added to the Spotsylvania County WWTP maintenance crew and one lab technician would be added at the regional WWTP laboratory.

For a 7-mgd Po-Ni WWTP, staff requirements would increase to a 12-person operating staff consisting of one chief operator, one Class II shift operator, three class III shift operators, two trainees, and one laborer. Additionally, two persons would be added to the Spotsylvania County WWTP maintenance crew and two lab technicians would be added at the regional WWTP laboratory (currently located at the FMC WWTP). This staff corresponds to the current staff at the 4-mgd FMC WWTP and 6-mgd Massaponax WWTP.

O&M Costs

Annual operating costs for the 2-mgd and 7-mgd Po-Ni WWTP have been calculated by comparing the 1999-2000 annual operating budgets for the existing Thornburg and FMC WWTP's with the anticipated staff, operating horsepower, and average annual flows for the proposed Po-Ni WWTP. The Thornburg and FMC WWTP's and the proposed Po-Ni WWTP have the following similarities which impact annual operating costs:

- None of the WWTP have primary clarifiers or primary sludge disposal
- All utilize a biological reaction tank with mechanical aerataors/mixers
- All utilize effluent filtration
- All utilize chlorination-dechlorination and mechanical effluent re-aeration
- All have on-site sludge holding facilities for off-site sludge stabilization and disposal

Proposed annual operating budget for the Po-Ni WWTP are shown in Table 5.2.

Table 5.2 – Annual Operating Budget for Po-Ni Wastewater Treatment Plant

Budget Line Items	Existing Thornburg WWTP	2-mgd Po-Ni WWTP	7-mgd Po-Ni WWTP
Budget for Total Staff	$197,890	$358,000	$477,000
Electric Service	$ 17,100	$92,000	$327,000
Chemicals	$ 4,200	$ 25,000	$88,000
Other Operating Expenses	$ 27,220	$100,000	$350,000
Capital Outlay	$ 12,000	$ 20,000	$70,000
Total Annual Budget	$258,410	$587,000	$1,312,000

5.2 Wastewater Treatment for Thornburg Development District – Pump to Massaponax Wastewater Treatment Plant

A sewage pumping option for the Thornburg Development District would require a new Thornburg sewage pumping station, force main, interceptor capacity for sewage conveyance to the Massaponax Creek interceptor, and capacity in the Massaponax Creek interceptor and WWTP. Components of the Pumping System sewerage option include:

1. A 2100-gpm Thornburg Sewage Pumping Station located between the Po and Ni Rivers, west of I-95 and accessible from Route 632. The pumping station would be expandable to 8700-gpm capacity.

2. A 14-inch force main extending 26,000 feet to the north along the Ni River and Route 633 and 608 from the pumping station to a point of discharge to a new gravity trunk main at the intersection of Routes 608 and 668. A parallel 30-inch force main along the same alignment, would be required when flows exceed 2100 gpm.

3. A new Route 17 Trunk Main extending down-gradient 17,000 feet from the termination of the 14-inch and 30-inch force mains to the Massaponax Creek Interceptor. Without the sewage flow from the Thornburg Development District, an 8" to 18" Route 17 Trunk Main would be required. Addition of sewage from the Thornburg Development District increases the size of the Route 17 Trunk Main to 48". The new Route 17 Trunk Main has been located to:

    - Facilitate sewage collection from six designated, but un-sewered, industrial development sites along Route 17 and Route 608.

    - Convey sewage from the Thornburg Development District to a down-gradient segment of the Massaponax Creek Interceptor, to minimize the cost of Massaponax Creek Interceptor expansion.

    - Avoid discharge to the existing trunk mains immediately west of I-95 and Route 1, reserving the capacity in these trunk mains for anticipated residential development.

4. Expand the size of 10,000 feet of the Massaponax Creek Interceptor from 60" diameter to 66" diameter, to increase pipe capacity by 10 mgd.

5. Expand the Massaponax WWTP by 7 mgd.

<u>Capital Costs</u>

Capital cost for a sewage pumping station near the confluence of the Ni and Po Rivers and a 14" and 30" force main to convey sewage to a new Route 17 trunk main that flows by gravity to the Massaponax Creek Interceptor has been estimated at $ 8,400,000. Costs are in 2000 dollars and include engineering, but not property acquisition.

A 7-mgd expansion of the Massaponax WWTP is estimated to cost $21,000,000. Itemized capital costs to pump sewage from the Thornburg Development District to the Thornburg WWTP are itemized in the table below.

Table 5.3 – Capital Costs to Pump Sewage From Thornburg Development District to Massaponax Wastewater Treatment Plant

Component	Capital Cost
2100 gpm Thornburg Sewage Pumping Station	$1,070,000
Thornburg Sewage Pumping Station Expansion to 8700 gpm	$1,050,000
14" Force Main	$1,876,000
30" Force Main	$3,745,000
Increased Capacity in Route 17 Trunk Main	$4,910,000
Increased Capacity in Massaponax Creek Interceptor	$903,000
Increased Capacity in Massaponax WWTP by 7 mgd	$21,000,000
Total Cost	$34,554,000

Personnel Costs

Personnel cost for the pumping station sewerage system is assumed to be zero; operation and maintenance will be handled by County personnel with responsibility for O&M of all County sewage collection systems and sewage pumping stations.

O&M Costs

Annual electric service costs of pumping station operation have been estimated to be $85,000 at full development of the Thornburg Development District and including an additional 3-mgd industrial contribution.

Annual operating costs of the Massaponax WWTP would increase by $750,000, were the WWTP to be expanded by 7 mgd (Defined in the Stage I Design Preliminary Engineering Report).

Recommendation for Thornburg Development District Wastewater Treatment

Capital and annual operating costs for Thornburg Development District wastewater treatment, either at a new Thornburg WWTP or by pumping to an expanded Massaponax WWTP, are shown in Table 5.4. The 20-year annual budget includes debt retirement on the capital cost (based on a 20-year, 6% loan) plus the annual O&M costs.

Table 5.4 - Comparative Costs, Thornburg Development District Wastewater Treatment Options

WWTP Option	Capital Cost	Debt Service	Annual O&M Costs	20-Yr Annual Budget (2001 Dollars)
Po-Ni WWTP	$23,304,000	$2,032,100	$1,312,000	$3,344,100
Pump to Massaponax WWTP	$34,554,000	$3,013,100	$835,000	$3,848,100

The annual cost to pump wastewater from the Thornburg Development District is projected to have a 20-year annual budget (2001 dollars) that is almost $500,000 per year less than the cost of a new Po-Ni Wastewater Treatment Plant. Other factors critical to the selection of a Thornburg Development District wastewater treatment alternative include:

1. Responsiveness to new industries in the Thornburg Development District: As new industrial prospects develop in the Thornburg Development District, immediate wastewater treatment capacity will be required. Pumping capacity to the Massaponax WWTP will be easier to expedite than expansion of the Po-Ni WWTP. It is likely that some reserve capacity will already be available at the Massaponax WWTP.

