Chapter 3:

Subwatershed Condition

3.1 North Little Hunting Creek Subwatershed

The North Little Hunting Creek Subwatershed has an area of approximately 1,384 acres and contains the north portion of the Little Hunting Creek main stem. It is bounded to the west by Saul Road, Mariposa Place, and the intersection of Martha Street and Richmond Highway; to the south by Shaw Park Court; to the east by Fordson Road, Boswell Avenue, and Cornith Drive; and to the north by Collard Street and Popkins Lane. This subwatershed drains commercial and high-density residential areas located near Richmond Highway—the most heavily traveled roadway located in this subwatershed. A portion of Huntley Meadows Park is located on the western side of the subwatershed. The North Little Hunting Creek subwatershed is shown on Map 3.1 and its condition is summarized as follows.

North Little Hunting Creek Subwatershed Condition Summary

- Current imperviousness = 34% with majority of land use high-density residential
- Future imperviousness = 37%
- Two of seven crossings have moderate to severe impacts.
- A small number of BMPs (11) are not enough for the amount of paved area.
- The stream has been altered in upstream reaches and downstream reaches are actively widening.
- The habitat quality is poor with inadequate buffers.
- No erosion or head cuts were observed.
- Trash dumps were located at several places.

3.1.1 Subwatershed Characteristics

The stormwater runoff from this subwatershed drains into the northern portion of Little Hunting Creek, otherwise known as North Little Hunting Creek. The headwaters of North Little Hunting Creek begin at a storm drain system outfall located north of the Gum Springs area and east of Richmond Highway. North Little Hunting Creek first flows west to southwest and then changes its direction and flows south to southeast. The length of North Little Hunting Creek from its headwaters to the tidal section of the creek (located near Shaw Park Court) is approximately 2.2 miles.

Numerous smaller tributaries emerging from storm drain outfalls convey flows into North Little Hunting Creek along its length. Of these smaller tributaries, seven are of significant length ranging from 1,000 to 5,000 feet. The terrain in the subwatershed is flat with elevations ranging from 30 to 35 feet in the northern part to elevations of five to 10 feet in the southern part. The creek has a low-gradient slope of less than 0.20%.

The current impervious area in this subwatershed is 34% of the total area. Land use in the subwatershed is predominantly high-density residential and includes Huntley Meadows Park to the northwest and light-industrial and commercial districts along the Richmond Highway corridor. The existing and future land use in the North Little Hunting Creek subwatershed is described in Table 3.1. High-density residential currently comprises 28% of the subwatershed area. In the future, with ultimate buildout conditions, estate residential may be replaced by more dense residential development and the future imperviousness may increase to 37%. Parcels that are currently undeveloped (141 acres) and underutilized (16 acres) consist of more than 11% of the area and primarily have residential zoning. The county's GIS data showed that no wetland areas are located in this subwatershed.

Table 3.1 North Little Hunting Creek Land Use

Land Use Description	Land Use			
	Existing		Future	
	Area (acres)	%	Area (acres)	%
Open space, parks, and recreational areas	191	14	205	15
Estate residential	25	2	0	0
Low-density residential	57	4	0	0
Medium-density residential	140	10	540	39
High-density residential	473	34	317	23
Low-intensity commercial	71	5	62	5
High-intensity commercial	145	11	75	5
Industrial	18	1	4	0
Other	0	0	58	4
Unknown	2	0	2	0
Undeveloped	141	10	0	0
Road right-of-way (including shoulder areas)	121	9	121	9
Wetlands	0	0	0	0
TOTAL	1,384	100	1,384	100

The county's list of master plan drainage projects shows that seven of the eight identified projects in this subwatershed have been completed. Table 3.2 summarizes the type of master plan drainage project, project name/location, and current status. No cost estimates were available for these projects.

Table 3.2 North Little Hunting Creek Master Plan Drainage Projects

Type of Work	Project Name/Location
Completed projects	
Flood study	Little Hunting Creek
Install pipe along tributary LH-10	Little Hunting Creek
3,800 feet storm sewer and 1,650 feet road improvement	Gum Springs Ph. III
3,500 feet storm sewer and road improvement	Gum Springs Ph. III
Storm sewer and road improvement	Gum Springs Ph. V
Storm sewer and road improvement	Gum Springs Ph. IV
Road construction and storm drain	Gum Springs
Inactive project	
Replace culvert at Fordson Road north of Mount Vernon Plaza	Fordson Road

Ten complaints regarding standing water, yard flooding, or other miscellaneous flooding were registered with the county and included in the database files for this subwatershed. The locations of these complaints are shown on Map 3.1. The county has addressed one complaint by cleaning the pipe and the remaining complaints are referred to as private responsibilities. Based on the isolated locations of the complaints, this subwatershed does not appear to have major flooding problems.

The National Resources Conservation Service State Soil Geographic (STATSGO) database assigns a weighted hydrologic soil group index of 2.4 in the headwater region and a weighted hydrologic soil group index of 2.2 for the remainder of the subwatershed. This soil group index indicates that the soils in this subwatershed exhibit characteristics of hydrologic soil groups B and C. The hydrologic soil group classifications of A, B, C, and D explain the characterics of soil texture, permeability, and infiltration rate. Based on the soil group index values, the soils are more similar to hydrologic soil group B with moderately coarse texture and moderate infiltration rates. The county's GIS coverage for soils is incomplete for this subwatershed and shows small pockets of hydrologic soil groups C and D located in this subwatershed.

3.1.2 Storm Drain System Infrastructure

The subwatershed areas located east and west of Richmond Highway are drained through a network of storm drain pipe systems. The storm drain systems from this area have outfalls located at various smaller tributaries flowing into North Little Hunting Creek. These outfalls vary in size, ranging from 60 inches in diameter to a seven-foot by 10-foot box culvert. Most segments of the outfall channels have been altered with concrete lining or with riprap bed and bank protection. A network of storm drain pipe systems also serves most of the area surrounding the southern portion of the subwatershed. Huntley Meadows Park and Audubon Estates Mobile Home Park are drained by open channel systems.

Map 3.2 shows the location of all crossings and their impacts on the stream. The major road crossings in this subwatershed, starting from the upstream end of North Little Hunting Creek, are described as follows:

- Richmond Highway: The Gum Springs area storm drain system pipe outfall is located downstream of the Richmond Highway crossing. No impact on the stream was noted.

- Fordson Road: Stormwater runoff from neighborhood areas of Mount Vernon Square, Millway Meadows, and Hybla Valley Farms is collected and conveyed through a storm drain pipe system and the outfall, a double eight-foot by eight-foot box culvert, is located under Fordson Road. No impact on the stream was observed due to concrete lined channels on the downstream side as shown in Photo 3.1.
- Pelican Place: A double six-foot by six-foot box culvert does not appear to impact the stream.
- Audubon Avenue: A double six-foot by six-foot box culvert does not appear to impact the stream.
- Janna Lee Avenue: A 20-foot high concrete bridge with three, 50-foot spans had debris and sediment on the downstream side with a moderate impact as shown in Photo 3.2.
- Richmond Highway: An eight-foot high concrete bridge with a single, 40-foot span has no impact.
- East of Huntley Meadows Park: Two crossings are located in a new subdivision being constructed east of Huntley Meadows Park. One of the crossings is a 24-inch (diameter) concrete pipe that has a moderate to severe impact on the stream with debris, sediment, and bank erosion upstream of the pipe. The other crossing is a temporary stone construction road crossing with a minor impact on the stream.

Twenty-six storm drain pipes discharge to North Little Hunting Creek. All outfall pipe material is concrete and the pipes range in size from 15 to 96 inches in diameter. Most pipe outfalls have minor erosion due to discharges from the pipes. The locations of all pipe impacts are shown on Map 3.2.

Photo 3.1 Double 8' x 8' outfall box culvert located under Fordson Road

Photo 3.2 Sediment and debris causing a moderate impact downstream of Janna Lee Avenue bridge crossing

Nine private and two public stormwater management facilities are located in the subwatershed and included in the county's database. Four of the private facilities and one public facility are located in the Gum Springs area. The other stormwater management facilities are located throughout the rest of the subwatershed. The type of facility and area served are provided in

Table 3.3. The locations of the known stormwater management facilities in the subwatershed are also shown on Map 3.2.

Table 3.3 North Little Hunting Creek Stormwater Management Facilities

Location	Type of Facility	Parcel Area (Acres)
Privately Owned		
North of Holly Hill Road	Infiltration trench	1.02
South of Stone Hedge Drive	Underground facility	0.30
Located in the area bounded by Fordson Road, Richmond Highway, and Lockheed Boulevard	Underground facility	1.20
Southwest of the Lockheed Boulevard and Richmond Highway intersection	Manufactured BMP	0.49
Southeast of the Fordson Road and Beechcraft Drive intersection	Rooftop	1.98
Southwest of the Fordson Road and Joseph Makell Court intersection	Infiltration trench	1.33
Northwest of the Sherwood Hall Lane and Fordson Road intersection	Dry pond	3.98
Southeast of the Sherwood Hall Lane and Fordson Road intersection	Underground facility	0.93
East of the Sherwood Hall Lane and Kingland Road intersection	Dry pond	1.75
Publicly Owned		
At Kings Village Road in Gum Springs area	Dry pond	5.34
Southeast of Buckman Road and Roxbury Place	Dry pond	0.91

3.1.3 Stream Geomorphology

The geomorphology of the stream segments of the North Little Hunting Creek can be summarized as follows:

- The dominant substrate in all stream segments is sand.
- The downstream reaches are of CEM type 3, referring to nearly vertical stream bank slopes, active widening, and accelerated bend migration. It was observed that the channel has been dredged and altered.
- The upstream segments are paved with concrete, hence no geomorphic assessment was performed.
- The tributaries flowing from the west to North Little Hunting Creek, north of Janna Lee Road crossing, are of CEM type 2, referring to a deep incised channel formed by head cutting of the stream bed. It was observed that construction and clear cutting in the area would result in accelerating the bank slope destabilization and widening the channel.

Map 3.3 shows the stream segment CEM type in the subwatershed. Fallen trees and debris obstructing the flow were observed at two locations in the upstream reaches. The impact of this debris on the stream is moderate and can be seen in Photo 3.3. In the downstream stream segment, the stream is littered with shopping carts, trash, and a camper shell. Photos

3.4 and 3.5 show dumpsites in the downstream segments. The locations of the dumpsites identified during the stream physical assessment are shown on Map 3.3. Two additional dumpsites have been identified in the area behind the Hybla Valley Shopping Center. A partially buried 12-inch sanitary sewer pipe crosses the stream in the downstream segment and does not cause a significant impact. A raised sanitary sewer manhole is located in the upstream stream segment north of Audubon Avenue and has little impact on the stream as shown in Photo 3.6.

