Abiotic Characteristics

Geology and Soils

Little Bennett Creek, Upper Great Seneca Creek, and the Upper Patuxent River watersheds within Montgomery County lie entirely within the Piedmont physiographic province, where bedrock is generally composed of metamorphic and igneous rocks of Paleozoic age. The study area is predominantly underlain by crystalline rocks of the Ijamsville, Urbana, and Harper Phyllites, and the Wissahickon (schist) Formation (see Figure 8). The Upper Patuxent River and Great Seneca Creek watersheds also have minor amounts of mafic and ultramafic rock in the area dominated by schist. A mantle of loose unconsolidated material, the regolith, generally overlies solid rock. It comprises saprolite, soils and alluvium. The saprolite is gradational material overlying bedrock. Saprolite is rocky and barely weathered just above the bedrock and clay-rich at the surface.

The northern half of the study area is characterized by soils of the Blocktown-Brinklow-Linganore map unit. These are gently sloping to steep, well drained, shallow and moderately deep soils that are loamy throughout and occur on ridgetops and side slopes. The depth to bedrock typically ranges from 18 to 26 inches. More than 60 percent of this unit is used as woodland or pasture for which it is well suited. The depth to bedrock and the slope are the major limitations affecting cultivation. The Blocktown-Brinklow-Linganore unit is poorly suited to most urban uses. The main limitations affecting onsite sewage disposal are the depth to bedrock and the slope (USDA-NRCS, 1995). Deeper but poorly drained soils, including Hatboro, Codorus, and Baile soils are more common in the floodplains and low-lying areas of the stream valleys.

The southern half of the study area is characterized by soils of the Brinklow-Baile-Occoquan map unit. These are nearly level to moderately steep, well drained and poorly drained, moderately deep to very deep soils that are loamy throughout and occur on broad ridgetops and side slopes. More than 60 percent of this unit is used for cultivated crops, hay, or pasture; the unit is well suited for these uses. The main limitations are the available water capacity and the slope. On more than 30 percent of the unit, the water table, the slope, or the depth to bedrock limits most agricultural uses. On more than 40 percent of this unit, the water table, the slope, or the depth to bedrock limits urban uses. The major limitations affecting onsite sewage disposal are restricted permeability, the depth to bedrock, the water table, and the slope (USDA-NRCS, 1995). The nearly level, poorly drained, very deep Baile soils are in upland depressions and in low-lying areas along drainageways.

Throughout the study area, in low lying areas, and in the proximity of streams in general, hydric and poorly drained soils present severe limitations to on-site sewage disposal. In those areas, development using traditional individual on-site sewage disposal systems may be constrained due to slow percolation, wetness, flooding or depth to bedrock (see Figure 9). Approximately 68% of the study area outside the sewer service area and parkland, contain soils which present severe limitations to on-site sewage disposal, with an additional 32% presenting moderate limitations.

Topography and Slopes

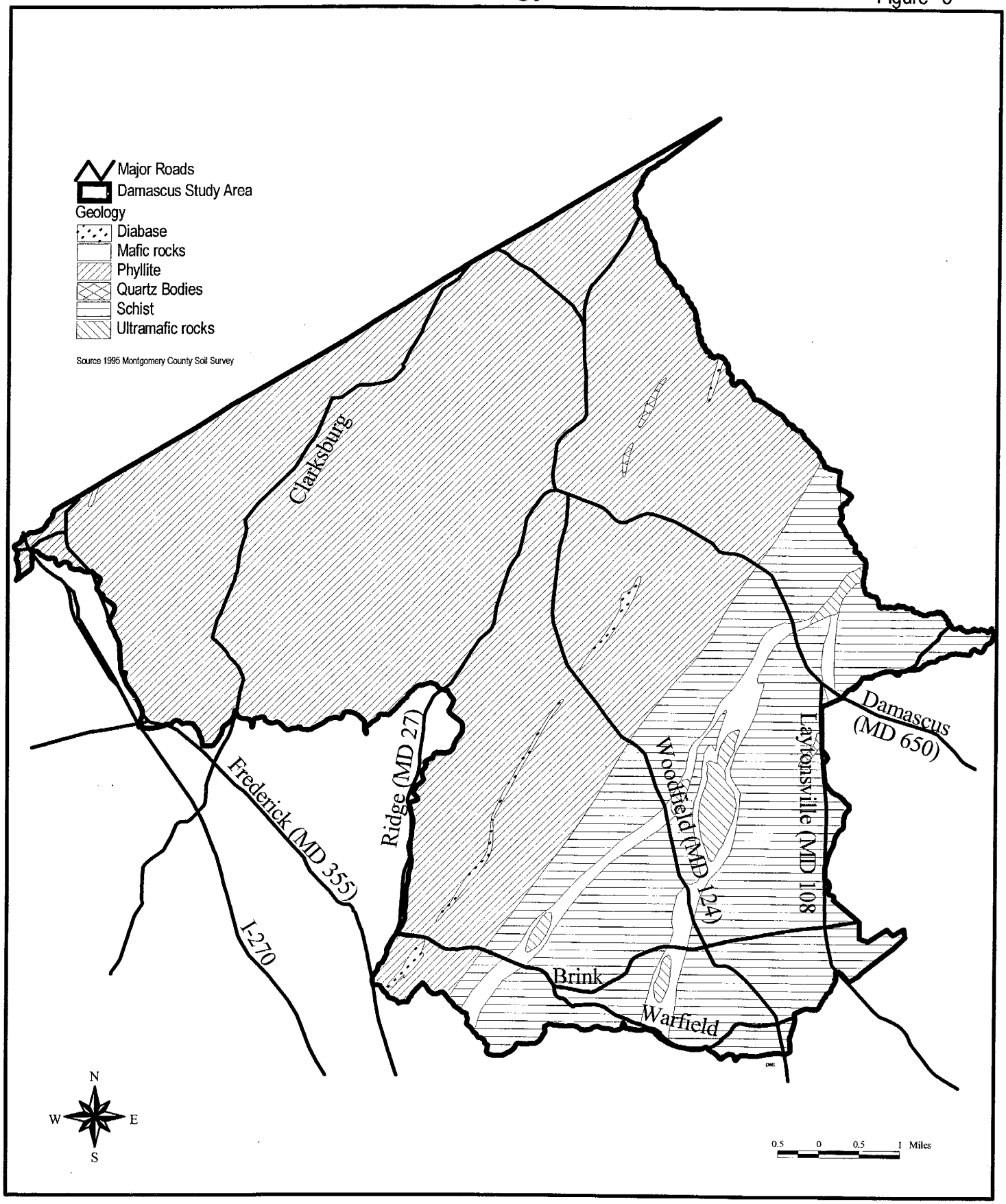
The terrain of the study area exhibits gentle to steep slopes (see Figure 10). The majority of the area has slopes between 3 and 14 percent (see Table 7). Steep slopes (25 percent or greater) occur along the mainstems and major tributaries of Bennett Creek, Little Bennett Creek, Patuxent River, and Great Seneca Creek. 58% of the steep slopes in the Damascus Study Area are contained within parkland.

Study Area Slopes **Table 7**

Slope	Approximate % of Total Area
0-3%	12.
3-8%	31
8-14%	34
15-24%	17
25 or greater	6