2. Unknown future VPDES Permit conditions: Due to the limited low-flow characteristics of the Po-Ni River, more stringent future discharge limits are more probable than for the Rappahannock River discharge.

3. WWTP manpower utilization flexibility. Manpower can be more effectively utilized at two wastewater treatment plants than at three.

4. Unknown environmental issues in the Mattaponi Basin. East of I-95, the Mattaponi River supports significant wetlands and possible other wildlife habitat and cultural resources and is under consideration as a water supply resource for Newport News; impact of these issues is unknown. By contrast, the Massaponax WWTP discharges to a tidal, brackish reach of the Rappahannock River; although water supply use of the river is possible, such a use is not likely to impact Massaponax WWTP discharge.

On the basis of annual budget projections and the above four non-cost issues, it is recommended that sewage from the Thornburg Development District be pumped to the Massaponax Creek Interceptor for treatment at an expanded Massaponax WWTP.

5.3 Wastewater Collection for the Thornburg Development District

Regardless of the method of providing wastewater treatment for the Thornburg Development District, a system of interceptors and trunk mains are required to fully sewer the Thornburg Development District. These sewers are shown on Figure 3 and include the following:

1. A 10" to 24" Ni River Interceptor extending up-gradient 15,600 feet to the west from the WWTP to the upper limit of the Thornburg Development District.

2. A 10" to 18" trunk main extending from the Ni River Interceptor up-gradient 4,600 feet to the north and a 12" trunk main extending up-gradient 3,800 feet to the south. These trunk mains allow full service to the portion of the Ni River basin between Route 1 and I-95.

3. A 42" Lower Po River Interceptor extending up-gradient 5,700 feet along the Po River to the west side of I-95 and an 18" to 24" Upper Po River Interceptor extending up-gradient an additional 11,800 feet along the Po River to the upper limit of the Thornburg Development District. The interceptor would serve Indian Acres.

4. A 30" Thornburg Trunk Main extending up-gradient from the Po River Interceptor 6,700 feet to the south to Route 606, to pick up the existing Thornburg WWTP collection system and wastewater generated in the Matta River drainage basin.

5. A 10" trunk main extending up-gradient from the Po River Interceptor 3,600 feet to the north and a 10" to 12" trunk main extending up-gradient 5,000 feet to the south. These trunk mains allow full service to the Po River drainage basin.

6. A 3200 gpm Matta Sewage Pumping Station on the Matta River at the Caroline County line and an 18" force main extending from the Matta Sewage Pumping Station to the Thornburg Trunk Main, to convey all sewage from the Matta River drainage basins to the Po River Interceptor. The pumping station and force main are sized to accommodate build-out demands in the Matta River drainage basins, with an additional 3-mgd undesignated industrial demand. The existing industrial complex pump station and force main are adequate for service until the undesignated industrial complex is built.

7. A 12" Matta River Interceptor extending from the Matta Sewage Pumping Station up-gradient 4,700 feet to the west to the upper limit of the Route 1-Thornburg Industrial Development Area.

8. A 24" Matta Trunk Main extending from the Matta Sewage Pumping Station up-gradient 3,000 feet to the north parallel to the Caroline County line. This trunk main serves the existing Thornburg industrial area and has been sized to accommodate build-out demands in the Matta River drainage basins, with an additional 3-mgd undesignated industrial demand.

Sanitary sewer interceptors and trunk mains designed for the Thornburg Development District have been sized based on build-out flow rates at minimum pipe slopes. Design of the sanitary

Figure 3 – Thornburg Development District Interceptors and Trunk Mains

sewer improvement will be based on actual slopes encountered, which may enable a smaller pipe size to handle the build-out flow.

The estimated capital cost for the eight proposed interceptors and trunk mains is included in Table 5.5. Costs are based on 2000 dollars and include engineering fees, and contractor's overhead and profit.

Table 5.5 – Thornburg Development District Sewage Collection Capital Costs

Component	Capital Cost
Ni River Interceptor	$ 1,496,000
Ni River Trunk Mains	$766,000
Po River Interceptor	$2,674,000
Thornburg Trunk Main	$1,279,000
Po River Trunk Mains	$749,000
Matta River Pump Station and Force Main	$1,738,000
Matta River Interceptor and Trunk Main	$765,000
Total Cost	$9,467,000

5.4 Hazel Run Sewage Collection System

Hazel Run Between Route 3 and City of Fredericksburg

The existing Hazel Run sewage collection system in Spotsylvania County does not drain by gravity to an interceptor system along Hazel Run. The Hazel Run drainage area is a residential region with residential-supported commercial development along major corridors. The area was developed over the last 20 to 30 years by numerous developers, without the benefit of a development plan. Consequently, individual wastewater collection systems were provided for individual developments rather than for the entire drainage basin.

Sewage from the drainage basin is collected by a series of pump stations and pumped either to a trunk main or another pump station, depending on proximity. Fifteen pump stations are scattered throughout the Hazel Run drainage basin. Four pump stations are located north of Route 3 and pump sewage from the residential and commercial property across Route 3 into the Hazel Run drainage basin. These properties drain toward the Rappahannock River, which has not sewage collection system; thus, these pump stations are necessary to pump the sewage back to the Hazel Run drainage basin. Eleven pump stations within the Hazel Run drainage basin, south of Route 3, could be replaced with a gravity interceptor and trunk main system.

The existing Spotsylvania County Hazel Run collection system flows into the City of Fredericksburg through a gravity sewer adjacent to Route 1 and along an unnamed tributary

adjacent to the City limits until it reaches Hazel Run. The City monitors the quantity of sewage entering the City of Fredericksburg from Spotsylvania County and an equal amount of sewage is pumped by the City of Fredericksburg to the Spotsylvania County FMC wastewater treatment plant.

Many existing and all future sewage pump stations in Hazel Run drainage basin can be eliminated and the sewage conveyed to a new Hazel Run interceptor and trunk main system. Figure 4 locates the proposed Hazel Run Interceptor and two trunk mains to serve all sub-basins within the drainage basin.

The proposed Hazel Run Interceptor would receive flow from the four existing pump stations north of Route 3. A small length of existing 8-inch sewer between Route 3 (H-8) and H-7 can be incorporated into the proposed interceptor. The interceptor follows Hazel Run to the point where it enters the City of Fredericksburg and includes 2,000 feet of 10-inch, 1,300 feet of 12-inch, 6,000 feet of 18-inch, 10,400 feet of 24-inch, and 2600 feet of 30 inch along Hazel Run. Two 8-inch trunk mains - the Route 3 trunk main and the Long Branch Interceptor - flow into the Hazel Run Interceptor before it connects to the City of Fredericksburg sewage collection system.