Photo 3.3 Dump observed in the downstream channel near Richmond Highway

Photo 3.4 Trash dump and littering in the downstream segment near Richmond Highway

Photo 3.5 Trash located upstream of Fordson Road

Photo 3.6 Raised manhole obstructing the flow of the tributary located north of Audubon Avenue

3.1.4 Stream Quality

The stream reaches of North Little Hunting Creek have low-gradient slopes and are classified as the glide pool prevalent stream type. A glide pool is an area in a stream characterized by calm water that typically follows a riffle. The habitat assessment for North Little Hunting Creek can be summarized as follows:

- In most of the stream reaches, at least three habitat types were common for less than 50% of the reach.
- Two upstream channel reaches are made of concrete, hence no habitat was assessed.
- The majority of the pools are large and shallow except in the tidal portion of North Little Hunting Creek. Most pools in the stream reaches have sand bottoms and showed no submerged vegetation. Little to no root mat was present.

- Sediment deposition is mainly sand and/or gravel with 40% to 50% of the stream bottom affected in the downstream segments and 50% to 60% of the stream bottom affected in the upstream segments.
- Approximately 70% of the stream segments have alteration of the channel or banks. The tributaries located on the west side of the subwatershed north of the Janna Lee Road culvert crossing exhibit little channel disturbance.
- North Little Hunting Creek exhibits mostly straight channel reaches and uniform depth of flow, causing fewer habitat types to be found in the stream.
- For most of the creek, the water fills approximately 80% of the available channel cross section during normal flow periods. This amount of water filling the channel allows for adequate aquatic habitat.
- A majority of the channel banks are highly unstable with approximately 60% of the banks covered by thin vegetative cover and scattered grasses, non-grass plants, and shrubs. Fifty to 60% of the banks have erosion.
- The majority of the stream buffer consists of lawn grass with less than 25 feet of buffer width. The tributaries that flow from the west side from Huntley Meadows Park to North Little Hunting Creek exhibit a buffer width of 50 to 100 feet or greater with minimal disturbance.
- Fifty-one percent of North Little Hunting Creek exhibits poor habitat quality and 33% of the creek exhibits very poor habitat quality as depicted on Map 3.4. Flows were observed in the stream channel for the majority of the creek and no erosion and/or head cuts were observed. The majority of the stream segments are good candidates for stream restoration projects because each individual project would have adequate stream length, would not involve easement acquisition, and would have good access for construction.

The general characteristics of the stream water quality were assessed and can be described as follows:

- Water in the downstream reaches appears turbid with the rest of upstream flows appearing clear.
- In the downstream reaches, a rotten egg smell was noted in both the water and the sediment. The upstream reaches were odor free.
- Small fish of one to two inches in length were observed in the farthest downstream reaches. In addition, aquatic plants were observed in the stream margin in less than 10% of the entire stream bank area. The locations of fish observance in the stream segments are shown on Map 3.4.
- Green algae of light density with a slimy coating and green filamentous algae were observed in the downstream stream segments. The upstream stream segments were free of algae.

At several locations in the downstream stream segments, there is a severe to extreme impact due to a lack of natural forested buffer as shown in Photo 3.7. At one location in the upstream stream segments, the buffer zone is covered with a parking lot and roadway, causing the severe impact shown in Photo 3.8. Overall, North Little Hunting Creek does not have adequate natural buffer widths of 100 feet. The locations of deficient buffer areas along the stream corridor are shown on Map 3.4.

Photo 3.7 Lack of natural forested buffer upstream of Richmond Highway

Photo 3.8 Paved surface in the buffer zone upstream of Fordson Road crossing

3.1.5 Problem Areas from Public Forum

Problem areas were identified by the stakeholders in the watershed forum held on July 19, 2003; the locations are shown on Map 3.1. The majority of the complaints for this subwatershed were trash and dumpsites. The impact of the future Richmond Highway roadway widening on the creek is also a stakeholder concern.

Table 3.4 North Little Hunting Creek Problem Areas from Public Forum

Problem ID	Description
A1	A large trash dumping area begins at the border of Huntley Meadows Park and Richmond Highway. The 45-acre land area (with unknown ownership) is used by vagrants and people who dump trash.
B1	There is a trash dump near the mouth of Little Hunting Creek at Old Mount Vernon Parkway and the Sunny View neighborhood.
C5	An animal passageway at Richmond Highway and Little Hunting Creek leads to frequent roadkill.
C7	A major trash dumpsite is located on the Little Hunting Creek main stem behind the trailer park community on Pace Lane.
D3	Stream bank erosion exists at the intersection of Mount Vernon Highway and Richmond Highway.
E2	A trash and dumpsite in the backyard of a property at Mount Vernon Highway and the Sunny View neighborhood is filling in the tributary stream.
E6	The widening of Richmond Highway to eight lanes from Hybla Valley to Woodrow Wilson Bridge will have a major impact on the Little Hunting Creek Watershed.

3.1.6 Modeling Results

The hydrology developed for this subwatershed produced stormwater runoff that is fairly high with respect to the size of the watershed. Over one-third of this subwatershed is covered by impervious surfaces and over half of the land use is residential or commercial of moderate to high density/intensity. This land use results in peak discharges that are relatively high for the two- and 10-year rainfall events. This subwatershed has the most significant increase in stormwater discharge due to the potential development of vacant parcels and the increase in medium-density residential land use, especially in the area located east of Huntley Meadows

Park. Please see Table 3.5 for a comparison of the existing and future two-and 10-year peak discharges for each sub-basin.

During the stream physical assessment, no erosion or head cuts were observed in North Little Hunting Creek that corresponded to the modeling results; however, there may be some areas with significant erosion potential. The velocities produced by the two-year rainfall event in North Little Hunting Creek are generally low through its upper portions and increase as it flows south near the Richmond Highway crossing. The model indicated a few areas of higher velocity north of Richmond Highway that correspond to the stream habitat assessment results that described the stream bank area as having 70% to 90% erosion.

The two-year peak discharge is contained within the main channel banks for the upper third of North Little Hunting Creek. The two-year event overtops the channel banks but stays within the floodplain for most of the remainder of the creek to the north end of the South Little Hunting Creek Subwatershed. The 10-year peak discharge is well outside the main channel banks and into the floodplain area for the length of North Little Hunting Creek, except where the channel has steep side slopes and relatively no natural floodplain area. The model showed some minor flooding of the Harmony Trailer Park for the 10-year rainfall event.

The water quality modeling results for North Little Hunting Creek show that the average sediment loading rate exceeds the tributary strategy target level for sediment for both the existing and future land use conditions. The North Little Hunting Creek Subwatershed has a higher sediment loading rate than the other four subwatersheds due to the higher percentage of commercial area, such as along Route 1. For existing and future conditions, the four sub-basins located along Route 1 are identified as having a greater sediment loading rate than the other sub-basins in the North Little Hunting Creek Subwatershed. For future land use conditions, the average sediment loading rates are predicted to increase by 12%.

The existing and future average phosphorus loading rates for North Little Hunting Creek exceed the tributary strategy target levels. The North Little Hunting Creek Subwatershed has the greatest annual pollutant loading for total phosphorus of the five subwatersheds. This can be attributed to the relatively high percentage of developed land in the watershed. For total phosphorus, the greater the proportion of medium- and high-density residential area compared to the other land uses, the greater the phosphorus loading for the watershed. The predicted increase in the phosphorus loading rate for the future is 28%, which corresponds to an increase in medium-density residential land use in the subwatershed.

For North Little Hunting Creek, the average total nitrogen loading rate exceeds the tributary strategy target level. Large areas of commercial development cause higher nitrogen pollutant loading rates. As with sediment, the higher loading rates are found in the sub-basins located along the Route 1 commercial corridor. For existing conditions, four sub-basins exceed the tributary strategy nitrogen target value. For future conditions, six sub-basins are predicted to exceed the tributary strategy target limit. The sub-basin with the Mount Vernon Plaza commercial area is predicted to exceed the poor nitrogen pollutant loading rates.

Table 3.5 North Little Hunting Creek Peak Runoff Flows

Sub-basin	Two-Year Rainfall Event			Ten-Year Rainfall Event		
	Existing Peak Flow	Future Peak Flow	% Peak Flow Increase	Existing Peak Flow	Future Peak Flow	% Peak Flow Increase
	(cfs)	(cfs)		(cfs)	(cfs)	
LH-LH-0001	77	89	17%	143	166	16%
LH-LH-0002	173	185	7%	316	337	7%
LH-LH-0003	209	215	3%	383	393	3%
LH-LH-0004	214	221	3%	387	398	3%
LH-LH-0005	143	145	1%	258	262	2%
LH-LH-0006	77	77	0%	154	154	0%
LH-LH-0007	154	162	5%	286	300	5%
LH-LH-0008	288	317	10%	523	570	9%
LH-LH-0009	153	168	10%	284	311	10%

3.2 South Little Hunting Creek Subwatershed

The South Little Hunting Creek Subwatershed has an area of approximately 1,404 acres. It is bounded to the west by Wagon Wheel Road, to the north by Shaw Park Court and Pennsylvania Boulevard, to the east by Carter Farm Court, to the south and southeast by the George Washington Memorial Parkway and Prices Lane, and to the southwest by the intersection of Mount Vernon Highway and George Washington Memorial Parkway.

The South Little Hunting Creek Subwatershed contains the southern portion of Little Hunting Creek, seen in Photo 3.9, and South Branch, a tributary of Little Hunting Creek located on the east side of the creek. Other smaller streams are located on the west side of the subwatershed and discharge directly into Little Hunting Creek as shown on Map 3.5. The South Little Hunting Creek Subwatershed's condition is summarized as follows.

South Little Hunting Creek Subwatershed Condition Summary

- Current imperviousness = 22% with majority of land use medium-density residential
- Future imperviousness = 23%
- Twelve crossings create minor impacts.
- No BMPs currently exist.
- The stream has been altered with concrete lining in portions of Wessynton and South Branch.
- The stream has poor habitat quality with inadequate buffers.
- No erosion or headcuts were observed except for the stream located south of George Washington Memorial Parkway.
- No trash dumps were located.
- Sedimentation of South Little Hunting Creek is a problem.
- Development adjacent to the creek negatively impacts the wetlands and buffer area.
- PCBs and chlordane are contaminants found in the sediments.

3.2.1 Subwatershed Characteristics

Photo 3.9 Tidal portion of Little Hunting Creek

The main stem of Little Hunting Creek included in this subwatershed is tidal and has a length of approximately 2.1 miles. The headwaters of South Branch emerge from a storm drain system outfall located east of Vernon View Road. South Branch has a length of less than 0.6 miles and a low-gradient slope of 0.50%. The ground surface elevation at the eastern portion of the subwatershed is 45 feet and gradually slopes with less than 0.70% gradient to an elevation of five feet near the Creek Drive and Camden Street intersection. In the western part of the subwatershed, the ground surface slopes are greater, with slopes exceeding 3.0%. The ground surface elevation at the western portion of the subwatershed is 90 to 95 feet and the surface slopes down to an elevation of five feet.