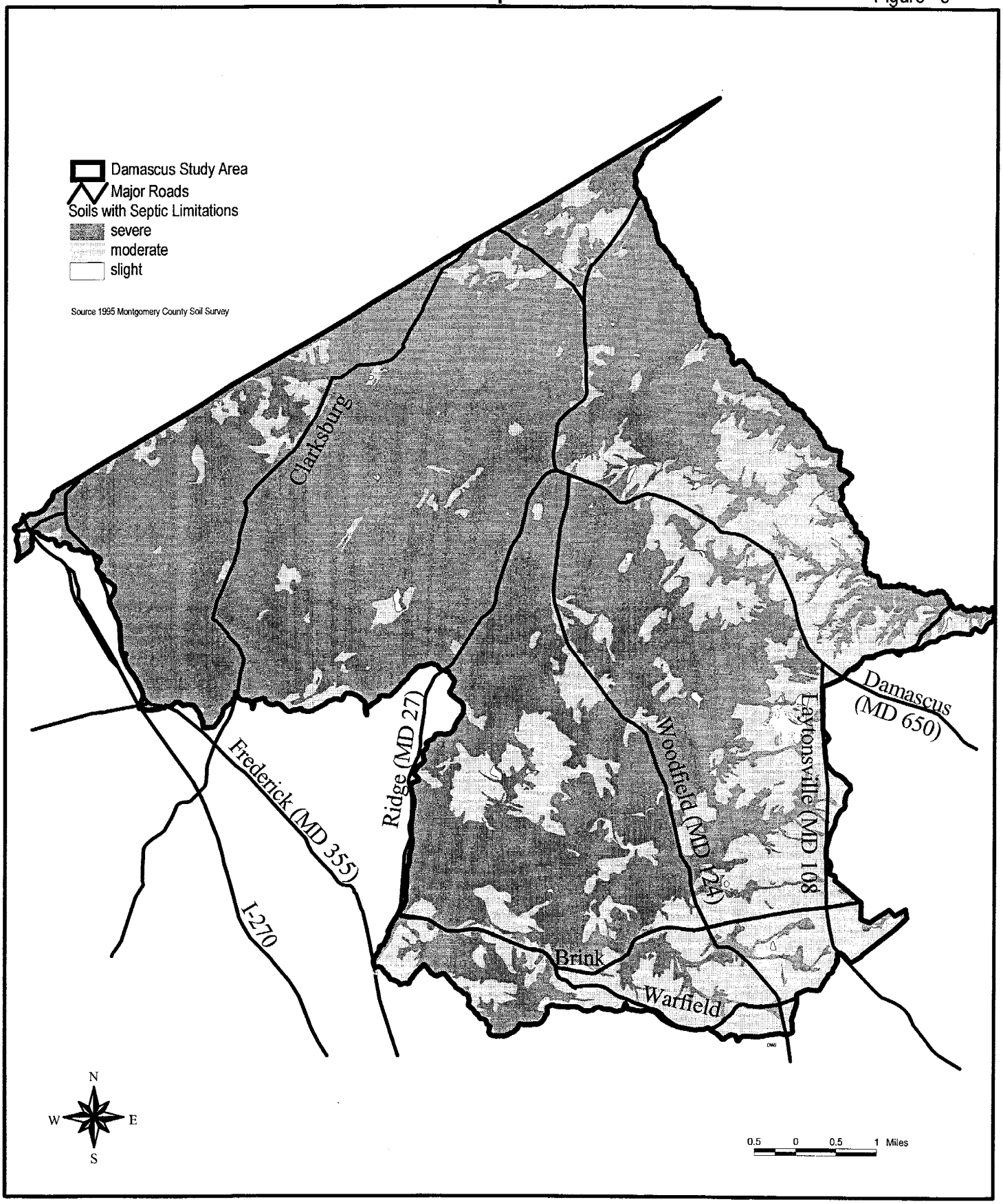
Geology

Figure 8



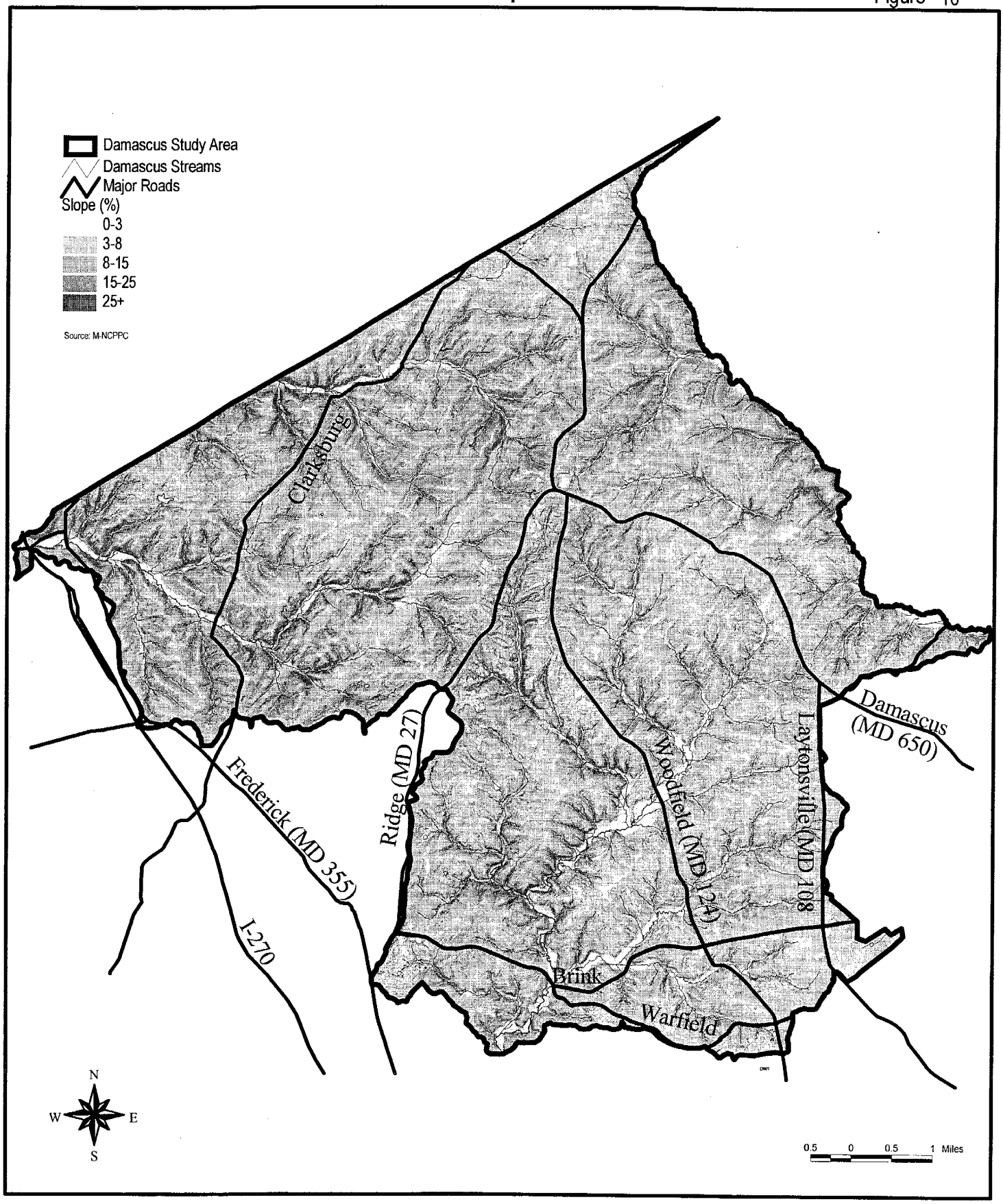
Soils With Septic Limitations

Figure 9



Slope

Figure 10



Groundwater

The Damascus Study Area lies entirely within the upland section of the Piedmont physiographic province in Montgomery County. The hydrogeologic setting of the watersheds within the study area is typical of the Maryland Piedmont – precipitation that infiltrates the ground recharges ground water, which discharges to streams. Precipitation is the primary source of aquifer recharge in Montgomery County. The average annual rainfall is about 42 inches, of which an estimated 9 to 10 inches is available as recharge. Most precipitation either runs off or is intercepted or taken up by plants and other organisms and returned to the atmosphere as evapotranspiration.

Groundwater flow systems in the Maryland Piedmont are generally unconfined and local. By unconfined we mean that the top of the aquifer is not bounded by an impermeable layer; rather, the top of the aquifer is simply the top of the zone of saturation, otherwise known as the water table. The water table surface generally reflects the overlying topography. As a result, groundwater watersheds and divides generally mimic surface watersheds and drainage divides. There is little or no groundwater flow between drainage basins in the Maryland Piedmont; therefore, processes acting within the individual basins determine water quality. This is a fundamental difference between crystalline rock aquifers of the Piedmont and the sedimentary aquifers of the Coastal Plain, where recharge water travels long distances in confined aquifers and water quality may not bear any relation to land use near the well. During dry weather, stream flow is maintained predominantly by groundwater discharge. As a result, under low flow conditions, groundwater and surface water quality are closely linked.

In areas of Montgomery County (like the rural parts of the study area) that depend on individual well systems, protection of groundwater quality is essential. Ironically, those same areas usually depend on individual on-site sewage disposal systems (septic systems) that may contribute to groundwater pollution. Regulations are in place to require separation of wells and septic systems, and for proper design to avoid contamination from failing systems. Use of such systems, however, requires large lots, especially where soils have septic limitations due to shallow bedrock or wet conditions. Other sources of groundwater pollution include animal waste, excessive application of fertilizers and pesticides, improper land disposal of hazardous substances, and recharge from heavily contaminated surface sources such as stormwater management infiltration trenches.

From a water quantity standpoint, the disturbance or replacement of natural water recharge and discharge areas interferes with the hydrologic cycle of groundwater. Streams in heavily urbanized areas experience a decrease in stream base flow and lower groundwater yields. The impacts can be serious for areas that depend on public or private wells. Also, low baseflow in streams adversely impacts the natural aquatic environment.

As discussed in the previous section, the four major watersheds that make up the Damascus Study Area are all characterized by similar geology and soils (see Figure 8). In general, the crystalline rock aquifers are considered suitable for providing limited quantities of high quality water, such as for individual homes in rural areas. Well yields in the phyllite bedrock aquifer are generally the lowest in the county, and range from less than 1 gallon per minute (gpm) to 25 gpm, with a median yield of about 7 gpm. Well yields in schist bedrock are slightly higher, but still generally low, with a median yield of about 8 gpm. The relatively low typical yields from wells in these aquifers have been attributed to the poorly developed network of points and fractures in the rock. Movement of groundwater is slow, with typical specific capacities of 0.075 to 0.090 gallon per foot per minute (g/ft/m).

Variability in well yields has been associated with area topography and geology. A greater percentage of wells in the valleys have higher yields than wells located on hilltops. This is a typical occurrence in the crystalline rocks of the Piedmont where valleys tend to develop along zones of structural weakness, where fracturing is greater. In addition, groundwater flows naturally from upland recharge areas to lower-lying valleys, resulting in lower depths to the water table and often contributing to higher flow rates.

100-Year Floodplain

The 100-year floodplain is defined as the land area adjacent to streams and lakes that is susceptible to inundation by the 100-year flood (a flood with the statistical probability of occurrence of 1 in 100 years) as a result of heavy rainfall and runoff from upland areas. The 100-year floodplain is a component of the Sensitive Areas element required by the 1992 State Planning Act. The

100-year floodplain boundary may be approximated through engineering studies, field observations, soils surveys, or historical data.

Protection of the floodplain from development presents several advantages. The floodplain helps protect water quality and natural habitats by reducing erosion and sedimentation, and by providing a natural corridor for wildlife. It also helps guard against injury and destruction of property and moderate/attenuate flood flow.

Much of the floodplain information available for Great Seneca Creek consists of the M-NCPPC ultimate land use 100-year floodplain maps which are based on a detailed hydrologic study of larger tributaries. These maps were developed in the late 1970s, taking into account projected development densities based on zoning plans in effect at that time. While they may not satisfy current regulatory requirements, they remain the best available reference for planning purposes.

No county sponsored floodplain study has been conducted for the Bennett Creek, Little Bennett Creek, or the mainstem Patuxent River basins. As a result, the floodplain information available for these watersheds consists of Federal Emergency Management Agency (FEMA) floodplain insurance maps. The 1995 revised Soil Survey in Montgomery County provides less detailed information on areas that are generally associated with floodplains. However, the survey provides supplemental floodplain information for areas not covered by the M-NCPPC or FEMA's more detailed studies. Figure 11 depicts the floodplain mapping for the study area.

Except for Bennett Creek, most of the 100-year floodplain areas in the Damascus Study Area are contained within parkland. The known or estimated 100-year floodplain outside parkland consists of areas associated with smaller headwater tributaries. Most of the area within the 100-year floodplain is forested, with minor areas in agriculture.