The Route 3 trunk main would collect wastewater from residential and commercial property south of Route 3 and west of Interstate 95 and includes 5,800 feet of 10-inch sewer. The Long Branch Interceptor drains the southern part of the Hazel Run drainage basin, south of Harrison Road and between Interstate 95 and Route 1. The proposed Long Branch Interceptor includes 4,800 feet of 12-inch, 4,300 feet of 18-inch, and 6,300 feet of 24-inch pipe.

Construction of the Hazel Run Interceptor, Route 3 Trunk Main, Long Branch Interceptor, and the necessary 8-inch collectors will eliminate eleven existing sewer pump stations and allow all future development within the Hazel Run drainage basin to drain by gravity to the Hazel Run Interceptor.

To facilitate calculation of interceptor and trunk main pipe sizes at build-out, the proposed Hazel Run Interceptor was divided into 7 segments. An additional 9 segments were created for the Route 3 Interceptor, the Long Branch Interceptor and smaller trunk mains and collector sewers. Figure 4 locates all required sanitary sewers larger than 8” diameter within the drainage basin.

For each segment of interceptor and trunk main, the sum of all upstream drainage area sub-basin average annual dry weather water demand at build-out was calculated. The build-out water demands, developed and presented in Part 3 of this document, were increased by a 50% infiltration factor to account for infiltration and inflow. The average sewer flows were then multiplied by a 2.5 flow peaking factor to arrive at a design sewage flow. A minimum sanitary sewer size was defined, based on minimum slope for each pipe diameter. Table 5.6 summarizes the pipe sizes.

Sanitary sewer interceptors and trunk mains designed for the Hazel Run drainage basin have been sized based on build-out sewage flow rates at minimum pipe slopes. Design of the sanitary sewer improvement will be based on actual slopes encountered, which may enable a smaller pipe size to handle the build-out flow.

Figure 4 – Hazel Run Drainage Basin Interceptors and Trunk Mains

Table 5.6 – Hazel Run Drainage Basin, Interceptor and Trunk Main Sizes

Pipe Segment	Current Ave Water Demand	Ave Sewage Flow at Build-out	Peak Sewage Flow at Build-out	Build-out Pipe Size	Existing Pipe Size
Route 3 Interceptor					
H-10 to H-9	190,185 gpd	203,770 gpd	509,424 gpd	10	None
Hazel Run Branch Interceptor					
H-8 to H-7	168,851 gpd	231,219 gpd	578,048 gpd	10	8
H-7 to H-6	250,256 gpd	394,028 gpd	985,070 gpd	12	None
H-6 to H-5	454,784 gpd	502,811 gpd	1,257,026 gpd	18	None
H-5 to H-4	504,367 gpd	623,420 gpd	1,558,550 gpd	18	None
H-4 to H-3	570,605 gpd	988,409 gpd	2,471,023 gpd	24	None
H-3 to H-2	601,945 gpd	1,036,213 gpd	2,590,533 gpd	24	None
H-2 to H-1	1,143,778 gpd	2,458,436 gpd	6,146,091 gpd	30	Unknown
Long Branch Interceptor					
L-5 to L-4	178,195 gpd	353,272 gpd	883,180 gpd	12	None
L-4 to L-3	192,833 gpd	438,778 gpd	1,096,946 gpd	18	None
L-3 to L-2	364,655 gpd	846,889 gpd	2,117,222 gpd	18	None
L-2 to L-1	406,842 gpd	1,028,103 gpd	2,570,257 gpd	24	None
L-1 to H-2	474,312 gpd	1,225,163 gpd	3,062,908 gpd	24	None

The current gravity collection systems in the Hazel Run and Long Branch drainage areas are located based on the pump station locations and existing gravity sewer does not exist between many of the points shown in Figure 4 and the previous table. The sewers proposed in the previous table are needed to accommodate future flows and to eliminate existing sewage pump stations.

Hazel Run Inside the City of Fredericksburg

The proposed Spotsylvania County Hazel Run Interceptor will flow into the City of Fredericksburg at junction H-2 as shown in Figure 4. This flow will join the City of Fredericksburg's Hazel Run Interceptor at junction H-1 (MH 4432 in the 2001 Whitman, Requardt and Associates report; refer to Appendix C). A small area of the Hazel Run drainage basin drains eastward and enters the City of Fredericksburg at junction H-9 (MH 9024 in the 2001 Whitman, Requardt and Associates report).

By contract to HSMM, Whitman, Requardt and Associates analyzed the existing City of Fredericksburg sanitary sewer system to identify future required upgrades, to meet City growth

and build-out sewage flow from Spotsylvania County. Table 5.7 summarizes the required improvements.

Table 5.7 – Required Improvements to Hazel Run Interceptor Inside City of Fredericksburg

From MH	To MH	Length (feet)	Existing Pipe Size	Size Required to Meet City Flow	Size Required to Meet City & County Flow
MH 9024	MH 9022	500	15”	Two 15”	Two 15”
MH 9022	MH 9014	1960	15”	15”	15”
MH 9014	MH 9011	952	15”	Two 15”	Two 15”
MH 9011	MH 9001	3520	15”	15”	15”
MH 9001	MH 4421	504	24”	24”	24”
MH 4421	MH 4412	1449	24”	24”	Two 24”
MH 4412	MH 4411	151	24”	30”	Two 24”
MH 4411	MH 4407	1069	24”	24”	Two 24”
MH 4407	MH 4401	1273	24”	Two 24”	24” & 30”
MH 4401	MH 4007	2625	24”	24” & 30”	24” & 36”
MH 4007	MH 2100	5352	24”	24” & 36”	24” & 42”
MH 2100	MH 2099	340	27”	27” & 36”	27” & 42”
MH 2099	MH 0002	414	30”	30” & 36”	30” & 42”
MH 0002	MH PS	947	39”	39” & 48”	39” & 48”

Note: All lengths and pipe sizes required are based on letter summary of City of Fredericksburg Hazel Run Interceptor by Whitman, Requardt & Associates, dated January 15, 2001; refer to Appendix C

Table 5.7 demonstrates that the majority of the City of Fredericksburg Lower Hazel Run Interceptor will need to be upgraded to handle future flows developed in the City of Fredericksburg. Addition of the future flows from Spotsylvania County will result in a larger upgrade size from MH 4407 to the pump station. A small portion of the upper length of the interceptor will need to be upgraded to handle flows from the City of Fredericksburg, but no further increase is needed to handle flows from the Route 3 Interceptor from Spotsylvania County.

Bypass City of Fredericksburg

In lieu of gravity sewer flow along Hazel Run through the City of Fredericksburg, it may be possible to construct a Hazel Run Pumping Station and pump flow into the Massaponax Creek

drainage basin. The facilities within the City of Fredericksburg would require the following components:

- A duplex submersible pump station located on Hazel Run at the City of Fredericksburg city limits. The pump station would pump the build-out design sewage flow of 4,700 gpm.