The existing impervious area in this subwatershed is 22% of the total area. Land use in the subwatershed is predominantly medium-density residential comprising 42% of the subwatershed area as shown on Table 3.5. Parks and recreational facilities comprise 20% of the area, including a portion of Fort Hunt located in the South Little Hunting Creek Subwatershed. The total area of the undeveloped parcels in the subwatershed is 54 acres. The majority of the zoning for the undeveloped and underutilized parcels is medium-density residential as shown by the increase in this future land use in Table 3.5. As shown on Map 3.5, the open water area of the main stem of Little Hunting Creek is approximately 117 acres, and tidal wetlands comprise approximately 3.0% of the subwatershed area.

Table 3.6 South Little Hunting Creek Land Use

Land Use Description	Land Use			
	Existing		Future	
	Area (acres)	%	Area (acres)	%
Open space, parks, and recreational areas	275	20	314	22
Estate residential	26	2	0	0
Low-density residential	155	11	0	0
Medium-density residential	596	42	824	59
High-density residential	14	1	5	1
Low-intensity commercial	44	3	30	2
High-intensity commercial	1	0	0	0
Industrial	8	1	0	0
Unknown	6	0	6	0
Undeveloped	54	4	0	0
Road right-of-way (including shoulder areas)	181	13	181	13
Wetlands	44	3	44	3
TOTAL	1,404	100	1,404	100

Twenty-one complaints regarding standing water, yard flooding, or other miscellaneous flooding were registered with the county and included in the database files for this subwatershed. The locations of these complaints are shown on Map 3.5. The county addressed two standing water complaints by clearing blockages from the drainage system and considered the other flooding complaints private responsibilities. The flooding complaints were at isolated locations and do not indicate a widespread flooding problem in this subwatershed. The county's master plan drainage projects listed the completed Wessynton Way cul-de-sac drainage improvements as the only project for this subwatershed.

The National Resources Conservation Service STATSGO has a weighted hydrologic soil group index of 2.2 for the entire subwatershed. This weighted index indicates that the soils in this subwatershed have a moderately coarse texture with moderate infiltration rates. The hydrologic soil group classifications of A, B, C, and D explain the characterics of soil texture, permeability, and rate of infiltration. The county's GIS coverage for soils is incomplete and shows small pockets of hydrologic soil group B, C, and D located in the subwatershed.

3.2.2 Storm Drain System Infrastructure

The South Little Hunting Creek Subwatershed has many independent storm drain systems that discharge directly into Little Hunting Creek. The area located east of Linton Lane is drained by a storm drain system with pipe outfalls to South Branch at two different locations. The outfalls include double 54-inch (diameter) pipes at one location and a single 72-inch (diameter) pipe at the other location. Twelve stream crossings are located in this subwatershed and all had minor impacts on the stream as shown on Map 3.6. The impacts can be described as follows:

- Brady Street: The five-foot diameter concrete pipe drains to the tributary located on the west side of South Little Hunting Creek as shown in Photo 3.10.
- Linton Lane: Five-foot and three-foot (diameter) concrete pipes drain to South Branch as shown in Photo 3.11.
- Linton Lane: A triple six-foot by three-foot concrete box culvert drains to South Branch.
- East of Linton Lane: Two wooden foot bridges, each 12 feet long with four-foot openings, and four wooden foot bridges, each eight feet long with four-foot openings, are located on South Branch between Linton Lane and Vernon View Drive.

Photo 3.10 5' diameter concrete pipe located under Brady Street

Photo 3.11 5' and 3' diameter pipes located under Linton Lane

- South of Wessynton Way: A wooden foot bridge, eight feet long with a four-foot opening, is located on a tributary on the west side of South Little Hunting Creek.
- Wessynton Way: A two-foot (diameter) concrete culvert is located on a tributary on the west side of South Little Hunting Creek as shown in Photo 3.12.
- East of Doeg Indian Court: Five-foot, three-foot, and two-foot (diameter) concrete pipes are located on a tributary on the west side of South Little Hunting Creek.
- East of Doeg Indian Court: A wooden foot bridge, 10 feet long with a four-foot opening, is located on a tributary on the west side of South Little Hunting Creek.

Four storm drain outfall pipes discharge into South Branch. All outfall pipe material is concrete and the pipes range in size from 15 to 36 inches in diameter. Double 36-inch (diameter) outfall pipes located under Vernon View Drive discharge runoff collected from the River Bend Estates subdivision and are shown in Photo 3.13. These pipe outfalls are causing minor erosion but are not of significant concern. No private or public stormwater management facilities are listed in the county's inventory for this subwatershed.

Photo 3.12 2' (diameter) concrete pipe located under Wessynton Way

Photo 3.13 Double 3' (diameter) concrete pipes located west of Vernon View Drive

3.2.3 Stream Geomorphology

A geomorphic stream assessment was not performed for South Branch stream segments because of wetlands and paved channels. The geomorphology of the two tributaries discharging to South Little Hunting Creek on the west side of Little Hunting Creek was assessed. The results are shown on Map 3.7 and summarized as follows:

- The tributary located near Brady Street has a dominant substrate of gravel and is classified as CEM type 4, referring to a stabilizing stream bank and channel. The stream will widen if encroachment in the stream corridor continues to increase.
- The tributary located near Wessynton Way has a dominant substrate of sand and is beginning to show the characteristics of CEM type 2, referring to a deep, incised channel formed by head cutting of the stream bed.
- Flow obstructions or trash/debris were not observed in the South Little Hunting Creek stream segments, and there are no utility crossings located in this subwatershed (as shown on Map 3.7). A private industrial dumpsite is located east of Martin Luther King, Jr. Park with piles of construction debris, several pieces of earthmoving equipment, and large industrial

size drums with unknown contents that have a chemical smell. The debris and some of the drums are adjacent to a stream that drains into South Little Hunting Creek.

3.2.4 Stream Quality

Habitat assessment was not performed for South Branch due to wetlands and paved channels. During drought conditions, no flow was observed in South Branch or in the tributary (LHLH012) located on the west side of South Little Hunting Creek near Wessynton Way. The tributary (LHLH011) located near Brady Street had flow present during the drought. Both stream tributaries located on the west side of the subwatershed have low-gradient slopes and are classified as the glide pool prevalent stream type. The habitat assessment of the tributaries can be summarized as follows:

- At least three or four habitat types were common for less than 50% of the stream.
- The majority of the pools at LHLH011 are large and shallow with clay bottoms and greater than 10% of habitat structure available.
- The majority of pools at LHLH012 are small and shallow with sand bottoms and less than 10% of habitat structure available.
- For LHLH011, 30% of the channel reach has been straightened, dredged, or otherwise altered and for LHLH012, 50% of the channel reach has been altered.
- The sediment deposition is sand and/or silt with 60% to 70% of the bottom affected for LHLH011 and with 20% to 30% of the bottom affected for LHLH012.
- The stream segments are essentially straight with uniform depth of flow.
- For LHLH011, the water in the channel fills approximately 80% of the available cross section during normal flow periods. For LHLH012, the water in the channel fills approximately 35% to 40% of the available cross section during normal flow periods.
- Most of the channel banks for both streams have thick vegetative cover with a few barren spots and are moderately stable with 15% of the bank area exhibiting erosion.
- For LHLH011, the stream banks exhibit a five- to 25-foot width of forested buffer with lawn grass beyond the forested buffer. For LHLH012, the stream banks exhibit a 50- to 100-foot width of forested vegetative buffer with lawn grass beyond the forested buffer.

Habitat quality is considered fair for LHLH011 and poor for LHLH012 as shown on Map 3.8. An adequate buffer width does not exist along most of the stream corridors of the tributaries in the South Little Hunting Creek Subwatershed due to residential development in the area. Photo 3.14 shows planted lawns located in the buffer zone along the north branch of South Branch, west of Linton Lane; Photo 3.15 shows deficient buffer along the tributary LHLH012 located on the west side of South Little Hunting Creek. The impact of deficient buffer areas on the streams in this subwatershed is moderate. The stream segments of South Branch and the tributary (LHLH011) located near Brady Street are ideal candidates for stream restoration projects because each individual project would be of adequate stream length, would not involve easement acquisition, and would appear to have good access for construction. No head cuts or erosion of the stream bed and banks were observed as part of the stream physical assessment. An eroded area with large trees along the banks being undercut was identified at a stream tributary on the west side of South Little Hunting Creek near the George Washington Memorial Parkway.

Photo 3.14 Deficient buffer zone with planted lawn grass west of Linton Lane along the north branch of South Branch

Photo 3.15 Deficient buffer zone along the tributary LHLH012 located on the west side of South Little Hunting Creek

The stream characteristics assessment for the South Little Hunting Creek Subwatershed can be summarized as follows:

- The sediment and water in all of the streams were odor free.
- No fish were observed in South Branch or in the tributary near Wessynton Way. LHLH011 had small fish.
- No aquatic plants and/or algae were observed in any of the streams.

The amount of wetlands lost in the subwatershed is difficult to quantify as there is no data on the area of wetlands in the past. The water and sediment quality of the main stem of South Little Hunting Creek has been tested by the Virginia DEQ. The Virginia DEQ stated that aquatic life is threatened by the presence of excessive algae measured in the tidal waters of Little Hunting Creek. Algae blooms can be evidence of too much nitrogen and phosphorous in the water. Little Hunting Creek has been designated by the Virginia DEQ as nutrient enriched waters.

Little Hunting Creek is included in a segment of the Potomac River listed as an impaired water in the 2002 303(D) priority list prepared by the Virginia DEQ. The impairment classification is due to a health advisory issued by the Virginia Department of Health (VDH) for fish consumption based on high levels of PCBs found in the fish tissue. Fish tissue analysis has revealed exceedances of the human health-risk based screening value of 54 ppb of PCBs. Five different types of fish taken from Little Hunting Creek in 2000 had concentrations between 81 ppb and 682 ppb of PCBs.

Sediment samples taken in 2000 from the tidal portion of Little Hunting Creek contained 7.57 ppb of chlordane which is above the 6 ppb concentration that can threaten aquatic life. The five fish taken from Little Hunting Creek in 2000 were analyzed for chlordane in their tissue and had results below the DEQ screening value of 300 ppb. The sources of chlordane and PCBs are listed as unknown.

3.2.5 Problem Areas from Public Forum

Problem areas were identified by the stakeholders in the watershed forum held on July 19, 2003, and the locations are shown on Map 3.5. The majority of the problem areas included sedimentation of the creek, loss of forested buffer, and alteration of the streams.