Air Quality

The entire Washington metropolitan region, which includes all Montgomery County, is currently a severe ground level ozone "nonattainment area" as designated by the United States Environmental Protection Agency. Exposure to excessive ground-level ozone can pose health risks to vulnerable populations including children, the elderly, and people with respiratory ailments.

Ground-level ozone is an invisible gas formed when two pollutants -- volatile organic compounds (VOCs) and nitrogen oxides (NO_x) -- react in sunlight. The primary sources of these pollutants are emissions from utilities and other industrial sources, automobiles, trucks (especially low mileage SUVs), buses, lawnmowers, boats, and small businesses that use solvents and cleaning solutions. Other sources of these pollutants include household products such as non-latex paints, household cleaners, and insecticides.

In the year 2000, the Environmental Protection Agency (EPA) issued new rules for the regulation of air pollution from newly manufactured trucks and buses. These rules will require more stringent emissions standards for these vehicles beginning with the 2004 model year. Even more stringent standards are established for model year 2007 vehicles. According to the EPA, the new emissions standards established in these rules will result in particulate matter and NOx emission levels that are 90 percent and 95 percent below today's levels, respectively. The reduction will be achieved through the use of pollution control devices (e.g. catalytic converters) and diesel fuel requirements for low sulfur content. Low sulfur fuel is needed because sulfur in fuel damages the emission control devices used to reduce NO_x emissions during fuel combustion. The overall clean air impact of these rules will be dramatic when fully implemented. EPA estimates that this program will provide annual emission reductions equivalent to removing the pollution by more than 90 percent (or about 13 million) of today's trucks and buses. However, we will not begin to reap these benefits until after 2007 and then only gradually as our fleet ages and begins to be replaced by these air quality positive vehicles.

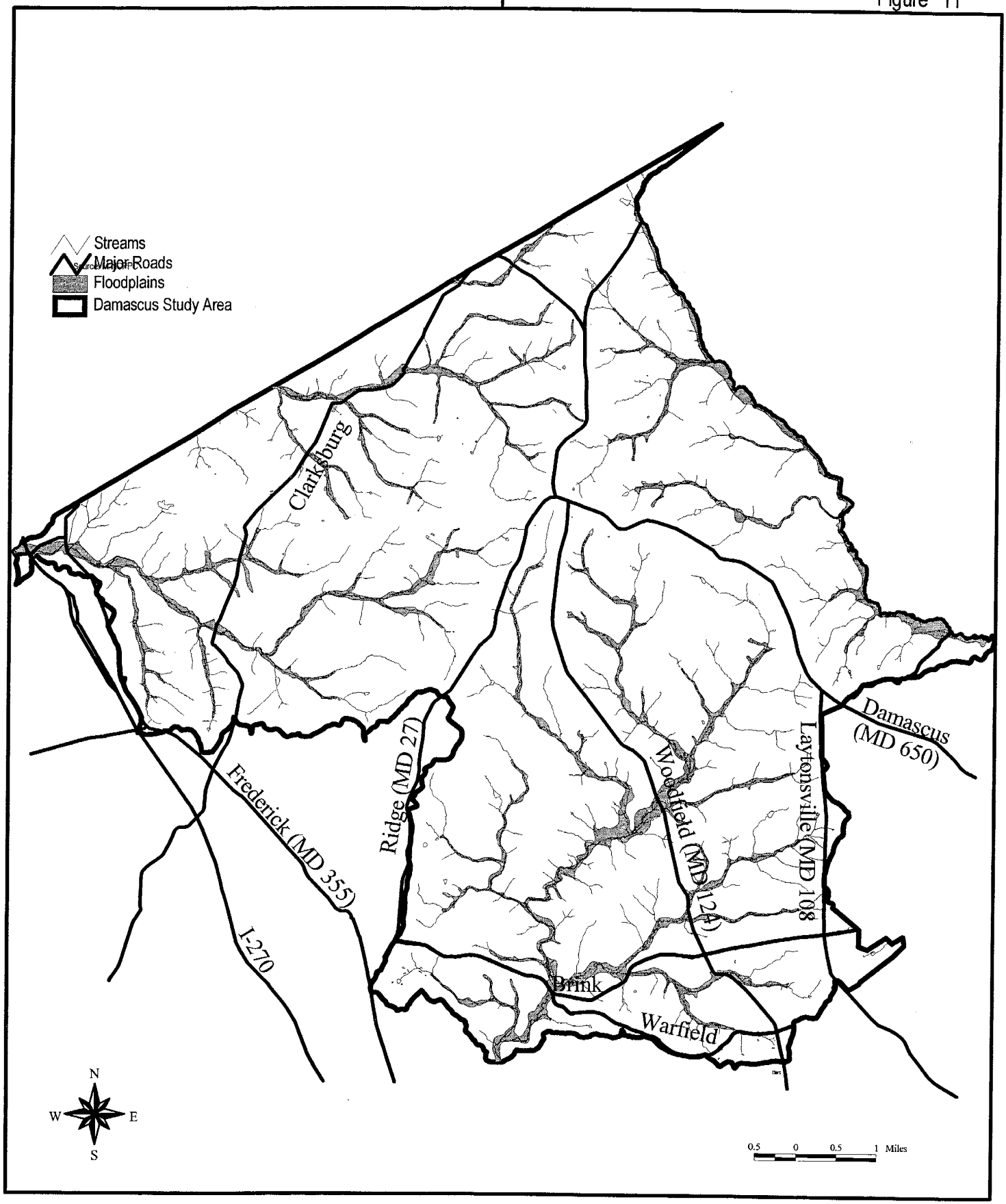
On a typical summer day, over one third the pollutants that cause ground-level ozone in the Washington region come from sources outside the region. Some sources migrate from other states, hundreds of miles away. Likewise, sources in the Washington area emit pollutants that travel many miles and eventually affect ozone concentrations in other regions and states. From 1986 to 1995, the Washington metropolitan region exceeded the federal one-hour ozone standard, on average, twelve days a year. Since 1996, the Region exceeded the federal one-hour ozone standard, on average, six days a year. Today, the region faces the challenge of meeting stricter federal health standards for ground-level ozone. In 1997, the United States Environmental Protection Agency changed the averaging

time from one-hour to eight-hours and reduced the standard downward to reflect the best current knowledge of the effects of ozone on human health.

Local carbon monoxide violations noted in the 1980 air quality plan have been virtually eliminated due to cleaner burning fuels.

Floodplains

Figure 11



Noise

Excessive noise is an environmental health problem, which can interfere with sleep, disrupt speech, cause psychological stress and degrade the quality of life for an impacted community. The degree of annoyance and impact varies among individuals and by the type of noise. Mobile sources of nuisance noise in the Damascus Study Area include traffic-generated noise along major roadways. General motor vehicle traffic volume is the most prevalent noise source due to the distribution of roads throughout the master plan area.

Noise is expressed in decibels (dB), a standard for units of sound, with an "A" weighting (dBA) to account for the sensitivity of the human ear. Noise generated over a 24-hour period is measured as L_{dn}, which is an average sound pressure level reflecting the variations in noise over time, including "dn", a weighting, or penalty, for nighttime noise. The Federal Highway Administration estimates background noise in typical urban neighborhoods to be approximately 55 L_{dn}. Humans experience increased levels of interference with sleep, speech and communication at a level greater than 55 L_{dn}.

The Noise Guidelines (M-NCPPC, June 1983) set attainable goals for all areas of the county. For the Damascus Study Area, an attainable goal of 55 to 60dBA Ldn has been selected given its low-density residential and rural character. This goal sets a maximum noise level for new residential development and noise-sensitive land uses, measured over a 24-hour period at the building line.

Noise contours of existing conditions for all major roads have been computer-generated using an approved Federal Highway Administration model (see Figure 12). The noise model does have limitations, as it does not account for the influence of existing noise barriers and natural land features, which act to reduce noise. The noise contours generated do not provide the level of accuracy needed to determine site-specific noise impacts.

A noise contour map can be used to identify where existing houses and other noise sensitive uses are currently impacted by excessive noise. The contours also identify vacant or redevelopable properties that may be affected should they develop or redevelop in the future. The master plan should use this information to:

- identify noise compatible land uses, e.g. (industrial/commercial) in areas impacted by excessive noise;
- recommend site design criteria to minimize noise impacts; and
- recommend noise compatible uses for existing structures in noise affected areas.

Water Supply and Sewerage Systems

The community water supply and sewerage systems in the Damascus Study Area are operated and maintained by the Washington Suburban Sanitary Commission (WSSC). The community service mains and other facilities were incrementally extended into this master plan area to serve the growth areas identified in the master plan under the policies of the *Comprehensive Water and Sewer Plan*. *Water and Sewer Plan* policies generally provide for community service to property zoned for one-half acre lots or more dense development, and for clustered lots in the one and two units per acre zones. The *Water and Sewer Plan* also allows for the provision of community water service to areas zoned for one- to two-acre lots, and to clustered lots with a one unit per five-acre density. Although the 1980 master plan predates this *Water and Sewer Plan* water service policy, the County Council has acknowledged its appropriate application in this master plan area.