- A 24-inch force main from the Hazel Run pump station located within a developed region of Spotsylvania County, most likely along or parallel to Route 1.

- A duplex submersible pump station located where the Route 3 Interceptor flows into the City of Fredericksburg. The pump station would pump the build-out design sewage flow of 472 gpm from the Route 3 Interceptor into the Hazel Run Interceptor.

- An 8-inch force main from the Route 3 pump station.

- A 10-inch gravity sewer main collecting flow from the Route 3 force main and connecting to the Hazel Run Interceptor.

- A 30-inch gravity sewer collecting flow from the Hazel Run force main and connecting to the Massaponax Creek drainage basin.

Due to the magnitude of the required improvements, it does not appear cost-effective to by-pass the City of Fredericksburg. Continued gravity flow through the City of Fredericksburg is recommended. Current utilities agreements between the City and the County have provisions to accommodate these improvements. Capital costs are shared between the City and County based on the average daily flow proportions.

Capital Cost

The estimated capital cost to upgrade the City of Fredericksburg Hazel Run Interceptor is included in Table 5.8. Costs are based on 2000 dollars and include engineering fees, and contractor's overhead and profit.

Table 5.8 – Cost of Hazel Run Interceptor Improvements Inside City of Fredericksburg

Component	Capital Cost (City flow only)	Capital Cost (City and County flow)
MH 9024 to MH 9022	$53,500	$53,500
MH 9014 to MH 9011	$96,100	$96,100
MH 4421 to MH 4412	$0	$182,500
MH 4412 to MH 4411	$34,300	$22,300
MH 4411 to MH 4407	$0	$126,700
MH 4407 to MH 4401	$154,400	$255,800
MH 4401 to MH 4007	$515,900	$594,900
MH 4407 to MH 2100	$1,221,600	$1,449,000
MH 2100 to MH 2099	$79,000	$93,500
MH 2099 to MH 0002	$94,800	$112,400
MH 0002 to MH PS	$280,200	$280,200
Total Cost	$2,529,800	$3,266,900

Coordinated improvement to the City of Fredericksburg Hazel Run Interceptor, to meet future City and Spotsylvania County build-out sewage flows, will cost $3,266,900. Under the current utilities agreement, the City of Fredericksburg and Spotsylvania County will share financing of the new lines based on the percentage of average daily flow from each entity. In this option, the cost to Spotsylvania County would be about $800,000. However, project timing is a factor in apportioning project costs; if Spotsylvania County requires the Hazel Run Interceptor upgrade before the City, Spotsylvania County may be required to burden a larger share of the cost of Hazel Run Interceptor improvements due to a smaller average daily flow required by the City.

5.5 Deep Run Sewage Collection System

The existing Deep Run Interceptor extends up-gradient along Deep Run from the Deep Run pump station to Route 1. The interceptor consists of approximately 6500 feet of 15-inch sewer and 9300 feet of 18-inch sewer parallel to Deep Run. The Deep Run Pump station is located on the east side of Route 2. Existing force mains allow the Deep Run pump station to pump sewage to either the FMC Wastewater Treatment Plant or the Massaponax Creek Interceptor.

One existing collector main drains along a tributary to the Deep Run Interceptor. This collector includes 1500 feet of 8-inch pipe and 1000 feet of 12-inch pipe. In addition, as a part of the Deep Run sewer upgrade, a future 8-inch collector will be required to drain an area to the west of Route 2, and north of the military park.

Figure 5 – Deep Run Drainage Basin Interceptors and Trunk Mains

To assess the adequacy of the existing Deep Run Interceptor to handle build-out sewage flows, the interceptor was divided into six segments. An additional three segments of collector within the Deep Run drainage basin were also defined. The interceptor and trunk main segments are located on Figure 5.

For each segment of the Deep Run Interceptor and collector mains, the sum of all upstream drainage area sub-basin average annual dry weather water demand at build-out was calculated. The projected average annual water demands, developed and presented in Part 3 of this document, were increased by a 50% infiltration factor to account for infiltration and inflow. The average sewer flows were then multiplied by a 2.5 peaking factor to arrive at a design sewage flow. A minimum sanitary sewer size was defined, based on minimum slope for each pipe diameter. Below is a tabulation of the pipe sizes.

Sanitary sewer interceptors and trunk mains designed for the Deep Run drainage basin have been sized based on build-out sewage flow rates at minimum pipe slopes. Design of the sanitary sewer improvement will be based on actual slopes encountered, which may enable a smaller pipe size to handle the build-out flow.

Table 5.9 – Deep Run Drainage Basin Interceptor and Trunk Main Sizes

Pipe Segment	Current Average Water Demand	Ave Sewage Flow at Build-out	Peak Sewage Flow at Build-out	Build-out Pipe Size	Existing Pipe Size
D-9 to D-8	46,721 gpd	310,728 gpd	776,820 gpd	12”	15”
D-8 to D-7	93,441 gpd	435,019 gpd	1,087,548 gpd	18”	15”
D-7 to D-3	103,120 gpd	446,333 gpd	1,115,833 gpd	18”	18”
D-3 to D-2	297,764 gpd	959,360 gpd	2,398,401 gpd	24”	18”
D-2 to PS-1	306,984 gpd	1,111,201 gpd	2,778,003 gpd	24”	18”
PS-1 to D-1	311,057 gpd	1,314,953 gpd	3,287,383 gpd	12” (FM)	12”

Table 5.9 also defines the diameter of existing sewers along the alignment of the required Deep Run Interceptor. Based on available sewer maps, some segments of the existing Deep Run Interceptor are adequate to handle build-out sewer flows in the drainage basin. The new sewer requirements have been itemized and included in the CIP.

5.6 Regional Wastewater Treatment for Primary Settlement Area – Expand FMC Wastewater Treatment Plant

Two options for regional wastewater treatment in the Primary Settlement Area of Spotsylvania County have been investigated. They include:

- Maintain in service and upgrade and expand both the FMC WWTP and the Massaponax WWTP. The FMC WWTP would serve the Deep Run and Hazel Run drainage basins within Spotsylvania County and provide 1.5 mgd of sewage treatment capacity to the City of Fredericksburg. The Massaponax WWTP would serve the Massaponax Creek drainage basin. Approximately 1 mgd of sewage would be pumped by the Deep Run pump station to the Massaponax WWTP, to limit FMC WWTP build-out capacity to 6 mgd.

- Abandon the FMC WWTP and pump all sewage to the Massaponax WWTP (Single Regional WWTP)

Maintain FMC Wastewater Treatment Plant

Expansion of the FMC WWTP to 6.0 mgd would enable the plant to handle all but 1 mgd of sewage from the Deep Run and Spotsylvania County portion of Hazel Run/Long Branch drainage basins and provide 1.5 mgd of sewage treatment capacity to the City of Fredericksburg (in accordance with the 1983 City-County Annexation Agreement). As tabulated below, approximately 1 mgd of sewage would be pumped to the Massaponax WWTP, to limit FMC WWTP build-out capacity to 6 mgd.