Table 3.7 South Little Hunting Creek Problem Areas from Public Forum

Problem ID	Description
A2	South Branch: At the end of Wakefield Drive there is sewer rehabilitation project that is not using any erosion controls. It is unclear if this is a county project.
A5	South Branch: At the end of Orange Court there was an old dumpsite. While the debris has likely since been removed, there may be toxic or harmful elements still buried at the site.
A6	South Little Hunting Creek: The tide used to flush out the sediment years ago when there were discharges from the sewage treatment pump station that is now closed. In 1980, depths were four feet, but today they are only two feet.
A8	South Branch: A concrete pipe flows directly into the creek carrying stormwater into the main stem without any treatment for volume or quality.
B2	South Little Hunting Creek: A concrete channel filled with trash results in poor drainage at Martin Luther King Jr. Park.
B3 & D2	South Little Hunting Creek: Sedimentation has made Little Hunting Creek unnavigable near Woodland Heights.
B4	South Little Hunting Creek: High amounts of sedimentation have made the channel smaller near the George Washington Memorial Parkway Bridge. Several drownings have occurred here.
C4	South Branch: The channel near Creek Drive is filled with sediment and is no longer navigable.
C6	South Little Hunting Creek: A hardened shoreline exists near Carter Farm Court.
D1	South Little Hunting Creek: There is a loss of wooded floodplain at private land on Linton Lane, Camden Lane, and Fort Hunt Park.
D4	South Little Hunting Creek: There is development of land adjacent to South Little Hunting Creek on Stockton Parkway.
D6	South Little Hunting Creek: Sedimentation of the creek exists near the Wessynton subdivision.
E3	South Little Hunting Creek: The concrete-lined stream channel that ends at Linton Lane leads to sediment build-up and high discharge velocities on the downstream side.

3.2.6 Modeling Results

The hydrologic model for the South Little Hunting Creek Subwatershed consists of the entire subwatershed area. The hydraulic model for this subwatershed consists of only South Branch and not the tidal portion of Little Hunting Creek.

The hydrology developed for this subwatershed produced stormwater runoff that is fairly high with respect to the size of the watershed. Over 20% of this subwatershed is covered by impervious surfaces and over half of the land use is residential with moderate to high density. This results in peak discharges that are relatively high for the two- and 10-year rainfall events. The potential future development for this watershed will increase the density of residential land use, mainly through redevelopment of low-density residential parcels and medium-density residential development on currently undeveloped parcels. This development will result in

relatively minor increases in stormwater peak discharges. Please see Table 3.8 for a comparison of existing and future two-and 10-year peak discharges for each sub-basin.

The velocities produced by the two-year rainfall event in South Branch are generally slow to moderate. During the stream physical assessment, no erosion or head cuts were observed in South Branch that corresponded to the slow to moderate velocities from hydraulic model. Erosion was observed in the stream located south of George Washington Memorial Parkway; however, this stream was not included in the hydraulic modeling.

The main reaches of South Branch have little or no natural floodplain areas mainly due to significant manmade improvements, which essentially extend the limits of the main channel. As a result, the two- and 10-year peak discharges are almost entirely contained within the extended channel banks for both reaches of South Branch. There are no roadway overtopping locations for the two- or 10-year storm event along any reach of South Branch.

The water quality modeling results for South Little Hunting Creek show that the average sediment loading rate exceeds the tributary strategy target level for sediment. Three of the sub-basins have sediment loading rates less than the tributary strategy target level for sediment. For future land use conditions, the average sediment loading rate is predicted to increase by 16% due to the increase in medium-density residential land use and the decrease in undeveloped area.

The average total phosphorus loading rate for the South Little Hunting Creek watershed exceeds the tributary strategy levels. At 32%, South Little Hunting Creek has the greatest increase in phosphorus pollutant loading from existing to future conditions of the five subwatersheds. This increase corresponds to the 60% increase in medium-density residential land use in the subwatershed.

For the South Little Hunting Creek Subwatershed, the average total nitrogen loading rate for existing and future conditions is less than the tributary strategy target value. None of the sub-basins exceeds the tributary strategy nitrogen target levels for either existing or future land use conditions. The relatively low values for nitrogen when compared to the other subwatersheds can be attributed to the higher percentage of open space and residential land use, which accounts for roughly 80% of the existing and future land uses in the subwatershed. The expected increase in nitrogen for the future land use conditions in the subwatershed is 25%.

Table 3.8 South Little Hunting Creek Peak Runoff Flows

Sub-basin	Two-Year Rainfall Event			Ten-Year Rainfall Event		
	Existing Peak Flow	Future Peak Flow	% Peak Flow Increase	Existing Peak Flow	Future Peak Flow	% Peak Flow Increase
	(cfs)	(cfs)		(cfs)	(cfs)	
LH-LH-0010	27	27	0%	54	54	0%
LH-LH-0011	102	102	0%	224	224	0%
LH-LH-0012	288	294	2%	544	555	2%
LH-LH-0013	361	366	1%	694	702	1%
LH-LH-0014	166	183	10%	319	348	9%
LH-SB-0001	59	59	0%	117	118	1%
LH-SB-0002	155	160	3%	283	292	3%
LH-SB-0003	89	90	1%	166	168	1%

3.3 Paul Spring Branch Subwatershed

The Paul Spring Branch Subwatershed is approximately 1,262 acres and is bounded to the west by the intersection of Harrison Street and Groveton Lane; to the southwest by Collard Street, Popkins Lane, the intersection of Sherwood Hall Lane and Evening Lane, and the Paul Spring Branch confluence with North Branch; to the southeast by Rossiter Place and Baltimore Road; to the east by the intersection of Belle Vista Drive and Park Terrace Drive; and to the northeast by the intersection of Beacon Hill Road and Quander Road and the intersection of Rollins Drive and Marlan Drive. Paul Spring Branch is a tributary to North Branch and drains a portion of the commercial area located along Richmond Highway including Beacon Mall. The Paul Spring Branch Subwatershed is shown on Map 3.9, and its condition is summarized as follows:

Paul Spring Branch Subwatershed Condition Summary

- Current impervious area = 26% with majority of land use medium-density residential
- Future impervious = 28%
- Severe to moderate impacts were observed at two crossings.
- Eight BMPs exist in the subwatershed.
- Eighty percent of the stream in the upstream reaches has been altered.
- The subwatershed exhibits poor habitat quality with inadequate buffers.
- Severe to extreme erosion was found at two pipe outfalls.
- Most of the channel has widened and bank slopes are stabilizing.
- The stream is obstructed, with fallen trees and debris at several locations.
- Sedimentation of the stream affects an average of 50% of the bottom.
- Uncontrolled runoff from developed areas negatively impacts the stream with severe bank erosion at several locations.

3.3.1 Subwatershed Characteristics

The headwaters of Paul Spring Branch emerge from a storm drain system outfall located in the Groveton area east of Maple Street. The stream first flows southeast and then changes its direction downstream of Sherwood Hall Lane and flows southwest. The total length of Paul Spring Branch, from its beginning to its confluence with North Branch, is approximately 3.25 miles. The stream slopes gently with a gradient of 0.81%.

The ground surface slopes are typically greater than 5% with ground elevation ranging from 220 to 240 feet in the Groveton area in the northern part of the subwatershed. The ground surface slopes down to an elevation of 150 to 160 feet at the headwaters of Paul Spring Branch and then gradually slopes to an elevation of 15 to 20 feet near its confluence with North Branch.

Storm drain pipe outfalls discharge to small tributaries draining to Paul Spring Branch at various locations along its length. A stream physical assessment was performed for the main stem of Paul Spring Branch and for a main tributary of Paul Spring Branch that is approximately 3,500 feet in length and drains the eastern portion of the subwatershed.

The impervious area in this subwatershed is 26% of the total area with predominately medium-density residential land use that makes up 41% of the subwatershed area as shown in Table 3.7. Commercial and industrial land uses are located near the Richmond Highway corridor and total approximately 6% of the subwatershed area. For ultimate future buildout conditions, medium-density residential land use may increase by 23% from potential development of undeveloped and underutilized parcels. The future imperviousness with ultimate buildout conditions is projected at 28%.

Table 3.9 Paul Spring Branch Land Use

Land Use Description	Land Use			
	Existing		Future	
	Area (acres)	%	Area (acres)	%
Open space, parks, and recreational areas	42	3	137	11
Estate residential	48	4	0	0
Low-density residential	217	17	0	0
Medium-density residential	516	41	800	64
High-density residential	73	6	67	5
Low-intensity commercial	35	3	25	2
High-intensity commercial	34	3	30	2
Industrial	6	0	0	0
Unknown	0	0	0	0
Undeveloped	89	7	0	0
Road right-of-way (including shoulder areas)	202	16	202	16
Wetlands	0	0	0	0
TOTAL	1,262	100	1,261	100

There are no wetlands in the county's GIS data for the Paul Spring Branch Subwatershed. The stream physical assessment of the Paul Spring Branch segment identified a potential wetland BMP area of 150 feet by 150 feet near the intersection of Paul Spring Road and Rippon Road. This potential wetland BMP site is near a large, private, dry detention stormwater management facility located to the northeast of the intersection.

In the Paul Spring Branch Subwatershed, seven of the 17 identified master plan drainage projects have been completed, and the remaining 10 projects are listed as inactive due to insufficient funds. The master plan drainage projects include stream bank stabilization, storm sewer improvements, and/or culvert replacements; these are summarized in Table 3.8.

Table 3.10 Paul Spring Branch Master Plan Drainage Projects

Type of Work	Project Name/Location
Completed projects	
Install gabions at Paul Spring Road	Paul Spring Road
Raise road and replace culvert at Clayborne Avenue	Clayborne Avenue
Improve drainage at Schooley Drive	Schooley Drive
Purchase house in floodplain	1801 Paul Spring Road
Install riprap at Kenyon Drive	Paul Spring Branch II
Install 200 feet of gabion and riprap	Paul Spring Branch II
Install 350 feet of riprap at Paul Spring Parkway	Paul Spring Parkway
Inactive projects	
Construct 300 feet of storm sewer	Hollindale Drive
Replace culvert at Woodcliff Drive	Woodcliff Drive
Replace culvert at Morningside Lane	Morningside Lane
Replace culvert at Lyndale Drive	Lyndale Drive
Replace culvert at Admiral Road	Admiral Road
Raise road and replace culvert at Paul Spring Road	Paul Spring Road
Replace culvert at Paul Spring and Rippon Road	Paul Spring Road
Stabilize 900 feet of stream at Fort Hunt Road	Fort Hunt Road
Stabilize 600 feet of stream bank at Fort Hunt Road	Fort Hunt Road
Replace culvert at Fort Hunt Road	Fort Hunt Road

Twenty-eight yard flooding and miscellaneous flooding complaints were registered with the county and included in the database files for this subwatershed. The locations of some of the complaints are shown on Map 3.9. Most of the complaints were yard flooding problems at isolated locations. This type of complaint is typically considered by the county to be a private responsibility.