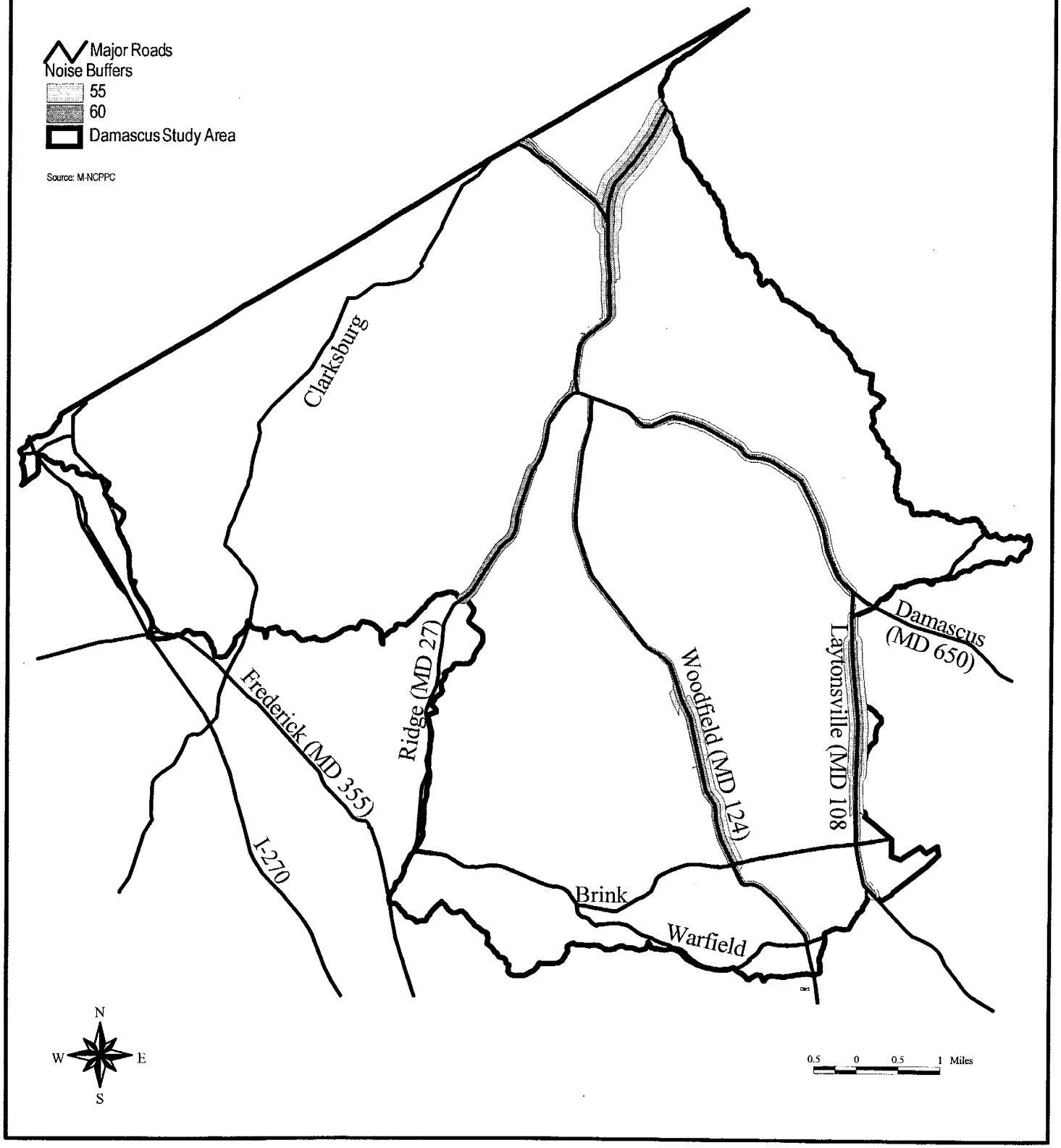
Service Areas

The current water and sewer envelopes are shown in Figures 13 and 14[4]. Community water and sewer are generally available to areas zoned for high and moderate density development and to the commercial center. In the Damascus Study Area, this corresponds almost exactly to the entirety of the Magruder Branch subwatershed. Most of the study area therefore, is outside the current and planned expansion area for the water and sewer envelope. Exceptions do exist however, such as Hyattstown and portions of the study area to the south and southwest near Germantown and Clarksburg.

[4] In Figure 14, a portion of Little Bennett Regional Park is shown as "service planned" because it is in category S-3, service planned within two years. The S-3 was for a multi-use sewerage system for the park's golf course, and shouldn't be interpreted as approval for public service.

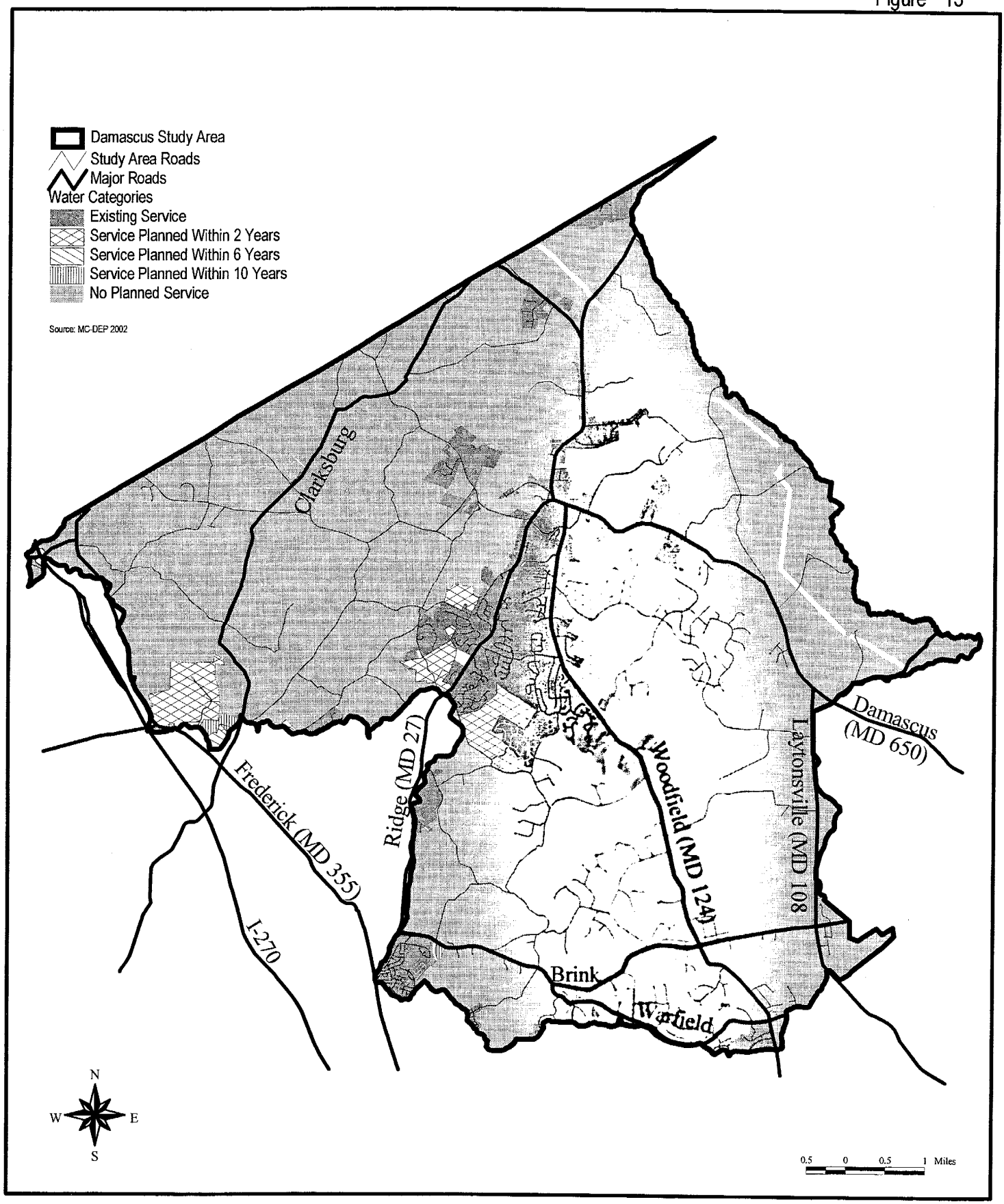
Noise

Figure 12



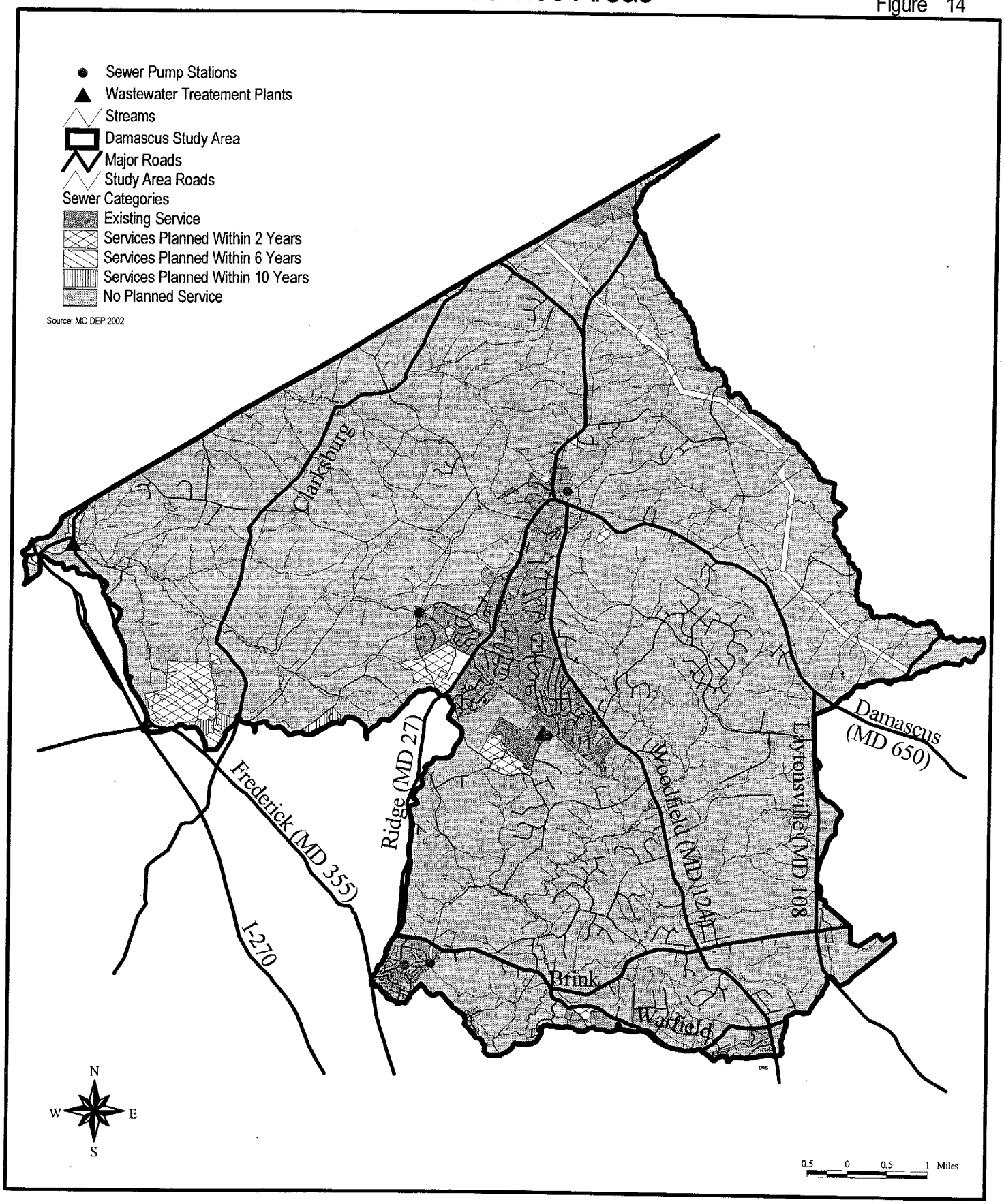
Water Service Areas

Figure 13



Sewer Service Areas

Figure 14



Properties located outside the existing/planned community water and sewer service envelopes may be served by individual, on-site wells and septic systems. MCDPS regulates and permits these on-site systems.