Table 5.10 - FMC Wastewater Treatment Plant Build-Out Sewage Flows

Drainage Basin	Current Average Water Demand	Build-out Average Water Demand	Build-out Maximum Month Sewage Flow
Hazel Run	1.33 mgd	2.30 mgd	3.45 mgd
Deep Run	0.32 mgd	1.37 mgd	2.05 mgd
City of Fredericksburg	0.50 mgd	1.50 mgd	1.50 mgd
Pump to Massaponax WWTP			(1.00 mgd)
Total Flow to FMC WWTP	2.15 mgd	5.17 mgd	6.00 mgd

With the exception of the chlorine contact tanks and sludge handling facilities, the FMC WWTP already has a 6-mgd capacity and the plant can achieve the current VPDES Permit effluent concentrations for a design flow of 6.0 mgd (Effluent limits are 15 mg/l $CBOD_5$ and TSS, May-October TKN of 3 mg/l, November-April ammonia of 13.2 mg/l, total phosphorus of 2.0 mg/l and non-detectable total residual chlorine). Therefore, FMC WWTP expansion to 6.0 mgd capacity can be accomplished at a reduced capital cost as compared to a 2-mgd expansion at the Massaponax WWTP. Expansion of the sludge handling facilities would not be required, because

partially stabilized, mechanically dewatered sludge will be trucked to a regional sludge handling facility at the Livingston Landfill.

However, FMC WWTP expansion beyond 6-mgd capacity would be far more costly because property adjacent to the WWTP is not available to accommodate the expansion and expansion would involve additional capacity in all treatment processes. For this reason, FMC WWTP expansion and upgrade beyond 6-mgd capacity has not been considered.

Components of Expanded FMC WWTP Sewerage System

Components of the expanded and upgraded FMC WWTP sewerage system include:

1. Upgrade the WWTP to meet total nitrogen limits of 8 mg/l. Convert one of the three existing aeration lagoons to an anoxic mixing lagoon by replacing floating aerators with floating mixers. Re-build the flow splitter channel and influent pipes to direct all raw sewage and return activated sludge to the converted anoxic lagoon and to direct effluent from the anoxic lagoon to the two aerobic lagoons. Install nitrate recycle pumps at the effluent end of the two aerobic lagoons and provide force mains to convey nitrified mixed liquor to the anoxic lagoon.

2. Rebuild major process equipment to extend the useful life of the plant. Overhaul or replace the grit dewatering screws, bar screen media/teeth, clarifier drives, return sludge pumps, clarifier scum pumps, sludge holding tank aerators, and sludge dewatering belt filter press.

3. Provide a third chlorine contact tank and larger chlorination and dechlorination feeders.

Capital Costs

Capital cost to expand the FMC WWTP is estimated at $1,761,000 shown in Table 5.11. Costs are in 2000 dollars and includes engineering.

Table 5.11 – Capital Costs to Expand FMC Wastewater Treatment Plant

Component	Capital Cost
Upgrade WWTP for Total Nitrogen Removal	$404,000
Rebuild Major Process Equipment	$1,203,000
Expand Chlorination/Dechlorination Systems	$ 154,000
Total Cost	$1,761,000

An equivalent 2-mgd expansion of the Massaponax WWTP is estimated to cost $3,000,000 (one half the $6,000,000 capital cost for Massaponax WWTP expansion from 8 mgd to 12 mgd as defined in the Stage I Design Preliminary Engineering Report).

Personnel

Currently the FMC WWTP has a 12-person operating crew consisting of one chief operator, one Class II shift operator, three Class III shift operators, two trainees, one laborer, two maintenance personnel (assigned to all Spotsylvania County WWTP maintenance), and two laboratory technicians as the regional WWTP laboratory (currently located at the FMC WWTP). If the FMC WWTP were expanded to 6 mgd, one additional trainee would be added to the staff.

O&M Costs

Annual operating costs for the 6-mgd FMC WWTP have been calculated by comparing the 1999-2000 annual operating budgets for the existing FMC WWTP with the anticipated staff, operating horsepower, and average annual flows for the expanded WWTP. Proposed annual operating budget for the existing and expanded FMC WWTP are tabulated below.

Table 5.12 – Annual Operating Budget for FMC Wastewater Treatment Plant

Budget Line Items	Existing WWTP 2.3 mgd	Existing WWTP 4 mgd	Expanded WWTP 6 mgd
Budget for Total Staff	$476,635	$476,635	$517,000
Electric Service	$ 135,000	$ 235,000	$352,000
Chemicals	$ 49,500	$ 86,000	$ 129,000
Other Operating Expenses	$ 232,098	$232,098	$233,000
Capital Outlay	$ 56,683	$ 56,683	$ 57,000
Total Annual Budget	$949,916	$1,086,416	$1,288,000

5.7 Regional Wastewater Treatment for Primary Settlement Area – Abandon FMC Wastewater Treatment Plant

If the FMC WWTP were to be abandoned, the entire projected build-out sewage flow from the Primary Settlement Area would be treated at the Massaponax WWTP. Required modifications to the sewerage system include:

- Additional 6-mgd expansion of the Massaponax WWTP.
- Transfer sewage from the Hazel Run/Long Branch drainage basin in Spotsylvania County to the Massaponax Creek Interceptor.
- Transfer all sewage from the Deep Run drainage basin to the Massaponax Creek Interceptor

- Amend the City-County Sewer Agreement must be amended to eliminate treatment of City sewage at the FMC WWTP

Convey Deep Run Drainage Basin to Massaponax WWTP

Deep Run sewage can be pumped to Massaponax Creek Interceptor using the existing Deep Run pumping station and force main.

Convey Hazel Run/Long Branch Drainage Basin to Massaponax WWTP

Hazel Run and Long Branch sewage currently flow to the City of Fredericksburg Hazel Run Trunk Sewer and thence to the City WWTP. From there, the quantity of the sewage that flows into the City is pumped to the FMC WWTP. To abandon the FMC WWTP, sewage from Spotsylvania County must be intercepted (where Hazel Run enters the City of Fredericksburg) and pumped to the Massaponax Creek Interceptor.

Use of the existing Spotsylvania County Cafarro sewage pumping station, to pump Hazel Run and Long Branch sewage to Massaponax Creek Interceptor, was investigated. The Cafarro sewage pumping station is located on Hazel Run at Route 1 and has a 12" force main discharging to the Massaponax Creek Interceptor. The pumping station was taken out of service in 1986. It is probable that the pumping station can be upgraded to the 6000-gpm peak pumping capacity (2.30-mgd average annual flow + infiltration allowance x 2.5 peaking factor) required to transfer all sewage from the Hazel Run and Long Branch drainage basins to the Massaponax Creek Interceptor. Unfortunately, the 14,000 feet force main will limit peak pumping capacity to about 2000 gpm, which is not adequate for the application.