The National Resources Conservation Service STATSGO database has a weighted hydrologic soil group index of 2.4 for most parts of the watershed and a value of 2.2 for a small area near its confluence with North Branch. This weighted index indicates that the soils in this subwatershed have moderately fine texture with low infiltration rates. The hydrologic soil group classifications of A, B, C, and D explain the characterics of soil texture, permeability, and

rate of infiltration. The county's GIS soil layer has incomplete coverage and shows small pockets of hydrologic soil group C and D located in the subwatershed.

3.3.2 Storm Drain System Infrastructure

The Groveton area, located east of Maple Street, is drained by an extensive storm drain pipe system that discharges through double 72-inch (diameter) pipes into the headwaters of Paul Spring Branch. The rest of the Paul Spring Branch Subwatershed is drained by smaller, independent storm drain systems that discharge directly into the stream. These storm drain outfalls include open channels and pipes that vary in size from 18 to 33 inches in diameter. Thirteen stream crossings are located in this subwatershed, and all but two of the crossings had minor impacts to the stream as shown on Map 3.10. The impacts from the crossings can be described as follows:

- Mary Baldwin Drive: Two four-foot (diameter) corrugated metal pipes causes severe erosion of the bed and banks on the downstream side. The bank erosion is six feet high as shown in Photo 3.16. A wooden footbridge crossing the stream is located downstream of Mary Baldwin Drive and has minor impact on the stream.
- Paul Spring Road: A five and one-half-foot by four-foot elliptical pipe and a four-foot (diameter) circular pipe does not impact the stream. A wooden footbridge crossing the stream is located upstream of Paul Spring Road and has no impact on the stream.
- Mason Hill Drive: Three 10-foot by 12-foot concrete box culverts have no impact on the stream.
- Private Road South of Mason Hill Drive: A concrete arch bridge with a 15-foot by five-foot opening has no impact on the stream.
- Sherwood Hall Lane: Four 10-foot by six-foot concrete box culverts, shown in Photo 3.17, with downstream bank erosion of four feet in height, cause a moderate impact on the stream.

Photo 3.16 Severe erosion downstream of the Mary Baldwin Drive crossing

Photo 3.17 Four 10'x 6' concrete box culverts located under Sherwood Hall Lane

- Fort Hunt Road: A three-foot (diameter) concrete pipe under the roadway and two three-foot (diameter) concrete pipes under the trail impact the stream.
- Woodcliff Court: A three-foot (diameter) concrete pipe has no impact on the stream.

- Lyndale Drive: A two-foot (diameter) concrete pipe has a minor impact on the stream. A wooden footbridge crosses the downstream of Lyndale Drive and has a minor impact on the stream.
- Admiral Road: A two-foot (diameter) concrete pipe has a minor impact on the stream.

There are 11 storm drain pipe outfalls discharging to Paul Spring Branch as shown on Map 3.10. The outfall pipe materials include concrete, corrugated metal, plastic, and rubber, and the pipes range in size from 12 to 60 inches in diameter. The stream physical assessment noted moderate to severe erosion caused by a 53-inch by 34-inch (diameter) elliptical concrete outfall pipe located north of Devonshire Road as shown in Photo 3.18. Discharges from an 18-inch (diameter) outfall pipe located west of Mary Baldwin Drive and a 24-inch (diameter) outfall pipe located north of Wellington Road have caused severe to extreme erosion (shown in Photos 3.19 and 3.20).

Discharges from four pipe outfalls have caused moderate erosion to the stream, and discharges from the remaining eight outfall pipes have caused minor erosion. The sites of severe to extreme erosion are of significant concern and will need immediate attention. The four ditches that discharge to Paul Spring Branch have caused minor to moderate erosion of the stream, and as an example, the ditch outfall located near the intersection of Paul Spring Road and Pickwick Lane is shown in Photo 3.21.

Photo 3.18 Discharge from 53"x 34" elliptical pipe outfall north of Devonshire Road caused moderate erosion on the downstream side

Photo 3.19 Severe erosion caused by discharge from an 18" pipe outfall west of the Mary Baldwin Drive crossing

Photo 3.20 Severe erosion caused by discharge from 24" pipe outfall located north of Wellington Road

Photo 3.21 Minor erosion of the right bank at the ditch outfall north of the intersection of Paul Spring Road and Pickwick Lane

Four private and two public stormwater management facilities are listed in the county's inventory for this subwatershed. A large dry detention basin located at the intersection of Paul Spring Road and Fort Hunt Road discharges directly into Paul Spring Branch. Table 3.9 describes the stormwater management facilities in the subwatershed.

Table 3.11 Paul Spring Branch Stormwater Management Facilities

Location	Type of Facility	Parcel Area (Acres)
Privately Owned		
Southeast of Richmond Highway and Schooley Drive intersection at 6733 Richmond Highway (not shown on Map 3.10)	Dry pond	0.86
Northwest of Paul Spring Road and Fort Hunt Road intersection	Dry pond	12.21
North of Mason Hill Drive and south of Windmill Lane at Mount Vernon Unitarian Church	Dry pond	7.71
Southeast of the intersection of Sherwood Hall Lane and Wellington Road at the Mount Vernon Presbyterian Church	Bioretention	1.20
Parking lot south of the Jemal/Metrocall Building at 6910 Richmond Highway	Underground Retention	Unknown
Publicly Owned		
Northeast of Bryant Towne Court and Popkins Lane intersection (not shown Map 3.10)	Dry pond	1.31
Southwest of Popkins Lane near the intersection of Popkins Lane and Devonshire Road	Infiltration trench	0.30
North of Windmill Lane near the intersection of Windmill Lane and Windmill Court	Dry pond	0.37
Southwest of Admiral Drive and Essex Manor Place intersection	Dry pond	1.00

3.3.3 Stream Geomorphology

The geomorphology of Paul Spring Branch and the tributary located on the east side of Paul Spring Branch near Admiral Drive was assessed. The results are shown on Map 3.11 and can be summarized as follows:

- Cobble is the dominant substrate in the stream reaches located upstream of Mason Hill Drive, and gravel is the dominant substrate in the stream reaches located between Mason Hill Drive and the intersection of Fort Hunt Road and Paul Spring Parkway. Sand is the dominant substrate in the downstream reaches of Paul Spring Branch near its confluence with North Branch.
- The majority of the stream reaches are CEM type 4, referring to widening of the channel with stabilizing bank slopes.

Photo 3.22 Fallen trees and eroding banks causing severe impact to Paul Spring Branch north of Fairfax Road

- At the headwaters of Paul Spring Branch east of Maple Street, the channel reach is CEM type 2, referring to a deep, incised channel formed by head cutting of the stream bed.

Fallen trees, dumps, and debris obstructing the flow were observed at many locations in Paul Spring Branch as shown in Photo 3.22. The stream corridor is also littered with lawn waste and

Photo 3.23 Concrete blocks obstructing the flow south of the intersection of Rollins Drive and Radcliff Drive

Photo 3.24 Partially buried telephone line south of the intersection of Rollins Drive and Radcliff Drive

trash as shown in Photo 3.23. At three locations, partially buried utility lines crossing the stream bed have caused a minor impact to the stream as shown in Photo 3.24. The locations of obstructions, dumpsites, and utility lines crossing the stream are shown on Map 3.11.

3.3.4 Stream Quality

Paul Spring Branch has a low-gradient slope and is classified as a glide pool prevalent stream type. The habitat assessment for Paul Spring Branch can be summarized as follows:

- The majority of the stream has four to five habitat types found in more than 50% of the reach length, except for the farthest upstream reach which has three habitat types for less than 50% of the reach length.
- Soft sand, mud, and clay characterize the pool substrate and help in providing suitable soil for subaqueous plants.
- The stream bottom is covered with more than 10% of habitat structure consisting of organic debris, root mats, and/or submerged vegetation.
- In the downstream segment of Paul Spring Branch, near its confluence with North Branch, the pools are evenly mixed in size. The majority of the pools found in the upstream segments of Paul Spring Branch are large and deep.
- In the downstream segments, the channel bed and banks exhibit minor manmade disturbances. As you travel upstream, the reaches exhibit increasingly more manmade disturbances with 80% of the reach having been altered near the headwaters.
- Sediment deposition in the downstream reaches is mainly gravel and/or sand with 40% to 50% of the stream bottom affected. Sediment deposition in the upstream segments consists mainly of sand and/or silt with 50% to 70% of the stream bottom affected.
- Most of the stream reaches exhibit infrequent bends and variable bottom contours that may

provide some habitat.

- During normal flow conditions, water fills approximately 65% to 75% of the available channel cross section, and during drought conditions, the water is mostly present as standing pools.
- For the majority of the stream, vegetation covers 60% to 70% of the channel bank surface with scattered shrubs, grasses, and forbes.
- Most of the stream reaches have moderately unstable banks with 40% to 60% of the bank surface exhibiting erosional areas.
- The forested vegetated buffer width is 25 to 50 feet with significant impervious areas beyond the buffer zone for the majority of the stream.

Photo 3.25 Head cutting of 2' of stream bed on the tributary to Paul Spring Branch west of Lyndale Drive

The habitat quality is fair for 53% of Paul Spring Branch and poor for 47% of the stream. The habitat quality is fair for the stream segments located between the Paul Spring Branch/North Branch confluence and Mason Hill Drive. The habitat quality is poor in the stream segments located upstream from Mason Hill Drive to the headwaters (shown on Map 3.12). In the tributary to Paul Spring Branch, two feet of head cutting of the stream bed was observed causing minor impacts to stream as shown in Photo 3.25.

Approximately 1,500 feet upstream of its confluence with North Branch, there is severe erosion of the left bank (six feet high) as shown in Photo 3.26. Downstream of Mason Hill Drive and upstream of the tributary flowing into Paul Spring Branch, moderate to severe erosion with four- to six-foot height of bank erosion was observed at three locations (as shown at one location in Photo 3.27). Downstream of Mary Baldwin Drive, severe erosion of the right bank with eight-foot height of erosion was observed. This erosion problem will require immediate attention.

Photo 3.26 Severe erosion of 6' height was observed west of Admiral Drive

Photo 3.27 Severe erosion of 6' height observed upstream of confluence with North Branch

The upstream segments of Paul Spring Branch are good candidates for stream restoration projects because each individual project would have adequate stream length, would not involve easement acquisition, and would have good access for construction. In the downstream segments of Paul Spring Branch, minor bank stabilization would be appropriate to protect adjacent properties from future problems.