Water Service

For areas receiving community water service, except for Rattlewood Golf Course which is served by the Mill Bottom community system of Frederick County, WSSC provides water primarily from the Potomac Water Treatment Plant. In addition to those high- and moderate-density areas which receive community water service, the *Water and Sewer Plan* allows for the consideration of water service to areas zoned for lower-density development: RE-1, RE-2, and RC with cluster. There is currently adequate water transmission and treatment capacity for the Damascus service area.

Sewer Service

Unlike the water system, which operates under pressure, sewers in the planning area rely primarily on gravity to transmit sewage flows, thus they are located in the stream valleys and other low areas. Wastewater produced in the study area is treated in four locations. There are two Wastewater Treatment Plants (WTTP) in the study area itself. For the town of Damascus all sewage is treated at the Damascus WTTP which has a capacity of 1.5 million gallons per day (mgd) and is located in the southern portion of Magruder Branch. The effluent is then released into Magruder Branch. The other WTTP is located in the far western portion of the study area in Hyattstown where it serves the Hyattstown Historic District (50 residential and commercial buildings). The recently built plant was deemed necessary due to septic system failures and contaminated drinking water supplies (WSSC). The remaining wastewater not treated at the above facilities is treated at the Seneca WTTP except for the Rattlewood Golf Course, which is served by the Mill Bottom community sewerage system and WTTP from Frederick County.

Areas zoned R-200 and greater receive sewer service. The current master plan does not generally support the provision of community service to areas zoned for lower-density development: RE-1, RE-2, Rural, and RDT. In specific cases, the current master plan also recommends against the provision of sewer service to the RE-2C zone, even where the plan promotes the use of the cluster option.

Not all the areas approved or planned for community sewer service have access to treatment via all gravity sewerage systems; these areas are served by wastewater pumping stations, force mains, or grinder pumps. There are six sewage pump stations in the study area: Damascus Shopping Center, Damascus Wastewater Treatment Plant, Freedom Hill, Kings Bridge, Spring Garden Estates, and Wexford. The Damascus Wastewater Treatment Plant serves only the Damascus WTTP. It should also be noted that the study area includes properties that are within the Seneca WTTP service area and that the Freedom Hill and Wexford pump stations serve this system and not Damascus.

Tributary Watersheds of Damascus and Vicinity

The Damascus Study Area includes the headwaters of Bennett Creek, Great Seneca Creek, Little Bennett Creek, and the Patuxent River[5]. It also includes a tiny fraction of the headwaters of the Hawlings River. The watershed character and stream condition of each of these streams is discussed in this section. Watershed management strategies for each stream are also covered.

The discussion of stream water quality focuses mainly on current conditions. Current conditions of each watershed are summarized from both county and state sources. Current conditions of the natural stream waters in the study area are summarized in the *County-wide Stream Protection Strategy* (CSPS) document (MCDEP, 1998). The CSPS is based on a biological monitoring program (1994-1996 data) that assesses all county

[5] In Montgomery County Bennett Creek drains 11.1 square miles (7,081 acres) and Little Bennett Creek 12.6 square miles (8,165 acres). Both are tributaries of the Monocacy River with Little Bennett Creek converging with Bennett Creek in Frederick County. The Upper Great Seneca Creek watershed drains 26.2 square miles (16,790 acres) and as part of Great Seneca Creek which flows into the Potomac River, the entire super watershed covers 74.7 square miles (47,791 acres). The Patuxent River, the largest river entirely contained within the state of Maryland, drains 909.4 square miles (582,000 acres) of land, of which 60.2 square miles (38,550 acres) lie in Montgomery County. The Hawlings River is the largest Patuxent River tributary solely within Montgomery County. However, due to its small size within the Damascus Study Area, >1 square mile (303 acres), its characteristics will not be described in the following section.

streams according to the same methodology. The CSPS ranks biological stream conditions as excellent, good, fair, or poor. The results of the CSPS monitoring have been presented in this inventory with updates added when more recent information was available.

Maryland's water quality standards are described in Maryland regulations. (COMAR § 26.08.01 General, which contains definition of terms, and COMAR § 26.08.02- Water Quality, which describes the uses, criteria and policies). Under section 303(d) of the federal Clean Water Act, the state of Maryland is required to prepare a list of all water bodies in which applicable water quality standards are not being met through the use of required controls, as set forth in the Code of Federal Regulations, 40 C.F.R. 130.7(b)(1)(i, iii). Also, under section 305(b) of the Clean Water Act the state is required to prepare a water quality report that includes an inventory of Maryland's waters and an update on the progress made toward meeting the goals of the federal Clean Water Act. The Maryland 305(b) report identifies water pollution problems and sources, describes water quality control programs, and highlights special state concerns. The 303(d) list and 305(b) report are updated and submitted to the US Environmental Protection Agency (EPA) every two years. Current and recent information pertinent to the study area watersheds from these reports is summarized in this inventory.

Watershed management strategies are also summarized from both county and state sources. Based on the assessments and projections of potential development (with existing zoning), the CSPS assigns a management category for each subwatershed in the study area, and identifies a set of management tools to address the stream conditions and anticipated levels of development. The management categories and tools provide a basis for prioritizing resources to address stream quality problems using a focused, watershed approach. The Appendix in this report contains a detailed description of the management categories from the CSPS.

The Maryland Clean Water Action Plan identifies several watersheds in Montgomery County that need restoration and deserve priority consideration. The Maryland Unified Watershed Assessment (UWA) under the 1998 Clean Water Action Plan (see Chapter 2 of this report) categorizes watersheds based upon consideration of components of the watershed related to aquatic systems including; biological, physical, and chemical characteristics, and related landscape factors. Category 1 watersheds are those found to not meet clean water and other natural resource goals, and to therefore be in need of restoration.

Watersheds may also be designated as watershed restoration priorities under the Maryland Clean Water Action Plan. The schedule of restoration and protection actions must be coordinated with the state's schedule to determine Total Maximum Daily Loads (TMDLs) for pollutants from watersheds. There are no as yet approved or proposed TMDLs for any of the water bodies occurring in the Damascus Study Area.

An important policy related to water quality is the provision of community sewer service. Providing community sewer service to relieve failed septic systems minimizes groundwater contamination. However, the provision of community sewer service can damage the environment by impairing water resources. Extensions along stream valleys can create habitat disturbance, forest fragmentation, corridor creation for invasive exotic plant species entry- threatening native species survival, and general disruption to the natural hydrologic systems. Once sewer lines are in place, their structural integrity may deteriorate over time, resulting in sewerage leaks and further ecosystem disturbance. This is particularly troublesome where eroding or shifting stream channels expose sewer mains and manholes, leaving them more susceptible to damage.

Little Bennett Creek

Watershed Character

Little Bennett Creek is located in the northwestern part of the study area where it flows southwesterly into Frederick County and converges with Bennett Creek which ultimately drains into the Monocacy River. Agricultural land uses, interspersed with large remaining tracts of forest, dominate this drainage area. Most of the Little Bennett Creek basin is protected by parkland, and above Route 355 it supports cold-water trout streams. Stream conditions have been affected by past agricultural land use and there is continuing evidence of this in the form of bank instability and some sedimentation. In general, conditions are better where forested stream buffers were left in place, while stream conditions have

Although Little Bennett Creek is a high quality cold-water stream, habitat and flow problems presently limit its ability to improve as a coldwater fishery. Channelization of some of the lower reaches within the I-270 median is an example of factors affecting specific subwatersheds (see Figure 15). The hydrology of Little Bennett Creek is also affected by the fracture formation in the watershed's underlying geology. Rock outcroppings are common along the hillsides and the shallow soils underlain by bedrock makes the streams prone to flash flooding, with streams having naturally low baseline flow at times, that rises and peaks rapidly following runoff-producing rain (MCCSPS, 1998).

Stream Conditions

The CSPS divides Little Bennett Creek in Montgomery County into 14 subwatersheds (13 are partially or completely located within the study area). All the subwatersheds with the exception of I-270 Tributary and Little Bennett South are designated as Watershed Preservation Areas. These subwatersheds are placed in this category due to their good to high stream quality, and the existence of extensive parkland, which functions to preserve watershed conditions. In addition to the large area already preserved in parkland, efforts both are planned and underway to improve the preservation of these resources (MCCSPS, 1998).

According to the CSPS, the stream condition in Little Bennett Creek ranges from fair to excellent. Stream conditions were evaluated for nine out of 13 subwatersheds. Data are not available for the Lower Main I-270 subwatershed. The I-270 subwatershed is the only subwatershed in fair condition, the water quality problems stemming from channelization in the median, and runoff from, I-270. Most of the remaining subwatersheds show good conditions with four subwatersheds in excellent condition. Areas of channel widening and/or incision, sedimentation, and fish blockages are identified as primary factors affecting stream condition in this watershed. This said, it should be noted that improvements are being made, as in the removal, and replacement by bridges, of the culverts on the road crossings over Soper's Branch and Dark Branch.