A new Hazel Run Sewage Pumping Station and 24" force main would be required to transfer all sewage from the County portion of the Hazel Run and Long Branch drainage basins to the Massaponax Creek Interceptor. Capital cost for a new Hazel Run Sewage Pumping Station and 20,000 feet of 24" force main has been estimated at $4,319,000 and annual operating cost for the pumping station has been estimated at $51,000.

Additional 6-mgd Expansion of the Massaponax WWTP

A 6-mgd expansion of the Massaponax WWTP is estimated to cost $18,000,000. Annual operating costs would increase by $750,000.

Cost Summary

Capital costs and annual operating costs to abandon the FMC WWTP and divert all sewage to the expanded Massaponax WWTP are tabulated below. Personnel cost for the Hazel Run Sewage Pumping Station is assumed to be zero; operation and maintenance will be handled by County personnel with responsibility for O&M of all County sewage collection systems and sewage pumping stations.

Table 5.13 – Costs to Abandon FMC Wastewater Treatment Plant

Component	Capital Cost	Annual Operating Costs
Expand Massaponax WWTP by 6 mgd	$18,000,000	$750,000
Hazel Run Sewage Pumping Station	$4,319,000	$51,000
Total Cost	$22,319,000	$801,000

Expansion and upgrade of the FMC WWTP from 4-mgd capacity to 6-mgd capacity was estimated at $1,761,000 and annual operating costs for the 6-mgd FMC WWTP was estimated at $1,288,000. Therefore, upgrade and expansion of the FMC WWTP to 6-mgd capacity is recommended.

5.8 Upgrade and Expansion of Massaponax WWTP

Massaponax WWTP Capacity

The existing 6-mgd Massaponax WWTP will be expanded and upgraded to treat wastewater from all drainage basins of the Primary Settlement Area except Hazel Run and Deep Run and to treat wastewater from the Thornburg Development District. Required Massaponax WWTP capacity at build-out is shown in Table 5.14.

Table 5.14 – Massaponax Wastewater Treatment Plant Build-Out Sewage Flows

Drainage Basin	Current Average Water Demand	Build-out Average Water Demand	Build-out Maximum Month Sewage Flow
Massaponax Creek	2.50 mgd	8.45 mgd	12.68 mgd
American Central	0.19 mgd	0.59 mgd	0.89 mgd
Courthouse Area	0.00 mgd	0.80 mgd	1.20 mgd
Hazel Run	0.02 mgd	0.10 mgd	0.15 mgd
Rappahannock River	0.07 mgd	0.43 mgd	0.65 mgd
Transfer from FMC	0.00 mgd		1.00 mgd
Thornburg Development District	0.00 mgd	5.75 mgd	7.14 mgd
Total Flow	2.78 mgd	16.12 mgd	23.71 mgd

Design for upgrade and expansion of the Massaponax WWTP from 6 mgd to 8 mgd has been completed and construction is scheduled for completion in November 2002. Further WWTP

expansion to 24-mgd capacity is recommended. The following cost for the expansion from 6 to 8-mgd is the actual project bid price. Subsequent expansion costs are estimated at $3/gallon.

Table 5.15 – Costs to Expand Massaponax Wastewater Treatment Plant

Plant Expansion	Capital Cost	Annual O&M Cost
Expand Existing 6-mgd WWTP to 8 mgd	$23,000,000	$2,000,000
Expand 8-mgd WWTP to 12 mgd	$12,000,000	$2,500,000
Expand 12-mgd WWTP to 16 mgd	$12,000,000	$3,000,000
Expand 16-mgd WWTP to 24 mgd	$24,000,000	$4,000,000

Personnel

Currently the Massaponax WWTP has a 12-person operating crew consisting of one wastewater treatment supervisor (responsible for all Spotsylvania County WWTP's), one chief operator, one Class II shift operator, three Class III shift operators, three trainees, two laborers, and one maintenance superintendent (for all Spotsylvania County WWTP maintenance). When the Massaponax WWTP is expanded to 8 mgd, four additional Class III shift operators will be required. For further expansion to 12 mgd, one trainee and one laborer would be added. For further expansion to 16 mgd, add four Class III shift operators and one assistant chief operator. For further expansion to 24 mgd, add four Class III shift operators and one assistant chief operator.

5.9 American Central System

The American Central sewer conveyance system is a series of pump stations, force mains, and gravity sewers serving residential development around Fawn Lake. The system consists of a single sewage transmission line, paralleling an abandoned railroad grade. This conveyance system ties into a trunk main of the Massaponax Creek Interceptor at Route 627 (Gordon Road).

According to the 1994 Spotsylvania County Water/Sewer Master Plan, the American Central System included 7 pump stations ranging in capacity from 0.76 mgd (528 gpm) to 1.40 mgd (972 gpm), over 15,000 feet of 6-inch and 12-inch force main, and over 26,000 feet of 15-inch through 18-inch gravity sewer. The capacity of the gravity sewer was a minimum of 4.32 mgd, three times the largest pump station capacity.

Within the Water/Sewer Master Plan Revisions, the American Central drainage basin includes all sub-basins that drain into the American Central sewer conveyance system and are west of the point where the system flows by gravity to the Massaponax Creek Interceptor. This drainage basin includes five sub-basins in the area surrounding Fawn Lake. These sub-basins are not currently connected to the American Central system, so future sewage pumping stations would be required to incorporate them. In addition, six existing sewage pump stations collect flow

from development along the length of the American Central sewer conveyance system. These pump stations are tabulated in Section 4.2. Based on available sewer maps, existing force mains range in size from 4-inch to 12-inch and gravity sewers range in size from 8-inch to 18-inch.

To assess the adequacy of the existing American Central conveyance system to handle build-out sewage flows, the system was divided into 16 segments. Additional segments of collector sewers within the American Central drainage basin were also defined, to facilitate sizing of all sanitary sewers larger than 8" diameter within the drainage basin. The American Central System is shown on Figure 6.

For each segment of the sewer conveyance system, the sum of all upstream drainage area sub-basin average annual dry weather water demand at build-out was calculated. The projected water demands, developed and presented in Part 3 of this document, were increased by a 50% infiltration factor to account for infiltration and inflow. The average sewer flows were then multiplied by a 2.5 flow peaking factor to arrive at a design sewage flow. A minimum gravity sanitary sewer size was defined, based on minimum slope for each pipe diameter. Force main sizes are based on pump capacity rather than build-out sewage flow.

Table 5.16 shows the cumulative flow demands for current and build-out conditions, the existing pipe sizes, where known, and the required build-out pipe size. Build-out pipe sizes from pump stations include both the pipe size required for the force main and the gravity sewer.