The general characteristics of the stream water quality were assessed and can be described as follows:

- Water in the downstream pools of Paul Spring Branch appears clear, and in the upstream reaches, the water appears green in color.
- A petroleum or methane smell was observed in both the water and sediment of the downstream segment near the confluence with North Branch. The upstream segments were odor free.
- Medium fish of three to six inches in length were observed in some of the stream segments as shown on Map 3.12.
- No aquatic plants or algae were observed in Paul Spring Branch stream segments.
- The buffer width is inadequate along the majority of Paul Spring Branch due to residential development in the area. The impact of deficient buffer areas on the stream segment is

Photo 3.28 Deficient buffer area at the upstream segment of Paul Spring Branch west of Kenyon Drive

Photo 3.29 Deficient buffer area along the downstream segment of Paul Spring Branch north of Sherwood Hall Lane

moderate and the locations of deficient buffer areas are shown on Map 3.12. Typical deficient buffer areas in the upstream and farthest downstream segments of Paul Spring Branch are shown in Photos 3.28 and 3.29.

3.3.5 Problem Areas from Public Forum

Problem areas were identified by the stakeholders in the watershed forum held on July 19, 2003, and the locations are shown on Map 3.9 (except as noted). The majority of the problems include uncontrolled runoff to the stream, erosion, and loss of forested buffer.

Table 3.12 Paul Spring Branch Problem Areas from Public Forum

Problem ID	Description
A7	Excessive flooding in the forested areas is due to road and parking lot runoff.
C3	There are obstructions with trees on Paul Springs Branch near Paul Springs Parkway.
D5	Large impervious areas consisting of commercial parking lots are located at Beacon Hill Mall.
E4	A dry detention pond located near Preston Avenue and Bryant Towne Court doesn't work. Approximately 12 years ago, Popkins Lane was widened and storm sewers created more inflow to the stream.
E5	Several new homes built five years ago near Schooley Drive and East Side Drive are too close to the creek and the riparian buffer was lost when vegetation was stripped from the lots. At the low point of Memorial Street (east), there are possible illicit discharges from car repair and painting.
E8	Stream bank erosion exists Paul Spring Branch in the Hollin Hall area.

3.3.6 Modeling Results

The hydrology developed for this subwatershed produced stormwater runoff that is fairly high with respect to the size of the watershed. Over 25% of this subwatershed is covered by impervious surfaces and almost two-thirds of the land use is residential of moderate to high density. This development results in peak discharges that are high for the two- and 10-year rainfall events relative to the size of the drainage area. The planned development in this watershed will result in a slight increase in impervious surfaces, mainly due to redevelopment of low-density residential parcels into medium-density residential areas and will result in minor increases in stormwater peak discharges which may lead to erosion and sedimentation in the stream. Please see Table 3.13 for a comparison of existing and future two-and 10-year peak discharges for each sub-basin.

The velocities produced by the two-year rainfall event in Paul Spring Branch are generally moderate throughout its length with several areas of notably high velocity. Locations of erosion ranging from moderate to severe were observed in Paul Spring Branch during the stream physical assessment, which correspond to the locations of high velocity from the hydraulic model. Severe to extreme erosion was observed at two pipe outfalls which also correspond to the hydraulic model.

The two-year peak discharge overtops the main channel but is contained within the floodplain for the majority of the length of Paul Spring Branch. The 10-year peak discharge overtops the channel banks but is contained within the floodplain for the majority of Paul Spring Branch. The two-year storm overtops Paul Spring Road, and the 10-year storm overtops the roadway at Mary Baldwin Drive and Paul Spring Road.

The water quality modeling results for Paul Spring Branch show that the average sediment loading rates exceed the tributary strategy target levels for sediment for both existing and future land use conditions. The Paul Spring Branch Subwatershed has a relatively high residential density and the Route 1 commercial corridor is located in the headwaters of the

subwatershed. The sub-basins located in the headwaters have the highest sediment loading rates in the subwatershed and the sediment loading rates exceed the poor values for future land use conditions. The average sediment loading rate is predicted to increase by 7% in the future due to the increase in medium-density residential area and the decrease in undeveloped land.

The average total phosphorus loading rate for the Paul Spring Subwatershed exceeds the tributary strategy target levels. The average increase in the future phosphorus loading rate is 21%, which can be attributed to the 23% increase in medium-density residential land use and the development of all existing undeveloped property. All sub-basins for the existing and future conditions exceed the phosphorus tributary strategy levels. For future conditions, the highest phosphorus loading rate is associated with sub-basin LH-PS-0007, which is the sub-basin with the greatest density of development in the subwatershed. The predicted future loading rates for all sub-basins exceed the tributary strategy target level for phosphorus.

The average total nitrogen rate for the subwatershed is less than the tributary strategy target level. For existing and future conditions, sub-basin LH-PS-0007, located in the headwaters of the Paul Spring Subwatershed, is predicted to exceed the tributary strategy target level. The higher rate for this sub-basin is attributed to the high percentage of commercial area and the increase in medium-density residential land use. The expected increase in the future nitrogen loading rate for the entire subwatershed is 13%.

Table 3.13 Paul Spring Branch Peak Runoff Flows

	Two-Year Rainfall Event			Ten-Year Rainfall Event		
Sub-basin	Existing Peak Flow	Future Peak Flow	% Peak Flow Increase	Existing Peak Flow	Future Peak Flow	% Peak Flow Increase
	(cfs)	(cfs)		(cfs)	(cfs)	
LH-PS-0001	216	230	6%	437	454	4%
LH-PS-0002	261	271	4%	531	542	2%
LH-PS-0003	96	99	2%	185	188	2%
LH-PS-0004	205	208	1%	390	395	1%
LH-PS-0005	120	121	1%	234	236	1%
LH-PS-0006	165	166	1%	313	315	1%
LH-PS-0007	297	310	4%	541	564	4%

3.4 North Branch Subwatershed

The North Branch Subwatershed has an area of 1,760 acres and contains North Branch, a tributary to Little Hunting Creek located on the east side of the creek. The subwatershed is bounded to the west by Cornith Drive and Holland Road; to the south by Stirrup Lane and Alden Road; to the east by George Washington Memorial Parkway; and to the north by the intersection of Martha Road and Popkins Lane, the North Branch and Paul Spring Branch confluence, and Custis Street. Sherwood Hall Lane and Collingwood Road are two major roads located in this subwatershed. The North Branch Subwatershed is shown on Map 3.13, and its condition is summarized as follows:

North Branch Subwatershed Condition Summary

- Current imperviousness = 26% with majority of land use medium-density residential
- Future imperviousness = 27%
- Road crossings create minor impacts on the stream.
- There are 11 existing BMPs—the largest one is at the Mount Vernon Hospital.
- The stream has extensive, manmade alterations.
- Poor habitat quality was noted in 82% of the stream with inadequate buffers.
- One head cut location was observed.
- One obstruction with a moderate impact was found on a tributary.
- The stream is CEM type 3 with active widening.

3.4.1 Subwatershed Characteristics

The headwaters of North Branch emerge from a 36-inch (diameter) storm drain pipe outfall serving the area north of Lisbon Lane. The stream has a low gradient slope of 0.40%. The length of North Branch to its confluence with Little Hunting Creek is approximately 2.5 miles. Paul Spring Branch is a tributary of North Branch located on the east side of North Branch. It is a separate subwatershed described in Section 3.3. There are two other major tributaries of significant length. Tributary Reach LHNB001 is located approximately 1,500 feet upstream of the North Branch confluence with Little Hunting Creek and is over 1,500 feet in length. Tributary Reach LHNB008 is located 2,500 feet downstream of the North Branch and Paul Spring Branch confluence and is approximately 5,000 feet in length.

Most of the land in this subwatershed is relatively flat with ground surface slopes greater than 10% found in the headwater region of the subwatershed. Elevations at the northern edge of the subwatershed are approximately 200 feet. The ground surface slopes steeply down to an elevation of 50 feet at the beginning of North Branch and then gradually slopes to an elevation of five feet at the confluence of North Branch and Little Hunting Creek.

The impervious area in this subwatershed is 26% of the total area with a predominate land use of medium-density residential as shown in Table 3.11. The low-density, medium-density, and high-density residential land uses comprise 61% of the subwatershed area. The subwatershed area contains approximately 59 acres of undeveloped land, and the projected future land use for the subwatershed will remain predominately medium-density residential with open space and park land use increasing by 44 acres.The wetland area is approximately 1% of the total subwatershed area and is shown on Map 3.13.

Table 3.14 North Branch Land Use

Land Use Description	Land Use			
	Existing		Future	
	Area (acres)	%	Area (acres)	%
Open space, parks, and recreational areas	113	6	157	9
Estate residential	48	3	0	0
Low-density residential	279	16	0	0
Medium-density residential	781	44	1143	65
High-density residential	20	1	2	0
Low-intensity commercial	167	10	167	10
High-intensity commercial	8	1	7	0
Industrial	2	0	0	0
Unknown	5	0	6	0
Undeveloped	59	3	0	0
Road right-of-way (including shoulder areas)	255	15	255	15
Wetlands	23	1	23	1
TOTAL	1,760	100	1,760	100

In the North Branch Subwatershed, nine of the 16 identified master plan drainage projects have been completed and the remaining 10 projects are listed as inactive due to insufficient funds. The master plan drainage projects include storm drain system improvements and culvert replacements and are summarized in Table 3.12.

Table 3.15 North Branch Master Plan Drainage Projects

Type of Work	Project Name/Location
Completed projects	
Install 1,100 feet of storm sewer	Greenway Road
Install a storm sewer	Greenway Road
Replace culvert at Greenway Road	Greenway Road
Install a storm sewer system	Boswell Avenue
Perform flood control	Stacey Road
Raise Collingwood Road and replace two culverts	Little Hunting Creek
Improve 2,000 feet of drainage	Hollin Hall phase II
Improved storm drains	Hollin Hall phase I
Raise road and replace culvert at Collingwood Road	Collingwood Road
Inactive projects	
Raise Bainbridge Road	Bainbridge Road
Floodwall at Sherwood Hall Lane	Sherwood Hall Lane
Floodwall at Collingwood Road	Collingwood Road
Candlewood Road	Candlewood Road
Stabilize 200 feet of stream bank	Candlewood Road
Install an additional culvert at Sherwood Hall Lane	Sherwood Hall Lane
Flood protection	Davenport Street

For this subwatershed, 33 miscellaneous flooding and yard flooding complaints were registered with the county and listed in the database files. The locations of some of these complaints are shown on Map 3.13. Most of the complaints were yard flooding problems at isolated locations and are typically considered by the county to be private responsibilities.