The DEP 2000 Annual NPDES Report indicates that the condition of Little Bennett Creek is generally similar to that reported in the 1998 CSPS document. The cause of impairment in this watershed continues to appear to be from habitat stressors. Benthic macroinvertebrate scores were predominantly good, with one fair station and two excellent stations. The scores for fish were predominantly good, with several excellent stations. Habitat was assessed as predominantly good, with one excellent station for benthic macroinvertebrate habitat, and good for all monitored fish habitat.

The 1996 Maryland 305(b) report does not mention Little Bennett Creek. Likewise, Little Bennett Creek is not listed in the Draft 2002 303(d) List. However, the entire Lower Monocacy River watershed, of which Little Bennett Creek is a part, is listed by the state for fecal coliform of unknown source, and is assigned a medium priority for this pollutant. Further work will be necessary to determine the source and if a TMDL will be needed.

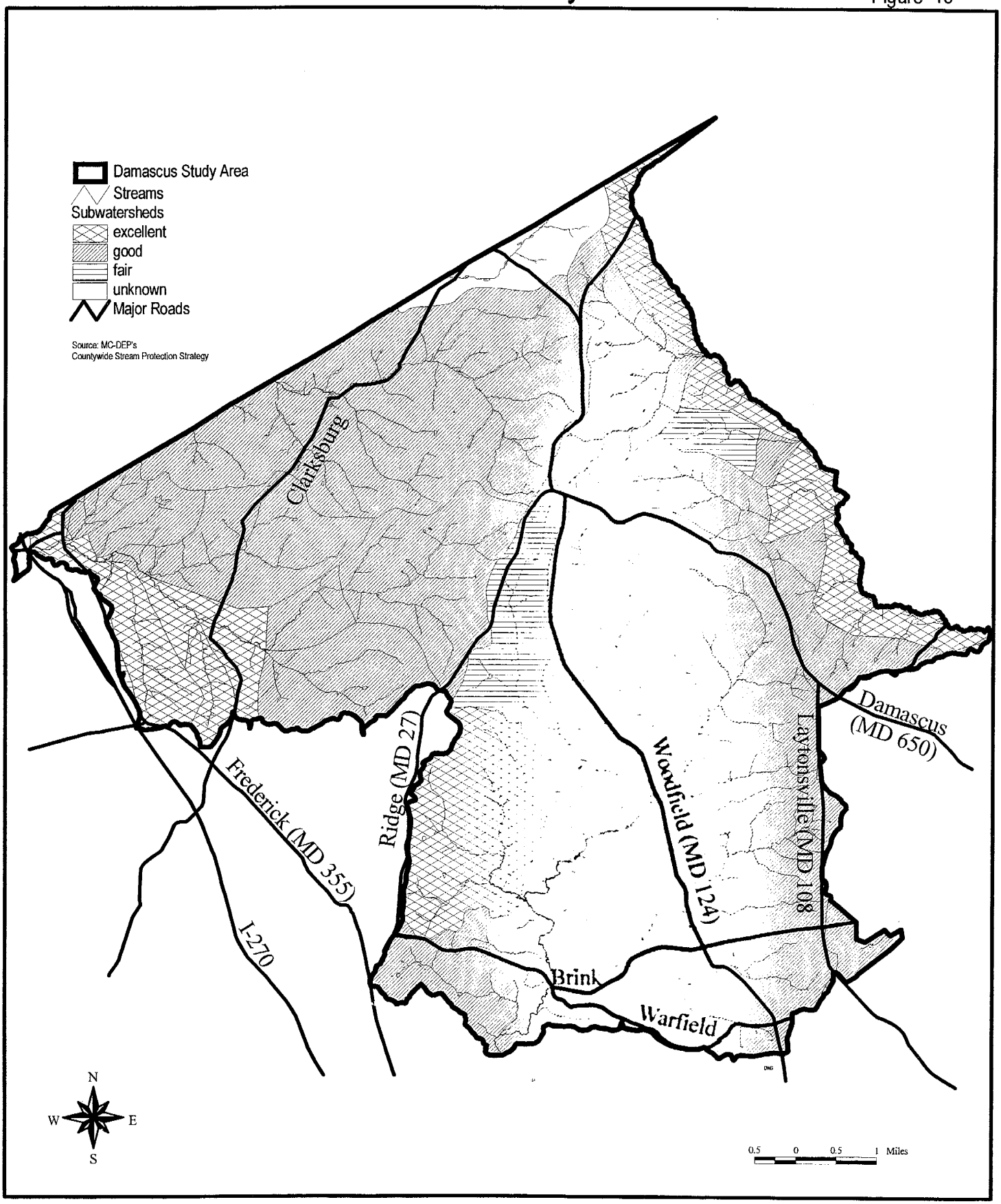
Watershed Management

The Maryland Clean Water Action Plan identifies the Lower Monocacy River, which contains both the Little Bennett Creek and Bennett Creek watersheds, (see Figure 2), as needing restoration and deserving priority consideration. The watershed, a Category 1 Priority (Restoration) Watershed of the Maryland Unified Watershed Assessment (UWA), does not to meet clean water and other natural resource goals, and is in need of restoration. The priority designation indicates an additional recommendation for restoration actions should be undertaken during the next two years. The Lower Monocacy River is also listed as a Selected Category 3 (Preservation) watershed that has at least some stream in pristine or high quality condition. Thus, though the watershed shows signs of stress and degradation, it nevertheless contains pristine or sensitive habitat resources.

I-270 Tributary is listed as a Watershed Restoration Area and Little Bennett South is indicated as an Agricultural Watershed Management Area. The primary land uses in these areas are agriculture and fallow land with occasional large lot residential. Imperviousness is not expected to increase significantly, and with the use of appropriate Best Management Practices (BMPs) on actively farmed areas, streams should remain in good condition. Standard environmental guidelines and

Water Quality

Figure 15



regulations are expected to adequately protect stream resources from limited areas of residential development. Increasing the length of forested stream buffer where feasible will also help to preserve or improve stream quality and overall health (MCCSPS, 1998).

Bennett Creek

Watershed Character

As with Little Bennett Creek, Bennett Creek is located in the northwestern part of the study area where it flows southwesterly into Frederick County, is met by Little Bennett Creek, and drains into the Monocacy River. Agricultural land uses interspersed with large remaining tracts of forest dominate the watershed. Stream conditions have been affected by past agricultural land use and there is continuing evidence of this in the form of bank instability and some sedimentation. In general, conditions are better where forested stream buffers were left in place, while stream conditions have improved where land has been farmed with modern best management practices (MCCSPS, 1998).

Although Bennett Creek has less overall forest cover than Little Bennett Creek and has a larger actively farmed area, it still supports a cold-water fish community. The Bennett Creek watershed is mainly zoned as an agricultural preserve; agriculture being the preferred land use with residential development occurring on large lots (generally more than 25 acres). Bennett Creek's headwaters are influenced by imperviousness and other runoff impacts from the town center of Damascus at the head of the drainage basin (MCCSPS, 1998).

Stream Condition

According to the CSPS, Bennett Creek, with the exception of the substantial northern tributary of Fahrney Branch (no data), shows good stream biological and habitat conditions. Reconnaissance of the upper Bennett Creek watershed revealed areas of deeply entrenched channels in the headwaters. This is identified as a primary factor affecting stream condition in this watershed (MCCSPS, 1998).

According to DEP's 2000 Annual NPDES Report, the condition of Bennett Creek is generally similar to the good condition reported in the CSPS document. The cause of impairment in this watershed continues to appear to be from habitat stressors. Benthic macroinvertebrate scores were mostly good to excellent. The scores for fish were predominantly good. Habitat was assessed as good for both benthic macroinvertebrate and fish habitat.

The 1996 305(b) report indicated an impacted biological community at a site on Bennett Creek. The Draft 2002 Maryland 303(d) List cites Bennett Creek as biologically impaired. The cause is cited as unknown, and the watershed is given a low priority. The location of the monitoring station is actually in Frederick County, about 4 miles downstream from Montgomery County. Thus, it is not known to what degree Bennett Creek in Montgomery County is contributing to this condition. Current state procedure is to list the entire subwatershed in case of an impairment. Future work will be necessary to determine the cause, and if a TMDL will be required to address the problem. In addition, the entire Lower Monacacy River watershed, of which Bennett Creek is a tributary, is listed in the Draft 2002 303(d) document for fecal coliform of unknown source, and is assigned a medium priority for this pollutant. Further work will be necessary to determine the source and if a TMDL will be needed.

Watershed Management

The Bennett Creek subwatersheds are designated in the CSPS as Agricultural Watershed Management Areas. The primary land uses in these areas are agriculture and fallow land with occasional large lot residential uses. Imperviousness is not expected to increase significantly, and with the use of appropriate BMPs on actively farmed areas, streams should remain in good condition. Standard environmental guidelines and regulations are expected to adequately protect stream resources from limited areas of residential development. Increasing the length and/or width of forested stream buffer where feasible will also help to preserve or improve stream quality and overall health (MCCSPS, 1998).

Patuxent River

Watershed Character

The Patuxent River originates just north of the Montgomery County-Frederick County-Howard County border (see Figure 2). As such, just downstream of its source, the Patuxent River forms the entire boundary

between Montgomery and Howard Counties. The Upper Patuxent watershed includes approximately 47 miles of stream that drain 11 square miles (6,816 acres) of land upstream of the Triadelphia reservoir. The upper Patuxent is designated by the state as a Use III-P stream. The Damascus Study Area covers approximately the upper third of this drainage area, from the beginning of the river to the just north of Hipsley Mill Road. Hence, this water is a major component of our potable water system. The watershed includes large forested areas, particularly along the mainstem of the Patuxent River, along with agricultural cropland, pasture, and large-lot rural residential development. Forest and agricultural land predominate in this watershed, with imperviousness in all subwatersheds below 10 percent (MCCSPS, 1998) (see Figure 5).