Table 5.16 – American Central System Gravity Sewer and Force Main Sizes

Pipe Segment	Current Average Water Demand	Ave Sewage Flow at Build-out	Peak Sewage Flow at Build-out	Build-out Pipe Size (FM/G)	Existing Pipe Size
PS-612 to PS-611	37,755 gpd	94,686 gpd	236,714 gpd	4"/8"	8"
PS-611 to PS-610	51,632 gpd	140,676 gpd	351,689 gpd	6"/8"	4"
PS-610 to PS-609	59,515 gpd	167,633 gpd	419,083 gpd	6"/8"	Unknown
PS-609 to PS-608	64,855 gpd	234,610 gpd	586,526 gpd	8"/10"	Unknown
PS-608 to PS-607	90,593 gpd	422,473 gpd	1,056,181 gpd	10"/12"	6"
PS-607 To M-604	90,593 gpd	584,203 gpd	1,460,508 gpd	12"/18"	15"
M-604 to PS-606	90,750 gpd	592,441 gpd	1,481,103 gpd	--/18"	15"
PS-606 to PS-605	90,750 gpd	592,441 gpd	1,481,103 gpd	12"/--	12"/15"
PS-605 to M-603	90,857 gpd	604,336 gpd	1,510,840 gpd	12"/18"	15"
M-603 to PS-604	91,126 gpd	625,825 gpd	1,564,562 gpd	--/18"	18"
PS-604 to M-602	91,126 gpd	625,825 gpd	1,564,562 gpd	12"/--	12"
M-602 to M-601	91,126 gpd	671,989 gpd	1,679,973 gpd	--/18"	18"

M-601 to PS-603	91,126 gpd	688,223 gpd	1,720,558 gpd	--/18”	16”/18”
PS-603 to PS-602	91,126 gpd	688,223 gpd	1,720,558 gpd	12”/--	12”/15”
PS-602 to PS-601	106,115 gpd	714,757 gpd	1,786,892 gpd	12”/18”	18”
PS-601 to M-507	193,548 gpd	808,807 gpd	2,022,019 gpd	12”/18”	18”

Sanitary sewer interceptors and trunk mains proposed for the American Central drainage basin have been sized based on peak build-out flow rates at minimum pipe slopes. Design of the actual sanitary sewer improvement will be based on actual slopes encountered, which may enable a smaller pipe size to handle the build-out flow.

Based on available sewer maps, many segments of the American Central conveyance system are adequate to handle build-out sewer flows. The following table summarizes the thirteen pump stations required to fully sewer the American Central system. All pump stations are in need of replacement due to deteriorating conditions. New pump sizes are based on the accumulated upstream build-out sewer flows presented in the previous table.

Table 5.17 – American Central System, Build-out Pumping Station Requirements

Pump Station	Existing Pump Rate (where applicable)	Peak Sewage Flow at Build-out	Proposed Future Pump Rate
PS-612	No existing pump station	160 gpm	2@ 160 gpm
PS-611	No existing pump station	245 gpm	2@ 245 gpm
PS-610	No existing pump station	290 gpm	2@ 290 gpm
PS-609	No existing pump station	410 gpm	2@ 410 gpm
PS-608	No existing pump station	730 gpm	2@ 730 gpm
PS-607	No existing pump station	1020 gpm	2@ 1020 gpm
PS-606	No existing pump station	1030 gpm	2@ 1030 gpm
PS-605	600 gpm	1050 gpm	2@ 1050 gpm
PS-604	700 gpm	1090 gpm	2@ 1090 gpm
PS-603	700 gpm	1200 gpm	2@ 1200 gpm
PS-602	700 gpm	1240 gpm	2@ 1240 gpm
PS-601	700 gpm	1400 gpm	2@ 1400 gpm
PS-613	No existing pump station	115 gpm	2@ 115 gpm

Due to the layout of the American Central conveyance system, it is not feasible to eliminate existing pump stations, with the exception of existing pump station #20. Each pump station serves an existing sub-basin, which cannot be drained by gravity into the Massaponax Creek

drainage basin. Pump station #20 receives flow from the American Central system, but is located in the Massaponax Creek drainage area. With the construction of a gravity sewer to the Massaponax Creek Interceptor, the pump station can be removed from service.

5.10 Massaponax Creek Collection System

The existing Massaponax Creek Interceptor extends up-gradient along Massaponax Creek from the Massaponax WWTP to Route 3. According to the 1994 Spotsylvania County Water/Sewer Master Plan, the interceptor consists of approximately 34,000 feet of 24" and 30" sewer between Massaponax WWTP and Route 1, approximately 13,500 feet of 18" sewer between Route 1 and Route 208, and approximately 32,800 feet of 15" and 18" sewer between Route 208 and Route 3.

To assess the adequacy of the existing Massaponax Creek Interceptor to handle build-out sewage flows, the interceptor was divided into 22 segments. An additional 35 segments of trunk main and collector within the Massaponax Creek drainage basin were also created, to facilitate sizing of all sanitary sewers larger than 8" diameter within the drainage basin. The interceptor and trunk main segments are located on Figure 6.

For each segment of interceptor and trunk main, the sum of all upstream drainage area sub-basin average annual dry weather water demand at build-out was calculated. For the Courthouse trunk main and the Massaponax Interceptor between the Courthouse trunk main intersection and the Massaponax Wastewater Treatment Plant, proposed build-out pipe slopes match slopes of existing pipes; as-built drawings were referenced to determine existing pipe slopes. The remaining trunk mains, connectors, and the upper lengths of the Massaponax Creek Interceptor are sized using minimum pipe slope for the appropriate pipe size. Design of the sanitary sewer improvement will be based on actual slopes encountered, which may enable a smaller pipe size to handle the build-out flow.

The build-out annual average water demands, developed and presented in Part 3 of this document, were increased by a 50% infiltration factor to account for infiltration and inflow. The average annual sewer flows were then multiplied by a 2.5 flow peaking factor to arrive at a design sewage flow. Any available capacity in the existing Massaponax Creek Interceptor was ignored. Flows in the Massaponax Interceptor are based on the construction of a pump station near the confluence of the Po and Ni Rivers, to pump sewage flow from the Thornburg Development District to the Massaponax Creek Interceptor. Table 5.18 lists the detailed requirements for the Massaponax Creek Interceptor.