The National Resources Conservation Service STATSGO database has a weighted hydrologic soil group index of 2.4 in the headwater region and a value of 2.2 for the remainder of the subwatershed. This weighted index indicates that the soils in this subwatershed have a moderately coarse texture with moderate infiltration rates. The hydrologic soil group classifications of A, B, C, and D explain the characterics of soil texture, permeability, and rate of infiltration. The county's GIS soil layer has incomplete coverage and shows small pockets of hydrologic soil group C located in the subwatershed.

3.4.2 Storm Drain System Infrastructure

The North Branch Subwatershed is drained by a network of storm drain pipe systems except for the Kirkside subdivision (which is drained by open channels). The storm drain pipe outfalls vary in size ranging from 18 to 72 inches in diameter. There are five road crossings, two driveway and trail crossings, and nine footbridge crossings in this subwatershed as shown on Map 3.14. There are minor to no impacts on the stream from the driveway, trail, and footbridge crossings. The road crossings are described as follows:

- Davenport Street: Three 60-inch (diameter) corrugated metal pipe culverts with minor stream bed erosion of two-foot height were observed downstream of the pipe as shown in Photo 3.30.

- Sherwood Hall Lane: Two 72-inch (diameter) corrugated metal pipe culverts have no impact on the stream as shown in Photo 3.31.
- Collingwood Road: Five 12-foot by eight-foot box culverts, shown in Photo 3.32, cause minor stream bed erosion upstream of the crossing.
- Collingwood Road: Four 10-foot by 15-foot concrete box culverts, shown in Photo 3.33, with sedimentation upstream of the crossing, are causing a moderate impact on the stream.
- Stacey Road: Four elliptical, five-foot by three-foot corrugated metal pipe culverts are causing minor downstream bed erosion.

Photo 3.30 Triple 60" corrugated metal pipe culverts located under Davenport Street

Photo 3.31 Double 72" corrugated metal pipe culverts located under Sherwood Hall Lane

Photo 3.32 Five 12' x 8' concrete box culverts located under Collingwood Road to convey North Branch main stem flows

Photo 3.33 Four 10' x 15' concrete box culverts located under Collingwood Road to convey flows of the eastern tributary

Fifteen concrete pipe outfalls discharge to North Branch and its tributaries. They range in size from 12 to 72 inches in diameter. Photo 3.34 shows a 60-inch concrete pipe outfall located at the headwaters of the tributary LHNB001 to North Branch. Discharges from the majority of pipe outfalls are causing only minor erosion and their locations are shown on Map 3.14. Downstream of the confluence with Paul Spring Branch, a small ditch with an 18-inch width discharges into the stream and causes moderate erosion (shown in Photo 3.35).

Photo 3.34 A 60" diameter concrete pipe outfall at the headwaters of the tributary to North Branch

Photo 3.35 A small ditch, 18' wide, discharges to North Branch just south of the confluence with Paul Spring Branch

There are 10 public (no private) stormwater management facilities located in the subwatershed and listed in the county's inventory. One of the largest stormwater management facilities is a detention basin located at the Mount Vernon Hospital that serves an area of approximately 38 acres. The stormwater management facilities are described in Table 3.13 and shown on Map 3.14.

Table 3.16 North Branch Publicly Owned Stormwater Management Facilities

Location	Type of Facility	Parcel Area (Acres)
Northeast of the Holland Road and Hinson Farm Road intersection	Wet retention	33.35
North of Rampart Court	Dry pond	0.65
Northwest of the Sherwood Hall Lane/Midday Lane intersection near Traies Court	Underground tank	0.71
North of Collingridge Court	Underground tank	0.37
South of Lakeshire Drive at Marble Dale Court	Extended detention	1.17
South of Hinson Farm Road	Dry pond	0.45
Southeast of the Holland Road and Hinson Farm Road intersection	Dry pond	4.56
East of Stacey Road south of Collingwood Road	Dry pond	0.23
Southwest of the intersection of Collingwood Road and Collingwood Court	Underground tank	0.28
West of Noral Place	Extended detention	0.15
Southeast of Riverton Lane	Extended detention	0.34

3.4.3 Stream Geomorphology

The geomorphology of North Branch and its tributaries was assessed and is shown on Map 3.15. The results of the geomorphologic assessment can be summarized as follows:

- The dominant substrates in all stream segments are sand and silt.
- All stream segments of North Branch are CEM type 3, referring to near vertical stream bank

slopes, active widening, and accelerated bend migration. It was observed that the channel has been dredged and altered.

- No geomorphologic assessment was made of the downstream segment due to wetlands.

Downstream of the North Branch confluence with Paul Spring Branch, a fallen tree obstructed the fish passage without much of an impact on the stream (shown in Photo 3.36). Tributary LHNB001 has fallen trees obstructing the channel flow at two locations as shown in Photo 3.37. In the upstream segments of North Branch, the channel is littered with lawn waste consisting of grass and leaves. Partially buried or fully encased sanitary sewer pipes cross North Branch at four different locations and cause minor impacts on the stream. The location of all obstructions, dumpsites, and utility crossings impacting the stream are shown on Map 3.15.

Photo 3.36 Flow obstruction downstream of the North Branch/Paul Spring Branch confluence

Photo 3.37 Flow obstruction in Tributary LHNB001 upstream of North Branch outfall to Little Hunting Creek

3.4.4 Stream Quality

North Branch is a low-gradient stream and is classified as the glide pool prevalent stream type. The habitat assessment for North Branch can be summarized as follows:

- In the stream segment located downstream of the North Branch confluence with Paul Spring Branch, six habitat types are common. In Tributary LHNB008, one to three habitat types are common. In the other stream segments, three to four habitat types are common.
- The majority of the pool substrate is characterized by a mud/clay bottom with less than 10% habitat structure.
- No habitat assessment was performed for the farthest downstream segment of North Branch because of wetlands.
- In the downstream tidal reaches, the pools are large and deep, and in the upstream segments, the pools are large and shallow. Tributary LHNB008 has pools that are shallow and small.
- Channel disturbance was 100% of the stream segment lengths in Tributary LHNB008. Significant disturbance of approximately 70% of the stream length was observed in other segments of North Branch.
- Pools are completely absent due to sediment affecting 90% to 100% of the bottom in the downstream portion of Tributary LHNB008. The other stream segments show 50% to 80% of the bottom being affected by sediment deposition of sand and/or silt.

- Except in the segment immediately downstream of the North Branch confluence with Paul Spring Branch, the stream segments have straight reaches with uniform depth of flow.
- During normal flow conditions, water fills approximately 80% to 90% of the available channel cross section for the majority of the stream.
- Vegetation covers approximately 50% to 70% of the channel bank area and consists of shrubs, grasses, and forbes.
- Most of the channel banks are moderately unstable with 50% to 60% of the bank having erosional areas with high erosion potential during floods. Tributary LHNB008 has slightly more stable banks.
- The majority of the vegetated buffer is 25 to 50 feet wide with impervious areas located beyond the buffer. The buffer width is less than the desired width of 100 feet.

The habitat quality is poor for 82% of the North Branch stream segments as shown on Map 3.16. No erosion problems were observed for the stream bed and banks. Head cutting up to two feet of stream bed was observed in Tributary LHNB001 with a minor impact on the stream as shown in Photo 3.38.

Photo 3.38 Head cutting of the stream bed on Tributary LHNB001

The majority of North Branch stream segments are not ideal candidates for stream restoration projects because each individual project would not be of adequate size and would have access issues Minimal bank stabilization would be appropriate to protect adjacent properties from future problems.

The general characteristics of the stream water quality were assessed and can be described as follows:

- The water and sediment in the North Branch stream segments were odor free.
- In the stream segments downstream of the North Branch confluence with Paul Spring Branch, fish of three to six inches in length were observed (locations shown on Map 3.16).
- Aquatic plants attached to the stream margin were observed in less than 10% of the area in Tributary LHNB008.
- Orange filamentous algae were observed in stream segments located downstream of the North Branch confluence with Paul Spring Branch. Tributary LHNB008 exhibited green filamentous algae.

In the North Branch stream segments located immediately upstream and downstream of the North Branch/Paul Spring Branch confluence, the buffer area is covered with lawn causing a severe to extreme impact as shown in Photo 3.39. The downstream segments of Tributary LHNB001 have inadequate buffers adjoining pavement, causing a severe impact on the stream as shown in Photo 3.40. Overall, the North Branch stream segments do not have adequate natural buffer widths of 100 feet. The locations of deficient buffer areas along the stream corridor are shown on Map 3.16.

Photo 3.39 Lawn in the buffer zone downstream of Paul Spring Branch confluence

Photo 3.40 Buffer zone next to Collingwood Road on the eastern tributary to North Branch

3.4.5 Problem Areas from Public Forum

Problem areas were identified by the stakeholders in the watershed forum held on July 19, 2003, and the locations are shown on Map 3.13 and in Table 3.14. The majority of the problem areas identified at the forum included sedimentation and stream bank erosion of North Branch.

Table 3.17 North Branch Problem Areas from Public Forum

Problem ID	Description
A3	There is a blocked culvert at Collingwood Road. The creek is still tidal up to Collingwood Road.
A4 & C2	At North Branch near Collingwood Road, VDOT is clearing away sediment. However, their efforts are ineffectual because their methods don't take into account that the creek is still tidal at this location. The area is smelly and prone to flooding, and there are concerns about West Nile Virus.
B5	Massive stream bank erosion was reported on North Branch near Candlewood Drive.
C1	The beaver dam near Stirrup Lane was destroyed a few years ago due to flooding problems, reestablish the retention pond.
E7	There is stream bank erosion near the Collingwood Road crossing.

3.4.6 Modeling Results

The hydrology developed for this subwatershed produced stormwater runoff that is fairly high with respect to the size of the watershed. Over 25% of this subwatershed is covered by impervious surfaces with the majority of land use being low- to medium-density residential and low-intensity commercial. This amount of imperviousness produces peak discharges that are relatively high for the two- and 10-year rainfall events. The potential development in this watershed will result in an overall slight increase in impervious surfaces, as future land uses are almost exclusively medium-density residential and low-intensity commercial. This potential development will produce peak discharges for the two- and 10-year rainfall events that are slightly higher than they are currently. Please see Table 3.18 for a comparison of existing and future two-and 10-year peak discharges for each sub-basin.

The velocities produced by the two-year rainfall event in North Branch are generally moderate throughout its length with several areas of higher velocity. No erosion or head cuts were observed in North Branch during the stream physical assessment that corresponds to the slow to moderate velocities from hydraulic model.

The two-year peak discharge overtops the main channel but is contained within the floodplain for the majority of the length of North Branch. There are several locations where the two-year discharge overtops the channel banks and inundates the floodplain area. The 10-year peak discharge overtops the channel banks throughout the length of North Branch but is contained within the floodplain for the majority of the channel. There are no roadway overtopping locations for the two- or 10-year storm event along any reach of North Branch.