A naturally reproducing *S. trutta* (brown trout) population occurs in the stream above Annapolis Rock Road (Route 94). To protect this resource, the upper Patuxent above Georgia Avenue (Route 97) has been designated a special trout management area (catch and release stream) by the Maryland Department of Natural Resources. The *S. trutta* population is part of a generally high quality coldwater fish community found throughout this watershed. Extensive forested areas in the Patuxent River State Park surround the river for much of its length. 1579 acres of the state park have been designated as Maryland Wildlands (750 acres in Montgomery County). The mature floodplain and upland forests support a rich wildlife community with some of the best forest interior breeding bird habitat remaining in the county. The streams in the Patuxent watershed are among the best remaining in the county and many serve as reference streams for the county's stream monitoring program (MCCSPS, 1998).

There has been some concern about accelerated rates of sedimentation, elevated nutrient levels, and depressed dissolved oxygen concentrations being observed at Triadelphia Reservoir, and further downstream at the Rocky Gorge Reservoir. These two reservoirs have a total capacity of over 11 billion gallons of drinking water for suburban Montgomery County and Prince George's County, and to a limited extent, Howard County (MCCSPS, 1998).

Triadelphia Reservoir

The Triadelphia Reservoir is an 800-acre water supply/storage reservoir on the upper Patuxent River, located downstream from the Damascus Study Area. The reservoir is owned by WSSC and water is released from Triadelphia to meet demands on the Rocky Gorge Reservoir, located downstream on the Patuxent River. Using a trophic classification scheme and data from samples collected as part of the statewide lake assessment program in 1991, Triadelphia reservoir was classified as a mesotrophic lake, meaning it has a moderate amount of dissolved nutrients. Over the years, the reservoir has experienced water quality problems due to sediment and nutrient enrichment from agricultural runoff and increased urban development in the watershed. For more information on the Triadelphia reservoir see the "Environmental Resources Inventory for Olney and Vicinity" (M-NCPPC, 2002).

Stream Condition

The CSPS divides the upper part of the Upper Patuxent River watershed into 10 subwatersheds. According to the CSPS, the stream conditions in the portion of the Upper Patuxent within the study area range from fair to excellent, with mainstem segments generally rated excellent and tributaries generally rated good (see Figure 15). The Mid Upper Main A, Lower Scotts Branch, Upper Main C, Upper Main B, and Upper Main A subwatersheds are designated as Watershed Protection Areas. These subwatersheds have excellent resource conditions and are located almost entirely within the Patuxent River State Park. The protection provided by the park is expected to continue to preserve the excellent conditions in these stream reaches. Improvement of riparian conditions, especially extending the forested buffer, and BMPs in the upper sections of these subwatersheds will further ensure that the lower reaches remain in excellent condition (MCCSPS, 1998).

The remaining subwatersheds in the Upper Patuxent are designated as Agricultural Watershed Management Areas. The primarily agricultural character of these upper stream reaches is not expected to change significantly, due to current zoning which promotes agricultural uses (MCCSPS, 1998).

The portion of the Upper Patuxent watershed within the study area supports a generally high-quality coldwater fish community, although sculpin, which are usually found in these communities, are absent. Although adequate habitat and water quality exist in the Upper Patuxent to support sculpin, their absence is probably due to the isolation of the stream from the rest of the watershed

caused by the presence of the Triadelphia reservoir. The mainstem upstream from Annapolis Rock Road (MD 94) supports a naturally reproducing trout population. Most of the excellent subwatersheds are within the Patuxent River State Park and are heavily forested. Upper Izaac Walton subwatershed exhibits impacts to the riparian zone and floodplain, and is in fair condition (MCCSPS, 1998).

In 2001, DEP prepared a watershed study for the Upper Patuxent River using more recent data. This study indicates that the watershed is in overall good condition. The scores for fish generally ranged from fair to good, with one excellent station. Most of the benthic macroinvertebrate rapid habitat assessment scores were in the excellent range, with a few in the good range. Rapid habitat assessment parameters were within the good to excellent range, and overall, do not show any degradation that would affect the biological community. A quantitative habitat analysis revealed a station in the Upper Main A subwatershed that exhibits entrenchment of the stream channel and a station in the Lower Izaac Walton subwatershed that exhibits moderate entrenchment. This entrenchment is resulting in sedimentation which in turn is having negative effects on the fish community. A station in the Mid Upper Main A subwatershed shows slight entrenchment that is apparently not causing degradation to the fish community. A fish blockage was noted in the Lower Izaac Walton subwatershed. All sites had adequate streambed particle class size and diversity to sustain a healthy macroinvertebrate population (MCDEP, 2001).

The 1996 305(b) report indicated that water quality in this segment is generally good. However, it notes that some high nitrate, total nitrogen, and elevated phosphorus, bacteria and temperature levels were observed at a monitoring station above the Triadelphia Reservoir in the study area. These higher levels were presumably due to agricultural runoff. The 2000 305(b) report indicated that data from the sampling stations upstream of the reservoir do not show any water quality impairment. However, based on biological sampling data, the state's Biological Criteria Advisory Committee identifies these watershed segments as potentially impaired.

The 1996 305(b) report stated that the Triadelphia Reservoir experienced water quality problems due to moderate nutrient enrichment from agricultural runoff and increasing urban development in the watershed. The 1998 and 2000 305(b) reports list the reservoir as only partially supporting aquatic life uses as a result of low oxygen levels in the deeper portion of the lake. These hypoxic conditions are the result of natural stratification, which restricts circulation of oxygen to deeper portions of the lake, worsened by eutrophication from non-point source runoff.

The Draft 2002 303(d) list does not cite any of the Upper Patuxent tributaries in the study area. However, the report lists the entire upper Patuxent River draining to the Triadelphia Reservoir for metals, nutrients, and sediment. The source for the metals is cited as atmospheric deposition and is assigned a high priority. The source for the nutrients and sediment is given as due to non-point sources and both are assigned a medium priority. Further analysis will be required for any TMDL determinations for the Upper Patuxent.

Watershed Management

The Maryland Clean Water Action Plan identifies the Lower Brighton Dam watershed (roughly equivalent to the CSPS Upper Patuxent watershed), which contains the Upper Patuxent River, (see Figure 2), as needing restoration and deserving priority consideration. The watershed is a Category 1 Priority (Restoration) Watershed of the Maryland Unified Watershed Assessment (UWA) being found not to meet clean water and other natural resource goals, and being in need of restoration. The priority designation indicates an additional recommendation for restoration actions during the next two years. The Upper Patuxent River is also listed as a Selected Category 3 (Preservation) watershed that has at least some stream in pristine or high quality condition. Thus, the watershed shows signs of stress and degradation but still contains pristine or sensitive habitat resources.

Patuxent Primary Management Area (PMA)

The Patuxent Primary Management Area (PMA) in Montgomery County is a water quality protection and restoration area, providing a stream buffer and transition zone, where land use activities, which go through the county regulatory review process, are managed to protect and enhance water quality in the Patuxent River and its tributaries. The application of the PMA and associated water resource protection measures are implemented through the "Environmental Guidelines" by the Montgomery County Planning Board. The PMA consists of a 1320 foot buffer along the mainstem of the Patuxent

and Hawlings Rivers as well as 660 foot buffers along all tributaries flowing into both of these rivers. Approximately 5,098 acres of land within the Patuxent River and Hawlings River watersheds fall within the PMA in the Damascus Study Area (see Figure 16). The recommended land uses and related activities within the PMA are managed through a series of specially designed programs directed to promote water quality and improve overall stream condition by reducing non-point source pollution, providing Best Management Practices (BMPs), preserving agricultural land, and protecting and re-establishing forest cover. The ultimate goal for the PMA is to maintain low-density, low intensity land uses in the stream valleys of the Patuxent River and its tributaries, and to actively establish a minimum 50-foot forested buffer immediately adjacent to all streams. Implementation of recommendations for the PMA is voluntary on lands not seeking subdivision or site design approval. Education and outreach efforts to increase the use of the most current BMPs, and particularly forested buffers, are currently being pursued as part of the Patuxent Reservoir Protection Strategy effort.

Interagency Watershed Management Activities

The Patuxent Reservoirs Watershed Protection Group (PRWPG) is an interagency group..consisting of representatives from M-NCPPC, DEP, MDE, DNR, ...The PRWPG Agreement signed in 1996 committed the signatories to cooperate to protect the biological, physical, and chemical integrity of the aquatic and terrestrial watershed resources. The Comprehensive Management Planning Study for the Patuxent Reservoir Watershed (TetraTech, 1997) identified six priority resources for protection: reservoirs, terrestrial habitat, stream system quality, aquatic biota, rural character and landscape, and public awareness and stewardship. Elements of the year 2003 work program which affect the Upper Patuxent include reservoir water chemistry monitoring, completion of the reservoir's water quality model and participating in TMDL development using the model, enhancing the implementation of local cost-share agricultural best management practices, and continuing public outreach and involvement initiatives.