Figure 6 – Massaponax Creek Drainage Basin Interceptors and Trunk Mains

Table 5.18 – Massaponax Creek Interceptor Build-out Pipe Sizes

Pipe Segment	Current Ave. Water Demand	Average Sewage Flow at Build-out	Peak Sewage Flow at Build-out	Build-out Pipe Size	Existing Pipe Size
Route 3 to Route 673					
M-22 to M-21		1,216,810 gpd	3,042,024 gpd	24”	15”
M-21 to M-20	69,851 gpd	2,570,429 gpd	6,426,073 gpd	36”	15”
M-20 to M-19	107,806 gpd	2,871,768 gpd	7,179,420 gpd	36”	18”
Route 673 to Route 208					
M-19 to M-18	113,307 gpd	3,422,207 gpd	8,555,517 gpd	36”	18”
M-18 to M-17	113,581 gpd	3,592,391 gpd	8,980,977 gpd	36”	18”
M-17 to M-16	116,283 gpd	3,697,334 gpd	9,243,335 gpd	36”	18”
M-16 to M-15	120,658 gpd	3,922,698 gpd	9,806,744 gpd	42”	18”
M-15 to M-14	138,843 gpd	4,353,040 gpd	10,882,600 gpd	42”	18”
Route 208 to Route 1					
M-14 to M-13	162,638 gpd	4,880,821 gpd	12,202,051 gpd	48”	18”
M-13 to M-12	162,638 gpd	5,194,477 gpd	12,986,192 gpd	48”	18”
M-12 to M-11	222,697 gpd	7,301,177 gpd	18,252,942 gpd	54”	18”
Route 1 to Railroad					
M-11 to M-10	227,144 gpd	7,553,163 gpd	18,882,908 gpd	54”	24”
M-10 to M-9	251,646 gpd	7,726,030 gpd	19,315,075 gpd	54”	24”
M-9 to M-8	252,939 gpd	7,991,546 gpd	19,978,864 gpd	54”	24”
M-8 to M-7	263,143 gpd	8,170,006 gpd	20,425,015 gpd	54”	24”
M-7 to M-6	275,761 gpd	8,329,349 gpd	20,823,373 gpd	54”	24”
M-6 to M-5	275,927 gpd	8,548,568 gpd	21,371,420 gpd	54”	24”
Railroad to Massaponax WWTP					
M-5 to M-4	276,687 gpd	8,817,837 gpd	22,044,593 gpd	54”	24”
M-4 to M-3	278,970 gpd	9,107,474 gpd	22,768,684 gpd	60”	24”
M-3 to M-2	278,970 gpd	16,947,165 gpd	37,867,912 gpd	72”	24”
M-2 to M-1	280,668 gpd	17,360,317 gpd	38,900,793 gpd	72”	30”

By comparing pipe size requirements at build-out to existing pipe sizes, it is evident that the entire Massaponax Creek Interceptor must be replaced or paralleled to meet build-out sewage demand in the drainage basin.

To prioritize replacement of the most deficient segments of the Massaponax Creek Interceptor, a pipe capacity factor was computed for each gravity sanitary sewer segment, as defined in Table 5.19. The capacity factor is the ratio of the existing pipe capacity to the existing sewage flow; existing sewage flow was calculated by applying the 50% infiltration factor and a 2.5 flow peaking factor to existing average annual water demands. Sewage flow capacity factor of one or less indicates that the current flow exceeds the design capacity of the existing pipe. The smaller the capacity factor, the more critical the pipe replacement is.

Table 5.19 – Massaponax Creek Interceptor Growth Factors

Pipe Segment	Existing Pipe Capacity	Existing Peak Sewage Flow	Capacity Factor (Capacity/Flow)
M-22 to M-21	1800 gpm	500 gpm	3.6
M-21 to M-20	900 gpm	1900 gpm	0.47
M-20 to M-19	900 gpm	2100 gpm	0.43
M-19 to M-18	1500 gpm	2600 gpm	0.58
M-18 to M-17	1500 gpm	2800 gpm	0.54
M-17 to M-16	1500 gpm	3100 gpm	0.48
M-16 to M-15	1500 gpm	3200 gpm	0.47
M-15 to M-14	1500 gpm	3800 gpm	0.39
M-14 to M-13	1500 gpm	4100 gpm	0.37
M-13 to M-12	1500 gpm	4100 gpm	0.37
M-12 to M-11	1500 gpm	5700 gpm	0.26
M-11 to M-10	2300 gpm	5900 gpm	0.39
M-10 to M-9	4300 gpm	6400 gpm	0.67
M-9 to M-8	4400 gpm	6600 gpm	0.67
M-8 to M-7	5100 gpm	6600 gpm	0.77
M-7 to M-6	5100 gpm	6600 gpm	0.77
M-6 to M-5	5100 gpm	6700 gpm	0.76
M-5 to M-4	4600 gpm	6800 gpm	0.68
M-4 to M-3	3500 gpm	6800 gpm	0.51
M-3 to M-2	3500 gpm	6800 gpm	0.51
M-2 to M-1	3200 gpm	6800 gpm	0.47

Based on the capacity factors, the majority of the Massaponax Creek Interceptor is undersized to handle the peak current flows. However, the segments from M-10 to M-15 are the most critical lengths of the Massaponax Interceptor and should be given highest priority for replacement. These segments begin down gradient from Route 1 and Interstate 95 and extend upstream past Route 208. Spotsylvania County is already proceeding with design of a parallel Massaponax Creek Interceptor from east of Interstate 95 (M-11) up gradient to Levells Road (between M-13 and M-14). This project is expected to be constructed in 2002.

The Massaponax Creek Interceptor segments with second highest priority for replacement are segments M-1 through M-4. These segments begin at the Massaponax WWTP and extend up gradient to the railroad crossing. Replacement of these segments is recommended for incorporation into the Capital Improvements Plan (CIP).

Spotsylvania Courthouse Area

The 1999 Revisions to Water/Sewer Master Plan for Courthouse Area recommended several wastewater collection and treatment system alternatives for the Spotsylvania Courthouse area.

Since the Wishner Wastewater Treatment Plant will not be expanded and is currently not providing adequate wastewater treatment, the wastewater treatment plant will be abandoned. To treat the sewage currently flowing to the Wishner WWTP, wastewater will be pumped to the adjacent Massaponax Creek drainage basin. A new pump station will be constructed along the Ni River, just downstream from the site of the existing Wishner WWTP, to collect wastewater from the Courthouse interceptor. The pump station will pump the flows to a discharge point along Route 628, near Courtland High School (M-401, as shown in Figure 6). From this point, the wastewater will flow by gravity to the Massaponax Creek Interceptor.

Within the Courthouse area, the existing wastewater collection system consists of gravity sewers, small pump stations, and force mains to convey sewage to the pump station on the Ni River. The 1999 Revisions to Water/Sewer Master Plan for Courthouse Area recommends construction of the new pump station along the Ni River and connecting gravity sewers to enable the small existing pump station (identified as #42) to be abandoned. Three additional pump stations will need to be constructed in the future to allow full development of the Courthouse Area. These pump stations are identified as PS-402, PS-403, and PS-404 in Figure 6. Construction of PS-402 will allow an existing pump station in that drainage area to be abandoned.