The water quality modeling results for North Branch show that the average sediment loading rates for existing and future land use conditions exceed the tributary strategy target level for sediment. For future land use conditions, the average sediment loading is predicted to increase by 5% and is attributed to the slight increase in medium-density residential land use in the subwatershed and the decrease in undeveloped land. The sub-basin containing Mount Vernon Hospital and the commercial area just south of Sherwood Hall Lane has the highest sediment loading rates for the subwatershed. In addition, the sub-basin LH-NB-0004 that contains the Carl Sandburg Middle School and the Stratford Landing Elementary School is expected to have a high sediment loading rate for future land use conditions compared to the other sub-basins in the subwatershed.

The average total phosphorus loading rate for existing and future land use conditions for the North Branch Subwatershed exceeds the tributary strategy target value for all sub-basins. For future land use conditions, the relatively high percentage of medium-density land use, low-intensity commercial land use, and the low percentage of open space contribute to the high level of phosphorus loading.

For the existing and future land use conditions in the subwatershed, the average total nitrogen loading rate for North Branch is less than the tributary strategy target value. Sub-basin LH-NB-0003, located at the downstream end of North Branch, is predicted to exceed the tributary strategy nitrogen target value due to the high commercial land use of the sub-basin for existing and future conditions. This sub-basin contains the Mount Vernon Hospital as well as other large commercial areas. The expected increase in the future nitrogen loading rate for the entire subwatershed is 11%.

Table 3.18 North Branch Peak Runoff Flows

Sub-basin	Two Year Rainfall Event			10-Year Rainfall Event		
	Existing Peak Flow	Future Peak Flow	% Peak Flow Increase	Existing Peak Flow	Future Peak Flow	% Peak Flow Increase
	(cfs)	(cfs)		(cfs)	(cfs)	
LH-NB-0001	108	108	0%	216	216	0%
LH-NB-0002	96	97	1%	190	192	1%
LH-NB-0003	54	54	0%	94	93	0%
LH-NB-0004	175	178	2%	324	330	2%
LH-NB-0005	118	118	0%	223	223	0%
LH-NB-0006	147	161	10%	277	302	9%
LH-NB-0007	217	222	2%	402	409	2%
LH-NB-0008	225	233	4%	427	440	3%
LH-NB-0009	87	97	11%	164	179	9%
LH-NB-0010	131	136	4%	248	255	3%
LH-NB-0011	197	202	3%	374	384	3%

3.5 Potomac River Subwatershed

The Potomac River Subwatershed is a narrow band of land bordering the Potomac River and located adjacent to the east and west sides of the Little Hunting Creek Watershed as shown on Maps 3.17 and 3.18. This area does not drain to Little Hunting Creek but was included in this watershed plan. The east and west portions of the subwatershed are referred to as East Potomac and West Potomac in this section. The condition of the subwatershed can be summarized as follows:

Potomac River Subwatershed Condition Summary

- Current imperviousness = 15% with the majority of land use open space and parks
- Future imperviousness = 17%
- The majority of the existing land use is open space, parks, and recreational areas.
- No physical assessment of the streams (except for one tributary) was performed.
- There are no existing BMPs.
- The stream located south of Eaglebrook Court has been altered and has poor habitat quality with inadequate buffers.
- No erosion or head cuts were observed.
- No trash dumps were located.

3.5.1 Subwatershed Characteristics

West Potomac has one large stream and East Potomac has five small streams, all ranging from a few hundred feet to 2,000 feet in length. The streams have a gentle slope of 1.0% to 2.0%. The terrain is mostly flat with elevations of 75 to 80 feet, and steep slopes (25% and greater) are found in the vicinity of the stream bank areas.

The impervious area in this subwatershed is 15% of the total area with a future projected imperviousness of 17%. The predominant existing land use in the subwatershed is open space, parks, and recreational land use as shown in Table 3.15. The West Potomac area of the subwatershed has an area of approximately 496 acres and includes the historic Mount Vernon area and a portion of the Riverwood subdivision. The East Potomac portion of the subwatershed has an area of approximately 761 acres and includes the George Washington Memorial Parkway, a portion of Fort Hunt, and a few small residential subdivisions. The amount of undeveloped land is approximately 43 acres and there is a possible increase in medium-density residential land use with future buildout conditions. The wetland area for the subwatershed totals approximately 18 acres. No drainage complaints were registered with the county and no master plan projects were constructed or planned for this subwatershed.

Table 3.19 Potomac River Land Use

Land Use Description	Land Use			
	Existing		Future	
	Area (acres)	%	Area (acres)	%
Open space, parks, and recreational areas	579	46	585	47
Estate residential	72	6	0	0
Low-density residential	144	11	0	0
Medium-density residential	283	23	553	44
High-density residential	1	0	0	0
Low-intensity commercial	19	2	5	0
High-intensity commercial	1	0	0	0
Industrial	1	0	0	0
Unknown	0	0	0	0
Undeveloped	43	3	0	0
Road right-of-way (including shoulder areas)	96	8	96	8
Wetlands	18	1	18	1
TOTAL	1,257	100	1,257	100

For the West Potomac portion of the subwatershed, the National Resources Conservation Service STATSGO database has a weighted hydrologic soil group index of 2.2. For the East Potomac portion of the subwatershed, the STATSGO database has a weighted hydrologic soil group index of 2.4 north of Waynewood Boulevard and a value of 2.2 for the remainder of the area. The weighted index values of 2.2 and 2.4 indicate that the soils in this subwatershed have a moderately coarse texture with moderate infiltration rates. The county's GIS soil layer has incomplete coverage and shows small pockets of hydrologic soil groups C and D located in the subwatershed.

3.5.2 Storm Drain System Infrastructure

The developed areas such as the Waynewood subdivision have storm drain systems that discharge directly into the Potomac River. The major road crossings include a seven-foot by six-foot concrete arch culvert under the George Washington Memorial Parkway (shown in Photo 3.41). This crossing is free of sediment, trash, and obstructions and causes no impact

Photo 3.41 Concrete arch culvert of size 7' by 6' located under George Washington Memorial Parkway

Photo 3.42 Concrete pipe outfall located west of Eaglebrook Court

on the stream. A 66-inch (diameter) concrete pipe discharges into one of the streams in the East Potomac portion of the subwatershed without causing any erosion (shown in Photo 3.42). There are no private or public stormwater management facilities in this subwatershed.

3.5.3 Stream Geomorphology

The geomorphology of the stream located south of Eaglebrook Court and north of Emerald Drive in the East Potomac portion of the subwatershed was assessed. Sand is the dominant substrate and the stream segment is CEM type 3, referring to near vertical stream bank slopes, active widening, and accelerated bend migration. Encroachment from the adjacent residential subdivision is causing the stream to widen and degrade. The stream segments are free of any obstructions and dumpsites. There are no utility crossings in the stream segments.

3.5.4 Stream Quality

The stream located south of Eaglebrook Court has a low-gradient slope and is classified as the glide pool prevalent stream type. The stream habitat assessment can be summarized as follows:

- The stream has three habitat types for less than 50% of the length.
- The pools have mud or clay bottoms with less than 10% habitat structure.
- Large and small shallow pools are evenly mixed.
- More than 60% of the channel has been altered.
- Sediment deposition is mainly sand and/or silt with 70% to 80% of the bottom affected.
- The stream has very little sinuosity and is essentially straight with a uniform depth.
- During normal flow conditions, water fills approximately 75% of the available channel cross section.
- Forty percent of the stream bank surface is covered with vegetation, though there are many bare spots and rocks. The trees and shrubs are isolated or in widely scattered clumps.
- The stream banks are moderately unstable with 50% to 60% of the banks having eroded areas. There is high erosion potential during floods.
- The vegetated buffer is 25 to 50 feet wide with greater than 25% imperviousness beyond the 50-foot buffer zone width.

The entire stream was assessed with poor habitat quality based on the extensive channel alterations and lack of vegetated buffer. The water and sediment in the stream were odor free and the water appeared clear. No head cuts along the stream bed or erosion of the stream bed and banks were observed. Minor bank stabilization would be appropriate to protect adjacent properties from future bank erosion problems.

The general characteristics of the water quality for the stream located south of Eaglebrook Court were assessed and can be described as follows:

- Small fish of one to two inches in length were observed.
- No aquatic plants and/or algae were observed.

The natural buffer zone has been altered with planted lawns causing minor impacts on the stream as shown in Photo 3.43.

Photo 3.43 Lawn grass in the buffer zone along the stream located south of Eaglebrook Court

3.5.5 Problem Areas from Public Forum

No problem areas were identified by the stakeholders in the watershed forum held on July 19, 2003.

3.5.6 Modeling Results

The Potomac River Subwatershed hydrology was evaluated and peak discharges were estimated; however, no hydraulic modeling was performed for the small streams located in the Potomac River Subwatershed.

The hydrology developed for this subwatershed produced stormwater runoff that is moderate with respect to the size of the watershed. Almost half of this subwatershed is comprised of open spaces, parks, and recreational areas while the majority of the remainder of the watershed consists of low- to medium- density residential land use. The existing land use produces peak discharges that are moderate for the two- and 10-year rainfall events. The future land use for this subwatershed is planned to be medium-density residential, which will produce minor increases in peak discharges. Please see Table 3.20 for a comparison of existing and future two-and 10-year peak discharges for each sub-basin.

The water quality modeling results for the Potomac River Subwatershed show that the average sediment loading rates for existing and future land use conditions were less than the tributary strategy target level for sediment. For future land use conditions, the average sediment loading is predicted to increase by 15%, which can be attributed to the future development of the low-density residential and the estate residential land use and the 20% increase in medium-density residential land use subwatershed-wide. The low sediment loading rates for the subwatershed can be attributed to the high percentage of open space in the watershed at 46%.

The average total phosphorus loading rate for existing and future land use conditions for the Potomac River Subwatershed is predicted to not exceed the phosphorus tributary strategy

target value. The average subwatershed phosphorus loading rate for future conditions is predicted to increase by 27%, which can be attributed to the 21% increase in medium-density residential land use which has a relatively higher phosphorus loading rate in relation to the existing land uses in the subwatershed.

The average total nitrogen loading rate will be less than the tributary strategy target level. Two sub-basins are not predicted to exceed the nitrogen levels for either existing or future conditions. The expected increase in the future nitrogen loading rate for the subwatershed is 22%.

Table 3.20 Potomac River Peak Runoff Flows

	Two-Year Rainfall Event			Ten-Year Rainfall Event		
Sub-basin	Existing Peak Flow	Future Peak Flow	% Peak Flow Increase	Existing Peak Flow	Future Peak Flow	% Peak Flow Increase
	(cfs)	(cfs)		(cfs)	(cfs)	
LH-PO-0001	244	253	4%	514	528	3%
LH-PO-0002	472	525	11%	872	966	11%