Great Seneca Creek

Watershed Character

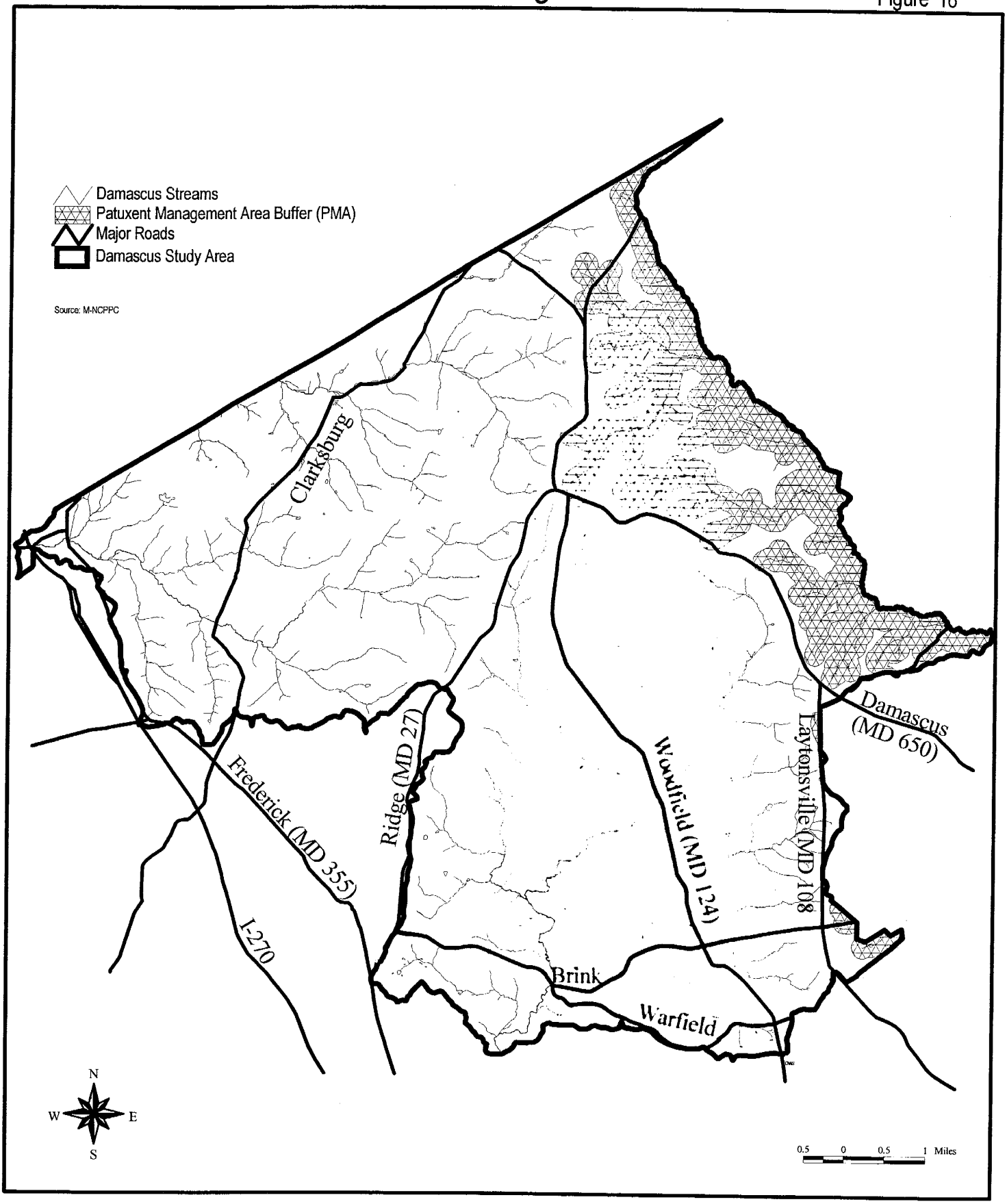
Great Seneca Creek is the largest drainage basin located entirely within Montgomery County and is divided into three watersheds: the Upper Great Seneca, the Middle Great Seneca, and the Lower Great Seneca. Great Seneca Creek originates southeast of the Damascus town center and flows south through Germantown and Gaithersburg, entering the Potomac River near the town of Seneca. In addition, the large tributary systems of Little Seneca Creek and Dry Seneca Creek also flow into Great Seneca Creek. Great Seneca Creek contains almost every species of freshwater fish found in Montgomery County, ranging from smallmouth bass found in the lower sections, redbreast sunfish and central stonerollers throughout the middle section, and coldwater fish communities in portions of the upper reaches (MCCSPS, 1998).

The Damascus Study Area includes all the subwatersheds of the Upper Great Seneca watershed and a small portion of the Middle Great Seneca watershed (see Figure 15). Great Seneca Creek originates south of the First Baptist Church off Damascus Road (MD108) and flows through low density residential and agriculture areas. Magruder Branch, a major tributary of Great Seneca Creek, begins just south of the intersection of Main Street (MD 108) and Ridge Road (MD 27) in downtown Damascus and flows through county parkland (abutted by commercial and then low and medium density residential areas) before flowing into Great Seneca Creek downstream of Woodfield Road (MD 124). The Damascus Wastewater Treatment Plant (WWTP) is located in the Magruder Branch subwatershed (MCCSPS, 1998).

Great Seneca Creek continues southwest of Laytonsville and rapidly increases in size as it picks up additional flow from Wildcat Branch, Goshen Branch and other tributaries. Wildcat Branch, a naturally reproducing brown trout stream, and Goshen Branch join Great Seneca above Brink Road. Great Seneca Creek then flows through the Montgomery Village area, where landuse densities increase considerably. Many of these areas were built before modern stormwater runoff controls were required by the state and, consequently the quality of the stream channel has declined (MCCSPS, 1998).

Patuxent Management Area

Figure 16



Stream Condition

The "Countywide Stream Protection Strategy" lists three of the four tributaries to Upper Great Seneca Creek (the Upper Great Seneca, Goshen Branch and Wildcat Branch subwatersheds), as being in good or excellent biological stream condition. Habitat conditions are generally good, with Goshen Branch listed as showing fair habitat conditions. The Upper Great Seneca Creek subwatershed continues to support good resource conditions, although sparse riparian buffer and sediment deposition in pools and riffles below Hawkins Creamery Road, affect stream conditions. The Magruder Branch subwatershed, however, is shown as being in fair biological stream condition. Higher imperviousness levels and sedimentation are given as primary factors affecting stream condition in Magruder Branch (MCCSPS, 1998).

To the south, Goshen Branch still supports good biological conditions although it has undergone considerable development activity as part of the growth of Montgomery Village. In Goshen Branch, extreme downcutting of the channel has occurred along with major areas of sediment deposition in the pools and runs. The upper reaches of the Goshen Branch subwatershed are in transition from largely agricultural to residential uses. Additionally, large agricultural tracts still exist east of Route 124, where several small tributaries flow through agricultural fields with no stream buffers. Development of RE-2 zoned areas, generally exempt from stormwater runoff controls due to lot size, is also impacting Goshen Branch (MCCSPS, 1998).

Biological condition in Wildcat Branch is rated as excellent and the subwatershed supports the only cold-water fish community currently found in Great Seneca. However, some tributaries of Wildcat Branch experience severe bank erosion and sediment deposition. Low-density land uses predominate around Wildcat Branch, although several areas adjacent to Route 27 are now being developed as higher density areas (MCDEP, 1998).

The portion of the Middle Great Seneca watershed that occurs in the Damascus Study Area is listed as having a good biological stream condition. Habitat condition is also good, with good riparian stream buffer in general (MCCSPS, 1998).

In 1999, DEP prepared a more in-depth analysis for Great Seneca Creek. This watershed study gave the same stream biological condition ratings to the subwatersheds in the study area except for Magruder Branch and Middle Great Seneca. Magruder Branch received a rating of poor, and Middle Great Seneca received a rating of fair. The overall habitat rating within the monitored reaches was in the good range, indicating that habitat conditions alone are unlikely to be causing the observed impaired biological community. Likely causes of impairment include altered stormwater and baseflow patterns and/or illicit discharges (MCCSPS, 1998).

The 1996 305(b) Report indicates that water quality in the Great Seneca Creek watershed as a whole is generally good. The 2002 303(d) List indicates that Magruder Branch shows biological impairment of unknown cause, and is assigned a low priority. Further work will be necessary to determine the source of the impairment, and if a TMDL will be needed to address it.

Watershed Management

The Maryland Clean Water Action Plan identifies the entire Great Seneca Creek, (see Figure 2), as needing restoration and deserving priority consideration. The watershed is a Category 1 Priority (Restoration) Watershed of the Maryland Unified Watershed Assessment (UWA), being found not to meet clean water and other natural resource goals, and being in need of restoration. The priority designation indicates an additional recommendation for restoration actions during the next two years. Great Seneca Creek is also listed as a Selected Category 3 Watershed (Preservation) that has at least some stream in pristine or high quality condition. Thus, here again, the watershed shows signs of stress and degradation but still maintains pristine or sensitive habitat resources.

The CSPS designates Upper Great Seneca, Wildcat Branch, and Goshen Branch subwatersheds as Watershed Protection Areas, at the regular level, special level, and remedial level, respectively. Magruder Branch is designated as a Watershed Restoration Area (see Figure 15). The portion of Middle Great Seneca watershed within the study area is also designated as a Watershed Protection Area (regular level). Restoration areas are primarily in densely developed regions, while protection areas are mostly rural or low density in character. Increasing the length and/or width of forested stream buffers where feasible in all these subwatersheds will help to preserve or improve stream quality and overall health (MCCSPS, 1998).

Upper Great Seneca subwatershed is designated to receive a regular level of protection through the application of existing environmental guidelines and regulations. A key strategy to achieve this will be the use of educational initiatives and voluntary implementation, to increase forested stream buffer coverage. The current environmental guidelines and regulations will be enough to provide adequate stream protection despite the fairly rapid development of the area with generally 2 acre and greater lot sizes, because the subwatershed contains forested hills with few actively farmed areas. (MCCSPS, 1998).

Wildcat Branch, as part of the Clarksburg Special Protection Area (SPA), has a special level of protection to ensure that existing high stream quality conditions remain even as predominantly rural, agricultural lands are developed. The increase in development pressures in the areas surrounding Clarksburg, redevelopment along the MD 27 corridor, and special exception uses within the agricultural reserve, all have the potential for adverse impact to this stream system. Strategies include the encouragement of continued voluntary implementation of best management practices on agricultural lands, environmental education, and identifying and pursuing opportunities for voluntary establishment of riparian buffers, wetland protection, and impervious area reduction on private lands (MCCSPS, 1998).

Goshen Branch is in need of remedial habitat improvements to address areas of instability and past degradation. Strategies to achieve this include public education and outreach to sensitize landowners regarding the importance of stream valley buffers and an increase in forested buffer area through educational incentives and voluntary implementation (MCCSPS, 1998).

The CSPS recommends a comprehensive approach to overall restoration of Magruder Branch due to impacts from older developed areas and high density uses associated with the growth of Damascus. A key component of this approach will be the utilization of all available opportunities to retrofit controls in older developments and higher density areas (MCCSPS, 1998).

As with the Upper Great Seneca subwatershed, for the Middle Great Seneca subwatershed, the CSPS recommends the continued application of current environmental guidelines and regulations, and other regular protection tools (MCCSPS, 1998).